California Environmental Protection Agency

Office of Environmental Health Hazard Assessment

Synthetic Turf Study

Synthetic Turf
Scientific Advisory Panel Meeting

May 31, 2019

MEETING MATERIALS

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Agenda

Synthetic Turf Scientific Advisory Panel Meeting

May 31, 2019, 9:30 a.m. – 4:00 p.m.
1001 I Street, CalEPA Headquarters Building, Sacramento
Byron Sher Auditorium

The agenda for this meeting is given below. The order of items on the agenda is provided for general reference only. The order in which items are taken up by the Panel is subject to change.

1. Welcome and Opening Remarks

2. Synthetic Turf and Playground Studies Overview

4. Synthetic Turf Field Exposure Model
    - Exposure Equations
    - Exposure Parameters

3. Non-Targeted Chemical Analysis
    - Volatile Organics on Synthetic Turf Fields
    - Non-Polar Organics Constituents in Crumb Rubber
    - Polar Organic Constituents in Crumb Rubber

5. Public Comments:
   For members of the public attending in-person: Comments will be limited to three minutes per commenter. For members of the public attending via the internet: Comments may be sent via email to SyntheticTurf@oehha.ca.gov. Email comments will be read aloud, up to three minutes each, by staff of OEHHA during the public comment period, as time allows.

6. Further Panel Discussion and Closing Remarks

7. Wrap Up and Adjournment

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List of Acronyms

A – inhalation absorption factor

ABS – fraction of a chemical absorbed across skin

AF_{hand} – adherence factor of crumb rubber for the hand

AF_i – adherence factor of crumb rubber for a body part

$AF_{weighted}$ – weighted adherence factor of crumb rubber for exposed skin

ASF – age sensitivity factor for carcinogenic health effects

AT – averaging time

BW – bodyweight

C_{air} – total concentration of a chemical in air

$C_{air\text{-}adj}$ – adjusted concentration of a chemical in air for a partial day exposure

$C_{annual\ average}$ – annual average concentration of a chemical in air

$C_{crumb\ rubber}$ – bioaccessible concentration of a chemical from crumb rubber

CF - conversion factor

C_{gas} – concentration of a chemical in the gas or vapor phase

Chronic Inhalation REL – chronic inhalation reference exposure level of a chemical

Chronic Oral REL – chronic oral reference exposure level of a chemical

$C_{particles}$ – concentration of a chemical in the inhalable size fraction of the particulate phase

CPF_{inh} - inhalation cancer potency factor

CPF_{oral} – oral cancer potency factor

DL – daily dermal skin load of particles

$Dose_{C\text{-}ing}$ – for cancer (C) assessment, exposure dose of a chemical through ingestion

$Dose_{inh}$ – exposure dose of a chemical through inhalation

$Dose_{NC\text{-}der}$ – for non-cancer (NC) assessment, exposure dose of a chemical from dermal absorption

$Dose_{NC\text{-}ing}$ – for non-cancer (NC) assessment, exposure dose of a chemical from ingestion

ED – exposure duration

EF – exposure frequency

EL – exertion level

ESI – electrospray ionization

ET – exposure time

EV – event frequency

$FTSA_i$ – fraction of the total body surface area for a specified body part

GC/MS – gas chromatography/mass spectrometry

GI – gastrointestinal

GRAF – gastrointestinal relative absorption factor

$HI_{exposure\ pathway}$ – hazard index of a specific exposure pathway

HI_{field} – hazard index for a field

HQ – hazard quotient

HQ_{der} – chronic hazard quotient of a chemical through dermal absorption

HQ_{ing} – chronic hazard quotient of a chemical through ingestion

HQ_{inh} – chronic hazard quotient of a chemical through inhalation

HRAM – high resolution accurate mass/HTM – hand-to-mouth

HTOTM – hand-to-object-to-mouth

Ing/BW – ingestion rate normalized to bodyweight via all the direct and indirect ingestion pathways

Ing/BW_{direct} – ingestion rate normalized to bodyweight via all the direct ingestion pathways

Ing/BW_{HTM} – ingestion rate normalized to bodyweight for direct HTM activity

Ing/BW_{HTOTM} – ingestion rate normalized to bodyweight for HTOTM activity

Ing/BW_{OTM} – ingestion rate normalized to bodyweight for OTM activity

IR/BW – inhalation rate normalized to bodyweight

IRIS – Integrated Risk Information System

IUR – inhalation unit risk factor

LBNL – Lawrence Berkeley National Lab

LC/MS – liquid chromatography/mass spectrometry

OEHHA – Office of Environmental Health Hazard Assessment

OTM – object-to-mouth

PAH – polycyclic aromatic hydrocarbon

pRfC – provisional reference concentration

QB3 - California Institute for Quantitative Biosciences

RfC – reference concentration

$Risk_{der}$ – cancer risk of a chemical through dermal absorption for an age group or lifestage

$Risk_{der\text{-}lifetime}$ – lifetime cancer risk of a chemical from dermal absorption

$Risk_{ing}$ – cancer risk of a chemical through ingestion for an age group

$Risk_{ing\text{-}lifetime}$ – lifetime cancer risk of a chemical from ingestion

$Risk_{inh}$ – inhalation cancer risk of a chemical for an age group

$Risk_{inh\text{-}lifetime}$ – lifetime cancer risk of a chemical from inhalation exposure

SA_{BW} – exposed skin surface area normalized to bodyweight

SA_D – surface area of the part of the hand in direct contact with the mouth

SA_I – surface area of the part of the hand in contact with object reaching the mouth

SA_{obj} – surface area of the part of the object reaching the mouth

SA_{total} – total body skin surface area

SAP – Scientific Advisory Panel

SIM – selected ion mode

TF_{direct} – fraction of the amount of crumb rubber transferred from the hand to the mouth

$TF_{indirect}$ – fraction of the amount of crumb rubber transferred from the portion of a hand in contact with an object to the mouth

TF_{loss} – fraction of crumb rubber lost from the hand prior to transfer into the mouth

TF_{obj} – fraction of the amount of crumb rubber transferred from the object into the mouth

TBSP – tablespoon

TSP – teaspoon

US EPA – United States Environmental Protection Agency

VOC – volatile organic chemical

λ_{HTM} – number of HTM contacts per hour

λ_{HTOTM} – number of HTOTM contacts per hour

λ_{OTM} – number of OTM contacts per hour

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Section 2
Synthetic Turf and Playground Studies Overview
May 2019 Update

Section 2. Synthetic Turf and Playground Studies Overview May 2019 Update

2.1. Background

The California Office of Environmental Health Hazard Assessment (OEHHA) is conducting a multi-year study of the potential health effects associated with use of synthetic turf fields that contain crumb rubber infill and playground mats that were made with crumb rubber. This work is being performed in collaboration with researchers at the Lawrence Berkeley National Laboratory, University of California, Berkeley and University of Arizona.

Crumb rubber is made from ground-up waste tires, which have a complex physical structure and chemical composition. The following are tasks of the synthetic turf study:

1. Expert, public and interagency consultation and input
2. Hazard Identification
3. Exposure Scenario Development
4. Characterization of chemicals that can be released from synthetic turf and playground mats, and determination of the potential for human exposures
5. Biomonitoring and personal monitoring protocol development
6. Reporting
7. Health assessment from play on synthetic turf and playground mats

The project is scheduled to be completed in 2019. The sections below briefly describe the main project tasks and current status.

Task 1: Expert, public and interagency consultation and input

In order to ensure the study uses the most appropriate scientific approaches and technology, OEHHA has established a Scientific Advisory Panel (SAP) to provide advice and input to the study. Meetings were held February 8, 2016; March 10, 2017; May 25, 2018, and a meeting is being convened in Sacramento on May 31, 2019.

OEHHA has consulted with several federal agencies as well as other academic research institutions in the United States and overseas. In response to a request from OEHHA, the National Toxicology Program is performing toxicology studies on crumb rubber. OEHHA also met with representatives of the Rubber Manufacturers Association and the Carbon Black Association.

These consultations were discussed at 2016, 2017, and 2018 SAP meetings.

2.2. Synthetic Turf Study

Task 2: Hazard Identification

Work related to this task includes conducting literature reviews to identify chemicals of potential concern and to characterize the toxicity of chemicals found in the study. In carrying out this task, OEHHA:

- Has conducted a thorough review on available tire-related research and studies to identify and compile a preliminary list of chemicals to guide the chemical analyses of field samples. The approach to chemical identification from field sample and monitoring samples was discussed in detail during the March 2017 Scientific Advisory Panel Meeting.
- Is updating the chemical list based on chemicals identified in the analysis of field samples—targeted and non-targeted chemical analyses. This work is ongoing.
- Is performing a scientific literature review to gather the physicochemical properties, health effects and toxicity criteria of the chemicals of potential concern—information will be used in exposure and risk assessments of chemicals found in the study. This work is ongoing.

Task 3: Exposure Scenario Development

The goals of this task are to:

- Identify and evaluate potential exposure pathways to synthetic turf chemicals and particulate matter.
- Develop exposure scenarios.
- Develop an exposure model.
    - Develop exposure equations.
    - Estimate values of exposure parameters.

A Time-Activity Behavior Study of California soccer players was conducted to assist the evaluation of activities and behaviors of athletes, coaches, and bystanders while performing sport- or non-sport-related activities on synthetic turf fields. The study protocols, potential exposure pathways, and exposure scenarios were presented at the

May 2018 SAP meeting. Results of the Time-Activity Behavior Study are included in Section 4 (Synthetic Turf Field Exposure Model) of the meeting materials.

Results of the Time-Activity Behavior Study will contribute to the characterization of exposures and the calculation of oral, dermal, and inhalation doses for exposure and risk assessments.

The use of the data from this study to parameterize the exposure model will be discussed at the May 2019 SAP meeting.

Task 4: Field Characterization Study: Characterization of chemicals that can be released from synthetic turf and playground mats and determination of human exposure potentials

To understand the chemical and physical characteristics of exposures on synthetic turf fields, multiple activities have taken place or are in progress. These include:

- Sampling of pre-installed crumb rubber from manufacturers for developing analytical protocols for chemical analysis and bioavailability evaluation. This work has been completed and was described at the previous SAP meetings.
- Protocol development for sample analysis and bioavailability assessment. This work has been completed and was described and received SAP input at the previous SAP meetings.
- Random selection and entering into agreements for sampling 35 fields of various ages from four climate regions across California. This work has been completed and was discussed at the 2018 SAP meeting.
- Collection of crumb rubber and airborne particle samples - for analysis and characterization of the chemicals present and their bioaccessibility for uptake into a human body following exposure. Sample collection has been completed and was discussed at the 2018 SAP meeting.
- Conducting targeted and non-targeted analyses of classes of chemicals, including volatile organic compounds (VOCs), aldehydes and ketones, semi-volatile organic compounds (sVOCs), polycyclic aromatic hydrocarbons (PAHs), non-volatile organics, and metals. This work is ongoing. Analyses protocols and preliminary results will be discussed at the May 2019 SAP meeting. For background see Section 3 (Non-Targeted Chemical Analysis) of the meeting materials.

The chemical concentration data resulting from the sample analyses are key inputs for the characterization of inhalation, dermal and oral exposures for the risk assessment. The physical stressor data (e.g., high temperature) will also be discussed in the risk assessment.

Task 5: Biomonitoring and Personal Monitoring Protocol Development

The objective of this task is to develop a study plan for Institutional Review Board approval. OEHHA has contracted with UC Berkeley to develop these protocols, which are considering the following information:

- Physicochemical data, pharmacokinetics (absorption, distribution, metabolism, and elimination) and toxicity of the chemicals of potential concern provided by the Hazard Identification (Task 2).
- Exposure data in Task 3 and chemical data in Task 4.

Task 7: Human Health Risk Assessment

The results from Tasks 2-4 will be integrated to assess the potential human health risks associated with the use of synthetic turf fields. This will include:

- The hazard identification and toxicity characterizations (Task 2) of chemicals released from synthetic fields (Task 4).
- The air concentrations of chemicals and particulate matter resulting from the sampling of synthetic turf fields (Task 4).
- Data on chemical and physical stressors (Task 4.)
- The results of the bioaccessibility studies of chemicals in crumb rubber samples (Task 4).
- The exposure parameters resulting from the characterization of activities and behaviors of players, bystanders and coaches using synthetic turf fields (Task 3).

2.3. Playground Study

OEHHA is conducting a risk assessment of children playing on outdoor playground mats made of crumb rubber. This will rely on samples collected on surfaces of and in the environment at outdoor playgrounds. These samples will be used to characterize the chemicals that may be released from playground mats. Multiple activities have taken place or are in progress. These include:

- Collection of multi-media samples at selected playgrounds of different ages and locations in California.
- Collection of micro-level activity data from archived studies on young children playing on turf and playgrounds in California.
- Characterization of exposure parameters based on activity patterns of children playing in the outdoor environment.

The playground sampling protocols and the activity data of young children playing on playground Micro-level activity data collected by the University of Arizona were presented in the 2018 SAP meeting. Micro-level activities data of young children playing on playground are included in the Section 4 (Synthetic Turf Field Exposure Model) of the meeting materials for the May 2019 SAP meeting.

Section 3
Non-Targeted Chemical Analysis

Section 3. Non-Targeted Chemical Analysis

3.1. Non-Targeted Chemical Analysis

3.1.1. Background

Characterization of the chemical composition of crumb rubber is one of the major tasks of the synthetic turf study. To perform this task, OEHHA has been collaborating with scientists from the Lawrence Berkeley National Laboratory (LBNL) and the California Institute for Quantitative Biosciences (QB3) at the University of California, Berkeley.

Tires are made of complex mixtures and polymers, including, but not limited to, natural rubber, synthetic rubber, and fillers (e.g., silica and carbon black), along with a number of known or proprietary chemicals (e.g., antioxidants, antiozonants, and curing systems) (ICBA, 2016; USTMA, https://www.ustires.org/whats-tire-0). These chemicals react, transform, and/or polymerize to form different chemicals, not only during the multi-step tire manufacturing process, but also after recycled waste tires have been processed into crumb rubber and then installed in synthetic turf fields, where they are exposed to environmental conditions. Field crumb rubber samples therefore contain a large number of unknown chemicals from many different sources.

OEHHA is conducting non-targeted chemical analyses on the following types of samples collected for this project:

- Volatile organics emitted from emission chamber studies of uninstalled crumb rubber, installed crumb rubber and air samples taken in the field
- Non-polar and polar solvent extractions of new (pre-installed) and installed (field samples)

Considering the large number and wide variety of unknown chemicals in crumb rubber, the application of traditional non-targeted chemical analyses, given their labor-intensiveness and the substantial research involved, is a challenge. OEHHA is beginning its non-targeted analysis with a suspect screening analysis (a technique of non-targeted chemical analysis) to tentatively identify chemicals in the crumb rubber through batch searching of available chemical databases. In addition, cheminformatics[1] tools are being applied to predict the structures of tentatively identified chemicals.

[1] Cheminformatics is the use of computer and informational techniques to assist in chemical analyses and related activities.

Tentatively identified chemicals are then prioritized for confirmation (Appendix A) and are being confirmed using reference standards. Chemicals with available toxicity data and reference values, including from alternative test methods (e.g., US Environmental Protection Agency [US EPA]/ Chemical Dashboard) and data from literature search are given priority. Based on the chemical composition results, OEHHA is compiling a Targeted Chemical List to guide the studies of bioaccessiblity being conducted on crumb rubber samples taken from synthetic turf fields throughout the state. Finally, the bioaccessible chemical results will be applied to assess risk from potential exposures on synthetic turf fields.

3.1.2. Non-Targeted Analysis of Volatile Organic Chemicals Emitted from Crumb Rubber

For non-targeted chemical analysis of volatile organic chemicals (VOCs) emitted from crumb rubber, Lawrence Berkeley National Laboratory (LBNL) has analyzed both pre-installed crumb rubber samples and field air samples to build a list of tentatively identified turf-related chemicals. LBNL’s approach combined results from controlled emission chamber tests of pre-installed crumb rubber samples, direct thermal desorption of pre-installed crumb rubber samples, and analysis of air samples collected on synthetic turf fields. By combining results from these measurements, VOCs from new and aged crumb rubber samples could be included into the Targeted Chemical List.

- Emission Chamber Testing: Pre-installed crumb rubber samples were placed in an environmental emission chamber under controlled conditions of 25°C and 50% relative humidity (as described in Appendix B Once the samples came to steady state, air samples were taken and analyzed by gas chromatography/mass spectrometry (GC/MS) according to details in Appendix C. Chamber testing from four samples of pre-installed crumb rubber were used. These highly controlled measurements provide data of mostly volatile range compounds with a high confidence that chemicals were from crumb rubber samples.
- Direct Thermal Desorption: Installed crumb rubber samples were directly desorbed into the GC/MS to provide information on mid-range VOCs in crumb rubber with a high confidence that the chemicals were from crumb rubber samples. A small amount (10 mg) of pre-installed crumb rubber was placed into a clean thermal desorption tube. The tube was heated at 150°C under a flow of helium and directly injected into the GC/MS following details in Appendix C.
- Field Air Samples: Field air samples taken at three different fields were used to provide information on the volatile range of chemicals that could be expected from crumb rubber aged in the fields.

The GC/MS data from all three approaches were analyzed using two different computer algorithms:

- Enhanced ChemStation (version F.01.03.2357, Agilent Technologies, Inc., Santa Clara, CA, https://www.agilent.com/cs/library/usermanuals/Public/G2070-91126_Understanding.pdf): a GC/MS integration software for data acquisition and evaluation
- Automatic Mass Spectral Deconvolution and Identification System (AMDIS, NIST Standard Reference Data Program, Gaithersburg, MD, https://chemdata.nist.gov/mass-spc/amdis/explanation.html): a deconvolution software for extracting the spectrum of each component in a mixture.

Suspect screening analysis was performed by comparing the unknown molecular features (MS fragmentation patterns acquired by GC/MS) with reference spectra in the National Institute of Standards and Technology 14 (NIST 14) spectral library (NIST, https://www.nist.gov/srd/nist-standard-reference-database-1a-v17). Matched suspects with a quality score of at least 80 percent are labeled as tentatively identified chemicals in the field air. Reference standards were used to confirm the tentatively identified chemicals by matching the chromatographic (GC retention time) and spectral (MS fragmentation pattern) data. LBNL has confirmed 67 VOCs that were detected in the field air samples.

3.1.3. Non-Targeted Analysis Workflow – Extractable Chemicals in Crumb Rubber

OEHHA has collected pre-installed crumb rubber samples from tire recycling facilities and aged crumb rubber samples from randomly selected synthetic turf fields in California. Currently, LBNL is analyzing these samples. For non-targeted chemical analysis of extractable chemicals in crumb rubber, LBNL has prepared and has extracted three pre-installed samples and two composite field samples of crumb rubber with two solvents for the following analyses:

- **Non-Polar Organic Chemical Analysis:** Samples are extracted with acetone/hexane (1:1) using an accelerated solvent extraction (ASE) system. Extracts are analyzed by gas chromatography/mass spectrometry (GC/MS).
- **Polar Organic Chemical Analysis:** Samples are extracted with water/methanol (9:1) extraction using the ASE system. Extracts are analyzed by liquid chromatography/mass spectrometry (LC/MS).

Together with the field air sample analysis, these two solvent extractions and instrumental analyses complement each other to provide a comprehensive spectrum of organic chemicals in the crumb rubber samples. **Figure 3-1** shows the schematic diagram of the workflow of non-targeted analysis of extractable organic chemicals in crumb rubber. Details of non-targeted chemical analysis for crumb rubber are discussed in this section.

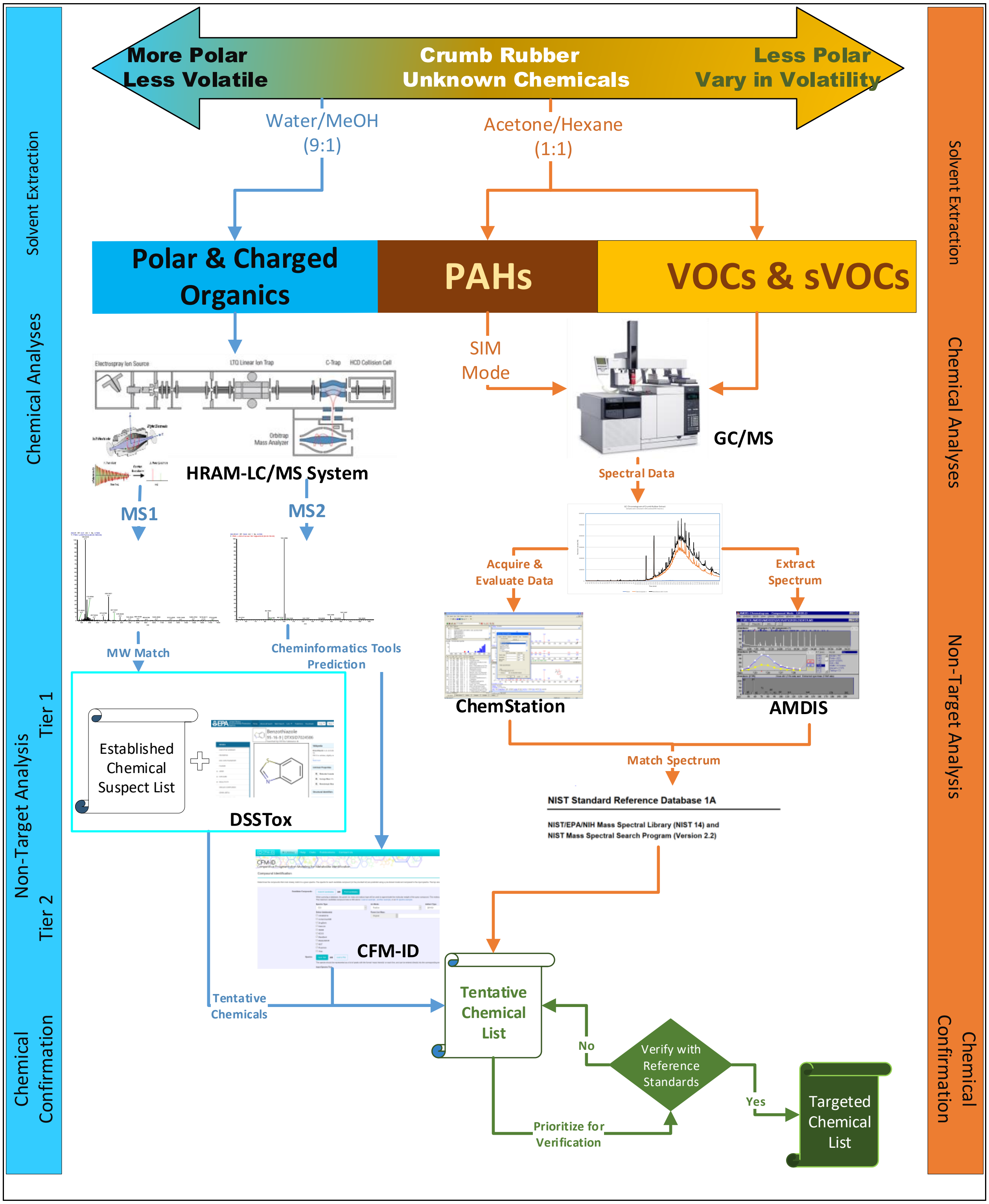

Figure 3-1. A Schematic Diagram of the Workflow for Non-Targeted Chemical Analysis of Crumb Rubber Extracts

3.1.4. Identification of Extractable Non-Polar Chemicals in Crumb Rubber Using Gas Chromatography/Mass Spectrometry

Gas Chromatography/Mass Spectrometry (GC/MS) is widely used in studies of non-polar organic chemicals. By calibrating the instrument to proper settings, GC/MS can resolve and detect complex mixtures containing volatile, semi-volatile, or non-volatile (e.g., polycyclic aromatic hydrocarbons) organic chemicals. Standardized GC/MS protocols and spectral libraries rich in non-polar organic chemicals of various sources (e.g. National Institute of Standards and Technology, NIST, spectral library) are readily available (NIST, https://www.nist.gov/srd/nist-standard-reference-database-1a-v17). As a result, application of these resources in complex environmental mixtures studies can improve the efficiency and accuracy of identifying non-targeted chemicals.

To characterize the extractable non-polar constituents in the crumb rubber samples, LBNL has prepared and has extracted three individual pre-installed samples and two composite field samples of crumb rubber (each from four different individual fields) with acetone/hexane, following the procedures outlined in Appendix D. The extracts are being analyzed by GC/MS under the conditions and instrumental settings detailed in Appendix C. The GC/MS data are being analyzed using two different computer algorithms:

- Enhanced ChemStation (version F.01.03.2357, Agilent Technologies, Inc., Santa Clara, CA, https://www.agilent.com/cs/library/usermanuals/Public/G2070-91126_Understanding.pdf): a GC/MS integration software for data acquisition and evaluation
- Automatic Mass Spectral Deconvolution and Identification System (AMDIS, NIST Standard Reference Data Program, Gaithersburg, MD, https://chemdata.nist.gov/mass-spc/amdis/explanation.html): a deconvolution software for extracting the spectrum of each component in a mixture.

Suspect screening analysis is performed by comparing the unknown molecular features (MS fragmentation patterns acquired by GC/MS) with reference spectra in the National Institute of Standards and Technology 14 (NIST 14) spectral library (NIST, https://www.nist.gov/srd/nist-standard-reference-database-1a-v17). Matched suspects with a quality score[2] of 80 percent are labeled as tentatively identified chemicals in the crumb rubber extracts. Tentatively identified chemicals are being prioritized based on toxicity information obtained from the US EPA Chemical Dashboard (USEPA, https://comptox.epa.gov/dashboard) and availability of reference standards. Reference

[2] Enhanced ChemStation quality score describes the match of sample MS signal to the NIST library, with 100 percent being an exact match.

standards are used to confirm the tentatively identified chemicals by matching the chromatographic (GC retention time) and spectral (MS fragmentation pattern) data.

In addition, the extracts have been analyzed for polycyclic aromatic hydrocarbons (PAHs) by GC/MS in selected ion mode (SIM) following the protocol in Appendix E. Individual PAHs are verified against 23 pure PAH standards (EPA 8310 PAH mix, P/N CRM47543, Supelco, Bellefonte, PA).

Following the workflow in **Figure 3-1**, there have been 182 tentatively identified non-polar organic chemicals (including PAHs) and 49 confirmed non-polar organic targets in the non-polar crumb rubber extracts. These chemicals are summarized in **Table 3-1**. Among these chemicals are 20 confirmed PAHs (18 from the GC/MS-SIM analysis, 2 from GC/MS). These confirmed non-polar targets have been added to the Targeted Chemical List to guide the bioaccessibility measurements of crumb rubber. It is noteworthy that the identity of tentatively identified chemicals is uncertain until they are confirmed by analyzing the respective reference standards.

Table 3-1. Non-Targeted Chemical Analysis of Extractable Non-Polar Chemicals: Confirmed Targets and Tentatively Identified Chemicals

Chemical Name	INCHIKEY
Confirmed Non-Polar Organic Targets	
Benzothiazole	IOJUPLGTWVMSFF-UHFFFAOYSA-N
1,4-Benzenediamine, N,N'-diphenyl-	UTGQNNCQYDRXCH-UHFFFAOYSA-N
2-Mercaptobenzothiazole	YXIWHUQXZSMYRE-UHFFFAOYSA-N
Hexadecane	DCAYPVUWAIABOU-UHFFFAOYSA-N
Dibutyl phthalate	DOIRQSBPFJWKBE-UHFFFAOYSA-N
Diethyl Phthalate	FLKPEMZONWLCSK-UHFFFAOYSA-N
Dimethyl phthalate	NIQCNGHVCWTJSM-UHFFFAOYSA-N
2,6-Di-tert-butyl-p-cresol	NLZUEZXRPGMBCV-UHFFFAOYSA-N
n-Butylbenzene	OCKPCBLVNKHBMX-UHFFFAOYSA-N
Aniline	PAYRUJLWNCNPSJ-UHFFFAOYSA-N
D-Limonene	XMGQYMWWDOXHJM-JTQLQIEISA-N
3,5-di-tert-Butyl-4-hydroxybenzaldehyde	DOZRDZLFLOODMB-UHFFFAOYSA-N
N-Cyclohexyl-N-methylcyclohexanamine	GSCCALZHGUWNJW-UHFFFAOYSA-N
Dicyclohexylamine	XBPCUCUWBYBCDP-UHFFFAOYSA-N
Benzothiazolone	YEDUAINPPJYDJZ-UHFFFAOYSA-N
Bis(2-ethylhexyl) phthalate	BJQHLKABXJIVAM-UHFFFAOYSA-N
Resorcinol	GHMLBKRAJCXXBS-UHFFFAOYSA-N
Diisononyl phthalate	HBGGXOJOCNVPFY-UHFFFAOYSA-N
Benzyl butyl phthalate	IRIAEXORFWYRCZ-UHFFFAOYSA-N
Phenol, 4-(1,1,3,3-tetramethylbutyl)-	ISAVYTVYFVQUDY-UHFFFAOYSA-N

Chemical Name	INCHIKEY
Dibenzothiophene	IYYZUPMFVPLQIF-UHFFFAOYSA-N
Diisobutyl phthalate	MGWAVDBGNNKXQV-UHFFFAOYSA-N
Di-n-octyl phthalate	MQIUGAXCHLFZKX-UHFFFAOYSA-N
Cyclohexyl isothiocyanate	MZSJGCPBOVTKHR-UHFFFAOYSA-N
Cyclohexylamine	PAFZNILMFXTMIY-UHFFFAOYSA-N
bis(2-Ethylhexyl)adipate	SAOKZLXYCUGLFA-UHFFFAOYSA-N
Bis(2,2,6,6-tetramethyl-4-piperidyl) sebacate	XITRBUPOXXBIJN-UHFFFAOYSA-N
Phthalimide	XKJCHHZQLQNZHY-UHFFFAOYSA-N
Diisodecyl phthalate	ZVFDTKUVRCTHQE-UHFFFAOYSA-N
Confirmed PAH Targets	
2-Methylnaphthalene	QIMMUPPBPVKWKM-UHFFFAOYSA-N
Pyrene	BBEAQIROQSPTKN-UHFFFAOYSA-N
Fluoranthene	GVEPBJHOBDJJJI-UHFFFAOYSA-N
1-Methylnaphthalene	QPUYECUOLPXSFR-UHFFFAOYSA-N
Naphthalene	UFWIBTONFRDIAS-UHFFFAOYSA-N
1-Hydroxypyrene	BIJNHUAPTJVVNQ-UHFFFAOYSA-N
Acenaphthene	CWRYPZZKDGJXCA-UHFFFAOYSA-N
Benzo[a]anthracene	DXBHBZVCASKNBY-UHFFFAOYSA-N
Benzo(a)pyrene	FMMWHPNWAFZXNH-UHFFFAOYSA-N
Benzo(b)fluoranthene	FTOVXSOBNPWTSH-UHFFFAOYSA-N
Benzo(g,h,I)perylene	GYFAGKUZYNFMBN-UHFFFAOYSA-N
Benzo(k)fluoranthene	HAXBIWFMXWRORI-UHFFFAOYSA-N
Acenapthylene	HXGDTGSAIMULJN-UHFFFAOYSA-N
Dibenz(a,h)anthracene	LHRCREOYAASXPZ-UHFFFAOYSA-N
Anthracene	MWPLVEDNUUSJAV-UHFFFAOYSA-N
Fluorene	NIHNNTQXNPWCJQ-UHFFFAOYSA-N
2-Bromomethylnaphthalene	RUHJZSZTSCSTCC-UHFFFAOYSA-N
Indeno(1,2,3-cd)pyrene	SXQBHARYMNFBPS-UHFFFAOYSA-N
Chrysene	WDECIBYCCFPHNR-UHFFFAOYSA-N
Phenanthrene	YNPNZTXNASCQKK-UHFFFAOYSA-N
Tentatively Identified Non-Polar Chemicals (including PAHs)	
Oleic acid	ZQPPMHVWECSIRJ-KTKRTIGZSA-N
Noraporphin-7-one, 4,5,6,6a-tetradehydro-10-ethoxy-1,2,9-trimethoxy-	ANPHOVYHXGXALX-UHFFFAOYSA-N
1,4-benzenediamine, N1,N1-bis(4-methylphenyl)-	APUMQQZMCHMHPW-UHFFFAOYSA-N
Tris(2,4-di-tert-butylphenyl) phosphate	AZSKHRTUXHLAHS-UHFFFAOYSA-N
trans-13-Octadecenoic acid	BDLLSHRIFPDGQB-AATRIKPKSA-N

Chemical Name	INCHIKEY
Heptacosane	BJQWYEJQWHSSCJ-UHFFFAOYSA-N
17-Pentatriacontene	BLCUZCCTSBVFSV-LAPDZXRHSA-N
Silane diethyl(2-chloro-5-methylphenoxy)decyloxy-	BSAIYLSZAFPXIX-UHFFFAOYSA-N
Benzothiazole, 2-propyldithio-	BTHJYDJZMRDGNV-UHFFFAOYSA-N
Cyclopenta[cd]pyrene	BZCXQYVNASLLQO-UHFFFAOYSA-N
Eicosane	CBFCDTFDPHXCNY-UHFFFAOYSA-N
3-Methylbenzylamine, N,N-didecyl-	CBFQTDCWCFJSHB-UHFFFAOYSA-N
1-Octadecene	CCCMONHAUSKTEQ-UHFFFAOYSA-N
3-Chloro-1-anthraquinonecarboxylic acid	CISPGBHKPKMNKZ-UHFFFAOYSA-N
Decahydro-8a-ethyl-1,1,4a,6-tetramethylnaphthalene	CLRULWBJJWDXOA-UHFFFAOYSA-N
6-Octadecenoic acid, (Z)-	CNVZJPUDSLNTQU-SEYXRHQNSA-N
2H-Benzimidazol-2-one, 1,3-dihydro-5-methyl-	CTCHXZUMFHNSHM-UHFFFAOYSA-N
Androstan-3-one, (aminocarbonyl)hydrazone, (5.alpha.)-	CTIMIVMPECOCMD-RGNNZJRVSA-N
Phenanthrene, 1-methyl-	DOWJXOHBNXRUOD-UHFFFAOYSA-N
o-Cyanobenzoic acid	DTNSDCJFTHMDAK-UHFFFAOYSA-N
Benzene, 2,4-diisocyanato-1-methyl-	DVKJHBMWWAPEIU-UHFFFAOYSA-N
Oxalic acid, isobutyl nonyl ester	FFFMBVYSYMUSKR-UHFFFAOYSA-N
Tricosane	FIGVVZUWCLSUEI-UHFFFAOYSA-N
Benzenamine, 2-methoxy-N-[2-[1-(4-bromophenyl)-5-tetrazolyl]ethenyl]-	FIROPRPTDLRILV-ZHACJKMWSA-N
Hexadecanoic acid, methyl ester	FLIACVVOZYBSBS-UHFFFAOYSA-N
Phenol, 2,4-bis(1-methyl-1-phenylethyl)-	FMUYQRFTLHAARI-UHFFFAOYSA-N
Heneicosane	FNAZRRHPUDJQCJ-UHFFFAOYSA-N
Triacontyl pentafluoropropionate	FQGLWEGVMMDANK-UHFFFAOYSA-N
7H-Benzo[c]fluorene	FRIJWEQBTIZQMD-UHFFFAOYSA-N
p-Anisic acid, 3,4-dichlorophenyl ester	FRVXSRVZQSAALV-UHFFFAOYSA-N
C(14a)-Homo-27-nor-14.beta.-gammaceran-3.alpha.-ol	GAPITCNXWSCZLW-UHFFFAOYSA-N
Pyridine, 3-(1a,2,7,7a-tetrahydro-2-methoxy-1-phenyl-1,2,7-metheno-1H-cyclopropa[b]naphthalen-8-yl)-	GAYPUVQXMOAWPJ-UHFFFAOYSA-N
2-(5-Amino-3,4-dicyanopyrazol-1-yl)-5,6-dimethylpyridine-3,4-dicarbonitrile	GBVKRCMZSHTBNE-UHFFFAOYSA-N
(1S,2E,4S,5R,7E,11E)-Cembra-2,7,11-trien-4,5-diol	GFPBWVUILKAAQD-ZJRJPKBJSA-N
Benzene, (2-methylene-1-phenylcyclopropyl)-	GILVKAZLLFNSHJ-UHFFFAOYSA-N

Chemical Name	INCHIKEY
1,1':4',1":4",1'"-Quaterphenyl	GPRIERYVMZVKTC-UHFFFAOYSA-N
Tetratriacontane	GWVDBZWVFGFBCN-UHFFFAOYSA-N
Anthracene, 2-methyl-	GYMFBYTZOGMSQJ-UHFFFAOYSA-N
7-Hydroxy-1-indanone	HFMZPBSZKCDKOR-UHFFFAOYSA-N
9-Hexacosene	HGTCGIXAQAYYBS-UHFFFAOYSA-N
A'-Neogammacer-22(29)-ene	HHXYJYBYNZMZKX-PYQRSULMSA-N
Hexacosane	HMSWAIKSFDFLKN-UHFFFAOYSA-N
5,9-Undecadien-2-one, 6,10-dimethyl-, (Z)-	HNZUNIKWNYHEJJ-XFXZXTDPSA-N
Docosane	HOWGUJZVBDQJKV-UHFFFAOYSA-N
N-(2,6-Dimethylphenyl)-N-[(2E)-3-methyl-1,3-thiazinan-2-ylidene]amine	HOYUJOLOMZWOON-UHFFFAOYSA-N
Methyl stearate	HPEUJPJOZXNMSJ-UHFFFAOYSA-N
6-(4-Methoxyphenyl)-4-(3-methylphenyl)-2-oxo-1H-pyridine-3-carbonitrile	HVTYZTZTCVQEEF-UHFFFAOYSA-N
Undecane, 4,7-dimethyl-	IEVWHTVOIZEXCC-UHFFFAOYSA-N
Nonacosane	IGGUPRCHHJZPBS-UHFFFAOYSA-N
9-Tricosene, (Z)-	IGOWHGRNPLFNDJ-ZPHPHTNESA-N
Diisooctyl phthalate	IJFPVINAQGWBRJ-UHFFFAOYSA-N
n-Hexadecanoic acid	IPCSVZSSVZVIGE-UHFFFAOYSA-N
Hentriacontane	IUJAMGNYPWYUPM-UHFFFAOYSA-N
2-[4-(4-Methoxyphenyl)-3-phenylpyrazol-1-yl]-4-phenylthiazole	IUYUBWDOLWCQLQ-UHFFFAOYSA-N
6-Isopropenyl-4,8a-dimethyl-4a,5,6,7,8,8a-hexahydro-1H-naphthalen-2-one	IVZATFCVCDHOLU-UHFFFAOYSA-N
Benzo[d,E]benzimidazo[2,1-a]isoquinolin-7-one, 2-nitro-3-hydroxy-	IXZMACLZYUKKSA-UHFFFAOYSA-N
17,21-Dimethylheptatriacontane	JFFONUMNQVVGPB-UHFFFAOYSA-N
3-Pyrrolidinol	JHHZLHWJQPUNKB-UHFFFAOYSA-N
Hexahydropyridine, 1-methyl-4-[4,5-dihydroxyphenyl]-	JKYGPAJMFOJYKA-UHFFFAOYSA-N
1-Formyl-2,2,6-trimethyl-3-(3-methyl-but-2-enyl)-6-cyclohexene	JMUCXOSTKXDDDI-UHFFFAOYSA-N
(Z)-(Z)-Hex-3-en-1-yl 2-methylbut-2-enoate	JNWQKXUWZWKUAY-BHHIIOOYSA-N
Benzenepropanoic acid, 4-[(2,4-dinitrophenyl)azo]-, 1-methylethyl ester	JRNMWCQNLLKQDY-UHFFFAOYSA-N
Triacontane	JXTPJDDICSTXJX-UHFFFAOYSA-N
4-(2,4,4,5-Tetramethyl-1-cyclohexenyl)-trans-3-buten-2-one 2,4-dinitrophenylhydrazone	JYOCKQZMDMEGHE-KKVXJHJLSA-N
1,4-Benzenediol, 2,5-bis(1,1-dimethylethyl)-	JZODKRWQWUWGCD-UHFFFAOYSA-N
Heptadecanoic acid	KEMQGTRYUADPNZ-UHFFFAOYSA-N

Chemical Name	INCHIKEY
Phthalic acid, di(2-propylpentyl) ester	KIYUVQCUDDMZRE-UHFFFAOYSA-N
Pyridine, 2-(4-methylphenyl)-	KJNZQKYSNAQLEO-UHFFFAOYSA-N
Nonahexacontanoic acid	KTUPKHQFSAAMEE-UHFFFAOYSA-N
Hexane, 3,3-dimethyl-	KUMXLFIBWFCMOJ-UHFFFAOYSA-N
Tetracontane	KUPLEGDPSCCPJI-UHFFFAOYSA-N
4H-Pyran-3-carboxylic acid, 2-amino-5-cyano-6-ethyl-4-(3-pyridinyl)-, methyl ester	KVZIBJODRKBIRE-UHFFFAOYSA-N
.gamma.-Sitosterol	KZJWDPNRJALLNS-FBZNIEFRSA-N
Cyclotetradecane, 1,7,11-trimethyl-4-(1-methylethyl)-	LHORCXXUZJAMPU-UHFFFAOYSA-N
Nonadecane	LQERIDTXQFOHKA-UHFFFAOYSA-N
Cholest-5-en-3-ol, 24-propylidene-, (3.beta.)-	LVMOSMRIAUDGQC-CDXQRKPWSA-N
n-Caproic acid vinyl ester	LZWYWAIOTBEZFN-UHFFFAOYSA-N
ethanone, 1-[5-(methylthio)-2-nitrophenyl]-	MCGHSLFZLHZTOS-UHFFFAOYSA-N
Baccharane	MDHNGUIZZLNVNV-UHFFFAOYSA-N
9,10-Anthracenedione, 1-amino-4-hydroxy-2-phenoxy-	MHXFWEJMQVIWDH-UHFFFAOYSA-N
24-Norcholane, 23-[2-methyl-1-(1-methylethyl)cyclopropyl]-, (5.alpha.)-	MLIRMQLHYQMJGR-GSNUTHIDSA-N
Lupeol	MQYXUWHLBZFQQO-QGTGJCAVSA-N
Tetrapentacontane, 1,54-dibromo-	MYKPFQFCUJYEOQ-UHFFFAOYSA-N
1,8-Dioxa-5-thiaoctane, 8-(9-borabicyclo[3.3.1]non-9-yl)-3-(9-borabicyclo[3.3.1]non-9-yloxy)-1-phenyl-	MYMAGHMBDNHZAR-UHFFFAOYSA-N
Allopregn-5,16-diene-3.beta.-ol-20-one acetate	MZWRIOUCMXPLKV-UHFFFAOYSA-N
Pentanoic acid, 2-methyl-, anhydride	NCYCWNILADFMPI-UHFFFAOYSA-N
Heptadecane	NDJKXXJCMXVBJW-UHFFFAOYSA-N
l-Norvaline, n-propoxycarbonyl-, undecyl ester	NLNVUHNNULQOPG-UHFFFAOYSA-N
3-Octanol	NMRPBPVERJPACX-UHFFFAOYSA-N
Demecolcine	NNJPGOLRFBJNIW-HNNXBMFYSA-N
8-Phenyl-5,5a,6,10,10a,11-hexahydro-5,11-(O-benzeno)-6,10-ethenocyclohepta(b)naphthalen-7-one	NULPYAOBDIJGTA-UHFFFAOYSA-N
Phenanthrene, 1,7-dimethyl-	NZCMUISOTIPJAM-UHFFFAOYSA-N
Behenyl chloride	OACXFSZVCDOBKF-UHFFFAOYSA-N
2-Ethyl-hexoic acid	OBETXYAYXDNJHR-UHFFFAOYSA-N
benzene, 1-ethoxy-4-[(trimethylsilyl)oxy]-	OBSRGAKXHVEYPY-UHFFFAOYSA-N
3,3'-Dinitrobenzidine	OCEINMLGYDSKFW-UHFFFAOYSA-N

Chemical Name	INCHIKEY
Friedelan-3-one	OFMXGFHWLZPCFL-SVRPQWSVSA-N
3,3',8,8'-Tetrahydroxy-6,6'-dimethyl-2,2'-binaphthalene-1,1',4,4'-tetrone	OIIQHPXVAMWSOY-UHFFFAOYSA-N
2,5-Hexanedione	OJVAMHKKJGICOG-UHFFFAOYSA-N
Dodecahydropyrido[1,2-b]isoquinolin-6-one	OLWPUTPKEBKCOC-UHFFFAOYSA-N
1-Hexacosene	OMXANELYEWRDAW-UHFFFAOYSA-N
Benzene, [1-(3-butenylthio)-2-nitroethyl]-	OODANBUQRYURTF-UHFFFAOYSA-N
Stigmasta-5,24(28)-dien-3-ol, (3á,24Z)-	OSELKOCHBMDKEJ-WGMIZEQOSA-N
Isophthalic acid, di(1-isopropyl-2-methylpropyl) ester	OVNLBUVYWFGXSX-UHFFFAOYSA-N
Anthracene, 9-butyltetradecahydro-	PJCBPPKQWYVHKO-UHFFFAOYSA-N
Tetracosane	POOSGDOYLQNASK-UHFFFAOYSA-N
3-Methyl-3H-naphth[1,2-e]indol-10-ol	PRJIMCPILGWGTL-UHFFFAOYSA-N
Octadecane, 2,6,10,14-tetramethyl-	PUTSHCSOTBWQAI-UHFFFAOYSA-N
2,5-Dimethyl-2-(2-tetrahydrofuryl)tetrahydrofuran	PXUOEQRALJWORR-UHFFFAOYSA-N
8,9-Dihydrocyclopenta[def]phenanthrene	QBMIPMOSKSYZNU-UHFFFAOYSA-N
9,19-Cycloergost-24(28)-en-3-ol, 4,14-dimethyl-, acetate, (3.beta.,4.alpha.,5.alpha.)-	QEBAXZCXAFWBDK-UHFFFAOYSA-N
Dotriacontane	QHMGJGNTMQDRQA-UHFFFAOYSA-N
Octadecanoic acid	QIQXTHQIDYTFRH-UHFFFAOYSA-N
Octadecane, 1-(ethenyloxy)-	QJJDJWUCRAPCOL-UHFFFAOYSA-N
Ergost-25-ene-3,5,6,12-tetrol, (3.beta.,5.alpha.,6.beta.,12.beta.)-	QPSIXZTWWLBRTC-USWUIBTHSA-N
Silicic acid, diethyl bis(trimethylsilyl) ester	QZGNEODXJZDIBK-UHFFFAOYSA-N
1,11-Diphenyl-1,3,5,7,9-undecapentaene	RDKSRSULOVSRSX-YQEDPBEWSA-N
4-Chloro-2,7,8-trimethyl-quinolin-5-ylamine	RDZZDXXURQBAEQ-UHFFFAOYSA-N
Methyltris(trimethylsiloxy)silane	RGMZNZABJYWAEC-UHFFFAOYSA-N
17.alpha.,21.beta.-28,30-Bisnorhopane	RLPRHPNFVLCDPC-UHFFFAOYSA-N
Cyclotriacontane	RPRAXXJCTCCPOZ-UHFFFAOYSA-N
9,19-Cyclolanostan-3-ol, 24,24-epoxymethano-, acetate	RQUCHTRBFYBJLV-UHFFFAOYSA-N
ç-Sitostenone	RUVUHIUYGJBLGI-AXAJWWPKSA-N
Stigmast-4-en-3-one	RUVUHIUYGJBLGI-XJZKHKOHSA-N
Phthalic acid, 6-ethyloct-3-yl 2-ethylhexyl ester	RYIRRKVWFBLZCM-UHFFFAOYSA-N
Eicosane, 2,6,10,14,18-pentamethyl-	SJBLBJCIOBWHAC-UHFFFAOYSA-N
Tetracosamethyl-cyclododecasiloxane	SOGKSNZFDBFKCV-UHFFFAOYSA-N
Silane, diethyloctyloxypentyloxy-	SPYDCMISJLGANF-UHFFFAOYSA-N

Chemical Name	INCHIKEY
Cyclopentadecane	SRONXYPFSAKOGH-UHFFFAOYSA-N
Ethanone, 2-(2-benzothiazolylthio)-1-(3,5-dimethylpyrazolyl)-	SSHGNGPVGMIRKF-UHFFFAOYSA-N
1H-imidazole-2-methanol, 1-decyl-	STRKTRKPDFMRIL-UHFFFAOYSA-N
Tritriacontane	SUJUOAZFECLBOA-UHFFFAOYSA-N
Tetradecanoic acid	TUNFSRHWOTWDNC-UHFFFAOYSA-N
Cyclohexanol, 1-methyl-4-(1-methylethenyl)-, acetate	URVNHQCLMBMWIW-UHFFFAOYSA-N
5,16[1',2']:8,13[1'',2'']-Dibenzenodibenzo[a,g]cyclododecene, 6,7,14,15-tetrahydro-	VCCYKNKAQTXXMJ-UHFFFAOYSA-N
Desoxyisosteviol	VHAZSZJVOSGWCB-UHFFFAOYSA-N
Pentatriacontane	VHQQPFLOGSTQPC-UHFFFAOYSA-N
Antra-9,10-quinone, 1-(3-hydrohy-3-phenyl-1-triazenyl)-	VJPSIIDNGIKKDT-FCQUAONHSA-N
Urs-20-en-16-ol, (16.beta.,18.alpha.,19.alpha.)-	VLZQPZWTOKZMQA-UHFFFAOYSA-N
1,3-Benzenediamine, 4-methyl-	VOZKAJLKRJDJLL-UHFFFAOYSA-N
l-Norleucine, N-ethoxycarbonyl-, decyl ester	VUBFUZRWAIWSCE-UHFFFAOYSA-N
3,5-Dinitrobenzoyl ester of tetradecen-1-ol	VXJITDSTVSJKRQ-UHFFFAOYSA-N
Fumaric acid, hexadecyl 2,2,2-trifluoroethyl ester	VXYGDTVSELMRSH-WUKNDPDISA-N
1,1'-Biphenyl, 6,2',3',4'-tetramethoxy-	WAFUMOLLNZWEQO-UHFFFAOYSA-N
Terephthalic acid, phenyl undecyl ester	WCBXIUNHUIHWAR-UHFFFAOYSA-N
benzenesulfonyl fluoride, 4-[2-(6-chloro-4-hydroxy-1-naphthalenyl)diazenyl]-3-nitro-	WCLHEMXUYREJTK-UHFFFAOYSA-N
Benzamide, 2-trifluoromethyl-5-fluoro-N-butyl-	WEMKHYPGWLQWOO-UHFFFAOYSA-N
Terephthalic acid, 3,5-difluorophenyl nonyl ester	WFSHKZROWITMLY-UHFFFAOYSA-N
Cyclohexene, 4-pentyl-1-(4-propylcyclohexyl)-	WHKAMDSYJQSDFE-UHFFFAOYSA-N
2,6,10,14-Tetramethyl-7-(3-methylpent-4-enylidene) pentadecane	WSXXWIKHJGKODD-XIEYBQDHSA-N
Cyclohexadecane, 1,2-diethyl-	WTKPOZCPQVMNOI-UHFFFAOYSA-N
1,2-Benzenediol, o-(4-methoxybenzoyl)-o'-(2,2,3,3,4,4,4-heptafluorobutyryl)-	WZIRZQOPXQZJIY-UHFFFAOYSA-N
Benzothiazole, 2-phenyl-	XBHOUXSGHYZCNH-UHFFFAOYSA-N
Octane, 3-ethyl-2,7-dimethyl-	XEMFRSYZKNPRTA-UHFFFAOYSA-N
Phenol, 4-(1-phenylethyl)-	XHASMJXNUHCHBL-UHFFFAOYSA-N
28-Nor-17.alpha.(H)-hopane	XKJROQIFLGXWEY-RWRWHMSNSA-N

Chemical Name	INCHIKEY
28-Nor-17.beta.(H)-hopane	XKJROQIFLGXWEY-UHFFFAOYSA-N
Argon	XKRFYHLGVUSROY-UHFFFAOYSA-N
Limonene	XMGQYMWWDOXHJM-UHFFFAOYSA-N
4H-1,2,4-triazole-3,5-diamine, N3-(4-fluorophenyl)-N5-methyl-	XMTBPMSCYOGVAV-UHFFFAOYSA-N
N-(2-Acetylcyclopentylidene)cyclohexylamine	XPYRJAVRRRFRPK-UHFFFAOYSA-N
1,1,3,3-Tetraallyl-1,3-disilacyclobutane	XQTQGKSKOTXWNX-UHFFFAOYSA-N
phenol, 2-(1,1,3,3-tetramethylbutyl)-	XSXWOBXNYNULJG-UHFFFAOYSA-N
Hexatriacontane	YDLYQMBWCWFRAI-UHFFFAOYSA-N
Dibenzo[def,mno]chrysene	YFIJJNAKSZUOLT-UHFFFAOYSA-N
1-Bromo-11-iodoundecane	YIAXRTMSPXAUAF-UHFFFAOYSA-N
Phenanthrene, 2-dodecyltetradecahydro-	YIZZECQVSWASEZ-UHFFFAOYSA-N
Pentacosane	YKNWIILGEFFOPE-UHFFFAOYSA-N
[1,2,4]Oxadiazole, 3-(5-bromofuran-2-yl)-5-furan-2-yl-	YSJMNSLGYCCHMD-UHFFFAOYSA-N
5-Amino-3-[1-cyano-2-(3,4-dimethoxyphenyl)vinyl]-1-phenyl-1H-pyrazole-4-carbonitrile	YUNFBRJQRROFMB-GDNBJRDFSA-N
Benzenamine, 4-bromo-4-(4-diethylaminobenzylidene)-	YWMVXLSSSKJXMI-UHFFFAOYSA-N
3-Methyldotriacontane	YXJZLSDRPAJSLL-UHFFFAOYSA-N
Nitrone, N-(p-chlorophenyl)-.alpha.-(o-methoxyphenyl)-	YXKKDOOUKQUKBL-UHFFFAOYSA-N
Dotriacontyl trifluoroacetate	ZKTKQWPZEBJTKD-UHFFFAOYSA-N
1,30-Triacontanediol	ZOIJRPSLRHKPEH-UHFFFAOYSA-N
Nonadecane, 1-chloro-	ZPHKHTAJPZOPHM-UHFFFAOYSA-N
9-Octadecenoic acid, (E)-	ZQPPMHVWECSIRJ-MDZDMXLPSA-N
9-Octadecenoic acid	ZQPPMHVWECSIRJ-UHFFFAOYSA-N
Benzamide, N-phenyl-	ZVSKZLHKADLHSD-UHFFFAOYSA-N
9H-Fluorene, 9-methylene-	ZYASLTYCYTYKFC-UHFFFAOYSA-N
Octacosane	ZYURHZPYMFLWSH-UHFFFAOYSA-N
1,4-Benzenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-	ZZMVLMVFYMGSMY-UHFFFAOYSA-N

3.1.5. Identification of Polar Organic Chemicals in Crumb Rubber Extracts Using High-Resolution Accurate-Mass Liquid Chromatography/Mass Spectrometry

The analysis of polar (hydrophilic or charged) organic chemicals by GC/MS is less desirable due to the low mobility of these chemicals in the GC capillary column. As a result, OEHHA has elected to use LC/MS to characterize the polar organic constituents in the crumb rubber extracts. Polar solvent extracts of crumb rubber samples are being analyzed using reversed-phase high-resolution accurate-mass liquid chromatography/mass spectrometry (HRAM-LC/MS) under a positive ionization mode and repeated in a negative ionization mode with instrumental settings detailed in Appendix F.

The crumb rubber samples were extracted with water/methanol (9:1) following methods detailed in Appendix D. Extracts are being analyzed by a HRAM-LC/MS system consisting of an LC system (Agilent Technologies, Santa Clara, CA) that is connected in line with an LTQ-Orbitrap-XL (linear iontrap quadrupole) mass spectrometer system equipped with an electrospray ionization (ESI) source (Thermo Fisher Scientific, Waltham, MA). The LTQ-Orbitrap mass analyzer system delivers mass spectral data (MS1[3] and MS2[4]) in a high-resolution accurate-mass capacity (sub-1 ppm range) with a high sensitivity and a wide dynamic range. The highly accurate molecular ion masses (MS1) can then be used to derive the precise molecular formula of unknown chemicals, but not the structure of the chemicals. With sufficient prior knowledge of mixtures of interest (structure and properties of chemical suspects, along with the availability of reference mass spectra), molecular mass and unknown molecular features obtained from the HRAM-LC/MS analysis can be compared with a spectral database of suspected chemicals to identify plausible hits (Sobus et al., 2018).

It is noteworthy that there is a lack of standardized LC/MS analytical protocols in the literature and LC/MS spectral databases containing diverse chemical classes. These deficiencies hinder the use of HRAM-LC/MS for non-targeted analysis, especially suspect screening analysis of crumb rubber.

To tackle this challenge, OEHHA is performing non-targeted chemical analysis with a two-tiered approach. Currently, OEHHA has evaluated the HRAM-LC/MS data collected under the positive ionization mode. However, HRAM- LC/MS data collected under negative ionization model will be processed using the same approach.

First, we are making tentative chemical identifications using suspect screening analysis against established tire-related chemical lists. Then, we are conducting non-targeted chemical analysis to predict tentative chemical identifications using available cheminformatics tools (see **Figure 3-1** for the workflow). Based on the non-targeted chemical analysis results, OEHHA is compiling a list of tentatively identified polar

[3] MS1 spectral data are mass of molecular ion/charge (m/z). For ESI ionization, predominant ions recorded in the MS1 spectrum are the parent molecular ions with single charge (z=1) or with limited fragments. Generally, the molecular ions take the form of $[M+H]^+$ under the positive ionization mode and $[M-H]^-$ under the negative ionization mode of the LC/MS.

[4] MS2 spectral data are the fragmentation patterns or molecular features of a parent chemical. These signature molecular features can be used to identify unknown chemical structures.

organic chemicals in the crumb rubber extracts. These chemicals are being prioritized and high priority chemicals are being confirmed using reference standards. The confirmed chemicals are being compiled into the Targeted Chemical List, which will be used to guide the bioaccessibility study of field samples. Detailed steps in each tier analysis are listed in Appendix A.

3.1.5.1. Tier 1. Suspect Screening Analysis of Extractable Polar Organic Chemicals in Crumb Rubber Using Established Databases

In the early phase of this project, OEHHA conducted a literature review of tire-related studies. A tire-related chemical (confirmed or suspected) list was assembled and presented at the First Meeting of the OEHHA Synthetic Turf Scientific Advisory Panel on February 5, 2016 (OEHHA, 2016). OEHHA applies this tire-related chemical list to search for chemicals in polar extracts of crumb rubber in the Tier 1 suspect screening analysis. In addition, the US EPA Distributed Structure-Searchable Toxicity (DSSTox) Database (USEPA, https://comptox.epa.gov/dashboard) is searched to enrich the pool of tentatively identified chemicals (**Figure 3-2** and Appendix A).

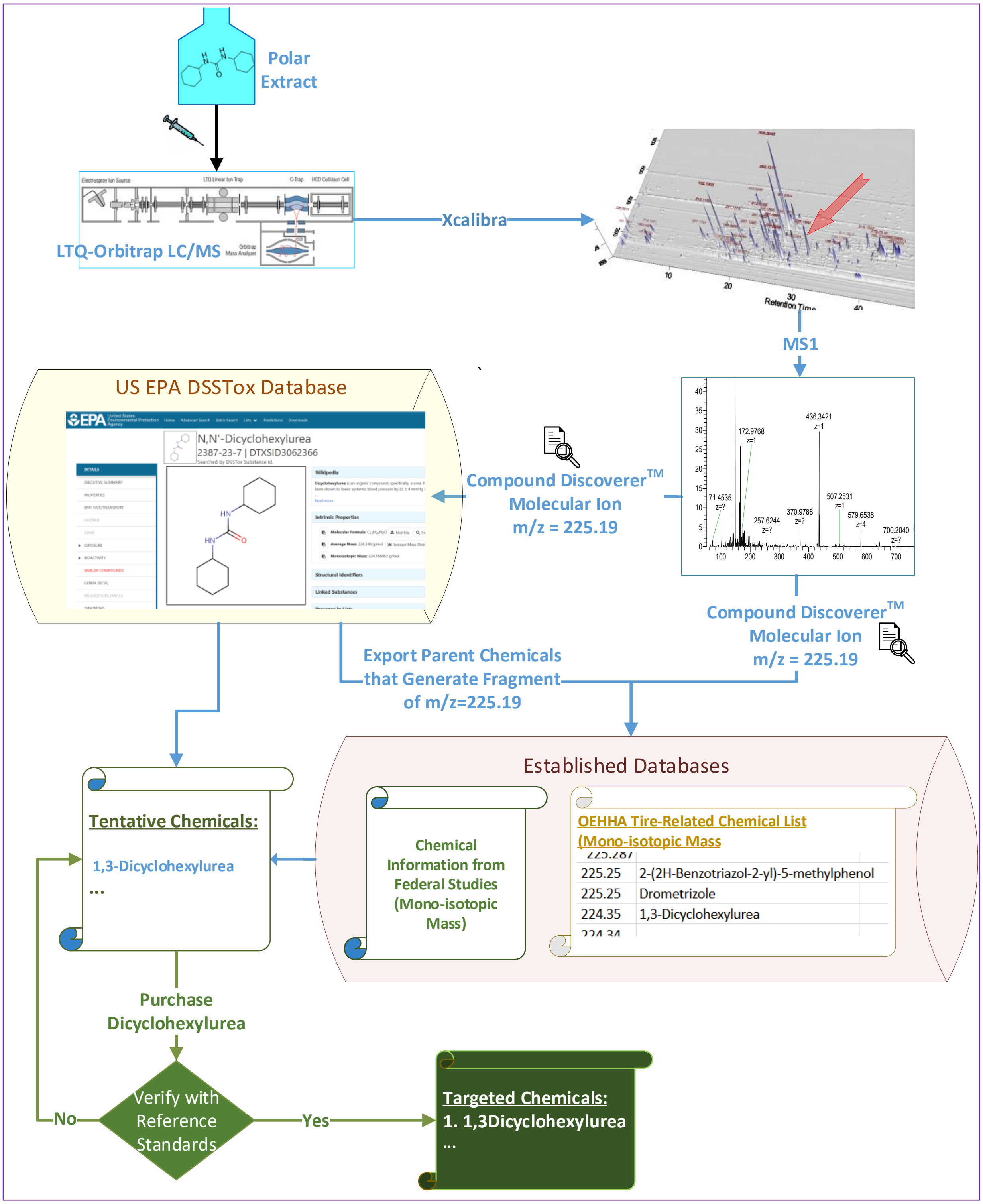

Figure 3-2. A Scheme Diagram Showing the Workflow of Tier 1 Suspect Screening Analysis – Application of Established Databases to Identify Extractable Polar Organic Chemicals in Crumb Rubber

For the first attempt, OEHHA has selected 23 tentatively identified polar chemicals to be confirmed by reference standards. Currently, the identity of 18 chemicals has been confirmed (**Table 3-2**). The confirmed chemicals have been added to the Chemical Target List.

Table 3-2. Eighteen Polar Chemicals, in Crumb Rubber Extracts, Identified by Suspect Screening Analysis and Confirmed Using Reference Standards

Chemical Name	CAS	Formula
1,3-Benzothiazole-2-thiol	149-30-4	C7H5NS2
N,N-Diethyl-meta-toluamide (DEET)	134-62-3	C12H17NO
Phenoxazine	135-67-1	C12H9NO
1,3-Benzothiazol-2-amine	136-95-8	C7H6N2S
3,5-Di-tert-butyl-4-hydroxybenzaldehyde	1620-98-0	C15H22O2
N,N'-Dicyclohexylurea	2387-23-7	C13H24N2O
13-cis-Retinoic acid	4759-48-2	C20H28O2
2-(Methylthio)benzothiazole	615-22-5	C8H7NS2
Linoleic acid	60-33-3	C18H32O2
N-Cyclohexyl-N-methylcyclohexanamine	7560-83-0	C13H25N
N-Cyclohexylformamide	766-93-8	C7H13NO
Benzothiazolone	934-34-9	C7H5NOS
N,N'-Diphenyl-p-phenylenediamine - 2H	74-31-7	C18H14N2
Benzothiazole	95-16-9	C7H5NS
Dicyclohexylamine	101-83-7	C12H23N
1,3-Diphenylguanidine	102-06-7	C13H13N3
Diphenylurea	102-07-8	C13H12N2O
Oleic acid	112-80-1	C18H34O2

Chemicals that were tentatively identified through the US EPA DSSTox Database search do not yield suitable candidates for the confirmation process. A majority of the matches from US EPA DSSTox Database search are either pesticides, food additives, or pharmaceuticals, which are probably not related to crumb rubber. As a result, OEHHA has developed a Tier 2 chemical identification protocol to expand the non-targeted chemical analysis with the aid of cheminformatics tools.

3.1.5.2. Tier 2 Non-Targeted Analysis of Extractable Polar Organic Chemicals in Crumb Rubber with the Aid of Cheminformatics Tools

OEHHA queries the HRAM-LC/MS data for tentative chemical predictions with the aid of the web-based Competitive Fragmentation Modeling algorithm (CFM-ID, version 3.0, Wishart Research Group, University of Alberta, Edmonton, Canada, http://cfmid3.wishartlab.com/publications). CFM-ID encompasses an ESI-MS/MS spectral library of in silico spectra and experimental spectra collected from eleven databases (CASMI2016, ContaminantDB, DrugBank, FiehnLib, HMDB, KEGG, MassBank, MetaboBASE, NIST, PytoHub and iTree). **Figure 3-3** shows the workflow of the Tier 2 non-targeted analysis of extractable polar chemicals in crumb rubber and Appendix A presents details in model input and steps of the analysis.

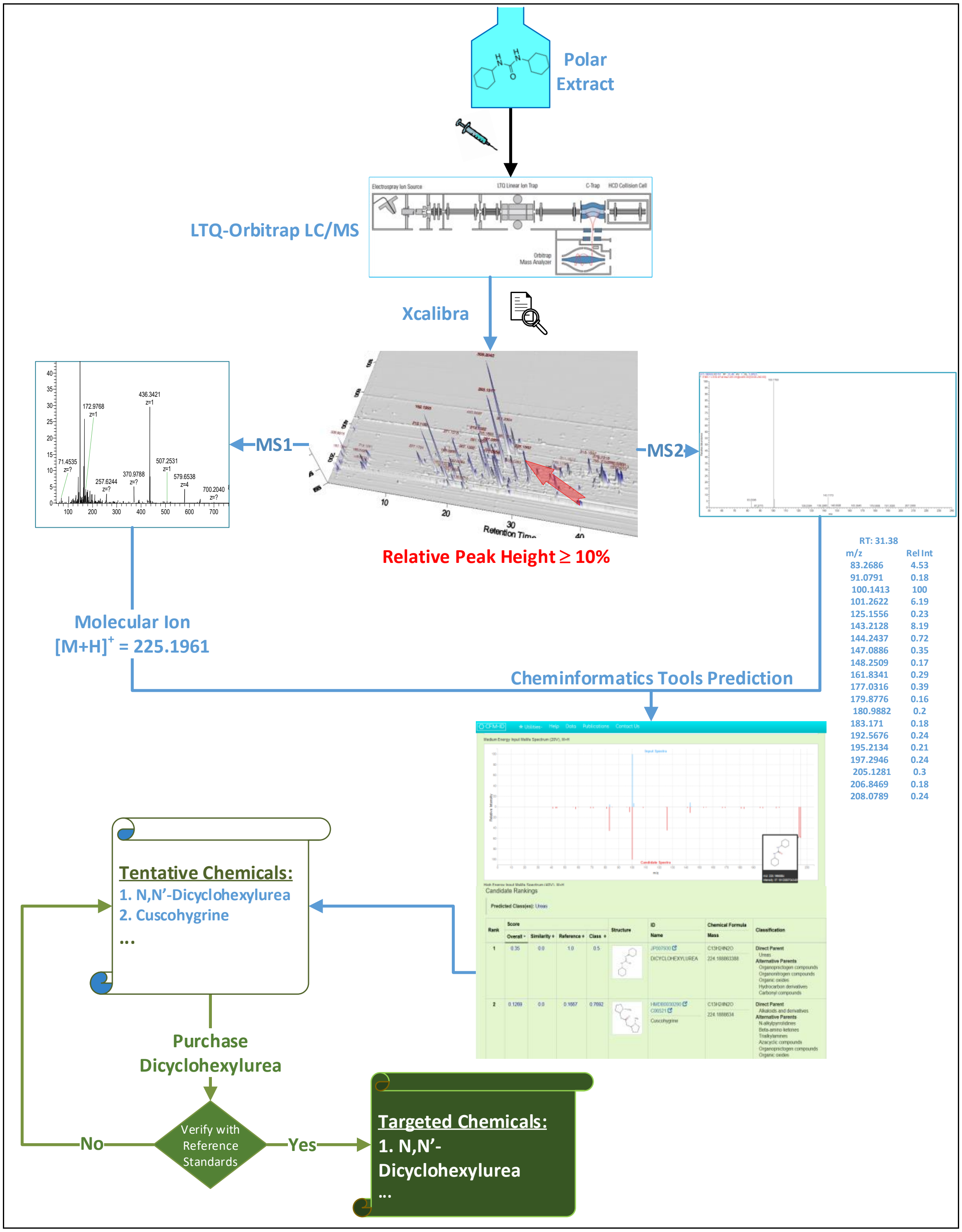

Figure 3-3. A Schematic Diagram Showing the Workflow of Tier-2 Non-Targeted Chemical Analysis – Predication of Tentatively Identified Polar Chemicals in Crumb Rubber Extracts Using HRAM-LC/MS and Cheminformatics Tools

OEHHA has tested five web-based and one proprietary cheminformatic algorithms that were developed to predict chemical structures based on MS/MS fragmentation patterns.

- MetFrag (Mass Spectroscopy and Bioinformatics, Bioinformatics Center Gatersleben-Halle, German, https://msbi.ipb-halle.de/MetFragBeta/) (Ruttkies et al., 2016)
- Global Natural Products Social Molecular Networking (GNPS, (University of California San Diego, https://gnps.ucsd.edu/ProteoSAFe/static/gnps-splash.jsp) (Wang et al., 2016)
- XCMS (The Scripps Research Institute, La Jolla, CA, https://xcmsonline.scripps.edu/landing_page.php?pgcontent=mainPage)
- CSI FingerID (Friedrich Schiller University, Jena, Germany, https://www.csi-fingerid.uni-jena.de/) (Duhrkop et al., 2015)
- Compound Discoverer (version 3.0, ThermoFisher Scientific, Waltham, MA)
- Competitive Fragmentation Modeling-ID (CFM-ID, version 3.0, Wishart Research Group, University of Alberta, Edmonton, Canada, http://cfmid3.wishartlab.com/publications) (Djoumbou-Feunang et al., 2019)

Depending on the focus of each algorithm, these models were trained with spectral data generated from selected chemical categories (e.g. DrugBank for pharmaceuticals, HMDB for metabolomics, or KEGG for genomics). OEHHA challenged these models with the MS2 data of 18 reference standards. Among these models, CFM-ID produced the highest prediction accuracy, by correctly predicting the chemical structure of 13 standards with 11 as the top first candidates, 2 as the top second candidates. The other 5 standard chemicals were not in the database. The CFM-ID model validation results are summarized in Table 3-3.

Table 3-3. CFM-ID Validation Results

Reference Standard[1]	CAS no.	Molecular Formula	m/z Ion Mass	CFM-ID Candidate Number[2]
1,3-Benzothiazole-2-thiol		7H5NS2	167.9935	1
N,N-Diethyl-meta-toluamide (DEET)	134-62-3	C12H17NO	192.1383	1
N,N'-Dicyclohexylurea	2387-23-7	C13H24N2O	225.1961	1
13-cis-Retinoic acid	4759-48-2	C20H28O2	301.2162	1

Reference Standard[1]	CAS no.	Molecular Formula	m/z Ion Mass	CFM-ID Candidate Number[2]
1,3-Dihydro-2H-benzimidazole-2-thione	583-39-1	C7H6N2S	151.0323	1
2-(Methylthio)benzothiazole	615-22-5	C8H7NS2	182.0092	1
N-Cyclohexylformamide	766-93-8	C7H13NO	128.107	1
N,N'-Diphenyl-p-phenylenediamine - 2H	74-31-7	C18H14N2	259.123	1
Benzothiazole	95-16-9	C7H5NS	136.0215	1
Dicyclohexylamine	101-83-7	C12H23N	182.1903	1
Oleic acid	112-80-1	C18H34O2	281.248	1
1,3-Benzothiazol-2-amine	136-95-8	C7H6N2S	151.0324	2
Benzothiazolone	934-34-9	C7H5NOS	152.0164	2
N-Cyclohexyl-N-methylcyclohexanamine	7560-83-0	C13H25N	196.206	Not Found
1,3,3-Trimethyl-2-methyleneindoline	118-12-7	C12H15N	174.1277	Not Found
Phenoxazine	135-67-1	C12H9NO	184.0755	Not Found
3,5-Di-tert-butyl-4-hydroxybenzaldehyde	1620-98-0	C15H22O2	235.1693	Not Found
1,3-Diphenylguanidine	102-06-7	C13H13N3	212.1182	Not Found

[1]All reference standards were analyzed with LC/MS under a positive ionization mode, except for oleic acid, which was analyzed with LC/MS under a negative ionization mode.

[2]Not Found: Chemical is not on the list of possible candidates in the model.

OEHHA has selected the web-based cheminformatics algorithm CFM-ID (version 3.0) to support the Tier-2 non-targeted analysis of polar crumb rubber extracts. One purpose of this tool is to aid in the non-targeted identification using electrospray ionization-MS2 (ESI-MS2) data via MS2 spectra matching. The latest version of CFM-ID (Djoumbou-Feunang et al., 2019) encompasses a library of over 397,000 unique ESI-MS/MS spectra with more than 229,000 unique chemicals. Over 87,000 of the spectra were experimentally collected and more than 300,000 spectra were in silico (computationally) generated. Briefly, molecular ion mass and fragmentation data are entered to start a query. CFM-ID filters the spectral database to pool candidate chemicals with molecular masses that fall within the queried molecular mass range (e.g., ± 5 ppm). An overall score, composed of a set of three normalized scores[5], are calculated for each candidate. The candidates are then ranked according to the overall scores, which suggest the best match.

Tools like CSI:FingerID, when given an ESI-MS/MS spectrum, attempt to quantify the probability that a given chemical structure may produce the given fragmentation pattern. MetFrag, another web-based tool, creates a candidate pool by searching the queried monoisotopic mass in publicly available databases e.g., PubChem and ChemSpider. The model then generates in silico spectral data for each candidate, which are compared with the unknown spectral data for matching. CFM-ID, on the other hand, attempts to match the queried unknown spectrum with the model's library of in silico predicted ESI-MS/MS spectra and experimentally collected ESI-MS-MS spectra.

3.1.6. Results – Confirmed Targeted Chemical Lists and Tentatively Identified Chemical List

OEHHA is following the non-targeted chemical analysis workflows to characterize the solvent-extractable chemicals from pre-installed and field crumb rubber samples. Spectral data of polar extracts analyzed by HRAM-LC/MS in negative ionization mode are still being evaluated. The current listed tentatively identified polar organic chemicals and confirmed targeted chemicals generated from HRAM-LC/MS were analyzed in a positive ionization mode.

Currently, OEHHA has confirmed 126 chemicals. They have been compiled to the Targeted Chemical List (**Table 3-4**). In the crumb rubber extracts, OEHHA confirmed 22 polar targets, 32 non-polar targets, and 20 PAH targets. In addition, 11 aldehydes and 67 confirmed volatile organic targets were detected in field air samples. Some of these chemicals were detected in multiple samples (field air samples, polar extracts and/or non-polar extracts of crumb rubber) by different instruments (LC/MS and GC/MS).

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[5]The set of chemical scores are the normalized spectral matching CFM-ID score, the normalized ClassyFire score, and the Reference score. The spectral matching CFM-ID score describes how well the unknown fragments matched with each respective candidate. The Classyfire score indicates the structural and functional similarities between the unknown chemical and each respective candidate. The Reference score relates to the number of citations each candidate is mentioned in the literature. The maximum number of citations applied to derive the Reference score is 156. Finally, a computationally generated weighing factor is applied to each of these 3 normalized score to derive the Overall Score of each candidates.

Table 3-4. Confirmed Chemical Target List

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
2-Methylnaphthalene	QIMMUPPBPVKWKM-UHFFFAOYSA-N		x	x		x
Benzothiazole	IOJUPLGTWVMSFF-UHFFFAOYSA-N	x	x			x
1,4-Benzenediamine, N,N'-diphenyl-	UTGQNNCQYDRXCH-UHFFFAOYSA-N	x	x			x
2-Mercaptobenzothiazole	YXIWHUQXZSMYRE-UHFFFAOYSA-N	x	x			x
Pyrene	BBEAQIROQSPTKN-UHFFFAOYSA-N		x	x		
Hexadecane	DCAYPVUWAIABOU-UHFFFAOYSA-N		x			x
Dibutyl phthalate	DOIRQSBPFJWKBE-UHFFFAOYSA-N		x			x
Diethyl Phthalate	FLKPEMZONWLCSK-UHFFFAOYSA-N		x			x
Fluoranthene	GVEPBJHOBDJJJI-UHFFFAOYSA-N		x	x		
Benzaldehyde	HUMNYLRZRPPJDN-UHFFFAOYSA-N				x	x
Hexanal	JARKCYVAAOWBJS-UHFFFAOYSA-N				x	x
Dimethyl phthalate	NIQCNGHVCWTJSM-UHFFFAOYSA-N		x			x
2,6-Di-tert-butyl-p-cresol	NLZUEZXRPGMBCV-UHFFFAOYSA-N		x			x

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
n-Butylbenzene	OCKPCBLVNKHBMX-UHFFFAOYSA-N		x			x
Aniline	PAYRUJLWNCNPSJ-UHFFFAOYSA-N		x			x
1-Methylnaphthalene	QPUYECUOLPXSFR-UHFFFAOYSA-N			x		x
Naphthalene	UFWIBTONFRDIAS-UHFFFAOYSA-N			x		x
D-Limonene	XMGQYMWWDOXHJM-JTQLQIEISA-N		x			x
Butanal	ZTQSAGDEMFDKMZ-UHFFFAOYSA-N				x	x
3,5-di-tert-Butyl-4-hydroxybenzaldehyde	DOZRDZLFLOODMB-UHFFFAOYSA-N	x	x			
N-Cyclohexyl-N-methylcyclohexanamine	GSCCALZHGUWNJW-UHFFFAOYSA-N	x	x			
2-(Methylthio)benzothiazole	UTBVIMLZIRIFFR-UHFFFAOYSA-N	x				x
DICYCLOHEXYLAMINE	XBPCUCUWBYBCDP-UHFFFAOYSA-N	x	x			
Benzothiazolone	YEDUAINPPJYDJZ-UHFFFAOYSA-N	x	x			
Mesitylene	AUHZEENZYGFFBQ-UHFFFAOYSA-N					x
Benzene, 2-ethyl-1,4-dimethyl-	AXIUBBVSOWPLDA-UHFFFAOYSA-N					x
Tetradecane	BGHCVCJVXZWKCC-UHFFFAOYSA-N					x

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
1-Hydroxypyrene	BIJNHUAPTJVVNQ-UHFFFAOYSA-N			x		
Bis(2-ethylhexyl) phthalate	BJQHLKABXJIVAM-UHFFFAOYSA-N		x			
3-Carene	BQOFWKZOCNGFEC-UHFFFAOYSA-N					x
Acetone	CSCPPACGZOOCGX-UHFFFAOYSA-N				x	
o-Xylene	CTQNGGLPUBDAKN-UHFFFAOYSA-N					x
Azulene	CUFNKYGDVFVPHO-UHFFFAOYSA-N					x
Acenaphthene	CWRYPZZKDGJXCA-UHFFFAOYSA-N			x		
Tetrachloroethylene	CYTYCFOTNPOANT-UHFFFAOYSA-N					x
Texanol TXIB (mono-isomer)	DAFHKNAQFPVRKR-UHFFFAOYSA-N					x
Decane	DIOQZVSQGTUSAI-UHFFFAOYSA-N					x
Benzo[a]anthracene	DXBHBZVCASKNBY-UHFFFAOYSA-N			x		
2-Hexanone, 5-methyl-	FFWSICBKRCICMR-UHFFFAOYSA-N					x
Benzo(a)pyrene	FMMWHPNWAFZXNH-UHFFFAOYSA-N			x		
Benzo(b)fluoranthene	FTOVXSOBNPWTSH-UHFFFAOYSA-N			x		

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
Heptanal	FXHGMKSSBGDXIY-UHFFFAOYSA-N					x
Benzene, 1,2,3-trimethyl-	FYGHSUNMUKGBRK-UHFFFAOYSA-N					x
Resorcinol	GHMLBKRAJCXXBS-UHFFFAOYSA-N		x			
a-Pinene	GRWFGVWFFZKLTI-RKDXNWHRSA-N					x
Benzene, 1,2,4-trimethyl-	GWHJZXXIDMPWGX-UHFFFAOYSA-N					x
Benzo(g,h,I)perylene	GYFAGKUZYNFMBN-UHFFFAOYSA-N			x		
Nonanal	GYHFUZHODSMOHU-UHFFFAOYSA-N					x
Benzo(k)fluoranthene	HAXBIWFMXWRORI-UHFFFAOYSA-N			x		
Diisononyl phthalate	HBGGXOJOCNVPFY-UHFFFAOYSA-N		x			
Trichloromethane	HEDRZPFGACZZDS-UHFFFAOYSA-N					x
p-Cymene	HFPZCAJZSCWRBC-UHFFFAOYSA-N					x
Valeraldehyde	HGBOYTHUEUWSSQ-UHFFFAOYSA-N				x	
Cyclotetrasiloxane, octamethyl-	HMMGMWAXVFQUOA-UHFFFAOYSA-N					x
Cyclotrisiloxane, hexamethyl-	HTDJPCNNEPUOOQ-UHFFFAOYSA-N					x

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
Acenapthylene	HXGDTGSAIMULJN-UHFFFAOYSA-N			x		
Acetaldehyde	IKHGUXGNUITLKF-UHFFFAOYSA-N				x	
Heptane	IMNFDUFMRHMDMM-UHFFFAOYSA-N					x
Benzyl butyl phthalate	IRIAEXORFWYRCZ-UHFFFAOYSA-N		x			
Phenol, 4-(1,1,3,3-tetramethylbutyl)-	ISAVYTVYFVQUDY-UHFFFAOYSA-N		x			
Phenol	ISWSIDIOOBJBQZ-UHFFFAOYSA-N					x
Dibenzothiophene	IYYZUPMFVPLQIF-UHFFFAOYSA-N		x			
Cyclohexanone	JHIVVAPYMSGYDF-UHFFFAOYSA-N					x
Decanal	KSMVZQYAVGTKIV-UHFFFAOYSA-N					x
Dibenz(a,h)anthracene	LHRCREOYAASXPZ-UHFFFAOYSA-N			x		
Benzene, 1-ethyl-2,4-dimethyl-	MEMBJMDZWKVOTB-UHFFFAOYSA-N					x
Diisobutyl phthalate	MGWAVDBGNNKXQV-UHFFFAOYSA-N		x			
Di-n-octyl phthalate	MQIUGAXCHLFZKX-UHFFFAOYSA-N		x			
Anthracene	MWPLVEDNUUSJAV-UHFFFAOYSA-N			x		

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
Cyclohexyl isothiocyanate	MZSJGCPBOVTKHR-UHFFFAOYSA-N		x			
Propionaldehyde	NBBJYMSMWIIQGU-UHFFFAOYSA-N				x	
Fluorene	NIHNNTQXNPWCJQ-UHFFFAOYSA-N			x		
Methyl Isobutyl Ketone	NTIZESTWPVYFNL-UHFFFAOYSA-N					x
Octanal	NUJGJRNETVAIRJ-UHFFFAOYSA-N					x
Benzene, 1,4-dichloro	OCJBOOLMMGQPQU-UHFFFAOYSA-N					x
TXIB "Kodaflex"	OMVSWZDEEGIJJI-UHFFFAOYSA-N					x
m-Tolualdehyde	OVWYEQOVUDKZNU-UHFFFAOYSA-N				x	
Cyclohexylamine	PAFZNILMFXTMIY-UHFFFAOYSA-N		x			
2-Butoxyethanol	POAOYUHQDCAZBD-UHFFFAOYSA-N					x
Styrene	PPBRXRYQALVLMV-UHFFFAOYSA-N					x
Indane	PQNFLJBBNBOBRQ-UHFFFAOYSA-N					x
Benzene, 1-chloro-4-(trifluoromethyl)-	QULYNCCPRWKEMF-UHFFFAOYSA-N					x
Undecane	RSJKGSCJYJTIGS-UHFFFAOYSA-N					x

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
2-Bromomthylnaphthalene	RUHJZSZTSCSTCC-UHFFFAOYSA-N			x		
bis(2-Ethylhexyl)adipate	SAOKZLXYCUGLFA-UHFFFAOYSA-N		x			
Formamide, N-(1,1-dimethylethyl)-	SDLAKRCBYGZJRW-UHFFFAOYSA-N					x
Dodecane	SNRUBQQJIBEYMU-UHFFFAOYSA-N					x
Benzene, 1,2,4,5-tetramethyl-	SQNZJJAZBFDUTD-UHFFFAOYSA-N					x
Methacrolein	STNJBCKSHOAVAJ-UHFFFAOYSA-N				x	
Indeno(1,2,3-cd)pyrene	SXQBHARYMNFBPS-UHFFFAOYSA-N			x		
Octane	TVMXDCGIABBOFY-UHFFFAOYSA-N					x
Benzene	UHOVQNZJYSORNB-UHFFFAOYSA-N					x
m/p-Xylene	URLKBWYHVLBVBO-UHFFFAOYSA-N					x
Hexane	VLKZOEOYAKHREP-UHFFFAOYSA-N					x
Furan, 2-methyl-	VQKFNUFAXTZWDK-UHFFFAOYSA-N					x
Chrysene	WDECIBYCCFPHNR-UHFFFAOYSA-N			x		
Formaldehyde	WSFSSNUMVMOOMR-UHFFFAOYSA-N				x	

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
a-Terpineol	WUOACPNHFRMFPN-UHFFFAOYSA-N					x
Bis(2,2,6,6-tetramethyl-4-piperidyl) sebacate	XITRBUPOXXBIJN-UHFFFAOYSA-N		x			
Phthalimide	XKJCHHZQLQNZHY-UHFFFAOYSA-N		x			
Cyclopentasiloxane, decamethyl-	XMSXQFUHVRWGNA-UHFFFAOYSA-N					x
Trichloroethylene	XSTXAVWGXDQKEL-UHFFFAOYSA-N					x
1-Hexanol, 2-ethyl-	YIWUKEYIRIRTPP-UHFFFAOYSA-N					x
g-Terpinene	YKFLAYDHMOASIY-UHFFFAOYSA-N					x
Phenanthrene	YNPNZTXNASCQKK-UHFFFAOYSA-N			x		
Ethylbenzene	YNQLUTRBYVCPMQ-UHFFFAOYSA-N					x
Toluene	YXFVVABEGXRONW-UHFFFAOYSA-N					x
Biphenyl	ZUOUZKKEUPVFJK-UHFFFAOYSA-N					x
Diisodecyl phthalate	ZVFDTKUVRCTHQE-UHFFFAOYSA-N		x			
2-Butanone	ZWEHNKRNPOVVGH-UHFFFAOYSA-N				x	
1,3-Dicyclohexylurea	ADFXKUOMJKEIND-UHFFFAOYSA-N	x				

Chemicals Name	INCHIKEY	Chemical or Matrix				
		Polar Extract	Non-Polar Extract	PAH	Aldehyde Field Air	VOC Field Air
2,2'-Dithiobisbenzothiazole	AFZSMODLJJCVPP-UHFFFAOYSA-N	x				
Diphenylurea	GWEHVDNNLFDJLR-UHFFFAOYSA-N	x				
DEET	MMOXZBCLCQITDF-UHFFFAOYSA-N	x				
1,3-Diphenylguanidine	OWRCNXZUPFZXOS-UHFFFAOYSA-N	x				
Linoleic acid	OYHQOLUKZRVURQ-HZJYTTRNSA-N	x				
2,8-dimethyl-dibenzothiophene	RRYWCJRYULRSJM-UHFFFAOYSA-N	x				
13-cis-Retinoic acid	SHGAZHPCJJPHSC-XFYACQKRSA-N	x				
N-Cyclohexylformamide	SWGXDLRCJNEEGZ-UHFFFAOYSA-N	x				
Phenoxazine	TZMSYXZUNZXBOL-UHFFFAOYSA-N	x				
1,3-Benzothiazol-2-amine	UHGULLIUJBCTEF-UHFFFAOYSA-N	x				
benzoic acid	WPYMKLBDIGXBTP-UHFFFAOYSA-N	x				
1,3-Dihydro-2H-benzimidazole-2-thione	YHMYGUUIMTVXNW-UHFFFAOYSA-N	x				
1,3,3-Trimethyl-2-methyleneindoline	ZTUKGBOUHWYFGC-UHFFFAOYSA-N	x				

There are 228 tentatively identified chemicals that have been summarized in **Table 3-5**. Among these chemicals, 46 are polar chemicals detected by LC/MS, 181 are non-polar chemicals detected by GC/MS, and 1 chemical was detected by both instruments. Tentatively identified chemicals with high priority will be verified, depending on the availability of the reference standards.

Table 3-5. Tentatively Identified Chemical List of Crumb Rubber

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Oleic acid	ZQPPMHVWECSIRJ-KTKRTIGZSA-N	x	x
4-(pentamethyldisilanyl)-phenyltrimethylsilylmethanol	BFRCFBRSQSVTJZ-UHFFFAOYSA-N	x	
Netilmicin	CIDUJQMULVCIBT-KALHTFJLSA-N	x	
Octaethylene glycol	GLZWNFNQMJAZGY-UHFFFAOYSA-N	x	
3,6,9,12,15-pentaoxaheptadecane	HYDWALOBQJFOMS-UHFFFAOYSA-N	x	
2-azacyclotridecanone	JHWNWJKBPDFINM-UHFFFAOYSA-N	x	
Glycerol-1-(o-tolyl) ether	JWDYCNIAQWPBHD-UHFFFAOYSA-N	x	
Perilla ketone	LVHLZMUFIYAEQB-UHFFFAOYSA-N	x	
6-Methoxy-2(3H)-benzoxazolone	MKMCJLMBVKHUMS-UHFFFAOYSA-N	x	
1-acetyl-4-phenyl-3-(2-pyridyl)-2-pyrazoline	NIYILJAJXQAIMA-UHFFFAOYSA-N	x	
Oxandrolone	QSLJIVKCVHQPLV-PEMPUTJUSA-N	x	
O-diethoxybenzene	QZYDOKBVZJLQCK-UHFFFAOYSA-N	x	
Cis-Vaccenic acid	UWHZIFQPPBDJPM-FPLPWBNLSA-N	x	
3,7-dimethyl-1,2,3,7-octanetetraol	UWRGONHVPULUGX-UHFFFAOYSA-N	x	
Octadec-11-en-9-ynoic acid	VENIIVIRETXKSV-UHFFFAOYSA-N	x	

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Xi-2-Hydroxy-1,3,5-bisabolatrien-9-one	VLJVBISZYRTNJO-UHFFFAOYSA-N	x	
7-hydroxycostal	VRDBEJGMTYROKE-UHFFFAOYSA-N	x	
4-ethyl-5-methyl-2-(1H-tetrazol-5-yl)-1,2-dihydro-3H-pyrazol-3-one	WAVWUEFMWJZZFB-UHFFFAOYSA-N	x	
Ru-0211	WGFOBBZOWHGYQH-MXHNKVEKSA-N	x	
Salirasib	WUILNKCFCLNXOK-CFBAGHHKSA-N	x	
(1alpha,4alpha,5beta,6alpha,11betah)-1,4-Epoxy-5-hydroxy-10(14)-germacren-12,6-olide	XJRRUWSFQFWDFM-UHFFFAOYSA-N	x	
Heptaethylene glycol	XPJRQAIZZQMSCM-UHFFFAOYSA-N	x	
Xanthoxic acid	XTFOFYSQUZTRGJ-SAZLWWCESA-N	x	
Nonaethylene glycol	YZUUTMGDONTGTN-UHFFFAOYSA-N	x	
Furanogermenone	ZLESWHXADLWJPV-UAWPZABVSA-N	x	
Jasmonic acid	ZNJFBWYDHIGLCU-HWKXXFMVSA-N	x	
5-methoxydimethyltryptamine	ZSTKHSQDNIGFLM-UHFFFAOYSA-N	x	
Hexa(methoxymethyl)melamine	BNCADMBVWNPPIZ-UHFFFAOYSA-N	x	
Schembl18443	CIDUJQMULVCIBT-IULVMANBSA-N	x	
Triethylene glycol monobutyl ether	COBPKKZHLDDMTB-UHFFFAOYSA-N	x	
Calendic acid	DQGMPXYVZZCNDQ-KBPWROHVSA-N	x	
4,4'-thio-bis(3-methyl-6-tert-butylphenol)	HXIQYSLFEXIOAV-UHFFFAOYSA-N	x	
N-hexyl-epsilon-caprolactam	JDQRYRLJZGMNIB-UHFFFAOYSA-N	x	

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
3,5-dimethoxy-2,4-dimethylphenol	KMLNRCNJULZPTB-UHFFFAOYSA-N	x	
N-acetyl-glycyl-valyl-leucyl-alanine methyl ester	LJJHAWVPDHHHQY-DUVNUKRYSA-N	x	
4'-Dihydroabscisic acid	MWGXQVSTMXPXIW-WEYXYWBQSA-N	x	
3alpha,11beta-Dihydroxy-5alpha-androstane-17-one	PIXFHVWJOVNKQK-PTXZMSDUSA-N	x	
Beta-Santalic acid	PMCPDNGTLRPFQQ-YHYXMXQVSA-N	x	
2-Methoxy-4-propylphenol	PXIKRTCSSLJURC-UHFFFAOYSA-N	x	
N-despropyl ropinirole	VKDWFHAQOZYATG-UHFFFAOYSA-N	x	
1,4-diethoxybenzene	VWGNFIQXBYRDCH-UHFFFAOYSA-N	x	
Beta-Cyclocostunolide	XUYAKPXYKQEFPD-SFDCQRBFSA-N	x	
Tetradymol	YGPYHQDJFQOKLN-GLQYFDAESA-N	x	
2-(2H-Benzotriazol-2-yl)-4-methyl-6-(2-propenyl)phenol	YKONWVIRECCMQE-UHFFFAOYSA-N	x	
3,7-dimethyl-8-oxo-2,6-octadienyl acetate(z)	YODDEHYDMMDDCV-IKVLVDHLSA-N	x	
Para-nitroacetophenone	YQYGPGKTNQNXMH-UHFFFAOYSA-N	x	
Arabsin	YRFWEPYMRLGVBZ-ANGHFORKSA-N	x	
Noraporphin-7-one, 4,5,6,6a-tetradehydro-10-ethoxy-1,2,9-trimethoxy-	ANPHOVYHXGXALX-UHFFFAOYSA-N		x
1,4-benzenediamine, N1,N1-bis(4-methylphenyl)-	APUMQQZMCHMHPW-UHFFFAOYSA-N		x
Tris(2,4-di-tert-butylphenyl) phosphate	AZSKHRTUXHLAHS-UHFFFAOYSA-N		x
Trans-13-Octadecenoic acid	BDLLSHRIFPDGQB-AATRIKPKSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Heptacosane	BJQWYEJQWHSSCJ-UHFFFAOYSA-N		x
17-pentatriacontene	BLCUZCCTSBVFSV-LAPDZXRHSA-N		x
Silane diethyl(2-chloro-5-methylphenoxy)decyloxy-	BSAIYLSZAFPXIX-UHFFFAOYSA-N		x
Benzothiazole, 2-propyldithio-	BTHJYDJZMRDGNV-UHFFFAOYSA-N		x
Cyclopenta[cd]pyrene	BZCXQYVNASLLQO-UHFFFAOYSA-N		x
Eicosane	CBFCDTFDPHXCNY-UHFFFAOYSA-N		x
3-Methylbenzylamine, N,N-didecyl-	CBFQTDCWCFJSHB-UHFFFAOYSA-N		x
1-octadecene	CCCMONHAUSKTEQ-UHFFFAOYSA-N		x
3-Chloro-1-anthraquinonecarboxylic acid	CISPGBHKPKMNKZ-UHFFFAOYSA-N		x
Decahydro-8a-ethyl-1,1,4a,6-tetramethylnaphthalene	CLRULWBJJWDXOA-UHFFFAOYSA-N		x
6-Octadecenoic acid, (Z)-	CNVZJPUDSLNTQU-SEYXRHQNSA-N		x
2H-Benzimidazol-2-one, 1,3-dihydro-5-methyl-	CTCHXZUMFHNSHM-UHFFFAOYSA-N		x
Androstan-3-one, (aminocarbonyl)hydrazone, (5.alpha.)-	CTIMIVMPECOCMD-RGNNZJRVSA-N		x
Phenanthrene, 1-methyl-	DOWJXOHBNXRUOD-UHFFFAOYSA-N		x
O-Cyanobenzoic acid	DTNSDCJFTHMDAK-UHFFFAOYSA-N		x
Benzene, 2,4-diisocyanato-1-methyl-	DVKJHBMWWAPEIU-UHFFFAOYSA-N		x
Oxalic acid, isobutyl nonyl ester	FFFMBVYSYMUSKR-UHFFFAOYSA-N		x
Tricosane	FIGVVZUWCLSUEI-UHFFFAOYSA-N		x
Benzenamine, 2-methoxy-N-[2-[1-(4-bromophenyl)-5-tetrazolyl]ethenyl]-	FIROPRPTDLRILV-ZHACJKMWSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Hexadecanoic acid, methyl ester	FLIACVVOZYBSBS-UHFFFAOYSA-N		x
Phenol, 2,4-bis(1-methyl-1-phenylethyl)-	FMUYQRFTLHAARI-UHFFFAOYSA-N		x
Heneicosane	FNAZRRHPUDJQCJ-UHFFFAOYSA-N		x
Triacontyl pentafluoropropionate	FQGLWEGVMMDANK-UHFFFAOYSA-N		x
7H-Benzo[c]fluorene	FRIJWEQBTIZQMD-UHFFFAOYSA-N		x
P-Anisic acid, 3,4-dichlorophenyl ester	FRVXSRVZQSAALV-UHFFFAOYSA-N		x
C(14a)-Homo-27-nor-14.beta.-gammaceran-3.alpha.-ol	GAPITCNXWSCZLW-UHFFFAOYSA-N		x
Pyridine, 3-(1a,2,7,7a-tetrahydro-2-methoxy-1-phenyl-1,2,7-metheno-1H-cyclopropa[b]naphthalen-8-yl)-	GAYPUVQXMOAWPJ-UHFFFAOYSA-N		x
2-(5-Amino-3,4-dicyanopyrazol-1-yl)-5,6-dimethylpyridine-3,4-dicarbonitrile	GBVKRCMZSHTBNE-UHFFFAOYSA-N		x
(1S,2E,4S,5R,7E,11E)-Cembra-2,7,11-trien-4,5-diol	GFPBWVUILKAAQD-ZJRJPKBJSA-N		x
Benzene, (2-methylene-1-phenylcyclopropyl)-	GILVKAZLLFNSHJ-UHFFFAOYSA-N		x
1,1':4',1":4",1'"-quaterphenyl	GPRIERYVMZVKTC-UHFFFAOYSA-N		x
Tetratriacontane	GWVDBZWVFGFBCN-UHFFFAOYSA-N		x
Anthracene, 2-methyl-	GYMFBYTZOGMSQJ-UHFFFAOYSA-N		x
7-Hydroxy-1-indanone	HFMZPBSZKCDKOR-UHFFFAOYSA-N		x
9-hexacosene	HGTCGIXAQAYYBS-UHFFFAOYSA-N		x
A'-Neogammacer-22(29)-ene	HHXYJYBYNZMZKX-PYQRSULMSA-N		x
Hexacosane	HMSWAIKSFDFLKN-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
5,9-Undecadien-2-one, 6,10-dimethyl-, (Z)-	HNZUNIKWNYHEJJ-XFXZXTDPSA-N		x
Docosane	HOWGUJZVBDQJKV-UHFFFAOYSA-N		x
N-(2,6-Dimethylphenyl)-N-[(2E)-3-methyl-1,3-thiazinan-2-ylidene]amine	HOYUJOLOMZWOON-UHFFFAOYSA-N		x
Methyl stearate	HPEUJPJOZXNMSJ-UHFFFAOYSA-N		x
6-(4-Methoxyphenyl)-4-(3-methylphenyl)-2-oxo-1H-pyridine-3-carbonitrile	HVTYZTZTCVQEEF-UHFFFAOYSA-N		x
Undecane, 4,7-dimethyl-	IEVWHTVOIZEXCC-UHFFFAOYSA-N		x
Nonacosane	IGGUPRCHHJZPBS-UHFFFAOYSA-N		x
9-tricosene, (z)-	IGOWHGRNPLFNDJ-ZPHPHTNESA-N		x
Diisooctyl phthalate	IJFPVINAQGWBRJ-UHFFFAOYSA-N		x
N-Hexadecanoic acid	IPCSVZSSVZVIGE-UHFFFAOYSA-N		x
Hentriacontane	IUJAMGNYPWYUPM-UHFFFAOYSA-N		x
2-[4-(4-Methoxyphenyl)-3-phenylpyrazol-1-yl]-4-phenylthiazole	IUYUBWDOLWCQLQ-UHFFFAOYSA-N		x
6-Isopropenyl-4,8a-dimethyl-4a,5,6,7,8,8a-hexahydro-1H-naphthalen-2-one	IVZATFCVCDHOLU-UHFFFAOYSA-N		x
Benzo[d,E]benzimidazo[2,1-a]isoquinolin-7-one, 2-nitro-3-hydroxy-	IXZMACLZYUKKSA-UHFFFAOYSA-N		x
17,21-dimethylheptatriacontane	JFFONUMNQVVGPB-UHFFFAOYSA-N		x
3-pyrrolidinol	JHHZLHWJQPUNKB-UHFFFAOYSA-N		x
Hexahydropyridine, 1-methyl-4-[4,5-dihydroxyphenyl]-	JKYGPAJMFOJYKA-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
1-Formyl-2,2,6-trimethyl-3-(3-methyl-but-2-enyl)-6-cyclohexene	JMUCXOSTKXDDDI-UHFFFAOYSA-N		x
(Z)-(Z)-Hex-3-en-1-yl 2-methylbut-2-enoate	JNWQKXUWZWKUAY-BHHIIOOYSA-N		x
Benzenepropanoic acid, 4-[(2,4-dinitrophenyl)azo]-, 1-methylethyl ester	JRNMWCQNLLKQDY-UHFFFAOYSA-N		x
Triacontane	JXTPJDDICSTXJX-UHFFFAOYSA-N		x
4-(2,4,4,5-Tetramethyl-1-cyclohexenyl)-trans-3-buten-2-one 2,4-dinitrophenylhydrazone	JYOCKQZMDMEGHE-KKVXJHJLSA-N		x
1,4-Benzenediol, 2,5-bis(1,1-dimethylethyl)-	JZODKRWQWUWGCD-UHFFFAOYSA-N		x
Heptadecanoic acid	KEMQGTRYUADPNZ-UHFFFAOYSA-N		x
Phthalic acid, di(2-propylpentyl) ester	KIYUVQCUDDMZRE-UHFFFAOYSA-N		x
Pyridine, 2-(4-methylphenyl)-	KJNZQKYSNAQLEO-UHFFFAOYSA-N		x
Nonahexacontanoic acid	KTUPKHQFSAAMEE-UHFFFAOYSA-N		x
Hexane, 3,3-dimethyl-	KUMXLFIBWFCMOJ-UHFFFAOYSA-N		x
Tetracontane	KUPLEGDPSCCPJI-UHFFFAOYSA-N		x
4H-Pyran-3-carboxylic acid, 2-amino-5-cyano-6-ethyl-4-(3-pyridinyl)-, methyl ester	KVZIBJODRKBIRE-UHFFFAOYSA-N		x
.Gamma.-sitosterol	KZJWDPNRJALLNS-FBZNIEFRSA-N		x
Cyclotetradecane, 1,7,11-trimethyl-4-(1-methylethyl)-	LHORCXXUZJAMPU-UHFFFAOYSA-N		x
Nonadecane	LQERIDTXQFOHKA-UHFFFAOYSA-N		x
Cholest-5-en-3-ol, 24-propylidene-, (3.beta.)-	LVMOSMRIAUDGQC-CDXQRKPWSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
N-Caproic acid vinyl ester	LZWYWAIOTBEZFN-UHFFFAOYSA-N		x
Ethanone, 1-[5-(methylthio)-2-nitrophenyl]-	MCGHSLFZLHZTOS-UHFFFAOYSA-N		x
Baccharane	MDHNGUIZZLNVNV-UHFFFAOYSA-N		x
9,10-Anthracenedione, 1-amino-4-hydroxy-2-phenoxy-	MHXFWEJMQVIWDH-UHFFFAOYSA-N		x
24-Norcholane, 23-[2-methyl-1-(1-methylethyl)cyclopropyl]-, (5.alpha.)-	MLIRMQLHYQMJGR-GSNUTHIDSA-N		x
Lupeol	MQYXUWHLBZFQQO-QGTGJCAVSA-N		x
Tetrapentacontane, 1,54-dibromo-	MYKPFQFCUJYEOQ-UHFFFAOYSA-N		x
1,8-Dioxa-5-thiaoctane, 8-(9-borabicyclo[3.3.1]non-9-yl)-3-(9-borabicyclo[3.3.1]non-9-yloxy)-1-phenyl-	MYMAGHMBDNHZAR-UHFFFAOYSA-N		x
Allopregn-5,16-diene-3.beta.-ol-20-one acetate	MZWRIOUCMXPLKV-UHFFFAOYSA-N		x
Pentanoic acid, 2-methyl-, anhydride	NCYCWNILADFMPI-UHFFFAOYSA-N		x
Heptadecane	NDJKXXJCMXVBJW-UHFFFAOYSA-N		x
L-Norvaline, n-propoxycarbonyl-, undecyl ester	NLNVUHNNULQOPG-UHFFFAOYSA-N		x
3-octanol	NMRPBPVERJPACX-UHFFFAOYSA-N		x
Demecolcine	NNJPGOLRFBJNIW-HNNXBMFYSA-N		x
8-Phenyl-5,5a,6,10,10a,11-hexahydro-5,11-(O-benzeno)-6,10-ethenocyclohepta(b)naphthalen-7-one	NULPYAOBDIJGTA-UHFFFAOYSA-N		x
Phenanthrene, 1,7-dimethyl-	NZCMUISOTIPJAM-UHFFFAOYSA-N		x
Behenyl chloride	OACXFSZVCDOBKF-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
2-Ethyl-hexoic acid	OBETXYAYXDNJHR-UHFFFAOYSA-N		x
Benzene, 1-ethoxy-4-[(trimethylsilyl)oxy]-	OBSRGAKXHVEYPY-UHFFFAOYSA-N		x
3,3'-dinitrobenzidine	OCEINMLGYDSKFW-UHFFFAOYSA-N		x
Friedelan-3-one	OFMXGFHWLZPCFL-SVRPQWSVSA-N		x
3,3',8,8'-Tetrahydroxy-6,6'-dimethyl-2,2'-binaphthalene-1,1',4,4'-tetrone	OIIQHPXVAMWSOY-UHFFFAOYSA-N		x
2,5-hexanedione	OJVAMHKKJGICOG-UHFFFAOYSA-N		x
Dodecahydropyrido[1,2-b]isoquinolin-6-one	OLWPUTPKEBKCOC-UHFFFAOYSA-N		x
1-hexacosene	OMXANELYEWRDAW-UHFFFAOYSA-N		x
Benzene, [1-(3-butenylthio)-2-nitroethyl]-	OODANBUQRYURTF-UHFFFAOYSA-N		x
Stigmasta-5,24(28)-dien-3-ol, (3á,24Z)-	OSELKOCHBMDKEJ-WGMIZEQOSA-N		x
Isophthalic acid, di(1-isopropyl-2-methylpropyl) ester	OVNLBUVYWFGXSX-UHFFFAOYSA-N		x
Anthracene, 9-butyltetradecahydro-	PJCBPPKQWYVHKO-UHFFFAOYSA-N		x
Tetracosane	POOSGDOYLQNASK-UHFFFAOYSA-N		x
3-Methyl-3H-naphth[1,2-e]indol-10-ol	PRJIMCPILGWGTL-UHFFFAOYSA-N		x
Octadecane, 2,6,10,14-tetramethyl-	PUTSHCSOTBWQAI-UHFFFAOYSA-N		x
2,5-Dimethyl-2-(2-tetrahydrofuryl)tetrahydrofuran	PXUOEQRALJWORR-UHFFFAOYSA-N		x
8,9-Dihydrocyclopenta[def]phenanthrene	QBMIPMOSKSYZNU-UHFFFAOYSA-N		x
9,19-Cycloergost-24(28)-en-3-ol, 4,14-dimethyl-, acetate, (3.beta.,4.alpha.,5.alpha.)-	QEBAXZCXAFWBDK-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Dotriacontane	QHMGJGNTMQDRQA-UHFFFAOYSA-N		x
Octadecanoic acid	QIQXTHQIDYTFRH-UHFFFAOYSA-N		x
Octadecane, 1-(ethenyloxy)-	QJJDJWUCRAPCOL-UHFFFAOYSA-N		x
Ergost-25-ene-3,5,6,12-tetrol, (3.beta.,5.alpha.,6.beta.,12.beta.)-	QPSIXZTWWLBRTC-USWUIBTHSA-N		x
Silicic acid, diethyl bis(trimethylsilyl) ester	QZGNEODXJZDIBK-UHFFFAOYSA-N		x
1,11-Diphenyl-1,3,5,7,9-undecapentaene	RDKSRSULOVSRSX-YQEDPBEWSA-N		x
4-Chloro-2,7,8-trimethyl-quinolin-5-ylamine	RDZZDXXURQBAEQ-UHFFFAOYSA-N		x
Methyltris(trimethylsiloxy)silane	RGMZNZABJYWAEC-UHFFFAOYSA-N		x
17.alpha.,21.beta.-28,30-bisnorhopane	RLPRHPNFVLCDPC-UHFFFAOYSA-N		x
Cyclotriacontane	RPRAXXJCTCCPOZ-UHFFFAOYSA-N		x
9,19-Cyclolanostan-3-ol, 24,24-epoxymethano-, acetate	RQUCHTRBFYBJLV-UHFFFAOYSA-N		x
Ç-Sitostenone	RUVUHIUYGJBLGI-AXAJWWPKSA-N		x
Stigmast-4-en-3-one	RUVUHIUYGJBLGI-XJZKHKOHSA-N		x
Phthalic acid, 6-ethyloct-3-yl 2-ethylhexyl ester	RYIRRKVWFBLZCM-UHFFFAOYSA-N		x
Eicosane, 2,6,10,14,18-pentamethyl-	SJBLBJCIOBWHAC-UHFFFAOYSA-N		x
Tetracosamethyl-cyclododecasiloxane	SOGKSNZFDBFKCV-UHFFFAOYSA-N		x
Silane, diethyloctyloxypentyloxy-	SPYDCMISJLGANF-UHFFFAOYSA-N		x
Cyclopentadecane	SRONXYPFSAKOGH-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Ethanone, 2-(2-benzothiazolylthio)-1-(3,5-dimethylpyrazolyl)-	SSHGNGPVGMIRKF-UHFFFAOYSA-N		x
1H-imidazole-2-methanol, 1-decyl-	STRKTRKPDFMRIL-UHFFFAOYSA-N		x
Tritriacontane	SUJUOAZFECLBOA-UHFFFAOYSA-N		x
Tetradecanoic acid	TUNFSRHWOTWDNC-UHFFFAOYSA-N		x
Cyclohexanol, 1-methyl-4-(1-methylethenyl)-, acetate	URVNHQCLMBMWIW-UHFFFAOYSA-N		x
5,16[1',2']:8,13[1'',2'']-Dibenzenodibenzo[a,g]cyclododecene, 6,7,14,15-tetrahydro-	VCCYKNKAQTXXMJ-UHFFFAOYSA-N		x
Desoxyisosteviol	VHAZSZJVOSGWCB-UHFFFAOYSA-N		x
Pentatriacontane	VHQQPFLOGSTQPC-UHFFFAOYSA-N		x
Antra-9,10-quinone, 1-(3-hydrohy-3-phenyl-1-triazenyl)-	VJPSIIDNGIKKDT-FCQUAONHSA-N		x
Urs-20-en-16-ol, (16.beta.,18.alpha.,19.alpha.)-	VLZQPZWTOKZMQA-UHFFFAOYSA-N		x
1,3-Benzenediamine, 4-methyl-	VOZKAJLKRJDJLL-UHFFFAOYSA-N		x
L-Norleucine, N-ethoxycarbonyl-, decyl ester	VUBFUZRWAIWSCE-UHFFFAOYSA-N		x
3,5-Dinitrobenzoyl ester of tetradecen-1-ol	VXJITDSTVSJKRQ-UHFFFAOYSA-N		x
Fumaric acid, hexadecyl 2,2,2-trifluoroethyl ester	VXYGDTVSELMRSH-WUKNDPDISA-N		x
1,1'-Biphenyl, 6,2',3',4'-tetramethoxy-	WAFUMOLLNZWEQO-UHFFFAOYSA-N		x
Terephthalic acid, phenyl undecyl ester	WCBXIUNHUIHWAR-UHFFFAOYSA-N		x
Benzenesulfonyl fluoride, 4-[2-(6-chloro-4-hydroxy-1-naphthalenyl)diazenyl]-3-nitro-	WCLHEMXUYREJTK-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Benzamide, 2-trifluoromethyl-5-fluoro-N-butyl-	WEMKHYPGWLQWOO-UHFFFAOYSA-N		x
Terephthalic acid, 3,5-difluorophenyl nonyl ester	WFSHKZROWITMLY-UHFFFAOYSA-N		x
Cyclohexene, 4-pentyl-1-(4-propylcyclohexyl)-	WHKAMDSYJQSDFE-UHFFFAOYSA-N		x
2,6,10,14-Tetramethyl-7-(3-methylpent-4-enylidene) pentadecane	WSXXWIKHJGKODD-XIEYBQDHSA-N		x
Cyclohexadecane, 1,2-diethyl-	WTKPOZCPQVMNOI-UHFFFAOYSA-N		x
1,2-Benzenediol, o-(4-methoxybenzoyl)-o'-(2,2,3,3,4,4,4-heptafluorobutyryl)-	WZIRZQOPXQZJIY-UHFFFAOYSA-N		x
Benzothiazole, 2-phenyl-	XBHOUXSGHYZCNH-UHFFFAOYSA-N		x
Octane, 3-ethyl-2,7-dimethyl-	XEMFRSYZKNPRTA-UHFFFAOYSA-N		x
Phenol, 4-(1-phenylethyl)-	XHASMJXNUHCHBL-UHFFFAOYSA-N		x
28-Nor-17.alpha.(H)-hopane	XKJROQIFLGXWEY-RWRWHMSNSA-N		x
28-Nor-17.beta.(H)-hopane	XKJROQIFLGXWEY-UHFFFAOYSA-N		x
Argon	XKRFYHLGVUSROY-UHFFFAOYSA-N		x
Limonene	XMGQYMWWDOXHJM-UHFFFAOYSA-N		x
4H-1,2,4-triazole-3,5-diamine, N3-(4-fluorophenyl)-N5-methyl-	XMTBPMSCYOGVAV-UHFFFAOYSA-N		x
N-(2-Acetylcyclopentylidene)-cyclohexylamine	XPYRJAVRRRFRPK-UHFFFAOYSA-N		x
1,1,3,3-Tetraallyl-1,3-disilacyclobutane	XQTQGKSKOTXWNX-UHFFFAOYSA-N		x
Phenol, 2-(1,1,3,3-tetramethylbutyl)-	XSXWOBXNYNULJG-UHFFFAOYSA-N		x
Hexatriacontane	YDLYQMBWCWFRAI-UHFFFAOYSA-N		x

Chemical Name	INCHIKEY	Polar Extract of Crumb Rubber	Non-Polar Extract of Crumb Rubber
Dibenzo[def,mno]chrysene	YFIJJNAKSZUOLT-UHFFFAOYSA-N		x
1-Bromo-11-iodoundecane	YIAXRTMSPXAUAF-UHFFFAOYSA-N		x
Phenanthrene, 2-dodecyltetradecahydro-	YIZZECQVSWASEZ-UHFFFAOYSA-N		x
Pentacosane	YKNWIILGEFFOPE-UHFFFAOYSA-N		x
[1,2,4]Oxadiazole, 3-(5-bromofuran-2-yl)-5-furan-2-yl-	YSJMNSLGYCCHMD-UHFFFAOYSA-N		x
5-Amino-3-[1-cyano-2-(3,4-dimethoxyphenyl)vinyl]-1-phenyl-1H-pyrazole-4-carbonitrile	YUNFBRJQRROFMB-GDNBJRDFSA-N		x
Benzenamine, 4-bromo-4-(4-diethylaminobenzylidene)-	YWMVXLSSSKJXMI-UHFFFAOYSA-N		x
3-methyldotriacontane	YXJZLSDRPAJSLL-UHFFFAOYSA-N		x
Nitrone, N-(p-chlorophenyl)-.alpha.-(o-methoxyphenyl)-	YXKKDOOUKQUKBL-UHFFFAOYSA-N		x
Dotriacontyl trifluoroacetate	ZKTKQWPZEBJTKD-UHFFFAOYSA-N		x
1,30-triacontanediol	ZOIJRPSLRHKPEH-UHFFFAOYSA-N		x
Nonadecane, 1-chloro-	ZPHKHTAJPZOPHM-UHFFFAOYSA-N		x
9-Octadecenoic acid, (E)-	ZQPPMHVWECSIRJ-MDZDMXLPSA-N		x
9-Octadecenoic acid	ZQPPMHVWECSIRJ-UHFFFAOYSA-N		x
Benzamide, N-phenyl-	ZVSKZLHKADLHSD-UHFFFAOYSA-N		x
9H-Fluorene, 9-methylene-	ZYASLTYCYTYKFC-UHFFFAOYSA-N		x
Octacosane	ZYURHZPYMFLWSH-UHFFFAOYSA-N		x
1,4-Benzenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-	ZZMVLMVFYMGSMY-UHFFFAOYSA-N		x

3.2. References

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Section 4
Synthetic Turf Field Exposure Model

Section 4. Synthetic Turf Field Exposure Model

4.1. Introduction

OEHHA has evaluated the types and extent of potential human exposure to chemicals contained in crumb rubber occurring on synthetic turf fields. Using established mathematical models, literature data, synthetic turf-specific exposure parameters developed from the time-activity study (described in Appendices G, H, and I), and chemical concentration data obtained in the field characterization study, OEHHA has developed a synthetic turf field exposure model for estimating chemical exposure doses associated with the three main routes of exposure: inhalation, ingestion, and dermal. Different dose metrics are needed in estimating non-cancer hazard and cancer risk; how they can be calculated are also described in this document.

The following sections describe the design of the model, components of the model, and how it can be used to estimate exposure.

4.2. Model Design

OEHHA has developed an on-field exposure model for synthetic turf fields with crumb rubber infill that is shown in **Figure 4-1**. This figure illustrates the sources of potential chemical releases from the field, the migration of chemicals between the environmental matrices, the exposure media, the on-field or near-field categories of field users, and the potential routes of exposure.

4.2.1. Source of Chemicals and Exposure Media

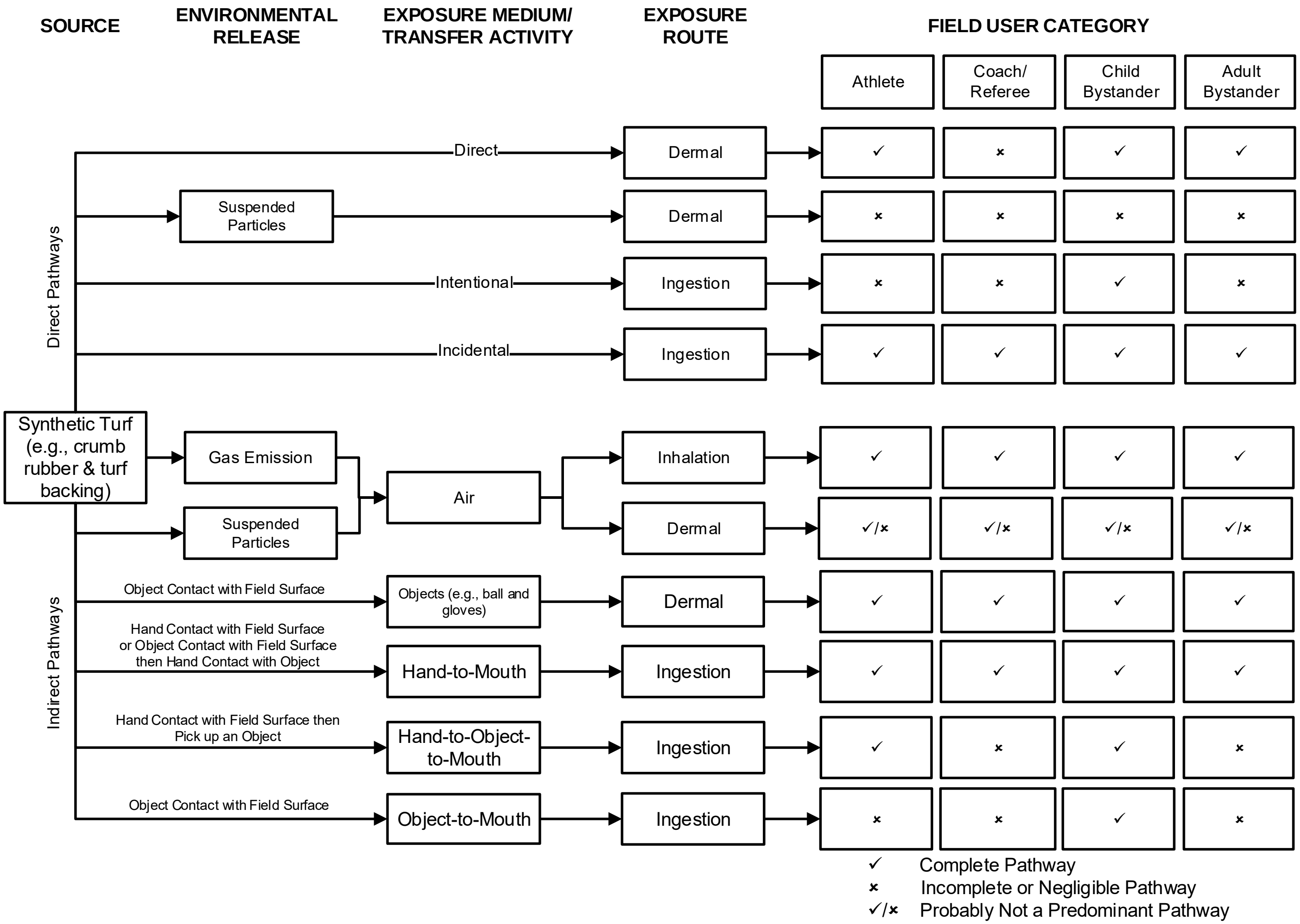
Synthetic turf fields are composed of three main parts: synthetic grass blades, backing materials, and crumb rubber infill. Field users can be exposed to chemicals in these parts through direct pathways (e.g., direct dermal contact with turf surface or ingestion of crumb rubber) as shown in **Figure 4-1**. It is likely that most direct exposures are related to chemicals in crumb rubber infill, and to a lesser extent, the synthetic grass blades and backing materials. This study focuses on exposure to crumb rubber infill.

Volatile or semi-volatile chemicals may evaporate from the synthetic turf into the air above the field. Due to the action of strong wind or physical activities of soccer players, fine particles of crumb rubber can be stirred up and suspended into the air above the field. Field users can be exposed to chemicals and fine particles in the air through inhalation (**Figure 4-1**).

In addition, crumb rubber particles can adhere to various objects, such as gloves, soccer ball, clothes, exposed skin, and constitute indirect exposures (**Figure 4-1**). For example, when a person's hand touches the turf surface and shortly afterwards picks up a cookie and puts it into the mouth, the hand can transfer crumb rubber from the field into the mouth. Both direct and indirect pathways are discussed in greater detail in the following sections.

Off-field exposure may result from windblown dust or particles, or groundwater or surface runoff from the field. These pathways are expected to be a smaller source of exposure than those pathways shown in **Figure 4-1** and are not included in this model.

Figure 4-1. Synthetic Turf Field On-Field Exposure Model



Pathway	Athlete	Coach/ Referee	Child Bystander	Adult Bystander
Direct – Dermal	✓	×	✓	✓
Suspended Particles – Dermal	×	×	×	×
Intentional – Ingestion	×	×	✓	×
Incidental – Ingestion	✓	✓	✓	✓
Air – Inhalation	✓	✓	✓	✓
Air – Dermal	✓/×	✓/×	✓/×	✓/×
Objects – Dermal	✓	✓	✓	✓
Hand-to-Mouth – Ingestion	✓	✓	✓	✓
Hand-to-Object-to-Mouth – Ingestion	✓	×	✓	×
Object-to-Mouth – Ingestion	×	×	✓	×

4.2.2. Field User Categories

The field users categories considered in this model are athletes, coaches/referees, and bystanders (child and adult). Within the athlete and bystander categories, there is a wide range possible in the age of the individuals. Among them, young children are particularly of concern because they have different behaviors than adults, and higher bodyweight-adjusted breathing rates and other physiological characteristics that can lead to higher exposures. The results of the time-activity exposure studies will be used to characterize behavior patterns of toddlers, children, and adults. Also, as a group, young children are often inherently more vulnerable to the effects of environmental chemicals (Faustman et al., 2000), and this will be considered in the estimation of their health risks.

4.2.2.1. Athletes

The athletes in this study are soccer players who participate in soccer practice and games seasonally or year-round. They may range in age from young children to adults, ages 4 to 70.

Athletes who participate in organized soccer teams may play one or more designated positions. The four positions considered in our model are forward, mid-fielder, defense, and goalkeeper. These positions are characterized by certain activities and these in turn may lead to different levels of a particular kind of exposure (e.g., the goalkeeper is more likely to dive into the field and ingest crumb rubber). The time-activity exposure studies characterize the micro-activities of the different positions and this information is used to estimate exposure parameters.

4.2.2.2. Coaches and Referees

Our model assumes coaches and referees are adults and older teens (starting to coach and/or referee around 16 years old) who may have previous experience as soccer players.

4.2.2.3. Bystanders

Bystanders are family members, friends, or other spectators who are present near or off the field to observe soccer activities. They can be adults or children, including toddlers, who are doing various activities (e.g. play, rest, eat, or drink) at the edge of the field. They can come in direct contact with crumb rubber as they sit, walk or crawl on the field surface. Young children up to 12 years old can have additional exposure through crawling on the ground, and putting their hands and fingers, or contaminated objects in their mouth.

4.2.3. Exposure Pathways

The main on-field pathways to chemicals from synthetic turf fields are:

- Inhalation: inhaling chemical vapors and chemicals on or in airborne fine particulates
- Dermal: skin contact to crumb rubber and deposited particulates
- Ingestion: ingestion of crumb rubber infill

Using the chemical concentrations measured in field samples, the model assesses exposure doses for these on-field pathways that can be later used to estimate non-cancer hazard and cancer risk. The following sections describe each pathway in greater detail and the equations and parameters for estimating the dose.

4.3. Inhalation Exposure Pathway

Inhalation exposure occurs when field users breathe the air that contains chemical vapors or airborne fine particulate matter released from the field. Volatile or semi-volatile chemicals may be evaporated to the air depending on local meteorological conditions (e.g. ambient temperature, atmospheric pressure, relative humidity, and wind speed etc.).

In addition, following evaporation, semi-volatile chemicals may redistribute and adsorb onto various particulate surfaces such as crumb rubber dust. These particles can vary greatly in size. Following inhalation, coarser particles (particles with an aerodynamic diameter equal to or less than 10 microns, PM10) may be removed by the defense system of the nose, but most of the fine particles (particles with an aerodynamic diameter equal to or less than 2.5 microns, PM2.5), will reach the deeper areas of the lung.

Athletes are expected to have the highest exposures through this pathway. Running, falling, and sliding on the field can cause particles to be stirred up into the air. Athletes have increased breathing rates due to their high physical activities and are likely to experience higher inhalation exposure to chemical vapors and particulates. Falling and diving (involving sliding head first onto the field) can cause particles to be suspended and increase the concentration of particles in the breathing zone of the athlete during these occurrences. Goalkeepers may have high exposures through these type of activities, especially during practice.

Due to their higher activity levels on the field, athletes, coaches and referees are expected to have higher inhalation rates and inhalation exposures than bystanders, who have relatively low activity levels associated with sitting, standing and cheering.

4.3.1. Calculating Inhalation Concentration for Non-Cancer Hazard Assessment

OEHHA provides guidelines for performing health risk assessments (OEHHA, 2015) using the hazard quotient (HQ) approach to assess the non-cancer hazard from exposure to a single chemical. A hazard quotient is a ratio of the exposure concentration to a reference level concentration (REL) at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration. An HQ of

1.0 or less indicates that adverse health effects are not expected to result from exposure to that chemical. As the HQ increases above one, the probability of human health effects increases. It is important to note, however, that an HQ of greater than 1.0 does not necessarily indicate that negative health impacts will occur since uncertainty factors are applied in the derivation of RELs.

For the inhalation pathway, the guidelines recommend using an annual average concentration of a chemical in air ($C_{annual\ average}$) in the calculation of the chronic inhalation hazard quotient of a chemical (HQ_{inh}). $C_{annual\ average}$ is representative of a long-term near-continuous exposure (e.g., a residential exposure scenario). This is not expected to be the case for synthetic turf field users. Field users are expected to be on or near the field for a few hours a day, a few days a week. For this reason an adjusted concentration of a chemical in air ($C_{air-adj}$) is used to estimate exposure during the period when field users are on the field. The term $C_{air-adj}$ represents the concentration of a chemical measured in air (C_{air}), measured in the field characterization study, that has been adjusted by the exposure time (ET, hours per day spent on the field) of a field user. This will more appropriately reflect the exposure concentration of a field user for the partial period of the day spent on the field as shown below in Equation 1.

$$C_{air-adj} = C_{air} \times ET \times \frac{1\ day}{24\ hours} \qquad \text{Equation 1}$$

where,

$C_{air-adj}$ = adjusted total concentration of a chemical in air for a partial day exposure, $\mu g_{chemical}/m^3$

C_{air} = total concentration of a chemical in air, $\mu g_{chemical}/m^3$

ET = exposure time, hours/day

Exposure time (ET) is the hours per day a field user spends on or near the synthetic turf field for a practice or game. Data on the ET of athletes for practices and games were collected during each of the four seasons in the exposure study (Appendix G) and are used in estimating this parameter. For athletes, the specific data for each individual participant was used to assess the participant's exposure. The distribution of survey data for athletes' ET is presented in **Table 4-1**, **Table 4-2**, and **Table 4-3**. Significant differences were found with age and gender.

Coaches are anticipated to have similar ET as athletes for both practices and games under the assumption that if athletes are on the field, a coach is present to provide supervision, training, and instruction. Referees are anticipated to be on the field and have the same ET as athletes for games only. Child bystanders (up to 12 years old) are assumed to be on the field at the same time as older siblings. They are assumed to attend every practice and game for a high-end exposure estimate. Their ET is assumed to be similar as that for athletes 2-16 years old for practices and games. For adult bystanders, ET for practices is assumed to be the same as that for athletes 2-16 years old with the assumption that they are present to supervise the child bystanders present at the field. Like children, they are assumed to attend every game and practice for a high-end estimate Adult bystanders are not anticipated to attend the practices of adult athletes. For games, the ET of adult bystanders is assumed to be the same as athletes. The survey data for all athletes was analyzed to estimate the ET of coaches for practices and games. The data for all athletes was also analyzed as a whole for referees and adult bystanders for games only. The data of athletes ages 2-16 was analyzed as a subset to estimate the ET of child bystanders for practices and games, and for adult bystanders for practices. The compiled survey data that will be used to derive the ET of coaches, referees and bystanders are presented in **Table 4-4**.

Table 4-1. Inhalation Exposure—Survey Data of Exposure Times for Female Athletes*

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	40	Spring	0.0	1.0	3.0	4.5	0.0	1.0	5.2	12.0
		Summer	0.0	0.1	2.0	5.0	0.0	0.0	5.3	15.0
		Fall	0.0	1.0	3.0	4.5	0.0	1.0	10.1	15.0
		Winter	0.0	1.0	2.1	3.0	0.0	0.0	2.2	10.0
11<16 years	246	Spring	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
		Summer	0.0	1.5	3.0	24.0	0.0	1.0	4.0	12.0
		Fall	0.0	1.5	3.0	24.0	0.0	1.5	4.0	20.0
		Winter	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
16-70 years	236	Spring	0.0	1.5	4.0	20.0	0.0	2.0	4.0	20.0
		Summer	0.0	1.0	4.0	20.0	0.0	1.5	5.0	15.0
		Fall	0.0	1.5	4.3	12.0	0.0	2.0	6.0	15.0
		Winter	0.0	1.0	6.0	12.0	0.0	1.5	5.0	22.0

*Ways of handling survey data outliers will be discussed at the May 2019 Scientific Advisory Panel (SAP) meeting (e.g., 24 hr/day playing soccer practices or games).

Table 4-2. Inhalation Exposure—Survey Data of Exposure Times for Male Athletes*

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	84	Spring	0.0	1.5	3.0	10.0	0.0	1.0	3.8	8.0
		Summer	0.0	1.0	2.8	10.0	0.0	0.4	3.8	5.0
		Fall	0.0	1.5	3.8	10.0	0.0	1.0	4.0	12.0
		Winter	0.0	1.0	4.0	15.0	0.0	0.1	3.8	7.5
11<16 years	250	Spring	0.0	1.5	4.0	24.0	0.0	1.0	3.0	13.0
		Summer	0.0	1.5	4.0	24.0	0.0	0.4	3.0	20.0
		Fall	0.0	1.5	4.0	24.0	0.0	1.0	4.0	20.0
		Winter	0.0	1.5	4.8	24.0	0.0	1.0	4.0	20.0
16-70 years	204	Spring	0.0	2.0	4.0	20.0	0.0	2.0	5.8	20.0
		Summer	0.0	2.0	4.0	20.0	0.0	1.5	4.0	15.0
		Fall	0.0	2.0	4.9	18.0	0.0	2.0	4.8	20.0
		Winter	0.0	2.0	5.0	20.0	0.0	2.0	6.0	20.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 24 hr/day playing soccer practices or games).

Table 4-3. Inhalation Exposure— Survey Data of Exposure Times for Athletes, No Gender Specified

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	2	Spring	1.5	1.8	2.0	2.0	1.0	1.1	1.2	1.3
		Summer	0.0	0.8	1.4	1.5	0.0	0.6	1.2	1.3
		Fall	0.0	0.8	1.4	1.5	0.0	0.6	1.2	1.3
		Winter	0.0	0.8	1.4	1.5	0.0	0.6	1.2	1.3
11<16 years	5	Spring	0.0	0.8	1.9	2.0	0.0	0.0	1.7	2.0
		Summer	0.0	0.8	1.9	2.0	0.0	0.3	1.8	2.0
		Fall	0.0	0.8	1.9	2.0	0.0	0.8	1.9	2.0
		Winter	0.0	1.8	2.0	2.0	0.0	1.0	2.9	3.0
16-70 years	1	Spring	-	3.0	-	-	-	3.0	-	-
		Summer	-	2.0	-	-	-	1.0	-	-
		Fall	-	5.0	-	-	-	6.0	-	-
		Winter	-	2.0	-	-	-	2.0	-	-

Table 4-4. Survey Data of Exposure Times for Coach, Referee, and Bystander*

Field User	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
Coach	1069	Spring	0.0	1.5	4.0	24.0	0.0	1.5	4.0	20.0
		Summer	0.0	1.5	4.0	24.0	0.0	1.0	4.0	20.0
		Fall	0.0	1.5	4.0	24.0	0.0	1.5	4.0	20.0
		Winter	0.0	1.5	4.0	24.0	0.0	1.0	4.0	22.0
Referee	1069	Spring	-	-	-	-	0.0	1.5	4.0	20.0
		Summer	-	-	-	-	0.0	1.0	4.0	20.0
		Fall	-	-	-	-	0.0	1.5	4.0	20.0
		Winter	-	-	-	-	0.0	1.0	4.0	22.0
Child Bystander	628	Spring	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
		Summer	0.0	1.5	3.0	24.0	0.0	1.0	3.0	20.0
		Fall	0.0	1.5	4.0	24.0	0.0	1.0	4.0	20.0
		Winter	0.0	1.5	4.0	24.0	0.0	1.0	4.0	20.0
Adult Bystander	628 (practice) 1069 (Game)	Spring	0.0	1.5	3.0	24.0	0.0	1.5	4.0	20.0
		Summer	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
		Fall	0.0	1.5	4.0	24.0	0.0	1.5	4.0	20.0
		Winter	0.0	1.5	4.0	24.0	0.0	1.0	4.0	22.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 24 hr/day playing soccer practices or games).

The total concentration of a chemical in air (C_{air}) represents the concentration of a chemical in the vapor (C_{gas}) and particulate phases ($C_{particles}$); it can be expressed as in Equation 2 below.

$$C_{air} = C_{gas} + C_{particles} \qquad \text{Equation 2}$$

where,

C_{air} = total concentration of a chemical in air, $\mu g_{chemical}/m^3$

C_{gas} = concentration of a chemical in the gaseous or vapor phase, $\mu g_{chemical}/m^3$

$C_{particles}$ = concentration of a chemical in the PM2.5 size fraction of the particulate phase, $\mu g_{chemical}/m^3$

C_{gas} is measured in the air above the field in the field study. $C_{particles}$ is equal to the amount of a chemical in a particle sample (in µg) multiplied by the concentration of particles in the air above the field as shown in Equation 3. The amount of chemical in a particle sample information was obtained from the field study.

$$C_{particles} = \frac{\mu g\ chemical}{mg\ particle} \times \frac{mg\ particle}{m^3\ air} \qquad \text{Equation 3}$$

Together with $C_{air-adj}$, the chronic inhalation reference exposure level ($Chronic\ Inhalation\ REL$) of the chemical is used to derive the chronic inhalation hazard quotient (HQ_{inh}) as shown in Equation 4 below:

$$HQ_{inh} = \frac{C_{air-adj}}{Chronic\ Inhalation\ REL} \qquad \text{Equation 4}$$

where,

HQ_{inh} = chronic inhalation hazard quotient of a chemical, unitless

$C_{air-adj}$ = total concentration of a chemical in air adjusted for exposure time, $\mu g_{chemical}/m^3$

$Chronic\ Inhalation\ REL$ = chronic reference exposure level for inhalation of a chemical, $\mu g_{chemical}/m^3$

The $Chronic\ Inhalation\ REL$ for a chemical is a concentration level at or below which negative health impacts would not be expected to occur. When available, OEHHA derived values will be used for this parameter, otherwise values from other sources such as the United States Environmental Protection Agency (US EPA) derived reference concentrations (RfC) or provisional reference concentrations (pRfC) will be applied.

4.3.2. Calculating Inhalation Dose for Cancer Risk Assessment

For cancer risk assessment, OEHHA guidelines (OEHHA, 2015) recommend applying a bodyweight normalized inhalation rate ($\frac{IR}{BW}$) to calculate a chemical-specific daily inhalation dose for cancer risk ($Dose_{inh}$). Inhalation rates normalized to bodyweight ($\frac{IR}{BW}$) for different age groups in the OEHHA guidelines (OEHHA, 2012) are used in this assessment. The rates are calculated from US EPA Metabolically Derived Breathing Rates (U.S. Environmental Protection Agency, 2009) and take into consideration that different levels of activity intensity affect the inhalation rate. This approach allows for estimating age- and activity level-specific inhalation rates. Five age groups, are considered in the cancer risk assessment for inhalation exposure: 0 to 1, 2 5, 6 t10, 11 15, and 16 to 70 years old. These age groups align with available one-hour inhalation rate data based on the energy expenditure required to perform activity at different intensity levels, including a high intensity level which is recommended by OEHHA guidelines for sports activities.

Based on the physical contact and vigor of soccer activity, an athlete is not expected to have exposure during the third trimester of pregnancy. However, exposure at this sensitive time may possibly occur for pregnant bystanders.

The exposure dose of a chemical through inhalation ($Dose_{inh}$) for each field user can be calculated by applying field user category and age-specific exposure parameters to the following equation:

$$Dose_{inh} = C_{air} \times A \times \sum_{activity\ level} \left(\frac{IR}{BW} \times EL\right) \times ET \times EF \times CF \qquad \text{Equation 5}$$

where,

$Dose_{inh}$ = exposure dose of a chemical through inhalation, μg$_{chemical}$/kg BW-day

A = inhalation absorption factor, unitless, if applicable, default value of one in the absence of chemical-specific value

C_{air} = total concentration of a chemical in air, μg$_{chemical}$/m^3

$\frac{IR}{BW}$ = inhalation rate normalized to bodyweight for a specific activity level, L/kg BW-hour

EL = exertion level, % of time on field spent at a specified level of activity intensity, %

ET = exposure time, hours/day

EF = exposure frequency, days/365 days

CF = conversion factor, 0.001 m^3/L

The inhalation absorption factor (A) represents the fraction of the exposure dose of a chemical that is absorbed. In the absence of chemical-specific data, this parameter value is assumed to be equal to one according to OEHHA guidelines (OEHHA, 2015).

For our study it is considered that while at the field, synthetic turf field users engage in various levels of activity intensity that include rest (sitting or standing), light (walking), moderate (jogging), and high activity (running). Athletes may engage in all levels of activity, while coaches and referees are anticipated to engage in only resting, light and moderate activity. Bystanders are anticipated to engage in resting and light activity. The $\frac{IR}{BW}$ for each field user group are presented in **Table 4-5**,Table 4-6, Table 4-7, and Table 4-8.

Table 4-5. Athlete—Inhalation Rate Normalized to Bodyweight (OEHHA, 2012)

	IR/BW (L/kg BW-hr)			
Age group	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
Sedentary & Passive Activities (Resting)				
Average	17	10	6	4
95th Percentile	23	14	8	5
Light Intensity Activities (Walking)				
Average	41	23	14	10
95th Percentile	54	32	19	13
Moderate Intensity Activities (Jogging)				
Average	76	44	28	21
95th Percentile	100	62	39	29
High Intensity Activities (Running)				
Average	140	82	55	38
95th Percentile	190	110	80	56

Table 4-6. Bystander—Inhalation Rate Normalized to Bodyweight (OEHHA, 2012)

	IR/BW (L/kg BW-hr)				
Age group	**0<2 years**	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
Sedentary & Passive Activities (Resting)					
Average	25	17	10	6	4
95th Percentile	31	23	14	8	5
Light Intensity Activities (Walking)					
Average	61	41	23	14	10
95th Percentile	75	54	32	19	13

Table 4-7. 3rd Trimester Bystander—Inhalation Rate Normalized to Bodyweight (OEHHA, 2012)

	IR/BW (L/kg BW-hr)
Age group	**3rd Trimester**
Average	21
95th Percentile	29

Table 4-8. Coach and Referee—Inhalation Rate Normalized to Bodyweight (OEHHA, 2012)

	IR/BW (L/kg BW-hr)	
Age group	**11<16 years**	**16-70 years**
Sedentary & Passive Activities (Resting)		
Average	6	4
95th Percentile	8	5
Light Intensity Activities (Walking)		
Average	14	10
95th Percentile	19	13
Moderate Intensity Activities (Jogging)		
Average	28	21
95th Percentile	39	29

The exertion level (EL) represents the percentage of time spent on the field that a field user performs activity at a specific intensity level. During the videotaping part of the exposure study (Appendix H), 40 participants were videotaped performing activities (e.g. sitting, walking, and running) and these are categorized into intensity levels (i.e. rest, light, moderate, and high activity), for some period of time. For a given participant, their EL was determined from the recorded tape showing the length of time (minutes per hour) spent performing various activities. Those participants were also asked in the exposure survey to estimate their EL for typical practices and games. An additional study group of 1029 participants (no video data were collected on these participants) completed the exposure survey for a total of 1069 survey responses.

Estimates of *EL* derived from video and survey data for the 40 video participants were compared. There are inconsistencies (greater than a ±10% difference) for many of the estimates. Individual bias in the survey responses are one possible reason for this. Another possibility is the difference in interpretation of the terms used in the survey; for example, an individual's definition of jogging versus running may differ from another's.

Furthermore, participants were videotaped for only one practice or game, which may not represent a typical practice or game for them. Since the video data present a snapshot of a participant's time on the field and there are only 40 participants, the survey data is used to derive EL for the estimation of $Dose_{inh}$.

No EL data for bystanders, coaches, or referees were captured in the exposure study. Typical soccer games may range from 40-90 minutes based on the age of the players. Based on an average game length of 60 minutes with a fifteen minute half-time break, the percentage of time for each EL was estimated. For athletes, EL values ranged from 0 to 100% for each intensity level. The sum of the percentages for all intensity levels could not equal more than 100% for each participant. For athletes, the EL data from each participant was used to assess their exposure. The distribution of survey data for athletes that will be used to derive EL is presented in **Table 4-9**, **Table 4-10**, and **Table 4-11**. Significant differences were found between gender and age group. Young children bystanders while on the field are assumed to be walking around, playing, sitting and resting on the turf. For adult bystanders, they are assumed to spend the entire time at the field sitting. Observations made on the field and anecdotal evidence from parents suggest that parents observe their young children playing from their seats on the field. Coaches during practice spend half the time walking and the other half jogging. They are less active during game and spend some time for sitting. Referees are assumed to have the same EL as coaches during the game. For coaches and referees, these assumptions are made with the understanding that the age and competitive level of players may affect their EL. Parameter values for the EL of coaches, referees, and bystanders are presented in **Table 4-12**.

Table 4-9. Survey Data of Exertion Levels for Female Athletes*

Age Group	N	Activity Intensity	Practice (%)				Game (%)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	40	Rest	0.0	10.0	25.3	30.0	0.0	10.0	30.0	40.0
		Light	0.0	15.0	31.0	50.0	0.0	10.0	45.3	50.0
		Moderate	0.0	30.0	50.0	80.0	0.0	25.0	50.0	50.0
		High	0.0	32.5	60.5	80.0	0.0	32.5	70.3	90.0
11<16 years	246	Rest	0.0	10.0	25.0	70.0	0.0	10.0	30.0	100.0
		Light	0.0	10.0	30.0	60.0	0.0	10.0	30.0	60.0
		Moderate	0.0	27.5	60.0	80.0	0.0	25.0	50.0	80.0
		High	0.0	30.0	75.0	90.0	0.0	40.0	80.0	100.0
16-70 years	236	Rest	0.0	10.0	20.0	40.0	0.0	10.0	30.0	70.0
		Light	0.0	10.0	30.0	50.0	0.0	10.0	30.0	60.0
		Moderate	0.0	30.0	60.0	80.0	0.0	30.0	60.0	80.0
		High	0.0	25.0	60.0	98.0	0.0	30.0	75.0	98.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 100% high exertion for an entire practice or game).

Table 4-10. Survey Data of Exertion Levels for Male Athletes*

Age Group	N	Activity Intensity	Practice (%)				Game (%)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	84	Rest	0.0	6.5	20.0	40.0	0.0	10.0	29.3	40.0
		Light	0.0	10.0	30.0	50.0	0.0	10.0	34.3	60.0
		Moderate	0.0	25.0	50.0	75.0	0.0	30.0	50.0	55.0
		High	0.0	30.0	80.0	100.0	0.0	30.0	79.3	100.0
11<16 years	250	Rest	0.0	10.0	25.0	100.0	0.0	10.0	40.0	100.0
		Light	0.0	10.0	30.0	100.0	0.0	10.0	30.0	100.0
		Moderate	0.0	30.0	60.0	100.0	0.0	30.0	50.0	100.0
		High	0.0	30.0	70.0	100.0	0.0	40.0	77.7	100.0
16-70 years	204	Rest	0.0	10.0	25.0	35.0	0.0	10.0	30.0	60.0
		Light	0.0	15.0	39.3	70.0	0.0	15.0	40.0	65.0
		Moderate	0.0	30.0	55.0	100.0	0.0	30.0	55.0	80.0
		High	0.0	25.0	70.0	90.0	0.0	30.0	80.0	100.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 100% high exertion for an entire practice or game).

Table 4-11. Survey Data of Exertion Levels for Athletes, No Gender Specified

Age Group	N	Activity Intensity	Practice (%)				Game (%)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	2	Rest	0.0	2.5	4.8	5.0	0.0	1.3	2.4	2.5
		Light	0.0	2.5	4.8	5.0	0.0	1.3	2.4	2.5
		Moderate	0.0	10.0	19.0	20.0	0.0	5.0	9.5	10.0
		High	0.0	35.0	66.5	70.0	0.0	42.5	80.8	85.0
11<16 years	5	Rest	0.0	10.0	19.0	20.0	5.0	10.0	42.0	50.0
		Light	0.0	10.0	28.0	30.0	0.0	10.0	14.0	15.0
		Moderate	0.0	30.0	30.0	30.0	0.0	25.0	72.0	80.0
		High	0.0	35.0	57.0	60.0	1.0	50.0	58.0	60.0
16-70 years	1	Rest	-	10.0	-	-	-	20.0	-	-
		Light	-	20.0	-	-	-	10.0	-	-
		Moderate	-	20.0	-	-	-	30.0	-	-
		High	-	50.0	-	-	-	40.0	-	-

Table 4-12. Exertion Levels for Coach, Referee, and Bystander

Field User	Activity Intensity	Practice (%)	Game (%)
Coach	Rest	-	25
	Light	50	25
	Moderate	50	50
	High	-	-
Referee	Rest	-	25
	Light	-	25
	Moderate	-	50
	High	-	-
Child Bystander	Rest	50	50
	Light	50	50
	Moderate	-	-
	High	-	-
Adult Bystander	Rest	100	100
	Light	-	-
	Moderate	-	-
	High	-	-

For each activity level, the EL is multiplied by the activity-specific $\frac{IR}{BW}$. The values for each level are summed to create an activity-weighted factor.

Exposure time (ET) is the hours per day an individual spends on the synthetic turf field for a practice or game and exposure frequency (EF) is the days per year spent on the field. Data on the ET and EF for practices and games during each of the four seasons was collected in the exposure study and are used in estimating these two parameters. ET parameter values for athletes, coaches, referees, and bystanders are discussed and presented in Section **4.3.1.** The assumptions for ET described in Section 4.3.1 are also used to estimate the parameter values for EF for coaches, referees, and bystanders. for the survey data that will be used to estimate EF for all field users can be found in **Table 4-13**, **Table 4-14**, **Table 4-15**, and **Table 4-16**.

Table 4-13. Inhalation Exposure—Survey Data for Exposure Frequency for Female Athletes

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	40	Spring	0.0	1.0	3.0	3.0	0.0	1.0	4.0	4.0
		Summer	0.0	0.3	2.1	3.0	0.0	0.0	2.0	2.0
		Fall	0.0	1.0	3.0	3.0	0.0	1.0	2.1	4.0
		Winter	0.0	1.0	2.1	3.0	0.0	0.0	2.0	6.0
11<16 years	246	Spring	0.0	2.0	4.0	6.0	0.0	1.0	3.0	5.0
		Summer	0.0	1.0	4.0	7.0	0.0	1.0	3.0	5.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	3.0	6.0
		Winter	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
16-70 years	236	Spring	0.0	2.0	4.3	6.0	0.0	1.0	4.0	7.0
		Summer	0.0	1.0	4.0	7.0	0.0	1.0	3.0	6.0
		Fall	0.0	2.0	5.0	6.0	0.0	2.0	4.3	7.0
		Winter	0.0	2.0	5.0	6.0	0.0	2.0	4.0	5.0

Table 4-14. Inhalation Exposure—Survey Data for Exposure Frequency for Male Athletes

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	84	Spring	0.0	1.0	3.0	4.0	0.0	1.0	3.0	7.0
		Summer	0.0	1.0	3.0	3.0	0.0	1.0	4.8	7.0
		Fall	0.0	1.0	3.0	4.0	0.0	1.0	3.0	5.0
		Winter	0.0	1.0	3.0	5.0	0.0	0.8	2.0	3.0
11<16 years	250	Spring	0.0	2.0	4.0	5.0	0.0	1.0	3.0	6.0
		Summer	0.0	1.0	4.0	5.0	0.0	0.8	2.0	5.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	3.0	7.0
		Winter	0.0	2.0	5.0	6.0	0.0	1.0	2.5	6.0
16-70 years	204	Spring	0.0	2.0	5.0	7.0	0.0	1.0	4.0	7.0
		Summer	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
		Fall	0.0	2.0	6.0	7.0	0.0	1.3	3.8	7.0
		Winter	0.0	2.0	6.0	7.0	0.0	2.0	4.0	6.0

Table 4-15. Inhalation Exposure—Survey Data for Exposure Frequency Athletes, No Gender Specified

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
6<11 years	2	Spring	2.0	2.0	2.0	2.0	1.0	2.0	2.9	3.0
		Summer	0.0	1.0	1.9	2.0	0.0	1.5	2.9	3.0
		Fall	0.0	1.0	1.9	2.0	0.0	1.5	2.9	3.0
		Winter	0.0	1.0	1.9	2.0	0.0	1.5	2.9	3.0
11<16 years	5	Spring	0.0	1.5	3.9	4.0	0.0	0.5	1.9	2.0
		Summer	0.0	0.5	3.6	4.0	0.0	0.3	0.9	1.0
		Fall	0.0	1.5	3.9	4.0	0.3	0.8	1.9	2.0
		Winter	0.0	1.5	4.6	5.0	0.0	0.5	1.9	2.0
16-70 years	1	Spring	-	4.0	-	-	-	2.0	-	-
		Summer	-	2.0	-	-	-	1.0	-	-
		Fall	-	5.0	-	-	-	3.0	-	-
		Winter	-	2.0	-	-	-	1.0	-	-

Table 4-16 .Exposure Frequency (EF) for Coach, Referee, and Bystander

Field User	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
Coach	1069	Spring	0.0	2.0	4.0	7.0	0.0	1.0	3.0	7.0
		Summer	0.0	1.0	4.0	7.0	0.0	1.0	3.0	7.0
		Fall	0.0	2.0	5.0	7.0	0.0	1.0	3.0	7.0
		Winter	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
Referee	1069	Spring	-	-	-	-	0.0	1.0	3.0	7.0
		Summer	-	-	-	-	0.0	1.0	3.0	7.0
		Fall	-	-	-	-	0.0	1.0	3.0	7.0
		Winter	-	-	-	-	0.0	1.0	3.0	6.0
Child Bystander	628	Spring	0.0	2.0	4.0	6.0	0.0	1.0	3.0	7.0
		Summer	0.0	1.0	3.6	7.0	0.0	1.0	3.0	7.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	3.0	7.0
		Winter	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
Adult Bystander	628 (practice) 1069 (Game)	Spring	0.0	2.0	4.0	6.0	0.0	1.0	3.0	7.0
		Summer	0.0	1.0	3.6	7.0	0.0	1.0	3.0	7.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	3.0	7.0
		Winter	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0

The $Dose_{inh}$ for a specific age group represents the total inhalation exposure dose for all activity intensity levels for practices and games, and for all seasons (i.e. spring, summer, fall, winter). It is used to estimate risk from exposure to cancer-causing chemicals found on synthetic turf fields. The inhalation cancer risk for an age group is derived by applying an age-specific exposure duration divided by the averaging time, an age-sensitivity factor for the age group and chemical-specific inhalation cancer potency factor as shown in Equation 6 below.

$$Risk_{inh} = \frac{Dose_{inh} \times CPF_{inh} \times ASF \times ED}{AT} \qquad \text{Equation 6}$$

where,

$Risk_{inh}$ = inhalation cancer risk of a chemical for an age group, unitless

$Dose_{inh}$ = exposure dose of a chemical through inhalation, $\mu g_{chemical}$/kg BW-day

CPF_{inh} = inhalation cancer potency factor of a chemical, ($\mu g_{chemical}$/kg BW-day)$^{-1}$

ASF = age sensitivity factor, unitless

ED = exposure duration for a specific age group, years

AT = averaging time, equal to 70 years

The inhalation cancer potency factor (CPF_{inh}) is used to estimate the increased cancer risk from a lifetime inhalation exposure to a chemical and is usually expressed in units of reciprocal dose (milligram per kilogram-bodyweight day). Not all chemicals will have established CPF_{inh} values. When available, OEHHA values will be used for this parameter. Otherwise, US EPA IRIS values may be used if available. If no CPF_{inh} are available, but inhalation unit risk factor (IUR) values are available, they will be converted to CPF_{inh}. The conversion is done by multiplying the CPF_{inh} by the reference human respiration rate per day, 20 m^3, and dividing by the reference human bodyweight of 70 kg, and applying the appropriate conversion factor from mg to µg (OEHHA, 2009). IURs estimate the increased cancer risk from inhalation exposure to a chemical at a dose of one µg/m^3 for a lifetime.

Age sensitivity factors ($ASFs$) are weighted factors that consider increased sensitivity to carcinogens during prenatal and early postnatal life stages, compared to adult life stages. OEHHA-developed $ASFs$ (OEHHA, 2015) for the inhalation age groups are presented in **Table 4-17**.

Table 4-17. Age Sensitivity Factors (ASF) for Inhalation Age Groups (OEHHA, 2015)

Age Group	Age Sensitivity Factor (unitless)
3rd trimester*	10
0<2 years	10
2<6 years	3
6<11 years	3
11<16 years	3
16-70 years	1

*Represents exposure to a baby during the 3rd trimester of pregnancy. Exposure is assumed to be the same as that of the mother.

The exposure duration (ED) represents the years of exposure for a specific age group. Parameter values for the inhalation exposure specific age groups are equal to 0.25, 2, 4, 5, 5, and 54 years for the 3rd trimester, 0<2 years, 2<6 years, 6<11 years, 11<16 years and 16-70 years age groups, respectively. Values are presented in **Table 4-18**.

Table 4-18. Exposure Duration (ED) for Inhalation Exposure Age Groups

Age Group	Exposure Duration (Years)
3rd trimester	0.25
0<2 years	2
2<6 years	4
6<11 years	5
11<16 years	5
16-70 years	54

The averaging time (AT) is the period over which the ED is averaged. By default, this parameter value is always equal to 70 years.

4.4. Ingestion Exposure Pathway

Ingestion exposure occurs when particles of any size get into the mouth and are swallowed. Ingestion of particles while engaging in activities on synthetic turf fields can be by either direct or indirect pathways.

4.4.1. Direct Ingestion Exposure Pathway

The direct ingestion exposure pathway can be divided into intentional ingestion and incidental ingestion. The incidental ingestion pathway is quite common and assumed to occur for athletes, coaches, referees, and bystanders, but the intentional pathway is assumed to occur for only child bystanders (2-12 years).

Intentional ingestion exposure occurs when the field user purposefully puts crumb rubber into the mouth and swallows it. Toddlers and young child bystanders may crawl around on and play with crumb rubber on the sidelines of the field during sport events. A small number of children may intentionally ingest crumb rubber and this is known as pica behavior. This behavior, however, is not common.

Incidental ingestion occurs when crumb rubber accidently enters the mouth and is swallowed. Athletes of all ages are expected to be exposed through this pathway. Falling onto the field or diving onto the field surface while playing soccer agitates the field surface and disperses particles of various sizes into the air. These airborne particles may then be incidentally ingested by the athletes. This may be an especially important exposure pathway for goalkeepers, who often lunge across the goal to block a ball and sometimes land face-down onto the turf. Coaches and referees are anticipated to have much lower incidental ingestion exposure than athletes since they are expected to have less contact with the field.

Child bystanders may play with the crumb rubber at the field or roll around on the field. As a result, they may incidentally ingest crumb rubber pieces. It is assumed that adult bystanders do not fall on or dive onto the field. Thus, the incidental ingestion pathway is not considered to be important for this field user category.

4.4.2. Indirect Ingestion Exposure Pathway

Indirect ingestion occurs via a carrier (hands or objects). Chemicals or particles can be transferred from the field via the following mechanisms: hand-to-mouth (HTM), object-to-mouth (OTM), and hand-to-object-to-mouth (HTOTM). Mouthing behaviors can include touching the face or mouth with objects (e.g. hand or toys) or putting them into the mouth. Other behaviors such as licking, sucking, chewing, and biting are more common in young children and adolescents (Groot et al., 1998). The differences in behaviors may cause varied exposure levels via this pathway among the age groups and individuals in the field user categories.

4.4.2.1. Hand-to-Mouth (HTM) Activities

The hands or fingers of field user may come into direct contact with the field and then the hands or fingers touch the mouth or the area around the mouth (peri-bucal area). Through HTM activities, fine particles or chemicals from the field are directly or indirectly transferred onto the face or into the mouth and eventually ingested.

Common examples of the HTM behaviors observed on the field are young child bystanders crawling on the sidelines of the field or playing with crumb rubber and then sucking their fingers. Athletes or bystanders may bite their fingernails, touch their mouth (e.g., braces or mouth guard) or face; or use their hands to wipe away sweat on their face. Coaches and referees may touch their face with their hands after touching the soccer ball and transfer chemicals or fine particles to the mouth or the area around the mouth.

4.4.2.2. Object-to-Mouth (OTM) Activities

Objects may come into contact with the field and then be put into the mouth or touched to the area around the mouth. The object acts as a carrier that may transfer fine particles or chemicals from the field into the mouth. OTM activity is considered for all objects that may come into contact with the turf prior to contact with the mouth such as soccer equipment (e.g. the soccer ball and plastic practice cones). In the video study, no observations of objects in contact with the field surface contacting the mouth were observed, therefore this pathway is considered to be incomplete for athletes. Since coaches and referees are anticipated to have similar contact with the soccer ball and other equipment, this pathway is also considered incomplete for these field user groups.

There are a number of examples of OTM activities and objects which are carriers. To take their gloves off, some goalkeepers may grab their gloves with their teeth. Athletes may use their clothes to wipe away sweat on their face. Athletes or bystanders may leave their water bottles on the ground and later drink through the drinking spouts. Young children may put toys which have contacted the turf in their mouths. Coaches and referees may accidentally drop their whistles on the field and blow through the uncleaned whistles. No data was collected on this type of activity on field, so this pathway is considered incomplete for coaches and referees.

4.4.2.3. Hand-to-Object-to-Mouth (HTOTM) Activities

A field users hands may come into contact with the field, and then the user may handle an object (such as a piece of fruit or other snack during a break) and put the object into their mouth. HTOTM activities involve indirectly transferring fine particles from the field via the hand, to a carrier object and into the mouth when the carrier touches to or near the mouth. This exposure pathway involves two carriers, the hand and then the object. OEHHA anticipates that the level of exposure from each event of HTOTM may be lower than that of HTM or OTM.

Mouthing behaviors are common in toddlers and young children, in which they touch the field or crumb rubber and use their unwashed hands to pick up an object, such as a pacifier or a toy, and ultimately put the objects into their mouth. Athletes and bystanders may touch the field surface and then handle and eat food with their unwashed hands (OEHHA, 2012), or touch the drinking spout of their water bottles and then consume the food or water.

In the exposure study, data were collected on instances of unwashed hands touching objects such as water bottles and food, and clothes (including towels). However, for clothes and towels, the surface that comes into contact with the mouth may not necessarily be the surface that has contacted the hand so this is considered to be a negligible source of exposure for this pathway and is not included in the exposure analysis.

For coaches and referees, the scenario for HTOTM activity is anticipated to be blowing on a whistle during practices or games. However, it is anticipated the whistle would be held on the sides and there would be very limited, if any, contact with the portion that goes into the mouth. With such limited contact, the HTOTM pathway is believed to be negligible and that any potential exposure may be captured in the assessment of HTM ingestion. Further, no data on this type of activity and contact were collected in the exposure study or is available in the literature.

4.4.3. Calculating Oral Dose for Non-Cancer Hazard Assessment

Similar to the non-cancer hazard assessment for inhalation exposure in Section 4.3.1, OEHHA guidelines (OEHHA, 2015) recommend deriving a hazard quotient for a chemical through ingestion (HQ_{ing}) from a daily dose through total direct and indirect ingestion ($Dose_{NC-ing}$) and a chronic oral reference level ($Chronic\ Oral\ REL$) of the chemical. For simplicity in this section, crumb rubber is used as the source of ingestion exposure. The equation to estimate HQ_{ing} is as follows:

$$HQ_{ing} = \frac{Dose_{NC-ing}}{Chronic\ Oral\ REL} \qquad \text{Equation 7}$$

where,

HQ_{ing} = chronic hazard quotient of a chemical through ingestion, unitless

$Dose_{NC-ing}$ = exposure dose of a chemical from ingestion of crumb rubber, $mg_{chemical}$/kg BW-day

$Chronic\ Oral\ REL$ = chronic oral reference exposure level of a chemical, $mg_{chemical}$/kg BW-day

The $Chronic\ Oral\ REL$ is similar to the $Chronic\ Inhalation\ REL$ in that it represents an exposure level at or below which negative health impacts would not be expected to occur. When available, OEHHA-derived values will be used for this parameter, otherwise other sources such as the US EPA derived reference dose (RfD) or provisional reference dose (pRfD) will be used.

Four traditional OEHHA age groups will be considered in the non-cancer risk assessment processes of ingestion exposure: 0 to 1, 2 to 8, 9 to 15, and 16 to 70 years old. It is not expected that ingestion exposure will occur for bystanders during the third trimester of pregnancy as they are not expected to have incidental or intentional ingestion, or have hand contact with or sit on the turf.

To estimate the exposure dose of a chemical from ingestion ($Dose_{NC-ing}$) for each age group the following equation is used:

$$Dose_{NC-ing} = \frac{C_{crumb\ rubber} \times GRAF \times \frac{Ing}{BW} \times ED}{AT} \qquad \text{Equation 8}$$

where,

$Dose_{NC-ing}$ = exposure dose of a chemical from ingestion of crumb rubber for an age group, $mg_{chemical}$/kg BW-day

$C_{crumb\ rubber}$ = bioaccessible concentration of a chemical from crumb rubber, $mg_{chemical}/g_{crumb\ rubber}$

$GRAF$ = gastrointestinal relative absorption factor, unitless

$\frac{Ing}{BW}$ = ingestion rate normalized to bodyweight via all the direct and indirect ingestion pathways, $g_{crumb\ rubber}$/kg BW-day

ED= exposure duration of an age group, years

AT = averaging time, equal to 70 years

The bioaccessible concentration of a chemical from the crumb rubber ($C_{crumb\ rubber}$) is a chemical-specific value that is measured from samples collected in the field characterization study. These values were measured in the bioaccessibility study during the chemical analysis. Briefly, crumb rubber were extracted in artificial biofluids to mimic conditions in the body. This concentration represents the amount of a chemical that is available to be absorbed from the crumb rubber; it does not necessarily reflect that amount of a chemical that enters the human body.

The gastrointestinal relative absorption factor ($GRAF$) is a fraction that represents the amount of a chemical that is absorbed by the gastrointestinal (GI) tract compared to the amount of a chemical that is available for absorption. It is assumed that the $GRAF$ is equal to one and 100% of the amount of chemical available to be absorbed from the crumb rubber is absorbed by the GI tract, unless chemical specific data are available.

The crumb rubber ingestion rate $\left(\frac{Ing}{BW}\right)$ is estimated based on literature values and information from the exposure study. The ingestion rate normalized to bodyweight is a collection of ingestion intake of particles via all the direct and indirect ingestion pathways for a field user:

$$\frac{Ing}{BW} = \left(\frac{Ing}{BW}\right)_{direct} + \left(\frac{Ing}{BW}\right)_{HTM} + \left(\frac{Ing}{BW}\right)_{OTM} + \left(\frac{Ing}{BW}\right)_{HTOTM} \qquad \text{Equation 9}$$

where,

$\frac{Ing}{BW}$ = ingestion rate normalized to bodyweight via all the direct and indirect ingestion pathways, $g_{crumb\ rubber}$/kg BW-day

$\left(\frac{Ing}{BW}\right)_{direct}$ = ingestion rate normalized to bodyweight via all the direct ingestion pathways, $g_{crumb\ rubber}$/kg BW-day

$\left(\frac{Ing}{BW}\right)_{HTM}$ = ingestion rate normalized to body via HTM ingestion pathway, $g_{crumb\ rubber}$/kg BW-day

$\left(\frac{Ing}{BW}\right)_{OTM}$ = ingestion rate normalized to body via OTM ingestion pathway, $g_{crumb\ rubber}$/kg BW-day

$\left(\frac{Ing}{BW}\right)_{HTOTM}$ = ingestion rate normalized to bodyweight via HTOTM ingestion pathway, $g_{crumb\ rubber}$/kg BW-day

The following sections describe the derivation of the ingestion rate for incidental, HTM, OTM, and HTOTM activities. As described in Section 4.4.2, these are activities that result in ingestion through a carrier which transfers chemical or particles from the field into the mouth. OEHHA guidelines (OEHHA, 2008, 2011) for the transfer of lead from consumer products and the framework for human health assessment at Superfund sites as stated in the US EPA Risk Assessment Guidelines for Superfund (RAGS) Volume I, Human Health Evaluation Manual (Part A) (U.S. Environmental Protection Agency, 1989) are used as guidance for developing the equations to calculate the ingestion rate for these activities.

4.4.3.1. Direct Incidental Ingestion Rate

The direct rate of ingestion ($\left(\frac{Ing}{BW}\right)_{Direct}$) represents the amount of crumb rubber granules (the actual crumb rubber pieces, not crumb rubber dust) that are accidently or incidentally swallowed while on a synthetic turf field. Anecdotal evidence from soccer players suggests that they may ingest from one teaspoon (TSP) to one tablespoon (TBSP) of crumb rubber while on the field during practice and games. Six randomly selected field samples were prepared and used to determine the weight of crumb rubber. One TSP of crumb rubber was equivalent to 3.6 g and one TBSP of crumb rubber was equivalent to 10.4 g.

Additionally, recent literature studies (ECHA, 2017; RIVM, 2017) of the health risks associated with crumb rubber on synthetic turf fields are consulted on the amounts of incidental ingestion of crumb rubber while on the field for young children bystanders , coaches, and referees. The ingestion amounts can be found in **Table 4-19, Table 4-20 and Table 4-21.**

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Table 4-19. Athlete—Direct Crumb Rubber Ingestion Amount

Ingestion Amount/Day	Reference
0.01 g crumb rubber granules	(ECHA, 2017)
0.05 g crumb rubber granules	(ECHA, 2017; RIVM, 2017)
0.2 g crumb rubber granules	(RIVM, 2017)
3.6 g crumb rubber granules (1 teaspoon)	Based on communication with Soccer Players, estimated by OEHHA
10.4 g crumb rubber granules (1 tablespoon)	Based on communication with Soccer Players, estimated by OEHHA

Table 4-20. Bystander (0-12 years)—Direct Crumb Rubber Ingestion Amount

Ingestion Amount/Day	Reference
0.01 g crumb rubber granules	(ECHA, 2017)
0.05 g crumb rubber granules	(ECHA, 2017; RIVM, 2017)
0.2 g crumb rubber granules	(RIVM, 2017)
3.6 g crumb rubber granules (1 teaspoon)	Communication with Soccer Players

Table 4-21. Coach and Referee—Direct Crumb Rubber Ingestion Amount

Ingestion Amount/Day	Reference
0.01 g crumb rubber granules	(ECHA, 2017)
0.05 g crumb rubber granules	(RIVM, 2017)

In addition to the ingestion amount, in order to calculate $\left(\frac{Ing}{BW}\right)_{Direct}$, bodyweight (BW) needs to be estimated. For athletes, BW data collected in the exposure study is used for this parameter. If BW was not provided by a participant, the appropriate age-matched OEHHA mean point estimate for bodyweight (Table 4-22) was used. OEHHA point estimates were also used to estimate BW for bystanders, coaches and referees.

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Table 4-22. Mean Point Estimates for Bodyweight (BW) (OEHHA, 2012)

Age Group	Mean BW (kg)
0<2 years	9.7
2<9 years	21.9
9<16 years	37
16-70 years	80

4.4.3.2. HTM Ingestion Rate

The rate of ingestion through HTM activity ($\left(\frac{Ing}{BW}\right)_{HTM}$) represents the amount of crumb rubber ingested after the hand or fingers had direct contact the field and then touch the mouth or near the mouth area. The following equation is used to calculate $\left(\frac{Ing}{BW}\right)_{HTM}$:

$$\left(\frac{Ing}{BW}\right)_{HTM} = \frac{AF_{hand} \times SA_D \times TF_{direct} \times \lambda_{HTM} \times CF1 \times CF2}{BW} \quad \text{Equation 10}$$

where,

$\left(\frac{Ing}{BW}\right)_{HTM}$ = ingestion rate normalized to bodyweight for direct HTM activity for an sage group, $g_{crumb\ rubber}$/kg BW-day

AF_{hand} = adherence factor of crumb rubber for the hand, $mg_{crumb\ rubber}/cm^2$

SA_D = surface area of the part of the hand in direct contact with the mouth, cm^2

TF_{direct} = fraction of the crumb rubber transferred from a specific part hand in contact with the mouth, unitless

λ_{HTM} = number of HTM contacts per hour

$CF1$ = conversion factor, 24 hours/day

$CF2$ = conversion factor, 0.001 g/mg

BW = bodyweight, kg

The adherence factor (AF_{hand}) describes the amount of crumb rubber that adheres to the skin per unit of surface area for the hand. In this study, it is assumed that adherence is uniform across the surface of the hand and that crumb rubber loading on the hand reaches a steady level after several contacts and the rate of transfer from subsequent hand-to-object contacts is less than or equal to the field-to-hand loading rate (Cohen Hubal et al., 2005). OEHHA did not measure the adherence of crumb rubber to skin in the field or exposure studies. There are many studies in the literature, however, that estimate skin loading factors that may be used as surrogates. Some of the more relevant studies are summarized in **Table 4-23**. Kissel et al. 1996, Holmes et al. 1999, and Tsou et al. 2018 performed measurements of skin loading of children and young adults for various body parts after various outdoor activities. OEHHA and US EPA recommended values for skin soil loadings are based on these studies. There is a wide range of estimates. Most of these studies look at soil adherence to the skin, but Kissel et al. 1996 measured the skin loading of crumb rubber for various body parts for adult female soccer players. The measured values from Kissel et al. 1996 are many-fold lower than the reported loading of soil in other studies. Since crumb rubber and soil have different physical properties and sizes that may affect skin loading, measured values for the hands from Kissel et al. 1996 are used for the AF_{hand} parameter.

Table 4-23. Soil Loading for the Hand from Various Studies

Reference	Media Type	Hand Loading (mg/cm^2)	n	Age (years)	Scenario
Kissel et al. 1996	Crumb Rubber	0.037	15	24-34	Soccer players playing on all- weather fields made with ground tires and sand
Holmes et al. 1999	Soil, Sand, Wood chip	0.130	16	1-6.5	Children engaging in activities such as playing with toys, playing with each other, wrestling, sleeping, eating
US EPA Exposure Factors Handbook, 2011	Soil	0.11	8	13-15	Soccer players playing on half grass/half bare earth field
	Soil	47	12	9-14	Children playing in mud
OEHHA, 2012	Soil	0.5919	n/a	2-16	Children engaging in sports and playing in wet and dry soil
Tsou et al. 2018	Sand	0.307	45	4.2-8.9	Young children engaging in activities, such as kicking a ball, playing on swing, dodgeball exercises

All hand contact in this study is assumed to be with the grasping side (the palm side) of the hand, which is assumed to represent half of the surface area of the hand. It is assumed that the fingers each have an equal surface area and together represent half of the surface area of the grasping side of the hand. For the HTM activity of soccer players on the synthetic turf field, the surface area of the part of the hand in direct contact with the mouth (SA_D) is assumed to be four fingers, i.e. 10% of the total surface of both hands. Data on the surface area of the hand was taken from the EPA Exposure Factors Handbook (U.S. Environmental Protection Agency, 2011). **Table 4-24** presents surface area of the hands values for each age group and **Table 4-25** presents the calculated values. SA_D.

Table 4-24. Surface Area of Both Hands by Age Group, (U.S. Environmental Protection Agency, 2011)

Gender	Age Group	Hand Surface Area (cm^2)		
		Average	Median	95%
Females	0<2 years	251	250	286
	2<9 years	437	424	586
	9<16 years	610	596	807
	16-70 years	914	899	1137
Males	0<2 years	256	258	297
	2<9 years	442	433	575
	9<16 years	621	612	823
	16-70 years	1034	1027	1243
Combined	0<2 years	256	256	293
	2<9 years	439	428	580
	9<16 years	614	603	814
	16-70 years	972	964	1204

Table 4-25. Surface Area of Hands in Contact with Mouth (SA_D) by Age Group

Gender	Age Group	Hand Area in Contact with Mouth (cm^2)		
		Average	Median	95%
Females	0<2 years	25	25	29
	2<9 years	44	42	59
	9<16 years	61	60	81
	16-70 years	91	90	114
Males	0<2 years	26	26	30
	2<9 years	44	43	58
	9<16 years	62	61	82
	16-70 years	103	103	124
Combined	0<2 years	26	26	29
	2<9 years	44	43	58
	9<16 years	61	60	81
	16-70 years	97	96	120

The hand-to-mouth transfer factor (TF_{direct}) is a unitless factor that describes the fraction of the amount of crumb rubber that is transferred from the portion of the skin of the hand in contact with the mouth. It is assumed to be the same regardless of age and activity category of field users. For this study, a value of 50% is assumed for TF_{direct} (OEHHA, 2008, 2011).

For athletes and young children bystanders, data on λ_{HTM} was collected in the exposure study. For athletes, λ_{HTM} is derived using the video data observations of 40 participants. No differences in the number of HTM contacts were found due to participant age, gender, position, or event type (i.e. practice versus game). For young children bystanders, λ_{HTM} was derived using archived video footage of 1- to 12- year-old children playing outdoors on natural turf. It is reasonable to believe playful behaviors on natural turf would be similar to those on synthetic turf and the archived video data may be used to represent exposure children may have on synthetic turf. Analysis of the video footage showed no differences in HTM contacts due to age or gender of the children. As a result, the frequency of HTM contact for all individuals was analyzed as a single dataset. Parameter values for these field user groups can be found in **Table 4-26**.

Data on the frequency of HTM contacts per hour (λ_{HTM}) can be found in the scientific literature. Most of the limited data available focuses on young children. OEHHA guidelines (OEHHA, 2012) propose λ_{HTM} values similar to those recommended by the

USEPA (U.S. Environmental Protection Agency, 2008). Both agencies' values were derived from a meta-analysis study of the available HTM data for children found in the literature and can be found in **Table 4-27**.

The data for adults in the scientific literature is even more limited. A recent study of adult workers (Gorman Ng et al., 2016) conducted an observational study to determine HTM-contact frequency of workers performing various tasks, such as deskwork or paperwork or operating machinery, throughout a one-hour period of the workday. Observed values for the tasks of deskwork and the periods in between tasks when workers are not actively engaged in work tasks but not on a formal break, such as lunch, are presented in **Table 4-27**. While engaged in deskwork, the assumption is that one's hands are engaged in the activity and are not available for frequent HTM contact, similar to a scenario of an athlete during active soccer play. Conversely, while in between tasks, one's hands are anticipated to be free and available for HTM contact, similar to a bystander or coach/referee scenario. For this reason, literature values for adult workers in between work tasks was selected to be used as parameter values for adult bystanders, coach, and referees and are presented in **Table 4-26**.

Table 4-26. Proposed Hand-to-Mouth Contact (λ_{HTM}) Parameter Values*

Field User	Contacts/Hour*						Data Source
	n	Minimum	Median	Mean	95%	Maximum	
Athlete	40	0.7	7.6	8.9	18.4	26.0	OEHHA Exposure Study
Bystander (0-12 years)	56	0.0	7.6	11.7	41.0	80.1	
Bystander (12-70 years) Coach Referee	55	-	18	23.6	-	140.0	(Gorman Ng et al., 2016)

*Ways of handling data outliers will be discussed in the May 2019 SAP meeting (e.g., 140 contacts/hour for coach and referee).

Table 4-27. Literature Data—Hand-to-Mouth Contact Frequency*

Age Group	Contacts/Hour				Reference
	Mean	Median	95%	Maximum	
3 months to < 6 months	-	-	-	-	(OEHHA, 2012; U.S. Environmental Protection Agency, 2008)
6 months to < 12 months	14.5	11.6	46.7	-	
1 year to < 6 years	8.7	5.1	32.0	-	
6 years to < 11 years	2.9	0.5	11.9	-	
Adult Worker (Desk/Paperwork)	8.4	0.0	-	60.0	(Gorman Ng et al., 2016)
Adult Worker (Between Task)	23.6	18.0	-	140.0	

*Ways of handling data outliers will be discussed in the May 2019 SAP meeting (e.g., 140 contacts/hour for coach and referee).

The values for BW are as described in Section 4.4.3.1.

4.4.3.3. OTM Ingestion Rate

The following equation is used to calculate the ingestion rate of crumb rubber particles from OTM activity ($\left(\frac{Ing}{BW}\right)_{OTM}$):

$$\left(\frac{Ing}{BW}\right)_{OTM} = \frac{AF_{obj} \times SA_{obj} \times TF_{obj} \times \lambda_{OTM} \times CF1 \times CF2}{BW} \qquad \text{Equation 11}$$

where,

$\left(\frac{Ing}{BW}\right)_{OTM}$ = ingestion rate normalized to bodyweight for OTM activity, $g_{crumb\ rubber}$/kg BW-day for an age group

AF_{obj} = adherence factor of crumb rubber for an object, $mg_{crumb\ rubber}/cm^2$

SA_{obj} = the surface area of the part of the object reaching the mouth, cm^2

TF_{obj} = the fraction of the amount of crumb rubber transferred from the object into the mouth, unitless

λ_{OTM} = the number of OTM contacts per hour

$CF1$ = conversion factor, 24 hours/day

$CF2$ = conversion factor, 0.001 g/mg

BW = bodyweight, kg

The adherence factor of crumb rubber for an object (AF_{obj}) describes the amount of crumb rubber that adheres to an object after contact with the field. This value may be affected by many factors such as the particle size of crumb rubber, the object's material (e.g. a hard surface versus a fabric surface), contact pressure (e.g. a child bouncing a ball versus an adult bouncing a ball), and the moisture content of the object (e.g. wet versus dry surface). OEHHA did not measure any adherence factors of crumb rubber to objects in the field study, but a variety of different objects with various properties are anticipated to have potential contact with the mouth such as toys, pacifiers, water bottles, and whistles. Toys and pacifiers are anticipated to be the most likely objects in OTM activity. These objects are often made of materials such as plastics or silicone. In particular, silicone has adherence properties similar to the skin and acts in a manner similar to the skin, passively absorbing chemicals that the materials are exposed to and permeating throughout the material. It is for this reason that wristbands made of silicone are often used as personal samplers in exposure studies to measure chemical exposure (Kile et al., 2016; Nicole, 2018; O'Connell et al., 2014). In the absence of specific data on the adherence of crumb rubber to objects, literature values of AF_{hand} (Kissel et al., 1996) (**Table 4-23**) are proposed to estimate this parameter with the assumption that the material of objects on the field will act in a similar way to the skin.

For this study, it is assumed the surface area of the part of the object that directly contacts the mouth (SA_{obj}) will be limited by the surface area of around the mouth area of the face. The face is assumed to be one-third of the surface area of the head and the area around the mouth is assumed to be the lower one-third of the face. Data on the surface area of the face (**Table 4-28**) was taken from the US EPA Exposure Factors Handbook (U.S. Environmental Protection Agency, 2011). **Table 4-29** presents the surface area values of the mouth used for SA_{obj} for each age group.

Table 4-28. Surface Area of the Head by Age Group, (U.S. Environmental Protection Agency, 2011)

Gender	Age Group	Head Surface Area (cm^2)		
		Average	Median	95%
Females	0<2 years	791	789	904
	2<9 years	641	622	860
	9<16 years	709	693	939
	16-70 years	1153	1134	1434
Males	0<2 years	808	814	935
	2<9 years	648	634	843
	9<16 years	722	712	958
	16-70 years	1304	1295	1568
Combined	0<2 years	806	806	925
	2<9 years	644	627	850
	9<16 years	714	701	947
	16-70 years	1226	1216	1519

Table 4-29. Surface Area of the Mouth Area for SA_{obj} by Age Group

Gender	Age Group	Mouth Area Surface Area (cm^2)		
		Average	**Median**	**95%**
Females	**0<2 years**	88	88	100
	2<9 years	71	69	96
	9<16 years	79	77	104
	16-70 years	128	126	159
Males	**0<2 years**	90	90	104
	2<9 years	72	70	94
	9<16 years	80	79	106
	16-70 years	145	144	174
Combined	**0<2 years**	90	90	103
	2<9 years	72	70	94
	9<16 years	79	78	105
	16-70 years	136	135	169

The object-to-mouth transfer factor (TF_{obj}) is a unitless factor that describes the fraction of the amount of crumb rubber that is transferred from the object into the mouth. It will remain the same regardless of age and activity category of field users. In this study, 100% of crumb rubber adhered to objects contacting the field is assumed to be transferred to the mouth after contact.

For young children bystanders, archived video footage (Appendix I) of 1- to 12-year old children playing outdoors is used to estimate the OTM contacts that may occur while on the sidelines of the field. It is anticipated that behaviors with objects on natural turf would be similar to those on synthetic turf and the archived video data may be used to represent exposure children may have on synthetic turf. No significant differences were found due to age or gender of the children. OTM contact rates compiled from the video footage are presented in **Table 4-30**. OEHHA will derive λ_{OTM} from these data. Adult bystanders are not anticipated to have exposure through OTM activity.

Table 4-30. Bystander (0-12 years)—Object-to-Mouth Contacts Rates Compiled from a Video Footage

Age group*	N	Contacts/hour			
		Minimum	Median	95%	Maximum
0<2 years	568	1.5	9.4	12.1	12.1
2<9 years	36	0.0	6.9	76.2	185.1
9-12 years	12	0.0	4.9	88.3	88.3

*P-value = 0.690 from Kruskal-Wallis test.

The values for BW are as described in Section 4.4.3.1.

4.4.3.4. HTOTM Ingestion Rate

The following equation is used to calculate the ingestion rate of crumb rubber particles from HTOTM activity $\left(\frac{Ing}{BW}\right)_{HTOTM}$:

$$\left(\frac{Ing}{BW}\right)_{HTOTM} = \frac{AF_{hand} \times SA_I \times TF_{indirect} \times \lambda_{HTOTM} \times CF1 \times CF2}{BW} \qquad \text{Equation 12}$$

where,

$\left(\frac{Ing}{BW}\right)_{HTOTM}$ = ingestion rate normalized to bodyweight for HTOTM activity, $g_{crumb\ rubber}$/kg BW-day

AF_{hand} = adherence factor of crumb rubber for the hand, $mg_{crumb\ rubber}/cm^2$

SA_I = the surface area of the part of the hand in contact with object reaching the mouth, cm^2

$TF_{indirect}$ = the fraction of the amount of crumb rubber transferred from the hand to an object then into the mouth, unitless

λ_{HTOTM} = the number of HTOTM contacts per hour

$CF1$ = conversion factor, 24 hours/day

$CF2$ = conversion factor, 1E-3 g/mg

BW = bodyweight, kg

For HTOTM activity of soccer players on the synthetic turf field, the part of the hand in direct contact an object (SA_I) may vary based on the type of contact. Values for the surface area of the hand are presented in **Table 4-24**. Data from the video study is used to guide the type of objects considered for this pathway of exposure. Video data show that the objects involved in HTOTM activity are dietary objects such as water bottles and food. For dietary objects such as food or a water bottle, it is assumed that contact will be with the whole hand if eating one-handed or only the fingers if eating with two hands or a few fingers if using a water bottle. These types of contact represent 25% and 12.5%, respectively, of the surface area of the hand. As a conservative, estimate, one hand will be assumed to be used when eating food or drinking on the field, i.e. 25% of the surface area of both hands. For non-dietary objects such as toys and pacifiers, it is also assumed that one hand contacts the object. **Table 4-31** presents the values for SA_I.

Table 4-31. Surface Area of Hands in Contact with Object Reaching the Mouth (SA_I) by Age Group

Gender	Age Group	Hand Area in Contact with Part of Object Reaching the Mouth (cm^2)		
		Average	Median	95%
Females	0<2 years	63	63	72
	2<9 years	109	106	147
	9<16 years	153	149	202
	16-70 years	229	225	284
Males	0<2 years	64	65	74
	2<9 years	111	108	144
	9<16 years	155	153	206
	16-70 years	259	257	311
Combined	0<2 years	64	64	73
	2<9 years	110	107	145
	9<16 years	154	151	204
	16-70 years	243	241	301

The number of HTOTM contacts per hour (λ_{HTOTM}) for athletes and young bystanders will be derived from the video data of 40 participants and archived footage of children playing on natural turf from the exposure study. For dietary objects such as food and water bottles, differences in the number of λ_{HTOTM} were found due to the gender of athletes. For child bystanders, no differences by age or gender were found in the number of λ_{HTOTM}. The contact per hour data compiled from the video are presented in **Table 4-32** and **Table 4-33**.

Table 4-32. Athletes—Hand-to-Object-to-Mouth Contacts (λ_{HTOTM})

Gender*	n	λ_{HTOTM} (contacts/hour)			
		Minimum	Median	95%	Maximum
Female	19	0.0	5.3	15.7	17.8
Male	21	0.0	2.8	7.2	17.6

*P-value = 0.016 from Kruskal-Wallis test.

Table 4-33. Bystander (0-12 years)—Hand-to-Object-to-Mouth Contacts Data Compiled from the Video Data

Age group*	n	Contacts/hour			
		Minimum	Median	95%	Maximum
0<2 years	8	3.0	9.4	63.8	63.8
2<9 years	36	0.0	7.7	189.6	205.1
9<12 years	12	0.0	6.5	160.8	160.8

*P-value = 0.726 from Kruskal-Wallis test.

The HTOTM transfer factor ($TF_{indirect}$) is a unitless factor that describes the fraction of the amount of crumb rubber that is transferred from the part of the hand in contact with an object to the object and then into the mouth. This factor will not change with age or activity category of field users. It is calculated as follows:

$$TF_{indirect} = TF_{direct} \times (1 - TF_{loss}) \qquad \text{Equation 13}$$

where,

$TF_{indirect}$ = the fraction of the amount of crumb rubber transferred from the portion of a hand in contact with an object to the mouth, unitless

TF_{direct} = the fraction of the amount of crumb rubber transferred from the hand to the mouth, unitless

TF_{loss} = the fraction of crumb rubber lost from the hand prior to transfer into the mouth, unitless

The fraction of the amount of crumb rubber loading lost from the hand (TF_{loss}), prior to transfer onto an object which eventually transfers into the mouth, describes the amount of crumb rubber that is lost from the hand after activities such as hand washing or wiping hands on clothing before handling an object, for example. It accounts for the possibility of multiple steps between hand loading and transfer to the mouth such as for example, an athlete may wipe their hands on their shirt, and then picks up a piece of fruit to eat (OEHHA, 2008, 2011).

Following OEHHA guidelines (OEHHA, 2008, 2011), a value of 50% is assumed for both TF_{direct} and TF_{loss}. Inserting these values into Equation 13, a value of 0.25 is calculated for $TF_{indirect}$. This means that only 25% of crumb rubber on the hand will ultimately be transferred into the mouth through HTOTM activity.

OEHHA will also consider the use of a TF_{loss} value equal to 0%. Opportunities for hand washing may not be readily available at a field. Additionally, athletes or bystander may wipe their hands on clothing or towels, that have been in contact with the field surface and may be saturated with crumb rubber.

The values for BW are as described in Section 4.4.3.1.

4.4.4. Calculating Oral Dose for Cancer Risk Assessment

Following OEHHA guidelines (OEHHA, 2015), an exposure dose of a chemical through direct and indirect ingestion for cancer risk assessment ($Dose_{C-ing}$) is calculated as below. Unlike $Dose_{NC-ing}$, $Dose_{C-ing}$ is adjusted by activity-category- and age-specific ET and EF.

$$Dose_{C-ing} = C_{Crumb\ rubber} \times GRAF \times \frac{Ing}{BW} \times ET \times EF \times CF \qquad \text{Equation 14}$$

where,

$Dose_{C-ing}$ = exposure dose of a chemical from ingestion of crumb rubber, cancer, $mg_{chemical}/kg$ BW-day

$C_{Crumb\ rubber}$ = bioaccessible concentration of chemical from crumb rubber, $mg_{chemical}/g_{crumb\ rubber}$

$GRAF$ = gastrointestinal relative absorption factor, (assume equals to one, in the absence of chemical-specific data), unitless

$\frac{Ing}{BW}$ = ingestion rate normalized to bodyweight via all the direct and indirect ingestion pathways, $g_{crumb\ rubber}/kg$ BW-day

ET = exposure time, hours/day

EF = exposure frequency, days/365 days

CF = conversion factor, 1 day/24 hours

$C_{Crumb\ rubber}$ and $GRAF$ are described in Section 4.4.3 $\frac{Ing}{BW}$ is calculated as in Section 4.4.3.

Survey data for ET and EF were discussed in Sections 4.3.1 and 4.3.2 for the four age groups used for this exposure pathway, 0<2 years, 2<9 years, 9<16 years, and 16-70 years. Data for athletes are presented in **Table 4-34**, **Table 4-35**, **Table 4-36**, **Table 4-37**, **Table 4-38**, and **Table 4-39**. ET and EF values for coaches, referees, and bystanders are presented in **Table 4-4** and **Table 4-16** .

Table 4-34. Ingestion and Dermal Exposure—Survey Data of Exposure Times for Female Athletes*

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
2<9 years	7	Spring	0.0	0.0	1.7	2.0	0.0	1.0	7.6	10.0
		Summer	0.0	0.0	0.7	1.0	0.0	0.0	1.4	2.0
		Fall	0.0	0.0	2.0	2.0	0.0	1.0	7.6	10.0
		Winter	0.0	0.0	1.9	2.0	0.0	1.0	8.8	10.0
9<16 years	279	Spring	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
		Summer	0.0	1.5	3.0	24.0	0.0	1.0	4.0	15.0
		Fall	0.0	1.5	3.0	24.0	0.0	1.5	4.0	20.0
		Winter	0.0	1.5	3.0	24.0	0.0	1.0	4.0	20.0
16-70 years	236	Spring	0.0	1.5	4.0	20.0	0.0	2.0	4.0	20.0
		Summer	0.0	1.0	4.0	20.0	0.0	1.5	5.0	15.0
		Fall	0.0	1.5	4.3	12.0	0.0	2.0	6.0	15.0
		Winter	0.0	1.0	6.0	12.0	0.0	1.5	5.0	22.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 24 hr/day on or near a turf field).

Table 4-35. Ingestion and Dermal Exposure—Survey Data of Exposure Times for Male Athletes*

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
2<9 years	26	Spring	0.0	1.5	2.8	3.0	0.0	1.0	3.8	4.5
		Summer	0.0	0.0	2.0	3.0	0.0	0.0	2.8	4.0
		Fall	0.0	1.3	3.0	3.0	0.0	1.0	3.6	4.0
		Winter	0.0	1.0	2.9	8.0	0.0	0.0	3.5	7.5
9<16 years	309	Spring	0.0	1.5	0.0	24.0	0.0	1.0	0.0	13.0
		Summer	0.0	1.5	0.0	24.0	0.0	0.5	0.0	20.0
		Fall	0.0	1.5	0.0	24.0	0.0	1.0	0.0	20.0
		Winter	0.0	1.5	0.0	24.0	0.0	1.0	0.0	20.0
16-70 years	204	Spring	0.0	2.0	4.0	20.0	0.0	2.0	5.8	20.0
		Summer	0.0	2.0	4.0	20.0	0.0	1.5	4.0	15.0
		Fall	0.0	2.0	4.9	18.0	0.0	2.0	4.8	20.0
		Winter	0.0	2.0	5.0	20.0	0.0	2.0	6.0	20.0

*Ways of handling survey data outliers will be discussed at the May 2019 SAP meeting (e.g., 24 hr/day on or near a turf field).

Table 4-36. Ingestion and Dermal Exposure—Survey Data of Exposure Times for Athletes, No Gender Specified

Age Group	N	Season	Practice (Hours/day)				Game (Hours/day)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
9<16 years	7	Spring	0.0	1.5	2.0	2.0	0.0	1.0	1.8	2.0
		Summer	0.0	0.0	1.9	2.0	0.0	0.0	1.8	2.0
		Fall	0.0	1.5	1.9	2.0	0.0	1.0	1.8	2.0
		Winter	0.0	1.5	2.0	2.0	0.0	0.0	2.7	3.0
16-70 years	1	Spring	-	3.0	-	-	-	3.0	-	-
		Summer	-	2.0	-	-	-	1.0	-	-
		Fall	-	5.0	-	-	-	6.0	-	-
		Winter	-	2.0	-	-	-	2.0	-	-

Table 4-37. Ingestion and Dermal Exposure—Survey Data of Exposure Frequency for Female Athletes

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
2<9 years	7	Spring	0.0	0.3	1.0	1.0	0.0	1.0	3.4	4.0
		Summer	0.0	0.0	1.0	1.0	0.0	0.0	1.7	2.0
		Fall	0.0	0.3	1.7	2.0	0.0	1.0	2.0	2.0
		Winter	0.0	1.0	2.4	3.0	0.0	1.0	4.5	6.0
9<16 years	279	Spring	0.0	2.0	4.0	6.0	0.0	1.0	3.1	5.0
		Summer	0.0	1.0	4.0	7.0	0.0	1.0	3.0	5.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	3.0	6.0
		Winter	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
16-70 years	236	Spring	0.0	2.0	4.3	6.0	0.0	1.0	4.0	7.0
		Summer	0.0	1.0	4.0	7.0	0.0	1.0	3.0	6.0
		Fall	0.0	2.0	5.0	6.0	0.0	2.0	4.3	7.0
		Winter	0.0	2.0	5.0	6.0	0.0	2.0	4.0	5.0

Table 4-38. Ingestion and Dermal Exposure—Survey Data of Exposure Frequency for Male Athletes

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
2<9 years	26	Spring	0.0	1.0	3.0	3.0	0.0	1.0	3.0	5.0
		Summer	0.0	0.0	3.0	3.0	0.0	0.3	4.3	6.0
		Fall	0.0	1.0	3.8	4.0	0.0	1.0	3.0	3.0
		Winter	0.0	1.0	3.0	4.0	0.0	0.5	2.0	3.0
9<16 years	309	Spring	0.0	2.0	4.0	5.0	0.0	1.0	3.0	7.0
		Summer	0.0	1.0	4.0	5.0	0.0	1.0	3.0	7.0
		Fall	0.0	2.0	4.0	7.0	0.0	1.0	4.0	7.0
		Winter	0.0	2.0	4.0	6.0	0.0	1.0	4.0	6.0
16-70 years	204	Spring	0.0	2.0	5.0	7.0	0.0	1.0	4.0	7.0
		Summer	0.0	2.0	5.0	7.0	0.0	1.0	3.0	6.0
		Fall	0.0	2.0	6.0	7.0	0.0	1.3	3.8	7.0
		Winter	0.0	2.0	6.0	7.0	0.0	2.0	4.0	6.0

Table 4-39. Ingestion and Dermal Exposure—Survey Data of Exposure Frequency for Athletes, No Gender Specified

Age Group	N	Season	Practice (Days/week)				Game (Days/week)			
			Minimum	Median	95%	Maximum	Minimum	Median	95%	Maximum
9<16 years	7	Spring	0.0	2.0	3.7	4.0	0.0	1.0	2.7	3.0
		Summer	0.0	0.0	3.4	4.0	0.0	0.0	2.4	3.0
		Fall	0.0	1.0	3.7	4.0	0.0	0.5	2.7	3.0
		Winter	0.0	1.0	4.1	5.0	0.0	0.0	2.7	3.0
16-70 years	1	Spring	-	4.0	-	-	-	2.0	-	-
		Summer	-	2.0	-	-	-	1.0	-	-
		Fall	-	5.0	-	-	-	3.0	-	-
		Winter	-	2.0	-	-	-	1.0	-	-

The cancer risk by ingestion exposure is derived similarly to the cancer risk by inhalation exposure. Age-specific exposure duration (ED), an age-sensitivity factor for the age group (ASF), and the chemical-specific oral cancer potency factor (CPF) are applied to the to $Dose_{C-ing}$ as shown in the following equation:

$$Risk_{ing} = \frac{Dose_{C-ing} \times CPF_{oral} \times ASF \times ED}{AT} \qquad \text{Equation 15}$$

where,

$Risk_{ing}$ = cancer risk of a chemical through ingestion for an age group or lifestage, unitless

$Dose_{C-ing}$ = exposure dose of a chemical through ingestion, $mg_{chemical}$/kg BW-day

CPF_{oral} = oral cancer potency factor of a chemical, $mg_{chemical}$/kg BW-day^{-1}

ASF = age sensitivity factor, unitless

ED = exposure duration, years

AT = averaging time, equal to 70 years

Similar to the CPF used in Equation 6, CPF_{oral} estimates the increased cancer risk from ingestion exposure to a chemical at a dose of 1 mg/kg-BW per day. When available, OEHHA values will be used for this parameter, otherwise US EPA IRIS values may be used if available.

ASF and ED values for the age groups used in this exposure pathway are presented in **Table 4-40** and **Table 4-41**, respectively.

Table 4-40. Age Sensitivity Factors for Ingestion and Dermal Age Groups (OEHHA, 2015)

Age Group	Age Sensitivity Factor (unitless)
3rd trimester	10
0<2 years	10
2<9 years	3
9<16 years	3
16-70 years	1

Table 4-41. Exposure Duration for Ingestion and Dermal Exposure Age Groups

Age Group	Exposure Duration (Years)
3rd trimester	0.25
0<2 years	2
2<9 years	7
9<16 years	7
16-70 years	54

4.5. Dermal Exposure Pathway

The dermal exposure pathway can occur (i) directly, via skin contact with crumb rubber, or (ii) indirectly, via contact with crumb rubber adhered to skin. Depending on the physical and chemical properties of the chemical and the skin condition, the chemicals may enter the body by dermal absorption.

4.5.1. Direct Dermal Exposure Pathway

Direct dermal exposure refers to the scenario when there is direct skin contact with crumb rubber on the field surface. The particles may adhere to the skin during the contact. Chemicals can be transferred from the adhered particles onto the skin, where they may be available for dermal uptake. Moisture on the skin surface, like sweat, may enhance adhesion of crumb rubber particles onto the skin and facilitate transfer of chemicals across the skin. Another scenario is the transfer of chemicals from the suspension of fine airborne particles that may deposit on the skin. During soccer practices or games, ball kicking, running, and tackling activities agitate the field and disperse crumb rubber particulate into the air, potentially providing opportunity for release of chemicals from particles into the air. These fine particles settle onto the skin of players, where chemicals may get absorbed through the skin. Chemical absorption from fine particles is considered a negligible pathway in comparison to direct contact with crumb rubber.

Soccer uniforms traditionally consist of short-sleeve shirts and shorts. The moderate climate in California and the outdoor environment of most synthetic turf fields reinforce the tendency for athletes to dress lightly during practices and games. Their exposed arms and legs can come into direct contact with the field surface during practices and games: conducting warm-up exercises (sit-ups and push-ups) on the field; pushing off the field with hands to maintain balance or get up after a fall; lunging, jumping, and falling repeatedly onto the field (especially for goalkeepers). Bystanders of all ages can have dermal exposure and their skin can be in frequent contact with the field surface (see Section 4.2.2.34.2.2.3).

While coaches routinely spend time on the field, they have much less skin contact with the field compared to athletes. They seldom fall and do not dive onto the turf like athletes. They typically stand on the sidelines of the field during an entire game. Similarly, referees rarely have direct dermal contact with the field surface.

4.5.2. Indirect Dermal Exposure Pathway

Dermal exposure may also occur indirectly through chemicals such as vapor in the air. During hot summers in some regions of California, volatile and semi-volatile chemicals may be vaporized from crumb rubber on the field or from suspended fine particles into the air. These chemicals may be deposited on the skin. Players, coaches and by-standers may have continuous indirect dermal exposure to chemicals via these mechanisms. However, unlike the inhalation of these vapors, these indirect exposure pathways are unlikely to be predominant since they require specific environmental conditions.

Indirect dermal exposure may also occur through the transfer of chemicals or particles from an object to the skin. Objects such as soccer balls, soccer gloves, and shoes are in constant or frequent contact with the field surface. The object-field interactions may lead to adhesion of chemicals or fine particles onto the objects. Subsequent dermal contact with these objects may transfer the adhered chemicals or particles from the object to the skin of the field user, resulting in chemical absorption through the skin. All field user categories may be exposed through this indirect dermal pathway. Body parts, such as hands, lower legs, and the forehead of the athletes are in frequent dermal contacts with these objects before, during, and after practice or game: athletes may handle, get hit by, or head the ball to score, athletes may put on and take off the shoes, the goalkeeper puts on or take offs the gloves, etc. Coaches and referees often have dermal (especially the hands) contact with the ball and their shoes. Bystanders who assist in handling soccer equipment, play with the soccer equipment after the practice or game, or pick up their water bottles that have been left on the field surface may also be exposed through this indirect dermal pathway. In addition, chemicals or particles transferred onto the hands through this indirect dermal mechanism may be ingested and result in adsorption of chemicals via an indirect ingestion pathway. The indirect ingestion pathway is discussed in the Section 4.4.2.

4.5.3. Calculating Dermal Dose for Non-Cancer Hazard Assessment

The OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 2015) provide detailed directions on assessing chemical exposure via the dermal exposure pathway. The age groups and field users considered for this assessment are the same as those used in Sections 4.4.3 and 4.4.4.

Dermal exposure dose is a function of particle loading onto the skin surface, the area of exposed skin surface that comes into contact with field surface, and the concentration and bioaccessibility of a chemical from crumb rubber particles. Similar to the non-cancer hazard assessment for ingestion exposure, OEHHA (OEHHA, 2015) recommends deriving a hazard quotient (HQ_{der}) for a chemical from an exposure dose through dermal absorption ($Dose_{NC-der}$) and the $Chronic\ Oral\ REL$ for the chemical using the equation below:

$$HQ_{der} = \frac{Dose_{NC-der}}{Chronic\ Oral\ REL} \qquad \text{Equation 16}$$

where,

HQ_{der} = chronic dermal hazard quotient of a chemical, unitless

$Dose_{NC-der}$ = non-cancer systemic dose of a chemical through dermal absorption, $mg_{chemical}$/kg BW-day

$Chronic\ Oral\ REL$ = chronic oral reference exposure level of a chemical, $mg_{chemical}$/kg BW-day

Exposure dose for dermal absorption for non-cancer assessment ($Dose_{NC-der}$) is calculated following the OEHHA (OEHHA, 2015) guidelines.

$$Dose_{NC-der} = \frac{DL \times C_{crumb\ rubber} \times ABS \times ED \times CF}{AT} \qquad \text{Equation 17}$$

where,

$Dose_{NC-der}$ = non-cancer exposure dose of a chemical through dermal absorption, $mg_{chemical}$/kg BW-day

DL = daily dermal skin load of particles, $mg_{crumb\ rubber}$/kg BW-day

$C_{crumb\ rubber}$ = dermal bioaccessible concentration of a chemical in particles, $mg_{chemical}/g_{crumb\ rubber}$

ABS = fraction of a chemical absorbed across skin, unitless

ED = exposure duration, equal to 2, 7, 7, and 54 years for the 0<2, 2<9, 9<16, and 16<70 age groups, respectively

CF = conversion factor, 0.001 $g_{crumb\ rubber}/mg_{crumb\ rubber}$

AT = averaging time, equals to 70 years

The dermal bioaccessible concentration of a chemical in particles ($C_{crumb\ rubber}$) is measured from samples collected in the field characterization study. This concentration is measured using artificial sweat and sebum biofluid extracts, and represents the amount of a chemical that is available for absorption into the body.

The fraction of a chemical absorbed across skin (ABS) is a unitless factor that describes the amount of a chemical that is absorbed through the skin. This value is chemical specific and can be found in various sources in the literature (OEHHA, 2012; U.S. Environmental Protection Agency, 2004). For this study, however, OEHHA will assume an ABS of 1 and that the full amount of chemical that is available to be absorbed from crumb rubber, i.e. $C_{crumb\ rubber}$, will be absorbed into the body.

Values of the daily dermal loading (DL) provided in OEHHA guidelines (OEHHA, 2015) are for modeling residential exposure to soil contaminants and they may not be applicable to the synthetic turf study. Instead, OEHHA derived DL using Equation 18. This equation was adapted from the OEHHA guidelines and the US EPA RAGS Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (U.S. Environmental Protection Agency, 2004) for skin contact with soil. To calculate DL from field surface contact, the following equation was used:

$$DL = AF_{weighted} \times SA_{BW} \times EV \qquad \text{Equation 18}$$

where,

DL = daily dermal load of particles, $mg_{crumb\ rubber}$/kg BW-day

$AF_{weighted}$ = weighted adherence factor of crumb rubber for exposed skin, $mg_{crumb\ rubber}/cm^2$

SA_{BW} = exposed skin surface area normalized to bodyweight, cm^2/kg BW

EV = event frequency, events/day

As described in Section 4.4.3, the AF describes the amount of crumb rubber that adheres to the skin per unit of surface area. For simplicity, it is assumed that the amount of particles adhered to the body may change during each skin contact with the field surface, but will quickly reach a steady state (i.e., amount lost is equal to amount adhered following each contact and remain the same throughout a practice or game (Cohen Hubal et al., 2005). It is also assumed that particles adhered to skin during a soccer event is not removed until hand washing or bathing occurs (U.S. Environmental Protection Agency, 2004). The weighted adherence factor ($AF_{weighted}$) describes the amount of crumb rubber particles that may adhere to only the skin that is exposed during a game or practice. This factor is a weighted sum based on the surface area of each exposed body part and the AF for those body parts. Equation 19 shows how $AF_{weighted}$ is calculated. The US EPA guidance, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (U.S. Environmental Protection Agency, 2004), was used for the estimation of $AF_{weighted}$ as presented in the following equation.

$$AF_{weighted} = \sum_{m}^{n} \frac{(AF_m \times FTSA_m) + \cdots (AF_n \times FTSA_n)}{FTSA_m + \cdots + FTSA_n} \qquad \text{Equation 19}$$

where,

$AF_{weighted}$ = weighted adherence factor of crumb rubber for exposed skin, $mg_{crumb\ rubber}/cm^2$

AF_i = adherence factor of crumb rubber to skin for a specified body part, $mg_{crumb\ rubber}/cm^2$

$FTSA_i$ = fraction of the total body surface area for a specified body part, unitless

Throughout the body, the structure and function of the skin can vary based on where the skin is located. As a result, there may be differences in the adherence of crumb rubber for different body parts (AF_i). Values from the crumb rubber adherence study of crumb rubber by Kissel et al. are used for this parameter and are presented in **Table 4-42**. Kissel et al. did not measure the AF for the feet of the soccer players on the synthetic turf field. However, crumb rubber particles can get into the shoes during play and come into contact with the feet. For this study, based on similarities such as skin thickness (Kolarsick et al., 2011), lack of hair and serum producing sebaceous glands (Smith and Thiboutot, 2008), and the presence of eccrine sweat glands (Bovell, 2015), the skin of the feet are assumed to behave similarly to the hand. Therefore, AF_{hand} is used as a surrogate for AF_{feet}.

Table 4-42. Body Part-Specific Adherence Factors (AF_i) (Kissel et al., 1996)

Body Part	AF (mg/cm^2)
Hands	0.037
Arms	0.005
Legs	0.036
Face	0.015
Feet	0.037

The fraction of the total body surface area varies by body part ($FTSA_i$). Fractions may change through growth in childhood and young adulthood as may vary based on age and gender. Values for $FTSA_i$ based on age and gender, presented in **Table 4-43**, are derived from the USEPA Exposure Factors Handbook (U.S. Environmental Protection Agency, 2011). No gender specific data for the age group 0<2 years was available, so the $FTSA_i$ parameters are based on combined female and male data for 0<2 years. For participants who did not specify a gender in the exposure study, parameter estimates are derived from the combined male- and female-specific data.

Table 4-43. Average Percent of Total Body Surface Area by Gender and Age Group ($FTSA_i$) (U.S. Environmental Protection Agency, 2011)

Gender	Age Group	Head	Trunk	Arms	Hands	Legs	Feet
Female	0<2 years	17%	36%	13%	6%	22%	6%
	2<9 years	7%	40%	14%	5%	27%	6%
	9<16 years	5%	39%	14%	4%	31%	6%
	16-70 years	6%	35%	13%	5%	32%	7%
Male	0<2 years	17%	36%	13%	6%	22%	6%
	2<9 years	7%	40%	14%	5%	26%	7%
	9<16 years	5%	40%	14%	5%	30%	7%
	16-70 years	7%	40%	15%	5%	33%	7%
Combined	0<2 years	17%	36%	13%	6%	22%	6%
	2<9 years	7%	40%	14%	5%	27%	7%
	9<16 years	5%	40%	14%	5%	30%	7%
	16-70 years	6%	38%	14%	5%	33%	7%

Parameter values for the calculated $AF_{weighted}$ for the field user categories are presented in **Table 4-44** and **Table 4-45**.

Table 4-44. Athlete and Child Bystander (0-12 years)—Weighted Adherence Factor for Exposed Skin Area by Gender and Age Group

Gender	Age Group	$AF_{weighted}$ ($mg_{crumb\ rubber}/cm^2$)
Female	0<2 years	0.028
	2<9 years	0.030
	9<16 years	0.031
	16-70 years	0.030
Male	0<2 years	0.028
	2<9 years	0.030
	9<16 years	0.031
	16-70 years	0.033
Combined	0<2 years	0.028
	2<9 years	0.030
	9<16 years	0.031
	16-70 years	0.031

Table 4-45. Coach, Referee, and Adult Bystander (12-70 years)—Weighted Adherence Factor for Exposed Skin Area by Gender and Age Group

Gender	Age Group	$AF_{weighted}$ ($mg_{crumb\ rubber}/cm^2$)
Female	9<16 years	0.013
	16-70 years	0.014
Male	9<16 years	0.013
	16-70 years	0.015

Dermal exposure is dependent on the availability of skin for contact with crumb rubber or the field surface. The exposed skin surface area normalized to bodyweight (SA_{BW}) is the amount of skin area that is available for contact with the field or crumb rubber particles normalized to the bodyweight of a field user. SA_{BW} is estimated based on the body parts exposed, e.g. arms and legs, and the $FTSA$ (**Table 4-43**) for each body part and is shown in Equation 20.

$$SA_{BW} = \sum_{m}^{n} (FTSA_m + \cdots + FTSA_n) \times \left(\frac{SA_{total}}{BW}\right) \qquad \text{Equation 20}$$

where,

SA_{BW} = exposed skin surface area normalized to bodyweight, cm^2/kg BW

$FTSA_i$ = fraction of the total body surface area for a specified body part, unitless

SA_{total} = total body skin surface area available for contact, cm^2

BW = bodyweight, kg

The exposed body parts may be dependent on the type of clothing that is worn, which can vary based on season, field location, and position. Data from the exposure study shows that for the spring, summer, and fall seasons, athletes typically dress in short sleeve shirts, shorts, long socks, and shoes for soccer activities. Goalies also wear gloves and may wear long sleeve shirts or long pants. During the winter season, athletes may wear long sleeve shirts and long pants more frequently, and occasionally gloves (for players other than the goalie). For this study, the total surface area of the body is assumed to be exposed for athletes for contact with crumb rubber particles. This assumption is based on anecdotal evidence that regardless of how athletes are dressed, crumb rubber particles frequently get inside of undergarments, clothing, and shoes during synthetic turf field use. Young children bystanders are also assumed to have their total body surface area available for contact since they may crawl around on and play on the field. For coaches, referees, and adult bystanders, it is assumed that only their legs and arms (including hands) are available for contact since they may not be falling or diving on the field, but they may have contact with objects, such as a clothing or equipment bag, that may have sat on the field. Parameter values for SA_{total} are derived from the US EPA exposure factors handbook (U.S. Environmental Protection Agency, 2011) and are presented in **Table 4-46**.

Table 4-46. Total Body Surface Area by Age Group and Gender (U.S. Environmental Protection Agency, 2011)

Gender	Age Group	Total Body Surface Area (cm^2)		
		Average	Median	95%
Female	0<2 years	4558	4550	5208
	2<9 years	9167	8900	12300
	9<16 years	13250	12950	17550
	16-70 years	18381	18088	22859
Male	0<2 years	4658	4692	5392
	2<9 years	9278	9078	12056
	9<16 years	13500	13300	17900
	16-70 years	20789	20647	24997
Combined	0<2 years	4646	4646	5333
	2<9 years	9211	8978	12167
	9<16 years	13350	13100	17700
	16-70 years	19542	19389	24222

The event frequency (EV) describes the number of field events a field user may participate in during a single day. For this study, all field users are assumed to participate in a single field event per day, i.e. they do not re-enter the field or enter another at a later time of the day after the particles loaded on the skin are removed and the skin is ready for another dermal loading. The single field event may be a single practice period or multiple games in a tournament.

4.5.4. Calculating Dermal Dose for Cancer Risk Assessment

Following OEHHA guidelines (OEHHA, 2015), an exposure dose of a chemical through dermal absorption for cancer risk assessment ($Dose_{C-der}$) is calculated using the following equation:

$$Dose_{C-der} = DL \times C_{crumb\ rubber} \times ABS \times ET \times EF \times CF1 \times CF2 \qquad \text{Equation 21}$$

where,

$Dose_{C-der}$ = exposure dose of a chemical through dermal absorption, cancer, $mg_{chemical}$/kg BW-day

DL = daily dermal skin load of particles, $mg_{crumb\ rubber}$/kg BW-day

$C_{crumb\ rubber}$ = dermal bioaccessible concentration of a chemical in particles, $mg_{chemical}/g_{crumb\ rubber}$

ABS = fraction of bioaccessible chemical absorbed across skin, unitless

ET = exposure time, hours/day

EF = exposure frequency, days/365 days

$CF1$ = conversion factor 1, 0.001 $g_{crumb\ rubber}/mg_{crumb\ rubber}$

$CF2$ = conversion factor, 1 day/24 hours

The cancer risk from dermal exposure ($Risk_{der}$) is derived similarly to inhalation and ingestion cancer risk.

$$Risk_{der} = \frac{Dose_{C-der} \times CPF_{oral} \times ASF \times ED}{AT} \qquad \text{Equation 22}$$

where,

$Risk_{der}$ = cancer risk of a chemical through dermal exposure, unitless

$Dose_{C-der}$ = exposure dose of a chemical through dermal absorption, $mg_{chemical}$/kg BW-day

CPF_{oral} = oral cancer potency factor of a chemical, $mg_{chemical}$/kg BW-day^{-1}

ASF = age sensitivity factor, unitless, presented in **Table 4-17**

ED = exposure duration, years, equal to 2, 7, 7, and 54 years for the 0<2 years, 2<9 years, 9<16 years and 16-70 years age groups, respectively

AT = averaging time, equal to 70 years

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Appendix A
Two-Tiered Non-Targeted Analysis Approach to Identify Tentative Extractable Polar Chemicals in Crumb Rubber

Appendix A. Two-Tiered Non-Targeted Analysis Approach to Identify Tentative Extractable Polar Chemicals in Crumb Rubber

A-1. Tier 1. Suspect Screening Analysis of Polar Organic Chemicals in Crumb Rubber Extracts Using Established Chemical Databases

A-1.1. Match Mass of Molecular Ions (MS1) with Established Tire-Related Chemical Lists

A-1.1. Tire-Related Chemical Lists:

A-1.1.1 *OEHHA Tire-Related Chemical List* (OEHHA, 2016) - tire-related chemicals (confirmed or unconfirmed) reported in literature and chemicals used in tire manufacturing processes (information provided by the Rubber Manufacturers Association (USTMA, https://www.ustires.org/whats-tire-0) and International Carbon Black Association (ICBA, 2016), along with chemicals advertised for use tire or rubber manufacturing).

A-1.1.2 *Chemical Information from the Federal Tire Studies* – chemicals identified (confirmed or unconfirmed) in tire studies conducted by federal agencies.

A-1.2. Download Monoisotopic Masses of Chemicals in the Established Tire-Related Chemical List:

A-1.2.1 Import chemical abstracts service (CAS) numbers of chemicals on the Tire-Related Chemical Lists into the US EPA DSSTox Database and batch search for monoisotopic mass of the chemicals.

A-1.2.2 Incorporate monoisotopic masses into the Tire-Related Chemical Lists.

A-1.3. Match Molecular Ion Peaks on LC/MS (MS1) with Chemicals on the Tire-Related Chemical List:

A-1.3.1 Use Compound Discoverer software (version 3.0, ThermoFisher Scientific, Waltham, MA) to derive molecular mass of molecular ions on MS1 spectra of the crumb rubber extracts and truncate molecular masses to the 100th decimal place.

A-1.3.2 Truncate monoisotopic mass of listed chemicals to the 100th decimal place.

A-1.3.3 Make tentative chemical identifications through matching the monoisotopic masses on the Tire-Related Chemical Lists with the molecular masses obtained from the LC/MS analysis of crumb rubber extracts.

A-1.3.4 Enter the matched chemicals to the Tentatively Identified Chemicals List for crumb rubber.

A-1.4. Use the US EPA DSSTox Database Search to Further Enrich the Tentatively Identified Chemical List:

A-1.4.1 Import the exact neutral mass of molecular ions from Compound Discoverer (LC/MS analysis of field sample extracts) into the US EPA DSSTox Database for batch search of parent chemicals that generate fragment(s) with monoisotopic mass matching the mass of the unknown molecular ions, within (±) 5 ppm.

A-1.4.2 Export CAS numbers of matched parent chemicals.

A-1.4.3 Make tentative chemical identifications by matching the CAS number of the exported parent chemicals with the Tire-Related Chemical Suspect Lists.

A-1.4.4 Enter the matched chemicals to the Tentatively Identified Chemical List for crumb rubber.

A-2. Identify Tentatively Identified Chemical Using Only the US EPA DSSTox Database – Search Molecular Masses Derived from Mass of Molecular Ions on the US EPA DSSTox Database:

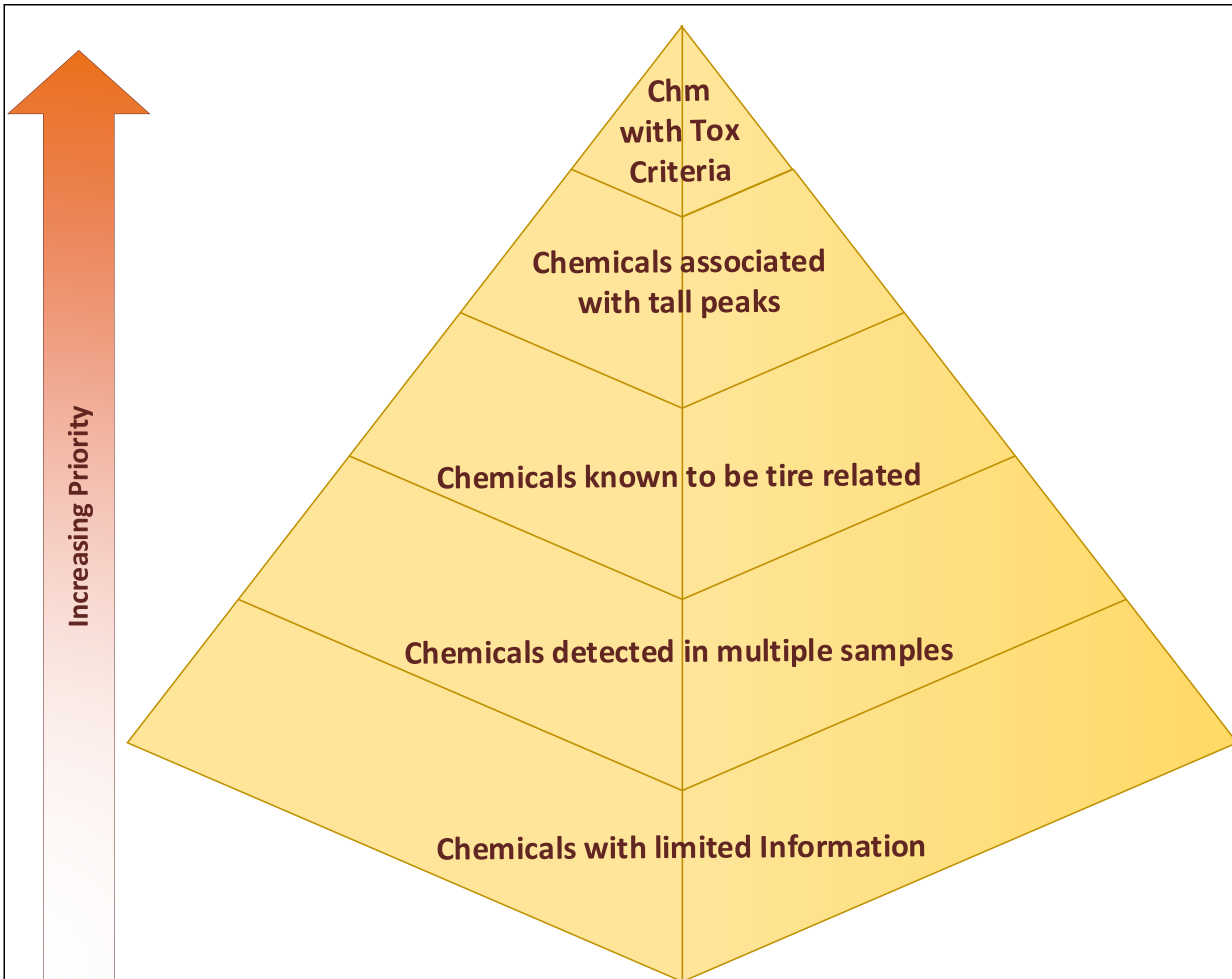
A-2.1. Import the exact neutral mass of molecular ions from Compound Discoverer (LC/MS analysis of field sample extracts) into the US EPA DSSTox Database for batch search of parent chemicals that generate fragment(s) with monoisotopic mass matching the mass of the molecular ions, within (+/-) 5 ppm.

A-2.2. Export the chemicals and enter into the Tentative Chemical List of crumb rubber.

A-3. Prioritize and Confirm Tentatively Identified Chemicals according to the priority scheme show in Figure A-1.

A-4. Use reference standards to confirm the identity of the tentatively identified chemicals by comparing their LC retention time and spectral data (MS1 and MS2).

A-5. Add the confirmed chemicals to the Chemical Target List, which will used to guide the bioassessibility measurements.



- Choose the top first tentatively identified chemical over the top second tentatively identified chemical if no toxicity information is available and both chemicals are not associated with tire
- Choose the top second tentatively identified chemical over the top first tentatively identified chemical , if the top first tentatively identified chemical is known to be non-toxic but the second top tentatively identified chemical is known to be toxic

Figure A-1. Prioritization Scheme of Tentatively Identified Chemicals in Crumb Rubber Extracts

A-2. **Tier 2. Non-Targeted Chemical Analysis of Polar Chemicals in Crumb Rubber Extracts with the Aid of Cheminformatics Tools** Tentative chemicals are identified through matching unknown spectral data (from the HRAM- LC/MS analysis of crumb rubber extracts) with spectral library using the web-based Competitive Fragmentation Modeling algorithm (CFM-ID, Wishart Research Group, University of Alberta, Edmonton, Canada, http://cfmid3.wishartlab.com/publications). The algorithm search its spectral library, which is compiled with in a silico mass spectra and experimental spectral data collected from eleven databases: CASMI2016, ContaminantDB, DrugBank, FiehnLib, HMDB, KEGG, MassBank, MetaboBASE, NIST, PytoHub and iTree (Djoumbou-Feunang et al., 2019). Below are the steps of the analysis:

A-2.1. Use Xcalibur (v. 2.0.6, ThermoFisher Scientific, Waltham, MA) to extract the MS2 data for each significant parent ion peak. Significant parent ions are chromatographic peaks satisfying both of the conditions below:

- A relative peak height ≥ 5% in at least three consecutive scans (~3 seconds/MS1 scan).
- Among those scans, one must have a relative peak height ≥10%.

A-2.2. Apply CFM-ID settings as shown in **Table A-4-47**:

Table A-4-47. CFM-ID Model Input Summary

Model Parameter	Input	Note
Spectra Type	ESI	ElectroSpray Ionization
Ion Mode	positive or negative	match with the lc/ms ionization settings
Adduct Type	$[M+H]^+$ or $[M-H]^-$	match with the lc/ms ionization settings
Parent Ion Mass	m/z value of parent ion (MS1)	obtained from xcalibur (4 decimals)
Candidate Mass Tolerance	5 ppm	depend on the accuracy of LC/MS
Candidate Limit	100	maximum
Databases	Check all	11 databases available
Spectra	Input Text	
Input Spectra Text – Medium Energy	MS2 data: [*m/z,* relative intensity]	extract by Xcalibur
Scoring Function	Dotproduct +Metadata	default
Number of Results	10	
Mass Tolerance	10 ppm	depend on the accuracy of LC/MS

A-2.3. Designate the top two candidates with the highest Overall Scores (output from CMF-ID) as tentative chemicals for the corresponding molecular ion peak.

A-2.4. Prioritize and Confirm Tentatively Identified Chemicals according to the priority scheme show in **Figure A-1**.

A-2.5. Use reference standards to confirm the tentative chemical identifications by comparing their LC retention time and spectral data (MS1 and MS2).

A-2.6. Add the confirmed chemicals to the Chemical Target List, which will used to guide the bioassessibility measurements.

Appendix B
Chamber Testing SOP

Appendix B. Chamber Testing SOP

B-1. Material Preparation

New (un-installed) samples of artificial "grass" blades and crumb rubber samples were stored at room temperature and in the dark. Crumb rubber samples were stored in amber glass jars and the grass blade samples were wrapped in aluminum foil and sealed in plastic bags. Samples were coded with ID numbers only and scientists at LBNL were blinded as to the source of the material. In preparation for testing, a section of turf field was created in a 6 x 6 x 2 inch stainless steel box. A sample of artificial blades was removed from its individual sealed bag and a 6-inch (15.25 cm) square was cut from the piece using a straight edge and razor knife. The sample was placed into the stainless steel box then filled with 300 g of crumb rubber to create a reconstructed section of turf field (Figure B-1). The turf sections were reconstructed based on previous reports (Norwegian Institute for Air Research, NILU) on amounts of crumb rubber used in soccer field applications.

Figure B-1. Example of 6 x 6 x 2 inch reconstructed turf field sample for emission testing

B-2. Material Testing

Emission testing generally follows ASTM Standard Guide D-5116-97 and California Specification 01350 using small emission chambers. The emission testing apparatus consisted of four 10.75-liter stainless steel chambers (Figure B-2) that were treated with Sulfinert® coating (http://www.silcotek.com/) to minimize wall interaction for active compounds. The test materials were placed on a Sulfinert® treated screen resting slightly below the center of the test chambers and the chambers were sealed with clamp-on lids. The chambers were mounted inside a controlled environment incubator (Forma Scientific, Model 3919) that was used to provide a constant temperature.

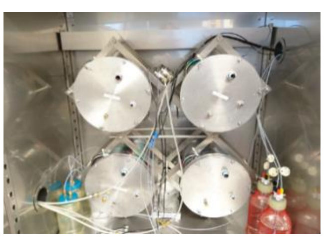


Figure B-2. Four emission chambers.

All four chambers were maintained at a nominal standard temperature and humidity (25°C and 50% RH). HOBO data loggers (Onset Model U12-011) were used to record temperature and RH. Preconditioned air was supplied to each test chamber continuously at 1 LPM. Dry house air was passed through an activated carbon filter followed by a HEPA filter and then a portion of the air stream was passed through a bubbler containing deionized water. A small amount of activated carbon was placed in the bubbler reservoir. The wet and dry air streams were mixed to produce the desired relative humidity and the humidified air was delivered (at 1 LPM) to each chamber using flow control valves and taper-tube flow meters (**Figure B-3**). The ventilation rate in the chambers was approximately 5.6 air changes per hour (ACH). Reconstructed turf field samples were sealed into a chamber typically 24 hours before sampling to allow time for the conditions to stabilize.

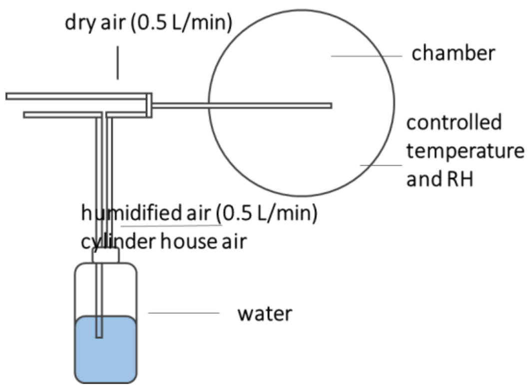


Figure B-3. Flow of conditioned air to emission chamber

B-3. Air Sampling for VOCs and Low Molecular Weight Carbonyls

The samples were drawn directly from the chamber through a port in the lid of the chamber. The sampling rate was maintained at less than 80% of the total flow through the chamber to prevent backflow of air into the test chamber. VOC samples were collected onto multibed custom sorbent tubes containing a primary bed of Carbopack B® with a backup bed of Carbopack X® (Supelco). Prior to use, the sorbent tubes were conditioned by helium purge (25cc/min) at 345°C for 30 minutes and sealed in Teflon capped tubes (see SOP Conditioning TD Tubes). A variable speed peristaltic pump (MasterFlex, Cole-Parmer) was used to pull air through the sample tubes at a sampling rate of 100 cc/min. Flows were checked using a DryCal gas flow meter (BIOS, 500 cc/min) at least twice during each sampling period. Approximately 3 liters were collected from the emission chambers. After sample collection, the sorbent tubes were sealed with Teflon lined caps and transferred to a freezer until analysis by GC/MS (see Turf Project Instrument Descriptions).

Samples of low molecular weight carbonyl compounds were collected and analyzed following ASTM Test Method D 5197-92 (ASTM, 1997). The air samples were drawn directly from the small emission chamber at steady state. Samples were collected on commercially available silica gel cartridges coated with 2,4-dinitrophenyl-hydrazine (XPoSure Aldehyde Sampler P/N WAT047025; Waters corporation). Chamber air was drawn through the sample cartridge at 850 cc/min using a peristaltic pump (MaterFlex, Cole-Parmer) Sample cartridges were capped and stored in the freezer until extraction and anlaysis by HPLC (see Turf Project Instrument Descriptions).

Appendix C
Turf Project Instrument Descriptions Draft v1

Appendix C. Turf Project Instrument Descriptions Draft v1

C-1. Analysis of Volatile Organic Compounds (VOCs) by Thermal Desorption coupled with Gas Chromatography Mass Spectrometry (TD-GC/MS)

VOCs were collected onto multibed glass thermal desorption tubes (Supelco, P/N 28286-U) custom packed with primary bed of Carbopack B© sorbent (4 mm) and backed with a 2 mm section of Carbopack X©. Prior to use, the sorbent tubes were conditioned at 345°C for 30 minutes with a helium purge (30 cc/min) then sealed in Teflon capped TDS3 storage containers (Sigma P/N 25045-U). VOC samples were collected using a calibrated vacuum pump to pull air through the sample tubes at nominal flow rate of 100 cc/min. Approximately 6 liters of sample was collected. Flows were verified using a calibrated flow meter prior to and during sampling. Exposed sorbent tubes were sealed with Teflon lined caps after use stored on ice for transport to the laboratory for analysis.

Before analysis, a gas-phase internal standard (120 ng of 1-bromo-4-fluorobenzene) was injected into each sorbent tube with a helium purge (30 cc/min) at room temperature for 4 minutes. Once prepared, the sorbent tubes were analyzed by thermal desorption coupled gas chromatography/mass spectrometry using the following thermal desorption injection system: a ThermoDesorption Autosampler (Model TDSA2; Gerstel), a thermal desorption oven (Model TDS3, Gerstel) and a cryogenically cooled injection system (Model CIS4; Gerstel). The cooled injection system contained a Tenax-TA©-packed glass injection liner (P/N 013247- 005-00; Gerstel). The samples were desorbed at 50cc/min (splitless) using the following temperature profile: 25°C (0.5 minute delay) followed by a 60°C/min ramp to 330°C with a 1 minute hold time. The cooled inlet was held at 1°C and then heated after 0.1 minutes to 300°C at a rate of 12°C/s, followed by a 2 minute hold time. The GC was operated in the solvent vent mode with a splitless injection. Compounds were resolved on a GC (Series 6890 Plus; Agilent Technologies) equipped with a 30 meter by 0.25-mm-diameter Restek Rxi-624Sil MS capillary column (P/N 13868) with 1.4 micron film thickness. The initial oven temperature was 1°C, held for 2 minutes, then increased to 100°C at 5°C/min (hold 2 minutes), increase to 140°C at 3°C/min, then to 300°C at 10°C/min and held for 10 minutes. The helium flow through the column was held constant at 1.2 mL/min (initial pressure 47 kPa, 39 cm/sec). The resolved analytes were detected using electron impact MS (5973; Agilent Technologies) operated in total ion current (TIC) mode with target and qualifier ions specified for each target compound. The MS temperature settings were 240°C, 230°C, and 150°C for the transfer line, MS source, and MS quad, respectively. The MS was operated in scan mode with a range of 34 m/z to 450 m/z. Multipoint calibrations were prepared from pure standards for all target VOCs. The response for each analyte was normalized to the internal standard response.

C-2. Low Molecular Weight Carbonyl Analysis by High Performance Liquid Chromatography (HPLC)

Target aldehydes and ketones with low molecular weight (i.e., formaldehyde, acetaldehyde, and acetone) were actively sampled onto silica gel cartridges coated with 2,4-dinitrophenylhydrazine (DNPH XPoSure Aldehyde Sampler P/N WAT047205; Waters corporation) with ozone scrubbers installed upstream (P/N WAT054420; Waters). An SKC pump was used to draw the air through the sampling media with a target sampling flow rate of approximately 1000 mL/min. Before the start of sampling, the airflow rates through each sampling line were measured using a BIOS flow meter (S/N 118925) and adjusted to the target flow rate. Actual airflow rates were recorded on a sampling record sheet once at the start and once towards the end of each sampling period. Sampling was carried out for 180 minutes at two locations on field.

The DNPH-coated cartridges were analyzed for the target aldehydes by HPLC. Each cartridge was eluted with 2 mL of high purity acetonitrile (P/N 018-4, Burdick & Jackson) and analyzed by high-performance liquid chromatography (HPLC; 1200 Series; Agilent Technologies). Target analytes were resolved on a 200 mm by 3.2 mm Allure AK column (P/N 9159523-700; Restek) and run with 60:40 acetonitrile/water mobile phase at 0.5 mL/minute with UV detection at 360 nm. Multipoint calibration curves were prepared from certified standard hydrazone derivatives of the target analytes (CRM47651: Sigma-Aldrich).

C-3. Analysis of Semi-Volatile Organic Compounds (SVOCs) by Gas Chromatography Mass Spectrometry (GC/MS)

Before analysis, a deuterated internal standard (100 pg of p-Terphenyl-D14) was added to each sample. Once prepared, 1 µL of sample was injected into a GC (Series 7890 Plus; Agilent Technologies) fitted with a PTV-inlet (Model CIS4; Gerstel) with a septumless sampling head. The injection system contained a deactivated glass wool injection liner (P/N 23432; Restek). The samples were introduced into the system via a splitless injection at 45kPa using the following temperature profile: 40°C (0.1 minute delay) followed by a 20°C/min ramp to 275°C with a 5 minute hold time. Compounds were resolved on a 30 meter by 0.25-mm diameter DB-UI8270D column (Agilent, P/N 122-9732) with 2.5 micron film thickness. The initial oven temperature was 40°C, held for 2 minutes, then increased to 320°C at 20°C/min (hold 5 minutes). The helium flow through the column was held constant at 1.2 mL/min. The resolved analytes were detected on a high efficiency source MS detector (5977B; Agilent Technologies) via electron impact. The MS temperature settings were 300°C, 200°C, and 150°C for the transfer line, MS source, and MS quad, respectively. The MS was operated in scan mode with a range of 34 m/z to 1000 m/z. Multipoint calibrations were prepared from pure standards for all target VOCs. The response for each analyte was normalized to the internal standard response.

C-4. Analysis of Volatile Sulfur Compounds (VSCs) by Thermal Desorption coupled with Gas Chromatography Sulfur Chemiluminescence Detection (TD-GC/SCD)

Volatile sulfur compounds were collected using the same protocol for VOCs. They were collected onto multibed glass thermal desorption tubes (Supelco, P/N 28286-U) custom packed with primary bed of Carbopack B© sorbent (4 mm) and backed with a 2 mm section of Carbopack X©. Prior to use, the sorbent tubes were conditioned at 345°C for 30 minutes with a helium purge (30 cc/min) then sealed in Teflon capped TDS3 storage containers (Sigma P/N 25045-U). VOC samples were collected using a calibrated vacuum pump to pull air through the sample tubes at nominal flow rate of 100 cc/min. Approximately 6 liters of sample was collected. Flows were verified using a calibrated flow meter prior to and during sampling. Exposed sorbent tubes were sealed with Teflon lined caps after use stored on ice for transport to the laboratory for analysis.

The sorbent tubes were analyzed by thermal desorption coupled gas chromatography and a sulfur chemiluminescence detector (SCD). Samples were introduced into the system using the following thermal desorption injection system: a ThermoDesorption Autosampler (Model TDSA2; Gerstel), a thermal desorption oven (Model TDS3, Gerstel) and a cryogenically cooled injection system (Model CIS4; Gerstel). The cooled injection system contained a deactivated glass bead liner (P/N 011714-005-00; Gerstel). The samples were desorbed at 50cc/min (splitless) using the following temperature profile: 20°C (0.5 minute delay) followed by a 60°C/min ramp to 280°C with a 2.3 minute hold time. The cooled inlet was held at -120°C and then heated after 0.1 minutes to 280°C at a rate of 12°C/s, followed by a 2 minute hold time. The GC was operated in the solvent vent mode with a splitless injection. Compounds were resolved on a GC (Series 7890 Plus; Agilent Technologies) equipped with a 30 meter by 0.32-mm-diameter DB-1 capillary column (P/N 123-1033;Agilent) with 1.0 mm film thickness. The initial oven temperature was 10°C, held for 1 minute, then increased to 120°C at 8°C/min, hold for 2 minutes then to 280°C at 16°C/min and held for 10 minutes. The helium flow through the column was held constant at 3.5 mL/min. The resolved analytes were detected by Sulfur Chemiluminescence (8355; Agilent Technologies) with a burner temperature of 800°C and base temperature of 250°C.

Appendix D
Extraction of Crumb Rubber for LC/MS

Appendix D. Extraction of Crumb Rubber for LC/MS

SAFETY: This procedure uses flammable solvents and a high pressure extraction system located in B70-217. Workers need to have WPC approval (EA-0002) to work on this system. All work is to be performed in the fume hood while wearing nitrile gloves, safety glasses and lab coat.

D-1. Extracting Crumb Rubber samples for LCMS analysis

Crumb rubber samples are extracted with 90/10 water/methanol using the Accelerated Solvent Extraction (ASE).

D-2. Equipment and Supplies:

- Accelerated Solvent Extraction System (Dionex, ASE 200)
- Micro Balance
- Muffle furnace
- Crumb Samples
- N_2 cylinder
- Water, HPLC grade
- Methanol, pesticide residue grade
- Dichloromethane, pesticide residue grade
- Acetone, pesticide residue grade
- Diatomaceous earth
- Small ASE cells, 11 mL
- Caps for ASE cells
- Funnel aluminum
- Amber Bottle, 1L
- 40 ml amber VOA vials (IChem)
- Caps for 40 mL vials
- Septa
- Glass drying dish
- Weigh boat, Al foil
- Spatula
- ASE glass fiber filter, solvent clean
- Kimwipes
- Bench paper
- Nitrile gloves
- Timer
- Labeling tape

D-3. Procedure

D-3.1. Preparation of Diatomaceous Earth (D.E.)

D-3.1.1 Solvent clean 1L amber bottle and lid, air dry.
D-3.1.2 Solvent clean glass Pyrex drying dish.
D-3.1.3 Place about 500 mL of D.E. in drying dish.
D-3.1.4 Muffle bake for 4 hours at 400C.
D-3.1.5 Cool overnight and store tightly sealed in 1L bottle.

D-3.2. Crump Rubber Prep

D-3.2.1 Solvent rinse ASE cell and caps with dichloromethane followed by acetone then air dry.
D-3.2.2 Clean spatula, funnel, and foil weigh boat with dichloromethane followed by acetone.
D-3.2.3 Record the number on ASE 11 mL cell. Assemble bottom cap and insert a cleaned filter.
D-3.2.4 Weigh desired amount of crumb and record weight.
D-3.2.5 Add D.E. to crumb sample in the weigh boat.
D-3.2.6 Mix thoroughly so crumb particles are dispersed into the D.E.
D-3.2.7 Transfer prepared sample to the ASE cell.
D-3.2.8 Cap cell tightly.
D-3.2.9 Label one 40 mL VOA vial for each sample and place in ASE carousel.
D-3.2.10 Run ASE method 16 (Table D-1) for each ASE cell. (90% water and 10% methanol).

Table D-1. ASE Program: Method 16 Crumb Rubber Extraction

Parameter	Value
Oven Temperature (°C)	75
Pressure (psi)	1500
Preheat (min)	0
Static (min)	5
Heat (min)	5
Solvent	90% Water/10% Methanol
Cycles	1
Purge (sec)	120
Flush	50%
Elapsed Time (min)	30

D-3.3. When finished, replace vial cap with a closed top cap.
D-3.4. Store sample extracts in the fridge until analysis (Table D-2).

Table D-2. Sample IDs and Weights (uninstalled crumb rubber sample XX was used)

Sample ID	% Crumb	Cell ID	ASE position	Wt. CR (g)	Wt. DE (g)
CRBXX-100	100%	K14609	1	4.5000	0
CRBXX-75	75%	K11994	2	3.3842	0.5053
CRBXX-50	50%	K14538	3	2.2445	0.9965
CRBXX-25	25%	K12039	4	1.1200	1.5054
CRBXX-10	10%	K15122	5	0.4500	1.8079
CRBXX-00	0%	K14480	6	0	2.00

Appendix E
Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) by Gas Chromatography Mass Spectrometry (GC/MS) with Selected Ion Monitoring (SIM)

Appendix E. Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) by Gas Chromatography Mass Spectrometry (GC/MS) with Selected Ion Monitoring (SIM)

E-1. Pure Standards

Multipoint calibration standards were prepared from pure chemicals for all target analytes (Table E-1). A certified reference material was purchased from Supelco (P/N CRM47543, EPA 8310 Mix) and diluted in dichloromethane to produce 10 calibration levels ranging from 5000 pg/µL to 0.4 pg/µL. Each standard also contained 100 pg/µL of a deuterium-labeled surrogate (P/N ES-2528, Cambridge Isotope Laboratories) to match each target plus 100 pg/µL of an internal standard (used to normalize instrument response). The internal standard contained three deuterium-labeled PAHs purchased from Cambridge Isotope Laboratories: 2-Methylnaphthalene-D10 (P/N DLM-1322-S), p-Terphenyl-D14 (P/N DLM-382-S), and Perylene-D12 (P/N DLM-366-S).

Table E-1. List of Target PAH Analytes (CRM47543, Supelco).

Analyte	***CAS#***
Naphthalene	91-20-3
2-Methylnaphthalene	91-57-6
1-Methylnaphthalene	90-12-0
Acenapthylene	208-96-8
Acenaphthene	83-32-9
Fluorene	86-73-7
Phenanthrene	85-01-8
Anthracene	120-12-7
Fluoranthene	206-44-0
Pyrene	129-00-0
Chrysene	218-01-9
Benzo[a]anthracene	56-55-3
Benzo(b)fluoranthene	205-99-2
Benzo(k)fluoranthene	207-08-9
Benzo(a)pyrene	50-32-8
Indeno(1,2,3-cd)pyrene	193-39-5
Dibenz(a,h)anthracene	53-70-3
Benzo(g,h,I)perylene	191-24-2

E-2. Instrument Parameters

Before analysis each sample was spiked with 100 pg/µL of internal standard. Once prepared, 1 µL of standard or sample was introduced into an Agilent model 7890A gas chromatograph using a septumless sampling head (Gerstel model SLH) fitted with a single baffle injection liner with wool (P/N 23432, Restek). The injection liner was held at 40°C for 0.1 minute for the manual injection, then heated to 275°C at 12°C/min with a 3 minute hold. The GC was operated in the solvent vent mode with a splitless injection. An Agilent DB-UI8270D column (30m x 0.25mm x 0.25µm) was held at 40°C for 1 minute then heated to 320°C at 20°C/min and held for 5.5 minutes. The helium flow through the column was held constant at 1.2 mL/minute. The resolved analytes were detected using an electron impact mass spectrometer containing a high efficiency source (5977B MSD; Agilent Technologies) operated in selected ion monitoring (SIM) mode with target and qualifier ions specified for each analyte, surrogate and internal standard compound (Table E-2). The MS temperature settings were 240°C, 230°C, and 150°C for the transfer line, MS source, and MS quad, respectively.

Table E-2. Parameters for Selected Ion Monitoring Measurement of PAHs.

Chemical	RT(min)	Target Ion	Qualifier Ion
Naphthalene	6.85	128.1	127.0
Naphthalene-D8	6.83	136.1	137.1
2-Methylnaphthalene-D8	7.63	152.1	150.1
2-Methylnaphthalene	7.67	142.1	141.1
1-Methylnaphthalene	7.79	142.1	141.1
Acenaphthylene	8.75	152.1	151.1
Acenaphthylene-D8	8.73	160.1	158.1
Acenaphthene	8.97	154.1	153.1
Acenaphthene-D10	8.93	164.1	162.1
Fluorene	9.59	166.1	165.1
Fluorene-D10	9.56	176.1	174.1
Phenanthrene	10.76	178.1	176.1
Phenanthrene-D10	10.71	188.1	184.1
Anthracene	10.81	178.1	176.1
Anthracene-D10	10.77	188.1	184.1
Fluoranthene	12.20	202.1	200.1
Fluoranthene-D10	12.19	212.2	208.1
Pyrene	12.49	202.1	200.1
Pyrene-D10	12.47	212.2	208.1
p-Terphenyl-D14	12.70	244.2	243.2
Benzo(a)anthracene	13.96	228.1	226.1
Benzo(a)anthracene-D12	13.93	240.2	236.2
Chrysene	13.99	228.1	226.1
Chrysene-D12	13.98	240.2	236.2

Chemical	RT(min)	Target Ion	Qualifier Ion
Benzo(b)fluoranthene	15.19	252.1	250.1
Benzo(b)fluoranthene-D12	15.16	264.2	260.1
Benzo(k)fluoranthene	15.22	252.1	250.1
Benzo(k)fluoranthene-D12	15.19	264.2	260.1
Benzo(a)pyrene	15.56	252.1	250.1
Benzo(a)pyrene-D12	15.53	264.2	260.1
Perylene-D12	15.61	264.2	260.1
Indeno(1,2,3-cd)pyrene	17.03	276.1	274.1
Indeno(1,2,3-cd)pyrene-D12	17.00	288.2	
Dibenz(a,h)anthracene	17.06	278.1	276.1
Dibenz(a,h)anthracene-D14	17.02	292.2	293.2
Benzo(g,h,i)perylene	17.44	276.1	274.1
Benzo(g,h,i)perylene-D12	17.40	288.2	287.2

Appendix F
LC/MS Instrumental Settings

Appendix F. LC/MS Instrumental Settings

Samples of crumb rubber extracts were analyzed using a 1200 series liquid chromatography (LC) system (Agilent Technologies, Santa Clara, CA) that was connected in line with an (linear ion trap) LTQ-Orbitrap-XL mass spectrometer equipped with an electrospray ionization (ESI) source (ThermoFisher Scientific, W). The LC system contained the following modules: G1322A solvent degasser, G1311A quaternary pump, G1316A thermostatted column compartment, and G1329A autosampler (Agilent Technologies). The LC column compartment was equipped with an Atlantis T3 column (length: 150 mm, inner diameter: 1.0 mm, particle size: 3 µm, part number: 186003714, Waters). Water purified to a resistivity of 18.2 MΩ·cm (at 25 °C) using a Milli-Q Gradient ultrapure water purification system (Millipore) and methanol (Optima LC-MS grade, 99.9%, Fisher) were used to prepare the mobile phase solvents, A and B, respectively. The elution program consisted of isocratic flow at 5% (volume/volume) B for 2 min, a linear gradient to 30% B over 0.5 min, a linear gradient to 95% B over 32 min, isocratic flow at 95% B for 5 min, a linear gradient to 5% B over 0.5 min, and isocratic flow at 5% B for 20 min, at a flow rate of 100 µL/min. The column compartment was maintained at 40 °C and the sample injection volume was 25 µL. Full-scan mass spectra were acquired over the range of mass-to-charge ratio (m/z) = 50 to 1800 using the Orbitrap mass analyzer, in profile format, with a mass resolution setting of 60,000 (at m/z = 400, measured at full width at half-maximum peak height, FWHM). In the data-dependent mode, the six most intense ions exceeding an intensity threshold of 10,000 raw ion counts were selected from each full-scan mass spectrum for tandem mass spectrometry (MS/MS) analysis using collision-induced dissociation (CID). MS/MS spectra were acquired using the linear ion trap, in centroid format, with the following parameters: isolation width 5 m/z units, normalized collision energy 35%, default charge state 1, activation Q 0.25, and activation time 30 ms. Real-time charge state screening was enabled to exclude unassigned charge states and charge states ≥4 from MS/MS analysis. To avoid the occurrence of redundant MS/MS measurements, real-time dynamic exclusion was enabled to preclude re-selection of previously analyzed precursor ions, with the following parameters: repeat count 3, repeat duration 30 s, exclusion list size 500, exclusion duration 180 s, and exclusion mass width ±20 parts-per-million. Measurements were acquired using the positive ion mode and the negative ion mode. Data acquisition was controlled using Xcalibur software (version 2.0.7, Thermo Fisher Scientific).

Appendix G. Draft Report Assessing Human Time-Activity Exposure Patterns Occurring on Synthetic Turf Fields

Appendix G. Draft Report Assessing Human Time-Activity Exposure Patterns Occurring on Synthetic Turf Fields

Agreement #16-E0019

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Disclaimer

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Table 19. Percent of time resting, lightly active, moderately active, and highly active at practice or game reported in questionnaire and observed during videotaping

Abbreviations

COPC	Contaminants of Potential Concern
CPHS	Committee for the Protection of Human Subjects
NBI	Norwegian Building Institute
OEHHA	Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
STFCR	Synthetic Turf Field with Crumb Rubber
UA	University of Arizona
VOC	Volatile Organic Compound

Overview

Due to their low water and maintenance requirements, the use of synthetic turf fields has become popular in California in recent years; however, concerns have emerged that playing soccer and other sports on synthetic turf fields with crumb rubber (STFCR) may result in exposure to chemicals present in recycled tires that pose risks to human health.[1] For example, crumb rubber infill made from recycled tires contains various toxicants such as PAHs and other organic contaminants.[2] Athletes and bystanders that spend time on or near synthetic turf fields may be exposed to these chemicals through oral, dermal, and inhalation routes.[2]

Exposure to chemicals from synthetic turf fields are of particular concern among soccer players in California. In addition to being the most popular sport among high school students in California, there is an abundance of recreational and competitive soccer leagues throughout the state that attract diverse participants of varying ages.[3]

While some health risk assessments have not found significantly increased risk from activity on synthetic turf fields,[1 2, 4] the majority of studies to date have focused on short-term exposures. This study aims to provide information necessary to assess potential risks resulting from lifetime exposures to synthetic turf fields among California soccer players.[3]

This project includes three main components: i) administration of an online survey to obtain statewide information regarding players' soccer history and exposure-related behaviors; ii) videotaping players at soccer practices and games on synthetic turf fields containing crumb rubber in the San Francisco Bay Area and Sacramento area; and iii) administration of in-person questionnaires to players or parents of players participating in the videotaping. For the online survey, we recruited male and female recreational and competitive soccer players over the age of 18 and invited parents/guardians to complete the survey for soccer players under 18. For the videotaping and in-person questionnaires, we recruited male and female soccer players aged 7 to 25 years old.

Using publically available datasets, we acquired email addresses for coaches, managers, club presidents, and other affiliates of youth, high school, collegiate, and adult recreational and competitive soccer teams throughout California. Between December, 2017 and April, 2018 we sent emails to soccer coaches and managers i) throughout California to recruit participants for the online survey, and ii) in the San Francisco Bay Area and Sacramento area to recruit participants for the videotaping and in-person questionnaires.

A total of 1,069 participants completed the online or in-person surveys and 40 soccer players were videotaped during five practices and five games on STFCRs. Information from these studies will inform the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) efforts to assess potential chemical exposures health risks resulting from use of synthetic turf fields.

Body of Report

1. Introduction

Concerns have been raised about the safety of using recycled tire crumb rubber as infill in synthetic turf playing fields due to the potential for exposure of athletes and bystanders to harmful chemicals, including known and suspected carcinogens, neurotoxins, and potential endocrine disruptors.[5, 6] Numerous laboratory and field studies have found that volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, particulates, and other substances may be released from recycled tires and tire crumb under various conditions.[7]

While some risk assessments have concluded that the use of tire crumb rubber in synthetic turf playing fields presents minimal risk to athletes and bystanders, there is limited information from quantitative exposure assessments characterizing exposure to compounds released from crumb rubber via oral, inhalation, and dermal routes of exposure. Current risk assessments have also largely focused on short-term exposures and there are data gaps regarding exposures and risks associated with synthetic turf field use over a lifetime.[6]

Although no epidemiological studies have been published that have shown associations between use of synthetic turf fields with crumb rubber (STFCRs) and adverse health outcomes, there have been case reports of cancer among soccer players, particularly for goalies, who may have greater contact with synthetic turf.[8]

In this report, we describe time-activity data collected from Californians that play soccer on STFCRs. This information about players' histories and exposure-related behaviors will inform the development of exposure scenarios and modeling by OEHHA that will be used to evaluate potential health risks associated resulting from use of synthetic turf fields with crumb rubber.

1.1. Routes of Exposure

Soccer players, coaches, referees, bystanders, and others spending time on or near STFCRs may be exposed to chemicals present in the crumb rubber via inhalation, ingestion, and dermal contact.

Inhalation

Inhalation exposures occur when soccer players or bystanders inhale gases emitted from crumb rubber granules or suspended particles generally ≤ 10 microns. The greatest exposures are expected among athletes, particularly while they are engaged in high intensity activities that increase breathing rates. The resuspension of small crumb rubber particles into air from activities such as running, falling, or sliding can also result in higher inhalation exposures among players, coaches, referees, and other personnel located on the field. Bystanders near the field are likely to be engaged in sedentary activities, such as sitting or standing, and may have lower exposures via inhalation.

Ingestion

Non-dietary Ingestion

- Can be intentional (i.e., infant/toddler mouthing, pica behavior) or inadvertent (non-dietary ingestion);
- May occur during activities where hands, fingers, or other objects come in contact with the turf surface and then touch the face or mouth of an individual (i.e., when eating, scratching, etc.);
- May also occur when large dust particles are trapped in the upper respiratory system before entering the lungs and are then transported to the throat and swallowed.

Ingestion of crumb rubber may be inadvertent or intentional. Inadvertent ingestion may occur when a player or bystander's hands contact the crumb rubber or field surface and then their mouth. For example, soccer players may fall or dive during games or practice, touch the field surface and then touch their mouth with their hands, transferring chemicals into the oral cavity. Soccer players and bystanders may also be exposed via indirect hand-to-mouth activity when their hands contact an object that has contacted the field or other contaminated surface, such as a water bottle or toy, which ultimately comes into contact with their mouth. Inadvertent ingestion can also occur if crumb rubber granules directly enter the mouth when diving, slipping, tackling, or other strenuous contact with the field surface.[9] Among soccer players, goalkeepers are expected to have higher ingestion exposures than other positions because they repeatedly dive and make contact with the field in practices and games.

Young bystanders, including infants and children, may crawl on the sidelines and then put their fingers in their mouth, also resulting in inadvertent ingestion. Young children may also be more likely to have a snack or play with toys on the field, which could result in indirect ingestion of crumb rubber particles, particularly if they do not wash their hands.

Intentional ingestion, in which crumb rubber is directly consumed, may be an important exposure pathway for infants and young children who crawl on the field sidelines and put crumb rubber directly in their mouth and eat it.

Dermal Absorption

Dermal exposure occurs when chemicals on skin are absorbed into the body. Soccer players routinely come in contact with the field during games and practices when diving, sliding, or slipping. Players may also push off the field with their hands to maintain balance during warm-up activities or to get themselves up after falling. Kicking the turf, running, and diving may temporarily dislodge crumb rubber from the field surface and suspend it into the air where it may contact skin. Falling or making contact with the turf can also cause crumb rubber to adhere to clothing or exposed skin, potentially resulting in more prolonged exposure if players do not remove their clothes and take a shower immediately following a practice or game. Anecdotal reports from parents often describe extensive crumb rubber dust on children's skin or granules and dust in shoes, clothing, or hair. Bystanders may also be exposed by dermal contact with field surfaces, as adults may sit on the turf to watch practices or games and young children may play on or crawl around the turf.

Dermal exposure may also occur when gases emitted from crumb rubber granules are directly absorbed through the skin.

1.2. Relevant Research

Several laboratory studies, exposure assessments, and risk assessments conducted in the United States and Europe have aimed to assess exposure to chemicals released from recycled tires and crumb rubber and their potential health risks among users of STFCRs. Key studies include:

- The State of Connecticut collected personal air samples from 3-4 volunteers playing soccer for a 2-hour sampling event at one indoor and four outdoor STFCRs.[10-12] Investigators identified 22 potentially field-related chemicals of potential concern (COPC) that were elevated at the synthetic turf fields compared to background samples, including 10 VOCs, 11 PAHs, and the SVOC benzothiazole.[10-12]

- In a 2009 study in New York, investigators compared contaminants in the air above synthetic turf fields in the breathing zone of children collected under simulated playing conditions with background samples collected from grass fields and upwind locations.[13] The investigators did not identify an increased risk for human health effects resulting from ingestion, dermal, or inhalation exposure to crumb rubber COPCs.[13]

- The Norwegian Building Institute (NBI) conducted two studies in which they measured VOCs in air samples from indoor artificial turf fields[14] and analyzed PAHs in rubber granule and turf fiber samples from different distributors of artificial turf sytems.[15]

- A French study measured the concentrations of VOCs emitted from crumb rubber under laboratory conditions.[16] The data were used by the French National Institute for Industrial Environment and Risks to evaluate possible health risks from inhaling VOCs released from synthetic turf.[16] The study authors concluded that the concentrations of organic compounds emitted did not pose a health concern for athletes, officials or spectators.[16]

Previous exposure assessment studies of synthetic turf with crumb rubber have not adequately addressed multiple scenarios of exposure frequency/duration and routes of exposure. Despite significant research on the topic, questions still remain about the safety of long-term exposure to crumb rubber in synthetic turf fields.

1.3. Research Objectives

Objective 1: Exposure Scenario Development - Estimate Nature, Duration, and Frequency of Exposures

a. Use available databases to characterize the number and age of soccer players in California.

b. Develop and administer online and in-person questionnaires to soccer players (and their parents, for players under 18) throughout California to characterize time-activity patterns of soccer participants.
c. Videotape soccer players at practices and games taking place on synthetic turf fields containing crumb rubber in the San Francisco Bay Area and Sacramento area to capture information needed to identify exposure-related sport and non-sport activities that occur on synthetic turf fields.

2. Materials and Methods

2.1. Approach

This project focused on youth and adult competitive and recreational soccer players using STFCRs throughout California. The project included three primary components: i) administration of an online survey to collect statewide information about players' soccer history and behaviors while playing soccer; ii) videotaping soccer players during scheduled practices and games in the San Francisco Bay Area and Sacramento area to characterize activity patterns while playing soccer and characterize exposure-related behaviors among soccer players using STFCRs; and, iii) administration of an in-person questionnaire to players participating in the videotaping to collect information on their soccer history and behaviors while using STFCRs.

Our goal was to recruit 1,000 participants of various ages throughout California to participate in the online survey. For the in-person videotaping and questionnaire, our goal was to videotape four soccer players at up to 10 practices or games taking place on a STFCR, for a maximum of 40 participants. At each event, we attempted to videotape one soccer player for each player position on the team (i.e., forward, midfielder, defender, and goalkeeper). In order to capture exposure-related behaviors among a range of soccer players, we aimed to enroll one male and one female soccer team in each of the following age categories: under 9 years, 9-12 years, 12-15 years, 15-18 years, and 18-25 years.

Video data were sent to the University of Arizona (UA) for analysis. Investigators at UA transcribed the video data and coded the exposure-related time-activity behaviors using VirtualTimingDevice™. VirtualTimingDevice™ is a software program developed by UA to track the duration of contact of a body part (e.g., hands, legs) with surfaces (e.g., artificial turf) and other objects, such as a water bottle, food, or a mouth guard.

Data from the online surveys, videotaping and in-person questionnaires will be used by OEHHA to develop exposure scenarios for soccer players using STFCRs.

2.2. Human Subjects Review and Approval

Human subjects approval for this project was received from the UC Berkeley Committee for the Protection of Human Subjects (CPHS) on November 13, 2017 and from the State of California CPHS on December 4, 2017. The UA CPHS relied on the UC Berkeley CPHS for this project.

2.3. Online Survey

2.3.1. Survey Development

The online survey was developed by study staff and OEHHA after review of instruments developed by U.S. EPA[17] and consultation with soccer players and their parents. Additional input was provided by OEHHA management. An independent soccer coach also reviewed the questionnaire. The survey focused solely on use of STFCRs and included questions about general demographic information, frequency of use, frequency of contact with the field during games and practices, usual activity levels during games and practices, potential dermal and non-dietary ingestion exposures during games and practices, hygiene practices, and take-home of crumb rubber particles and dust (i.e., on shoes or clothing) after playing soccer on STFCRs. The online survey also included a detailed player history section. For the parents/guardians completing the survey for their child under the age of 18, the player history section addressed the use of STFCRs for soccer when their child was between the ages of 4-8, 9-12, and 13-17 years old. For soccer players over the age of 18 completing the survey themselves, the player history section addressed the use of STFCRs during college, high school, and youth soccer. The online survey is provided in Appendix A.

2.3.2. Recruitment

We primarily used email to recruit participants for the online survey. We obtained publicly available email addresses for coaches, managers, and other soccer club affiliates in California from websites for youth/club recreational and competitive soccer, high school soccer, adult recreational soccer, and collegiate competitive and intramural soccer. We obtained email addresses for collegiate competitive and recreational soccer teams by manually searching for coaches and managers associated with teams from all colleges and universities in California.

NorCal Premier, Cal North Soccer, and Cal South Soccer were the primary organizations that were used to obtain email addresses for youth and adult recreational and competitive soccer teams. Together, these organizations have over 600 member clubs and their websites were used to obtain the email addresses for coaches, mangers, and other contacts associated with youth and adult soccer throughout California.

In December 2017 and January 2018, we sent a recruitment email for the online survey to over 10,000 email addresses for coaches and managers associated with youth, high school, collegiate, and adult recreational and competitive soccer teams throughout California. The email briefly outlined the study and asked coaches/managers to forward the link to the online survey to parents and players on the team. Links to the email in English and in Spanish were included in the email. The recruitment email also asked the coach/manager to complete the survey if they currently play soccer or had played soccer in the past. Parents of soccer players under the age of 18 were invited to complete the survey for their child.

Between February and April 2018, we sent follow-up emails asking soccer coaches and managers to forward the link to the survey to the parents and players on their team if they had not done so already. Staff also conducted follow up calls to key clubs and organizations in different regions of the state to encourage participation.

In addition to sending emails to soccer coaches and clubs in California, study staff distributed recruitment flyers with a link to the online survey to bystanders and parents at the in-person videotaping fieldwork events. The flyer also included a link to the Facebook page that we maintained that allowed potential participants to obtain more information about the study and contact study investigators.

2.3.3. Data Collection

The UC Berkeley version of Qualtrics was used to administer the online surveys.

2.3.4. Data Management and Analysis

Data from the English and Spanish surveys were downloaded from Qualtrics in an Excel file and transferred to STATA statistical software Version 14, which was used for all data analysis.

2.4. In-Person Survey and Videotaping Time-Activity Assessment

2.4.1. Questionnaire Development

A questionnaire nearly identical to the online survey addressing exposure-related behaviors was administered to each of the players 14 years or older being videotaped. A parent/guardian was asked to complete the questionnaire for participants younger than 14 years. The questionnaire focused on use of STFCRS and included questions about demographics, use frequency of STFCRs, frequency of contact with the fields during games and practices, activity levels during games and practices, potential dermal and non-dietary ingestion exposures during games and practices, hygiene practices, and take-home of crumb rubber particles and dust (i.e., on shoes or clothing) after playing soccer on STFCRs. Information was also collected about the soccer history and the use of STFCRs at younger ages (4-8, 9-12, 13-17, and 18-25 years old, depending on the age of the participant). The in-person questionnaire is provided in Appendix A.

2.4.2. Recruitment

Beginning in December 2017, we sent a recruitment email to managers and coaches of recreational and competitive soccer teams in the San Francisco Bay Area and Sacramento area with players ages 7-25 years. The email detailed the goals of the study, what potential participation would involve for the team, and asked the coach and/or manger to respond to study staff via phone or email if they were potentially interested in participating. Study staff communicated with coaches and managers that demonstrated interest in the study and provided more details about the study. Most coaches were able and willing to reach out to players and parents and help with forwarding study recruitment and consent information. Study staff then interacted with parents and players to obtain consent and assent (from players <18 years).

2.4.3. Data Collection

Videotape: Teams of two study staff were assigned a player to videotape from the time the participant stepped on the field until the time the participant left the field, including breaks. Study staff completed an "Object Palette Log Sheet" and "Taper's Log Time Sheet" to record additional behaviors of the player they were videotaping. The purpose of the Object Palette Log Sheet was to record objects the participant touched to provide more detail for the staff transcribing the video footage. Examples of details study staff recorded on the Object Palette Log Sheet include "clear plastic water bottle" or "yellow polyester jersey". Field staff also recorded other events that caused them to turn off or move the camera, such as during half-time or a camera malfunction. The videotape observation forms (Object Palette Log Sheet and Taper's Log Time Sheet) are provided in Appendix A.

If enough staff were available, 1-2 high definition wide-angle cameras were set up on the edge of the field in order to capture the entire field to provide back-up footage in case participants were not in view for a segment of the primary video recording.

Questionnaire: Study staff administered the questionnaire to the soccer player, or a parent/guardian of the participant, as described above. A parent/guardian was asked to complete the questionnaire if the soccer player was younger than 14 years and the soccer player was asked to complete the questionnaire if they were 14 years or older. The UC Berkeley version of Qualtrics was used to administer the in-person questionnaires on electronic tablets.

2.4.4. Data Management and Analysis

Questionnaire Data

Data from the questionnaires collected on the Qualtrics offline application were uploaded to the Qualtrics server in the field or upon returning to the office.

Video Data

Video footage recorded on SD cards were transferred to i) an external hard drive device, and ii) Box file sharing service. A link to the password-protected and encrypted video files on Box was shared with collaborators at UA so they could download and analyze the data.

Video translation was completed using VirtualTimingDevice™ software, as described in previous studies.[18-20] Briefly, study staff from CERCH, OEHHA, and UA collaborated to tailor a video palette for this project containing potential locations of soccer players (e.g., field, sideline), time (e.g., before practice/game, during practice/game), activities (e.g., diving), and object surface categories (e.g., artificial turf, water bottle). Translators at UA would transcribe the videos in 30-minute segments and activate cells in each of the location, time, activity, and object categories that correlated with the activity and contact occurring in the video. Once a cell was activated, a timer started that recorded the length of each activity and contact. If a new cell was activated, a new timer began. Through this process, data is collected that translates to the types of contacts being made and the contact frequencies and durations. This process was repeated for the left hand, right hand, left foot, and right foot to gather data for various body parts of interest.

Additionally, existing video footage from 56 children collected in 1998-2000 by Stanford's Exposure Research Group was reviewed and translated to gather micro-level data regarding the frequency of hand-to-mouth activity of young children playing outdoors.[21] These data were used to develop exposure parameters for bystanders who may play on the sidelines of synthetic turf fields during practices and games.

3. Results and Discussion

3.1. Number and Age of Soccer Players in California *(Objective 1a)*

Soccer is often a lifelong sport and has been increasing in popularity in California in recent years. The abundance of recreational and competitive soccer leagues in California attracts diverse participants of varying ages. Soccer is also popular among both boys and girls in elementary, middle, and high school. While data are not readily available regarding how often soccer practices and games take place on STFCRs, factors such as minimal water requirements have resulted in increased installation of STFCRs across the United States and California.[17] In 2016, California had over 900 STFCRs that were located primarily in the San Francisco Bay Area and Los Angeles County.[22]

According to the US Youth Soccer Organization, over 320,000 boys and girls ages 18 and under were involved in recreational or competitive soccer in California between 2013 and 2014.[23] Among the sports most often played on STFCRs, soccer has one of the highest number of high school participants in California. The California Interscholastic Federation reported that nearly 100,000 males and females participated on high school soccer teams in 2016, representing nearly 13% of California's population of high school student athletes and over 5% of the total high school population in the state.[3, 24] While participation in competitive soccer teams decreases at the collegiate, semi-professional, and professional levels, college intramural and adult recreational soccer leagues are also common in California.

In addition to being a favorite sport for recreational and competitive players of all ages, the Latino population has grown significantly in recent years and soccer has long been an important part of Latino culture in California. Data from the March 2016 Census Bureau Current Population Survey indicate that Hispanic/Latinos made up 38% of California's population in 2015.[25, 26] In 2014, the estimated Latino population in California was nearly 15 million, compared to 7.7 million in 1990 and 2.4 million in 1970.[27] An online blog titled "Hispanic Media" described soccer as an "outlet of cultural pride for Hispanics"[28] and a study on the impact of soccer in the Latin American community in Richmond, CA indicated that the sport plays a "central role" within the Latino community and creates "social networks through the community's relationship with teams and clubs centered in Richmond".[29] While data are not currently available regarding soccer enrollment among different ethnic groups, there are indications that soccer continues to grow in popularity in California due various factors, including the increasing Latino population in the state.

Factors such as increasing participation at the high school level, the widespread availability of recreational and competitive leagues for adults, and popularity among groups of diverse demographic backgrounds make soccer one of the most popular sports in California. We estimate that there are approximately 440,000 individuals involved with some form of recreational or competitive soccer in California that may have contact with synthetic turf fields containing crumb rubber (Table 1).

Table 1. Overview of soccer participation in California

Competitive Level	Age Range (Years)	Gender	Estimated Players (n)	Year
Youth Recreational and Competitive	4-18	Both	162,297[a,b]	2013-2014 seasonal year (Northern CA)
			159,278[a,b]	2013-2014 seasonal year (Southern CA)
High School Competitive	14-18	Boys	52,266[b,c]	2016
		Girls	46,778[b,c]	
College Competitive (Divisions I-III)	18-22	Men	1,614[d]	2016-2017
		Women	1,681[d]	
College Recreational (Intramural)	18-22	Both	5,000[e]	2017
Adult Recreational	18+	Both	11,000[f]	2017
Professional and Semi-Professional Competitive	18+	Men	566[g]	2016-2017
		Women	241[g]	
			Total = 440,721	

[a]Retrieved from US Youth Soccer Association at http://www.usyouthsoccer.org/media_kit/keystatistics/.
[b]High school players may participate in US Youth Soccer club teams and high school teams
[c]Retrieved from California Interscholastic Federation at http://www.cifstate.org/coaches-admin/census/2016_CIF_Participation_Census.pdf.
[d]Calculated by tallying rosters of all NCAA and NAIA collegiate teams in CA for 2016-2017 season
[e]Estimate based on number of universities and colleges in CA, assuming two intramural teams per school and 15 players per team
[f]Estimate based on number of teams affiliated with California Soccer Association-North (Cal North), California Soccer Association-South (Cal South), and other adult soccer leagues I California. Estimated 15 members per team for teams that did not provide number of participants.
[g]Calculated by tallying rosters of all semi-professional and professional teams in Men's Major League Soccer, United Women's Soccer, and Premier Leagues in CA

3.2. Online Survey Overview *(Objective 1b)*

A total of 1,028 individuals completed the online survey (1,019 in English and nine in Spanish). Responses were collected from 763 parents/guardians who completed the questionnaire for their child and 265 soccer players 18 years or older completing the questionnaire for themselves. One individual completed an in-person questionnaire (virtually identical to the online survey) but was not videotaped, for a total of 1,029 questionnaire-only respondents.

Figure 1 is a heat map of the residential zip code reported in the online survey. While the majority of the survey respondents were located in the San Francisco, Sacramento, Los Angeles, and San Diego metropolitan areas, it is important to note that these are the California regions with the greatest population. Furthermore, California's STFCRs are located primarily in the San Francisco Bay Area and the Greater Los Angeles Area.[22]

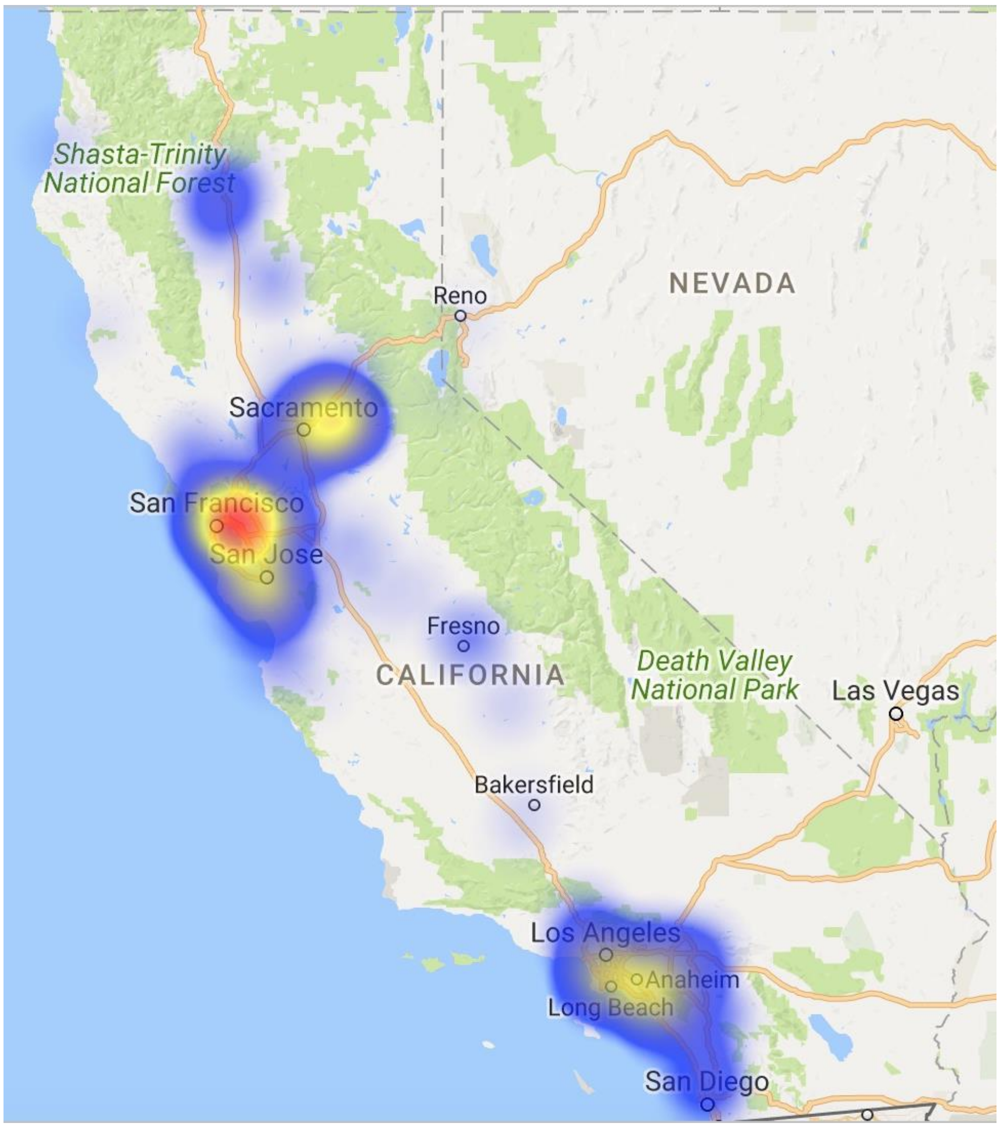


Figure 1. Heat map of zip code reported by online survey participants

3.3. In-Person Questionnaire and Videotaping Time-Activity Assessment Overview *(Objective 1c)*

Forty individuals participated in the videotaping and completed the in-person questionnaire. Events were evenly split by gender (i.e., five events with males and five events with females) and event type (i.e., five games and five practices) (Table 2). We also enrolled players with a range of ages and positions (Table 2).

Table 2. Videotaping player and event summary

Event Type	Gender	Age (Years)	Positions Videotaped	Number Videotaped
Game	Male	9	Defender Goalie Variable (2)	4
Game	Female	9	Defender/Goalie Midfielder (2)	3
Practice	Female	11-12	Defender Defender/Goalie Forward Midfielder	4
Practice	Male	11-12	Forward Goalie Midfielder	4
Practice	Female	14	Defender/Midfielder Forward Forward/Goalie Forward/Midfielder	4
Game	Male	14-15	Defender Forward Goalie (2) Midfielder	5
Game	Female	16-17	Defender (2) Defender/Forward/Goalie Forward	4
Game	Male	16-18	Defender (2) Goalie Midfielder	4
Practice	Male	19-22	Defender Defender/Midfielder Goalie Midfielder	4
Practice	Female	19-21	Defender Goalie Midfielder (2)	4
			TOTAL	**40**

3.4. Questionnaire Analysis

In the sections below, we provide overall population summaries of key variables collected using the online survey and in-person questionnaires. To support population-specific exposure modeling (for example, girls playing competitive soccer through age 25), we have prepared extensive tables stratifying player information by gender, participation in recreational or competitive soccer, player position, and age for all variables (Appendix B). This stratification results in hundreds of tables. For exposure scenario building, key parameters can be extracted to identify specific parameters for model building.

3.4.1. Demographic Information

Table 3 presents demographic information of the online and in-person survey respondents combined (n=1,069). The median age of soccer players whose parent/guardian completed the survey was 14 years (n=763) and the median age of soccer players completing the questionnaire themselves was 38 years (n=264). Approximately 60% of online survey respondents were Caucasian and 15% of respondents were Hispanic/Latino. Seventy-eight of the participants were between 9 and 25 years old and the respondents were almost evenly balanced on gender (50% male versus 49% female).

Table 4 shows soccer characteristics reported by the survey respondents, including soccer position and percent of soccer practices and games that take place on a synthetic turf field with crumb rubber. Approximately 11% of the survey population mainly played goalie, 11% mainly played forward, 24% mainly played midfielder, and 25% mainly played defender. The majority (>75%) of the survey population only played competitive soccer, with approximately 11% playing recreational soccer and approximately 13% playing both recreational and competitive soccer.

Table 3. Demographic characteristics of online and in-person survey respondents (n=1,069)[1]

	n (%)
Age of player	
0 - < 2	1 (0.1)

2 - < 9	11 (1.0)
9 - < 16	546 (51.1)
16 - < 25	296 (27.7)
25 - < 30	28 (2.6)
30 - < 40	64 (6.0)
40 - < 50	82 (7.7)
≥ 50	30 (2.8)
Prefer not to answer	11 (1.0)
Gender	
Male	539 (50.4)
Female	522 (48.8)
Prefer not to answer	8 (0.8)
Ethnicity	
Asian/Pacific Islander	55 (5.1)
Black/African American	19 (1.8)
Caucasian	640 (59.9)
Hispanic/Latino	158 (14.8)
Native American	5 (0.5)
Mixed	139 (13.0)
Other	17 (1.6)
Prefer not to identify	36 (3.4)
Survey Language	
English	1,060 (99.2)
Spanish	9 (0.8)

[1]Online survey completed by parent/guardian of soccer player (n=763) and players 18 years or older (n=265)

Table 4. Soccer player characteristics (n=1,069)

	n (%)
Soccer Position	
Goalie	120 (11.2)
Forward	117 (10.9)
Midfielder	258 (24.1)
Defender	263 (24.6)
Multiple Positions	300 (28.1)
DK[1]	11 (1.0)
Recreational/Competitive Soccer Player	
Recreational	115 (10.8)
Competitive	815 (76.2)
Both	134 (12.5)
DK[1]	5 (0.5)
Plays Soccer Year-Round	
No	118 (11.0)
Yes	946 (88.5)
DK[1]	5 (0.5)
Percent practices on synthetic turf with crumb rubber	
0%	132 (12.4)
> 0 – 25%	175 (16.4)
> 25 – 50%	155 (14.5)
> 50 – 75%	157 (14.7)
>75%	443 (41.4)
DK[1]	7 (0.7)
Percent games on synthetic turf with crumb rubber	
0%	19 (1.8)
> 0 – 25%	168 (15.7)

> 25 – 50%	216 (20.2)
> 50 – 75%	243 (22.7)
>75%	418 (39.1)
DK[1]	5 (0.5)

[1]Don't Know/Prefer not to answer

3.4.2. Player History

Information on player history collected in the questionnaires was categorized by pre-determined age groups (4-8; 9-12; 13-17; and 18-25 years, respectively). All other stratified information in this report and in Appendix B is reported according to OEHHA risk assessment age categories (0-<2; 2-<9; 9-<16; 16+ years, respectively).

Tables 5 and 6 present overall player history results for study participants. Table 5 shows the number of weeks per year and hours per week for players with more detailed age-specific history (i.e., for online subjects under age 18 and players who participated in the in-person questionnaire and videotaping). Note: because adults, many in middle age, completing the online survey may not have been able to recall detailed player history at younger ages, we asked participants 18 years and older detailed information about youth, high school, and college soccer (Table 6).

Tables 5 and 6 show that with increasing age, soccer players play more weeks and more hours on STFCRs. Within each of the age groups in Table 5, we did not find significant differences in the number of weeks participants reported playing soccer on STFCRs by gender (Kruskal-Wallis: p=0.14 for 4-8 age group; p=0.36 for 9-12 age group; p=0.65 for 13-17 age group; p=0.64 for 18-25 age group). Among adults who completed the online questionnaire, represented in Table 6, females tended to report playing soccer on STFCRs more weeks per year than males (p=0.10 for youth soccer; p=0.05 for high school soccer; p=0.06 for college soccer).

Note: The number of players in each group in Tables 5-8 do not equal the total number of surveys completed because many participants reported information for multiple age groups over their lifetime.

Table 5. Player history – weeks per year and hours per week child played on synthetic turf field with crumb rubber between the ages of 4-8, 9-12, 13-17 and 18-25

Age Range (years)	n[1]	Weeks Per Year Played[2]							Hours Per Week Played[2]						
		Percentiles				Mean	SD	Range	Percentiles				Mean	SD	Range
		25	50	75	95				25	50	75	95			
4-8	705[3]	0	2	12	40	9.3	13.4	0-52	0	1	2	6	1.8	4.6	0-104
9-12	692[4]	4	18	36	48	20.5	16.7	0-52	1.5	3	4.5	10	3.6	4.1	0-52
13-17	402[5]	15	30	45	52	29.5	16.4	0-52	3	5	7	14	6.1	6.9	0-100
18-25	7[6]	20	36	52	52	34.3	17.8	6-52	7	9	10	10	8.6	1.6	0-10

[1]Total responses by age range > 785 because many children played in multiple age groups
[2] "0s" represent participants who played soccer but not on synthetic turf
[3]Number of responses from parent/guardian whose child played soccer between ages of 4 and 8 years
[4]Number of responses from parent/guardian whose child played soccer between ages of 9 and 12 years
[5]Number of responses from parent/guardian whose child played soccer between ages of 13 and 17 years
[6]Number of responses from in-person questionnaire and videotaping who played soccer between the ages of 18 and 25 years

Table 6. Player history reported by older adults– weeks per year and hours per week played on synthetic turf field with crumb rubber during youth, high school, and college soccer

Player	n[1]	Weeks Per Year Played[2] Percentiles 25	50	75	95	Mean	SD	Range	Hours Per Week Played[2] Percentiles 25	50	75	95	Mean	SD	Range
Youth	223[3]	0	0	8	40	6.9	13.0	0-52	0	0	3	9	2.0	4.1	0-25
High School	230[4]	0	0	12	40	7.5	12.5	0-52	0	0	6	15	3.3	5.6	0-35
College	189[5]	0	2	20	42	10.0	13.8	0-52	0	2	6	18	4.3	6.4	0-42

[1]Total responses by age range > 284 because many children played in multiple age groups
[2]"0s" represent participants who played soccer but not on synthetic turf
[3]Number of responses from participants who played youth soccer
[4]Number of responses from participants who played high school soccer
[5]Number of responses from participants who played college soccer

Table 7. Days per year practiced on synthetic turf field

Age Range (Years)	n	Mean	SD	p25	p50	p75	p95	p99	Max
0 - <2	1	32.5	-	32.5	32.5	32.5	32.5	32.5	32.5
2 - <9	8	71.5	54.7	26.0	45.5	123.5	156.0	156.0	156.0
9 - <16	470	91.6	51.1	52.0	91.0	117.0	182.0	221.0	273.0
16+	404	128.1	69.7	78.0	117.0	169.0	247.0	325.0	351.0

Table 8. Days per year played games on synthetic turf field

Age Range (Years)	**n**	**Mean**	**SD**	**p25**	**p50**	**p75**	**p95**	**p99**	**Max**
0 - <2	1	39.0	-	39.0	39.0	39.0	39.0	39.0	39.0
2 - <9	8	65.0	10.8	52.0	71.5	78.0	91.0	91.0	91.0
9 - <16	490	57.1	38.8	26.0	52.0	78.0	130.0	195.0	273.0
16+	460	80.3	44.0	52.0	65.0	104.0	156.0	221.0	286.0

3.4.3. Longest Amount of Time Spent on Synthetic Turf Field in Past Year

Tables 9 and 10 summarize overall population information on the longest amount of time spent practicing and playing games on STFCRs in the past year.

There was a slight increase in the longest amount of time players reported practicing or playing soccer games on STFCRs as the age of the player increased, however, across all age groups, the most common responses were 1-2 or 2-4 hours. Among all ages combined, we did not observe differences in the longest amount of time reported spent practicing or playing games on STFCRs by gender (Chi-squared test: p=0.87 for practices; p=0.46 for games). We also did not find gender differences after stratifying by age for practices (Chi-squared test: p=0.23 for participants <9 years; p=0.81 for 9-<16 age group; p=0.91 for ≥ 16 age group; p=0.44 for those who prefer not to answer age) or games (Chi-squared test: p=0.39 for participants <9; p=0.09 for 9-<16 age group; p=0.80 for ≥ 16 age group; p=0.44 for those who prefer not to answer age).

Table 9. Longest amount of time on a single day players practice on synthetic turf field with crumb rubber in past year

Age Range (Years)[1]	Time (Hours) <1 n (%)	>1-2 n (%)	>2-4 n (%)	>4-5 n (%)	>5 n (%)	DK[2] n (%)
0 - <2	0 (0)	0 (0)	1 (100.0)	0 (0)	0 (0)	0 (0)
2 - <9	0 (0)	4 (50.0)	3 (37.5)	0 (0)	1 (12.5)	0 (0)
9 - <16	11 (2.2)	215 (43.7)	204 (41.5)	35 (7.1)	27 (5.5)	0 (0)
> 16	6 (1.4)	137 (32.2)	194 (45.7)	no data	39 (9.2)	6 (1.4)
Prefer not to answer	0 (0)	5 (45.5)	4 (36.4)	2 (18.2)	0 (0)	0 (0)

[1]Responses collected from 1 player 0-<2 years, 8 players 2-<9 years, 492 players 9-<16 years, 425 players ≥ 16 years, and 11 players who preferred not to answer age or entered birth year incorrectly
[2]Don't Know/Prefer not to Answer

Table 10. Longest amount of time on a single day players played games on synthetic turf field with crumb rubber in past year

Age Range (Years)[1]	Time (Hours) <1 n (%)	>1-2 n (%)	>2-4 n (%)	>4-5 n (%)	>5 n (%)	DK[2] n (%)
0 - <2	0 (0)	1 (100.0)	0 (0)	0 (0)	0 (0)	0 (0)
2 - <9	0 (0)	8 (88.9)	0 (0)	1 (11.1)	0 (0)	0 (0)
9 - <16	21 (3.9)	176 (32.8)	231 (43.1)	75 (14.0)	31 (5.8)	2 (0.4)
> 16	10 (2.0)	138 (28.0)	209 (42.4)	80 (16.2)	51 (10.3)	5 (1.0)
Prefer not to answer	0 (0)	4 (36.4)	5 (45.6)	2 (18.2)	0 (0)	0 (0)

[1]Responses collected from 1 player 0-<2 years, 9 players 2-<9 years, 536 players 9-<16 years, 493 players ≥ 16 years, and 11 players who preferred not to answer age or entered birth year incorrectly
[2]Don't Know/Prefer not to Answer

3.4.4. Reported Exertion During Practices and Games

Tables 11 and 12 illustrate the overall population activity levels players reported during practices and games. Participants reported the proportion of the time they typically are: a) resting; b) lightly active; c) moderately active; and d) highly active during practices and games. Tables 11 and 12 only include the results from participants whose responses totaled 100% across the four activity levels (n=774 for practices and 886 for games).

Overall, survey respondents reported a high level of activity. The median percent time participants reported being moderately or highly active during practices and games was 65% and 70%, respectively.

Males reported being lightly active slightly more percent of the time during practices than females (mean=17.6 vs. 16.2; Kruskal-Wallis test: p=0.04). We did not observe any differences in reported exertion levels during games by gender.

Table 11. Reported percent of time at varying activity levels during practice[1]

Highly Active		Moderately Active		Lightly Active		Resting	
Median (IQR)	Max	Median (IQR)	Max	Median (IQR)	Max	Median (IQR)	Max
35 (25, 50)	100	30 (25, 45)	80	15 (10, 20)	80	10 (5, 15)	55

Abbreviations: IQR, Interquartile Range (25th, 75th percentiles)
[1]Complete responses from 774 participants

Table 12. Reported percent of time at varying activity levels during games[1]

Highly Active		Moderately Active		Lightly Active		Resting	
Median (IQR)	Max	Median (IQR)	Max	Median (IQR)	Max	Median (IQR)	Max
40 (25, 55)	100	30 (20, 40)	80	10 (10, 20)	60	10 (5, 20)	90

Abbreviations: IQR, Interquartile Range (25th, 75th percentiles)
[1]Complete responses from 886 participants

3.4.5. Contact with Crumb Rubber During Practices and Games

Figures 2-7 illustrate the frequency survey respondents reported diving, sliding/tackling, and slipping/falling at practices and games taking place on STFCRs, stratified by the percent of respondents per soccer position.

Goalies reported diving, sliding/tackling, and slipping/sliding on field during practices and games significantly more frequently than forwards, midfielders, and defenders combined (Chi-squared test: $p<0.01$, for each of these macro activity category?). For example, 50.8% and 58.7% of goalies reported diving more than 10 times at practices and games, respectively, whereas less than 5% of forwards, midfielders, or defenders reported diving more than 10 times at practices or games. Additionally, males reported diving and sliding/tackling more frequently than females during practices and games (Chi-squared test: $p<0.01$).

Figures 8 and 9 illustrate the frequency that players reported crumb rubber in their mouth and eyes and played with crumb rubber during practices and games. The majority of soccer players reported “Rarely” getting crumb rubber in their mouths or eyes. There were no large differences in the frequency of these contacts with crumb rubber during practices and games (Chi-squared test: $p<0.01$).

Figures 10-13 illustrate the frequency players reported crumb rubber in their mouths and eyes during practices and games, stratified by player position (goalie vs. midfielder, forwards, and defenders combined). Goalies reported getting crumb rubber in their mouths and eyes during practices and games more frequently than players of other positions (Chi-squared test: $p<0.01$). For example, almost 43% of goalies reported getting crumb rubber in their mouth “sometimes”, “often”, or “always”, compared with 16% of midfielders, forwards, and defenders.

Figure 14 illustrates the frequency players and parents/guardians of players reported observing crumb rubber on their body or personal objects after playing soccer on a synthetic turf field with crumb rubber. Only 8% of participants reported observing crumb rubber on their water bottles >25% of the time after playing soccer on a synthetic turf field. However, 51% and 36% of participants reported observing crumb rubber on their clothes and body >25% of the time after playing soccer on a synthetic turf field, respectively.

Fig 2. Dive Frequency at Practices on Synthetic Turf Fields

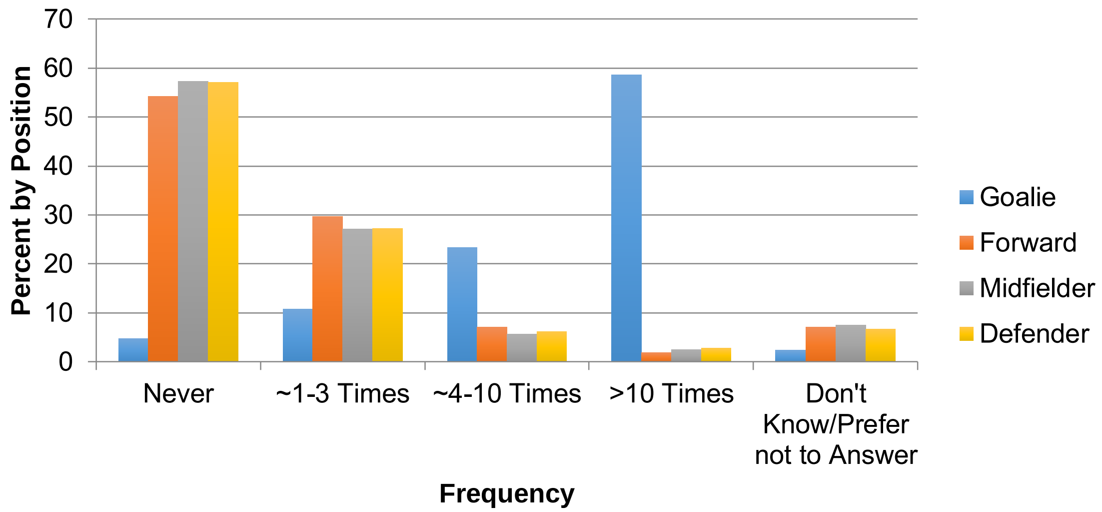
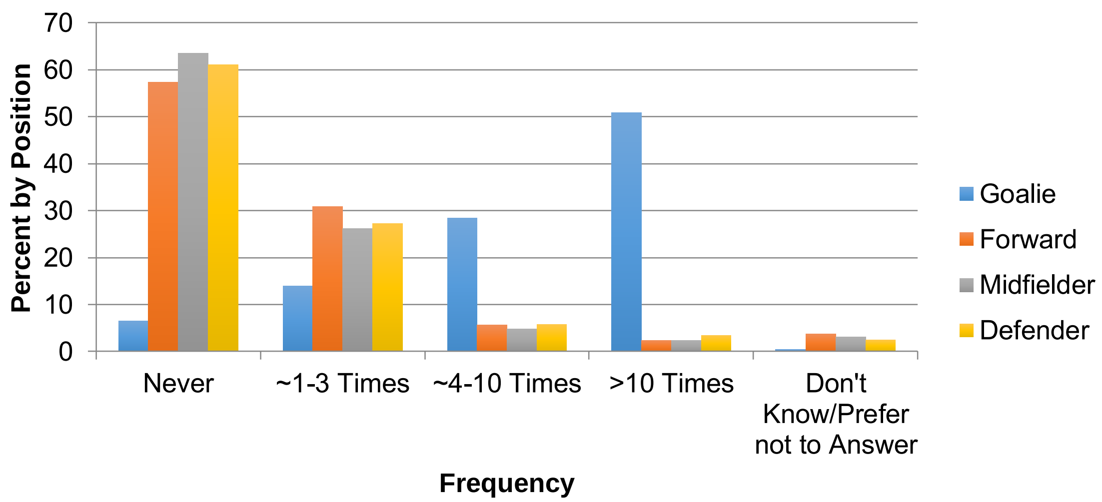


Fig 3. Dive Frequency at Games on Synthetic Turf Fields



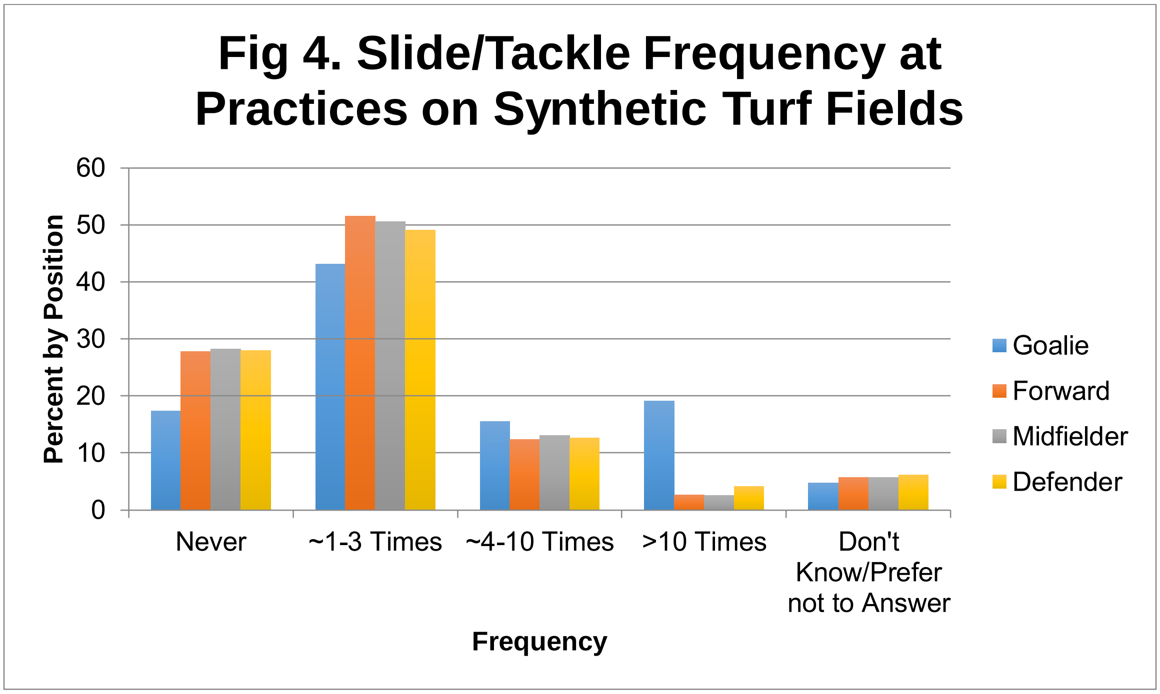


Fig 4. Slide/Tackle Frequency at Practices on Synthetic Turf Fields
Percent by Position
0
10
20
30
40
50
60
Never
~1-3 Times
~4-10 Times
>10 Times
Don't Know/Prefer not to Answer
Frequency
Goalie
Forward
Midfielder
Defender

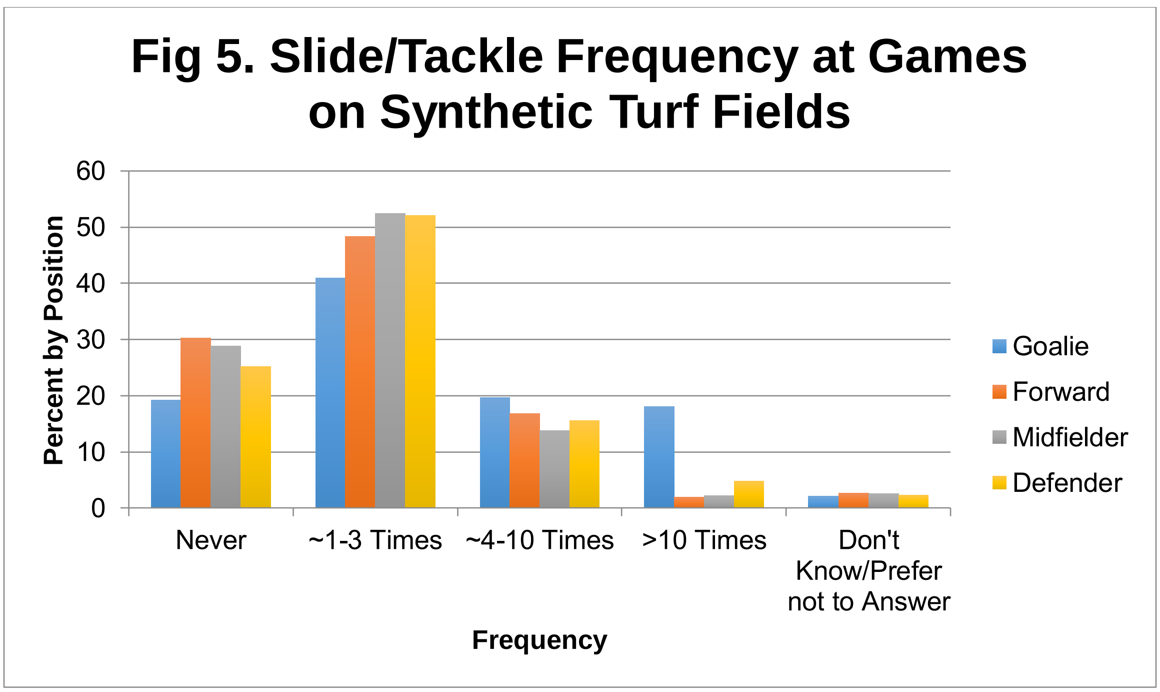


Fig 5. Slide/Tackle Frequency at Games on Synthetic Turf Fields
Percent by Position
0
10
20
30
40
50
60
Never
~1-3 Times
~4-10 Times
>10 Times
Don't Know/Prefer not to Answer
Frequency
Goalie
Forward
Midfielder
Defender

Fig 6. Slip/Fall Frequency at Practices on Synthetic Turf Fields

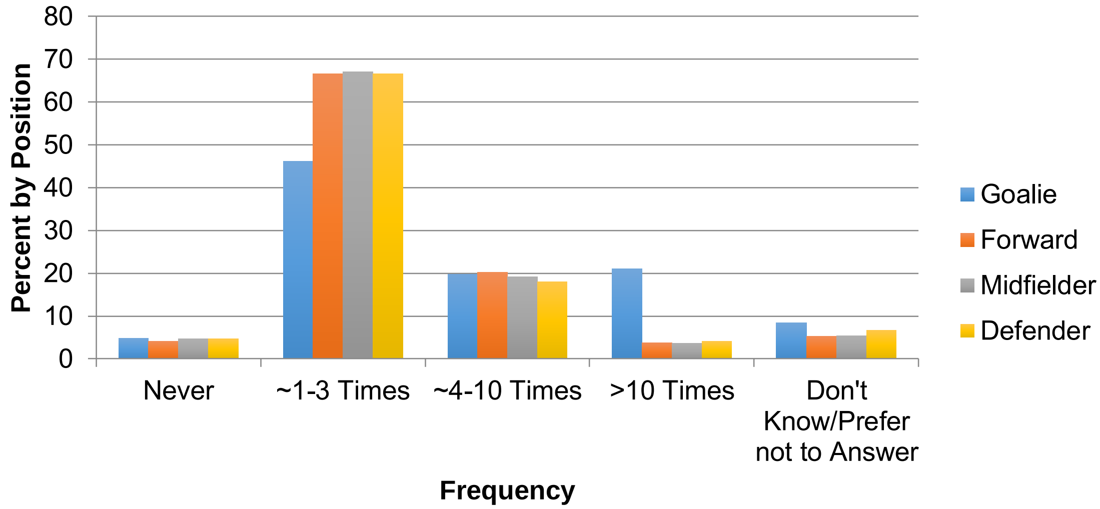
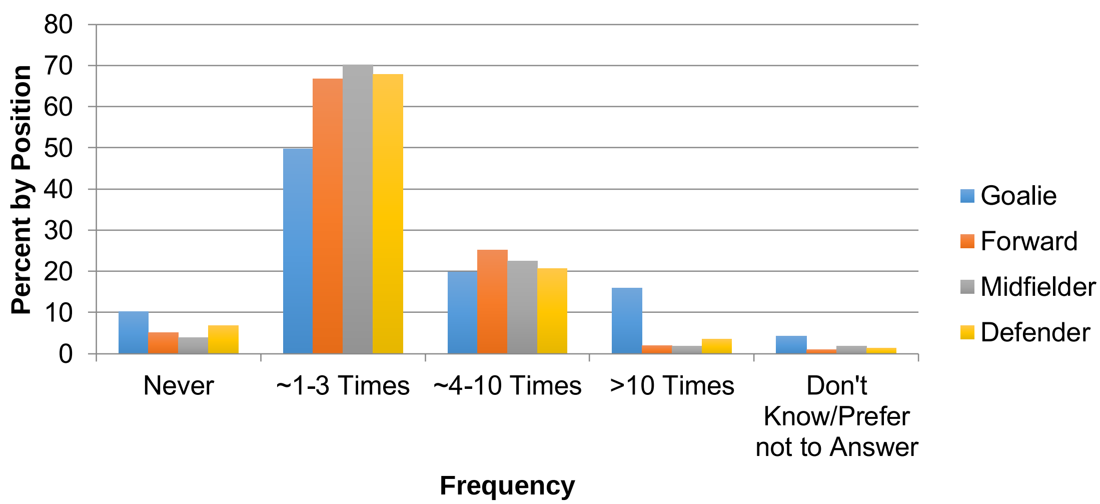


Fig 7. Slip/Slide Frequency at Games on Synthetic Turf Fields



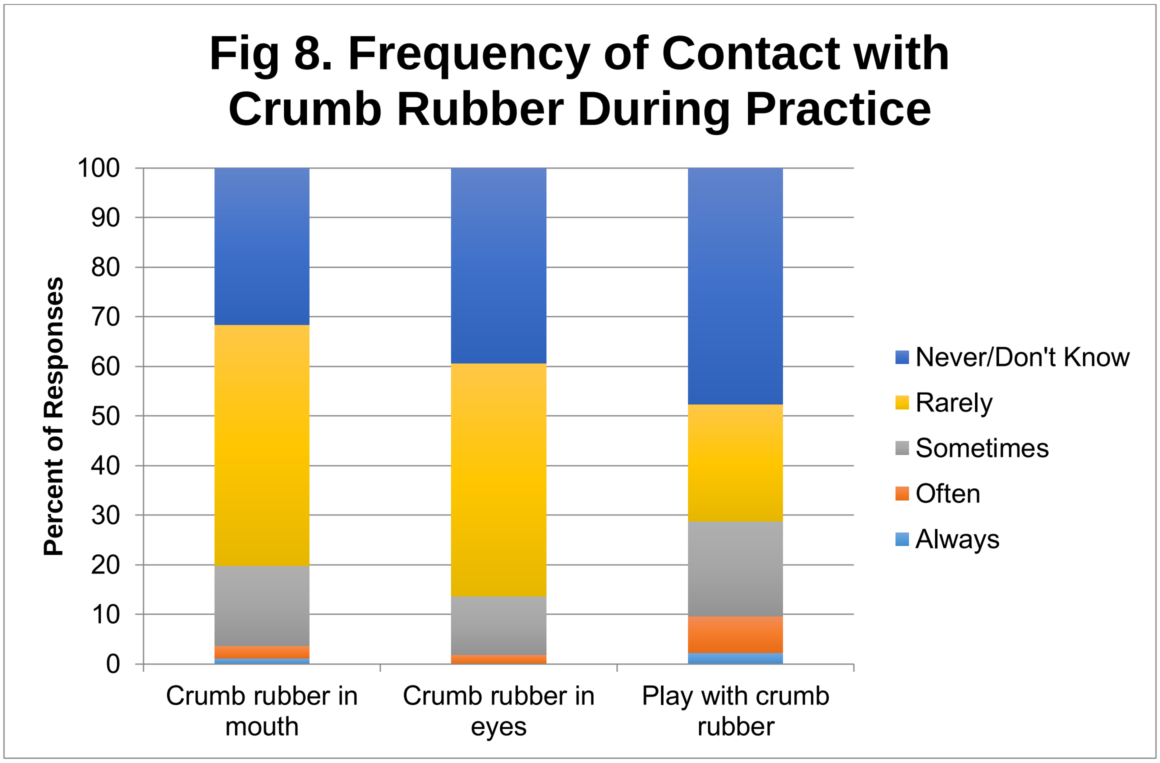


Fig 8. Frequency of Contact with Crumb Rubber During Practice
Percent of Responses
100
90
80
70
60
50
40
30
20
10
0
Crumb rubber in mouth
Crumb rubber in eyes
Play with crumb rubber
Never/Don't Know
Rarely
Sometimes
Often
Always

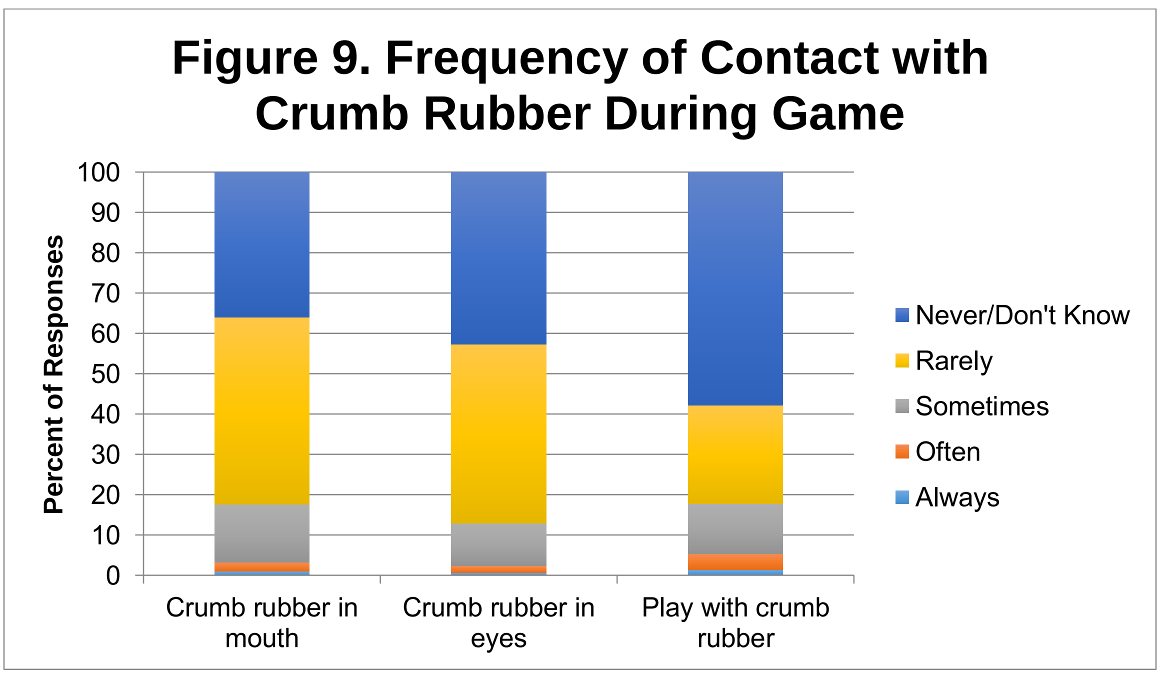


Figure 9. Frequency of Contact with Crumb Rubber During Game
Percent of Responses
100
90
80
70
60
50
40
30
20
10
0
Crumb rubber in mouth
Crumb rubber in eyes
Play with crumb rubber
Never/Don't Know
Rarely
Sometimes
Often
Always

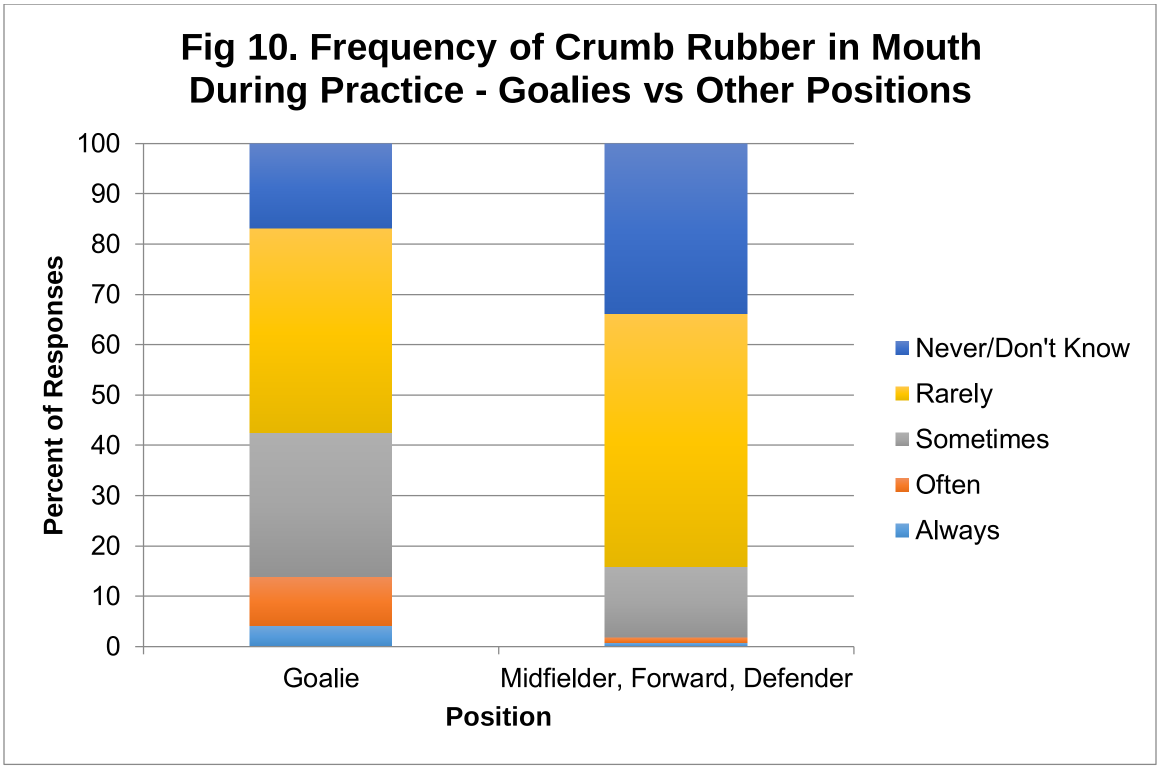


Fig 10. Frequency of Crumb Rubber in Mouth During Practice - Goalies vs Other Positions
100
90
80
70
60
50
40
30
20
10
0
Percent of Responses
Goalie
Midfielder, Forward, Defender
Position
Never/Don't Know
Rarely
Sometimes
Often
Always

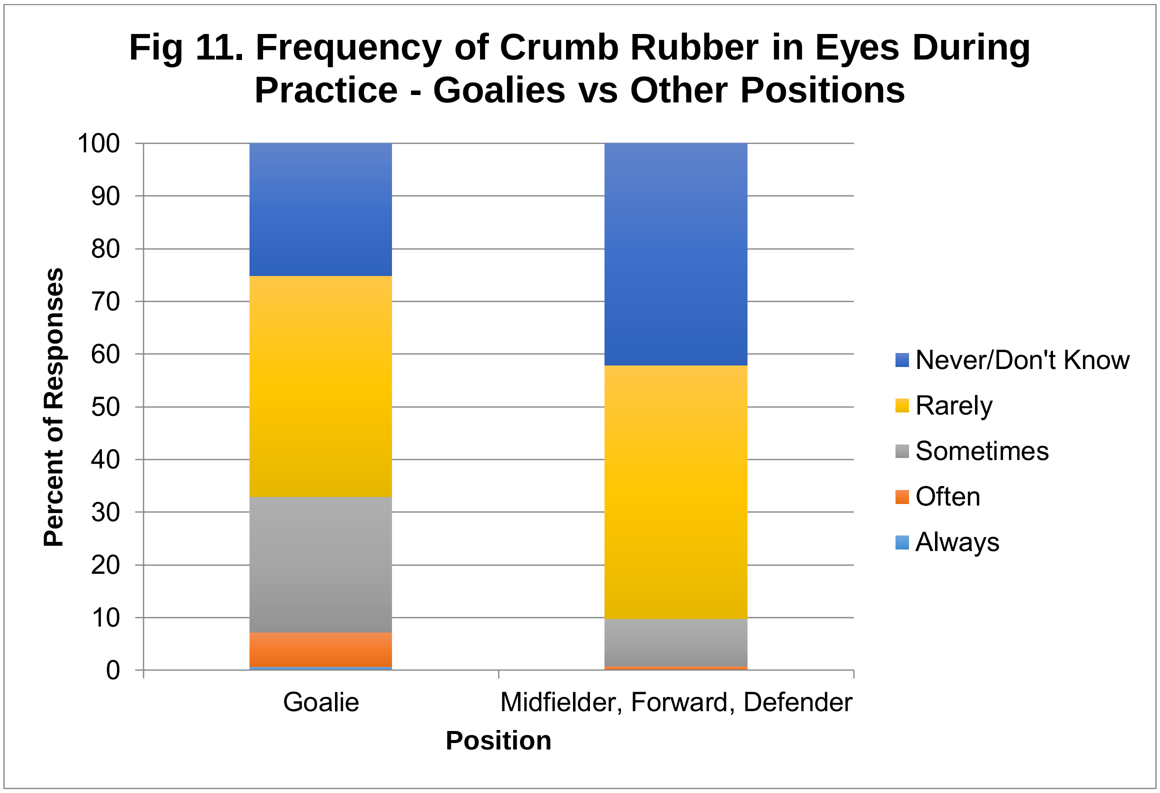


Fig 11. Frequency of Crumb Rubber in Eyes During Practice - Goalies vs Other Positions
100
90
80
70
60
50
40
30
20
10
0
Percent of Responses
Goalie
Midfielder, Forward, Defender
Position
Never/Don't Know
Rarely
Sometimes
Often
Always

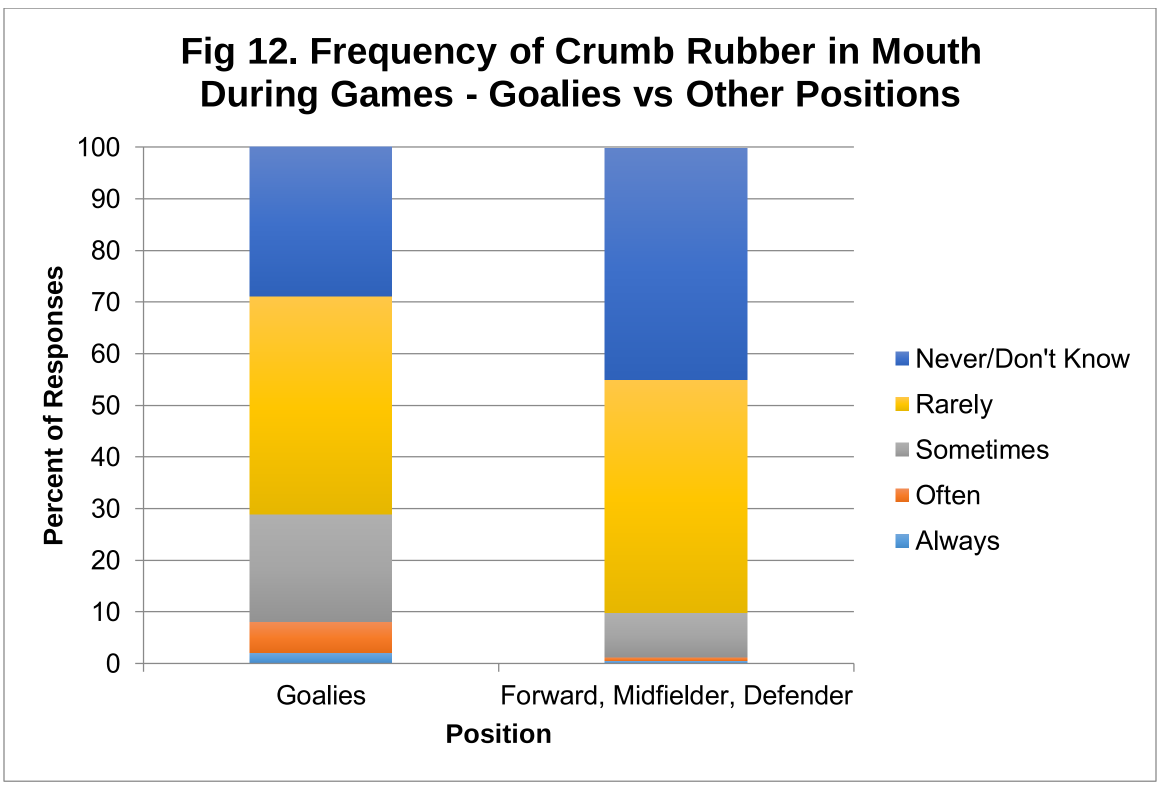


Fig 12. Frequency of Crumb Rubber in Mouth During Games - Goalies vs Other Positions
100
90
80
70
60
50
40
30
20
10
0
Percent of Responses
Goalies
Forward, Midfielder, Defender
Position
Never/Don't Know
Rarely
Sometimes
Often
Always

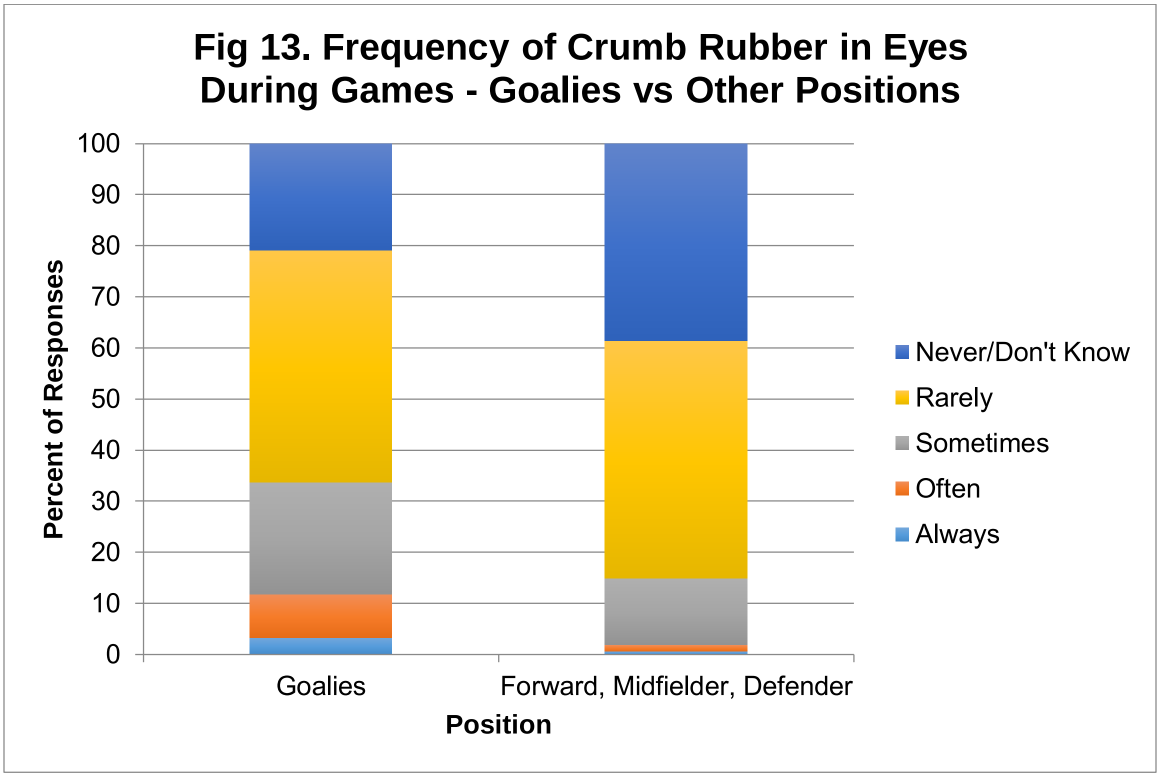


Fig 13. Frequency of Crumb Rubber in Eyes During Games - Goalies vs Other Positions
Percent of Responses
100
90
80
70
60
50
40
30
20
10
0
Goalies
Forward, Midfielder, Defender
Position
Never/Don't Know
Rarely
Sometimes
Often
Always

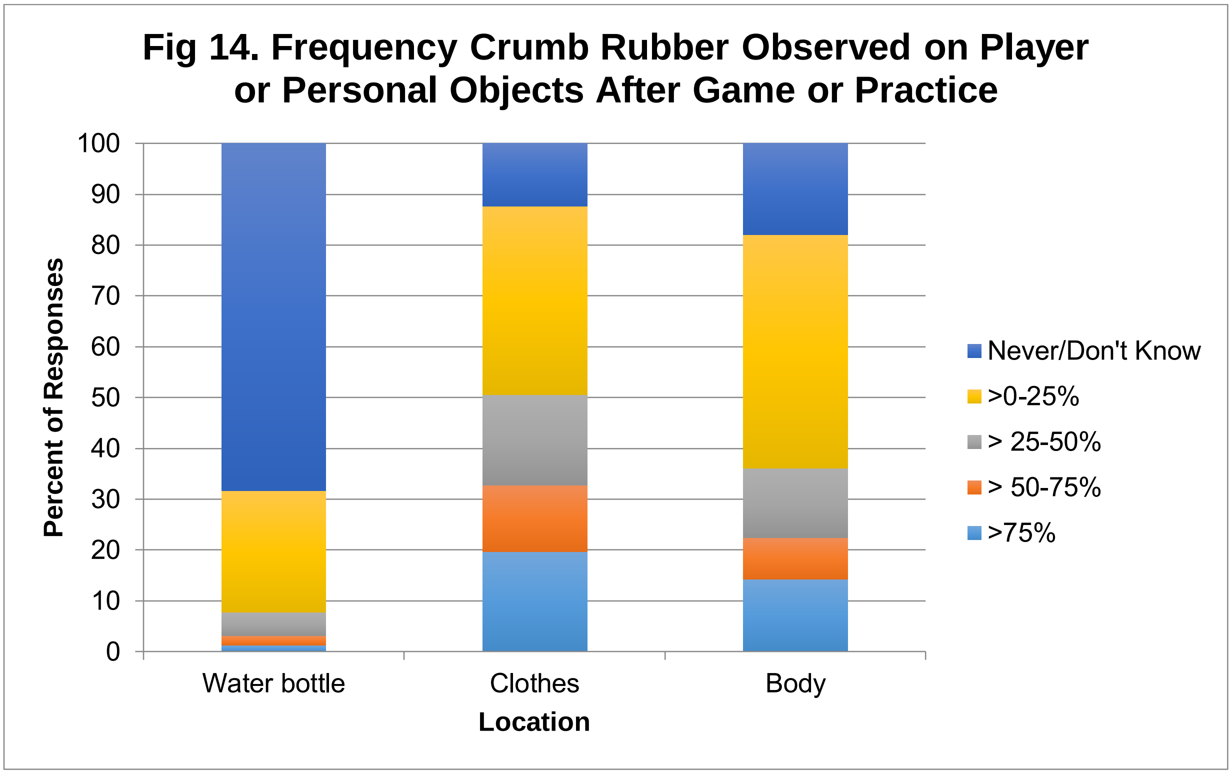


Fig 14. Frequency Crumb Rubber Observed on Player or Personal Objects After Game or Practice
Percent of Responses
100
90
80
70
60
50
40
30
20
10
0
Water bottle
Clothes
Body
Location
Never/Don't Know
>0-25%
> 25-50%
> 50-75%
>75%

3.4.6. Food and Water Consumption Before and During Practices and Games

Table 13 summarizes the amount of time before practices and games participants reported eating or having a snack/meal. While the most common response was 1-3 hours, more participants reported having eaten <1 hour before practices than before games (31.3% vs. 19.0%, respectively).

Table 14 summarizes how often participants reported having a snack during practices and games. The majority of participants indicated they never had a snack during practices or games. Less than 25% of participants reported consuming one or more snacks during practices or games (Table 14).

The majority of participants reported consuming between 16 and 32 ounces of water during practices and games (Table 15). Only 4.6% and 2.3% of players reported drinking more than 64 ounces of water during practices and games, respectively.

Table 13. Amount of time before practices and games participants reported eating or having a snack

Time	Practice n (%)	Game n (%)
< 1 Hour	333 (35.5)	204 (19.4)
> 1 -3 Hours	537 (57.3)	777 (74.0)
> 3 Hours	41 (4.4)	50 (4.8)
DK[1]	26 (2.8)	19 (1.8)

[1]Don't Know/Prefer not to answer

Table 14. Frequency of snack consumption during practices and games

Frequency	Practice n (%)	Game n (%)
Never	789 (84.2)	735 (70.0)
1 Time	90 (9.6)	260 (24.8)

Table 14. Frequency of snack consumption during practices and games

2 Times	14 (1.5)	31 (3.0)
>2 Times	6 (0.6)	6 (0.6)
DK[1]	38 (4.0)	18 (1.7)

[1]Don't Know/Prefer not to answer

Table 15. Amount of water consumed during practices and games

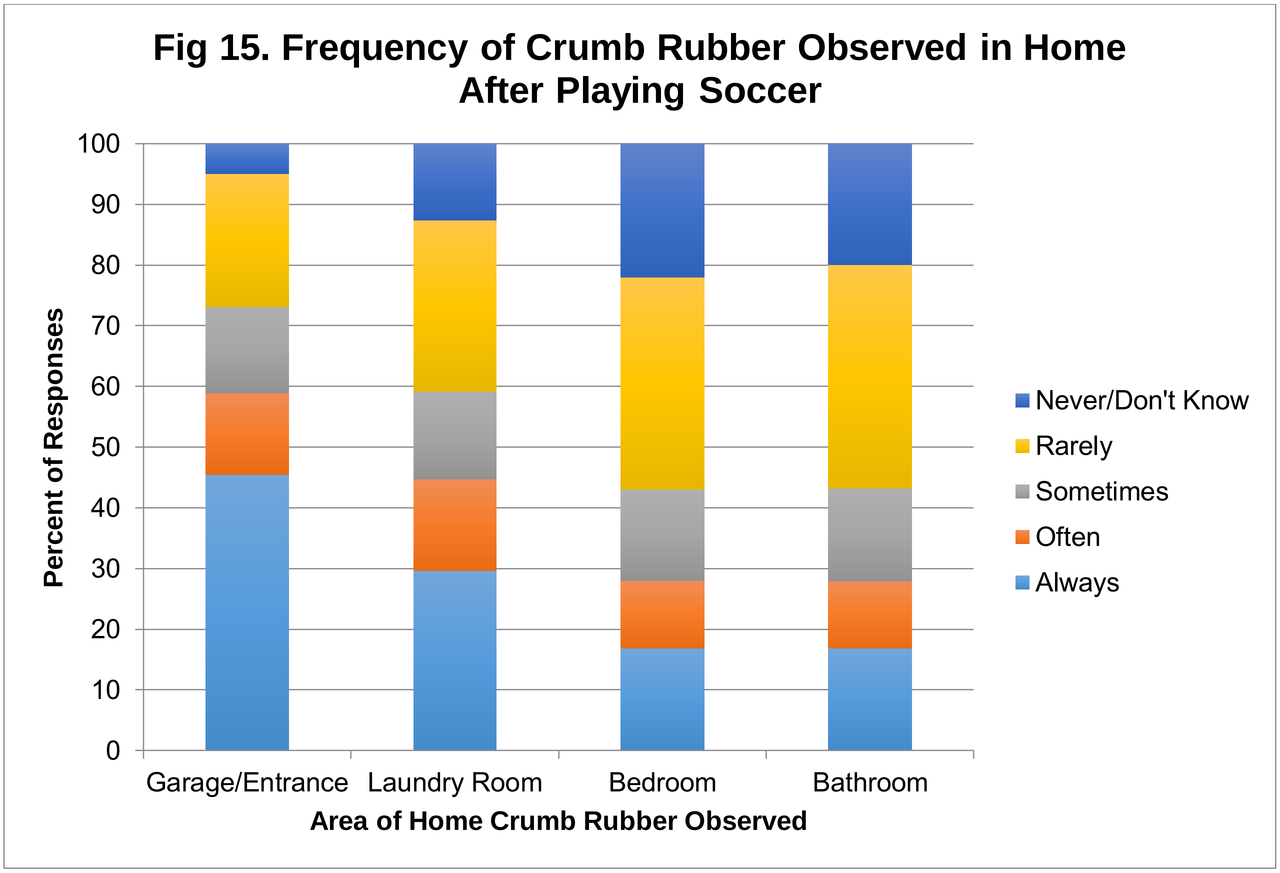
Amount of Water Consumed	Practice n (%)	Game n (%)
8 ounces	43 (4.6)	24 (2.3)
16 ounces	251 (26.8)	218 (20.8)
24 ounces	352 (37.8)	370 (25.2)
32 ounces	230 (24.6)	210 (29.5)
48 ounces	25 (2.7)	60 (5.7)
64 ounces	20 (2.1)	44 (4.2)
> 64 ounces	7 (0.8)	13 (1.3)
DK[1]	9 (1.0)	10 (1.0)

[1]Don't Know/Prefer not to answer

3.4.7. Observation of Crumb Rubber in Home

Figure 15 illustrates the frequency players and parents/guardians reported observing crumb rubber in various locations around the home after playing soccer on a synthetic turf field with crumb rubber. Nearly 46% of participants reported "always" observing crumb rubber in the garage/mudroom/entrance to their home after playing soccer, and 73% reported observing crumb rubber at least "sometimes" (i.e., "sometimes", "often", or "always"). While participants reported observing crumb rubber in other locations of the home less frequently, 59% reported finding crumb rubber in the laundry room at least "sometimes" and 43% reported finding crumb rubber in their bedrooms and bathrooms at least "sometimes". Only 21% and 32% of participants reported wiping, cleaning, or removing socks, shoes, shin guards, or other equipment more than 75% of the time before entering their car and their house, respectively (data not shown).

When asked about the quantity of crumb rubber participants observed in their home each time after playing soccer on a synthetic turf field with crumb rubber, the majority of participants said they find some crumb rubber, but less than one tablespoon (Figure 16).



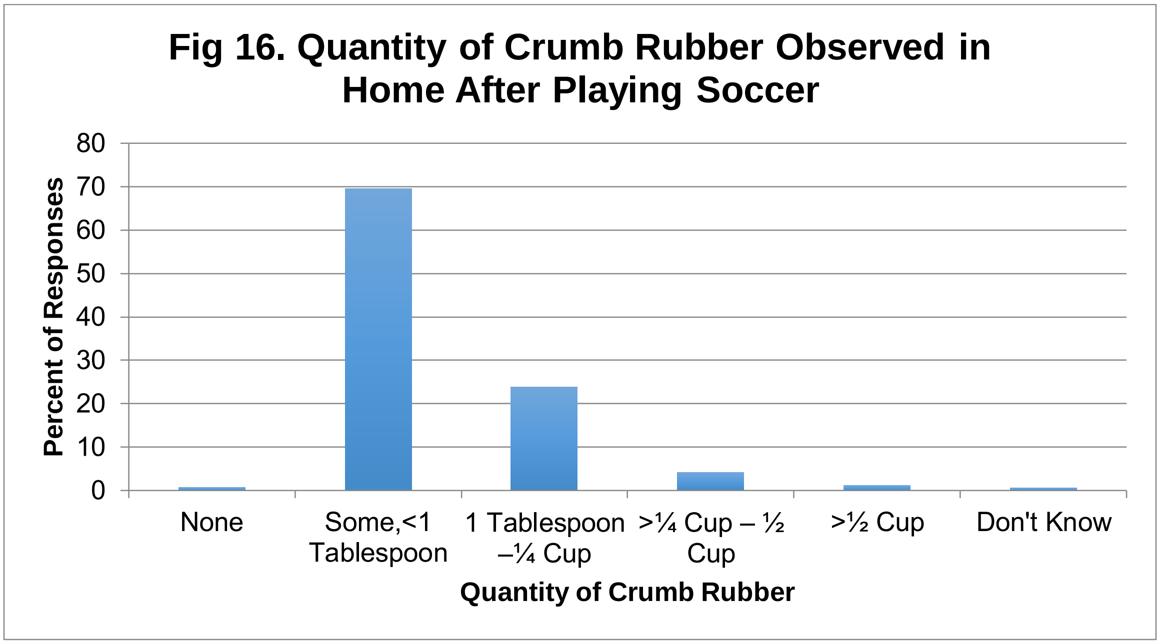


Fig 16. Quantity of Crumb Rubber Observed in Home After Playing Soccer
Percent of Responses
0
10
20
30
40
50
60
70
80
None
Some,<1 Tablespoon
1 Tablespoon –¼ Cup
>¼ Cup – ½ Cup
>½ Cup
Don't Know
Quantity of Crumb Rubber

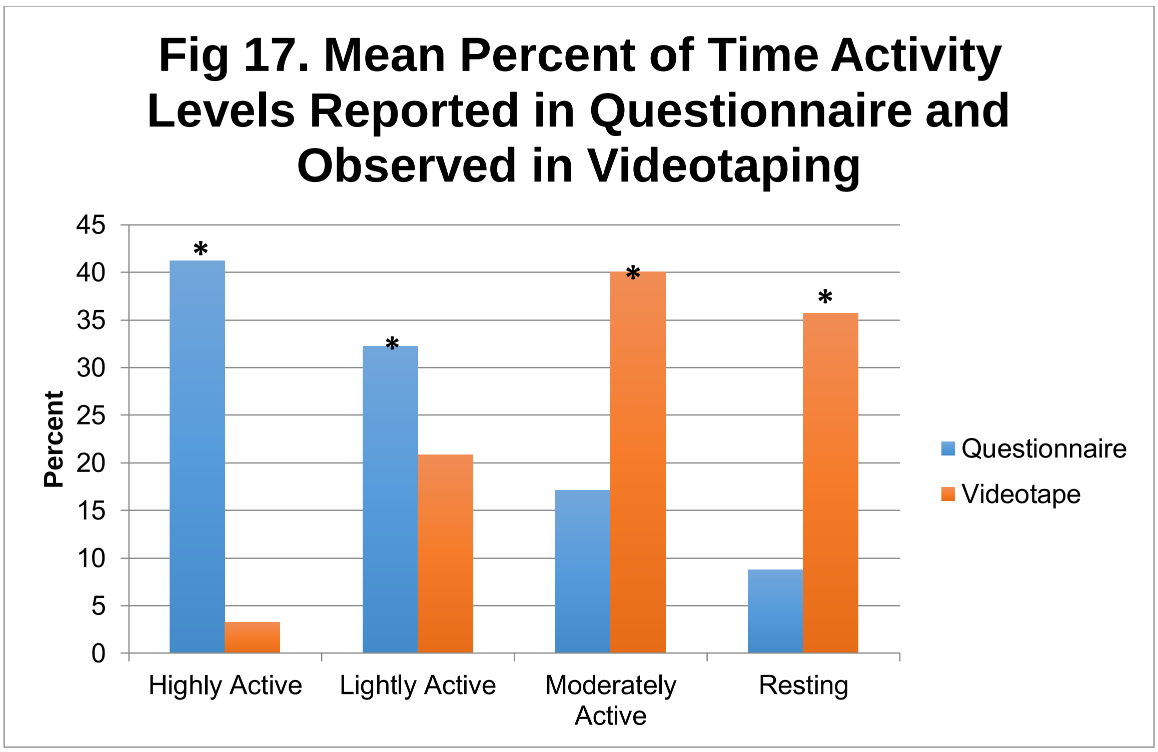
3.5. Comparisons Between Survey Responses and Videotaping Data

For the 40 individuals that participated in the in-person questionnaire and videotaping, we compared the frequency of diving, sliding/tackling, and slipping/falling during the event that was videotaped with the average number of times they reported doing these activities during a typical practice or game in the questionnaire. We also compared the percent of time participants were resting, lightly active, moderately active, and highly active in the event videotaped with the percent of time they reported these exertion levels at a typical practice or game. We only compared the responses from the questionnaire with the type of event videotaped (i.e. if a participant was videotaped at a practice, we used responses to questions regarding practices).

To evaluate the frequency of diving, sliding/tackling and slipping/falling during a typical practice or game, we observed these activities in the event videotaped for that participant. We first categorized the frequency of these events into four categories corresponding to the options provided to participants in the questionnaire, where 0 refers to never, 1 refers to 1-3 times per event, 2 refers to 4-10 times per event, and 3 refers to >10 times per event. For 19 of the 40 (48%) participants, there was no difference between the frequency of diving reported in the questionnaires versus observed in videotaping, however participants tended to report more frequent diving in the questionnaire versus during a typical practice or game (Chi-squared test: p=0.01). There was concurrence between the questionnaire responses and videotape information for only 25% and 30% of the participants for slipping/falling and sliding/tackling, respectively. These differences were not statistically significant, although given relatively low p-values (0.10 and 0.12, respectively), the overall findings suggest that the self-reported information is directly aligned with the videotaped observations.

Figure 17 presents the mean percent of time all 40 participants reported being highly active, moderately active, lightly active, and resting during a typical practice or game in the questionnaire compared with the mean percent of time we observed at these activity levels in the videotapes. We found that there were significant differences between the questionnaire responses and videotape (p-value <0.01 for each activity level). For example, compared to the event we videotaped, we found that participants reported being more highly and moderately active in the questionnaires, and conversely, we observed more moderate and resting activity they reported for a typical practice or game.

It is important to note that we only videotaped one practice or one game for each participant, and in the questionnaire we asked participants to report the average frequency of various activities and exertion levels in a typical practice or game. It is likely that their behaviors and exertion levels during the event videotaped are not representative of all practices or games. Our findings suggest that players may overestimate exertion levels, but further research is needed to appropriately compare self-report exertion against videotaping during the same time period.



3.6. Population-Specific Exposure Parameter Estimates

This report presents an overview of population characteristics and key variables that determine short and long-term exposures resulting from use of STFCRs (e.g., player history, practice and game frequency and duration, exertion, contact with fields, etc). To estimate exposures to specific sub-groups, it is necessary to stratify the information and identify parameters unique to each population. For example, young adult women playing competitive soccer through age 25. In this case, information on player history specific to girls and young women combined with practice and game frequency, exertion, and contact with crumb rubber can be used to develop a lifetime exposure scenario and model exposures. Given the number of variables collected by the questionnaire (90+), and the key factors requiring stratification (gender, participation in recreational or competitive soccer, player position, and age), hundreds of tables are required to identify specific parameters for developing scenarios and building exposure models, resulting in several thousand pages of output.

To create a manageable process to identify key parameters for exposure modeling, we stratified responses from the online and in-person surveys by age (i.e., 0-<2 years, 2-<9 years, 9-<16 years, 16 years and over), gender (i.e., female, male, prefer not to identify), player level (i.e., recreational, competitive, both), and player position (i.e., goalie, forward, midfielder, defender, multiple) and produced output in a text format. Using Python, we replaced code with a descriptor for each stratification, and then produced HTML format files with a linked table of contents for each question (for example, "*Approximately what percent of [your/your child's] soccer PRACTICES take place on synthetic turf fields? (Questions 12 and 99)*". We also produced an overall table of contents (index file) that automatically links to the appropriate HTML files with question-specific information. These files are provided in Appendix B. This procedure simplifies access to the stratified information, eliminates the potential for data entry errors, and can be used for each question from the questionnaire, thereby providing a mechanism to extract key parameters from the output to inform exposure modeling when specific exposure scenarios are developed.

4. Strengths and Limitations

This study combines the results of a large online survey with player interviews and video data obtained through direct observation. One of the primary strengths of this study is that we were able to recruit diverse soccer players of both genders and of various ages and competitive levels living throughout the state of California for the online survey. With over 1000 survey participants and videotaping of 40 soccer players in the San Francisco Bay Area and greater Sacramento, this study is the most extensive to date examining exposure-related activity of individuals using STFCRs and it is unique to California. Combined with extensive environmental sampling testing by the Lawrence Berkeley National Laboratory (LBNL), these data will support OEHHA's efforts to assess chemical exposures and potential health risks resulting from use of STFCRs.

As with all surveys, it is possible that recall bias may have affected the accuracy of participants' responses to the in-person and online questionnaires. To comply with the UC Berkeley CPHS and State of California CPHS human subjects guidelines, parents or guardians rather than the soccer players themselves were required to complete the online survey for all players under the age of 18. Because some parents or guardians are not familiar with their child's activities, some responses may not represent actual practices. To the extent possible for this report, we have presented comparisons of the time activity video data from the 40 participating soccer players and their corresponding questionnaire data. It is important to note that the timeframe of the in-person questionnaires covered a longer timeframe (e.g., weeks, months) and did not match the timeframe of the particular game or practice that was videotaped for this study. In addition, we have presented information on key variables stratified by player age, gender, field position and level of play (i.e., competitive vs. recreational). For some of these stratifications, there are few or no observations in many cells, making it impossible in these cases to interpret the distributions or make statistical comparisons. For example, there was only one player 0-<2 years of age.

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Appendix A – Online Survey, In-Person Questionnaire, and Videotape Observation Forms

Synthetic Turf Exposure Assessment Study

In-Person Participant Questionnaire

P1.	Date of interview	__ __ /__ __ /__ __ MO DAY YR	
P2.	Time interview began	__ __ : __ __	AM / PM
P3.	Study Interviewer	________________	__ __ **[CODE]**
P4.	HSN	__ __ __	

Thank you for participating in this important study. I would like to ask you some questions today regarding your/your child's activities while playing soccer on synthetic turf fields. Synthetic turf fields do not have natural grass and soil, but often have black rubber pebbles called crumb rubber for cushioning. In this study, we want to learn more about how soccer players come in contact with the black "crumb rubber" used in some synthetic turfs so that we can better understand potential exposure to chemicals released from crumb rubber while playing soccer on synthetic turf fields.

If you do not understand any of the questions or need clarification, please tell me and I will explain. If you don't want to answer any of the questions that I ask you, please let me know and we will skip it and go to the next question.

A. GENERAL DEMOGRAPHIC AND SOCCER PLAYER INFORMATION

1.	Are you a soccer player or a parent of a child soccer player?	Soccer player 14 or older...(89) ....1 Parent of child soccer player 2
2.	What is your child's year of birth?	__ __ __ __ YEAR
3.	What is your child's month of birth?	__ __ MONTH
4.	Is your child male or female?	Male ....1 Female....2 Prefer not to identify 3
5.	What ethnic group best describes your child?	Asian or Pacific Islander....1 Black/African American ....2 Caucasian....3 Hispanic/Latino ....4 Native American....5 Mixed....6 Prefer not to identify....7 Other ....8 Specify________________________________
6.	How tall is your child?	__ __ FEET __ __ INCHES
7.	How much does your child weigh?	__ __ POUNDS
8.	What is your child's current grade in school?	Pre-Kindergarten....1 Kindergarten ....2 1st ....3 2nd....4 3rd ....5 4th ....6 5th ....7 6th ....8 7th 9 8th 10

		9th .... 11 10th .... 12 11th .... 13 12th .... 14 Other .... 15 Specify ________________
9.	What is your child's residential zip code?	__ __ __ __ __
10.	Does your child primarily play recreational or competitive soccer?	Recreational .... 1 Competitive .... 2 Both .... 3 Don't know .... 9 Prefer not to answer 8
11.	What position does your child usually play? (**Check all that apply**)	Goalie .... ☐ Forward .... ☐ Midfielder .... ☐ Defender .... ☐ Don't Know .... 9 Prefer not to answer 8

B. CONTACT TYPES AND SCENARIOS DURING SOCCER PRACTICE

*The following questions pertain specifically to your child's activities and behaviors during soccer **PRACTICE** days on synthetic turf fields.*

12.	Approximately what percent of your child's soccer **PRACTICES** take place on synthetic turf fields?	0% .... (27) .... 1 >0-25% .... 2 >25-50% .... 3 >50-75% .... 4 >75% .... 5 Don't Know 9

Prefer not to answer 8

13. Approximately how long before a **PRACTICE** does your child eat or have a snack/meal?

< 1 Hour 1
>1-3 Hours 2
> 3 Hours 3
Don't Know 9
Prefer not to answer 8

14. Approximately how many hours in the **past week** has your child **PRACTICED** soccer on a synthetic turf field?

__ __ HOURS
[CODE 99 IF DK/DR]

15. **Over the past year**, approximately how many days per week has your child typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

b. Summer — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

c. Fall — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

d. Winter — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

16. **Over the past year**, approximately how many hours per day has your child typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

b. Summer — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

c. Fall — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

d. Winter — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

17. **Over the past year**, what is the longest period of time that your child has spent **PRACTICING** soccer on a synthetic turf field in a single day?

<1 Hour 1
>1-2 Hours 2
>2-4 Hours 3
>4-5 Hours 4
> 5 Hours 5
Don't Know 9
Prefer not to answer 8

*Please indicate how often your child does the following activities on a soccer **PRACTICE** day on synthetic turf fields.*

18. On a soccer **PRACTICE** day on synthetic turf fields, how often does your child do the following activities?

a. Dive
- Never.....0
- ~1-3 times.....1
- ~4-10 times.....2
- >10 times.....3
- Don't Know.....9
- Prefer not to answer.....8

b. Slide/tackle
- Never.....0
- ~1-3 times.....1
- ~4-10 times.....2
- >10 times.....3
- Don't Know.....9
- Prefer not to answer.....8

c. Slip/fall on ground
- Never.....0
- ~1-3 times.....1
- ~4-10 times.....2
- >10 times.....3
- Don't Know.....9
- Prefer not to answer.....8

C. DERMAL AND INGESTION EXPOSURES DURING SOCCER PRACTICE

19. On a soccer **PRACTICE** day on synthetic turf fields, how often does your child eat or have a snack while at practice?

Never................................(21) 0
1 time..1
2 times...2
> 2 times...3
Don't Know 9
Prefer not to answer..8

20. While your child is **PRACTICING** soccer on a synthetic turf field, how often does your child wash or wipe their hands before eating?

Never...0
Rarely..1
Sometimes...2
Often...3
Always 4
Don't Know 9
Prefer not to answer..8

21. On a soccer **PRACTICE** day on synthetic turf fields, how many ounces of water/sports drink does your child typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].

8 oz..1
16 oz...2
24 oz...3
32 oz...4
48 oz...5
64 oz...6
> 64 oz...7
Don't Know 9
Prefer not to answer..8

22. On a soccer **PRACTICE** day, approximately how much time does your child usually spend doing sit-ups, putting

0 minutes...0

	on equipment, stretching, etc., where more than their feet are in contact with the synthetic turf?	>0-15 minutes ....1 >15-30 minutes ....2 >30-60 minutes ....3 >60 minutes ....4 Don't Know ....9 Prefer not to answer 8
23.	On a soccer **PRACTICE** day, approximately how many minutes does your child usually spend walking barefoot on the synthetic turf?	0 minutes ....0 >0-10 minutes ....1 >10-30 minutes ....2 >30 minutes ....3 Don't Know ....9 Prefer not to answer 8
24.	While your child is **PRACTICING** soccer on a synthetic turf field, what percent of the time do they usually use a mouth guard?	0% ....0 >0-25% ....1 >25-50% ....2 >50-75% ....3 >75% ....4 Don't Know ....9 Prefer not to answer 8
25.	While your child is **PRACTICING** soccer on a synthetic turf field, how often do they usually:	
	a. Get crumb rubber in their mouth?	Never ....0 Rarely 1

	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
b. Get crumb rubber in their eyes?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in their hands, etc.)?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
d. Get cuts or abrasions from contact with the turf?	Never ....(26) 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4

Don't Know 9

Prefer not to answer 8

e. During **PRACTICE**, where on their body usually has the most cuts or abrasions?

Elbow...1

Knee 2

Thigh 3

Stomach 4

Other ________________________________

Don't Know 9

Prefer not to answer 8

D. INHALATION EXPOSURES DURING PRACTICE

26. While at soccer **PRACTICE** on synthetic turf fields, what percent of the time is your child typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
— —	— —	— —	— —
			100%

E. CONTACT TYPES AND SCENARIOS DURING SOCCER GAMES

The following questions pertain specifically to your child's activities and behaviors during soccer ***GAME*** *days, including warm-up and cool-down, on synthetic turf fields.*

27.	Approximately what percent of your child's soccer **GAMES** take place on synthetic turf fields?	0% ....(43) ....0 >0-25% ....1 >25-50% ....2 >50-75% ....3 >75% ....4 Don't Know ....9 Prefer not to answer 8
28.	Approximately how long before a **GAME** does your child usually eat or have a meal/snack?	< 1 Hour ....1 >1-3 Hours..2 > 3 Hours...3 Don't Know..9 Prefer not to answer 8
29.	Approximately how many minutes does your child play during a typical soccer **GAME**?	__ __ MINUTES **[CODE 99 IF DK/DR]**
30.	Approximately how many hours in the **past week** has your child played soccer **GAMES** on a synthetic turf field?	__ __ HOURS **[CODE 99 IF DK/DR]**
31.	**Over the past year**, approximately how many days per week has your child typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
	a. Spring	__ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	b. Summer	__ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	c. Fall	__ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	d. Winter	__ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**
32.	**Over the past year**, approximately how many hours per day has your child typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
	a. Spring	__ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

b. Summer — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**

c. Fall — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**

d. Winter — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**

33. **Over the past year**, what is the longest period of time that has your child has spent playing soccer **GAMES** on a synthetic turf field in a single day?

- <1 Hour..........1
- >1-2 Hours..........2
- >2-4 Hours..........3
- >4-5 Hours..........4
- > 5 Hours..........5
- Don't know..........9
- Prefer not to answer..........8

Please indicate how often your child does the following activities on a soccer ***GAME*** *day on synthetic turf fields.*

34. On a soccer **GAME** day on synthetic turf fields, how often does your child do the following activities?

a. Dive

- Never..........0
- ~1-3 times..........1
- ~4-10 times..........2
- >10 times..........3
- Don't Know..........9
- Prefer not to answer..........8

b. Slide/tackle

- Never..........0
- ~1-3 times..........1
- ~4-10 times..........2
- >10 times..........3
- Don't Know..........9
- Prefer not to answer..........8

c. Slip/fall on ground

- Never..........0

		~1-3 times........1
		~4-10 times........2
		>10 times........3
		Don't Know........9
		Prefer not to answer........8

F. DERMAL AND INGESTION EXPOSURES DURING SOCCER GAMES

35.	On a soccer **GAME** day on synthetic turf fields, how often does your child eat or have a snack while at the game?	Never........(37)........0
		1 time........1
		2 times........2
		> 2 times........3
		Don't Know........9
		Prefer not to answer........8
36.	While your child is playing a soccer **GAME** on a synthetic turf field, how often do they usually wash or wipe hands before eating?	Never........0
		Rarely........1
		Sometimes........2
		Often........3
		Always........4
		Don't Know........9
		Prefer not to answer........8
37.	On a soccer **GAME** day on synthetic turf fields, how many ounces water/sports drink does your child typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].	8 oz........1
		16 oz........2
		24 oz........3

		32 oz..4
		48 oz..5
		64 oz..6
		> 64 oz..7
		Don't Know 9
		Prefer not to answer.....................................8
38.	On a soccer **GAME** day, approximately how much time does your child spend doing sit-ups, putting on equipment, stretching, etc., where more than their feet are in contact with the synthetic turf?	0 minutes..0
		>0-15 minutes..1
		>15-30 minutes...2
		>30-60 minutes...3
		>60 minutes..4
		Don't Know 9
		Prefer not to answer.....................................8
39.	On a soccer **GAME** day, approximately how many minutes does your child spend walking barefoot on the synthetic turf?	0 minutes..0
		>0-10 minutes..1
		>10-30 minutes...2
		>30 minutes..3
		Don't Know 9
		Prefer not to answer.....................................8
40.	While your child is playing a soccer **GAME** on a synthetic turf field, what percent of the time do they usually use a mouth guard?	0% 0
		>0-25% 1
		>25-50% 2

>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

41. While your child is playing a soccer **GAME** on a synthetic turf field, how often do they usually:

a. Get crumb rubber in their mouth?

Never 0
Rarely 1
Sometimes 2
Often 3
Always 4
Don't Know 9
Prefer not to answer 8

b. Get crumb rubber in their eyes?

Never 0
Rarely 1
Sometimes 2
Often 3
Always 4
Don't Know 9
Prefer not to answer 8

c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in their hands, etc.)?

Never 0
Rarely 1
Sometimes 2

	Often....3
	Always....4
	Don't Know....9
	Prefer not to answer....8
d. Get cuts or abrasions from contact with the turf?	Never....(42)....0
	Rarely....1
	Sometimes....2
	Often....3
	Always....4
	Don't Know....9
	Prefer not to answer....8
e. During **GAMES**, where on their body usually has the most cuts or abrasions?	Elbow....1
	Knee....2
	Thigh....3
	Stomach....4
	Other ______________________
	Don't Know....9
	Prefer not to answer....8

G. INHALATION EXPOSURES DURING GAMES

42. While playing soccer **GAMES** on synthetic turf fields, what percent of the time is your child typically resting, lightly active, moderately active, and highly active? **Your**

responses should all add up to 100%. Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
— —	— —	— —	— —
			100%

H. ADDITIONAL DERMAL AND NON-DIETARY EXPOSURES

General Soccer Activities - the following questions pertain to your child's activities and behaviors while ***PRATICING SOCCER OR PLAYING SOCCER GAMES.***

43. Please indicate whether or not your child wears each of the following clothing items while playing soccer on synthetic turf fields in each of the four seasons **(Select all that apply)**:

a. Shorts (without leggings or long layers)

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

b. Short-sleeve shirt (without a long sleeve shirt or long layers)

Spring ☐

Summer .... ☐

Fall.. ☐

Winter .... ☐

Never.. ☐

Don't Know 9

Prefer not to answer 8

c. Long pants or leggings

Spring .... ☐

Summer .... ☐

Fall.. ☐

Winter .... ☐

Never.. ☐

Don't Know 9

Prefer not to answer 8

d. Long-sleeve shirt

Spring .... ☐

Summer .... ☐

Fall.. ☐

Winter .... ☐

Never.. ☐

		Don't Know 9
		Prefer not to answer 8
	e. Gloves	Spring .... ☐
		Summer .... ☐
		Fall .... ☐
		Winter .... ☐
		Never .... ☐
		Don't Know 9
		Prefer not to answer 8
	f. Long socks	Spring .... ☐
		Summer .... ☐
		Fall .... ☐
		Winter .... ☐
		Never .... ☐
		Don't Know 9
		Prefer not to answer 8
44.	Has <u>your child</u> ever complained about an unpleasant **odor** while playing soccer on synthetic turf field?	No 0
		Yes 1

		Don't Know 9
		Prefer not to answer 8
45.	Has your child ever experienced **eye or nose irritation** while playing soccer on a synthetic turf field?	No..0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
46.	Has your child ever experienced **nausea** while playing soccer on a synthetic turf field?	No..0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
47.	Has your child ever experienced **headaches** while playing soccer on a synthetic turf field?	No..0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
48.	Has your child ever felt **overheated** while playing soccer on a synthetic turf field?	No..0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
49.	Have you ever noticed a unpleasant **odor** while you are on synthetic turf field?	No...................................(51) 0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
50.	Can you describe the odor?	____

____

____

____

51.	Have you ever experienced **eye or nose irritation** while you are on a synthetic turf field?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8
52.	Have you ever experienced **nausea** while you are on a synthetic turf field?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8
53.	Have you ever experienced **headaches** while you are on a synthetic turf field?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8
54.	Have you ever felt **overheated** while you are on a synthetic turf field?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8

I. CRUMB RUBBER TAKE-HOME

*These questions pertain to your child's activities **AFTER** a soccer practice or game on a synthetic turf field.*

55. **After** your child plays soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your car?

Never ... 0
Rarely ... 1
Sometimes ... 2
Often ... 3
Don't Know ... 9
Prefer not to answer ... 8

b. In your home?

Never ... (57) ... 0
Rarely ... 1
Sometimes ... 2
Often ... 3
Don't Know ... 9
Prefer not to answer ... 8

56. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your garage/mudroom/entrance to your house?

0% ... 0
>0-25% ... 1
>25-50% ... 2
>50-75% ... 3
>75% ... 4
Don't Know ... 9
Prefer not to answer ... 8

b. In your laundry room?

0% ... 0
>0-25% ... 1

	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
c. In their bedroom?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. In your/their bathroom?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8

57. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In their water bottle?	0% 0
	>0-25% 1

	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
b. On their clothes?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
c. In their shoes?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. In their socks?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4

	Don't Know 9
	Prefer not to answer 8
e. In their underwear?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
58. **Each time after** your child plays soccer on a synthetic turf field, approximately how much crumb rubber (including granules or crumb rubber dirt and debris) do you find in your home? [SEE CARD].	None 0
	Some, but < 1 Tablespoon 1
	1 Tablespoon – ¼ Cup 2
	> ¼ Cup – ½ Cup 3
	> ½ cup....................4
	Don't Know 9
	Prefer not to answer 8
59. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust on their body?	0% ....(61) 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9

Prefer not to answer 8

60. **After** your child plays soccer on a synthetic turf field, what percent of the time do you find/notice crumb rubber particles or crumb rubber dirt and debris, such as black dust on the following parts of their body:

a. Mouth

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

b. Hair

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

c. Face

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9

Prefer not to answer 8

d. Neck

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

e. Chest

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

f. Back

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

g. Thighs

0% 0
>0-25% 1

	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
h. Lower legs	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
i. Feet	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
j. Upper arms	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4

	Don't Know 9
	Prefer not to answer 8
k. Lower arms	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
l. Hands	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8

J. HYGIENE PRACTICES

61. After playing soccer on a synthetic turf field, how often does your child wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **vehicle**?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9

		Prefer not to answer..8
62.	After playing soccer on a synthetic turf field, how often does your child wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **home**?	0%...0 >0-25% ....1 >25-50% ....2 >50-75% ....3 >75%..4 Don't Know ....9 Prefer not to answer..8
63.	After playing soccer on a synthetic turf field, how often do you/your child wash their gloves?	My child does not wear gloves...........................1 Weekly ....2 Monthly..3 > Once per month – once every six months........4 < Once every six months..................................5 Don't Know ....9 Prefer not to answer..8
64.	How long after playing soccer on a synthetic turf field does your child typically wear their soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
65.	What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that your child may wear their soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
66.	How long after playing soccer on a synthetic turf field does your child typically bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
67.	What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that your child may wait to bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**

K. GENERAL HYGIENE

68.	In general, how many times per day does your child wash their hands?	__ __ [CODE 99 IF DK]
69.	In general, how many times per week does your child bathe/shower?	__ __ [CODE 99 IF DK]

L. PLAYER HISTORY BEFORE THIS SEASON

70.	How many years has your child played soccer?	__ __YEARS [CODE 99 IF DK/DR]
71.	Does your child play soccer year-round?	No....0 Yes....1
72.	Did your child play <u>recreational</u> soccer in the two years prior to the current season?	No....0 Yes....1 Don't Know/Don't Remember....9 Prefer not to answer....8
73.	Did your child play <u>competitive</u> soccer in the two years prior to the current season?	No....0 Yes....1 Don't Know/Don't Remember....9 Prefer not to answer....8
74.	Did your child play soccer between the ages of **4 and 8**?	No....(78)....0 Yes....1 Don't Know/Don't Remember....9 Prefer not to answer....8
75.	What position did your child play between the ages of **4 and 8**? (Check all that apply)	Goalie .... ☐ Forward .... ☐ Midfielder .... ☐

Defender .... ☐

Didn't have a position 1

Don't Know/Don't Remember 9

Prefer not to answer 8

76. On average, how many weeks per year did your child play soccer on synthetic turf fields between the ages of **4 and 8**?

__ __WEEKS PER YEAR

[CODE 99 IF DK/DR]

77. On average, how many hours per week did your child play soccer on synthetic turf fields between the ages of **4 and 8**?

__ __ HOURS PER WEEK

[CODE 99 IF DK/DR]

78. Did your child play soccer between the ages of **9 and 12**?

No ....(82) 0

Yes 1

Not Applicable...................(86) 2

Don't Know/Don't Remember 9

Prefer not to answer 8

79. What position did your child play between the ages of **9 and 12**? (Check all that apply)

Goalie .... ☐

Forward .... ☐

Midfielder .... ☐

Defender .... ☐

Don't Know/Don't Remember 9

Prefer not to answer 8

80. On average, how many weeks per year did your child play soccer on synthetic turf fields between the ages of **9 and 12**?

__ __WEEKS PER YEAR

[CODE 99 IF DK/DR]

81. On average, how many hours per week did your child play soccer on synthetic turf fields between the ages of **9 and 12**?

__ __ HOURS PER WEEK

[CODE 99 IF DK/DR]

82. Did your child play soccer between the ages of **13 and 17**?

No ....(86) 0

Yes 1

Not Applicable...................(86) 2

Don't Know/Don't Remember 9

Prefer not to answer 8

83. What position did your child play between the ages of **13 and 17**? (Check all that apply)

Goalie .... ☐

Forward .... ☐

Midfielder .... ☐

Defender .... ☐

Don't Know/Don't Remember 9

Prefer not to answer 8

84. On average, how many <u>weeks per year</u> did your child play soccer on synthetic turf fields between the ages of **13 and 17**?

__ __WEEKS PER YEAR

[CODE 99 IF DK/DR]

85. On average, how many <u>hours per week</u> did your child play soccer on synthetic turf fields between the ages of **13 and 17**?

__ __ HOURS PER WEEK

[CODE 99 IF DK/DR]

86. Has your child attended a soccer camp where they played on synthetic turf fields **in the last year**?

No....................................**[END OF SURVEY]**..0

Yes 1

Don't Know 9

Prefer not to answer 8

87. Approximately how many <u>days per year</u> did your child spend playing soccer on synthetic turf fields for soccer camps **in the last year**?

__ __DAYS PER YEAR

88. Approximately how many <u>hours per day</u> did your child spend playing soccer on synthetic turf fields for soccer camps **in the last year**?

__ __HOURS PER DAY

Are there any other comments or concerns you would like to share?

____

____

____

____

____

____

____

****

This concludes the survey. Thank you for your time!

If you have any questions or concerns, please let me know now. If you have questions later, please refer to the informed consent sheet we gave you to obtain our contact information.

A. GENERAL DEMOGRAPHIC AND SOCCER PLAYER INFORMATION

89. What is your year of birth? __ __ __ __ YEAR
[IF BIRTH YEAR AFTER 1999 – END SURVEY]

90. What is your month of birth? __ __ MONTH
[IF BIRTH IN 11/1999 or 12/1999 – END SURVEY]

91. Are you male or female?
   - Male 1
   - Female....................2
   - Prefer not to identify 3

92. What ethnic group best describes you?
   - Asian or Pacific Islander 1
   - Black/African American 2
   - Caucasian 3
   - Hispanic/Latino 4
   - Native American 5
   - Mixed 6
   - Prefer not to identify 7
   - Other 8
   - Specify________________________________

93. How tall are you? __ __ FEET
__ __ INCHES

94. How much do you weigh? __ __ POUNDS

95. What is your current grade in school?
   - 11th 11
   - 12th 12
   - Other 13
   - N/A 14
   - Specify

96. What is your residential zip code? __ __ __ __ __

97.	Do you primarily play recreational or competitive soccer?	Recreational..1 Competitive..2 Both..3 Don't Know..9 Prefer not to answer..8
98.	What position do you usually play? **(Check all that apply)**	Goalie..☐ Forward..☐ Midfielder..☐ Defender..☐ Don't Know..9 Prefer not to answer..8

B. CONTACT TYPES AND SCENARIOS DURING SOCCER PRACTICE

*The following questions pertain specifically to activities during soccer **PRACTICE** days on synthetic turf fields.*

99.	Approximately what percent of your soccer **PRACTICES** take place on synthetic turf fields?	0%....................(114)....................1 >0-25%..2 >25-50%..3 >50-75%..4 >75%..5 Don't Know..9 Prefer not to answer..8
100.	Approximately how long before a **PRACTICE** do you eat or have a snack/meal?	< 1 Hour..1 > 1-3 Hours..2 >3 Hours..3 Don't Know..9 Prefer not to answer..8
101.	Approximately how many hours in the **past week** have you **PRACTICED** soccer on a synthetic turf field?	__ __ HOURS

[CODE 99 IF DK/DR]

102. **Over the past year**, approximately how many days per week have you typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
b. Summer	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
c. Fall	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
d. Winter	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**

103. Over the past year, approximately how many hours per day have you typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
b. Summer	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
c. Fall	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
d. Winter	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**

104. **Over the past year**, what is the longest period of time that you have spent **PRACTICING** soccer on a synthetic turf field in a single day?

<1 Hour....................1
>1-2 Hours....................2
>2-4 Hours....................3
>4-5 Hours....................4
> 5 Hours....................5
Don't Know 9
Prefer not to answer....................8

*Please indicate how often you do the following activities on a soccer **PRACTICE** day on synthetic turf fields.*

105. On a soccer **PRACTICE** day on synthetic turf fields, how often do you do the following activities?

a. Dive

Never....................0
~1-3 times....................1
~4-10 times....................2

	>10 times 3
	Don't Know 9
	Prefer not to answer 8
b. Slide/tackle	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't Know 9
	Prefer not to answer 8
c. Slip/fall on ground	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't Know 9
	Prefer not to answer 8

C. DERMAL AND INGESTION EXPOSURES DURING SOCCER PRACTICE

106. On a soccer **PRACTICE** day on synthetic turf fields, how often do you eat or have a snack while at practice?	Never ....(108) 0
	1 time 1
	2 times 2
	>2 times 3
	Don't Know 9
	Prefer not to answer 8
107. On a soccer **PRACTICE** day on synthetic turf fields, how often do you wash or wipe your hands before eating?	Never 0

	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
108. On a soccer **PRACTICE** day on synthetic turf fields, how many ounces water/sports drink do you typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].	8 oz....1
	16 oz....2
	24 oz....3
	32 oz....4
	48 oz....5
	64 oz....6
	> 64 oz....7
	Don't Know 9
	Prefer not to answer 8
109. On a soccer **PRACTICE** day, approximately how much time do you usually spend doing sit-ups, putting on equipment, stretching, etc., where more than your feet are in contact with the synthetic turf?	0 minutes 0
	>0-15 minutes 1
	>15-30 minutes 2
	>30-60 minutes 3
	>60 minutes 4
	Don't Know 9
	Prefer not to answer 8
110. On a soccer **PRACTICE** day, approximately how many minutes do you usually spend walking barefoot on the synthetic turf?	0 minutes 0

>0-10 minutes 1
>10-30 minutes 2
>30 minutes 3
Don't Know 9
Prefer not to answer 8

111. While you are **PRACTICING** soccer on a synthetic turf field, what percent of the time do you usually use a mouth guard?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

112. While you are **PRACTICING** soccer on a synthetic turf field, how often do you usually:

a. Get crumb rubber in your mouth?

Never 0
Rarely 1
Sometimes 2
Often 3
Always 4
Don't Know 9
Prefer not to answer 8

b. Get crumb rubber in your eyes?

Never 0
Rarely 1

	Sometimes..2
	Often..3
	Always 4
	Don't Know 9
	Prefer not to answer 8
c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in your hands, etc.)?	Never..0
	Rarely 1
	Sometimes..2
	Often..3
	Always 4
	Don't Know 9
	Prefer not to answer 8
d. Get cuts or abrasions from contact with the turf?	Never...............................(113) 0
	Rarely 1
	Sometimes..2
	Often..3
	Always 4
	Don't Know 9
	Prefer not to answer 8
e. During **PRACTICE**, where on your body usually has the most cuts or abrasions?	Elbow..1
	Knee 2
	Thigh 3
	Stomach 4
	Other ....

Don't Know 9

Prefer not to answer 8

D. INHALATION EXPOSURES DURING PRACTICE

113. While at soccer **PRACTICE** on synthetic turf fields, what percent of the time are you typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
__ __	__ __	__ __	__ __
			100%

E. CONTACT TYPES AND SCENARIOS DURING SOCCER GAMES

*The following questions pertain specifically to your activities and behaviors during soccer **GAME** days, including warm-up and cool-down, on synthetic turf fields.*

114. Approximately what percent of your soccer **GAMES** take place on synthetic turf fields?

0% ....(130) 1
>0-25% 2
>25-50% 3
>50-75% 4
>75% 5

Don't Know 9

Prefer not to answer 8

115. Approximately how long before a **GAME** do you usually eat or have a snack/meal?

< 1 Hour 1
> 1-3 Hours..2
> 3 Hours..3
Don't Know 9
Prefer not to answer..8

116. Approximately how many minutes do you play during a typical soccer **GAME**?

__ __ MINUTES
[CODE 99 IF DK/DR]

117. Approximately how many hours in the **past week** have you played soccer **GAMES** on a synthetic turf field?

___ ___ HOURS
[CODE 99 IF DK/DR]

118. **Over the past year**, approximately how many days per week have you typically spent playing soccer **GAMES** on synthetic turf fields in each season?

a. Spring — ___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
b. Summer — ___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
c. Fall — ___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
d. Winter — ___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**

119. **Over the past year**, approximately how many hours per day have you typically spent playing soccer **GAMES** on synthetic turf fields in each season?

a. Spring — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
b. Summer — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
c. Fall — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
d. Winter — ___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**

120. **Over the past year**, what is the longest period of time that you have spent playing soccer **GAMES** on a synthetic turf field in a single day?

<1 Hour..1
> 1-2 Hours..2
> 2-4 Hours..3
> 4-5 Hours..4
> 5 Hours..5
Don't know 9

Prefer not to answer 8

*Please indicate how often you do the following activities on a soccer **GAME** day on synthetic turf fields.*

121. On a soccer **GAME** day on synthetic turf fields, how often do you do the following activities?

a. Dive

Never 0
Rarely (~1-3 times) 1
Sometimes (~4-10 times) 2
Often (>10 times) 3
Don't Know 9
Prefer not to answer 8

b. Slide/tackle

Never 0
~1-3 times 1
~4-10 times 2
>10 times 3
Don't Know 9
Prefer not to answer 8

c. Slip/fall on ground

Never 0
~1-3 times 1
~4-10 times 2
>10 times 3
Don't Know 9
Prefer not to answer 8

F. DERMAL AND INGESTION EXPOSURES DURING SOCCER GAMES

122. On a soccer **GAME** day on synthetic turf fields, how often do you eat or have a snack while at the game?	Never .... (124) 0
	1 time 1
	2 times 2
	> 2 times 3
	Don't Know 9
	Prefer not to answer 8
123. While playing a soccer **GAME** on a synthetic turf field, how often do you usually wash or wipe hands before eating?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
124. On a soccer **GAME** day on synthetic turf fields, how many ounces water/sports drink do you typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].	8 oz 1
	16 oz 2
	24 oz 3
	32 oz 4
	48 oz 5
	64 oz 6
	> 64 oz 7
	Don't Know 9
	Prefer not to answer 8

125. On a soccer **GAME** day, approximately how much time do you usually spend doing sit-ups, putting on equipment, stretching, etc., where more than your feet are in contact with the synthetic turf?

0 minutes	0
>0-15 minutes	1
>15-30 minutes	2
>30-60 minutes	3
>60 minutes	4
Don't Know	9
Prefer not to answer	8

126. On a soccer **GAME** day, approximately how many minutes do you usually spend walking barefoot on the synthetic turf?

0 minutes	0
>0-10 minutes	1
>10-30 minutes	2
>30 minutes	3
Don't Know	9
Prefer not to answer	8

127. While playing a soccer **GAME** on a synthetic turf field, what percent of the time do you usually use a mouth guard?

0%	0
>0-25%	1
>25-50%	2
>50-75%	3
>75%	4
Don't Know	9
Prefer not to answer	9

128. While playing a soccer **GAME** on a synthetic turf field, how often do you usually:

a. Get crumb rubber in your mouth?

- Never....0
- Rarely....1
- Sometimes....2
- Often....3
- Always....4
- Don't Know....8
- Prefer not to answer....9

b. Get crumb rubber in your eyes?

- Never....0
- Rarely....1
- Sometimes....2
- Often....3
- Always....4
- Don't Know....9
- Prefer not to answer....8

c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in your hands, etc.)?

- Never....0
- Rarely....1
- Sometimes....2
- Often....3
- Always....4
- Don't Know....9
- Prefer not to answer....8

d. Get cuts or abrasions from contact with the turf?

- Never....(129)....0
- Rarely....1
- Sometimes....2

Often..3

Always 4

Don't Know 9

Prefer not to answer..8

e. During **GAMES**, where on your body usually has the most cuts or abrasions?

Elbow..1

Knee 2

Thigh 3

Stomach 4

Other ....

Don't Know 9

Prefer not to answer..8

G. INHALATION EXPOSURES DURING GAMES

129. On a soccer **GAME** day on synthetic turf fields, what percent of the time are you typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
— —	— —	— —	— —
			100%

H. ADDITIONAL DERMAL AND NON-DIETARY EXPOSURES

General Soccer Activities - the following questions pertain to your activities and behaviors while ***PRATICING SOCCER OR PLAYING SOCCER GAMES.***

130. Please indicate whether or not you wear each of the following clothing items while playing soccer on synthetic turf fields in each of the four seasons **(Select all that apply)**:

a. Shorts (without leggings or long layers)

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

b. Short-sleeve shirt (without a long sleeve shirt or long layers)

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

c. Long pants or leggings

Spring ☐
Summer ☐

		Fall .... ☐
		Winter .... ☐
		Never .... ☐
		Don't Know 9
		Prefer not to answer 8
d.	Long-sleeve shirt	Spring .... ☐
		Summer .... ☐
		Fall .... ☐
		Winter .... ☐
		Never .... ☐
		Don't Know 9
		Prefer not to answer 8
e.	Gloves	Spring .... ☐
		Summer .... ☐
		Fall .... ☐
		Winter .... ☐
		Never .... ☐
		Don't Know 9
		Prefer not to answer 8
f.	Long socks	Spring .... ☐

		Summer ☐
		Fall ☐
		Winter ☐
		Never ☐
		Don't Know 9
		Prefer not to answer 8
131.	Have you ever noticed an unpleasant **odor** while you are on synthetic turf field?	No (133) 0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
132.	Can you describe the odor?	____________________
		____________________
		____________________
133.	Have you ever experienced **eye or nose irritation** while you are on a synthetic turf field?	No 0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
134.	Have you ever experienced **nausea** while you are on a synthetic turf field?	No 0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
135.	Have you ever experienced **headaches** while you are on a synthetic turf field?	No 0

Yes 1

Don't Know 9

Prefer not to answer 8

136. Have you ever felt **overheated** while you are on a synthetic turf field?

No 0

Yes 1

Don't Know 9

Prefer not to answer 8

I. CRUMB RUBBER TAKE-HOME

*These questions pertain to your activities and behaviors **AFTER** a soccer practice or game on a synthetic turf field.*

137. **After** you play soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your car?

Never 0

Rarely 1

Sometimes 2

Often 3

Don't Know 9

Prefer not to answer 8

b. In your home?

Never .... (139) 0

Rarely 1

Sometimes 2

Often 3

Don't Know 9

Prefer not to answer 8

138. **After** you play soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your garage/mudroom/entrance to your house?

0%	0
>0-25%	1
>25-50%	2
>50-75%	3
>75%	4
Don't Know	9
Prefer not to answer	8

b. In your laundry room?

0%	0
>0-25%	1
>25-50%	2
>50-75%	3
>75%	4
Don't Know	9
Prefer not to answer	8

c. In your bedroom?

0%	0
>0-25%	1
>25-50%	2
>50-75%	3
>75%	4
Don't Know	9
Prefer not to answer	8

d. In your bathroom?

0%	0

>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

139. **After** you play soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your water bottle?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

b. On your clothes?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

c. In your shoes?

0% 0

	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. In your socks?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
e. In your underwear?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
140. **Each time after** you play soccer on a synthetic turf field, approximately how much crumb rubber (including granules or crumb rubber dirt and debris) do you find in your home? [SEE CARD].	None 0
	Some, but < 1 Tablespoon 1
	1 Tablespoon – ¼ Cup 2

> ¼ Cup – ½ Cup 3
> ½ cup....................4
Don't Know 9
Prefer not to answer 8

141. **After** you play soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust on your body?

0% ....(143) 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

142. **After** you play soccer on a synthetic turf field, how often do you find/notice crumb rubber particles or crumb rubber dirt and debris, such as black dust on the following parts of your body:

a. Mouth

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

b. Hair

0% 0
>0-25% 1
>25-50% 2

	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
c. Face	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. Neck	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
e. Chest	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9

	Prefer not to answer	8
f. Back	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
g. Thighs	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
h. Lower legs	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
i. Feet	0%	0
	>0-25%	1

	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
j. Upper arms	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
k. Lower arms	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
l. Hands	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4

Don't Know 9

Prefer not to answer 8

J. HYGIENE PRACTICES

143. After playing soccer on a synthetic turf field, how often do you wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **vehicle**?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

144. After playing soccer on a synthetic turf field, how often do you wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **home**?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

145. After playing soccer on a synthetic turf field, how often do you wash your gloves?

I do not wear gloves 1

Weekly 2

Monthly 3

> Once per month – once every six months........4

< Once every six months 5
Don't Know 9
Prefer not to answer 8

146. How long after playing soccer on a synthetic turf field do you typically wear your soccer clothes before changing them? __ __HOURS __ __MINUTES **[CODE 99 IF DK]**

147. What is the longest amount of time after playing soccer on a synthetic turf field that you may wear your soccer clothes before changing them? __ __HOURS __ __MINUTES **[CODE 99 IF DK]**

148. How long after playing soccer on a synthetic turf field do you typically bathe or shower? __ __HOURS __ __MINUTES **[CODE 99 IF DK]**

149. What is the longest amount of time after playing soccer on a synthetic turf field that you may wait to bathe or shower? __ __HOURS __ __MINUTES **[CODE 99 IF DK]**

K. GENERAL HYGIENE

150. In general, how many times per day do you wash your hands? __ __ **[CODE 99 IF DK]**

151. In general, how many times per week do you typically bathe/shower? __ __ **[CODE 99 IF DK]**

L. PLAYER HISTORY BEFORE THIS SEASON

152. How many years have you played soccer? __ __YEARS

153. Do you play soccer year-round?
No...0
Yes 1
Don't Know/Don't Remember 9
Prefer not to answer 8

154.	Did you play recreational soccer in the two years prior to the current season?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8
155.	Did you play competitive soccer in the two years prior to the current season?	No....0 Yes....1 Don't Know....9 Prefer not to answer....8
156.	Did you play soccer between the ages of **4 and 8**?	No....(160)....0 Yes....1 Don't Know....9 Prefer not to answer....8
157.	What position did you play between the ages of **4 and 8**?	Goalie....☐ Forward....☐ Midfielder....☐ Defender....☐ Didn't have a position....1 Don't Know/Don't Remember....9 Prefer not to answer....8
158.	On average, how many weeks per year did you play soccer on synthetic turf fields between the ages of **4 and 8**?	__ __ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
159.	On average, how many hours per week did you play soccer on synthetic turf fields between the ages of **4 and 8**?	__ __ HOURS PER WEEK **[CODE 99 IF DK/DR]**
160.	Did you play soccer between the ages of **9 and 12**?	No....(164)....0 Yes....1 Not applicable....(172)....2 Don't Know/Don't Remember....9 Prefer not to answer....8

161. What position did you play between the ages of **9 and 12**?	Goalie .... ☐ Forward .... ☐ Midfielder .... ☐ Defender .... ☐ Don't Know/Don't Remember .... 9 Prefer not to answer 8
162. On average, how many weeks per year did you play soccer on synthetic turf fields between the ages of **9 and 12**?	__ __ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
163. On average, how many hours per week did you play soccer on synthetic turf fields between the ages of **9 and 12?**	__ __ HOURS PER WEEK **[CODE 99 IF DK/DR]**
164. Did you play soccer between the ages of **13 and 17**?	No .... (168) .... 0 Yes .... 1 Not Applicable .... (172) .... 2 Don't Know/Don't Remember .... 9 Prefer not to answer 8
165. What position did you play between the ages of **13 and 17**?	Goalie .... ☐ Forward .... ☐ Midfielder .... ☐ Defender .... ☐ Don't Know/Don't Remember .... 9 Prefer not to answer 8
166. On average, how many weeks per year did you play soccer on synthetic turf fields between the ages of **13 and 17**?	__ __ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
167. On average, how many hours per week did you play soccer on synthetic turf fields between the ages of **13 and 17**?	__ __ HOURS PER WEEK **[CODE 99 IF DK/DR]**
168. Did you play soccer between the ages of **18 and 25**?	No .... (172) .... 0 Yes .... 1 Not Applicable .... (172) 2

	Don't Know/Don't Remember 9
	Prefer not to answer 8
169. What position did you play between the ages of **18 and 25**?	Goalie ....☐ Forward ....☐ Midfielder ....☐ Defender ....☐ Don't Know/Don't Remember ....9 Prefer not to answer 8
170. On average, how many weeks per year did you play soccer on synthetic turf fields between the ages of **18 and 25**?	___ ___ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
171. On average, how many hours per week did you play soccer on synthetic turf fields between the ages of **18 and 25**?	___ ___ HOURS PER WEEK **[CODE 99 IF DK/DR]**
172. Have you attended a soccer camp or pre-season conditioning camp where you have played soccer on synthetic turf fields **in the last year**?	No....**[END OF SURVEY]** 0 Yes ....1 Don't Know/Don't Remember ....9 Prefer not to answer 8
173. Approximately how many days per year did you spend playing soccer on synthetic turf fields for soccer camps or pre-season conditioning **in the last year**?	__ __DAYS PER YEAR
174. Approximately how many hours per day did you spend playing soccer on synthetic turf fields for soccer camps or pre-season conditioning **in the last year**?	__ __HOURS PER DAY

Are there any other comments or concerns you would like to share?

____

____

____

____

____

____

____

****

This concludes the survey. Thank you for your time!

If you have any questions or concerns, please let me know now. If you have questions later, please refer to the informed consent sheet we gave you to obtain our contact information.

Card 1. Water bottles

8 oz

16 oz

24 oz

32 oz

64 oz

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Card 2. Crumb rubber amounts

Synthetic Turf Exposure Assessment Study

Online Survey

Thank you for participating in this important study. Today you will answer some questions regarding your/your child's activities while playing soccer on synthetic turf fields. Synthetic turf fields do not have natural grass and soil, but often have black rubber pebbles called crumb rubber for cushioning. In this study, we want to learn more about how soccer players come in contact with the black "crumb rubber" used in some synthetic turfs so that we can better understand potential exposure to chemicals released from crumb rubber while playing soccer on synthetic turf fields.

If you are the parent of a soccer player and play soccer yourself, we invite you to complete this survey for your child and yourself. Please complete the survey for one soccer player at a time.

If you do not want to answer any of the questions, you may select "prefer not to answer" and go to the next question.

A. GENERAL DEMOGRAPHIC AND SOCCER PLAYER INFORMATION

1. Are you a soccer player or a parent of a child soccer player?
   - Soccer player 18 or older ..(89) 1
   - Parent of child soccer player 2
2. What is your child's year of birth? — — — — YEAR
3. What is your child's month of birth? — — MONTH
4. Is your child male or female?
   - Male 1
   - Female... 2
   - Prefer not to identify 3
5. What ethnic group best describes your child?
   - Asian or Pacific Islander 1

	Black/African American 2
	Caucasian 3
	Hispanic/Latino 4
	Native American 5
	Mixed 6
	Prefer not to identify 7
	Other 8
	Specify________________________________
6. How tall is your child?	__ __ FEET
	__ __ INCHES
7. How much does your child weigh?	__ __ POUNDS
8. What is your child's current grade in school?	Pre-Kindergarten 1
	Kindergarten 2
	1st 3
	2nd 4
	3rd 5
	4th 6
	5th 7
	6th 8
	7th 9
	8th 10
	9th 11
	10th 12
	11th 13
	12th 14
	Other 15
	Specify ________________________________
9. What is your child's residential zip code?	__ __ __ __ __
10. Does your child primarily play recreational or competitive soccer?	Recreational 1
	Competitive 2
	Both 3

Don't know 9

Prefer not to answer 8

11. What position does your child usually play? (**Check all that apply**)

Goalie .... ☐
Forward .... ☐
Midfielder .... ☐
Defender .... ☐
Don't Know 9
Prefer not to answer 8

B. CONTACT TYPES AND SCENARIOS DURING SOCCER PRACTICE

*The following questions pertain specifically to your child's activities and behaviors during soccer **PRACTICE** days on synthetic turf fields.*

12. Approximately what percent of your child's soccer **PRACTICES** take place on synthetic turf fields?

0% ....(27) 1
>0-25% 2
>25-50% 3
>50-75% 4
>75% 5
Don't Know 9
Prefer not to answer 8

13. Approximately how long before a **PRACTICE** does your child eat or have a snack/meal?

< 1 Hour 1
> 1-3 Hours 2
> 3 Hours 3
Don't know 9

Prefer not to answer 8

14. Approximately how many hours in the **past week** has your child **PRACTICED** soccer on a synthetic turf field?

__ __ HOURS

[CODE 99 IF DK/DR]

15. **Over the past year,** approximately how many days per week has your child typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

b. Summer — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

c. Fall — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

d. Winter — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

16. **Over the past year**, approximately how many hours per day has your child typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

b. Summer — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

c. Fall — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

d. Winter — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

17. **Over the past year**, what is the longest period of time that your child has spent **PRACTICING** soccer on a synthetic turf field in a single day?

<1 Hour....................1
> 1-2 Hours....................2
> 2-4 Hours....................3
> 4-5 Hours....................4
> 5 Hours....................5
Don't Know 9
Prefer not to answer....................8

*Please indicate how often your child does the following activities on a soccer **PRACTICE** day on synthetic turf fields.*

18. On a soccer **PRACTICE** day on synthetic turf fields, how often does your child do the following activities?

a. Dive

Never....................0
~1-3 times....................1
~4-10 times....................2
>10 times....................3
Don't Know 9

	Prefer not to answer 8
b. Slide/tackle	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't Know 9
	Prefer not to answer 8
c. Slip/fall on ground	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't Know 9
	Prefer not to answer 8

C. DERMAL AND INGESTION EXPOSURES DURING SOCCER PRACTICE

19. On a soccer **PRACTICE** day on synthetic turf fields, how often does your child eat or have a snack while at practice?	Never .... (21) 0
	1 time 1
	2 times 2
	>2 times 3
	Don't Know 9
	Prefer not to answer 8
20. While your child is **PRACTICING** soccer on a synthetic turf field, how often does your child wash or wipe their hands before eating?	Never 0
	Rarely 1

	Sometimes....2
	Often....3
	Always....4
	Don't Know....9
	Prefer not to answer....8
21. On a soccer **PRACTICE** day on synthetic turf fields, how many ounces water/sports drink does your child typically drink? A normal water bottle is approximately 16 ounces.	8 oz....1
	16 oz....2
	24 oz....3
	32 oz....4
	48 oz....5
	64 oz....6
	> 64 oz....7
	Don't Know....9
	Prefer not to answer....8
22. On a soccer **PRACTICE** day, approximately how much time does your child usually spend doing sit-ups, putting on equipment, stretching, etc., where more than their feet are in contact with the synthetic turf?	0 minutes....0
	>0-15 minutes....1
	>15-30 minutes....2
	>30-60 minutes....3
	>60 minutes....4
	Don't Know....9
	Prefer not to answer....8
23. On a soccer **PRACTICE** day, approximately how many minutes does your child usually spend walking barefoot on the synthetic turf?	0 minutes....0
	>0-10 minutes....1

	>10-30 minutes 2
	>30 minutes 3
	Don't know 9
	Prefer not to answer 8
24. While your child is **PRACTICING** soccer on a synthetic turf field, what percent of the time do they usually use a mouth guard?	0% 0
	0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
25. While your child is **PRACTICING** soccer on a synthetic turf field, how often do they usually:	
a. Get crumb rubber in their mouth?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
b. Get crumb rubber in their eyes?	Never 0
	Rarely 1

		Sometimes....................2
		Often....................3
		Always....................4
		Don't Know....................9
		Prefer not to answer....................8
c.	Play with crumb rubber (i.e. making a pile, throwing it, playing with it in their hands, etc.)?	Never....................0
		Rarely....................1
		Sometimes....................2
		Often....................3
		Always....................4
		Don't Know....................9
		Prefer not to answer....................8
d.	Get cuts or abrasions from contact with the turf?	Never..........(26)..........0
		Rarely....................1
		Sometimes....................2
		Often....................3
		Always....................4
		Don't Know....................9
		Prefer not to answer....................8
e.	During **PRACTICE**, where on their body usually has the most cuts or abrasions?	Elbow....................1
		Knee....................2
		Thigh....................3
		Stomach....................4
		Other ______________________

Don't Know 9

Prefer not to answer 8

D. INHALATION EXPOSURES DURING PRACTICE

26. While at soccer **PRACTICE** on synthetic turf fields, what percent of the time is your child typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
__ __	__ __	__ __	__ __
			100%

E. CONTACT TYPES AND SCENARIOS DURING SOCCER GAMES

*The following questions pertain specifically to your child's activities and behaviors during soccer **GAME** days, including warm-up and cool-down, on synthetic turf fields.*

27. Approximately what percent of your child's soccer **GAMES** take place on synthetic turf fields?

0% ....(42) 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

28.	Approximately how long before a **GAME** does your child usually eat or have a meal/snack?	< 1 Hour .... 1 > 1-3 Hours .... 2 > 3 Hours .... 3 Don't Know .... 9 Prefer not to answer 8
29.	Approximately how many minutes does your child play during a typical soccer **GAME**?	___ ___ MINUTES **[CODE 99 IF DK/DR]**
30.	Approximately how many hours in the **past week** has your child played soccer **GAMES** on a synthetic turf field?	___ ___ HOURS **[CODE 99 IF DK/DR]**
31.	**Over the past year**, approximately how many days per week has your child typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
	a. Spring	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	b. Summer	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	c. Fall	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
	d. Winter	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
32.	**Over the past year**, approximately how many hours per day has your child typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
	a. Spring	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
	b. Summer	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
	c. Fall	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
	d. Winter	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
33.	**Over the past year**, what is the longest period of time that has your child has spent playing soccer **GAMES** on a synthetic turf field in a single day?	<1 Hour .... 1 > 1-2 Hours .... 2 > 2-4 Hours .... 3 > 4-5 Hours .... 4 > 5 Hours .... 5 Don't know 9

Prefer not to answer 8

*Please indicate how often your child does the following activities on a soccer **GAME** day on synthetic turf fields.*

34. On a soccer **GAME** day on synthetic turf fields, how often does your child do the following activities?

a. Dive

Never 0
~1-3 times 1
~4-10 times 2
>10 times 3
Don't Know 9
Prefer not to answer 8

b. Slide/tackle

Never 0
~1-3 times 1
~4-10 times 2
>10 times 3
Don't Know 9
Prefer not to answer 8

c. Slip/fall on ground

Never 0
~1-3 times 1
~4-10 times 2
>10 times 3
Don't Know 9
Prefer not to answer 8

F. DERMAL AND INGESTION EXPOSURES DURING SOCCER GAMES

35.	On a soccer **GAME** day on synthetic turf fields, how often does your child eat or have a snack while at the game?	Never ....(37) ....0 1 time ....1 2 times ....2 > 2 times ....3 Don't Know ....9 Prefer not to answer 8
36.	While your child is playing a soccer **GAME** on a synthetic turf field, how often do they usually wash or wipe hands before eating?	Never ....0 Rarely ....1 Sometimes ....2 Often ....3 Always ....4 Don't Know ....9 Prefer not to answer 8
37.	On a soccer **GAME** day on synthetic turf fields, how many ounces water/sports drink does your child typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].	8 oz ....1 16 oz ....2 24 oz ....3 32 oz ....4 48 oz ....5 64 oz ....6 > 64 oz ....7 Don't Know ....9 Prefer not to answer 8

38. On a soccer **GAME** day, approximately how much time does your child spend doing sit-ups, putting on equipment, stretching, etc., where more than their feet are in contact with the synthetic turf?

0 minutes	0
>0-15 minutes	1
>15-30 minutes	2
>30-60 minutes	3
>60 minutes	4
Don't Know	9
Prefer not to answer	8

39. On a soccer **GAME** day, approximately how many minutes does your child spend walking barefoot on the synthetic turf?

0 minutes	0
>0-10 minutes	1
>10-30 minutes	2
>30 minutes	3
Don't Know	9
Prefer not to answer	8

40. While your child is playing a soccer **GAME** on a synthetic turf field, what percent of the time do they usually use a mouth guard?

0%	0
>0-25%	1
>25-50%	2
>50-75%	3
>75%	4
Don't Know	9
Prefer not to answer	8

41. While your child is playing a soccer **GAME** on a synthetic turf field, how often do they usually:

a. Get crumb rubber in their mouth?

Never	0

	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
b. Get crumb rubber in their eyes?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in their hands, etc.)?	Never 0
	Rarely 1
	Sometimes 2
	Often 3
	Always 4
	Don't Know 9
	Prefer not to answer 8
d. Get cuts or abrasions from contact with the turf?	Never ....(42) 0
	Rarely 1
	Sometimes 2
	Often 3

Always 4
Don't Know 9
Prefer not to answer 8

e. During **GAMES**, where on their body usually has the most cuts or abrasions?

Elbow....1
Knee 2
Thigh 3
Stomach 4
Other ________________
Don't Know 9
Prefer not to answer 8

G. INHALATION EXPOSURES DURING GAMES

42. While playing soccer **GAMES** on synthetic turf fields, what percent of the time is your child typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
__ __	__ __	__ __	__ __
			100%

H. ADDITIONAL DERMAL AND NON-DIETARY EXPOSURES

*General Soccer Activities - the following questions pertain to your child's activities and behaviors while **PRATICING SOCCER OR PLAYING SOCCER GAMES.***

43. Please indicate whether or not your child wears each of the following clothing items while playing soccer on synthetic turf fields in each of the four seasons: **(Select all that apply)**:

a. Shorts (without leggings or long layers)

- Spring ☐
- Summer ☐
- Fall ☐
- Winter ☐
- Never ☐
- Don't Know 9
- Prefer not to answer 8

b. Short-sleeve shirt (without a long sleeve shirt or long layers)

- Spring ☐
- Summer ☐
- Fall ☐
- Winter ☐
- Never ☐
- Don't Know 9
- Prefer not to answer 8

c. Long pants or leggings

- Spring ☐
- Summer ☐

Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

d. Long-sleeve shirt

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

e. Gloves

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

f. Long socks

Spring ☐
Summer ☐
Fall ☐
Winter ☐
Never ☐
Don't Know 9
Prefer not to answer 8

44. Has your child ever complained about a unpleasant **odor** while playing soccer on synthetic turf field?

No 0
Yes 1
Don't Know 9
Prefer not to answer 8

45. Has your child ever experienced **eye or nose irritation** while playing soccer on a synthetic turf field?

No 0
Yes 1
Don't Know 9
Prefer not to answer 8

46. Has your child ever experienced **nausea** while playing soccer on a synthetic turf field?

No 0
Yes 1
Don't Know 9
Prefer not to answer 8

47. Has your child ever experienced **headaches** while playing soccer on a synthetic turf field?

No 0

		Yes 1
		Don't Know 9
		Prefer not to answer 8
48.	Has your child ever felt **overheated** while playing soccer on a synthetic turf field?	No...0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
49.	Have you ever noticed an unpleasant **odor** while you are on synthetic turf field?	No..................................(51) 0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
50.	Can you describe the odor?	____________________________________
		____________________________________
		____________________________________
		____________________________________
51.	Have you ever experienced **eye or nose irritation** while you are on a synthetic turf field?	No...0
		Yes 1
		Don't Know 9
		Prefer not to answer 8
52.	Have you ever experienced **nausea** while you are on a synthetic turf field?	No...0
		Yes 1
		Don't Know 9
		Prefer not to answer 8

53. Have <u>you</u> ever experienced **headaches** while you are on a synthetic turf field?

No.....0
Yes.....1
Don't Know.....9
Prefer not to answer.....8

54. Have <u>you</u> ever felt **overheated** while you are on a synthetic turf field?

No.....0
Yes.....1
Don't Know.....9
Prefer not to answer.....8

I. CRUMB RUBBER TAKE-HOME

*These questions pertain to your child's activities **AFTER** a soccer practice or game on a synthetic turf field.*

55. **After** your child plays soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your car?

Never.....0
Rarely.....1
Sometimes.....2
Often.....3
Always.....4
Don't Know.....9
Prefer not to answer.....8

b. In your home?

Never.....(57).....0
Rarely.....1
Sometimes.....2
Often.....3

Always 4

Don't Know 9

Prefer not to answer 8

56. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your garage/mudroom/entrance to your house?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

b. In your laundry room?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

c. In their bedroom?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. In your/their bathroom?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8

57. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In their water bottle?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
b. On their clothes?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3

	>75% 4
	Don't Know 9
	Prefer not to answer 8
c. In their shoes?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. In their socks?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
e. In their underwear?	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8

58. **Each time after** your child plays soccer on a synthetic turf field, approximately how much crumb rubber (including granules or crumb rubber dirt and debris) do you find in your home?	None .... 0 Some, but < 1 Tablespoon .... 1 1 Tablespoon – ¼ Cup .... 2 > ¼ Cup – ½ Cup .... 3 > ½ cup .... 4 Don't Know .... 9 Prefer not to answer 8
59. **After** your child plays soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust on their body?	0% .... (61) .... 0 >0-25% .... 1 >25-50% .... 2 >50-75% .... 3 >75% .... 4 Don't Know .... 9 Prefer not to answer 8
60. **After** your child plays soccer on a synthetic turf field, what percent of the time do you find/notice crumb rubber particles or crumb rubber dirt and debris, such as black dust on the following parts of their body: a. Mouth	0% .... 0 >0-25% .... 1 >25-50% .... 2 >50-75% .... 3 >75% .... 4 Don't Know .... 9 Prefer not to answer 8

b. Hair
- 0% 0
- >0-25% 1
- >25-50% 2
- >50-75% 3
- >75% 4
- Don't Know 9
- Prefer not to answer 8

c. Face
- 0% 0
- >0-25% 1
- >25-50% 2
- >50-75% 3
- >75% 4
- Don't Know 9
- Prefer not to answer 8

d. Neck
- 0% 0
- >0-25% 1
- >25-50% 2
- >50-75% 3
- >75% 4
- Don't Know 9
- Prefer not to answer 8

e. Chest
- 0% 0
- >0-25% 1
- >25-50% 2

	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
f. Back	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
g. Thighs	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
h. Lower legs	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9

Prefer not to answer 8

i. Feet

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

j. Upper arms

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

k. Lower arms

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

l. Hands

0% 0
>0-25% 1

	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8

J. HYGIENE PRACTICES

61.	After playing soccer on a synthetic turf field, how often does your child wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **vehicle**?	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8
62.	After playing soccer on a synthetic turf field, how often does your child wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **home**?	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8
63.	After playing soccer on a synthetic turf field, how often do you/your child wash their gloves?	My child does not wear gloves...........................1
		Weekly 2
		Monthly..3

> Once per month – once every six months........4

< Once every six months..................................5

Don't Know 9

Prefer not to answer 8

64.	How long after playing soccer on a synthetic turf field does your child typically wear their soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
65.	What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that your child may wear their soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
66.	How long after playing soccer on a synthetic turf field does your child typically bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
67.	What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that your child may wait to bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**

K. GENERAL HYGIENE

68.	In general, how many times per day does your child wash their hands?	__ __ **[CODE 99 IF DK]**
69.	In general, how many times per week does your child bathe/shower?	__ __ **[CODE 99 IF DK]**

L. PLAYER HISTORY BEFORE THIS SEASON

70.	How many years has your child played soccer?	__ __YEARS **[CODE 99 IF DK/DR]**
71.	Does your child play soccer year-round?	No.........0 Yes 1
72.	Did your child play <u>recreational</u> soccer in the two years prior to the current season?	No.........0

		Yes ....1 Don't Know/Don't remember..............................9 Prefer not to answer 8
73.	Did your child play <u>competitive</u> soccer in the two years prior to the current season?	No...0 Yes ....1 Don't know/Don't remember ....9 Prefer not to answer 8
74.	Did your child play soccer between the ages of **4 and 8**?	No...................................(78) ....0 Yes ....1 Don't know/Don't remember ....9 Prefer not to answer 8
75.	What position did your child play between the ages of **4 and 8**? (Check all that apply)	Goalie .... ☐ Forward .... ☐ Midfielder .... ☐ Defender .... ☐ Didn't have a position ....1 Don't know/Don't remember ....9 Prefer not to answer 8
76.	On average, how many <u>weeks per year</u> did your child play soccer on synthetic turf fields between the ages of **4 and 8**?	__ __WEEKS PER YEAR **[CODE 99 IF DK/DR**
77.	On average, how many <u>hours per week</u> did your child play soccer on synthetic turf fields between the ages of **4 and 8**?	___ ___ HOURS PER WEEK **[CODE 99 IF DK/DR]**

78.	Did your child play soccer between the ages of **9 and 12**?	No ....(82) ....0 Yes ....1 Not Applicable....(86) ....2 Don't know/Don't remember ....9 Prefer not to answer 8
79.	What position did your child play between the ages of **9 and 12**? (Check all that apply)	Goalie ....☐ Forward ....☐ Midfielder ....☐ Defender ....☐ Don't know/Don't remember ....9 Prefer not to answer 8
80.	On average, how many <u>weeks per year</u> did your child play soccer on synthetic turf fields between the ages of **9 and 12**?	__ __WEEKS PER YEAR **[CODE 99 IF DK/DR**
81.	On average, how many <u>hours per week</u> did your child play soccer on synthetic turf fields between the ages of **9 and 12**?	__ __ HOURS PER WEEK **[CODE 99 IF DK/DR]**
82.	Did your child play soccer between the ages of **13 and 17**?	No ....(86) ....0 Yes ....1 Not Applicable....(86) ....2 Don't know/Don't remember ....9 Prefer not to answer 8
83.	What position did your child play between the ages of **13 and 17**? (Check all that apply)	Goalie ....☐ Forward ....☐ Midfielder ....☐ Defender ....☐ Don't know/Don't remember 9

Prefer not to answer 8

84. On average, how many weeks per year did your child play soccer on synthetic turf fields between the ages of **13 and 17**?

__ __WEEKS PER YEAR
[CODE 99 IF DK/DR

85. On average, how many hours per week did your child play soccer on synthetic turf fields between the ages of **13 and 17**?

___ ___ HOURS PER WEEK
[CODE 99 IF DK/DR]

86. Has your child attended a soccer camp where they played on synthetic turf fields **in the last year**?

No....................................**[END OF SURVEY]**..0

Yes 1

Don't Know 9

Prefer not to answer 8

87. Approximately how many days per year did your child spend playing soccer on synthetic turf fields for soccer camps **in the last year**?

__ __DAYS PER YEAR

88. Approximately how many hours per day did your child spend playing soccer on synthetic turf fields for soccer camps **in the last year**?

__ __HOURS PER DAY

****

This concludes the survey. Thank you for your time!

If you would like to complete the survey again for yourself or another child, click here.

Learn more about the Synthetic Turf Exposure Study on OEHHA's website.

Connect with us on the study's Facebook page.

A. GENERAL DEMOGRAPHIC AND SOCCER PLAYER INFORMATION

89. What is your year of birth? — — — —

YEAR

[IF BIRTH YEAR AFTER 1999 – END SURVEY]

90. What is your month of birth? — —

MONTH

[IF BIRTH IN 11/1999 or 12/1999 – END SURVEY]

91. Are you male or female?

Male 1
Female 2
Prefer not to identify 3

92. What ethnic group best describes you?

Asian or Pacific Islander 1
Black/African American 2
Caucasian 3
Hispanic/Latino 4
Native American 5
Mixed 6
Prefer not to identify 7
Other 8
Specify________________________________

93. How tall are you?

__ __ FEET

__ __ INCHES

94. How much do you weigh? __ __ POUNDS

95. What is your current grade in school?

11th 11
12th 12
Other 13
N/A 14

		Specify ______________________________
96.	What is your residential zip code?	__ __ __ __ __
97.	Do you primarily play recreational or competitive soccer?	Recreational....................1 Competitive....................2 Both....................3 Don't know....................9 Prefer not to answer....................8
98.	What position do you usually play? **(Check all that apply)**	Goalie ....☐ Forward ....☐ Midfielder....................☐ Defender....................☐ Don't know....................9 Prefer not to answer....................8

B. CONTACT TYPES AND SCENARIOS DURING SOCCER PRACTICE

*The following questions pertain specifically to activities and behaviors during soccer **PRACTICE** days on synthetic turf fields.*

99.	Approximately what percent of your soccer **PRACTICES** take place on synthetic turf fields?	0% ....(114) ....1 >0-25%....................2 >25-50%....................3 >50-75%....................4 >75%....................5 Don't know....................9 Prefer not to answer....................8
100.	Approximately how long before a **PRACTICE** do you eat or have a snack/meal?	< 1 Hour....................1 >1-3 Hours....................2 > 3 Hours....................3 Don't know....................9 Prefer not to answer....................8

101. Approximately how many hours in the **past week** have you **PRACTICED** soccer on a synthetic turf field?

__ __ HOURS

[CODE 99 IF DK/DR]

102. **Over the past year**, approximately how many days per week have you typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

b. Summer — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

c. Fall — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

d. Winter — __ __ DAYS PER WEEK **[CODE 99 IF DK/DR]**

103. **Over the past year,** approximately how many hours per day have you typically spent **PRACTICING** soccer on synthetic turf fields in each season?

a. Spring — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

b. Summer — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

c. Fall — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

d. Winter — __ __ HOURS PER DAY **[CODE 99 IF DK/DR]**

104. **Over the past year**, what is the longest period of time that you have spent **PRACTICING** soccer on a synthetic turf field in a single day?

<1 Hour 1
>1-2 Hours 2
>2-4 Hours 3
>4-5 Hours 4
> 5 Hours 5
Don't know 9
Prefer not to answer 8

Please indicate how often you do the following activities on a soccer ***PRACTICE*** *day on synthetic turf fields.*

105. On a soccer **PRACTICE** day on synthetic turf fields, how often do you do the following activities?

a. Dive

Never 0
~1-3 times 1

	~4-10 times 2
	>10 times 3
	Don't know 9
	Prefer not to answer 8
b. Slide/tackle	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't know 9
	Prefer not to answer 8
c. Slip/fall on ground	Never 0
	~1-3 times 1
	~4-10 times 2
	>10 times 3
	Don't know 9
	Prefer not to answer 8

C. DERMAL AND INGESTION EXPOSURES DURING SOCCER PRACTICE

106. On a soccer **PRACTICE** day on synthetic turf fields, how often do you eat or have a snack while at practice?	Never .... (108) 0
	1 time 1
	2 times 2
	> 2 times 3
	Don't know 9
	Prefer not to answer 8

107. On a soccer **PRACTICE** day on synthetic turf fields, how often do you wash or wipe your hands before eating?	Never....0 Rarely....1 Sometimes....2 Often....3 Always....4 Don't know....9 Prefer not to answer....8
108. On a soccer **PRACTICE** day on synthetic turf fields, how many ounces water/sports drink do you typically drink? A normal water bottle is approximately 16 ounces.	8 oz....1 16 oz....2 24 oz....3 32 oz....4 48 oz....5 64 oz....6 > 64 oz....7 Don't know....9 Prefer not to answer....8
109. On a soccer **PRACTICE** day, approximately how much time do you spend doing sit-ups, putting on equipment, stretching, etc., where more than your feet are in contact with the synthetic turf?	0 minutes....0 >0-15 minutes....1 >15-30 minutes....2 >30-60 minutes....3 >60 minutes....4 Don't know....9 Prefer not to answer....8

110. On a soccer **PRACTICE** day, approximately how many minutes do you usually spend walking barefoot on the synthetic turf?

- 0 minutes 0
- >0-10 minutes 1
- >10-30 minutes 2
- >30 minutes 3
- Don't know 9
- Prefer not to answer 8

111. While you are **PRACTICING** soccer on a synthetic turf field, what percent of the time do you usually use a mouth guard?

- 0% 0
- >0-25% 1
- >25-50% 2
- >50-75% 3
- >75% 4
- Don't Know 9
- Prefer not to answer 8

112. While you are **PRACTICING** soccer on a synthetic turf field, how often do you usually:

a. Get crumb rubber in your mouth?

- Never 0
- Rarely 1
- Sometimes 2
- Often 3
- Always 4
- Don't know 9
- Prefer not to answer 8

b. Get crumb rubber in your eyes?

- Never 0

	Rarely 1
	Sometimes....2
	Often....3
	Always 4
	Don't know 9
	Prefer not to answer 8
c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in your hands, etc.)?	Never....0
	Rarely 1
	Sometimes....2
	Often....3
	Always 4
	Don't know 9
	Prefer not to answer 8
d. Get cuts or abrasions from contact with the turf?	Never....(113) 0
	Rarely 1
	Sometimes....2
	Often....3
	Always 4
	Don't know 9
	Prefer not to answer 8
e. During **PRACTICE**, where on your body usually has the most cuts or abrasions?	Elbow....1
	Knee 2
	Thigh 3
	Stomach 4

Other ________________________________

Don't know 9

Prefer not to answer 8

D. INHALATION EXPOSURES DURING PRACTICE

113. While at soccer **PRACTICE** on synthetic turf fields, what percent of the time are you typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
__ __	__ __	__ __	__ __
			100%

E. CONTACT TYPES AND SCENARIOS DURING SOCCER GAMES

*The following questions pertain specifically to your activities and behaviors during soccer **GAME** days, including warm-up and cool-down, on synthetic turf fields.*

114. Approximately what percent of your soccer **GAMES** take place on synthetic turf fields?

0% ....(130) 1
>0-25% 2
>25-50% 3
>50-75% 4
>75% 5

Don't Know 9

	Prefer not to answer 8
115. Approximately how long before a **GAME** do you usually eat or have a snack/meal?	< 1 Hour ....1 > 1-3 Hours..2 > 3 Hours..3 Don't know..9 Prefer not to answer 8
116. Approximately how many minutes do you play during a typical soccer **GAME**?	__ __ MINUTES **[CODE 99 IF DK/DR]**
117. Approximately how many hours in the **past week** have you played soccer **GAMES** on a synthetic turf field?	___ ___ HOURS **[CODE 99 IF DK/DR]**
118. **Over the past year**, approximately how many <u>days per week</u> have you typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
a. Spring	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
b. Summer	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
c. Fall	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
d. Winter	___ ___ DAYS PER WEEK **[CODE 99 IF DK/DR]**
119. **Over the past year**, approximately how many <u>hours per day</u> have you typically spent playing soccer **GAMES** on synthetic turf fields in each season?	
a. Spring	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
b. Summer	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
c. Fall	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
d. Winter	___ ___ HOURS PER DAY **[CODE 99 IF DK/DR]**
120. **Over the past year**, what is the <u>longest period of time</u> that you have spent playing soccer **GAMES** on a synthetic turf field in a single day?	<1 Hour..1 > 1-2 Hours..2 > 2-4 Hours..3 > 4-5 Hours..4

> 5 Hours....5
Don't know 9
Prefer not to answer....8

*Please indicate how often you do the following activities on a soccer **GAME** day on synthetic turf fields.*

121. On a soccer **GAME** day on synthetic turf fields, how often do you do the following activities?

a. Dive
- Never....0
- ~1-3 times....1
- ~4-10 times....2
- >10 times....3
- Don't know....9
- Prefer not to answer....8

b. Slide/tackle
- Never....0
- Rarely (~1-3 times)....1
- Sometimes (~4-10 times)....2
- Often (>10 times)....3
- Don't know....9
- Prefer not to answer....8

c. Slip/fall on ground
- Never....0
- ~1-3 times....1
- ~4-10 times....2
- >10 times....3
- Don't know....9
- Prefer not to answer....8

F. DERMAL AND INGESTION EXPOSURES DURING SOCCER GAMES

122. On a soccer **GAME** day on synthetic turf fields, how often do you eat or have a snack while at the game?	Never..............................(124) 0
	1 time...1
	2 times...2
	> 2 times..3
	Don't know..9
	Prefer not to answer...8
123. While playing a soccer **GAME** on a synthetic turf field, how often do you usually wash or wipe hands before eating?	Never..0
	Rarely 1
	Sometimes...2
	Often...3
	Always 4
	Don't know..9
	Prefer not to answer...8
124. On a soccer **GAME** day on synthetic turf fields, how many ounces water/sports drink do you typically drink? A normal water bottle is approximately 16 ounces [SEE CARD].	8 oz...1
	16 oz...2
	24 oz...3
	32 oz...4
	48 oz...5
	64 oz...6
	> 64 oz..7
	Don't know..9

Prefer not to answer 8

125. On a soccer **GAME** day, approximately how much time do you spend doing sit-ups, putting on equipment, stretching, etc., where more than your feet are in contact with the synthetic turf?

0 minutes 0
>0-15 minutes 1
>15-30 minutes 2
>30-60 minutes 3
>60 minutes 4
Don't know 9
Prefer not to answer 8

126. On a soccer **GAME** day, approximately how many minutes do you usually spend walking barefoot on the synthetic turf?

0 minutes 0
>0-10 minutes 1
>10-30 minutes 2
>30 minutes 3
Don't know 9
Prefer not to answer 8

127. While playing a soccer **GAME** on a synthetic turf field, what percent of the time do you usually use a mouth guard?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't Know 9
Prefer not to answer 8

128. While playing a soccer **GAME** on a synthetic turf field, how often do you usually:

a. Get crumb rubber in your mouth?

Never	0
Rarely	1
Sometimes	2
Often	3
Always	4
Don't know	9
Prefer not to answer	8

b. Get crumb rubber in your eyes?

Never	0
Rarely	1
Sometimes	2
Often	3
Always	4
Don't know	9
Prefer not to answer	8

c. Play with crumb rubber (i.e. making a pile, throwing it, playing with it in your hands, etc.)?

Never	0
Rarely	1
Sometimes	2
Often	3
Always	4
Don't know	9
Prefer not to answer	8

d. Get cuts or abrasions from contact with the turf?

Never ....(129)	0
Rarely	1

Sometimes 2

Often 3

Always 4

Don't know 9

Prefer not to answer 8

e. During **GAMES**, where on your body usually has the most cuts or abrasions?

Elbow 1

Knee 2

Thigh 3

Stomach 4

Other ______________________________

Don't know 9

Prefer not to answer 8

G. INHALATION EXPOSURES DURING GAMES

129. On a soccer **GAME** day on synthetic turf fields, what percent of the time are you typically resting, lightly active, moderately active, and highly active? **Your responses should all add up to 100%.** Please enter "DK" if you don't know. You may leave this question blank if you prefer not to answer.

Resting (i.e. sitting or standing)	Lightly active (i.e. walking)	Moderately active (i.e. jogging)	Highly active (i.e. running hard)
__ __	__ __	__ __	__ __
			100%

H. ADDITIONAL DERMAL AND NON-DIETARY EXPOSURES

General Soccer Activities - the following questions pertain to your child's activities and behaviors while ***PRATICING SOCCER OR PLAYING SOCCER GAMES.***

130. Please indicate whether or not you wear each of the following clothing items while playing soccer on synthetic turf fields in each of the four seasons: **(Select all that apply)**:

a. Shorts (without leggings or long layers)

Spring .... ☐
Summer .... ☐
Fall .... ☐
Winter .... ☐
Never .... ☐
Don't know 9
Prefer not to answer 8

b. Short-sleeve shirt (without a long sleeve shirt or long layers)

Spring .... ☐
Summer .... ☐
Fall .... ☐
Winter .... ☐
Never .... ☐
Don't know 9
Prefer not to answer 8

c. Long pants or leggings

Spring .... ☐
Summer .... ☐

	Fall ☐
	Winter ☐
	Never ☐
	Don't know 9
	Prefer not to answer 8
d. Long-sleeve shirt	Spring ☐
	Summer ☐
	Fall ☐
	Winter ☐
	Never ☐
	Don't know 9
	Prefer not to answer 8
e. Gloves	Spring ☐
	Summer ☐
	Fall ☐
	Winter ☐
	Never ☐
	Don't know 9
	Prefer not to answer 8
f. Long socks	Spring ☐

	Summer .... ☐
	Fall .... ☐
	Winter .... ☐
	Never .... ☐
	Don't know 9
	Prefer not to answer 8
131. Have you ever noticed an unpleasant **odor** while you are on synthetic turf field?	No .... (133) 0
	Yes 1
	Don't know 9
	Prefer not to answer 8
132. Can you describe the odor?	________________
	________________
	________________
133. Have you ever experienced **eye or nose irritation** while you are on a synthetic turf field?	No 0
	Yes 1
	Don't know 9
	Prefer not to answer 8
134. Have you ever experienced **nausea** while you are on a synthetic turf field?	No 0
	Yes 1
	Don't know 9
	Prefer not to answer 8
135. Have you ever experienced **headaches** while you are on a synthetic turf field?	No 0

Yes 1

Don't know 9

Prefer not to answer 8

136. Have you ever felt **overheated** while you are on a synthetic turf field?

No 0

Yes 1

Don't know 9

Prefer not to answer 8

I. CRUMB RUBBER TAKE-HOME

*These questions pertain to your activities and behaviors **AFTER** a soccer practice or game on a synthetic turf field.*

137. **After** you play soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your car?

Never 0

Rarely 1

Sometimes 2

Often 3

Always 4

Don't know 9

Prefer not to answer 8

b. In your home?

Never .... (139) 0

Rarely 1

Sometimes 2

Often 3

Always 4

Don't know 9

Prefer not to answer 8

138. **After** you play soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your garage/mudroom/entrance to your house?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't know 9

Prefer not to answer 8

b. In your laundry room?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't know 9

Prefer not to answer 8

c. In your bedroom?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't know 9

Prefer not to answer 8

d. In your bathroom?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't know 9
Prefer not to answer 8

139. **After** you play soccer on a synthetic turf field, how often do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust:

a. In your water bottle?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't know 9
Prefer not to answer 8

b. On your clothes?

0% 0
>0-25% 1
>25-50% 2
>50-75% 3
>75% 4
Don't know 9
Prefer not to answer 8

	c. In your shoes?	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't know 9
		Prefer not to answer 8
	d. In your socks?	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't know 9
		Prefer not to answer 8
	e. In your underwear?	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8
140.	**Each time after** you play soccer on a synthetic turf field, approximately how much crumb rubber (including granules or crumb rubber dirt and debris) do you find in your home?	None 0

	Some, but < 1 Tablespoon 1
	1 Tablespoon – ¼ Cup......................................2
	> ¼ Cup – ½ Cup 3
	> ½ cup...4
	Don't Know 9
	Prefer not to answer...8
141. **After** you play soccer on a synthetic turf field, what percent of the time do you notice crumb rubber granules, or crumb rubber dirt and debris, such as black dust on your body?	0% ....(143) 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer...8
142. **After** you play soccer on a synthetic turf field, how often do you find/notice crumb rubber particles or crumb rubber dirt and debris, such as black dust on the following parts of your body:	
a. Mouth	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer...8
b. Hair	0% 0

	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
c. Face	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
d. Neck	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3
	>75% 4
	Don't Know 9
	Prefer not to answer 8
e. Chest	0% 0
	>0-25% 1
	>25-50% 2
	>50-75% 3

		>75% 4
		Don't Know 9
		Prefer not to answer 8
f.	Back	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8
g.	Thighs	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8
h.	Lower legs	0% 0
		>0-25% 1
		>25-50% 2
		>50-75% 3
		>75% 4
		Don't Know 9
		Prefer not to answer 8

i. Feet	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
j. Upper arms	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
k. Lower arms	0%	0
	>0-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
	Don't Know	9
	Prefer not to answer	8
l. Hands	0%	0
	>0-25%	1
	>25-50%	2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

J. HYGIENE PRACTICES

143. After playing soccer on a synthetic turf field, how often do you wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **vehicle**?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

144. After playing soccer on a synthetic turf field, how often do you wipe, clean, or remove shoes, socks, shin guards, etc. before entering the **home**?

0% 0

>0-25% 1

>25-50% 2

>50-75% 3

>75% 4

Don't Know 9

Prefer not to answer 8

145. After playing soccer on a synthetic turf field, how often do you wash your gloves?

I do not wear gloves 1

Weekly 2

Monthly 3

> Once per month – every six months 4

	< Once every six months....5
	Don't Know 9
	Prefer not to answer 8
146. How long after playing soccer on a synthetic turf field do you typically wear your soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
147. What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that you may wear your soccer clothes before changing them?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
148. How long after playing soccer on a synthetic turf field do you typically bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**
149. What is the <u>longest amount of time</u> after playing soccer on a synthetic turf field that you may wait to bathe or shower?	__ __HOURS __ __MINUTES **[CODE 99 IF DK]**

K. GENERAL HYGIENE

150. In general, how many times per day do you wash your hands?	__ __ **[CODE 99 IF DK]**
151. In general, how many times per week do you typically bathe/shower?	__ __ **[CODE 99 IF DK]**

L. PLAYER HISTORY BEFORE THIS SEASON

152. How many years have you played soccer?	__ __YEARS
153. Do you play soccer year-round?	No....0
	Yes 1
	Don't Know 9
	Prefer not to answer 8
154. Did you play <u>recreational</u> soccer in the two years prior to the current season?	No....0

	Yes .... 1 Don't Know .... 9 Prefer not to answer 8
155. Did you play competitive soccer in the two years prior to the current season?	No .... 0 Yes .... 1 Don't Know/Don't Remember .... 9 Prefer not to answer 8
156. **Do you currently** play competitive and/or recreational soccer in **college**? (i.e. for a college/university team, intramural team, etc.)	No .... 0 Yes .... (158) .... 1 Don't Know/Don't Remember .... 9 Prefer not to answer 8
157. **Did you ever** play competitive and/or recreational soccer in **college** (i.e. for a college/university team, intramural team, etc.)	No .... (165) .... 0 Yes .... 1 Don't Know .... 9 Prefer not to answer 8
158. **During college**, how many years have you played/did you play soccer?	1 Year .... 1 2 Years .... 2 3 Years .... 3 4 Years .... 4 Don't Know/Don't Remember .... 9 Prefer not to answer 8
159. **During college**, how many weeks per year do you/did you spend playing soccer on synthetic turf fields in each season?	__ __ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
160. **During college**, how many hours per week do you/did you spend playing soccer on synthetic turf fields in each season?	__ __ HOURS PER WEEK **[CODE 99 IF DK/DR]**

161. **During college**, what position do you/did you usually play?	Goalie .... 1 Forward .... 2 Midfielder .... 3 Defender .... 4 Don't Know/Don't Remember .... 9 Prefer not to answer 8
162. **During college,** do you/did you typically attend a soccer pre-season conditioning camp where you play on synthetic turf fields?	No........ (165) .... 0 Yes .... 1 Don't Know/Don't Remember .... 9 Prefer not to answer 8
163. Approximately how many days per year do you/did you spend playing soccer on synthetic turf fields for soccer conditioning camp during college?	__ __DAYS PER YEAR
164. Approximately how many hours per day do you/did you spend playing soccer on synthetic turf fields for soccer conditioning camp during college?	__ __HOURS PER DAY
165. Did you ever play competitive and/or recreational soccer while you were in **high school**?	No........ (173) .... 0 Yes .... 1 Don't Know/Don't Remember .... 9 Prefer not to answer 8
166. In **high school**, how many years did you play soccer?	1 Year .... 1 2 Years .... 2 3 Years .... 3 4 Years .... 4 Don't Know/Don't Remember .... 9 Prefer not to answer 8

167. In **high school**, how many <u>weeks per year</u> did you usually spend playing soccer on synthetic turf fields in each season?	___ ___ WEEKS PER YEAR **[CODE 99 IF DK/DR]**
168. In **high school**, how many <u>hours per week</u> did you usually spend playing soccer on synthetic turf fields in each season?	___ ___ HOURS PER WEEK **[CODE 99 IF DK/DR]**
169. In **high school**, what position did you usually play?	Goalie ....1 Forward ....2 Midfielder ....3 Defender ....4 Don't Know/Don't Remember ....9 Prefer not to answer 8
170. **In high school,** did you typically attend a soccer camp where you played on synthetic turf fields?	No.................(173) ....0 Yes ....1 Don't Know/Don't Remember ....9 Prefer not to answer 8
171. Approximately how many <u>days per year</u> did you spend playing soccer on synthetic turf fields for soccer camp while in high school?	__ __DAYS PER YEAR
172. Approximately how many <u>hours per day</u> did you spend playing soccer on synthetic turf fields for soccer camp during high school?	__ __HOURS PER DAY
173. Did you ever play competitive and/or recreational soccer **before high school (i.e. youth/club teams)**?	No.................**[END OF SURVEY]**..0 Yes ....1 Don't Know/Don't Remember ....9 Prefer not to answer 8
174. **During youth/club soccer** (before high school), how many years did you play soccer?	1 Year ....1 2 Years ....2 3 Years 3

4 Years 4
5 Years 5
6 Years 6
7 Years or more 7
Don't Know/Don't Remember 9
Prefer not to answer 8

175. **During youth/club soccer** (before high school), how many <u>weeks per year</u> did you usually spend playing soccer on synthetic turf fields?

__ __ WEEKS PER YEAR
[CODE 99 IF DK/DR]

176. **During youth/club soccer** (before high school), how many <u>hours per week</u> did you usually spend playing soccer on synthetic turf fields?

__ __ HOURS PER WEEK
[CODE 99 IF DK/DR]

177. **During youth/club soccer** (before high school), what position did you usually play?

Goalie 1
Forward 2
Midfielder 3
Defender..4
Multiple 5
Don't Know 9
Prefer not to answer 8

****

This concludes the survey. Thank you for your time!

If you would like to complete the survey again for yourself or another child, click here.

Learn more about the Synthetic Turf Exposure Study on OEHHA's website.

Connect with us on the study's Facebook page.

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Card 1. Water bottles

8 oz

16 oz

24 oz

32 oz

64 oz

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Card 2. Crumb rubber amounts

Synthetic Turf Exposure Assessment Study

Object Palette Sheet

Date	__ __ /__ __ /__ __ MO DAY YR	Field ID	__ __ __
Event Number	__ __		
Notetaker 1	________________	Notetaker 2	________________
Player Position	________________	Player Jersey Number	__ __

Location: List locations associated with soccer player

Object and surface type: list items and types of objects (e.g. porous surface, etc) that are not obvious in the recording.

LOCATION	OBJECT and SURFACES	PALETTE DESIGNATION
Example: soccer field	Black crumb, plastic porous sit.	(Leave blank - transcriber only)

LOCATION	OBJECT and SURFACES	PALETTE DESIGNATION

LOCATION	OBJECT and SURFACES	PALETTE DESIGNATION

Synthetic Turf Exposure Assessment Study

Taper's Log Time Sheet

Date	__ __ /__ __ /__ __ MO DAY YR	Field ID	__ __ __
Event Number	__ __	Video Camera Type	HD / Waterproof
Camera Serial #	__ __ __ __ __	SD Card Number	__ __ __
Time taping began	__ __ : __ __ AM / PM	Time taping ended	__ __ : __ __ AM / PM
Taper 1	______________	Taper 2	______________
Player Position	______________	Player Jersey Number	__ __

Tape Section	Counter time Start	Stop	Time (PST/PDT) Start	Stop	Comments

Running time as displayed on video camera: Pacific Standard Time

Start/Stop points typically refer to the Audio "MARKS" put on the tape

If "MARK" is missing indicate so in the "Comments"

~3 Defining features of participant being taped (i.e. red headband):

General comments:

Appendix B – Population-Specific Exposure Parameter Estimates

THE UNIVERSITY OF ARIZONA
Mel & Enid Zuckerman
College of Public Health

Appendix H. Part I. Final Report on the Quantification of Micro-level Activities from a Pre-existing Dataset of Children Playing on Turf/Playgrounds

Appendix H. Part I. Final Report on the Quantification of Micro-level Activities from a Pre-existing Dataset of Children Playing on Turf/Playgrounds

Prepared for the California Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

Principal Investigator: Paloma Beamer
Prepared by: Nicolas Lopez-Galvez
University of Arizona, College of Public Health

August 4, 2018

Table of Contents

1.0 Introduction

Non-dietary ingestion and dermal routes of exposure are important to consider when evaluating children's aggregate exposure to artificial turf or other tire-derived surfaces like playground mats. The objective of this study was to quantify dermal and mouthing contact behaviors of children playing on turf and playground structures. While these children were playing on natural turf, this data could be used to represent potential exposures of children bystanders at sporting events on artificial turf. Similarly, while most of the children were playing on playgrounds that were not above playground mats made from recycled tires or from chopped up recycled tires, we quantified contacts with floor surfaces to provide data that could be used in estimating these potential exposures. This task consisted of analyzing a pre-existing micro-level activity time series (MLATS) dataset originally collected by Stanford's Exposure Research Group. The dataset was derived by transcribing video footage of children playing outdoors by using a video-translation software (Virtual Timing Device). The activity patterns were quantified and analyzed to understand differences in behavior by age and gender of the children playing outdoors on turf and playground structures.

2.0 Methods:

2.1 Data collection:

Children MLATS data and videotapes were utilized from two previous studies, the Outdoor Residential Exposure Task Force (ORETF) project and the EPA study from the years 1998-2000. The videotaped activities have already been transcribed into computer text files using Virtual Timing Device by the Stanford's Exposure Research Group. For ORETF and EPA, the Virtual Timing Device palette presented in Figure 2.1a was used for translation of microlevel activity data. This palette allows the translator to record the child's location, contact type and object/surface. Details on ORTEF and EPA methods have been previously described (AuYeung et al., 2004; AuYeung et al., 2006; Ferguson et al., 2006; Beamer et al., 2012).

For the ORTEF project, MLATS data was collected for 15 body parts including hands and mouth by videotaping 36 children, aged 1-12 years of age while they were playing outdoors. Meanwhile, for the EPA study, MLATS data was collected for mouth and hands by videotaping 20 children, aged 1-6 years of age while they were playing outdoors. For both studies, children were videotaped for 2 hours each. We combined these data to quantify the mouthing and dermal contact behavior of 56 children while playing on turf and playground.

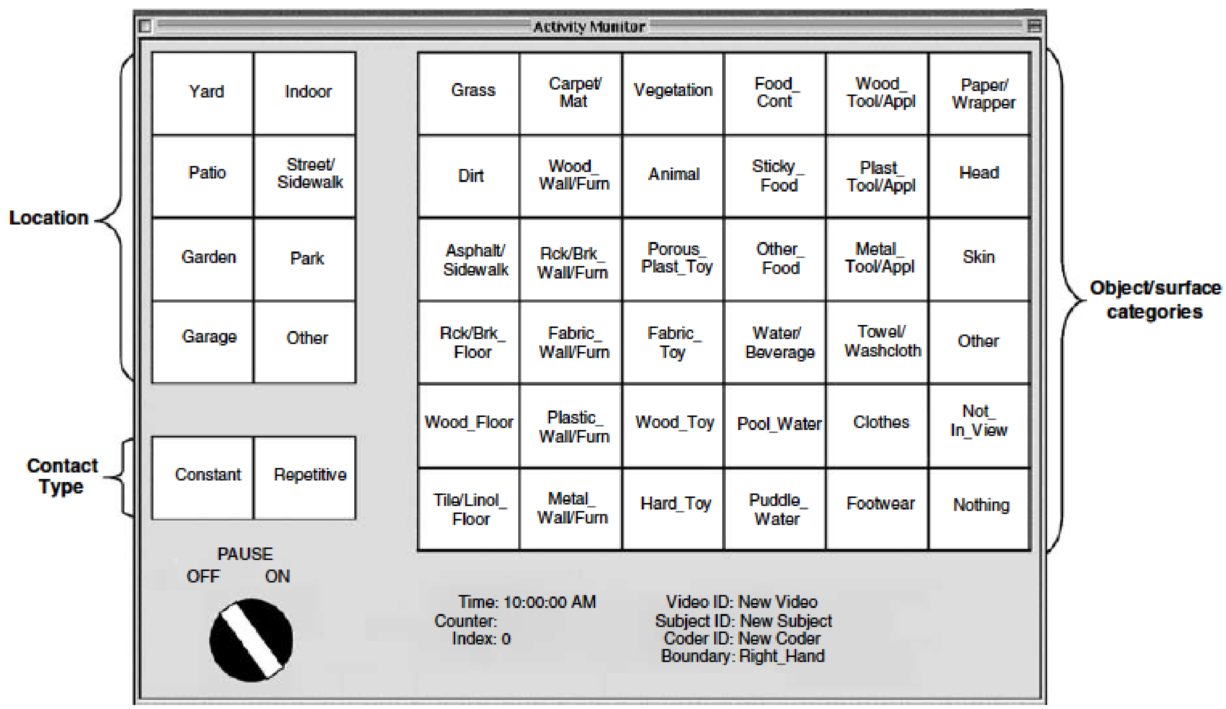

Figure 2.1a. Virtual Timing Device palette used by Stanford's Exposure Research Group for translation.

2.2 Data processing:

2.2.1 *Children playing on turf* The translated plain text files, obtained from ORETF and EPA, for all 56 children for right hand, left hand, and mouthing activities were used for the analysis. The object/surfaces were selected as presented in Table 2.2.1. Participants' contacts while playing in the location categories of yard, garden, and park were extracted and grouped as one turf-like location by using RStudio V1.1 (RStudio Team, 2016). Videotapes were reviewed to confirm turf like locations.

2.2.2 ***Children playing on playgrounds*** Since playground was not categorized in the previous studies, all of the existing videotapes (n = 56) were re-watched to only select footage where a playground structure was observed. The exact footage time and duration when children played on or near playground structures was recorded and then a specific "playground" location was added to each corresponding data file. The objects/surfaces selected for analysis are presented in Table 2.2.2. All floor surfaces were grouped in one category for the playground locations (Table 2.2.2) because we are assuming that playgrounds are on rubber mats made of tire or of chopped up tire.

Table 2.2.1. Selected categories for object/surfaces on turf

Super Categories	*Virtual Timing Device Palette Categories (Figure 2.1)*
Location	
Turf	Yard, park, garden
Object/Surface	
Grass	Grass
Dietary objects	Water/beverage, sticky food, other food, food container
Non-dietary objects	Everything, but dietary objects
Hands*	Hands
All objects/surfaces	Wood wall, wood tools, wood toy, vegetation, hard toys, porous plastic toys, fabric toys, plastic tool, plastic wall, paper, pool water, puddle water, metal wall, metal tool, footwear, carpet, wood floor, tile floor, rock floor, sidewalk, dirt

* Only analyzed for mouth contact files

Table 2.2.2. Selected categories for object/surfaces on playgrounds

Super Categories	*Virtual Timing Device Palette Categories (Figure 2.1)*
Location	
Playground	Child near playground in the following locations: Yard, Park, Garden, Patio, Street, Garage
Object/Surface	
Floors	Dirt, Asphalt, Rock floor, wood floor, tile, carpet/mat
Dietary objects	Water/beverage, sticky food, other food, food container
Non-dietary objects	Everything, but dietary objects
Hands*	Hands
All objects/surfaces	Wood wall, wood tools, wood toy, vegetation, hard toys, porous plastic toys, fabric toys, plastic tool, plastic wall, paper, pool water, puddle water, metal wall, metal tool, footwear, carpet, wood floor, tile floor, rock floor, sidewalk, dirt

* Only analyzed for mouth contact files

2.3 Data Analysis:

Using RStudio V1.1 , right hand, left hand, and mouth contact frequency, hourly contact duration and median contact duration with the selected object/surface categories (Tables 2.2.1 and 2.2.2) were calculated for each child while playing on turf and playground structures, respectively.

Contact frequency (events/hour) was calculated by summing the total number of contact events by hands or mouth with a specific object category divided by the total time that the child was in view.

Hourly duration (minutes/hour) was calculated by summing the total time in minutes that hands or mouth were in contact with the specific object category divided by the total time in view (hours).

Median duration (seconds) was obtained from the contact duration for the hand or mouth contact events with a specific object/category during the time in view for each child. It is the median value of all contacts of the body part (mouth/hand) with the object. Only children who contacted the object were included in these calculations.

Since Wilcoxon signed rank is for paired data on the same person (dependent data), we used it to compare to assess differences in the activity variables (contact frequency, hourly duration and median duration) between right and left hand. If no differences were observed, then data for the hands were combined and reported as “both hands.”

The data was then summarized based on age and gender. The activity variables (contact frequency, hourly duration and median duration) were evaluated for significant differences between genders and by age groups using non-parametric tests. To determine differences between male and female participants, we used the two tailed Wilcoxon-rank sum test (non-parametric test, similar to a t-test, for independent data).

To determine if contact activities correlated with age, Spearman’s rank correlation coefficient was computed using STATA Version 12.0. (College Station, TX: StataCorp). The data for each contact activity was summarized into three age groups: 0 < 2 years, 2 < 9 years, and 9 < 16 years. The Kruskal-Wallis test (non-parametric test similar to ANOVA) was used to assess if there are differences across the three age groups. Also, as presented in Appendix A and B, the data was summarized into additional age groups by following the US EPA guidance (U.S. EPA, 2005). Differences between the activities of the 1-6 year old children and the 7-12 year old children was assessed using the two tailed Wilcoxon-rank sum test (Appendix A and B).

3.0 Results:

A total of 43 hours (2548 minutes) of footage was collected from 56 children with a median footage time per child of 112 min (range: 60 – 133 min). This was the total amount of footage that was available for the retrospective analysis.

3.1 Children playing on turf:

3.1.1 Amount of footage with turf and demographics of children who played on turf

All 56 children played on turf at some point during their footage, with a median time on turf of 84 min (Table 3.1.1.a). Of the footage of children playing on turf, 3.9% of the time hands and/or mouth was not in view and excluded from analysis.

There were comparable numbers of male (n=27) and female (n=29) participants (Table 3.1.1.b). While among both male and females there were more children within the 2 < 9 years of age than the other two age groups. As presented in Appendix A, for the EPA age groups, the male children had an even distribution among the age groups, while female children were disproportionally distributed between the ages of 3 and <11 years old. However, there are similar proportions of female children below and above the age of 6.

Table 3.1.1.a Time spent on turf (N = 56)

	Total time on turf hand and/or mouth in view	Time on turf hand and/or mouth not in view
Total turf time (min)	1812.0	99.5
Median turf time (min) per child	84.0	2.5
Percentage of time spent on turf (%)	71.1*	3.9*

* Calculated from total footage time of 2,548 minutes

Table 3.1.1.b Number of children playing on turf grouped by age groups and gender

Gender	Age groups			
	0 < 2 years	2 < 9 years	9 < 16 years	Total
Male	5	15	7	27
Female	3	21	5	29
Total	8	36	12	56

3.1.2 Hand contact activity while playing on turf

There were no significant differences in the contact frequency with object/surfaces between right hand and left hand (Tables 3.1.2.a and 3.1.2.b). Therefore, both hands were combined and summarized (Table 3.1.2.c). This means that contact frequency for the left and right hands were summed, however it does not mean that both hands were in contact with the object at the same time. The median grass contact frequency for *both hands* combined was 4.14 events/h. Although the median contact frequency with "grass" was relatively low (less than once every 10 minutes), the child with the greatest potential exposure was contacting the "grass" very frequently (over 4 times per minute).

TTable 3.1.2.a Right hand contact frequency (event/h) while playing on the turf (n = 56)

	Grass	Dietary	Non-Dietary	All objects
Mean	7.20	3.10	129.40	132.50
SD	17.50	5.40	54.60	54.30
Min	0.00	0.00	57.30	57.30
p25	1.51	0.00	93.92	96.00
Median	3.73	0.14	112.50	115.68
p75	10.00	3.28	151.30	155.68
p95	26.50	15.34	221.12	221.12
p99	89.65	20.68	297.78	298.40
Max	122.3	20.72	371.99	373.36

Table 3.1.2.b Left hand contact frequency (event/h) while playing on the turf (n = 56)

	Grass	Dietary	Non-Dietary	All objects
Mean	7.00	3.10	134.20	137.30
SD	18.20	5.20	68.10	67.40
Min	0.00	0.00	9.60	9.60
p25	1.22	0.00	101.04	103.84
Median	3.55	0.15	118.70	127.17
p75	8.03	4.80	145.58	149.58
p95	30.91	14.92	242.44	242.72
p99	90.08	19.62	376.70	377.20
Max	129.54	19.64	393.85	394.96

Table 3.1.2.c Both hands object/surface contact frequency (event/h) (n = 56)

	Grass	Dietary	Non-Dietary	All objects
Mean	14.50	6.10	276.80	282.90
SD	35.50	10.30	126.70	125.30
Min	0.00	0.00	107.70	109.70
p25	0.78	0.00	192.78	205.57
Median	4.14	0.71	236.31	246.32
p75	14.93	8.82	308.21	324.38
p95	48.57	27.03	503.25	504.34
p99	151.84	40.30	718.79	719.90
Max	251.87	40.33	765.84	768.32
p-value*	0.7249	0.935	0.535	0.546

* from Wilcoxon Signed Rank test comparison of left and right hand contact frequency

There were no significant differences in hourly contact duration with object/surfaces between right hand and left hand (Tables 3.1.2.d and 3.1.2.e). Therefore, both hands were combined and summarized (Table 3.1.2.f). This means that contact hourly duration for the left and right hands were summed, however it does not mean that both hands were in contact with the object at the same time. If both hands were in contact with object for the entire time, the maximum value would be 120 min/hr. The median hourly contact duration for both hands with grass was 0.24 min/h. However, one child was in contact with grass 12 min/hr.

Table 3.1.2.d. Right hand hourly contact duration (min/h) while playing on the turf (n = 56)

	Grass	Dietary	Non-Dietary	All Objects
Mean	0.44	1.75	33.19	34.94

SD	0.97	3.08	9.61	9.04
Min	0.00	0.00	11.88	11.88
p25	0.00	0.00	26.33	29.04
Median	0.09	0.01	32.21	34.22
p75	0.36	2.41	39.14	40.28
p95	2.40	8.62	48.93	50.22
p99	5.87	11.99	53.06	55.06
Max	5.87	11.99	55.06	55.06

Table 3.1.2.e Left hand hourly contact duration (min/h) while playing on the turf (n=56)

	Grass	Dietary	Non-Dietary	All objects
Mean	0.45	1.61	31.94	33.55
SD	0.97	2.77	10.19	9.90
Min	0.00	0.00	5.68	5.68
p25	0.01	0.00	26.48	27.20
Median	0.11	0.01	31.23	32.94
p75	0.37	2.07	38.01	41.04
p95	2.20	7.46	48.49	48.49
p99	6.09	9.93	57.64	57.64
Max	6.09	9.93	57.64	57.64

Table 3.1.2.f Hourly object/surface contact duration for both hands while playing on turf (min/h) (n =56)

	Grass	Dietary	Non-Dietary	All objects
Mean	0.93	1.81	36.57	38.38
SD	1.97	3.08	13.71	14.60
Min	0.00	0.00	20.65	22.36
p25	0.05	0.00	29.26	31.55
Median	0.24	0.12	33.33	34.83
p75	1.22	2.47	35.98	36.97
p95	4.63	8.10	64.64	67.61
p99	8.02	11.90	81.66	87.12
Max	11.96	12.14	92.96	105.10
p-value*	0.876	0.265	0.167	0.071

* from Wilcoxon Signed Rank test comparison of left and right hand contact frequency

There were no significant differences in median contact duration with object/surfaces between right hand and left hand (Tables 3.1.2.g and 3.1.2.h). Therefore, both hands were combined, reanalyzed and summarized (Table 3.1.2.i). This means that for each object category the durations of all the discreet contacts with an object for both the right and left hands were grouped and reranked to determine the median value of contact duration across all the "hand" contacts with that object. Note that the median for aggregate categories like "All Objects" was calculated as the median duration of contacts with any object. The median contact duration of both hands combined and grass was 2.00 s. However, one child had a median contact duration of both hands with grass of 13.00 s.

Table 3.1.2.g Right hand median contact duration while playing on the turf (s)

	Grass	Dietary	Non-Dietary	All Objects
n*	38	28	56	56
Mean	2.54	8.07	3.37	3.44
SD	1.48	6.11	1.08	1.10
Min	0.50	1.00	1.00	1.00
p25	1.50	4.00	3.00	3.00
Median	2.00	6.50	3.00	3.00
p75	3.00	11.63	4.00	4.00
p95	5.00	16.65	5.00	5.00
p99	6.83	24.30	5.73	5.73
Max	8.00	27.00	6.00	6.00

*Only participants who contacted object included in calculation of median contact duration

Table 3.1.2.h Left hand median contact duration while playing on the turf (s)

	Grass	Dietary	Non-Dietary	All objects
n*	42	28	56	56
Mean	3.52	7.57	3.28	3.29
SD	4.19	5.63	0.89	0.87
Min	0.50	1.00	2.00	2.00
p25	2.00	3.00	3.00	3.00
Median	2.00	6.50	3.00	3.00
p75	3.00	10.38	4.00	4.00
p95	12.33	18.13	5.00	4.63
p99	19.48	20.46	5.23	5.23
Max	20.50	21.00	5.50	5.50

*Only participants who contacted object included in calculation of median contact duration

Table 3.1.2.i Both hands median contact duration while playing on the turf (s)

	Grass	Dietary	Non - Dietary	All objects
n*	42	28	56	56
Mean	2.72	7.47	3.28	3.31
SD	2.05	5.25	0.92	0.95
Min	0.50	1.00	1.00	1.00
p25	2.00	4.00	3.00	3.00
Median	2.00	6.75	3.00	3.00
p75	3.00	10.00	4.00	4.00
p95	5.00	18.00	5.00	5.00
p99	13.00	23.00	5.00	5.00
Max	13.00	23.00	5.00	5.00
p-value	0.815	0.367	0.611	0.245

***** from Wilcoxon Signed Rank test comparison of left and right hand contact frequency

3.1.2.1 Hand contact activity by age while playing on turf

Frequency, hourly duration and median duration for both hands contact activities while playing on turf are presented in Tables 3.1.2.1.a-c for the three age categories. Although there were more children in the 2 < 9 years of age group, most of the contact with grass seem to have occurred in the older group (9 < 16 years old). There were no significant differences in contact frequency, hourly contact duration, or median contact duration across all three age groups (Kruskal-Wallis Test). Also, there were no correlations between age groups and both hand activities (Table 3.1.2.1.d).

Tables 3.1.2.1.a Both hands contact frequency (event/h) while playing on turf by age groups

Age Group		Grass	Dietary	Non - Dietary	All objects
	Mean	11.06	1.42	285.68	287.10
	SD	11.83	3.56	75.83	76.10
	Min	0.34	0.00	187.91	187.91
< 2	p25	2.92	0.00	238.21	238.21
n = 8	Median	8.52	0.00	282.76	287.87
	p75	14.01	0.59	308.16	308.37
	p95	37.24	10.22	439.28	440.02
	p99	37.24	10.22	439.28	440.02
	Max	37.24	10.22	439.28	440.02
	Mean	8.00	6.76	271.32	278.08
	SD	13.24	10.28	143.03	140.67
	Min	0.00	0.00	107.69	109.66
2 to < 9	p25	0.00	0.00	191.80	200.72
n = 36	Median	2.61	1.47	218.08	228.40
	p75	11.59	9.12	290.15	290.15
	p95	29.39	27.91	680.29	680.29
	p99	70.00	40.28	765.84	768.32
	Max	70.00	40.28	765.84	768.32
	Mean	36.41	7.13	287.30	294.43
	SD	70.56	13.00	106.31	107.87
	Min	0.00	0.00	138.75	138.75
9 to < 16	p25	3.39	0.00	210.38	212.37
n = 12	Median	7.51	0.59	276.31	296.81
	p75	40.13	7.36	351.09	353.82
	p95	251.87	40.33	494.87	494.87
	p99	251.87	40.33	494.87	494.87
	Max	251.87	40.33	494.87	494.87
P-value*		0.081	0.281	0.398	0.368

*P-value from Kruskal-Wallis Test

Tables 3.1.2.1.b Both hands hourly contact duration (min/h) while playing on turf by age groups

Age Group		Grass	Dietary	Non - Dietary	All objects
	Mean	0.90	0.71	29.58	36.38
	SD	1.59	1.72	14.02	15.59
	Min	0.01	0.00	15.63	26.78
< 2	p25	0.10	0.00	22.66	28.18
n = 8	Median	0.49	0.01	26.90	29.61
	p75	0.61	0.39	29.87	38.14
	p95	4.79	4.91	62.19	72.41
	p99	4.79	4.91	62.19	72.41
	Max	4.79	4.91	62.19	72.41
	Mean	0.63	2.19	32.79	37.84
	SD	1.21	3.17	11.64	11.10
	Min	0.00	0.00	18.85	22.36
2 to < 9	p25	0.03	0.00	25.07	33.26
n = 36	Median	0.20	0.16	30.97	35.40
	p75	0.49	3.51	34.87	36.99
	p95	4.63	8.16	62.51	67.25
	p99	4.63	11.71	65.28	68.70
	Max	4.63	11.71	65.28	68.70
	Mean	1.87	1.39	34.82	41.35
	SD	3.44	3.46	22.90	22.49
	Min	0.00	0.00	14.72	22.89
9 to < 16	p25	0.06	0.00	20.87	30.87
n = 12	Median	0.51	0.01	30.87	34.02
	p75	2.00	1.04	35.41	37.19
	p95	11.96	12.14	96.03	105.10
	p99	11.96	12.14	96.03	105.10
	Max	11.96	12.14	96.03	105.10
P-value*		0.295	0.201	0.474	0.218

*P-value from Kruskal-Wallis Test

Tables 3.1.2.1.c Both hands median contact duration (s) while playing on turf by age groups

Age Group		Grass	Dietary	Non - Dietary	All objects
	n	8	3	8	8
	Mean	2.50	4.00	3.63	3.63
	SD	0.76	4.77	0.52	0.52
	Min	2.00	1.00	3.00	3.00
< 2	p25	2.00	1.00	3.00	3.00
	Median	2.00	1.50	4.00	4.00
	p75	3.00	9.50	4.00	4.00
	p95	4.00	9.50	4.00	4.00
	p99	4.00	9.50	4.00	4.00
	Max	4.00	9.50	4.00	4.00
	n	24	22	36	36
	Mean	2.54	9.09	3.38	3.43
	SD	1.62	5.35	0.83	0.87
	Min	0.50	1.00	2.00	2.00
2 to < 9	p25	1.75	6.00	3.00	3.00
	Median	2.00	7.75	3.25	3.75
	p75	3.00	12.00	4.00	4.00
	p95	5.00	18.00	5.00	5.00
	p99	8.00	23.00	5.00	5.00
	Max	8.00	23.00	5.00	5.00
	n	11	7	12	12
	Mean	3.27	3.86	2.75	2.75
	SD	3.29	1.93	1.22	1.22
	Min	1.00	1.00	1.00	1.00
9 to < 16	p25	2.00	2.50	2.00	2.00
	Median	2.00	4.00	2.50	2.50
	p75	3.00	6.00	3.00	3.00
	p95	13.00	6.50	5.00	5.00
	p99	13.00	6.50	5.00	5.00
	Max	13.00	6.50	5.00	5.00
P-value*		0.744	0.134	0.054	0.054

*P-value from Kruskal-Wallis Test

Table 3.1.2.1.d. Spearman rank correlation for age (years) and hand contact events

Activity Variables	r	P-value
Hand contact frequency (event/h) (n = 56)		
Grass	0.1371	0.314
Non-Dietary	0.0839	0.538
Dietary	-0.003	0.983
All objects	0.087	0.523
Hourly hand contact duration (min/h) (n = 56)		
Grass	0.113	0.406
Non-Dietary	0.098	0.471
Dietary	-0.083	0.542
All objects	0.139	0.306
Hand contact median duration (s)		
Grass (n = 42)	0.137	0.314
Non-Dietary (n =56)	0.084	0.538
Dietary (n = 28)	-0.003	0.983
All objects (n=56)	0.087	0.523

The hand contact frequency, hourly duration and median duration summary of the EPA recommended age categories (U.S. EPA, 2005) are presented in Appendix A. There were no significant differences in contact frequency, hourly contact duration, or median contact duration across the EPA recommended age groups (Kruskal-Wallis Test). Also, in Appendix A, the contact frequency, hourly duration and median duration for both hands contact activities while playing on turf are presented in Tables A5-8 for children aged 1-6 years and 7-12. There were no significant difference between these two age groups and contact activities (Table A9).

3.1.2.2 Hand contact activity by gender while playing on turf

As presented in Table 3.1.2.2.a-c by gender (i.e., male, female), there were no significant differences in contact frequency, hourly contact duration, or median contact duration by gender while playing on turf.

Tables 3.1.2.2.a Both hands contact frequency (event/h) while playing on turf by gender

Gender		Grass	Dietary	Non - Dietary	All objects
Male n = 27	Mean	12.54	5.11	267.70	272.80
	SD	15.15	9.45	137.05	137.48
	Min	0.00	0.00	107.69	109.66
	Median	1.08	0.00	189.18	190.04
	p25	7.34	0.86	227.39	228.25
	p75	17.43	4.36	300.83	320.07
	p95	45.03	26.61	528.37	532.73
	p99	59.17	40.33	765.84	768.32
	Max	59.17	40.33	765.84	768.32
Female n = 29	Mean	16.38	6.98	285.27	292.25
	SD	47.47	11.14	118.16	114.49
	Min	0.00	0.00	163.11	173.66
	Median	0.34	0.00	211.05	222.22
	p25	3.78	0.00	253.24	253.24
	p75	9.70	8.86	325.19	349.05
	p95	70.00	27.91	494.87	494.87
	p99	251.87	40.28	680.29	680.29
	Max	251.87	40.28	680.29	680.29
p-value*		0.242	0.621	0.321	0.216

*P-value from Wilcoxon sum rank

Tables 3.1.2.2.b Both hands hourly contact duration (min/h) while playing on turf by gender

Gender		Grass	Dietary	Non - Dietary	All objects
Male n = 27	Mean	0.94	1.86	33.78	39.52
	SD	1.40	3.52	17.40	18.16
	Min	0.00	0.00	14.72	22.36
	Median	0.09	0.00	23.44	30.02
	p25	0.40	0.13	29.74	34.01
	p75	0.96	2.36	34.97	37.26
	p95	4.63	11.71	62.19	72.41
	p99	4.79	12.14	96.03	105.10
	Max	4.79	12.14	96.03	105.10
Female n = 29	Mean	0.92	1.76	31.82	37.32
	SD	2.41	2.66	12.10	10.48
	Min	0.00	0.00	16.75	23.24
	Median	0.01	0.00	23.47	31.58
	p25	0.11	0.11	29.83	35.19
	p75	0.38	2.80	34.18	36.95
	p95	4.63	8.08	62.51	65.20
	p99	11.96	8.16	65.28	67.25
	Max	11.96	8.16	65.28	67.25
p-value		0.059	0.679	0.974	0.486

*P-value from Wilcoxon sum rank

Tables 3.1.2.2.c Both hands contact median duration (s) while playing on turf by gender

Gender		Grass	Dietary	Non - Dietary	All objects
Male	n	22	27	27	27
	Mean	2.70	16.67	62.50	79.17
	SD	1.67	45.85	30.09	52.22
	Min	0.50	0.00	22.75	34.00
	Median	2.00	0.00	39.00	50.50
	p25	2.00	1.50	57.00	59.00
	p75	3.00	19.00	80.00	87.00
	p95	5.00	31.50	114.50	173.00
	p99	8.00	241.00	159.00	282.50
	Max	8.00	241.00	159.00	282.50
Female	n	21	29	29	29
	Mean	2.54	9.69	77.80	87.49
	SD	2.12	33.31	54.47	65.71
	Min	0.50	0.00	22.50	22.50
	Median	1.50	0.00	52.25	52.25
	p25	2.00	0.00	61.00	74.50
	p75	2.50	16.00	85.25	90.00
	p95	4.00	42.50	135.50	191.50
	p99	13.00	56.00	415.50	445.00
	Max	13.00	56.00	415.50	445.00
p-value		0.324	0.567	0.358	0.566

*P-value from Wilcoxon sum rank

3.1.3 Mouthing activity while playing on turf

The mouthing contact frequency for children playing on turf is summarized in Table 3.1.3.a. Only 7% of the children (4/56) contacted grass with their mouth. Thus, the median mouth contact frequency for grass was 0.00 events/h, and the maximum was 2.49 events/h. The median mouthing frequencies were 7.56 events/h and 10.87 events/h for hands and non-dietary objects, respectively. These contacts could indicate additional exposure to crumb rubber if there have been transfers to the child's hands (Section 3.1.2) or the objects that they are placing in their mouths.

Table 3.1.3.a Mouth contact frequency (event/h) while playing on the turf (n = 56)

	Grass	Hand	Dietary	Non-Dietary	All objects
Mean	0.11	11.65	14.83	22.00	36.83
SD	0.44	14.16	28.40	29.87	44.66
Min	0.00	0.00	0.00	0.00	0.00
p25	0.00	3.38	0.00	6.61	7.28
Median	0.00	7.56	0.84	10.87	20.39
p75	0.00	15.74	19.82	26.36	56.17
p95	1.17	41.04	74.00	76.19	160.77
p99	2.49	80.11	159.12	185.14	205.09
Max	2.49	80.11	159.12	185.14	205.09

The mouthing hourly contact duration for children playing on turf is summarized in Table 3.1.3.b. The median mouthing hourly contact duration for grass was 0.00 min/h, and the maximum was 0.10 min/h. The median mouthing hourly durations were 0.21 min/h and 0.30 min/h for hands and non-dietary objects, respectively. These contacts could indicate additional exposure to crumb rubber if there have been transfers to the child's hands (Section 3.1.2) or the objects that they are placing in their mouths.

Table 3.1.3.b Mouthing hourly contact duration (min/h) while playing on the turf (n = 56)

	Grass	Hand	Dietary	Non-Dietary	All objects
Mean	0.00	0.46	1.80	1.39	3.19
SD	0.01	0.76	5.30	4.65	7.35
Min	0.00	0.00	0.00	0.00	0.00
p25	0.00	0.10	0.00	0.14	0.24
Median	0.00	0.21	0.04	0.30	0.66
p75	0.00	0.42	1.17	1.31	3.06
p95	0.02	2.25	9.47	3.92	12.53
p99	0.10	3.54	36.52	34.71	39.65
Max	0.10	3.54	36.52	34.71	39.65

The mouthing median contact duration for children playing on turf is summarized in Table 3.1.3.c. Median duration is only calculated from those children that contacted the object. The median mouthing contact duration for grass was 1.00 s, and the maximum was 2.5 s. The median mouthing contact durations were 1.00 s and 1.00s for hands and non-dietary objects, respectively. These contacts could indicate additional exposure to crumb rubber if there have been transfers to the child's hands (Section 3.1.2) or the objects that they are placing in their mouths.

Table 3.1.3.c Mouthing median contact duration while playing on turf (s)

	Grass	Hand	Dietary	Non-Dietary	All objects
n*	4	49	30	52	53
Mean	1.38	1.86	7.40	1.88	2.89
SD	0.75	1.90	22.05	1.87	8.09
Min	1.00	0.50	1.00	0.00	0.00
p25	1.00	1.00	2.00	1.00	1.00
Median	1.00	1.00	2.00	1.00	1.00
p75	1.75	2.00	4.00	2.00	2.00
p95	2.50	5.00	14.00	5.00	5.50
p99	2.50	12.00	123.00	12.00	60.00
Max	2.50	12.00	123.00	12.00	60.00

*****Only participants who contacted object included in calculation of median contact duration

3.1.3.1 Mouthing contact activity by age while playing on turf

Frequency, hourly duration and median duration for mouthing contact activities while playing on turf are presented in Tables 3.1.3.1.a-c for three age categories (< 2, 2 to < 9, 9 to < 16 years). There were no differences in mouthing contact frequency, hourly duration or median duration across these three age groups. Age (by year, 1-12 years) was negatively correlated ($p < 0.05$) with the hourly contact duration of mouthing activities for non-dietary objects and all objects (Table 3.1.3.1.d). Age was also negatively correlated ($p < 0.05$) with the median contact duration of mouthing activities for hands and non-dietary objects (Table 3.1.3.1.d).

Table 3.1.3.1.a Mouthing contact frequency (event/h) while playing on turf by age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2 n= 8	Mean	0.34	12.74	2.79	25.69	28.48
	SD	0.65	11.69	4.39	22.61	23.62
	Min	0.00	0.66	0.00	1.48	2.96
	Median	0.00	3.70	0.00	9.44	9.44
	p25	0.00	11.99	0.74	16.30	19.68
	p75	0.51	16.56	4.41	44.37	51.41
	p95	1.69	36.78	12.05	63.82	63.82
	p99	1.69	36.78	12.05	63.82	63.82
	Max	1.69	36.78	12.05	63.82	63.82
2 to < 9 n = 36	Mean	0.10	8.95	19.03	20.81	39.84
	SD	0.45	8.98	32.70	32.37	47.91
	Min	0.00	0.00	0.00	0.00	0.00
	Median	0.00	2.91	0.00	6.85	7.70
	p25	0.00	7.12	1.21	9.85	23.53
	p75	0.00	11.03	31.66	24.80	60.66
	p95	1.17	33.69	80.19	76.19	189.59
	p99	2.49	41.04	159.12	185.14	205.09
	Max	2.49	41.04	159.12	185.14	205.09
9 to < 16 n = 12	Mean	-	19.06	10.26	23.09	33.36
	SD	-	23.96	20.79	28.00	47.11
	Min	-	0.00	0.00	0.00	0.00
	Median	-	3.76	0.00	4.94	6.50
	p25	-	8.07	0.75	10.43	11.29
	p75	-	27.12	9.02	38.14	42.53
	p95	-	80.11	72.43	88.34	160.77
	p99	-	80.11	72.43	88.34	160.77
	Max	-	80.11	72.43	88.34	160.77
p-value		0.091	0.444	0.643	0.690	0.726

*P-value from Kruskal-Wallis Test

Tables 3.1.3.1.b Mouthing hourly contact duration (min/h) while playing on turf by age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2 n= 8	Mean	0.01	1.13	0.65	1.54	2.18
	SD	0.01	1.50	1.39	1.52	1.84
	Min	0.00	0.03	0.00	0.16	0.16
	Median	0.00	0.24	0.00	0.30	0.31
	p25	0.00	0.33	0.01	0.96	2.09
	p75	0.01	2.17	0.58	2.84	3.98
	p95	0.03	3.54	4.02	3.95	4.57
	p99	0.03	3.54	4.02	3.95	4.57
	Max	0.03	3.54	4.02	3.95	4.57
2 to < 9 n = 36	Mean	0.00	0.27	2.45	1.61	4.05
	SD	0.02	0.38	6.47	5.74	8.97
	Min	0.00	0.00	0.00	0.00	0.00
	Median	0.00	0.08	0.00	0.13	0.18
	p25	0.00	0.16	0.07	0.28	0.78
	p75	0.00	0.29	1.58	0.93	3.12
	p95	0.02	1.59	10.53	3.92	36.66
	p99	0.10	1.75	36.52	34.71	39.65
	Max	0.10	1.75	36.52	34.71	39.65
9 to < 16 n = 12	Mean	-	0.56	0.63	0.66	1.28
	SD	-	0.73	1.42	0.89	2.09
	Min	-	0.00	0.00	0.00	0.00
	Median	-	0.10	0.00	0.12	0.20
	p25	-	0.25	0.09	0.26	0.41
	p75	-	0.79	0.54	0.92	1.18
	p95	-	2.25	4.99	2.71	7.06
	p99	-	2.25	4.99	2.71	7.06
	Max	-	2.25	4.99	2.71	7.06
p-value*		0.094	0.075	0.797	0.145	0.415

*P-value from Kruskal-Wallis Test

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Table 3.1.3.1.c Mouthing contact median duration (s) while playing on turf by age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2	n	2	8	4	8	8
	Mean	1.00	3.69	6.88	3.44	2.63
	SD	0.00	3.83	5.81	3.90	2.15
	Min	1.00	1.00	1.00	1.00	1.00
	Median	1.00	1.00	2.25	1.00	1.00
	p25	1.00	2.50	6.25	2.00	2.00
	p75	1.00	4.75	11.50	4.25	3.75
	p95	1.00	12.00	14.00	12.00	6.50
	p99	1.00	12.00	14.00	12.00	6.50
	Max	1.00	12.00	14.00	12.00	6.50
2 to < 9	n	2	30	19	33	34
	Mean	1.75	1.58	9.11	1.71	3.46
	SD	1.06	1.11	27.65	1.19	10.05
	Min	1.00	0.50	1.00	0.00	0.00
	Median	1.00	1.00	1.00	1.00	1.00
	p25	1.75	1.00	2.00	1.00	1.50
	p75	2.50	2.00	4.00	2.00	2.00
	p95	2.50	5.00	123.00	5.00	5.00
	p99	2.50	5.00	123.00	5.00	60.00
	Max	2.50	5.00	123.00	5.00	60.00
9 to < 16	n	0	11	7	11	11
	Mean	-	1.27	3.07	1.23	1.32
	SD	-	0.47	2.65	0.41	0.46
	Min	-	1.00	1.50	1.00	1.00
	Median	-	1.00	2.00	1.00	1.00
	p25	-	1.00	2.00	1.00	1.00
	p75	-	2.00	3.00	1.50	2.00
	p95	-	2.00	9.00	2.00	2.00
	p99	-	2.00	9.00	2.00	2.00
	Max	-	2.00	9.00	2.00	2.00
p-value*		0.317	0.097	0.461	0.187	0.306

*P-value from Kruskal-Wallis Test

Table 3.1.3.1.d. Spearman rank correlation for age (1 - 12 years) and mouthing events

Activity Variables	r	P-value
Mouth contact frequency (event/h) (n = 56)		
Grass	-0.221	0.101
Hands	-0.033	0.811
Non-Dietary	-0.124	0.364
Dietary	-0.058	0.672
All objects	-0.160	0.241
Mouth contact duration (min/h) (n = 56)		
Grass	-0.221	0.102
Hands	-0.194	0.151
Non-Dietary*	**-0.308**	**0.021**
Dietary	-0.067	0.625
All objects*	**-0.266**	**0.048**
Mouth median duration (s)		
Grass (n = 4)	0.272	0.728
Hands* (n=49)*	**-0.357**	**0.012**
Non-Dietary* (n =52)*	**-0.353**	**0.010**
Dietary (n = 30)	-0.072	0.707
All objects (n=53)	-0.254	0.067

* Significant ($p < 0.05$) correlation with age (Spearman's rank correlation)

As presented in Tables A10-A12 in Appendix A, there were significant differences across the EPA recommended age groups (U.S. EPA, 2005) in mouthing hourly contact duration with hands and non-dietary objects (Table A11; Figure A1-A2). There were no significant differences in mouthing contact frequency and contact median duration. Also, for children aged 1-6 years and 7-12 years, the frequency, hourly duration and median duration for mouthing contact activities while playing on turf are presented in Tables A13-A15. There were significant differences between younger and older children in mouthing median duration with non-dietary objects and all objects (Table A16; Figure A3).

3.1.3.2 Mouthing contact activity by gender while playing on turf

Frequency, hourly duration and median duration for mouthing contact activities while playing on turf are presented in Tables 3.1.3.2.a-c by gender (i.e., male, female). There were no significant differences in contact frequency, hourly contact duration, or median contact duration by gender.

Table 3.1.3.2.a Mouthing contact frequency (event/h) while playing on turf by gender

Gender		Grass	Hands	Dietary	Non-Dietary	All Objects
Males n = 27	Mean	0.10	12.76	14.30	19.97	34.28
	SD	0.37	16.79	22.93	22.12	37.66
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	3.25	0.00	4.01	6.35
	Median	0.00	8.14	1.48	13.31	22.77
	p75	0.00	16.61	30.91	26.47	59.22
	p95	1.02	41.04	72.43	63.82	106.17
	p99	1.69	80.11	74.00	88.34	160.77
	Max	1.69	80.11	74.00	88.34	160.77
Females n = 29	Mean	0.13	10.63	15.33	23.88	39.20
	SD	0.50	11.38	33.10	35.92	50.87
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	4.51	0.00	7.14	7.42
	Median	0.00	7.14	0.00	10.85	18.28
	p75	0.00	12.63	19.69	26.24	53.12
	p95	1.17	36.78	80.19	76.19	189.59
	p99	2.49	47.70	159.12	185.14	205.09
	Max	2.49	47.70	159.12	185.14	205.09
p-value*		0.971	0.825	0.412	0.737	0.941

*P-value from Wilcoxon sum rank

Table 3.1.3.2.b Mouthing contact duration (min/h) while playing on turf by gender

Gender		Grass	Hands	Dietary	Non-Dietary	All Objects
Males n = 27	Mean	0.00	0.47	1.00	0.70	1.70
	SD	0.01	0.75	2.02	0.87	2.44
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	0.10	0.00	0.14	0.27
	Median	0.00	0.20	0.08	0.30	0.81
	p75	0.00	0.51	1.26	0.99	2.04
	p95	0.02	1.75	4.99	2.14	7.06
	p99	0.03	3.53	8.94	3.53	10.91
	Max	0.03	3.53	8.94	3.53	10.91
Females n = 29	Mean	0.00	0.45	2.55	2.03	4.59
	SD	0.02	0.78	7.08	6.39	9.82
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	0.10	0.00	0.12	0.16
	Median	0.00	0.22	0.00	0.29	0.50
	p75	0.00	0.30	1.06	1.67	3.88
	p95	0.02	2.25	10.53	3.95	36.66
	p99	0.10	3.54	36.52	34.71	39.65
	Max	0.10	3.54	36.52	34.71	39.65
p-value*		0.956	0.594	0.598	0.902	0.961

*P-value from Wilcoxon sum rank

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Table 3.1.3.2.c Mouthing median duration (s) by gender

Gender		Grass	Hands	Dietary	Non-Dietary	All Objects
Male	n*	2	25	17	25	26
	Mean	1.00	2.18	3.12	2.24	1.98
	SD	0.00	2.52	2.69	2.50	1.56
	Min	1.00	1.00	1.00	1.00	1.00
	p25	1.00	1.00	1.00	1.00	1.00
	Median	1.00	1.00	2.00	1.00	1.00
	p75	1.00	2.00	4.00	2.00	2.00
	p95	1.00	6.50	9.00	6.50	5.50
	p99	1.00	12.00	9.00	12.00	6.50
	Max	1.00	12.00	9.00	12.00	6.50
Female	n*	2	24	13	27	27
	Mean	1.75	1.52	13.00	1.54	3.76
	SD	1.06	0.81	33.24	0.91	11.27
	Min	1.00	0.50	1.00	0.00	0.00
	p25	1.00	1.00	2.00	1.00	1.00
	Median	1.75	1.00	3.00	1.00	2.00
	p75	2.50	2.00	3.50	2.00	2.00
	p95	2.50	3.00	123.00	3.00	4.00
	p99	2.50	3.50	123.00	4.00	60.00
	Max	2.50	3.50	123.00	4.00	60.00
p-value*		0.317	0.718	0.241	0.512	0.962

*P-value from Wilcoxon sum rank

3.2 Results from children playing on Playgrounds:

3.2.1 Children's description and footage length

From the analyzed total footage, we found that out of the total footage (2,548 min), children spent about 21% of the time playing on a playground. The median time per child spent playing on a playground was 21 min (See Table 3.2.1.a for details). 24 children (11 males and 13 females) played on playground structures at some point during the video recording and there was only one child in the oldest age group (9 to < 16 years old) that played on playgrounds. See Table 3.2.1.b for details.

Table 3.2.1.a. Time spent on playground (n = 24)

	Time in View	Time not in view

Total playground time (minutes)	531.0	38.2
Median playground time (min) per child	21.0	0.3
Percentage of time spent on playground (%)	20.8	1.5

Table 3.2.1.b Number of children playing on turf grouped by age groups and gender

Gender	Age groups			
	0 < 2 years	2 < 9 years	9 < 16 years	Total
Male	3	8	0	11
Female	2	10	1	13
Total	5	18	1	24

3.2.2 Hands object activity while playing on playground structures

The right and left hand frequencies are presented in Tables 3.2.2.a-b. Since there were no significant differences in the contact frequency with object/surfaces between right hand and left hand, both hands were combined and summarized (Table 3.2.2.c). This means that contact frequency for the left and right hands were summed, however, it does not mean that both hands were in contact with the object at the same time. The median contact frequency with floors for *both hands* combined was 12.12 events/h.

Table 3.2.2.a. Right hand frequency (event/h) while playing on the playground (n = 24)

	Floors	Dietary	Non-Dietary	All objects
Mean	15.69	0.56	148.11	148.68
SD	32.22	1.66	86.26	86.11
Min	0.00	0.00	15.88	15.88
p25	0.00	0.00	97.53	99.39
Median	4.81	0.00	128.13	128.13
p75	13.49	0.00	193.30	193.30
p95	69.23	3.71	327.27	327.27
p99	146.70	7.02	342.86	342.86
Max	146.70	7.02	342.86	342.86

Table 3.2.2.b. Left hand frequency while playing on playground (n = 24)

	Floors	Dietary	Non-Dietary	All objects
Mean	13.95	1.02	144.55	145.57
SD	20.58	2.83	79.16	78.79
Min	0.00	0.00	10.71	10.71
p25	0.00	0.00	95.60	95.60

Median	5.69	0.00	143.56	145.79
p75	15.55	0.00	174.49	175.07
p95	62.43	8.86	291.34	291.34
p99	72.00	10.77	337.96	337.96
Max	72.00	10.77	337.96	337.96

Table 3.2.2.c. Both hands object/surface contact frequency (event/h) on playground (n = 24)

	Floors	Dietary	Non-Dietary	All objects
Mean	29.64	1.58	292.67	294.25
SD	48.01	3.87	160.75	160.35
Min	0.00	0.00	30.60	30.60
p25	0.00	0.00	198.42	204.18
Median	12.12	0.00	261.38	262.28
p75	36.31	0.59	377.91	378.50
p95	141.23	10.77	602.49	602.49
p99	196.37	15.88	634.20	634.20
Max	196.37	15.88	634.20	634.20
p-value*	0.592	0.663	0.821	0.820

* from Wilcoxon Signed Rank test comparison of left and right hand contact

The hourly contact with the objects for right and left hand duration are presented in Tables 3.2.2.d-f. Since there were no significant differences in the contact duration with object/surfaces between right hand and left hand, both hands were combined and summarized (Table 3.2.2.f). This means that contact hourly duration for the left and right hands were summed, however it does not mean that both hands were in contact with the object at the same time. If both hands were in contact with object for the entire time, the maximum value would be 120 min/hr. The median hourly object contact duration with floors was 0.58 min/h for both hands, however, the 99th percentile was about ten times higher (10 min/h).

Table 3.2.2.d. Hourly object/surface contact duration (min/h) for right hand while playing on playground (n = 24)

	Floors	Dietary	Non-Dietary	All Objects
Mean	1.04	0.25	16.50	16.74
SD	1.83	1.03	3.28	3.26
Min	0.00	0.00	3.64	3.64
p25	0.00	0.00	15.52	15.93
Median	0.23	0.00	17.21	17.52
p75	1.17	0.00	18.62	18.64
p95	6.13	0.75	19.23	19.23
p99	6.26	5.04	19.85	19.85
Max	6.26	5.04	19.85	19.85

Table 3.2.2.e. Hourly object/surface contact duration (min/h) for left hand while playing on playground (n = 24)

	Floors	Dietary	Non-Dietary	All Objects
Mean	0.85	0.19	16.05	16.23
SD	1.21	0.80	3.29	3.33
Min	0.00	0.00	4.38	4.38
p25	0.00	0.00	14.86	15.16
Median	0.19	0.00	16.97	17.15
p75	1.25	0.00	18.09	18.24
p95	3.54	0.43	19.82	19.82
p99	3.81	3.93	20.00	20.00
Max	3.81	3.93	20.00	20.00

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Table 3.2.2.f. Hourly object/surface contact duration (min/h) for both hands while playing on playground (n = 24)

	Floors	Dietary	Non-Dietary	All Objects
Mean	1.96	0.43	32.44	32.87
SD	2.98	1.28	4.43	4.63
Min	0.00	0.00	22.98	22.98
p25	0.00	0.00	31.61	31.66
Median	0.58	0.00	32.76	33.66
p75	2.32	0.01	35.42	36.65
p95	9.67	3.93	38.59	38.59
p99	10.07	5.04	39.67	39.67
Max	10.07	5.04	39.67	39.67
p-value	0.753	0.737	0.275	0.216

* from Wilcoxon Signed Rank test comparison of left and right hand contact

The median durations for right and left contact with objects are presented in Tables 3.2.2.g-i. Since there were no significant differences in the contact median duration with object/surfaces between right hand and left hand, both hands were combined and summarized (Table 3.2.2.i). This means that for each object category the durations of all the discreet contacts with an object for both the right and left hands were grouped and reranked to determine the median value of contact duration across all the "hand" contacts with that object. The median duration for contact of hands with floors is 2.00 s as presented in Table 3.2.2.i. However, only 17 out of the 24 children touched the floors with their hands.

Table 3.2.2.g. Right hand median contact duration (s) while playing on the Playground

	Floors	Dietary	Non-Dietary	All Objects
n	15	3	24	24
Mean	4.10	18.67	4.15	4.13
SD	2.35	26.31	2.31	2.31
Min	1.00	2.00	1.00	1.00
p25	2.50	3.50	3.00	3.00
Median	4.00	5.00	4.00	4.00
p75	5.25	27.00	5.00	5.00
p95	7.90	44.60	6.85	6.85
p99	9.58	48.12	11.24	11.24
Max	10.00	49.00	12.50	12.50

Table 3.2.2.h. Left hand median contact duration (s) while playing on the Playground

	Floors	Dietary	Non-Dietary	All Objects
n	17	4	24	24
Mean	3.26	4.75	10.33	10.29
SD	2.89	6.18	23.87	23.89
Min	1.00	1.00	2.00	2.00
p25	1.50	1.75	3.00	3.00
Median	3.00	2.00	4.00	3.75
p75	4.00	5.00	5.00	5.00
p95	7.40	12.20	50.05	50.20
p99	11.88	13.64	97.66	97.66
Max	13.00	14.00	109.50	109.50

Table 3.2.2.i. Both hands object/surface median duration (s)

	Floors	Dietary	Non-Dietary	All Objects
n	17	6	24	24
Mean	3.32	11.75	3.90	3.94
SD	2.32	18.89	2.24	2.25
Min	1.00	1.00	1.00	1.00
p25	2.00	2.00	3.00	3.00
Median	2.00	2.25	4.00	4.00
p75	4.00	11.13	4.00	4.13
p95	6.90	40.25	6.00	6.00
p99	9.78	47.25	11.01	11.01
Max	10.50	49.00	12.50	12.50
p-value	0.136	0.279	0.942	0.883

* from Wilcoxon Signed Rank test comparison of left and right hand contact

3.2.2.1 Hand contact activity by age while playing on playground

Both hands contact frequency, hourly duration and median duration are summarized by age groups (<2, 2 to <9, 9 to <16 years) in Tables 3.2.2.1a-c. There were no significant differences between contact frequency, hourly contact duration, or median contact duration across all three age groups. Also, there were no correlations between age groups and both hand activities (Table 3.2.2.1.d).

Table 3.2.2.1.a. Both hands contact frequency (event/h) on playground (n = 24) by age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2 n= 5	Mean	39.97	0.23	426.60	426.84
	SD	27.85	0.52	184.50	184.39
	Min	0.71	0.00	205.86	205.86
	Median	20.26	0.00	336.18	336.18
	p25	58.06	0.00	354.28	355.45
	p75	58.41	0.00	602.49	602.49
	p95	62.43	1.17	634.20	634.20
	p99	62.43	1.17	634.20	634.20
	Max	62.43	1.17	634.20	634.20
2 to < 9 n = 18	Mean	28.41	2.04	257.28	259.32
	SD	53.40	4.39	142.43	142.33
	Min	0.00	0.00	30.60	30.60
	Median	0.00	0.00	182.39	182.39
	p25	9.87	0.00	256.63	259.11
	p75	19.48	2.80	288.28	304.16
	p95	196.37	15.88	567.27	567.27
	p99	196.37	15.88	567.27	567.27
	Max	196.37	15.88	567.27	567.27
9 to < 16 n = 1	Mean	-	-	259.97	259.97
	SD	-	-	-	-
	Min	-	-	-	-
	Median	-	-	-	-
	p25	-	-	-	-
	p75	-	-	-	-
	p95	-	-	-	-
	p99	-	-	-	-
	Max	-	-	-	-
p-value*		0.245	0.719	0.147	0.169

*P-value from Kruskal-Wallis Test

Table 3.2.2.1.b. Both hands hourly contact duration (min/h) on playground (n = 24) by age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2 n= 5	Mean	3.16	0.00	29.74	29.74
	SD	4.05	0.01	3.66	3.67
	Min	0.01	0.00	24.90	24.90
	Median	0.78	0.00	26.87	26.87
	p25	1.65	0.00	31.56	31.56
	p75	3.28	0.00	31.86	31.88
	p95	10.07	0.02	33.51	33.51
	p99	10.07	0.02	33.51	33.51
	Max	10.07	0.02	33.51	33.51
2 to < 9 n = 18	Mean	1.73	0.58	33.23	33.80
	SD	2.73	1.46	4.53	4.69
	Min	0.00	0.00	22.98	22.98
	Median	0.00	0.00	31.76	31.89
	p25	0.36	0.00	34.04	34.98
	p75	1.76	0.09	36.59	36.76
	p95	9.67	5.04	39.67	39.67
	p99	9.67	5.04	39.67	39.67
	Max	9.67	5.04	39.67	39.67
9 to < 16 n = 1	Mean	-	-	31.83	31.83
	SD	-	-	-	-
	Min	-	-	-	-
	Median	-	-	-	-
	p25	-	-	-	-
	p75	-	-	-	-
	p95	-	-	-	-
	p99	-	-	-	-
	Max	-	-	-	-
p-value*		0.233	0.719	0.151	0.088

*P-value from Kruskal-Wallis Test

Table 3.2.2.1.c. Both hands contact median duration (s) on playground (n = 24) by age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2	n	5	2	5	5
	Mean	2.60	1.00	3.50	3.50
	SD	1.95	-	1.00	1.00
	Min	1.00	-	2.00	2.00
	Median	2.00	-	3.00	3.00
	p25	2.00	-	4.00	4.00
	p75	2.00	-	4.00	4.00
	p95	6.00	-	4.50	4.50
	p99	6.00	-	4.50	4.50
	Max	6.00	-	4.50	4.50
2 to < 9	n	12	5	18	18
	Mean	3.63	13.90	4.00	4.06
	SD	2.48	20.28	2.55	2.56
	Min	1.00	2.00	1.00	1.00
	Median	2.00	2.00	3.00	3.00
	p25	3.50	2.50	4.00	4.00
	p75	4.00	14.00	4.00	5.00
	p95	10.50	49.00	12.50	12.50
	p99	10.50	49.00	12.50	12.50
	Max	10.50	49.00	12.50	12.50
9 to < 16	n	0	0	1	1
	Mean	-	-	4.00	4.00
	SD	-	-	-	-
	Min	-	-	-	-
	Median	-	-	-	-
	p25	-	-	-	-
	p75	-	-	-	-
	p95	-	-	-	-
	p99	-	-	-	-
	Max	-	-	-	-
p-value*		0.296	0.138	0.933	0.941

*P-value from Kruskal-Wallis Test

Table 3.2.2.1.d Spearman rank correlation for both hand events and age (years) while playing on playgrounds

Activity Variables	r	P-value
Both hands contact frequency (event/h) (n=24)		
Floors	-0.343	0.101
Non-Dietary	0.235	0.270
Dietary	0.054	0.801
All objects	-0.234	0.272
Both hands contact duration (min/h) (n = 24)		
Floors	-0.163	0.448
Non-Dietary	0.360	0.084
Dietary	0.061	0.776
All objects	0.391	0.059
Both hands median contact duration (s)		
Floors (n = 17)	0.274	0.287
Non-Dietary (n = 24)	-0.072	0.737
Dietary (n = 7)	0.537	0.272
All objects (n = 24)	-0.023	0.916

* Significant ($p < 0.05$) correlation with age (Spearman's rank correlation).

As presented in Appendix B, contact frequency, hourly contact duration and median contact duration divided by the EPA recommended age categories (U.S. EPA, 2005) for both hands are presented in Tables B2-B4. There were no statistically significant differences between EPA age groups (Kruskal Wallis Test). Contact frequency, hourly duration and median duration for hand contact activities while playing on playgrounds are presented in Appendix B in Tables B5-B7 for children aged 1-6 years and 7-12 years. There are no significant differences between younger and older children in hand contact activities Wilcoxon Rank Test.

3.2.2.2 Hand contact activity by gender while playing on playground

Frequency, hourly duration and median duration for both hands' contact activities while playing on playgrounds are presented in Tables 3.2.2.2.a-c by gender (i.e., male, female). There were no significant differences in contact frequency, hourly contact duration, or median contact duration by gender.

Table 3.2.2.2.a Both hands contact frequency while children play on playgrounds by gender (n = 24)

Gender		Floors	Dietary	Non-Dietary	All objects
Male n = 11	Mean	42.16	0.36	272.99	273.35
	SD	66.00	0.88	180.55	180.58
	Min	0.00	0.00	30.60	30.60
	p25	0.00	0.00	80.59	80.59
	Median	16.60	0.00	275.85	275.85
	p75	58.06	0.00	401.54	401.54
	p95	196.37	2.80	602.49	602.49
	p99	196.37	2.80	602.49	602.49
	Max	196.37	2.80	602.49	602.49
Female n = 13	Mean	19.04	2.61	309.32	311.93
	SD	22.85	5.05	147.34	146.19
	Min	0.00	0.00	171.54	171.54
	p25	0.00	0.00	205.86	208.83
	Median	11.01	0.00	259.97	261.77
	p75	19.48	3.62	288.28	304.16
	p95	62.43	15.88	634.20	634.20
	p99	62.43	15.88	634.20	634.20
	Max	62.43	15.88	634.20	634.20
	p-value*	0.224	0.599	0.257	0.251

* from Wilcoxon Sum Rank test comparison of male and female

Table 3.2.2.2.b. Both hands hourly contact duration (min/h) while children play on playgrounds by gender (n = 24)

Gender		Floors	Dietary	Non-Dietary	All objects
Male n = 11	Mean	2.51	0.01	32.71	32.72
	SD	3.31	0.03	4.43	4.43
	Min	0.00	0.00	22.98	22.98
	p25	0.00	0.00	31.56	31.56
	Median	0.78	0.00	32.20	32.20
	p75	5.60	0.00	36.34	36.34
	p95	9.67	0.09	39.67	39.67
	p99	9.67	0.09	39.67	39.67
	Max	9.67	0.09	39.67	39.67
Female n = 13	Mean	1.49	0.79	32.22	33.01
	SD	2.72	1.69	4.59	4.97
	Min	0.00	0.00	23.64	23.64
	Median	0.00	0.00	31.66	31.76
	p25	0.38	0.00	33.31	34.50
	p75	1.65	0.12	34.50	36.70
	p95	10.07	5.04	38.59	38.59
	p99	10.07	5.04	38.59	38.59
	Max	10.07	5.04	38.59	38.59
p-value*		0.630	0.224	0.599	0.257

* from Wilcoxon Sum Rank test comparison of male and female

Table 3.2.2.2c. Both hands median contact duration (s) while children play on playgrounds by gender

Gender		Floors	Dietary	Non-Dietary	All objects
Males	n	8	2	11	11
	Mean	3.44	1.50	4.59	4.59
	SD	3.18	0.71	3.01	3.01
	Min	1.00	1.00	1.00	1.00
	Median	1.50	1.00	3.00	3.00
	p25	2.00	1.50	4.00	4.00
	p75	4.50	2.00	6.00	6.00
	p95	10.50	2.00	12.50	12.50
	p99	10.50	2.00	12.50	12.50
	Max	10.50	2.00	12.50	12.50
Females	n	9	4	13	13
	Mean	3.22	16.88	3.31	3.38
	SD	1.39	22.12	1.13	1.21
	Min	2.00	2.00	1.00	1.00
	Median	2.00	2.25	3.00	3.00
	p25	3.00	8.25	3.50	3.50
	p75	4.00	31.50	4.00	4.00
	p95	6.00	49.00	5.00	5.00
	p99	6.00	49.00	5.00	5.00
	Max	6.00	49.00	5.00	5.00
P-value*		0.753	0.638	0.675	0.573

* from Wilcoxon Sum Rank test comparison of male and female

3.2.3 Mouthing activity while playing on playground

The mouthing contact frequency for children playing on playground is summarized in Table 3.2.3.a. Only one child (1/24) contacted “floors” with their mouth, resulting in a contact frequency of 2.30 events/hr. The median mouthing frequencies were 9.80 events/h and 10.20 events/h for hands and non-dietary objects, respectively. These contacts could indicate additional exposure to playmat chemicals that have transferred to their child’s hands (Section 3.2.2) or the objects they are placing in their mouths.

Table 3.2.3.a. Mouth contact frequency (event/h) while playing on the Playground (n = 24)

	Floors	Hands	Dietary	Non-Dietary	All Objects
Mean	2.30	19.60	43.10	28.20	71.30
SD	-	20.30	112.30	46.80	114.30
Min	-	1.40	0.00	0.00	0.00
p25	-	4.30	0.00	2.90	4.00
Median	-	9.80	0.00	10.20	20.40

p75	-	25.40	3.20	30.30	66.00
p95	-	67.50	313.40	82.50	335.00
p99	-	67.50	378.95	218.18	378.95
Max	-	67.50	378.95	218.18	378.95

The mouthing hourly contact duration for children playing on playgrounds is summarized in Table 3.2.3.b. The hourly contact duration for the one child who contacted "floors" with their mouth was 0.04 min/h. The median hourly mouthing duration was 0.10 and 0.00 min/h for hands and non-dietary objects, respectively. These contacts could indicate additional exposure to playmat chemicals that have transferred to their child's hands (Section 3.2.2) or the objects they are placing in their mouths.

Table 3.2.3.b. Hourly mouthing contact duration (min/h) while playing on playground (n = 24)

	Floors	Hands	Dietary	Non-Dietary	All Objects
Mean	0.04	1.00	1.50	1.70	3.20
SD	-	1.60	4.10	4.10	5.50
Min	-	0.00	0.00	0.00	0.00
Median	-	0.10	0.00	0.00	0.00
p25	-	0.30	0.00	0.30	0.80
p75	-	0.70	0.20	1.30	3.80
p95	-	5.00	11.40	5.00	16.60
p99	-	5.00	16.50	20.00	20.00
Max	-	5.00	16.50	20.00	20.00

The mouthing median contact duration for children playing on playgrounds is summarized in Table 3.2.3.c. Median duration is only contacted from those children that contacted the object. The median mouthing contact duration for the one child that contacted "floors" with their mouth is 1.00 s. Median mouthing contact duration was 1.00 s and 1.50 s for hands and non-dietary objects, respectively.

Table 3.2.3.c. Mouth median contact duration (s) while playing on playground

	Floors	Hands	Dietary	Non-Dietary	All Objects
n	1	14	6	13	20
Mean	1.00	2.07	25.58	2.21	7.83
SD	-	1.87	59.00	1.91	26.11
Min	-	1.00	0.50	0.00	0.00
p25	-	1.00	1.00	1.00	1.00
Median	-	1.00	1.50	1.00	1.00
p75	-	2.00	2.75	3.00	2.25
p95	-	6.18	110.25	6.10	12.10
p99	-	6.44	138.85	6.42	97.22

Max	-	6.50	146.00	6.50	118.50

3.2.3.1 Mouthing activity while playing on playground by age

Frequency, hourly duration and median duration for mouthing contact activities while playing on playgrounds are presented in Tables 3.2.3.1a-c for three age categories (<2, 2 to <9, 9 to <16 years). There were no significant differences in mouthing contact frequency across these age groups. Out of the 24 children, only one child (less than 2 years of age) made a mouthing contact with any type of floor while playing on playground structures. Age (by year, 1-12 years) was negatively correlated ($p < 0.05$) with the contact frequency, hourly contact duration and median contact duration of mouthing activities with total objects (Table 3.2.3.1.d). Age was also negatively correlated ($p < 0.05$) with hourly mouthing duration and frequency for hands. Finally, the non-dietary objects were negatively correlated with mouthing duration and median duration.

Table 3.2.3.1.a. Mouthing contact frequency (event/h) while on playground (n = 24) by age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
< 2 n= 5	Mean	2.30	26.60	6.39	27.23	33.63
	SD	-	18.56	9.31	14.84	18.91
	Min	-	9.22	0.00	4.96	4.96
	p25	-	9.22	0.00	24.43	24.43
	Median	-	24.43	0.00	29.95	41.47
	p75	-	46.15	11.52	30.68	46.15
	p95	-	46.15	20.45	46.15	51.13
	p99	-	46.15	20.45	46.15	51.13
	Max	-	46.15	20.45	46.15	51.13
2 to < 9 n = 18	Mean	-	17.74	55.69	29.98	85.67
	SD	-	21.18	127.94	53.51	129.04
	Min	-	1.39	0.00	0.00	0.00
	p25	-	3.85	0.00	2.78	2.94
	Median	-	9.12	0.00	9.54	13.42
	p75	-	25.42	0.00	25.42	82.50
	p95	-	67.50	378.95	218.18	378.95
	p99	-	67.50	378.95	218.18	378.95
	Max	-	67.50	378.95	218.18	378.95
9 to < 16 n = 0	Mean	-	-	-	-	-
	SD	-	-	-	-	-

	Min	-	-	-	-	-
	p25	-	-	-	-	-
	Median	-	-	-	-	-
	p75	-	-	-	-	-
	p95	-	-	-	-	-
	p99	-	-	-	-	-
	Max	-	-	-	-	-
p-value*		0.150	0.312	0.711	0.161	0.341

*P-value from Kruskal-Wallis Test

Table 3.2.3.1.b. Mouthing contact duration (min/h) on playground (n = 24) by age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
< 2 n= 5	Mean	0.04	3.09	0.26	2.66	2.92
	SD	-	2.60	0.42	2.05	1.88
	Min	-	0.12	0.00	0.33	0.33
	p25	-	0.12	0.00	0.78	1.74
	Median	-	4.14	0.00	3.07	3.41
	p75	-	5.00	0.34	4.14	4.14
	p95	-	5.00	0.96	5.00	5.00
	p99	-	5.00	0.96	5.00	5.00
	Max	-	5.00	0.96	5.00	5.00
2 to < 9 n = 18	Mean	-	0.41	1.98	1.53	3.52
	SD	-	0.49	4.62	4.64	6.23
	Min	-	0.02	0.00	0.00	0.00
	p25	-	0.06	0.00	0.00	0.04
	Median	-	0.27	0.00	0.24	0.55
	p75	-	0.51	0.00	1.00	3.16
	p95	-	1.75	16.52	20.00	20.00
	p99	-	1.75	16.52	20.00	20.00
	Max	-	1.75	16.52	20.00	20.00
9 to < 16 n = 0	Mean	-	-	-	-	-
	SD	-	-	-	-	-
	Min	-	-	-	-	-
	p25	-	-	-	-	-
	Median	-	-	-	-	-
	p75	-	-	-	-	-
	p95	-	-	-	-	-
	p99	-	-	-	-	-
	Max	-	-	-	-	-
p-value*		0.149	0.187	0.782	0.043	0.176

*P-value from Kruskal-Wallis Test

Table 3.2.3.1.c. Mouthing contact median duration (s) on playground (n = 24) by age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
< 2	n	1	3	2		5
	Mean	1.00	4.50	2.00	4.13	3.50
	SD	-	3.04	1.41	2.59	2.65
	Min	-	1.00	1.00	1.00	1.00
	p25	-	1.00	1.00	2.00	1.00
	Median	-	6.00	2.00	4.50	3.00
	p75	-	6.50	3.00	6.25	6.00
	p95	-	6.50	3.00	6.50	6.50
	p99	-	6.50	3.00	6.50	6.50
	Max	-	6.50	3.00	6.50	6.50
2 to < 9	n	0	11	4	13	15
	Mean	-	1.41	37.38	1.62	9.27
	SD	-	0.66	72.42	1.26	30.24
	Min	-	1.00	0.50	0.00	0.00
	p25	-	1.00	0.75	1.00	1.00
	Median	-	1.00	1.50	1.00	1.00
	p75	-	2.00	74.00	2.00	2.00
	p95	-	3.00	146.00	5.00	118.50
	p99	-	3.00	146.00	5.00	118.50
	Max	-	3.00	146.00	5.00	118.50
9 to < 16	n	0	0	0	0	0
	Mean	-	-	-	-	-
	SD	-	-	-	-	-
	Min	-	-	-	-	-
	p25	-	-	-	-	-
	Median	-	-	-	-	-
	p75	-	-	-	-	-
	p95	-	-	-	-	-
	p99	-	-	-	-	-
	Max	-	-	-	-	-
p-value*		-	0.121	0.814	0.055	0.183

*P-value from Kruskal-Wallis Test

Table 3.2.3.1.d Spearman rank correlation for age (years) and mouthing events while playing on playgrounds

Activity Variables	r	P-value
Mouth contact frequency (event/h) (n=24)		
Floors	-0.289	0.170
Hands*	-0.631	**0.016**
Non-Dietary	0.378	0.705
Dietary	-0.163	0.448
All objects*	-0.459	**0.024**
Mouth contact duration (min/h) (n = 24)		
Floors	-0.289	0.170
Hands*	-0.593	**0.025**
Non-Dietary*	-0.624	**0.011**
Dietary	-0.095	0.657
All objects*	-0.025	**0.025**
Mouth median contact duration (s)		
Floors (n = 1)	-0.289	0.169
Hands (n = 14)	-0.322	0.261
Non-Dietary* (n = 13)	-0.555	**0.005**
Dietary (n = 6)	-0.122	0.570
All objects* (n = 20)	-0.418	**0.042**

* Significant ($p < 0.05$) correlation with age (Spearman's rank correlation).

In the Appendix B, the mouthing events are summarized by the EPA recommended age categories (U.S. EPA, 2005) in Tables B8-B10. There were significant differences between the EPA age categories with respect to mouthing frequency for non-dietary objects and all objects. Similarly, a significant difference was observed for the mouthing duration for non-dietary objects.

Also, in Appendix B, the frequency, hourly duration and median duration for mouthing contact activities while playing on playgrounds are presented in Tables B11-13 for children aged 1-6 and 7-12 years. There were significant differences between younger (1-6 years old) and older children (7-12 years old) groups for the mouthing frequency and duration with all objects (Table B11 and Table B12) and for the mouthing duration with non-dietary objects (Table B12).

3.2.3.2. Mouthing activity while playing on playground by gender

Frequency, hourly duration and median duration for mouthing contact activities while playing on playgrounds are presented in Tables 3.2.3.2.a-c by gender (i.e., male, female). There were no significant differences in contact frequency or hourly contact duration by gender. However, female children had significantly longer contact durations with "All objects".

Table 3.2.3.2.a. Mouthing frequency (event/h) while children play on playgrounds by gender

Gender		Floors	Hands	Dietary	Non-Dietary	All objects
Males (n = 11)	Mean	2.30	27.87	64.96	27.91	92.87
	SD	-	24.68	137.82	30.70	128.10
	Min	-	2.94	0.00	0.00	0.00
	p25	-	9.22	0.00	0.00	2.94
	Median	-	20.36	0.00	24.43	51.13
	p75	-	46.84	20.45	65.16	82.50
	p95	-	67.50	378.95	82.50	378.95
	p99	-	67.50	378.95	82.50	378.95
	Max	-	67.50	378.95	82.50	378.95
Females (n = 13)	Mean	-	13.46	24.60	28.37	52.97
	SD	-	15.13	86.80	58.44	102.80
	Min	-	1.39	0.00	0.00	0.00
	p25	-	4.08	0.00	3.85	4.96
	Median	-	8.09	0.00	10.03	10.27
	p75	-	17.90	0.00	21.56	25.42
	p95	-	46.15	313.43	218.18	334.99
	p99	-	46.15	313.43	218.18	334.99
	Max	-	46.15	313.43	218.18	334.99
P-value*		-	0.197	0.223	0.705	0.212

* P-value from Wilcoxon Sum Rank test comparison of male and female

Table 3.2.3.2.b. Mouthing duration (min/h) while children play on playgrounds by gender

Gender		Floors	Hands	Dietary	Non-Dietary	All objects
Males (n = 11)	Mean	0.04	1.17	0.83	1.10	1.93
	SD	-	1.59	1.58	1.40	1.71
	Min	-	0.05	0.00	0.00	0.00
	p25	-	0.12	0.00	0.00	0.05
	Median	-	0.47	0.00	0.78	1.74
	p75	-	1.75	0.96	1.87	3.41
	p95	-	4.14	4.62	4.14	4.77
	p99	-	4.14	4.62	4.14	4.77
	Max	-	4.14	4.62	4.14	4.77
Females (n = 13)	Mean	-	0.84	2.15	2.21	4.36
	SD	-	1.69	5.35	5.51	7.20
	Min	-	0.02	0.00	0.00	0.00
	p25	-	0.17	0.00	0.04	0.04
	Median	-	0.28	0.00	0.33	0.33
	p75	-	0.42	0.00	0.58	5.00
	p95	-	5.00	16.52	20.00	20.00
	p99	-	5.00	16.52	20.00	20.00
	Max	-	5.00	16.52	20.00	20.00
P-value*		-	0.697	0.402	0.770	0.662

* P-value from Wilcoxon Sum Rank test comparison of male and female

Table 3.2.3.2.c. Mouthing median duration (s) while children play on playgrounds by gender

Gender		Floors	Hands	Dietary	Non-Dietary	All objects
Males	n	1	6	4	6	9
	Mean	1.00	1.83	1.38	1.83	1.50
	SD	-	2.04	1.11	2.04	1.70
	Min	-	1.00	0.50	1.00	0.50
	p25	-	1.00	0.75	1.00	1.00
	Median	-	1.00	1.00	1.00	1.00
	p75	-	1.00	2.00	1.00	1.00
	p95	-	6.00	3.00	6.00	6.00
	p99	-	6.00	3.00	6.00	6.00
	Max	-	6.00	3.00	6.00	6.00
Females	n	0	8	2	11	11
	Mean	-	2.25	74.00	2.41	13.00
	SD	-	1.85	101.82	1.91	35.04
	Min	-	1.00	2.00	0.00	0.00
	p25	-	1.00	2.00	1.00	1.00
	Median	-	1.75	74.00	2.00	2.00
	p75	-	2.50	146.00	3.00	5.00
	p95	-	6.50	146.00	6.50	118.50
	p99	-	6.50	146.00	6.50	118.50
	Max	-	6.50	146.00	6.50	118.50
P-value*		-	0.174	0.156	0.264	**0.041**

*** p-value from Wilcoxon Sum Rank test comparison of male and female**

APPENDIX A

Table A1. Number of children playing on turf grouped by U.S. EPA age categories and gender

Gender	Age groups					
	1 to <2 years	2 to < 3 years	3 to < 6 years	6 to < 11 years	11 to < 16 years	Total
Males	5	5	7	5	5	27
Females	3	2	10	13	1	29
Total	8	7	17	18	6	56

Tables A2. Both hands contact frequency (event/h) while playing on turf by EPA age groups. See Table A5 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All objects
< 2 n = 8	Mean	11.1	1.4	285.7	287.1
	SD	11.8	3.6	75.8	76.1
	Min	0.3	0.0	187.9	187.9
	p25	2.9	0.0	238.2	238.2
	Median	8.5	0.0	282.8	287.9
	p75	14.0	0.6	308.2	308.4
	p95	37.2	10.2	439.3	440.0
	p99	37.2	10.2	439.3	440.0
	Max	37.2	10.2	439.3	440.0
2 to < 3 n = 7	Mean	5.6	6.6	185.8	192.4
	SD	10.6	9.8	43.4	42.8
	Min	0.0	0.9	107.7	109.7
	p25	0.0	0.9	171.5	181.5
	Median	2.1	2.7	189.2	194.1
	p75	3.2	8.8	227.4	228.3
	p95	29.4	27.9	241.1	244.2
	p99	29.4	27.9	241.1	244.2
	Max	29.4	27.9	241.1	244.2
3 to < 6 n = 17	Mean	9.8	8.6	317.7	326.3
	SD	17.2	12.6	183.6	179.7
	Min	0.0	0.0	163.1	169.5
	p25	0.0	0.0	206.7	213.4
	Median	2.1	1.0	219.7	228.6
	p75	17.4	17.2	403.7	403.7
	p95	70.0	40.3	765.8	768.3
	p99	70.0	40.3	765.8	768.3
	Max	70.0	40.3	765.8	768.3
6 to < 11 n = 18	Mean	20.0	3.0	268.9	271.9
	SD	58.2	5.6	98.7	97.0
	Min	0.0	0.0	138.8	138.8
	p25	0.0	0.0	192.3	202.1
	Median	6.4	0.0	252.5	252.8
	p75	11.3	3.4	304.6	304.6
	p95	251.9	20.8	494.9	494.9
	p99	251.9	20.8	494.9	494.9
	Max	251.9	20.8	494.9	494.9
11 to < 16 n = 6	Mean	26.6	13.7	279.0	292.7
	SD	23.8	16.4	88.4	93.0
	Min	0.3	0.0	160.0	160.5
	p25	2.6	0.5	234.9	238.9
	Median	26.2	7.4	269.3	294.8
	p75	45.0	26.5	325.2	351.7
	p95	59.2	40.3	415.6	415.6
	p99	59.2	40.3	415.6	415.6
	Max	59.2	40.3	415.6	415.6

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Tables A3. Both hands hourly contact duration (min/h) while playing on turf by EPA age groups. See Table A5 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All objects
< 2 n = 8	Mean	0.9	0.7	29.6	36.4
	SD	1.6	1.7	14.0	15.6
	Min	0.0	0.0	15.6	26.8
	p25	0.1	0.0	22.7	28.2
	Median	0.5	0.0	26.9	29.6
	p75	0.6	0.4	29.9	38.1
	p95	4.8	4.9	62.2	72.4
	p99	4.8	4.9	62.2	72.4
	Max	4.8	4.9	62.2	72.4
2 to < 3 n = 7	Mean	0.8	3.2	36.6	41.6
	SD	1.7	4.7	15.5	16.5
	Min	0.0	0.1	18.9	22.4
	p25	0.1	0.1	26.9	34.0
	Median	0.2	0.2	32.4	35.2
	p75	0.4	8.1	56.8	60.3
	p95	4.6	11.7	59.7	68.7
	p99	4.6	11.7	59.7	68.7
	Max	4.6	11.7	59.7	68.7
3 to < 6 n = 17	Mean	0.7	2.3	29.0	34.5
	SD	1.4	3.2	6.1	6.7
	Min	0.0	0.0	20.8	23.2
	p25	0.0	0.0	23.5	32.7
	Median	0.1	0.2	28.5	34.7
	p75	0.4	5.6	33.4	36.2
	p95	4.6	8.2	44.3	55.9
	p99	4.6	8.2	44.3	55.9
	Max	4.6	8.2	44.3	55.9
6 to < 11 n = 18	Mean	1.1	1.0	34.4	39.8
	SD	2.8	1.7	14.8	12.1
	Min	0.0	0.0	14.7	30.5
	p25	0.1	0.0	27.4	32.8
	Median	0.3	0.0	33.2	35.9
	p75	0.7	2.4	35.5	37.3
	p95	12.0	5.5	65.3	67.3
	p99	12.0	5.5	65.3	67.3
	Max	12.0	5.5	65.3	67.3
11 to < 16 n = 6	Mean	1.4	2.7	38.2	43.9
	SD	1.8	4.7	29.2	30.4
	Min	0.0	0.0	20.9	22.9
	p25	0.1	0.0	20.9	31.0
	Median	0.6	1.0	27.6	34.0
	p75	3.0	2.1	36.4	36.4
	p95	4.2	12.1	96.0	105.1
	p99	4.2	12.1	96.0	105.1
	Max	4.2	12.1	96.0	105.1

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Tables A4. Both hands median contact duration (s) while playing on turf by EPA age groups. See Table A5 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All Objects
< 2	n*	8	3	8	8
	Mean	2.50	4.00	3.63	3.63
	SD	0.76	4.77	0.52	0.52
	Min	2.00	1.00	3.00	3.00
	p25	2.00	1.00	3.00	3.00
	Median	2.00	1.50	4.00	4.00
	p75	3.00	9.50	4.00	4.00
	p95	4.00	9.50	4.00	4.00
	p99	4.00	9.50	4.00	4.00
	Max	4.00	9.50	4.00	4.00
2 to < 3	n*	5	7	7	7
	Mean	3.50	8.64	3.43	3.43
	SD	1.41	6.99	0.79	0.79
	Min	2.00	1.00	2.00	2.00
	p25	2.50	4.00	3.00	3.00
	Median	3.00	7.00	4.00	4.00
	p75	5.00	10.00	4.00	4.00
	p95	5.00	23.00	4.00	4.00
	p99	5.00	23.00	4.00	4.00
	Max	5.00	23.00	4.00	4.00
3 to < 6	n*	11	10	17	17
	Mean	2.36	9.65	3.35	3.41
	SD	2.04	4.74	0.93	0.94
	Min	0.50	4.00	2.00	2.00
	p25	1.00	6.00	3.00	3.00
	Median	2.00	7.75	3.00	3.00
	p75	3.00	14.00	4.00	4.00
	p95	8.00	18.00	5.00	5.00
	p99	8.00	18.00	5.00	5.00
	Max	8.00	18.00	5.00	5.00
6 to < 11	n*	13	7	18	18
	Mean	3.04	7.29	3.14	3.19
	SD	3.10	4.64	1.03	1.10
	Min	1.00	2.00	1.00	1.00
	p25	2.00	4.00	2.00	2.00
	Median	2.00	5.00	3.00	3.00
	p75	3.00	12.00	4.00	4.00
	p95	13.00	14.00	5.00	5.00
	p99	13.00	14.00	5.00	5.00
	Max	13.00	14.00	5.00	5.00
11 to < 16	n*	6	5	6	6
	Mean	2.33	3.80	2.83	2.83
	SD	0.52	2.36	1.17	1.17
	Min	2.00	1.00	2.00	2.00
	p25	2.00	2.50	2.00	2.00
	Median	2.00	3.00	2.50	2.50
	p75	3.00	6.00	3.00	3.00
	p95	3.00	6.50	5.00	5.00
	p99	3.00	6.50	5.00	5.00
	Max	3.00	6.50	5.00	5.00

*Only participants who contacted object included in calculation of median contact duration

Table A5. Statistical analysis of hand contact events by EPA age groups. P-value from Kruskal-Wallis Test.

Activity Variables	P-value
Hand contact frequency (event/h) (n = 56)	
Grass	0.361
Non-Dietary	0.397
Dietary	0.644
All objects	0.058
Hourly hand contact duration (min/h) (n = 56)	
Grass	0.252
Non-Dietary	0.132
Dietary	0.644
All objects	0.165
Median hand contact duration (s)	
Grass (n = 42)	0.286
Non-Dietary (n=56)	0.116
Dietary (n = 28)	0.491
All objects (n=56)	0.165

Tables A6. Both hands contact frequency (event/h) while playing on turf by younger (1-6 years) and older (7-12 years). See Table A9 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All Objects
1 - 6 years n = 32	Mean	9.2	6.4	280.8	287.2
	SD	14.5	10.6	147.8	145.6
	Min	0.0	0.0	107.7	109.7
	p25	0.6	0.0	192.1	203.1
	Median	3.2	0.9	223.3	228.4
	p75	14.0	8.8	307.9	308.4
	p95	37.2	27.9	680.3	680.3
	p99	70.0	40.3	765.8	768.3
	Max	70.0	40.3	765.8	768.3
7 - 12 years n = 24	Mean	21.6	5.7	271.4	277.1
	SD	51.3	10.2	94.4	94.5
	Min	0.0	0.0	138.8	138.8
	p25	1.1	0.0	202.4	213.9
	Median	6.9	0.3	252.5	252.8
	p75	15.8	8.6	314.9	345.1
	p95	59.2	26.5	473.6	473.6
	p99	251.9	40.3	494.9	494.9

	Max	251.9	40.3	494.9	494.9

Tables A7. Both hands hourly contact duration (min/h) while playing on turf by younger (1-6 years) and older (7-12 years). See Table A5 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All Objects
1- 6 years n = 32	Mean	0.8	2.1	30.8	36.5
	SD	1.5	3.3	10.9	11.8
	Min	0.0	0.0	15.6	22.4
	p25	0.0	0.0	23.7	29.6
	Median	0.2	0.1	28.6	34.5
	p75	0.6	3.9	33.2	36.4
	p95	4.6	8.2	59.7	68.7
	p99	4.8	11.7	62.2	72.4
	Max	4.8	11.7	62.2	72.4
7 - 12 years n = 24	Mean	1.2	1.4	35.4	40.8
	SD	2.5	2.7	18.7	17.7
	Min	0.0	0.0	14.7	22.9
	p25	0.1	0.0	21.0	32.3
	Median	0.3	0.0	33.0	35.6
	p75	0.9	2.2	35.7	37.2
	p95	4.2	5.5	65.3	67.3
	p99	12.0	12.1	96.0	105.1
	Max	12.0	12.1	96.0	105.1

Tables A8. Both hands median contact duration (s) while playing on turf by younger (1-6 years) and older (7-12 years). See Table A5 for statistical analysis results.

Age Group		Grass	Dietary	Non - Dietary	All objects
1 - 6 years	n*	24	20	32	32
	Mean	2.65	8.45	3.44	3.47
	SD	1.59	5.69	0.80	0.80
	Min	0.50	1.00	2.00	2.00
	p25	2.00	5.00	3.00	3.00
	Median	2.00	7.25	3.50	4.00
	p75	3.00	10.00	4.00	4.00
	p95	5.00	20.50	5.00	5.00
	p99	8.00	23.00	5.00	5.00
	Max	8.00	23.00	5.00	5.00
7 - 12 years	n*	19	12	24	24
	Mean	2.82	5.83	3.06	3.10
	SD	2.57	4.12	1.05	1.10
	Min	1.00	1.00	1.00	1.00
	p25	2.00	2.75	2.00	2.00
	Median	2.00	4.50	3.00	3.00
	p75	3.00	8.25	4.00	4.00
	p95	13.00	14.00	5.00	5.00
	p99	13.00	14.00	5.00	5.00

Max	13.00	14.00	5.00	5.00

*Only participants who contacted object included in calculation of median contact duration

Table A9. Statistical analysis of hand contact events younger (1-6 years) and older (7-12 years) P-value from Kruskal-Wallis Test

Activity Variables	P-value
Hand contact frequency (event/h) (n = 56)	
Grass	0.318
Non-Dietary	0.581
Dietary	0.585
All objects	0.584
Hourly hand contact duration (min/h) (n = 56)	
Grass	0.295
Non-Dietary	0.264
Dietary	0.328
All objects	0.191
Median hand contact duration (s)	
Grass (n = 42)	0..884
Non-Dietary (n=56)	0.061
Dietary (n = 28)	0.092
All objects (n=56)	0.069

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Table A10. Mouthing contact frequency (event/h) while playing on turf by EPA age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2 (n = 8)	Mean	0.34	12.74	2.79	25.69	28.48
	SD	0.65	11.69	4.39	22.61	23.62
	Min	0.00	0.66	0.00	1.48	2.96
	Median	0.00	3.70	0.00	9.44	9.44
	p25	0.00	11.99	0.74	16.30	19.68
	p75	0.51	16.56	4.41	44.37	51.41
	p95	1.69	36.78	12.05	63.82	63.82
	p99	1.69	36.78	12.05	63.82	63.82
	Max	1.69	36.78	12.05	63.82	63.82
2 to < 3 (n = 7)	Mean	-	10.33	28.11	15.78	43.89
	SD	-	5.22	36.10	8.21	30.77
	Min	-	3.96	0.00	5.29	14.03
	Median	-	5.85	0.00	6.68	15.35
	p25	-	9.58	2.65	14.03	29.12
	p75	-	15.84	74.00	23.35	79.28
	p95	-	18.53	80.19	26.47	86.87
	p99	-	18.53	80.19	26.47	86.87
	Max	-	18.53	80.19	26.47	86.87
3 to < 6 (n = 17)	Mean	0.22	9.99	20.47	27.50	47.97
	SD	0.65	11.66	39.23	43.24	62.07
	Min	0.00	0.00	0.00	0.00	0.68
	Median	0.00	2.56	0.00	7.42	7.98
	p25	0.00	6.89	1.74	10.89	23.70
	p75	0.00	11.66	24.44	30.47	45.75
	p95	2.49	41.04	159.12	185.14	205.09
	p99	2.49	41.04	159.12	185.14	205.09
	Max	2.49	41.04	159.12	185.14	205.09
6 to < 11 (n =18)	Mean	-	6.74	8.26	12.21	20.46
	SD	-	5.48	15.73	17.48	25.25
	Min	-	0.00	0.00	0.00	0.00
	Median	-	0.54	0.00	5.86	5.86
	p25	-	7.12	0.00	7.79	8.87
	p75	-	9.00	7.76	10.85	28.12
	p95	-	19.25	48.83	76.19	76.19
	p99	-	19.25	48.83	76.19	76.19
	Max	-	19.25	48.83	76.19	76.19
11 to < 16 (n = 6)	Mean	-	31.22	19.15	38.08	57.24
	SD	-	29.72	27.42	34.06	58.80
	Min	-	1.23	0.00	2.47	5.01
	Median	-	4.01	1.00	4.01	11.73
	p25	-	27.12	9.02	38.14	42.53
	p75	-	47.70	23.44	57.40	80.84
	p95	-	80.11	72.43	88.34	160.77
	p99	-	80.11	72.43	88.34	160.77

	Max	-	80.11	72.43	88.34	160.77
p-value*		-	0.222	0.174	0.237	0.132

*P-value from Kruskal-Wallis Test

Tables A11. Mouthing hourly contact duration (min/h) while playing on turf by EPA age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2 (n = 8)	Mean	0.01	1.13	0.65	1.54	2.18
	SD	0.01	1.50	1.39	1.52	1.84
	Min	0.00	0.03	0.00	0.16	0.16
	Median	0.00	0.24	0.00	0.30	0.31
	p25	0.00	0.33	0.01	0.96	2.09
	p75	0.01	2.17	0.58	2.84	3.98
	p95	0.03	3.54	4.02	3.95	4.57
	p99	0.03	3.54	4.02	3.95	4.57
	Max	0.03	3.54	4.02	3.95	4.57
2 to < 3 (n = 7)	Mean	-	0.48	0.97	0.63	1.60
	SD	-	0.58	1.29	0.64	1.08
	Min	-	0.09	0.00	0.13	0.51
	Median	-	0.15	0.00	0.19	0.67
	p25	-	0.23	0.28	0.33	1.39
	p75	-	0.51	1.71	0.99	2.04
	p95	-	1.75	3.45	1.92	3.65
	p99	-	1.75	3.45	1.92	3.65
	Max	-	1.75	3.45	1.92	3.65
3 to < 6 (n = 17)	Mean	0.01	0.27	2.24	2.79	5.02
	SD	0.02	0.38	3.75	8.27	9.90
	Min	0.00	0.00	0.00	0.00	0.05
	Median	0.00	0.07	0.00	0.19	0.27
	p25	0.00	0.17	0.09	0.36	0.64
	p75	0.00	0.28	1.45	1.76	3.88
	p95	0.10	1.59	10.53	34.71	39.65
	p99	0.10	1.59	10.53	34.71	39.65
	Max	0.10	1.59	10.53	34.71	39.65
6 to < 11 (n =18)	Mean	-	0.16	2.42	0.40	2.82
	SD	-	0.14	8.58	0.90	8.57
	Min	-	0.00	0.00	0.00	0.00
	Median	-	0.04	0.00	0.04	0.04
	p25	-	0.12	0.00	0.13	0.20
	p75	-	0.23	0.23	0.27	0.88
	p95	-	0.52	36.52	3.92	36.66
	p99	-	0.52	36.52	3.92	36.66
	Max	-	0.52	36.52	3.92	36.66
	Mean	-	0.96	1.21	1.14	2.35
	SD	-	0.89	1.89	1.08	2.63

11 to < 16 (n = 6)	Min	-	0.02	0.00	0.05	0.30
	Median	-	0.15	0.15	0.15	0.60
	p25	-	0.79	0.54	0.92	1.18
	p75	-	1.75	1.06	2.07	3.77
	p95	-	2.25	4.99	2.71	7.06
	p99	-	2.25	4.99	2.71	7.06
	Max	-	2.25	4.99	2.71	7.06
p-value*		-	**0.025**	0.310	**0.016**	0.084

Table A12. Mouthing contact median duration (s) while playing on turf by EPA age groups

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
< 2	n	2	8	4	8	8
	Mean	1.00	3.69	6.88	3.44	2.63
	SD	0.00	3.83	5.81	3.90	2.15
	Min	1.00	1.00	1.00	1.00	1.00
	Median	1.00	1.00	2.25	1.00	1.00
	p25	1.00	2.50	6.25	2.00	2.00
	p75	1.00	4.75	11.50	4.25	3.75
	p95	1.00	12.00	14.00	12.00	6.50
	p99	1.00	12.00	14.00	12.00	6.50
	Max	1.00	12.00	14.00	12.00	6.50
2 to < 3	n	0	7	5	7	7
	Mean	-	1.71	2.20	1.64	1.71
	SD	-	0.91	1.10	0.75	0.76
	Min	-	1.00	1.00	1.00	1.00
	Median	-	1.00	2.00	1.00	1.00
	p25	-	1.50	2.00	1.50	2.00
	p75	-	2.00	2.00	2.00	2.00
	p95	-	3.50	4.00	3.00	3.00
	p99	-	3.50	4.00	3.00	3.00
	Max	-	3.50	4.00	3.00	3.00
3 to < 6	n	2	14	10	16	17
	Mean	1.75	1.61	3.40	1.94	1.85
	SD	1.06	1.13	2.49	1.25	1.09
	Min	1.00	0.50	1.00	0.50	0.50
	Median	1.00	1.00	2.00	1.00	1.00
	p25	1.75	1.00	2.75	1.75	2.00
	p75	2.50	2.00	4.00	2.50	2.00
	p95	2.50	5.00	8.50	5.00	4.00
	p99	2.50	5.00	8.50	5.00	4.00
	Max	2.50	5.00	8.50	5.00	4.00
6 to < 11	n	0	14	6	15	15
	Mean	-	1.29	21.92	1.27	5.27

	SD	-	1.07	49.53	1.10	15.18
	Min	-	1.00	1.00	0.00	0.00
	Median	-	1.00	1.00	1.00	1.00
	p25	-	1.00	1.75	1.00	1.00
	p75	-	1.00	3.00	1.00	2.00
	p95	-	5.00	123.00	5.00	60.00
	p99	-	5.00	123.00	5.00	60.00
	Max	-	5.00	123.00	5.00	60.00
11 to < 16	n	0	6	5	6	6
	Mean	-	1.50	3.60	1.42	1.58
	SD	-	0.55	3.05	0.49	0.49
	Min	-	1.00	2.00	1.00	1.00
	Median	-	1.00	2.00	1.00	1.00
	p25	-	1.50	2.00	1.25	1.75
	p75	-	2.00	3.00	2.00	2.00
	p95	-	2.00	9.00	2.00	2.00
	p99	-	2.00	9.00	2.00	2.00
	Max	-	2.00	9.00	2.00	2.00
p-value*		-	0.079	0.604	0.110	0.521

*P-value from Kruskal-Wallis Test (Only participants who contacted object included in calculation)

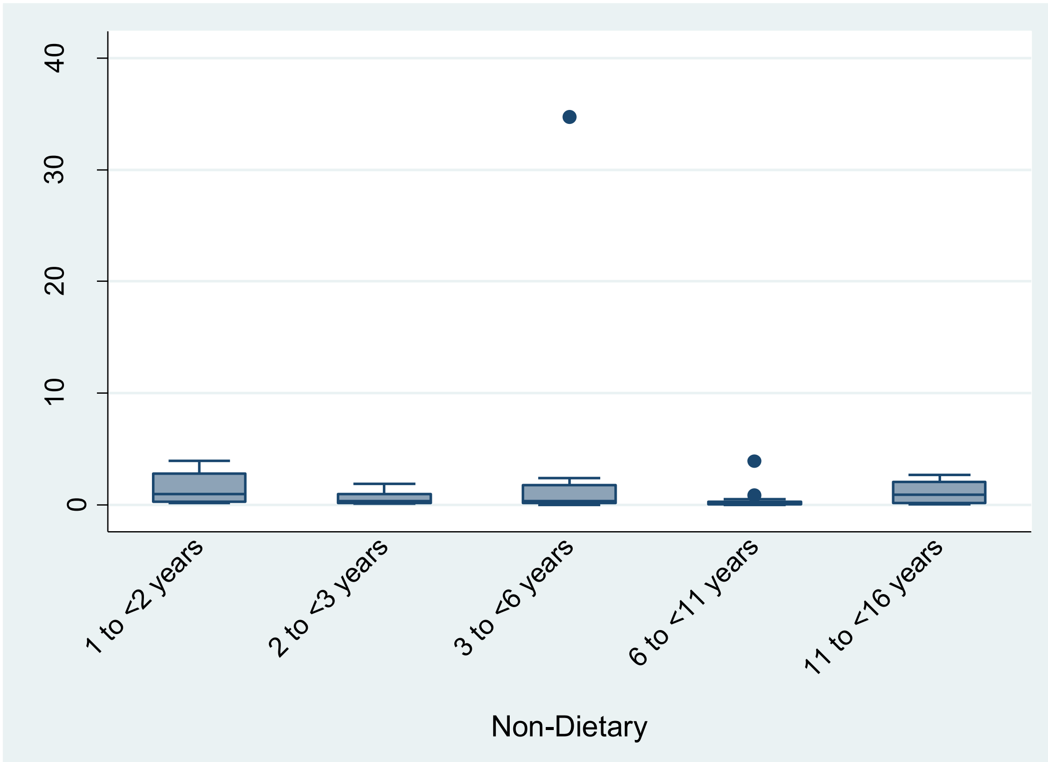

Figure A1. Mouthing hourly duration (min/h) with non-dietary objects by EPA age groups

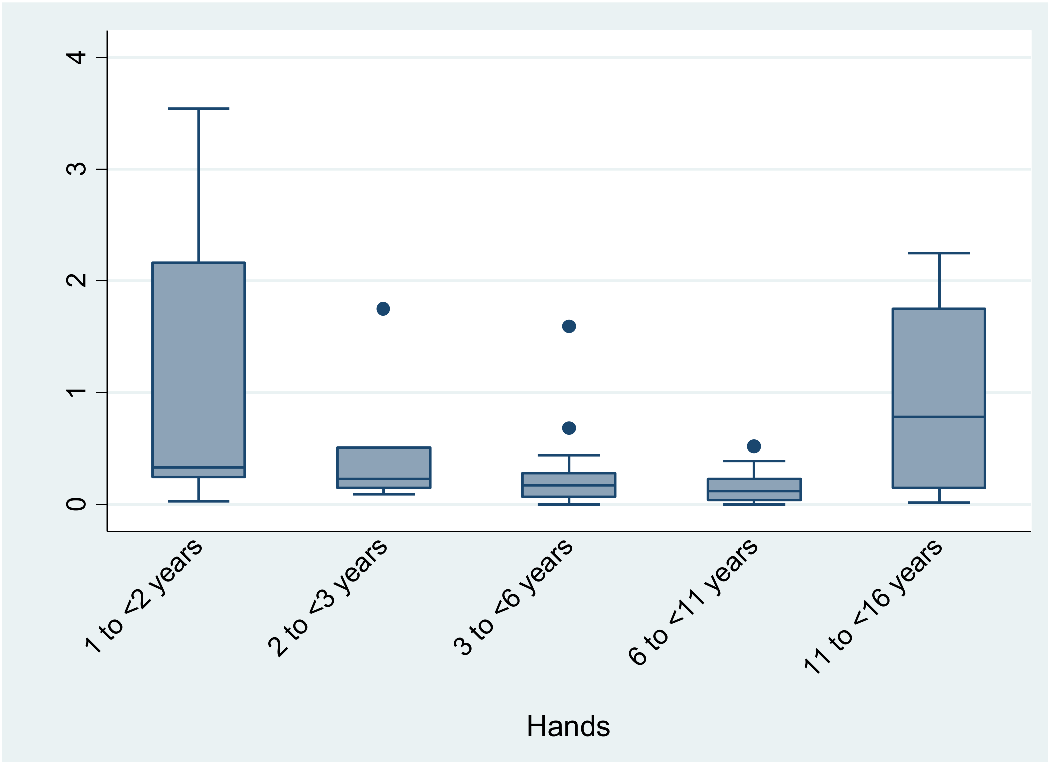

Figure A2. Mouthing hourly duration (min/h) with hands by EPA age groups

Tables A13. Mouthing contact frequency (event/h) while playing on turf by younger (1-6 years) and older (7-12 years)

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 38)	Mean	0.17	10.00	17.58	21.74	39.32
	SD	0.53	9.83	31.78	31.33	46.04
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	3.25	0.00	6.68	9.00
	Median	0.00	8.06	1.89	13.67	23.53
	p75	0.00	15.67	24.44	26.24	53.12
	p95	1.69	36.78	80.19	63.82	189.59
	p99	2.49	41.04	159.12	185.14	205.09
	Max	2.49	41.04	159.12	185.14	205.09
7 - 12 years (n = 18)	Mean	-	15.14	9.03	22.53	31.56
	SD	-	20.48	18.95	27.36	42.38
	Min	-	0.00	0.00	0.00	0.00

	p25	-	3.51	0.00	5.86	7.09
	Median	-	7.14	0.00	9.37	10.68
	p75	-	19.25	8.78	29.33	62.29
	p95	-	80.11	72.43	88.34	160.77
	p99	-	80.11	72.43	88.34	160.77
	Max	-	80.11	72.43	88.34	160.77
p-value*		-	0.699	0.252	0.752	0.239

* Wilcoxon sum rank test.

Tables A14. Mouthing hourly contact duration (min/h) while playing on turf by younger (1-6 years) and older (7-12 years)

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 38)	Mean	0.00	0.47	2.41	1.71	4.12
	SD	0.02	0.82	6.32	5.59	8.71
	Min	0.00	0.00	0.00	0.00	0.00
	p25	0.00	0.10	0.00	0.17	0.29
	Median	0.00	0.21	0.09	0.32	1.13
	p75	0.00	0.39	1.45	1.67	3.65
	p95	0.03	3.53	10.53	3.95	36.66
	p99	0.10	3.54	36.52	34.71	39.65
	Max	0.10	3.54	36.52	34.71	39.65
7 - 12 years (n = 18)	Mean	-	0.43	0.51	0.72	1.23
	SD	-	0.63	1.21	1.10	1.92
	Min	-	0.00	0.00	0.00	0.00
	p25	-	0.10	0.00	0.10	0.12
	Median	-	0.19	0.00	0.20	0.31
	p75	-	0.52	0.31	0.86	1.54
	p95	-	2.25	4.99	3.92	7.06
	p99	-	2.25	4.99	3.92	7.06
	Max	-	2.25	4.99	3.92	7.06
p-value*		-	0.732	0.205	0.174	0.058

* Wilcoxon sum rank test.

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Table A15. Mouthing contact median duration (s) while playing on turf by younger (1-6 years and older (7-12) children

Age Group		Grass	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years	n*	4	34	22	36	37
	Mean	1.38	2.15	9.07	2.19	3.61
	SD	0.75	2.21	25.65	2.16	9.63
	Min	1.00	0.50	1.00	0.50	0.50
	p25	1.00	1.00	2.00	1.00	1.00
	Median	1.00	1.00	2.75	1.50	2.00
	p75	1.75	2.00	4.00	2.00	2.00
	p95	2.50	6.50	14.00	6.50	6.50
	p99	2.50	12.00	123.00	12.00	60.00
	Max	2.50	12.00	123.00	12.00	60.00
7 - 12 years	n*	0	15	8	16	16
	Mean	-	1.20	2.81	1.16	1.22
	SD	-	0.41	2.56	0.51	0.55
	Min	-	1.00	1.00	0.00	0.00
	p25	-	1.00	1.75	1.00	1.00
	Median	-	1.00	2.00	1.00	1.00
	p75	-	1.00	2.50	1.25	1.75
	p95	-	2.00	9.00	2.00	2.00
	p99	-	2.00	9.00	2.00	2.00
	Max	-	2.00	9.00	2.00	2.00
p-value*		-	0.079	0.377	**0.030**	**0.026**

* Wilcoxon sum rank test. Only participants who contacted object included in calculation of median contact duration

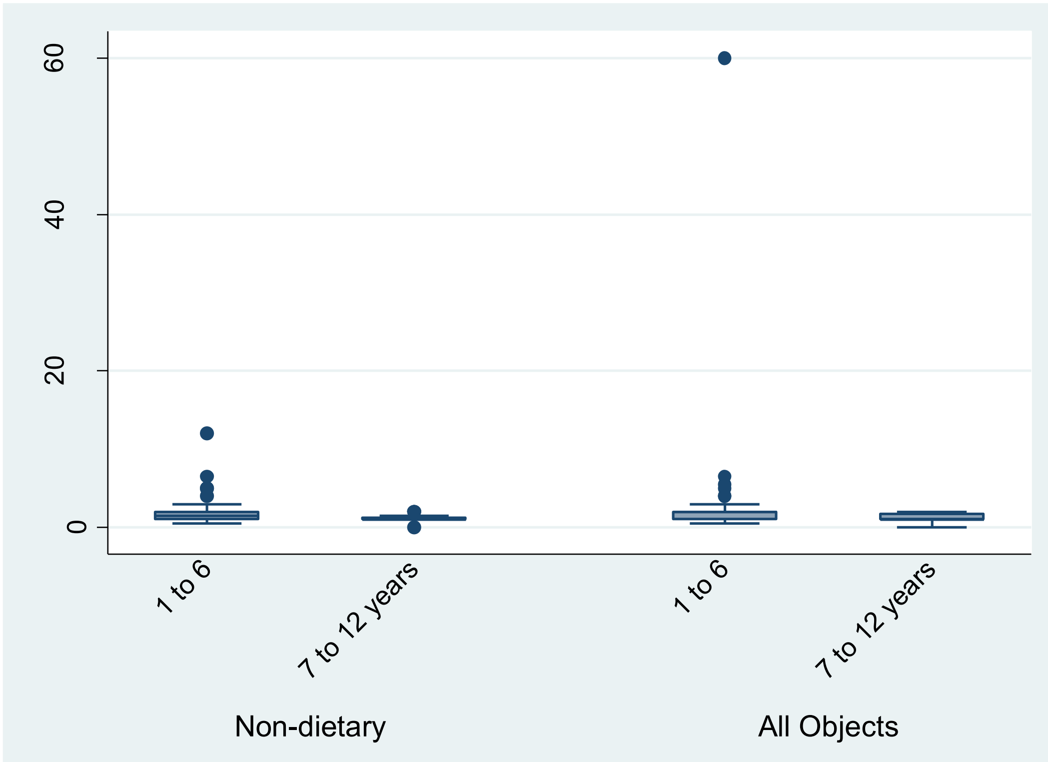

Figure A3. Median mouthing contact duration (s) of younger and older children while playing on turf

Appendix B

Table B1. Number of children playing on playground by EPA age groups and gender

Gender	Age groups					
	1 to <2 years	2 to < 3 years	3 to < 6 years	6 to < 11 years	11 to < 16 years	Total
Male	3	4	4	0	0	11
Female	2	1	4	6	0	13
Total	5	5	8	6	0	24

Table B2. Both hands contact frequency (event/h) on playground (n = 24) by EPA age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2 n = 5	Mean	39.97	0.23	426.60	426.84
	SD	27.85	0.52	184.50	184.39
	Min	0.71	0.00	205.86	205.86
	p25	20.26	0.00	336.18	336.18
	Median	58.06	0.00	354.28	355.45
	p75	58.41	0.00	602.49	602.49
	p95	62.43	1.17	634.20	634.20
	p99	62.43	1.17	634.20	634.20
	Max	62.43	1.17	634.20	634.20
2 to < 3 n = 5	Mean	10.00	2.71	166.48	169.20
	SD	10.37	4.66	107.28	108.58
	Min	0.00	0.00	30.60	30.60
	p25	0.00	0.00	80.59	80.59
	Median	8.73	0.00	191.72	202.49
	p75	19.48	2.80	253.65	256.45
	p95	21.78	10.77	275.85	275.85
	p99	21.78	10.77	275.85	275.85
	Max	21.78	10.77	275.85	275.85
3 to < 6 n = 8	Mean	51.70	1.99	330.43	332.42
	SD	75.65	5.61	170.99	170.52
	Min	0.00	0.00	37.60	37.60
	p25	0.00	0.00	222.59	222.59
	Median	12.59	0.00	344.91	352.85
	p75	96.03	0.00	451.80	451.80
	p95	196.37	15.88	567.27	567.27
	p99	196.37	15.88	567.27	567.27
	Max	196.37	15.88	567.27	567.27
6 to < 11 n = 6	Mean	7.97	1.22	235.85	237.07
	SD	7.13	1.89	38.45	38.32
	Min	0.00	0.00	171.54	171.54
	p25	0.00	0.00	205.12	208.83
	Median	8.65	0.00	256.63	257.54
	p75	13.23	3.62	259.97	261.77
	p95	17.32	3.71	265.19	265.19
	p99	17.32	3.71	265.19	265.19
	Max	17.32	3.71	265.19	265.19
P-value		0.245	0.714	0.051	0.055

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Table B3. Both hands hourly contact duration (min/h) on playground (n = 24) by EPA age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2 n = 5	Mean	3.16	0.00	29.74	29.74
	SD	4.05	0.01	3.66	3.67
	Min	0.01	0.00	24.90	24.90
	p25	0.78	0.00	26.87	26.87
	Median	1.65	0.00	31.56	31.56
	p75	3.28	0.00	31.86	31.88
	p95	10.07	0.02	33.51	33.51
	p99	10.07	0.02	33.51	33.51
	Max	10.07	0.02	33.51	33.51
2 to < 3 n = 5	Mean	0.47	0.80	31.87	32.67
	SD	0.74	1.75	5.28	5.82
	Min	0.00	0.00	22.98	22.98
	p25	0.00	0.00	31.89	31.89
	Median	0.25	0.00	33.31	34.48
	p75	0.33	0.09	34.39	36.76
	p95	1.76	3.93	36.76	37.24
	p99	1.76	3.93	36.76	37.24
	Max	1.76	3.93	36.76	37.24
3 to < 6 n = 8	Mean	3.09	0.15	32.63	32.77
	SD	3.70	0.42	4.89	4.96
	Min	0.00	0.00	23.64	23.64
	p25	0.00	0.00	30.19	30.19
	Median	1.61	0.00	33.24	33.35
	p75	5.93	0.00	35.42	35.90
	p95	9.67	1.18	39.67	39.67
	p99	9.67	1.18	39.67	39.67
	Max	9.67	1.18	39.67	39.67
6 to < 11 n = 6	Mean	0.68	0.86	34.93	35.79
	SD	0.67	2.05	2.91	2.49
	Min	0.00	0.00	31.66	31.83
	p25	0.00	0.00	31.83	33.80
	Median	0.64	0.00	35.20	36.65
	p75	1.10	0.12	37.10	37.22
	p95	1.70	5.04	38.59	38.59
	p99	1.70	5.04	38.59	38.59
	Max	1.70	5.04	38.59	38.59
p-value		0.377	0.635	0.250	0.123

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Table B4. Both hands median contact duration (s) on playground by EPA age groups

Age Group		Floors	Dietary	Non-Dietary	All objects
< 2	n	5	1	5	5
	Mean	2.60	1.00	3.50	3.50
	SD	1.95	-	1.00	1.00
	Min	1.00	-	2.00	2.00
	Median	2.00	-	3.00	3.00
	p25	2.00	-	4.00	4.00
	p75	2.00	-	4.00	4.00
	p95	6.00	-	4.50	4.50
	p99	6.00	-	4.50	4.50
	Max	6.00	-	4.50	4.50
2 to < 3	n	3	2	5	5
	Mean	3.00	8.00	5.30	5.30
	SD	1.73	8.49	4.30	4.30
	Min	1.00	2.00	1.00	1.00
	Median	1.00	2.00	4.00	4.00
	p25	4.00	8.00	4.00	4.00
	p75	4.00	14.00	5.00	5.00
	p95	4.00	14.00	12.50	12.50
	p99	4.00	14.00	12.50	12.50
	Max	4.00	14.00	12.50	12.50
3 to < 6	n	5	1	8	8
	Mean	4.70	2.50	3.50	3.50
	SD	3.49	-	1.85	1.85
	Min	2.00	-	1.00	1.00
	Median	2.00	-	2.00	2.00
	p25	4.00	-	3.50	3.50
	p75	5.00	-	5.00	5.00
	p95	10.50	-	6.00	6.00
	p99	10.50	-	6.00	6.00
	Max	10.50	-	6.00	6.00
6 to < 11	n	4	2	6	6
	Mean	2.75	25.50	3.58	3.75
	SD	0.96	33.23	0.49	0.76
	Min	2.00	2.00	3.00	3.00
	Median	2.00	2.00	3.00	3.00
	p25	2.50	25.50	3.75	3.75
	p75	3.50	49.00	4.00	4.00
	p95	4.00	49.00	4.00	5.00
	p99	4.00	49.00	4.00	5.00
	Max	4.00	49.00	4.00	5.00

p-value	0.587	0.527	0.778	0.825

Table B5. Both hands contact frequency (event/h) on playground (n = 24) while playing on playground by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 21)	Mean	33.24	1.81	301.30	303.11
	SD	50.36	4.10	169.75	169.22
	Min	0.00	0.00	30.60	30.60
	p25	0.71	0.00	205.12	205.86
	Median	16.60	0.00	262.79	262.79
	p75	50.83	1.17	401.54	401.54
	p95	141.23	10.77	602.49	602.49
	p99	196.37	15.88	634.20	634.20
	Max	196.37	15.88	634.20	634.20
7 -12 years (n = 3)	Mean	4.41	-	232.23	232.23
	SD	7.64	-	52.63	52.63
	Min	0.00	-	171.54	171.54
	p25	0.00	-	171.54	171.54
	Median	0.00	-	259.97	259.97
	p75	13.23	-	265.19	265.19
	p95	13.23	-	265.19	265.19
	p99	13.23	-	265.19	265.19
	Max	13.23	-	265.19	265.19
p-value		0.144	-	0.513	0.458

Table B6. Both hands hourly contact duration (min/h) on playground (n = 24) while playing on playground by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 21)	Mean	2.19	0.49	31.98	32.48
	SD	3.12	1.36	4.42	4.70
	Min	0.00	0.00	22.98	22.98
	p25	0.01	0.00	31.56	31.56
	Median	0.78	0.00	32.20	33.51
	p75	2.88	0.02	34.39	36.34
	p95	9.67	3.93	37.10	37.24
	p99	10.07	5.04	39.67	39.67
	Max	10.07	5.04	39.67	39.67
7 -12 years (n = 3)	Mean	0.30	-	35.67	35.67
	SD	0.51	-	3.47	3.47
	Min	0.00	-	31.83	31.83
	p25	0.00	-	31.83	31.83
	Median	0.00	-	36.59	36.59
	p75	0.89	-	38.59	38.59
	p95	0.89	-	38.59	38.59
	p99	0.89	-	38.59	38.59
	Max	0.89	-	38.59	38.59
p-value		0.178	-	0.206	0.316

Table B7. Both hands contact median duration (s) on playground (n = 24) while playing on playground by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Dietary	Non-Dietary	All Objects
1 - 6 years	n*	16	3	21	21
	Mean	3.28	11.75	3.95	4.00
	SD	2.39	18.89	2.39	2.40
	Min	1.00	1.00	1.00	1.00
	p25	2.00	2.00	3.00	3.00
	Median	2.00	2.25	4.00	4.00
	p75	4.00	14.00	4.00	4.50
	p95	10.50	49.00	6.00	6.00
	p99	10.50	49.00	12.50	12.50
	Max	10.50	49.00	12.50	12.50
7 - 12 years	n*	2	0	3	3
	Mean	4.00	-	3.50	3.50
	SD	4.00	-	0.50	0.50
	Min	4.00	-	3.00	3.00
	p25	4.00	-	3.00	3.00
	Median	4.00	-	3.50	3.50
	p75	4.00	-	4.00	4.00
	p95	4.00	-	4.00	4.00
	p99	4.00	-	4.00	4.00
	Max	4.00	-	4.00	4.00
p-value		0.456	-	0.622	0.623

Table B8. Mouthing contact frequency (event/h) while on playground (n = 24) by EPA age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
	Mean	0.5	26.6	6.4	27.2	33.6
	SD	1.0	18.6	9.3	14.8	18.9
	Min	0.0	9.2	0.0	5.0	5.0
< 2	p25	0.0	9.2	0.0	24.4	24.4
	Median	0.0	24.4	0.0	30.0	41.5
N = 5	p75	0.0	46.2	11.5	30.7	46.2
	p95	2.3	46.2	20.5	46.2	51.1
	p99	2.3	46.2	20.5	46.2	51.1
	Max	2.3	46.2	20.5	46.2	51.1
	Mean	-	34.4	60.7	47.1	107.8
	SD	-	27.8	135.8	34.4	114.7
	Min	-	7.1	0.0	4.4	16.5
2 to < 3	p25	-	11.7	0.0	16.5	65.2
	Median	-	31.6	0.0	65.2	66.9
N = 5	p75	-	57.2	0.0	66.9	82.5
	p95	-	67.5	303.7	82.5	308.1
	p99	-	67.5	303.7	82.5	308.1
	Max	-	67.5	303.7	82.5	308.1
	Mean	-	10.8	86.5	34.8	121.4
	SD	-	10.3	161.2	74.8	163.2
	Min	-	2.9	0.0	0.0	0.0
3 to < 6	p25	-	3.6	0.0	0.0	1.5
	Median	-	7.3	0.0	6.7	17.9
N = 8	p75	-	17.9	156.7	23.5	276.6
	p95	-	25.4	379.0	218.2	379.0
	p99	-	25.4	379.0	218.2	379.0
	Max	-	25.4	379.0	218.2	379.0
	Mean	-	4.8	1.1	4.3	5.4
	SD	-	3.9	2.6	4.4	5.0
	Min	-	1.4	0.0	0.0	0.0
6 to < 11	p25	-	1.4	0.0	0.0	0.0
	Median	-	3.9	0.0	3.3	5.9
N = 6	p75	-	9.1	0.0	9.1	10.0
	p95	-	9.1	6.4	10.0	10.3
	p99	-	9.1	6.4	10.0	10.3
	Max	-	9.1	6.4	10.0	10.3
p-value		-	0.118	0.833	**0.036**	**0.041**

Table B9. Mouthing hourly duration (min/h) while on playground (n = 24) by EPA age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
< 2 N = 5	Mean	0.0	3.1	0.3	2.7	2.9
	SD	0.0	2.6	0.4	2.0	1.9
	Min	0.0	0.1	0.0	0.3	0.3
	p25	0.0	0.1	0.0	0.8	1.7
	Median	0.0	4.1	0.0	3.1	3.4
	p75	0.0	5.0	0.3	4.1	4.1
	p95	0.0	5.0	1.0	5.0	5.0
	p99	0.0	5.0	1.0	5.0	5.0
	Max	0.0	5.0	1.0	5.0	5.0
2 to < 3 N = 5	Mean	-	0.7	0.9	0.9	1.9
	SD	-	0.7	2.1	0.6	1.7
	Min	-	0.3	0.0	0.2	0.6
	p25	-	0.3	0.0	0.6	1.0
	Median	-	0.5	0.0	1.0	1.1
	p75	-	1.2	0.0	1.1	1.9
	p95	-	1.8	4.6	1.9	4.8
	p99	-	1.8	4.6	1.9	4.8
	Max	-	1.8	4.6	1.9	4.8
3 to < 6 N = 8	Mean	-	0.3	1.8	2.8	4.6
	SD	-	0.2	4.0	7.0	7.6
	Min	-	0.1	0.0	0.0	0.0
	p25	-	0.2	0.0	0.0	0.0
	Median	-	0.3	0.0	0.2	0.4
	p75	-	0.4	1.6	1.0	8.1
	p95	-	0.5	11.4	20.0	20.0
	p99	-	0.5	11.4	20.0	20.0
	Max	-	0.5	11.4	20.0	20.0
6 to < 11 N = 6	Mean	-	0.1	2.8	0.1	2.8
	SD	-	0.1	6.7	0.1	6.7
	Min	-	0.0	0.0	0.0	0.0
	p25	-	0.0	0.0	0.0	0.0
	Median	-	0.1	0.0	0.0	0.0
	p75	-	0.3	0.0	0.1	0.3
	p95	-	0.3	16.5	0.3	16.6
	p99	-	0.3	16.5	0.3	16.6
	Max	-	0.3	16.5	0.3	16.6
p-value		-	0.189	0.961	**0.017**	0.183

Table B10. Mouthing median duration (s) while on playground by EPA age groups

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
< 2	n	1	3	2	4	5
	Mean	1.00	4.50	2.00	4.13	3.50
	SD	-	3.04	1.41	2.59	2.65
	Min	-	1.00	1.00	1.00	1.00
	p25	-	1.00	1.00	2.00	1.00
	Median	-	6.00	2.00	4.50	3.00
	p75	-	6.50	3.00	6.25	6.00
	p95	-	6.50	3.00	6.50	6.50
	p99	-	6.50	3.00	6.50	6.50
	Max	-	6.50	3.00	6.50	6.50
2 to < 3	n	0	4	1	4	5
	Mean	-	1.25	1.00	1.25	1.20
	SD	-	0.50	-	0.50	0.45
	Min	-	1.00	-	1.00	1.00
	p25	-	1.00	-	1.00	1.00
	Median	-	1.00	-	1.00	1.00
	p75	-	1.50	-	1.50	1.00
	p95	-	2.00	-	2.00	2.00
	p99	-	2.00	-	2.00	2.00
	Max	-	2.00	-	2.00	2.00
3 to < 6	n	0	4	2	5	6
	Mean	-	1.75	1.25	2.40	1.92
	SD	-	0.96	1.06	1.67	1.63
	Min	-	1.00	0.50	1.00	0.50
	p25	-	1.00	0.50	1.00	1.00
	Median	-	1.50	1.25	2.00	1.50
	p75	-	2.50	2.00	3.00	2.00
	p95	-	3.00	2.00	5.00	5.00
	p99	-	3.00	2.00	5.00	5.00
	Max	-	3.00	2.00	5.00	5.00
6 to < 11	n	0	3	1	4	4
	Mean	-	1.17	146.00	1.00	30.38
	SD	-	0.29	-	0.82	58.76
	Min	-	1.00	-	0.00	0.00
	p25	-	1.00	-	0.50	0.50
	Median	-	1.00	-	1.00	1.50
	p75	-	1.50	-	1.50	60.25

	p95	-	1.50	-	2.00	118.50
	p99	-	1.50	-	2.00	118.50
	Max	-	1.50	-	2.00	118.50
p-value*		-	0.385	0.431	0.125	0.542

Table B11. Mouthing contact frequency (event/h) while on playground (n = 24) by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 21)	Mean	0.11	19.64	49.26	31.75	81.01
	SD	0.50	20.31	119.10	49.09	119.24
	Min	0.00	1.39	0.00	0.00	0.00
	p25	0.00	4.31	0.00	3.85	10.03
	Median	0.00	9.80	0.00	16.45	25.42
	p75	0.00	25.42	6.42	30.68	66.91
	p95	0.00	67.50	313.43	82.50	334.99
	p99	2.30	67.50	378.95	218.18	378.95
	Max	2.30	67.50	378.95	218.18	378.95
7 - 12 years (n = 3)	Mean	-	-	0.00	3.02	3.02
	SD	-	-	0.00	5.23	5.23
	Min	-	-	0.00	0.00	0.00
	p25	-	-	0.00	0.00	0.00
	Median	-	-	0.00	0.00	0.00
	p75	-	-	0.00	9.05	9.05
	p95	-	-	0.00	9.05	9.05
	p99	-	-	0.00	9.05	9.05
	Max	-	-	0.00	9.05	9.05
p-value		-	-	-	0.072	**0.032**

* Significant ($p < 0.05$). Wilcoxon sum rank test

Table B12. Mouthing contact duration (min/h) while on playground (n = 24) by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years (n = 21)	Mean	0.04	0.98	1.76	1.95	3.71
	SD	0.0	1.59	4.30	4.37	5.70
	Min	0.0	0.02	0.00	0.00	0.00
	p25	0.0	0.12	0.00	0.06	0.33
	Median	0.0	0.28	0.00	0.51	1.08
	p75	0.0	0.67	0.34	1.58	4.14
	p95	0.0	5.00	11.40	5.00	16.58
	p99	0.0	5.00	16.52	20.00	20.00
	Max	0.0	5.00	16.52	20.00	20.00
7 - 12 years (n = 3)	Mean	-	-	0.00	0.00	0.00
	SD	-	-	0.00	0.00	0.00
	Min	-	-	0.00	0.00	0.00
	p25	-	-	0.00	0.00	0.00
	Median	-	-	0.00	0.00	0.00
	p75	-	-	0.00	0.00	0.00
	p95	-	-	0.00	0.00	0.00
	p99	-	-	0.00	0.00	0.00
	Max	-	-	0.00	0.00	0.00
p-value		-	-	0.301	**0.017**	**0.012**

* Significant ($p < 0.05$). Wilcoxon sum rank test

Table B13. Mouthing median contact duration (s) while on playground (n = 24) by younger (1-6 years) and older (7-12 years)

Age Group		Floors	Hands	Dietary	Non-Dietary	All Objects
1 - 6 years	n*	1	14	6	16	19
	Mean	1.00	2.07	25.58	2.34	8.24
	SD	-	1.87	59.00	1.89	26.76
	Min	-	1.00	0.50	1.00	0.50
	p25	-	1.00	1.00	1.00	1.00
	Median	-	1.00	1.50	1.50	1.00
	p75	-	2.00	3.00	3.00	3.00
	p95	-	6.50	146.00	6.50	118.50
	p99	-	6.50	146.00	6.50	118.50
	Max	-	6.50	146.00	6.50	118.50
7 - 12 years	n*		0	0	1	1
	Mean	-	-	0.00	0.00	0.00
	SD	-	-	0.00	0.00	0.00
	Min	-	-	0.00	0.00	0.00
	p25	-	-	0.00	0.00	0.00
	Median	-	-	0.00	0.00	0.00
	p75	-	-	0.00	0.00	0.00
	p95	-	-	0.00	0.00	0.00
	p99	-	-	0.00	0.00	0.00
	Max	-	-	0.00	0.00	0.00
P value		-	-	-	0.082	0.083

* only children who contacted the object are included in the calculation

Appendix I. Quantification of Micro-level Activities from Recorded Data of Children Playing Soccer on Artificial Turf

Appendix I. Quantification of Micro-level Activities from Recorded Data of Children Playing Soccer on Artificial Turf

Part II

THE UNIVERSITY OF ARIZONA
Mel & Enid Zuckerman College of Public Health

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"Quantification of Micro-level Activities from Recorded Data of Children Playing Soccer on Artificial Turf "

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1.0 Introduction

There is a lack of information on the exposure to crumb rubber infill for artificial soccer fields. The dermal and ingestion pathways of exposure have not been fully assessed and may pose a particular risk for children. Risk assessment models are used to evaluate the non-dietary ingestion and dermal pathway of exposure, which require the use of precise activity data on hand and mouthing contacts. However, there is limited information on the behaviors of soccer players while playing on artificial turf. Direct observation (including videotaping) is considered the most accurate way to record a child's dermal contact and mouthing behaviors (Cohen Hubal et al., 2000a). While eliminating recall bias, videotaping preserves real-time activities that can later be carefully analyzed for detailed contact frequency and duration, and for inter- and intra-observer reliability, as well as any other needs should new concerns arise (Zartarian et al., 1997a). This approach may be the only viable approach for collecting activity patterns to estimate non-dietary ingestion since it allows quantification of frequent mouthing events of short duration (Cohen Hubal et al., 2000b; Juberg et al., 2001). Therefore, this study focused on the collection and analysis of micro-level activity time series (MLATS) from video data of participants playing soccer in the San Francisco Bay Area and the Sacramento area. The objective of this report is to provide quantified activity data to support estimating potential health risks of Californians that play soccer on synthetic turf fields.

2.0 Methods

2.1 Data Collection

In order to collect the MLATS, a total of 40 participants were video recorded while playing soccer by a team of researchers from the University of California, Berkeley (UCB) and The Office of Environmental Health Hazard Assessment (OEHHA). The videotaping occurred during scheduled games or practices in Northern California. A total of 10 events (an average of 4 players per event) were recorded. Research staff completed an "Object Palette Log Sheet", where they recorded descriptions of the objects contacted by participants. This was later used to confirm objects in the video recording. The "Taper's Log Time" sheet was completed to record all of the start and stop times, and to describe any particular change during the recording.

The collected video data were saved to an encrypted computer at UCB and then the data were received by the University of Arizona (UA) via a secure platform. Once at UA, the data was saved to an encrypted protected external hard drive, which was stored in a locked drawer. The UA Institutional Review Board (IRB) approved to cede the project to the UC Berkeley Committee for the Protection of Human Subjects (CPHS) and the California State IRB. The UC Berkeley CPHS approval was received on November 13, 2017 and the California State IRB approved on December 4th, 2017.

2.2 Video Translation and Data Processing

The video data was translated for body part (hands and mouth) to object/surface contact data behavior, macro-activities, specific actions and intensity of players during a soccer event on artificial turf. Before transcription, each video was converted from an MTS file type to an MP4 file type using Windows Movie Maker V2013 to be analyzed. The Video Translator -TE software developed by Dr. Robert Canales in the College of Public Health at the University of Arizona was adapted from the Virtual Timing Device previously developed by Stanford's Exposure Research Group (Ferguson et al., 2006). This computer software was used to translate the video footage into computer text files. Video Translator -TE software is a tool designed to quantify real-time, sequential micro-activity pattern data collected via videos. The software couples grid activation with a computer clock that records (to fractions of a second), the total duration of each contact/activity event in the sequence that the activities occurred. A computer text file of the time series is produced from the translation process (Figure 2.2.a).

	Bodypart	Lacation	Activity	Object	Duration
1 Repetitive contact	Right_Hand	Yard	**Repetitive**	Hard_Toy	**2**
2 Continuous contacts between locations	Right_Hand	Yard	Constant	Hard_Toy	3
	Right_Hand	**Yard**	Constant	Head	**5**
	Right_Hand	**Patio**	Constant	Head	**5**
	Right_Hand	**Yard**	Constant	Head	**2**

	Bodypart	Lacation	Activity	Object	Duration
1 Repetitive contacts are expanded	Right_Hand	Yard	**Constant**	Hard_Toy	**0.5**
	Right_Hand	Yard	**Constant**	Nothing	**0.5**
	Right_Hand	Yard	**Constant**	Hard_Toy	**0.5**
	Right_Hand	Yard	**Constant**	Nothing	**0.5**
2 Continuous contacts are aggregated	Right_Hand	Patio	Constant	Hard_Toy	3
	Right_Hand	**Yard**	Constant	Head	**12**

Figure 2.2.a. Example of computer text file produced from Video Translator -TE interface and processing of repetitive and continuous contacts (adapted from AuYeung et al., 2006).

The Video Translator -TE interface is an on-screen window containing multiple grids. This interface is referred to as a "palette" and can be customized for a specific study. For this study, two palettes were designed. The first consists of four grids, each comprising cells labeled with names of: (a) locations, (b) moments/time of event, (c) glove use, and (d) object/surfaces relevant to people playing soccer (Figure 2.2.b). While monitoring a contact boundary (e.g., right hand, left hand, mouth) on the video, the video translator collects data by activating (i.e., positioning the cursor over a cell and clicking the pointing device) the appropriate cell in each grid.

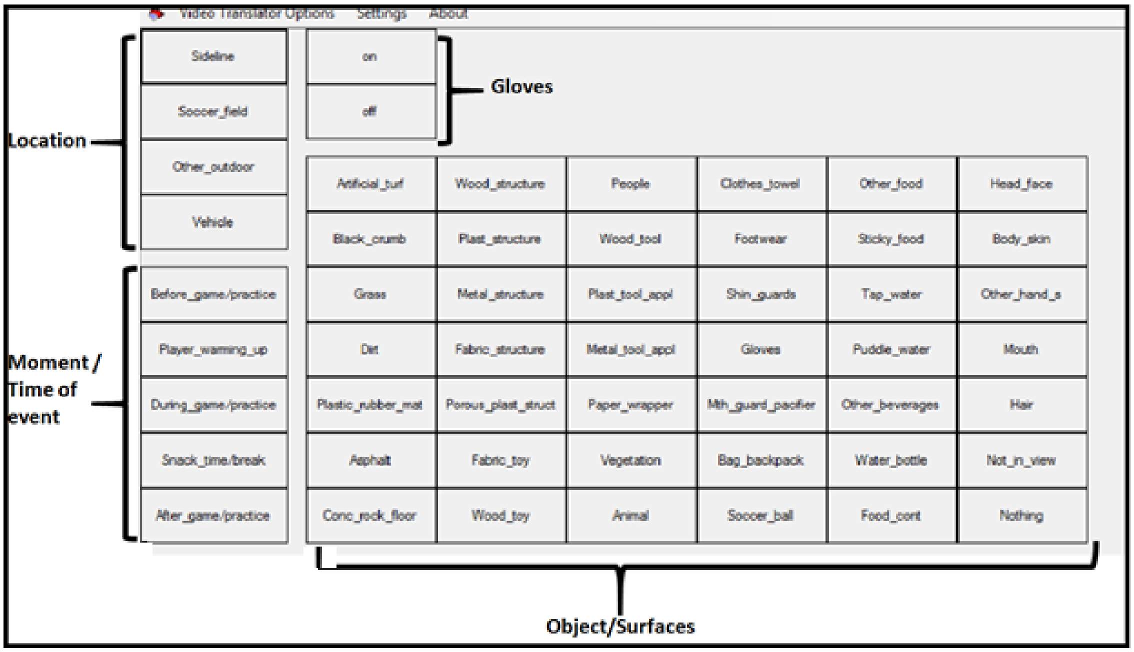

Figure 2.2b. Palette used to collect data on contact frequency and duration of body parts with objects, location of participant, glove use, and the moment/time of the event.

As presented in Figure 2.2.c, to collect data on macro-activities, specific actions and player intensity, the Video Translator -TE palette was modified to have four grids (palette) with: (a) locations, (b) moments/time of event, (c) macro-activities/actions and (d) player intensity during the soccer event.

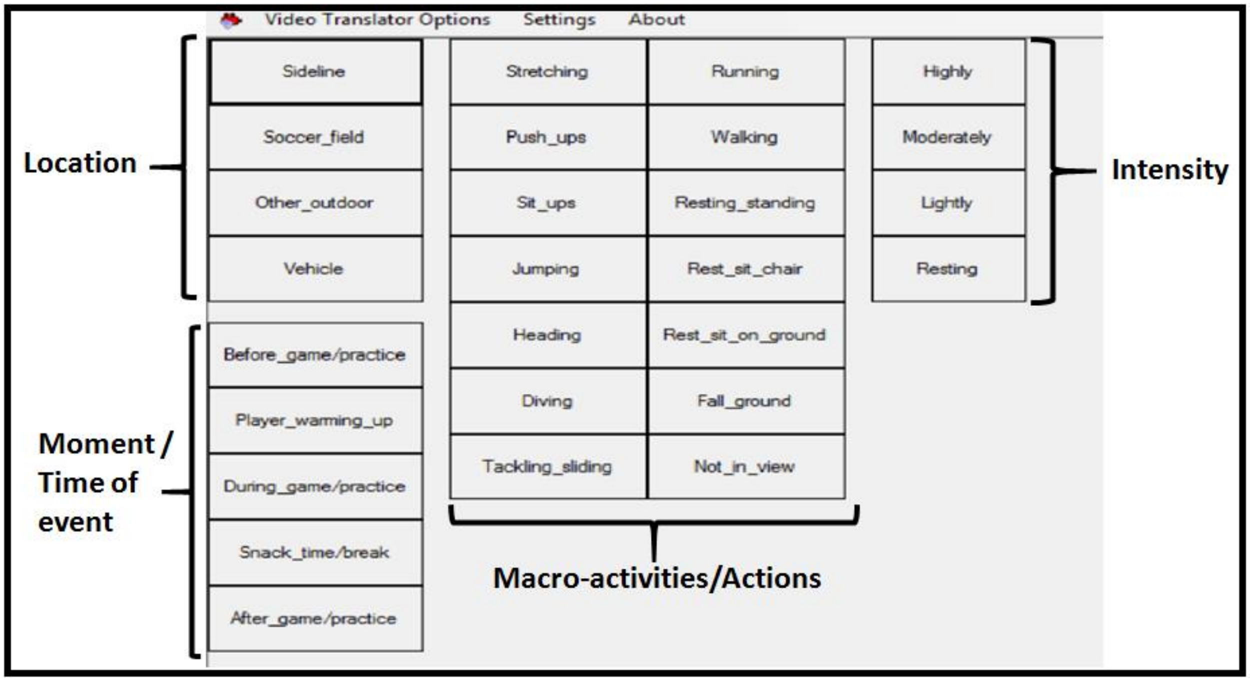

Figure 2.2.c. Palette used to collect data on macro-activities, specific actions, and intensity during the soccer event.

2.2.1 Training

All of the videos were translated by six members of the research team who passed a rigorous training. The training consisted of analyzing four videos of increasing difficulty. The training videos were transcribed using the two palettes (Figure 2.2.b-c). The transcribed data was then compared to a “gold standard” (previously transcribed by an experienced transcriber). To acquire a high inter-observer reliability, the trainee’s transcription had to be less than 10% different compared to the gold standard before the trainee could move on to the next training video and eventually to collect data once all 4 training videos were completed adequately. For additional information on the training process, see "Training Protocol" in Appendix A. Code was written in Rstudio V1.1 (RStudio Team, 2017) to compare the files and calculate the percent difference between them (Appendix A).

2.2.2 QC/QA

In addition to the translation training requirements, in order to maintain consistency and quality of translations, 10% of the translated video files were "spot-checked." These files were re-translated by experienced researchers. To pass the "spot-check," a 90% agreement between translator and experienced translator was required. For every 12 hours of translated video data, a re-translation was randomly conducted for the body parts (mouth and hands) and macro-activities. In case there was a discrepancy of more than 10% between the translator file and the experienced translator file, both worked together to resolve the discrepancy. Some of the errors may have occurred due to mis-designations of objects, lack of attention, or the participant not being in view. In order to check to correct and minimize the possible errors, a portion of videos were randomly reviewed following strict protocols attached in Appendix A. For intra-observer reliability, some of the videos were translated twice by the same translator. All these files had 90% agreement. All of the QC/QA checks were completed using code developed in Rstudio V1.1 (Appendix A.

2.3 Data Analysis

The translated plain text files were exported into Microsoft Excel 2013 files before analyzing them using Rstudio V1.1. (Rstudio team, 2017). Contact frequency, hourly contact duration and median contact duration were calculated for the mouth and each hand separately.

- Contact frequency (events/h) is the total number of contacts of a body part with a specific object divided by the total time that the child was in view (h).
- Hourly contact duration (min/h) is the total time that the body part was in contact with the object (min) divided by the total time that the child was in view (h).
- Median contact duration (s) for each child was calculated from the duration(s) of all the contacts a body part had with an object during the time in view. Median contact duration is only calculated for participants that contacted the object.

To represent the overall distribution for the population, children who did not contact an object/surface were still included in the calculation of contact frequency and hourly contact duration. However, median duration of contact was only calculated among those participants who contacted the object. The object/surfaces were selected and grouped as presented in Table 2.3.1.a.

More specific objects were assigned to the palette categories, and examples are available in Appendix A.

All calculations were made for individual categories and also for “non-dietary” and “all objects.” While for contact frequency and hourly contact duration, the values for individual object categories were summed, median contact duration for these aggregate categories was calculated across all of the contacts for that aggregate category. For example, median duration for “all objects” was calculated as the median duration of contact with any object.

Table 2.3.1.a. Selected object/surfaces summarized in this study

Object "Super" Categories	Specific Categories from Video Translator -TE Interface
Shin guards	Shin guards
Footwear	Footwear
Water bottle	Water bottle
Soccer ball	Soccer ball
Artificial turf	Artificial turf, Black crumb
Body	Body skin, People, Other hand
Clothes	Clothes and towels, Bags and backpacks, Fabric toys
Head	Head face, Hair
Field structures	Plastic tools, Plastic structures, Fabric structures, Metal structure
Dietary objects	Tap water, Other beverages, Water bottle, Other food, Food container
Non-Dietary objects	Everything, but dietary categories
Hands*	Hands
All objects/surfaces	Shin guards, Artificial turf, Black crumb, Head and face, Hair, Clothes and towels, Bag and backpack, Fabric toy, Plastic tools, Plastic structures, Fabric structures, Metal structures, Vegetation, Grass, Body skin, People, Concrete or rock floor, Paper wrapper, Water bottle, Soccer ball, Gloves, Footwear, Tap water, Food container, Wood toy, Other food, Dirt, Puddle water, Plastic or rubber mat, Asphalt, Wood structure, Porous plastic structure, Wood tool, Metal tools, Animal, Mouth guard - pacifier, Sticky food, Other beverages.

* Only used for mouthing events

The macro-activities, actions and intensity categories used in this study are presented in Table 2.3.1.b. Macro-activities are discrete major behavior or activities, such as walking, running, or resting. Using RStudio V1.1, activity patterns were also summarized for macro-activities, specific actions, and player intensity as follows:

- Frequency of specific actions (event/h) is the total number times a participant did a specific action (event) divided by participant's time in view (h)
- Hourly duration of macro-activities (min/h) is the total time a participant spent doing the macro-activity (min) over their total time in view (h)
- Hourly duration of player intensity (min/h) is the total time a player spent at each intensity (min) divided by their total time in view (h)

Table 2.3.1.b. Macro-activities, specific actions and player intensity categories

	Specific Categories from Video Translator -TE Interface
Macro-activity	Resting standing, Running, Stretching, Walking, Rest, Sit on the ground, Resting sitting on a chair, Push-ups, Sit ups.
Specific Actions	Jumping, Diving, Fall or slip on the ground, Tackling or sliding, Heading
Intensity	Highly, Moderately, Lightly, Resting

All of the previous activity variables were also calculated according to the following categories: event schedule (moment/time), player location, glove use, player age, player gender, player position, and event type. (Table 2.3.1.c).

Table 2.3.1.c. Description of Analysis Categories

Category	Description
Event Schedule	During game or practice, warming up, after/before/breaks, other combined time (after/before/breaks, and warming up with exception of during the game).
Player Location	On field, Off field (Sideline, Vehicle, Other)
Glove Use	Gloves on, Gloves off
Player Age	2 - <9 years, 9-16 years, >16 years
Player Gender	Male, Female
Player Position	Goalie, Others
Type of Event	Game, Practice

2.3.3 Statistical Analysis

Using Rstudio V1.1 (RStudio Team, 2017), the activity pattern variables (i.e., hand and mouth contact frequency, hourly contact duration, median contact duration, duration of macro-activities, frequency of specific actions, and duration of player intensity) were evaluated for significant differences as a function of each of the analysis categories (Table 2.3.1.c). The Wilcoxon Signed Rank Test for paired data was used to assess if there is a difference in hand contact activity between the left and right hands. The Kruskal-Wallis Test was used to assess for differences across the four age groups. To determine if there are differences between gender, position, event type, we used the Wilcoxon Rank Sum Test.

3.0 Results

40 participants were recruited and video recorded at 10 events for a total of 74 hours of footage (Table 3.0). Unless specified (i.e., by event schedule), activity patterns are summarized for the entire time each player was in view on the footage.

Table 3.0. Footage and view time for all 10 soccer events (N = 40)

	Total Footage	Time not in view	Time in view
Minutes	4410.30	272.30	4138.00
Hours	73.50	4.50	69.00
Percentage	100.00	6.20	93.80

3.0.1 Activities with left hand

3.1 Activities with hands

The left and right hand contact activities with objects are presented in Tables 3.1.1-3.1.6, respectively. The contact frequency, duration and median duration seem to be similar for the left and right hand. There was no significant difference for right and left hand contact activities (Table 3.1.7). Consequently, the activities for left and right hands were combined into both hands.

Table 3.1.1 Left hand contact frequency (event/h) (n = 40)

	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	4.34	6.06	0.00	0.73	1.75	4.83	16.60	23.96	28.43
Body	12.21	11.52	0.73	3.48	10.42	16.37	30.22	49.55	52.62
Clothes	76.33	39.32	17.15	53.55	65.18	94.63	150.49	194.80	212.21
Field Structures	7.33	5.90	0.50	2.18	5.88	10.20	16.83	23.50	26.41
Footwear	5.77	5.33	0.00	1.88	4.33	8.71	12.90	22.34	28.28
Head/face/hair	29.46	26.47	1.80	12.36	20.30	38.68	94.33	105.76	111.06
Shin guards	1.23	2.96	0.00	0.00	0.00	0.91	5.99	12.45	16.44
Soccer ball	20.73	25.79	0.43	6.25	10.35	23.63	63.62	107.16	108.32

Water bottle	6.15	5.23	0.00	1.86	5.25	9.28	13.65	19.73	22.80
Dietary Objects	6.21	5.26	0.00	1.86	5.25	9.28	13.65	19.73	22.80
Non-dietary Objects	200.97	79.63	87.56	152.38	187.48	217.86	354.94	421.31	429.36
All Objects	207.18	80.85	91.21	158.70	193.75	226.28	363.74	427.43	429.85

Table 3.1.2 Left hand contact duration (min/h) (n = 40)

	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0.24	0.52	0.00	0.02	0.09	0.27	0.58	2.29	3.21
Body	1.26	1.87	0.01	0.12	0.37	1.79	4.75	7.27	8.41
Clothes	13.94	12.14	1.71	5.51	9.39	17.83	36.88	47.70	52.61
Field Structures	0.77	0.83	0.03	0.13	0.46	1.35	2.56	2.97	3.15
Footwear	0.54	0.59	0.00	0.10	0.32	0.88	1.87	2.14	2.23
Head/face/hair	1.02	1.35	0.05	0.33	0.67	1.27	2.45	6.05	8.27
Shin guards	0.12	0.34	0.00	0.00	0.00	0.08	0.67	1.53	1.81
Soccer ball	0.78	0.89	0.01	0.16	0.45	1.12	3.17	3.57	3.81
Water bottle	1.00	1.17	0.00	0.25	0.78	1.52	2.04	5.13	6.73
Dietary Objects	1.01	1.17	0.00	0.25	0.80	1.53	2.04	5.13	6.73
Non-dietary Objects	21.31	12.68	5.93	12.96	17.40	26.87	45.67	54.05	58.09
All Objects	22.32	12.88	6.13	13.11	18.59	28.23	46.10	55.61	58.80

Table 3.1.3 Left hand contact median duration (s)

	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	35	2.55	3.72	0.19	0.87	1.22	2.55	9.59	16.73	18.23
Body	40	2.01	1.90	0.57	1.11	1.39	2.30	4.19	9.09	12.17
Clothes	40	4.21	2.55	1.68	2.62	3.38	4.53	9.35	12.44	13.65
Field Structures	40	3.47	2.27	0.38	1.85	2.90	4.71	7.71	9.87	10.22
Footwear	40	4.11	3.52	0.93	2.05	2.88	5.24	9.00	15.82	19.75
Head/face/hair	40	1.34	0.51	0.55	1.08	1.20	1.56	2.25	2.87	3.16
Shin guards	17	4.62	4.26	1.41	1.82	3.31	5.38	12.01	15.76	16.70
Soccer ball	40	1.69	0.77	0.64	1.20	1.55	2.03	3.16	3.93	4.39
Water bottle	38	7.88	5.83	0.73	4.66	6.39	10.18	16.14	27.90	31.77
Dietary Objects	38	7.86	5.84	0.73	4.71	6.39	10.18	16.14	27.90	31.77
Non-dietary Objects	40	2.33	1.14	0.54	1.61	2.15	2.79	3.65	6.21	7.19
All Objects	40	2.41	1.12	0.54	1.65	2.22	2.98	3.75	6.09	6.95

Table 3.1.4 Right hand contact frequency (event/h) (n = 40)

	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4.46	5.72	0.00	1.26	2.55	4.89	12.58	25.24	26.94
Body	14.77	11.99	1.85	6.33	10.90	18.56	38.45	50.19	56.20
Clothes	72.63	34.94	18.11	47.21	68.24	87.23	151.98	154.52	156.13
Field Structures	7.86	6.59	1.34	3.43	5.77	10.97	19.72	27.47	30.60
Footwear	6.75	5.89	0.73	2.76	5.74	8.36	14.37	25.84	33.06
Head/face/hair	27.32	24.59	1.39	9.49	19.78	37.98	70.45	103.02	116.46
Shin guards	1.47	3.69	0.00	0.00	0.00	1.23	5.53	16.32	21.16
Soccer ball	20.90	25.07	0.51	4.92	12.00	31.55	68.54	101.57	104.03

Water bottle	7.08	6.03	0.00	3.28	5.72	8.83	18.70	25.89	29.73
Dietary Objects	7.12	6.04	0.00	3.28	5.72	8.83	18.70	25.89	29.73
Non-dietary Objects	199.52	70.80	95.10	145.07	184.38	230.37	308.10	378.36	418.10
All Objects	206.64	71.95	101.04	149.90	195.47	249.85	318.85	382.38	419.59

Table 3.1.5 Right hand contact frequency (min/h) (n = 40)

	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.27	0.53	0.00	0.02	0.11	0.30	0.81	2.42	2.90
Body	1.25	1.65	0.04	0.16	0.54	1.62	4.73	5.67	5.73
Clothes	12.21	11.16	1.53	5.72	8.35	14.32	34.98	47.52	52.84
Field Structures	0.84	0.99	0.02	0.20	0.43	1.05	3.40	3.51	3.55
Footwear	0.59	0.56	0.02	0.15	0.31	0.86	1.73	1.89	1.93
Head/face/hair	0.99	1.42	0.01	0.31	0.61	1.20	2.15	6.32	8.87
Shin guards	0.12	0.34	0.00	0.00	0.00	0.09	0.65	1.50	1.89
Soccer ball	0.95	1.06	0.01	0.25	0.67	1.19	3.85	4.22	4.38
Water bottle	1.42	1.44	0.00	0.53	1.01	1.84	3.77	6.10	6.80
Dietary Objects	1.43	1.44	0.00	0.53	1.01	1.84	3.77	6.10	6.80
Non-dietary Objects	19.70	11.82	5.88	12.39	15.35	25.67	44.15	53.47	57.80
All Objects	21.13	12.06	6.53	12.87	18.15	26.10	44.64	55.62	59.75

Table 3.1.6 Right hand contact median duration (s) (n = 40)

	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	1.37	0.84	0.18	0.74	1.18	1.74	3.18	3.25	3.27
Body	1.59	1.39	0.43	0.91	1.18	1.85	3.15	7.11	7.70
Clothes	4.31	2.66	1.51	2.61	3.49	4.99	8.66	12.62	12.88
Field Structures	3.52	3.62	0.72	1.46	2.66	4.23	7.74	16.61	22.10
Footwear	3.55	3.18	0.83	1.55	2.30	4.99	9.91	13.84	15.40
Head/face/hair	1.34	0.47	0.54	1.05	1.24	1.48	2.13	2.94	3.42
Shin guards	4.96	5.07	0.90	2.28	3.02	5.39	16.97	18.00	18.26
Soccer ball	2.54	1.79	0.46	1.53	1.97	3.24	6.76	8.02	8.40
Water bottle	8.18	5.07	2.01	4.78	6.57	10.25	15.96	23.88	24.74
Dietary Objects	8.17	5.07	2.01	4.78	6.57	10.25	15.96	23.88	24.74
Non-dietary Objects	2.27	1.09	0.33	1.49	2.02	2.89	3.79	5.62	6.34
All Objects	2.36	1.12	0.33	1.55	2.26	2.98	3.94	5.79	6.52

Table 3.1.7. P-values from comparing the left and right hand activities using Wilcoxon Signed Rank Test

	Frequency (n = 40)	Duration (n = 40)	Median Duration
Artificial Turf	0.519	0.703	0.401 (n = 70)
Body	0.154	0.413	0.062 (n = 80)
Clothes	0.765	0.557	0.946 (n = 80)
Field Structures	0.707	0.686	0.447 (n = 80)
Footwear	0.303	0.651	0.168 (n = 78)

Head/face/hair	0.630	0.729	0.871 (n = 80)
Shin guards	0.499	0.472	0.917 (n = 30)
Soccer ball	0.950	0.356	0.153 (n = 80)
Water bottle	0.567	0.164	0.567 (n = 74)
Dietary Objects	0.564	0.167	0.566 (n = 74)
Non-dietary Objects	0.954	0.535	0.825 (n = 80)
All Objects	0.908	0.744	0.817 (n = 80)

***There were no significant differences between left and right hand for frequency, duration and median duration.**

Since there was no significant difference between left and right hand contact activities, the data sets were combined to calculate activity patterns for both hands (Table 3.1.7). The both hands contact frequency for participants playing soccer on turf is summarized in Table 3.1.8. The median hand contact frequency with artificial turf is 2.39 events/h, with a maximum of 27.68 events/h. Aside from clothes, body and their head, participants contacted soccer balls the most frequently with a median contact frequency of 10.83 event/h. The median hand contact frequency was 160.99 events/h for non-dietary objects.

Table 3.1.8 Both hands contact frequency (event/h) (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4.49	5.90	0.00	1.09	2.39	4.83	17.44	23.79	27.68
Body	13.54	11.52	1.52	5.10	9.78	16.48	35.48	49.38	54.40
Clothes	74.72	35.55	17.63	54.03	65.91	91.02	151.33	174.31	182.29
Field Structures	7.62	6.01	1.46	3.04	6.03	10.64	19.65	23.88	24.75
Footwear	6.32	5.52	0.72	2.26	5.05	9.15	12.68	23.74	30.66
Head/face/hair	28.74	25.09	2.28	12.35	20.21	33.70	78.41	103.75	113.79
Shin guards	1.36	3.30	0.00	0.00	0.00	1.10	5.76	14.38	18.79
Soccer ball	21.40	27.34	0.55	5.60	10.83	29.33	65.67	116.98	123.89
Water bottle	6.67	5.37	0.00	3.23	5.15	9.04	17.57	20.82	20.89
Dietary Objects	6.72	5.39	0.00	3.27	5.15	9.04	17.57	20.82	20.89
Non-dietary Objects	169.80	66.85	73.89	122.44	160.99	188.22	303.96	352.05	361.74
All Objects	176.52	68.47	80.69	131.96	165.08	197.66	308.60	364.63	371.23

The hourly hand contact duration for participants playing soccer on artificial turf is summarized in Table 3.1.9. The median hourly hand contact duration for artificial turf was 0.11 min/h, and the maximum is 3.05 min/h. The median hand hourly duration with non-dietary objects was 15.02 min/h.

Table 3.1.9. Both hands hourly contact duration (min/h) (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0.26	0.51	0.00	0.03	0.11	0.31	0.79	2.24	3.05
Body	1.26	1.72	0.03	0.16	0.43	2.03	4.56	6.25	6.99
Clothes	12.75	11.81	1.60	5.74	9.02	16.84	35.19	47.61	52.73
Field structures	0.81	0.87	0.03	0.18	0.44	1.29	2.43	3.20	3.30
Footwear	0.57	0.57	0.01	0.16	0.32	0.86	1.85	1.98	1.98
Head/face/hair	1.01	1.37	0.03	0.35	0.65	1.44	2.15	6.09	8.57
Shin guards	0.12	0.34	0.00	0.00	0.00	0.08	0.66	1.51	1.85
Soccer ball	0.89	1.03	0.01	0.22	0.57	1.19	3.61	4.20	4.27
Water bottle	1.23	1.26	0.00	0.42	0.89	1.77	2.74	5.48	6.77
Dietary objects	1.23	1.26	0.00	0.42	0.91	1.77	2.74	5.48	6.77
Non-dietary objects	18.44	12.01	1.27	9.83	15.02	22.65	42.63	52.64	56.91
All objects	19.67	12.11	3.44	11.78	15.92	24.87	43.15	54.50	58.83

The median hand contact duration for participants while playing on artificial turf is summarized in Table 3.1.10. Median duration is only calculated from those participants that contacted the object. The median hand contact duration for artificial turf was 1.20 s, and the maximum was 5.14 s. The median hand contact duration was 2.10 for non-dietary objects. Note that for the all objects (Table 2.3.1.a), median duration was calculated across all of the contacts with all of the object categories included. Thus, sometimes the values will be lower than for some of the individual object categories, particularly if there was proportionally a lower number of contacts with that object.

Table 3.1.10. Both hands contact median duration (s)

Objects	n*	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	35	1.53	1.11	0.46	0.84	1.20	1.65	3.85	4.95	5.14
Body	40	1.70	1.62	0.53	0.96	1.26	1.92	3.13	8.43	9.78
Clothes	40	4.21	2.54	1.85	2.50	3.43	4.77	9.26	12.23	13.16
Field structures	40	3.47	3.27	0.41	1.78	2.56	4.40	6.93	15.19	19.96
Footwear	40	3.74	3.38	0.89	1.66	2.47	4.83	9.91	15.18	15.34
Head/face/hair	40	1.35	0.46	0.60	1.11	1.21	1.59	2.08	2.79	3.09
Shin guards	17	4.28	4.26	0.90	1.61	2.64	4.68	13.55	16.07	16.70
Soccer ball	40	1.86	0.87	0.64	1.20	1.64	2.09	3.78	3.90	3.95
Water bottle	38	6.87	2.98	2.09	5.19	6.64	8.41	13.40	13.76	13.79
Dietary objects	38	6.84	2.97	2.09	5.16	6.64	8.30	13.40	13.76	13.79
Non-dietary objects	40	2.48	1.20	1.23	1.70	2.10	2.93	4.22	6.50	6.93
All objects	40	2.57	1.20	1.25	1.79	2.18	3.01	4.28	6.58	6.94

*only calculated from participants who contacted the object.

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3.2 Mouthing activities

The mouthing contact frequency for participants playing soccer on turf is summarized in Table 3.2.1. None of the participants observed contacted artificial turf (including black crumb) with their mouths during the recordings. There were also no mouthing contacts with shin guards or footwear observed. The median mouth contact frequency was 7.55 and 14.48 events/h for hands and non-dietary objects, respectively.

Table 3.2.1. Mouthing contact frequency (event/h) (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf*	-	-	-	-	-	-	-	-	-
Body skin	0.55	1.71	0.00	0.00	0.00	0.12	2.1	7.71	9.93
Clothes	9.13	16.98	0.00	1.33	4.05	11.1	24.3	74.82	104.27
Field structures	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.24	0.4
Footwear*	-	-	-	-	-	-	-	-	-
Hands	8.91	5.87	0.71	5.64	7.55	11.31	18.41	25.8	26.03
Head/face/hair	0.03	0.15	0.00	0.00	0.00	0.00	0.02	0.67	0.83
Shin guards*	-	-	-	-	-	-	-	-	-
Soccer ball	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.34	0.55
Water bottle	4.96	4.65	0.00	1.7	3.75	6.43	15.58	17.7	17.81
Dietary objects	5.17	4.56	0.00	2.04	4.03	6.85	15.58	17.7	17.81
Non-dietary objects	19.81	18.76	2.94	9.78	14.48	23.68	42.97	91	111.92
All objects	24.97	19.94	3.57	12.18	18.87	30.93	50.75	96.76	118.87

*No participants contacted artificial turf, shin guards or footwear with their mouths

The hourly mouthing contact duration for participants playing soccer on artificial turf is summarized in Table 3.2.2. There were no mouthing contacts observed with artificial turf, shin guards, or footwear. The median mouthing hourly duration was 0.21 and 0.41 min/h with hands and non-dietary objects, respectively.

Table 3.2.2. Mouthing hourly contact duration (min/h) (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf*	-	-	-	-	-	-	-	-	-
Body skin	0.01	0.04	0.00	0.00	0.00	0.00	0.04	0.2	0.25
Clothes	0.31	0.52	0.00	0.03	0.12	0.37	1.00	2.32	2.76
Field structures	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03
Footwear*	-	-	-	-	-	-	-	-	-
Hands	0.41	0.76	0.01	0.10	0.21	0.37	0.92	3.32	4.74
Head/face/hair	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Shin guards*	-	-	-	-	-	-	-	-	-
Soccer ball	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water bottle	0.36	0.55	0.00	0.10	0.24	0.41	1.12	2.5	3.17
Dietary objects	0.37	0.54	0.00	0.10	0.25	0.42	1.12	2.5	3.17
Non-dietary objects	0.76	0.92	0.05	0.20	0.41	0.98	1.8	4.21	4.99
All objects	1.13	1.18	0.06	0.40	0.82	1.42	3.06	5.34	6.45

*No participants contacted this object

The median mouthing contact duration for participants while playing on artificial turf is summarized in Table 3.2.3. Median duration is only contacted from those children that contacted the object with their mouth. No participants were observed contacting artificial turf, shin guards or footwear with their mouths. The median mouthing contact duration was 1.10 s for both hands and 1.14 s non-dietary objects. Thus, sometimes the values will be lower than for some of the individual object categories, particularly if there was proportionally a lower number of contacts with that object.

Table 3.2.3. Mouthing median contact duration (s)

Objects	n	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	10	1.00	0.41	0.54	0.61	0.98	1.25	1.59	1.60	1.60
Clothes	36	1.72	1.7	0.62	0.91	1.36	1.78	3.62	8.35	10.61
Field structures	1	5.18	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	40	1.35	0.79	0.66	0.91	1.10	1.45	2.56	4.15	4.76
Head/face/hair	2	1.15	0.5	0.79	0.97	1.15	1.33	1.47	1.50	1.50
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	1	0.13	-	-	-	-	-	-	-	-
Water bottle	35	3.60	1.33	1.71	2.59	3.37	4.40	5.81	6.5	6.83
Dietary objects	37	3.48	1.31	1.71	2.48	3.15	4.34	5.73	6.46	6.83
Non-dietary objects	37	1.33	0.73	0.74	0.87	1.14	1.40	2.55	3.87	4.45
All objects	39	1.64	0.86	0.79	1.08	1.34	2.06	3.07	4.5	5.36

3.3. Macro-activities (e.g. walking, running)

The hourly duration for participants engaging in macro-activities on artificial turf is summarized in Table 3.3.1. The macro-activities that participants engaged in for the largest proportion of their time were walking, standing, and running with median durations of 24.51, 16.75, 13.85 min/h respectively. All 40 participants were observed doing those activities. 39 participants were observed sitting on the ground, while only 17 were observed sitting in a chair. 31 participants were observed stretching and only 2 participants were observed doing push-ups.

Table 3.3.1. Hourly duration (min/h) of macro-activities (n = 40)

Macro-Activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.06	0.1
Running	13.69	6.13	2.47	9.13	13.85	18.21	23.61	24.49	24.99
Sit ups*	-	-	-	-	-	-	-	-	-
Sitting on chair	2.26	4.5	0.00	0.00	0.00	2.73	11.61	17.65	17.67
Sitting on ground	1.18	1.73	0.00	0.11	0.55	1.57	3.21	7.69	9.75
Standing	17.31	5.54	6.98	14.99	16.75	19.89	27.23	31.06	32.5
Stretching	0.75	1.27	0.00	0.09	0.37	0.81	3.24	5.6	5.86
Walking	24.49	6.08	10.5	21.18	24.51	28.52	33.63	35.87	37.28

*no participants were observed doing sit ups.

3.4. Specific actions (e.g. tackling, falling)

The event frequency for participants engaging in specific actions on artificial turf is summarized in Table 3.4.1. The specific actions that participants engaged in the most frequently was jumping with a median frequency of 3.65 events/h, followed by slipping/falling with a median frequency of 0.78 event/h. 34 participants were observed jumping. 27 participants were observed slipping or falling on the artificial turf. Fewer participants were observed diving, heading, and tackling, with only 8, 12, and 13 participants observed conducting these actions, respectively.

Table 3.4.1. Frequency (event/h) of actions during the whole event (n = 40)

Specific Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	0.53	1.69	0.00	0.00	0.00	0.00	2.44	7.40	9.89
Heading	0.33	0.61	0.00	0.00	0.00	0.48	1.91	2.07	2.10
Jumping	9.46	17.72	0.00	0.68	3.65	9.30	65.16	71.43	75.30
Slip/fall	2.19	3.45	0.00	0.00	0.78	2.31	11.30	13.06	13.19

Tackling or sliding	0.42	0.78	0.00	0.00	0.00	0.51	2.20	2.81	2.81

3.5. Player Intensity

The hourly duration for player intensity while on artificial turf is summarized in Table 3.5.1. Players spent the majority of their time at "low" intensity, with a median duration of 24.00 min/h. Low intensity corresponds to players who were moving but walking. Moderate and high intensity correspond to jogging and running, respectively. All 40 participants were observed at least for some time at each of the 4 intensities.

Table 3.5.1. Hourly duration (min/h) of player intensity (n = 40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	2.00	0.99	0.09	1.15	1.99	2.68	3.64	3.84	3.88
Moderate	12.52	5.09	3.75	8.65	12.98	15.88	20.80	22.05	22.82
Low	24.04	5.31	10.65	21.58	24.00	27.47	31.05	33.75	34.29
Resting	21.44	7.81	10.86	16.50	18.68	26.98	33.83	40.91	41.81

<u>3.6 Analyzed by event schedule, location, gloves usage, age, gender, players' position, and event type:</u>

3.6.1 Event Schedule (moment/time)

The data was summarized based on the event schedule which included: the whole event (Sections 3.1 to 3.5), during the game/practice, warming up, after/before/break time, and other combined time with the exception of during the game (i.e., warming up and after/before/break time combined). The hand to object, mouthing events, actions, macro-activities, and intensity according to different event times are presented in Appendix B. As presented in Appendix B, the data was summarized for each specific time of the event such as *during the game, game/practice, warming up, after/before/break time, and other combined time*.

<u>*During the game (Appendix B: Section B.1.1):*</u> Data during the game/practice were very similar to the whole event. There were more contacts of hands to artificial turf (median frequency: 2.16 event/h),

followed by contacts of hands to footwear (median frequency: 3.44 event/h), and hands to soccer ball (median frequency: 9.97 event/h) than contacts with dietary objects (median frequency: 1.30 event/h). However, the median contact duration was longer for dietary objects than all of the other objects, which may indicate that there was a longer holding time of these dietary objects than the rest of the objects. The mouth to hand median contact frequency was 7.49 event/h. Also, the most common action event per hour was jumping (median: 2.32 event/h) followed by slipping/falling on the artificial turf (median 0.81 event/h). With respect to macro-activities, players spent the majority of the time walking (median: 25.8 min/h) and running (median: 15.10 min/h) during the game and only about 0.37 min/h sitting on the ground, which corresponds to their intensity, as they spent only 1.84 min/h doing high intensity activities. (Within this document see Appendix B: Section B.1.1. of activity patterns during games/practice for details).

Warming up (Appendix B: Section B.1.2): The median frequency of players hands to artificial turf (0.00 event/h) contact was less during warm up than during the game as only four players made hand to artificial turf contact while warming up. Also, the median mouthing frequency event for mouth to hand (0.00 event/h) contact was lower than during the game. Similar to during the game, players spent the majority of the time walking (median: 21.12 min/h) and running (median: 15.21 min/h). However, while warming up, they spent less time sitting on the ground (0.00 min/h) than during the game. Additionally, with respect to intensity, players spent most of the time resting (median: 5.30 min/h) while warming up (Within this document see Appendix B: Section B.1.2. for details). *Please note that the intensity corresponds to actions and macro-activities together.*

After/before/break time (Appendix B: Section B.1.3): Similar to warming up, the median frequency of players hands to artificial turf contacts was 0.00 event/h. For the mouthing with artificial turf, regardless of the time of the event, there was not any mouthing events with artificial turf and only one person had a mouth to soccer ball contact. The median mouthing frequency event for mouth to hand was 0.00 event/h. For macro-activities, "Resting standing" was the macro-activity that players did most of the time (median: 30.40 min/h) on after/before/or during break time, which coincides with the intensity where they spent most of the time resting (37.00 min/h). (Within this document see Appendix B: Section B.1.3. for details).

Other combined time (Appendix B: Section B.1.4): the median frequency of players hands to artificial turf contacts was 0.00 event/h. The hand to non-dietary objects median contact frequency was 206.41. However, there were no mouthing events with artificial turf. Similarly to when players were on before/after/break time, dietary objects were contacted most frequently, for longer hourly durations and for longer periods of time (8.50 event/h, 1.10 min/h, and 3.70 s) than non-dietary objects. Also, "Resting standing" was the macro-activity that players did most of the time (median: 26.39 min/h) on other combined time, while the intensity that they spent most of the time was resting (34.95 min/h).

3.6.2 Location (on or off field) (Appendix B: Section B.2.1 and Section B.2.2)

There seems to not be some differences between hand to mouth contact when players were on or off the field. The hands to artificial turf median frequency contact for players recorded on field (2.61 event/h) was higher than players recorded off field (0.00 event/h). The mouthing median frequency with hands was higher for players on the field (6.99 event/h) than off the field (5.90 event/h). However, mouthing median frequency contact with clothes was higher off field than on field. While jumping was the most common event per hour for players on the field and off the field, players spent more time walking (median: 27.19 min/h) on the field and more than resting (median: 25.99 min/h) when off the field. (Within this document see Appendix B: Section B.2.1 to 2.2. for details).

3.6.3 Use of gloves (on or off) (Appendix B: Section B.3.1 and Section B.3.2)

There seem not be a large difference between the median frequency of players hands to artificial turf contacts when players wore gloves or not (2.30 event/h and 0\0 event/h, respectively). However, more mouthing events with hands were recorded for players who did not wear any gloves during the than the players who wore gloves at some point during the whole event (1.88 event/h and 7.18 event/h for people wearing gloves and not wearing gloves, respectively). (See Appendix B: Section B.3.1 to 3.2. for details).

3.6.4 Player Age (Appendix C – Separate Folder with Excel Files)

Activity statistics by age and results from statistical tests (Wilcoxon sum rank test) are presented in Appendix C.

During the whole event (Section C1 of Appendix C):

Hand to object contacts. There were significant differences ($p < 0.05$) in contact frequency (events/h) between the three age groups with artificial turf, clothes, soccer ball, and field structures. The younger age group (2 to < 9 years) had more contacts per hour with artificial turf, soccer ball, and field structure than the other two older age groups. There were significant differences in hourly contact duration between all three age groups with artificial turf and field structures. While the youngest children had the longer hourly contact duration with artificial turf, the oldest age group had longer hourly contact duration with field structures. However, for median duration, contact with artificial turf was not significantly different between the three age groups, but contact with non-dietary objects, clothes, and soccer ball were significantly different between the three age groups. The middle age group had the longest durations of contact with clothes. The oldest age group had the longest durations of contact with the soccer ball and the shortest with non-dietary objects.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing contact frequency (event/h) between age groups with water bottle and non-dietary objects. The younger age group (2 to < 9 years) had more mouthing contacts per hour with water bottle and non-dietary objects than the other two age groups. There were also significant differences ($p < 0.05$) in mouthing duration (min/h) between age groups with water bottle, non-dietary objects and all objects. For the mouthing median duration, there was a significant difference ($p < 0.05$) between age groups with hands. The younger age group (2 to < 9 years) had longer periods of hand to mouth contacts than the other age groups.

Actions. There were significant differences in frequency (event/h) between the three age groups while players were jumping and slipping/falling. Older soccer players (16+ years) were jumping and slipping/falling on the ground more frequently per hour than the younger age groups.

Macro-activities. There was a significant difference in hourly duration (min/h) between the three age groups while players were stretching. The older group (16 yrs +) spent more minutes per hour stretching than the other two age groups.

Intensity. There were no significant differences between the three age groups in hourly duration of player intensity.

During the game/practice (Section C2 of Appendix C):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between the three age groups with artificial turf, water bottle and dietary objects during the game/practice. The younger age group (2 to < 9 years) had more contacts per hour with artificial turf, water bottle and dietary objects than the other two age groups. There was only one significant difference in hourly duration between three age groups with soccer ball. The middle age group of players (9 to <16 years) contacted soccer ball more minutes per hour than the other age groups. For median duration (s), there were significant differences between the three age groups with artificial turf, body, head/face/hair, water bottle, and dietary objects.

Mouthing events. There were no significant differences ($p < 0.05$) in mouthing contact frequency (event/h) between age groups during the game/practice. There was a significant difference in mouthing duration (min/h) of hands between the age group. The younger age group (2 to <9 years) had longer mouthing of hands per hour than the other age groups. Similarly, for the median duration (s), there was a significant difference in mouthing between age groups with hands. The younger age group (2 to <9 years) had longer durations of hand to mouth contacts than other two age groups.

Actions. There were significant differences in frequency (event/h) between the three age groups for players jumping. Older soccer players (16+ years) jumped more frequently per hour than the younger age groups.

Macro-activities. There were no significant differences between the three age groups in hourly duration of macro-activities.

Intensity. There were no significant differences between the three age groups in hourly duration of player intensity.

Warming up (Section C3 of Appendix C):

Hands to object contacts. There were no significant differences in contact frequency (event/h), duration (min/h), or median duration (s) between the three age groups with any of the observed objects during warm up.

Mouthing events. Similarly, as hand to object activities, there were no significant differences in mouthing contact frequency (event/h), duration (min/h), or median duration (s) between the three age groups with any of the observed objects during warm up.

Actions. There were no significant differences between the three age groups for any of the specific actions while players were warming up.

Macro-activities. There was a significant difference in hourly duration between age groups for time spent walking during warm up. The older groups (9 to <16 years and 16 yrs +) spent more time walking than the younger age groups.

Intensity. There were no significant differences between the three age groups in hourly duration of player intensity.

After/before/break time (Section C4 of Appendix C):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between age groups with body, soccer ball, non-dietary objects, and all objects during after or before the event and during break times. The older age group (16+ years) had fewer contacts per hour with body, soccer ball, non-dietary objects, and all objects than the other two age groups. There was a significant difference in contact duration (min/h) between age groups with non-dietary objects. The middle age group of players (9 to <16 years) contacted non-dietary objects for more minutes per hour than the other age groups. For the median duration, there were no significant differences between age groups.

Mouthing events. There were no significant differences in mouthing contact frequency (event/h), duration (min/h), or median duration (s) between the three age groups with any of the observed objects after or before the event and during break times.

Actions. There were no significant differences in frequency (event/h) of specific actions between age groups.

Macro-activities. There were no significant differences in contact frequency and median duration between age groups. However, there were significant differences in hourly duration (min/h) between age groups while players were sitting on a chair or stretching. The older groups (9 to <16 years and 16 yrs +) had less minutes per hour stretching or sitting on a chair than the younger age group. Also, there were significant difference in hourly duration between age groups for time players spent walking and standing. The older groups (9 to <16 years and 16 yrs +) had more minutes per hour walking or standing than the younger age group.

Intensity. There were significant differences in hourly duration (min/h) of intensity between age groups. Older groups (9 to <16 years and 16 yrs +) had longer periods of light intensity, but shorter periods of moderate and high intensity than the younger age group.

<u>Other combined time (after/before/break/warming up time) but during the game (Section C5 of Appendix C):</u>

Hands to object contacts. There was a significant difference in contact frequency (event/h) with non-dietary objects between age groups during the other combined times that did not include the actual game or practice. The younger age group (2 to <9 years) had less contacts per hour with non-dietary objects than the other two age groups. There were significant differences in hourly duration (min/h) between age groups with soccer ball and non-dietary objects. The middle age group (9 to <16 years) contacted the ball and non-dietary objects for more minutes per hour than the other age groups. There were no significant differences in median duration(s) between age groups with any of the observed objects during this other combined time.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing frequency (event/h) between age groups with water bottle, non-dietary objects, and all objects. The older age group (16+ years) had fewer mouthing contacts with these objects than the other two groups. Also, there were significant differences ($p < 0.05$) in hourly contact duration (min/h) between age groups with water bottle, non-dietary objects, and all objects. The older age group (16+ years) had a shorter contact duration (min/h) with these objects than the other two groups. For the median duration (s), there were no significant differences between the three age groups.

Actions. There were no significant differences in frequency of any specific action between age groups not during the game or practice.

Macro-activities. Not during the game or practice, there was a significant difference in duration (min/h) between age groups while players were resting standing. The older group (16 yrs +) had shorter periods of standing per hour than the younger age groups. The younger age group (2 to <9 yrs) also had longer durations for running than other age groups. The older age group (16+ years) spent more time stretching than the other two groups.

Intensity. There were no significant differences between the three age groups in hourly duration of player intensity not during the game or practice (note: intensity includes activities and actions)

<u>On Field (Section C6 of Appendix C):</u>

Hands to object contacts. There was a significant difference in contact frequency (event/h) between age groups with body while participants were on the field. The older age group (16+ years) had more contacts per hour with body than the other two age groups. Another significant difference in contact frequency (event/h) between age groups was observed with soccer ball. There were significant differences in hourly duration (min/h) between age groups with soccer ball. The middle age group of players (9 to <16 years) contacted the ball for more minutes per hour than the other age groups. For the median contact duration, there were no significant differences between age groups with any of the observed objects.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing hourly duration between age groups with hands. The middle age group (2 to <9 years) had a greater contact duration (min/h) with hands than the other two age groups while on the field. The mouthing frequency and median duration were not significantly different between age groups while players were on the field.

Actions. There were significant differences in frequency (event/h) of specific actions between age groups when players were on the field. The older age group (16+ yrs) jumped and slipped/fell on the ground more times per hour than the younger age groups.

Macro-activities. There were no significant difference between age groups in hourly duration of player macro-activities while on the field.

Intensity. There were no significant differences between age groups in hourly duration of player intensity while on the field.

Off Field (Section C7 of Appendix C):

Hands to object contacts. There was a significant difference in contact frequency (event/h) between age groups with artificial turf while players were off the field. The younger age group (2 to <9 years) had more contacts per hour with artificial turf than the other two age groups. There were significant differences in contact hourly duration (min/h) between age groups with water bottles and artificial turf while off the field. The younger age group (2 to <9 years) contacted the turf and water bottles for more minutes per hour than the other age groups. For median contact duration, there were no significant differences between age groups with any of the observed objects (note that artificial turf can be present on sideline and not just on soccer field).

Mouthing events. There was a significant difference ($p < 0.05$) in mouthing frequency (event/h) between age groups with “all objects” while players were off the field. The youngest group (2 to <9 years) had more mouthing events with all objects per hour than the other two groups. There were no statistical differences in mouthing hourly duration between age groups. Also, there were no significant difference in median duration between age groups with contact with any object, while players were off the field.

Actions. There were no significant differences in frequency of specific actions between age groups while players were off the field.

Macro-activities. There was a significant difference in hourly duration between age groups when players were walking off the field. The younger age group (2 to <9 yrs) had less minutes walking per hour than the older age groups.

Intensity. There were no significant differences between age groups in hourly duration of player intensity.

Gloves On (Section C8 of Appendix C):

Hands to object contacts. There were no significant differences ($p < 0.05$) in contact frequency (event/h) between age groups. There were no significant differences in contact hourly duration (min/h) between age groups with field structures and artificial turf. There were significant differences in median contact duration (s) between age groups with water bottle, and dietary objects. The middle age group (9 to <16) had longer contacts with clothes and non-dietary than the other age groups. The younger age group (2 to <9 years) contacted water bottle and dietary objects for longer periods than the other age groups.

Mouthing events. There were no significant difference ($p < 0.05$) in mouthing contact frequency (event/h) between age groups. There were no significant difference ($p < 0.05$) in hourly contact duration (min/h) between the age groups. There was a significant difference ($p < 0.05$) in mouthing median duration between the age groups with water bottle. The younger group (2 to <9 years) had shorter mouthing periods with water bottle than the other age groups, even while wearing gloves.

Gloves OFF (Section C9 of Appendix C):

Hands to object contacts. There were significant differences ($p < 0.05$) in hand contact frequency (event/h) between age groups with clothes, water bottle, dietary objects, non-dietary objects, and all objects when players were not wearing gloves. The older age group (16+ years) had more contacts per hour with water bottle, dietary objects, non-dietary objects, and all objects than the other two age groups. There was a significant difference in hourly contact duration (min/h) between age groups with soccer ball, water bottle and dietary objects. The older age group (16+ years) contacted turf for less minutes per hour than the other age groups, while not wearing gloves. There were no significant differences in hand contact median duration (s) between age groups.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing frequency (event/h) between age groups with water bottle and dietary objects. The younger group (2 to <9 years) had more frequent mouthing with these two objects than the other two groups. There was a significant difference ($p < 0.05$) in hourly mouthing duration (min/h) between age groups with water bottle, dietary, and all objects. The younger group (2 to <9 years) had more mouthing minutes per hour with these objects than the other two groups. There were no significant difference ($p < 0.05$) in mouthing median duration (s) between age groups.

3.6.5 Player Gender

Activity statistics by gender and results from statistical tests (Wilcoxon sum rank test) are presented in Appendix D.

During the Whole Event (Section D1 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (events/h) between males and females with field structures, head/face/hair, water bottle, dietary, non-dietary, and all objects. Females had more contacts per hour with field structures, head/face/hair, water bottle, dietary, non-dietary, and all objects than males. There were significant differences ($p<0.05$) in hourly contact duration between males and females for head/face/hair, shin guards, water bottle, and dietary objects. Females' hands contacted these objects for more minutes per hour than males. For median contact duration, there were no significant differences between males and females.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing contact frequency (events/h) between males and females with water bottle and dietary objects. Females had more mouthing contacts with these objects than males. Similarly, there were significant differences ($p < 0.05$) in mouthing duration (min/h) between males and females with water bottle, and dietary objects. Females had longer mouthing of water bottle and dietary objects per hour than males. For the mouthing median contact duration, there were significant differences ($p < 0.05$) between males and females with dietary and all objects. Females touched these objects with their mouths for longer periods of times than males.

Actions. There were no significant differences between males and females in frequency of specific actions.

Macro-activities.-There were no significant differences between males and females in hourly duration of macro-activities.

Intensity. There were no significant differences between males and females in hourly duration of player intensity.

During the game/practice (Section D2 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in hand contact frequency (event/h) between males and females with head/face/hair, non-dietary objects, and all objects while during the game or practice. Females had more contacts per hour with these objects than males. There was a significant difference in contact hourly duration (min/h) between males and females with head/face/hair. Females' hands contacted head/face/hair for more minutes per hour than males. For the median duration, there were no significant differences between males and females.

Mouthing events. There were no significant differences in contact frequency, duration or median duration between males and females while during the game or practice.

Actions. There were no significant differences between males and females in frequency of specific actions while during the game or practice.

Macro-activities. There was a significant difference in hourly duration (min/h) between males and females with duration of time spent stretching. Females stretched more minutes per hour than males during the game.

Intensity. There were no significant differences between males and females in hourly duration of player intensity while during the game.

Warming up (Section D3 of Appendix D):

Hands to object contacts. There were no significant differences in hand contact frequency, hourly contact duration, or median contact duration between males and females while warming up.

Mouthing events. There were no significant differences by gender in mouthing frequency, hourly contact duration and median contact duration while warming up.

Actions. There were no significant differences between males and females in frequency of specific actions while warming up.

Macro-activities. There were no significant differences between males and females in hourly contact duration of macro-activities while warming up.

Intensity. There were no significant differences between males and females in hourly duration of player intensity while warming up.

Before/after/break time (Section D2 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in hand contact frequency (event/h) between males and females with head/face/hair, water bottle and dietary objects. Females had more contacts per hour with these objects than males. There were significant differences in contact hourly duration (min/h) between males and females with head/face/hair, water bottle, shin guards and dietary objects. Females' hands contacted head/face/hair, water bottle and dietary objects for more minutes per hour than males. However, males contacted shin guards for more minutes per hour than females. For the median duration, there were no significant differences between males and females.

Mouthing events. There were significant differences in mouthing frequency (event/h) between the males and females in water bottle, dietary and all objects. Females had more mouthing events per hour with these objects than males. Similarly, there were significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with water bottle, dietary and all objects. Females contacted these objects with their hands for more minutes per hour than males. Finally, there was a significant difference in mouthing median duration (s) between males and females for all objects. Females contacted all objects for longer period of time than males.

Actions. There were no significant differences between males and females in frequency of specific actions.

Macro-activities. There were no significant differences between males and females in hourly duration of macro-activities.

Intensity. There were no significant differences between males and females in hourly duration of player intensity.

<u>Other combined time (after/before/break/warming up time) but not during the game (Section D5 of Appendix D):</u>

Hands to object contacts. There were significant differences ($p < 0.05$) in hand contact frequency (event/h) between males and females with head/face/hair, water bottle and dietary objects. Females had more contacts per hour with these objects than males. There were significant differences in contact hourly duration (min/h) between males and females with head/face/hair, water bottle and dietary objects. Females' hands contacted head/face/hair, water bottle and dietary objects for more minutes per hour than males. For the contact median duration, there were no significant differences between males and females.

Mouthing events. There were significant differences in mouthing frequency (event/h) between males and females with water bottle, dietary and all objects. Females had more mouthing events per hour with these objects than males. There were significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with water bottle, dietary and all objects. Females mouthing contacts with these objects was more minutes per hour than males. There was a significant difference in mouthing median duration between males and females with all objects. Females had longer mouthing contacts with all objects than males.

Actions. There were no significant differences between males and females in frequency of specific actions.

Macro-activities. There were no significant differences between males and females in hourly duration of macro-activities.

Intensity. There were no significant differences between males and females in hourly duration of player intensity.

On field (Section D6 of Appendix D):

Hands to object contacts. While on the field, there were significant differences ($p < 0.05$) in contact frequency (event/h) between males and females with head/face/hair, non-dietary objects, and all objects. Females had more contacts per hour with these objects than males. There were significant differences in contact hourly duration (min/h) between males and females with head/face/hair, and shin guards. Females' hands contacted head/face/hair for more minutes per hour than males, while males' hands contacted shin guards for more minutes per hour than females. For the median contact duration, there were no significant differences between males and females.

Mouthing events. There were significant differences in mouthing frequency (event/h) between males and females with water bottle, dietary and all objects while on the field. Females had more mouthing events per hour with these objects than males. There were significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with water bottle, dietary and all objects. Females contacted these objects with their mouth for more minutes per hour than males. There was a significant difference in mouthing median duration (s) between males and females with all objects. Females contacted all objects with their mouth for longer period of time than males while on the field.

Actions. Males tackled or slid significantly ($p < 0.05$) more times than females (event/h) while on the field.

Macro-activities. There was a significant difference in hourly duration (min/h) between males and females with time spent stretching while on the field. Females stretched more minutes per hour than males on the field.

Intensity. There were no significant differences between males and females in hourly duration of player intensity while on the field.

Off field (Section D7 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between males and females with field structures, head/face/hair, water bottle, and dietary objects while off the field. Females had more contacts per hour with these objects than males. There were significant differences ($p < 0.05$) in hourly contact duration (min/h) between males and females with field structures, head/face/hair, water bottle, and dietary objects. Females' hands contacted these objects for more minutes per hour than males. There was a significant difference in contact median duration (s) between males and females with soccer ball. Females contacted soccer ball with their hands for longer periods than males.

Mouthing events. There were significant differences ($p < 0.05$) in mouthing frequency (event/h) between males and females with water bottle, and dietary objects while off the field. Females had more mouthing events per hour with these objects than males. There were significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with water bottle, and dietary objects. Females contacted these objects with their mouth for more minutes per hour than males. There was a significant difference in mouthing median duration (s) between males and females with all objects. Females contacted all objects with the mouth for longer periods of time than males.

Actions. There were no significant differences between males and females in frequency of specific actions while off the field.

Macro-activities. There were no significant differences between males and females in hourly duration of macro-activities while off the field.

Intensity. There were no significant differences between males and females in hourly duration of player intensity while off the field.

Gloves On (Section D8 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between males and females with non-dietary objects, and all objects when participants were wearing gloves. Females had more contacts per hour with these objects than males. There were significant differences in contact hourly duration (min/h) between males and females with all objects. Females' hands contacted these objects for more minutes per hour than males, while wearing gloves. For the median duration, there were no significant differences between males and females while wearing gloves.

Mouthing events. There was a significant difference in mouthing frequency (event/h) between males and females with hands. Males had more mouthing contacts per hour with their hands than females. There was significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with hands. Males contacted their mouths with their mouths for more minutes per hour than females. There were no significant differences in mouthing median duration (s) between males and females.

Gloves Off (Section D8 of Appendix D):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between males and females with field structures, and head/face/hair when they were not wearing gloves. Females had more contacts per hour with these objects than males. There was a significant difference in contact hourly duration (min/h) between males and females with head head/face/hair. Females' hands contacted these objects for more minutes per hour than males. For median hand contact duration, there were no significant differences between males and females while wearing gloves.

Mouthing events. There were significant differences in mouthing frequency (event/h) between males and females with hands. Females had more mouthing contacts per hour with hands than males while not wearing gloves. There were significant differences ($p < 0.05$) in mouthing hourly duration (min/h) between males and females with water bottle, and dietary objects. Females contacted these objects with their mouth for more minutes per hour than males. There were no significant differences in mouthing median duration (s) between males and females.

3.6.6 Player Position (goalie or others)

Activity statistics by player position and results from statistical tests (Wilcoxon sum rank test) are presented in Appendix E.

Whole Event (Section E1 of Appendix E):

Hands to object contacts. There were no significant differences ($p < 0.05$) in contact frequency and hourly contact duration between goalies and other positions. There was a significant difference in contact median duration (s) between goalies and other positions with head/face/hair. Goalies contacted their face/hair/head contact for longer periods of time than other players' positions.

Mouthing events. There were no significant differences in mouthing frequency and hourly contact duration between goalies and other positions. There was a significant difference ($p < 0.05$) in mouthing median duration (s) between goalies and other positions with clothes. Goalies mouthing of clothes was for longer periods of times than other players' positions.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions.

Macro-activities. There were significant differences in hourly duration (min/h) between goalies and other positions for the amount of time players spent stretching, sitting on the ground, or running. Goalies spent more time sitting on the ground that other players. Goalies ran and stretched for less minutes per hour than other players positions.

Intensity. There were significant differences on intensity between goalies and other positions for high, light, and resting. Goalies played more time at light and resting intensities in comparison to other players.

During the game/practice (Section E2 of Appendix E):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between goalies and other positions with contact with the body while during the game/practice. Goalies had less contacts per hour with body parts than other positions. There were not significant differences in contact hourly duration (min/h) between goalies and other positions. There was a significant difference in contact median duration (s) between goalies and other positions with face/head/hair. Goalies had longer contact with head/face/hair than other players' positions.

Mouthing events. There were no significant differences in mouthing frequency, and hourly duration between goalies and other positions while during the game/practice. There was a significant difference in mouthing median duration (s) between goalies and other positions with clothes. Goalies had longer mouthing contact with clothes than other the players' positions.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions.

Macro-activities. There were significant differences in hourly duration (min/h) between goalies and other positions for players in the time spent running and stretching while during the game. Goalies were running and stretching less minutes per hour than other players during the game.

Intensity. There were significant differences in hourly duration of player intensity between goalies and other positions for high, median and resting intensity. Goalies had less minutes per hour of high and median intensity than the other players' positions. However, goalies had more minutes per hour of resting intensity than other positions.

Warming up (Section E3 of Appendix E):

Hands to object contacts. There were no significant differences in frequency, duration, or median duration between goalies and other positions while warming up.

Mouthing events. For the mouthing frequency, duration and median duration, there were no significant differences between goalies and other positions while warming up.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions while warming up.

Macro-activities. There were no significant differences between goalies and other positions in hourly duration of macro-activities while warming up.

Intensity. There was a significant difference between goalies and other positions in hourly duration of player intensity. Goalies rested for more minutes per hour than other positions while warming up.

Before/after/break time (Section E4 of Appendix E):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between goalies and other positions with field structures and dietary objects. Goalies had less contacts per hour with field structures than other positions. Also, goalies had more contacts per hour with dietary objects than other positions. There was a significant difference in contact hourly duration (min/h) between goalies and other positions with field structures. Goalies contacted field structured in less minutes per hour than other players' positions. There were significant differences in contact median duration (s) between goalies and other positions with water bottle and dietary objects. Goalies had shorter contact with these objects than other players' positions.

Mouthing events. There were no significant differences in mouthing frequency, hourly duration, and median duration between goalies and other positions.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions.

Macro-activities. There were no significant differences between goalies and other positions in hourly duration of macro-activities.

Intensity. There no significant differences between goalies and other positions in hourly duration of player intensity.

Other combined time (after/before/break/warming up time) but during the game (Section E5 of Appendix E):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between goalies and other positions with field structures. Goalies had less contacts per hour with field structures than other positions. There was a significant difference in contact hourly duration (min/h) between goalies and other positions with field structures. Goalies contacted field structured for less minutes per hour than other players' positions. There were significant differences in contact median duration (s) between goalies and other positions with field structures, head/face/hair, and dietary objects. Goalies had shorter contact with field structures and dietary objects than other players' positions. However, goalies had longer contacts with head/face/hair than other players' positions.

Mouthing events. There were no significant differences in mouthing frequency, and hourly duration, and median duration between goalies and other positions.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions.

Macro-activities. There was a significant difference between goalies and other positions in hourly duration of players walking. Goalies had less minutes per hour walking than other players positions.
Intensity. There no significant differences between goalies and other positions in hourly duration of player intensity.

Intensity. There no significant differences between goalies and other positions in hourly duration of player intensity.

On field (Section E6 of Appendix E):
Hands to object contacts. There was significant difference ($p < 0.05$) in contact frequency (event/h) between goalies and other positions with field structures while on the field. Goalies had more contacts per hour with field structures. There was a significant difference in contact hourly duration (min/h) between goalies and other positions with field structures. Goalies contacted field structured for less minutes per hour than other players' positions. There was a significant difference in contact median duration (s) between goalies and other positions dietary objects. Goalies had shorter contacts with these objects than other players' positions.

Mouthing events. There were no significant differences in mouthing frequency, and hourly duration between goalies and other positions while on the field. There was significant difference in mouthing median duration (s) between goalies and other positions with clothes. Goalies had longer mouthing contacts with clothes than other players' positions.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions while on the field.

Macro-activities. There were significant differences between goalies and other positions in hourly duration for time spent by players running and sitting on the ground. Goalies ran less minutes per hour than other players' positions, but goalies sat on the ground more minutes per hour than other positions.

Intensity. There were significant differences between goalies and other positions in hourly duration of player intensity while players were at high, moderate, and resting intensities. Goalies rested for more minutes per hour than other positions. However, goalies spent less time playing at high and moderate intensities than other positions.

Off field (Section E7 of Appendix E):

Hands to object contacts. There were significant differences ($p < 0.05$) in contact frequency (event/h) between goalies and other positions with field structures and all objects while off the field. Goalies had less contacts per hour with field structures and all objects compared to other players. There was a significant difference in contact hourly duration (min/h) between goalies and other positions with field structures. Goalies contacted field structures for less minutes per hour than other players' positions. There were no significant differences in contact median duration (s) between goalies and other positions.

Mouthing events. There were no significant differences in mouthing frequency, hourly duration, and median duration between goalies and other positions while off the field.

Actions. There were no significant differences between goalies and other positions in frequency of specific actions while off the field.

Macro-activities. There were no significant differences between goalies and other positions in hourly duration for each micro-activity while off the field.

Intensity. There was a significant difference between goalies and other positions in hourly duration of player intensity for time that players spent resting while off the field. Goalies rested for more minutes per hour than other positions.

Gloves On (Section E8 of Appendix E):

Hands to object contacts. There was significant differences ($p < 0.05$) in contact frequency between goalies with head/face/hair while wearing gloves. Goalies contacted hand/face/hair less times per hour than players in other positions. There were no significant differences ($p < 0.05$) in contact hourly duration between goalies and other positions while players were wearing gloves. There was a significant difference in contact median duration (s) between goalies and other positions with body. Goalies contacted body for shorter durations than other players while wearing gloves.

Mouthing events. There were no significant differences in mouthing frequency, hourly duration, and median duration between goalies and other positions while wearing gloves.

Gloves Off (Section E9 of Appendix E):

Hands to object contacts. There was significant differences ($p < 0.05$) in contact frequency between goalies with footwear while not wearing gloves. Goalies contacted footwear less times per hour than players in other positions. There was a significant difference in contact hourly (min/h) between goalies and other positions with non-dietary objects and all objects. Goalies contacted these objects more minutes per hour than other positions when not wearing gloves. There were significant differences in contact median duration (s) between goalies and other positions with head/face/hair, soccer ball, non-dietary objects, and all objects. Goalies contacted these objects for longer durations than other players without gloves.

Mouthing events. There were no significant differences in mouthing frequency, hourly duration and median duration between goalies and other positions when not wearing gloves.

3.6.7 Event Type (game or practice)

Activity statistics by event type and results from statistical tests (Wilcoxon sum rank test) are presented in Appendix F.

Whole Event (Section F1 of Appendix F):

Hands to object contacts. Players had significantly more frequent contacts between their hands and clothes during a practice compared to a game. There were no significant differences ($p < 0.05$) in contact hourly duration and median duration between players playing a game or practice.

Mouthing events. There were no significant differences in mouthing frequency and median duration between players playing a game and practice. There was a significant difference ($p < 0.05$) in mouthing hourly duration (min/h) between game and practice with dietary objects. Players who were playing a game had more mouthing minutes per hour with dietary objects than players who played in practices.

Actions. There were no significant differences in frequency of specific actions between players who played soccer in a practice and players who played in a game.

Macro-activities. There was a significant difference in hourly duration (min/h) between players who played in practice and game when stretching. During practices players stretched for more minutes per hour than players who played in games.

Intensity. There were no significant differences in hourly duration of player intensity between players who played in practices and players who played in games.

During the game/practice (Section F2 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in contact frequency (event/h) between players playing games and practices with field structures while during the game/practice. Players who played in games had less contacts per hour with field structures than other players who played in practices. There was a significant difference in contact hourly duration (min/h) between players in games or practices with field structures. Players who played in games had less minutes per hour with field structures than players in practices. There was a significant difference in hand contact median duration (s) between players playing games and practices with water bottle and dietary objects. Players who played in games had longer contact with water bottle and dietary objects than players who played in practice while during the game/practice.

Mouthing events. There was a significant difference in mouthing frequency (event/h) between players playing in games and practices with body, while during the game and practice. Players who played in games had less mouthing events per hour with body than players who played in practices. There was a significant difference in mouthing hourly duration (min/h) between players playing games and practices with body while during the game or practice. Players who played in games had less mouthing minutes per hour with body than players who played in practices. There were no significant differences in mouthing median duration between players playing a game and practice, while during the game or practice.

Actions. There were no significant differences in frequency of specific actions between players who played in games and players who played in practices while during the game/practice.
Macro-activities. There were no significant differences in hourly duration of macro-activities between players who played in games and players who played in practices while during the game/practice.

Intensity. There were no significant differences in hourly duration of intensity between players who played in games and players who played in practices while during the game/practice.

Warming up (Section F3 of Appendix F):
Hands to object contacts. There were no significant differences in hourly hand contact duration, or median hand contact duration between players who played in games and players who played in practices while warming up. There was a significant difference in contact frequency (event/h) between players who played in games and players who played in practices with body, non-dietary and all objects.

Players who played in games had less hand contact events per hour with body, non-dietary and all objects than players who played in practices while warming up.

Mouthing events. There were no significant differences in mouthing frequency, duration and median duration between players who played in games and players who played in practices while warming up.

Actions. There were no significant differences between players who played in games and players who played in practices while warming up in frequency of specific actions.

Macro-activities. There was a significant difference between players who played in games and players who played in practices for time spent running. Players who played in games spent less minutes per hour running than players who played in practices.

Intensity. There were no significant differences in hourly duration of intensity between players who played in games and players who played in practices during warm up.

Before/after/break time (Section F4 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in hand contact frequency (event/h) between players playing games and practices with body and clothes. Players who played in games had less hand contacts per hour with clothes than other players who played in practices. Players who played in games had more contacts per hour with body than other players who played in practices. There was a significant difference in contact hourly duration (min/h) between players playing games or practices with body. Players who played in games had more hand hourly contact duration with body than players who played in practices. There was a significant difference in contact median duration (s) between players playing games and practices with artificial turf, field structure, and non-dietary objects. Players who played in games had shorter contact with artificial turf, field structure, and non-dietary objects than players who played in practice.

Mouthing events. There were significant differences in mouthing frequency (event/h) between players during games and practices with water bottle, dietary objects and all objects. Players who played in games had less mouthing events per hour with water bottle, dietary objects and all objects than players who played in practices. There were significant differences in hourly duration between players playing games and practices with water bottle, dietary objects and all objects. Players who played in games had less mouthing hourly duration with water bottle, dietary objects and all objects than other players who played in practices. There were no significant differences in mouthing median duration between players playing games and practices.

Actions. There were no significant differences in frequency of specific actions between players who played in games and players who played in practices.

Macro-activities. There were no significant differences in hourly duration of macro-activities between players who played in games and players who played in practices.

Intensity. There was a significant difference in hourly duration between players who played in games and players who played in practices. Players who played in games had more minutes per hour of high intensity activities than players during practices.

Other combined time (after/before/break/warming up time) but during the game (Section F5 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in hand contact frequency (event/h) between players playing in games and practices with body, clothes, non-dietary and all objects. Players who played in games had less hand contacts per hour with clothes, non-dietary and all objects than other players during practices. Players who played in games had more contacts per hour with body than other players during practices. There was a significant difference in contact hourly duration (min/h) between players playing games and practices with body. Players who played in games had longer hourly duration of contact with body than players during practice. There was a significant difference in contact median duration (s) between players playing games and practices with artificial turf. Players who played in games had shorter contacts with artificial turf than players during practice.

Mouthing events. There were significant differences in mouthing frequency (event/h) between players playing in games and practices with water bottle, dietary objects and all objects. Players who played in games had less mouthing events per hour with water bottle, dietary objects and all objects than other players who played in practices. There were significant differences in hourly duration between players playing games and practices with water bottle, dietary objects and all objects. Players who played in games had less mouthing hourly duration with water bottle, dietary objects and all objects than other players who played in practices. There were no significant differences in mouthing median duration between players playing games and practices.

Actions. There were no significant differences in frequency of specific actions between players who played in games and players who played in practices.

Macro-activities. There were no significant differences in hourly contact duration of macro-activities between players who played in games and players who played in practices.

Intensity. There were no significant differences in hourly duration of intensity between players who played in games and players who played in practices.

On field (Section F6 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in contact frequency (event/h) between players playing games and practices with clothes, field structure, water bottle, dietary, non-dietary and all objects while on the field. Players who played in games had less contacts per hour with clothes, field structure, water bottle, non-dietary and all objects than players during practices. There were significant differences in contact hourly duration (min/h) between players playing games and practices with field structure, water bottle, non-dietary and all objects. Players who played in games had shorter hourly hand contact duration with field structure, water bottle, non-dietary and all objects than other players who played in practices. There were no significant differences in contact median duration (s) between players playing games and practices.

Mouthing events. There were significant differences in mouthing frequency (event/h) between players playing games and practices with water bottle, dietary objects and all objects. Players who played in games had less mouthing events per hour with water bottle, dietary objects and all objects than other players who played in practices. There were significant differences in hourly contact duration between players during games and practices with water bottle, dietary objects, non-dietary and all objects. Players who played in games had shorter hourly mouthing duration with water bottle, dietary objects, non-dietary and all objects than other players who played in practices. Players had significantly longer median mouthing duration with all objects during games than during practices.

Actions. There were no significant differences in frequency of specific actions between players who played in games and players who played in practices while on the field.

Macro-activities. There was a significant difference in hourly duration between players who played in games and players who played in practices. Players who played in games spent more minutes per hour stretching than players during practices while on the field.

Intensity. There were no significant differences in hourly duration of intensity between players who played in games and players who played in practices while on the field.

Off field (Section F7 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in contact frequency (event/h) between players playing games and practices with body. Players who played in games had more contacts per hour with body than those during practice. There were significant differences in hand contact hourly duration (min/h) between players playing games and practices for contacts with body and head/face/hair. Players who played in games had longer hourly duration with body and head/face/hair than players during practices. There were no significant differences in contact median duration (s) between players playing games and practices.

Mouthing events. There were no significant differences in mouthing frequency and median duration between players during games and practices. Players during games had significantly less hourly mouthing duration with water bottle.

Actions. There were no significant differences in frequency of specific actions between players who played in games and players who played in practices while off the field.

Macro-activities. There was a significant difference in hourly duration between players who played in games and players who played in practices. Players who played in games spent more minutes per hour stretching than players who played in practices.

Intensity. There were no significant differences in hourly duration of intensity between players who played in games and players who played in practices.

Gloves On (Section F8 of Appendix F):

Hands to object contacts. There were no significant differences in contact frequency, hourly duration and median duration between players playing games and practices with gloves on.

Mouthing events. There were no significant differences in mouthing frequency and hourly duration between players playing games and practices with glove on. There was a significant difference in median duration between players playing games and practices with water bottle and dietary objects. Players who played in games had less mouthing time with water bottles and dietary objects than players who played in practices.

Gloves Off (Section F9 of Appendix F):

Hands to object contacts. There was a significant difference ($p < 0.05$) in contact frequency (event/h) between players playing games and practices with non-dietary objects and all objects. Players who played in games had less contacts per hour with these objects. There were no significant differences in contact hourly duration and median duration between players playing games and practices.

Mouthing events. There were no significant differences in mouthing frequency and median mouthing duration between players during games and practices. There was a significant difference in hourly mouthing duration between players playing games and practices with dietary objects while gloves were off. Players who played in games had less mouthing minutes per hour with dietary objects than players during practice while gloves were off.

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Appendix A. Protocols and Scripts

Section A.1. Translation protocol

TRANSLATION PROTOCOL

ARTIFICIAL TURF STUDY

Using VIDEO-TRANSLATOR

University of Arizona

MEZCOPH - Environmental Health Sciences

Written 12/16/17 (adapted from Stanford Protocol)

INTRODUCTION

The primary objective of this project is to quantify activity patterns of soccer players relevant to potential exposure from black crumb in artificial soccer turf around the state of California. You will use the Video Translator -TE software developed in the University of Arizona College of Public Health to translate what you see in the videotapes into computer text files. Video Translator -TE software is a tool designed to quantify real-time, sequential micro-activity pattern data collected via videotaping.

The Video Translator -TE interface you will use for this project is an on-screen window containing four grids (palette), each comprising cells labeled with names of (a) location, (b) time, (c) gloves, and (d) contact surfaces relevant to people playing soccer. While monitoring a contact boundary (e.g., right hand, left hand, mouth) on the videotape, the Video Translator -TE translator collects data by activating (i.e., positioning the cursor over a cell and clicking the pointing device) the appropriate cell in each grid. The software couples grid activation with a computer clock that records (to fractions of a second), the total duration of each contact/activity event.

The Video Translator -TE output files will allow us to conduct a detailed analysis and summarize information about contact frequency and duration between player's body parts and surfaces that may be contaminated with the black crumb that is usually put on artificial turf. In addition, because the data collected are sequential, i.e., each line in the text file corresponds to a real-time activity in the videotape, we can use the data to reconstruct a player's activity sequence.

Similarly, another separate portion of this project is to analyze their macro-activities and intensity. For this portion, there is another palette with four grids with names of (a) location, (b) time, (c) activities, and (d) intensity. While monitoring the activities (e.g., running, walking, jumping) of the players on the video, intensity (highly, moderately, etc) needs to be selected as well.

PLEASE READ THIS PROTOCOL CAREFULLY - QUALITY ASSURANCE IS OF THE UTMOST IMPORTANCE!!

STEP 1. Read the Video Translator -TE Manual

The attached Video Translator -TE manual contains all information about the Video Translator -TE software, including how to launch the program, enter output file header information, select a contact boundary, and decide on the proper grid cell selection for special circumstances (e.g., body part out of view, stopping the video, or touching two objects at once). Read the manual carefully and ask any questions you have to the Video Translator -TE prior to proceeding to training.

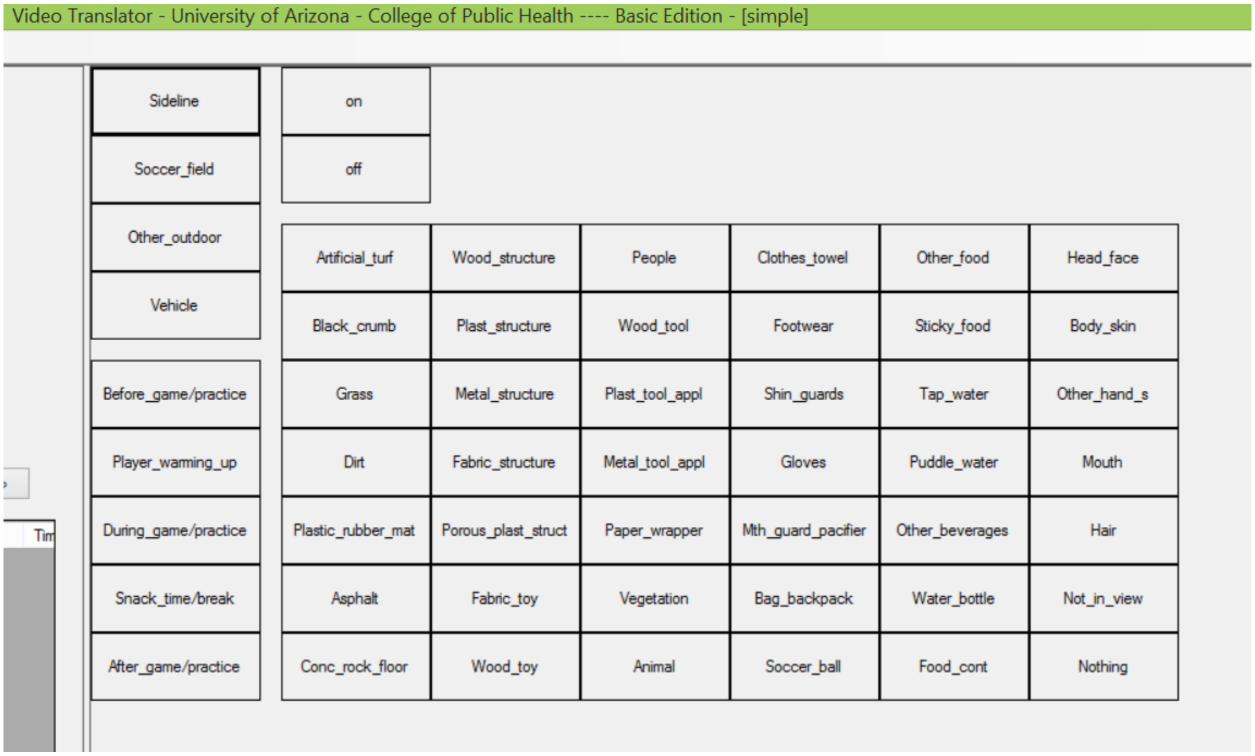
STEP 2. Receive Video Translator -TE Training

Before you translate actual videotapes from the field study, you must receive official training from one of the Video Translator -TE experts. The first step is to arrange a time with a Video Translator -TE trainer.

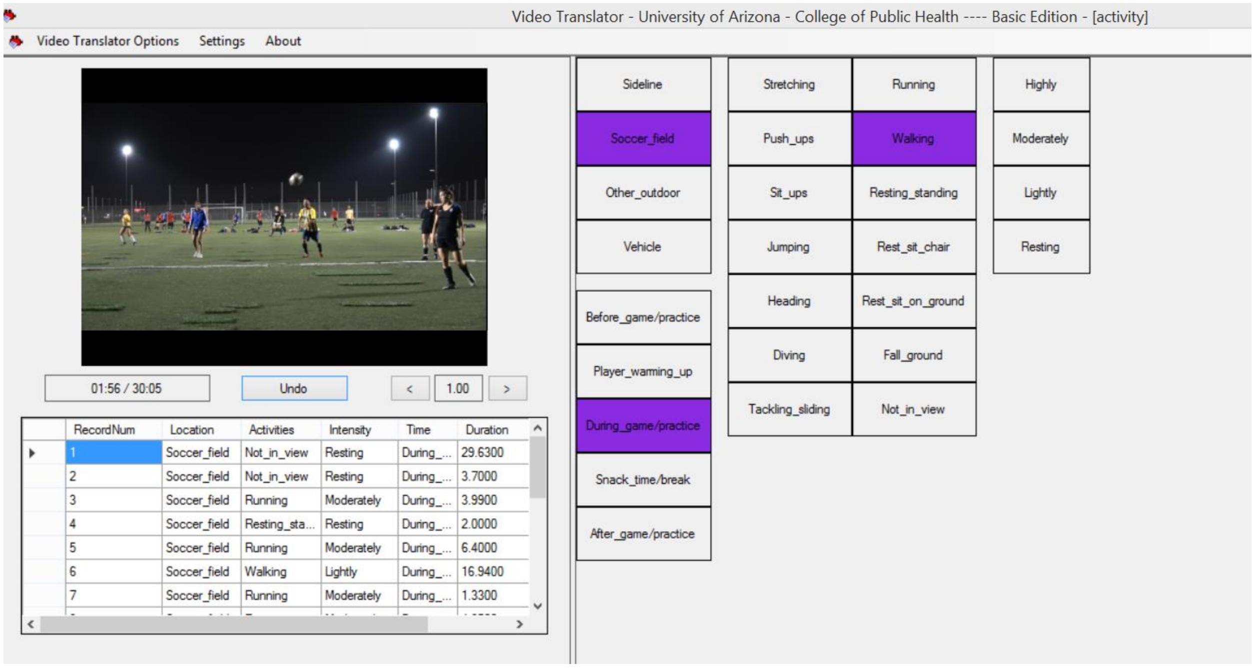
First the trainer will ask you to translate a 15 minute segment of videotape called "Training 0" while he or she watches you. The translation results from this initial session will not be analyzed: the "Training 0" is meant solely for you to get comfortable using the software, familiarize yourself with the grids, and ask the Video Translator -TE trainer any questions you may have regarding decision criteria or other issues.

Video Translator -TE trainer will observe you and point out any errors you make so that you can become a reliable Video Translator -TE translator.

After this initial orientation, you must translate each of three 30-minute videos that have been selected specifically for training purposes. These tapes are labeled “Training 1”, “Training 2”, and “Training 3" and they must be translated in that order, one at a time so that the Video Translator -TE trainer can analyze your results and consult with you after each training session. The Video Translator -TE trainer will not be present while you translate these four training videos. After you complete “Training 1”, save your file under the name “<YOURINITIALS>_Train1.txt” (e.g., NLG_Train1.txt) on the Training folder designated on the desktop computer you are using, then notify the Video Translator -TE trainer that you have completed the first training. The Video Translator -TE trainer will then run a series of programs to analyze your output file compared to a “standard” file, assess your percent agreement with the standard file (based on total contact durations for each unique contact event in the file), and meet with you to discuss where any errors occurred (e.g., reaction time, misdesignation of an object type, etc.). If your agreement with the standard file is less than 90%, you will need to translate that video again. When the agreement is at least 90%, and the Video Translator -TE trainer is satisfied with the results, he or she will instruct you to proceed to “Training 2.” Repeat the steps above until you have completed all four training with at least 90% reliability.



The template shown above will be used for video translation in this study. For the training sessions, select the “Right Hand” as the contact boundary in Video Translator -TE (see manual), and focus only on the player's right hand during translation, clicking on grids corresponding to the activities of the right hand.



The template shown above will also be used for video translation in this study. For the training sessions, select the "override" and write down "Activity" as the contact boundary in Video Translator -TE (see manual), and focus only on the player's activities during translation, clicking on grids corresponding to the activities and intensity as shown above.

Decision Criteria

During translation, there will be occasions when it will not be clear what type of object the subject is contacting and sound judgment calls will be required. To reduce the number of these occasions, audio annotations that can be heard during translation will be conducted during videotaping. This will add specificity by the onsite note-taker as to the characteristics of objects and surfaces contacted (e.g., plush toy, plastic toy, etc.). The following guidelines are an attempt at guiding the decision process for the translator. However, there will probably be some scenarios not addressed here, in which case the translator should opt for the conservative choice, i.e., the object that is likely to contain a higher concentration.

The following guidelines should be used in translating videotapes, with the ultimate goal to assess black crumb exposure:

1. What to do when subject's body part is out of view?

   Either click Not_In_View, or, if appropriate, deduce the object being contacted while the body part is out of view. For instance, assume the right hand is being translated, and imagine a goalie (goal keeper) is holding the ball with both hands. When the player's right hand is in view, it is clear to designate the object as hard surface and when the player's right hand disappears from camera view, it may be appropriate to deduce from context that the right hand is still contacting the ball. Many times it will be obvious or safe to assume the object contacted while the body part is out of view, but the translator should pause the video if the object contacted is not obvious from context.

2. What if the player's body part touches more than one object at a time?

   Ideally, one would stratify the exposure boundary and record both contacts. If the entire hand is being translated, however, select the object that is has the most surface area of contact with the hand.

3. What if an object does not obviously fit one of the categories and it is not on the object designation sheet?

   Make an assumption and write it down so that it may be added to the object designation sheet. Then give the sheet to the coordinator so that they can update everyone's sheet. (CHECK assumption sheet attached)

4. What to do when the activity on the second palette is not in it?

   Write down in the assumption lists, and discuss it with manager.

<u>STEP 3. Consult with the Project Videotape Manager</u>

After completing the Video Translator -TE training procedure, you will be considered qualified to proceed with translation of the field study videotapes. Consult with the Project Videotape Manager to receive specific instructions as to which videotapes you are responsible for, the body parts to focus on for each translation, and the order in which you should translate the videos.

STEP 4. Proceed with Translation of the Videos

You will be responsible for translating a number of videotapes from the field study. Again, quality of the collected data is extremely important. Because of this, random sections of the footage you translate will be checked by Video Translator -TE experts and possibly by the Quality Assurance Personnel. The sequential construct of the Video Translator -TE output file will allow in-house and quality assurance staff to go to a particular point of a section of video you translated and match your output file to a sequence translated by an expert. A Video Translator -TE expert should also be able to repeat a section of tape you translated, yielding at least a 90% agreement between the two output files. IF THE RELIABILITY IS LESS THAN 90% FOR A GIVEN VIDEOTAPE DURING RANDOM SPOT-CHECKS, YOU WILL NEED TO RECODE THE ENTIRE VIDEO AGAIN. To minimize repeated effort, you should translate the field study tapes carefully! Because videtape translation requires intense focus and your results may suffer if you fatigue, you must translate no more than 2 hours a day, and you should pause and take a break every 30 minutes to avoid fatigue.

STEP 5. Follow Data Management Procedures

Once the data has been gathered from videos, each file needs to be created and saved per participant. The name of the translator needs to be saved along with the video that he/she transcribed.

Section A.2. Verification of training

Table 1. Checking training output

Transcription	Trainee	Verified	Pass (Y/N)	Percentage (%)
T2	JN	x	Y	6.16
T2	AC	x	N	11.05*
T2	RS	x	N	6.0
T2	MK	x	Y	5.7
T3	AC	x	Y	3.18
T3	MK	x	Y	1.17
T3	JN	x	y	6.21
T3	RS	x	y	4.5
T4	RS	x	Y	8.61
T5	RS	x	y	2.41
T4	MK	x	Y	8.49
T5	MK	x	y	1.61
T4	JN	x	y	9.76
T5	JN	x	y	2.36
T4	AC	x	y	8.78
T5	AC	x	y	5.53

***Training was repeated until percentage was less than 10%**

Section A.3. Translation tips and Object Designation

TRANSLATION TIPS

ARTIFICIAL TURF STUDY

University of Arizona

MEZCOPH - Environmental Health Sciences

Written 12/16/17 (adapted from Stanford Protocol)

HOW TO REDUCE ERRORS:

1. **Preview the VIDEO segment** for the locations and objects involved.
2. **Read the taper's log** for palette designation and note time of "ON MARK" is located in video.
3. **Note any unusual object or location** not listed in the taper's log and determine the palette designation. **When in doubt, check with the project personnel.**
4. In general, **start translation with the mouth** since it is usually simplest body part to translate for.

DECISION CRITERIA:

Object designations:

Goal: To estimate the accumulation and transfer of black crumb used in artificial turf

Not_In_View:

If it is obvious what the player is touching even though the body part being translated is out of view, choose the palette category corresponding to the object that you believe he/she is touching. Otherwise, choose *Not_In_View*.

Example:

Player holding a water bottle (with back to you): *Water_bottle*.

Food_Cont:

Any item used to **contain, cook, transport, or consume food or beverage** (unless it is treated as a toy). **It doesn't matter what material the object is made of** (e.g. ceramic, metal, plastic, etc).

Logic: Food containers are frequently washed and therefore less likely to have a large build-up of black crumb.

Examples: Baby bottle, Utensils, Bowls, Cups

Toys: Something that the adults and children treat as toys. It is NOT just anything that the child is playing with. **It is important that the ADULTS also treat the object as a toy for the child.**

Logic: Toys are not washed often and therefore likely to have more build-up of contaminant. Also, they have a very high frequency of object-to-hand and object-to-mouth contacts, thus leading to a large transfer of residue.

Structure:

Something that is not moved or handled very often.

Logic: Walls and furniture tend to collect dust and chemical residues from the ambient air and they are not washed.

***Metal_structure*:** includes metal fences and glass materials (e.g. bench, fences, soccer pole)

Plastic_structure: it can be chairs, goalies, etc.

Tool/Appliance:

Something that is often handled and actively used.

Logic: Tools and appliances tend to be mobile and have frequent object-to-skin contact. Therefore, they may pick up and transfer more residues than stationary objects.

Examples: Soccer cones, plastic bag, tape to hold shin guards

Food: Solid foods are divided between ***Sticky_Food*** and ***Other_Food***.

Logic: Contact with sticky foods may affect the potential for picking up contaminants from other surfaces and artificial turf.

- ***Sticky_Food***: foods that tend to form films on the body (e.g. ice-cream, syrup, watermelon, apple, etc).
- ***Other_Food***: dry foods (e.g. cereal, crackers, bread, etc)
- ***Water or Beverage***: includes all edible liquids and water coming out of a tap (even sprinkler water; sodas).

Head/face: anything above the shoulders. (e.g. neck, face)

Clothes: No distinction is made between the participant's clothes or another person's clothes.

Footwear: includes soccer shoes, sandals, canvas shoes, leather shoes, plastic shoes, top of shoe, sole of shoe, etc.

Body_skin: any other part of the body (direct contact with the skin); note: no distinction made between participant's body or others.

Puddle_Water: includes standing water in a driveway, on soil, etc.

Paper/Wrapper: Includes all types of paper including food wrappers

Examples: photos, books, candy wrapper, tissue paper

Materials:

- ***Porous Plastic***: includes styrofoam, synthetic leather, etc.
- ***Fabric***: includes anything made of fibers (e.g. wallpaper, cloth toys, rope, etc).
- ***Metal***: includes glass and ceramic.

Location designations:

Tips: The location of a player is determined by where the player's torso is, not where his/her appendages are.

Sideline: next to the field, or near the soccer field, it includes the bench

Field: Inside the lines of soccer field

Other outdoor: near bathrooms, break area, parking lot etc

Vehicle: in the car

Gloves:
ON/OFF, usually goalies wear them all game, but not during breaks and other players when is cold. Shirts/sweaters sleeves that go over the hands and hold on thumbs were not considered gloves, but clothes.

THE UNIVERSITY OF ARIZONA
Mel & Enid Zuckerman
College of Public Health

Section A.4 Protocol for transcription training on software usage

SOFTWARE MANUAL

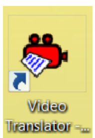
The Video Translator -TE

University of Arizona

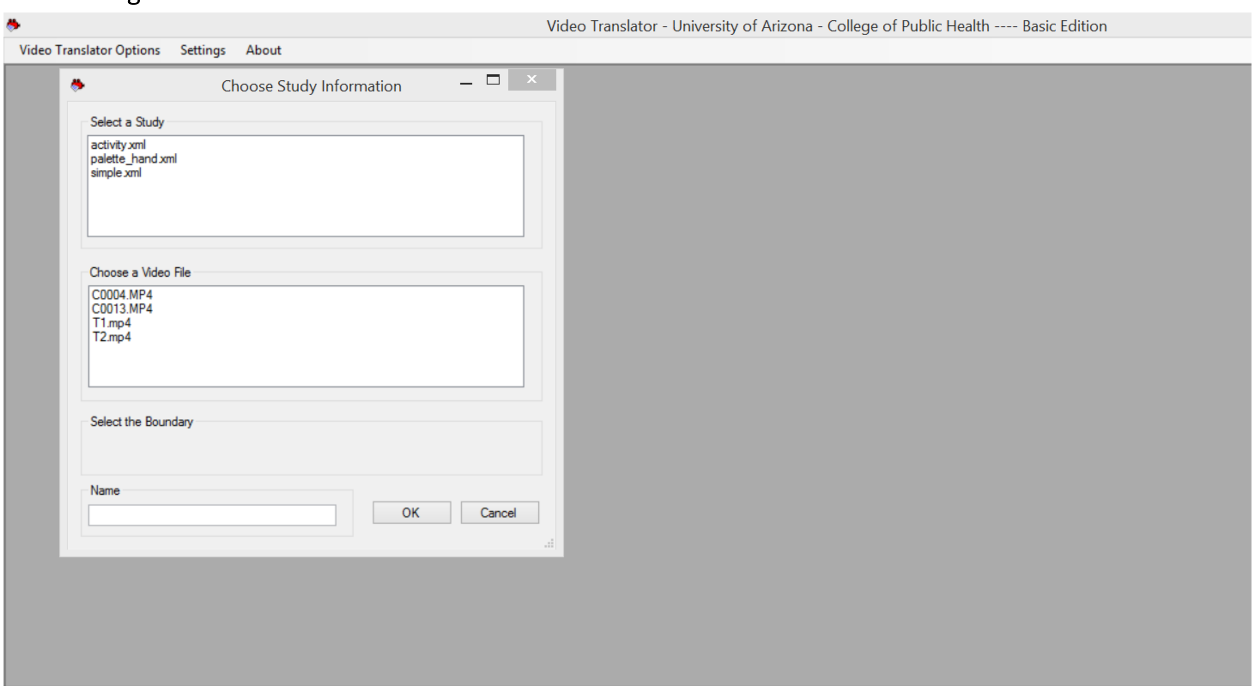
College of Public Health

STEP 1:

- Open Video Translator program by double clicking on icon below:



Once program is open right click on upper toolbar (left side) on "Video translator options" and select "Single form translate"



STEP 2:

- Choose the study information

- Select a study (select palette): Usually choose "SIMPLE.XML" for the object categories palette and "Activity.XML" for the activity/intensity palette.
- Chose video file: here you select the video that was assigned to you to translate
- Select boundary:

  RHD = right hand

  LHD = left hand

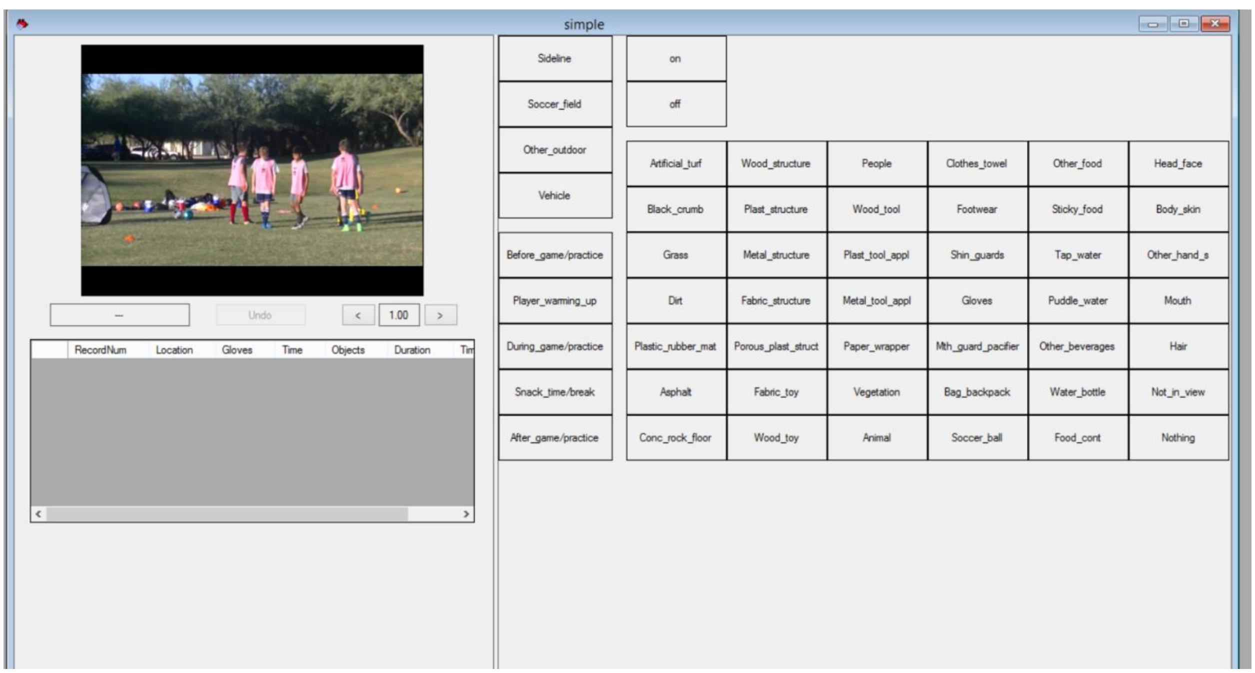
  MTH = mouth

  Override = select this option if you want to choose something else such as "activity"

  - NAME: finally write down the name of transcriber

  - CLICK "OK"

STEP 3: begin transcribing



NOTE: always start with "NOT IN VIEW" until getting into section MARK by note-taker login sheet showing where transcription should start.

STEP 4:

Once the video is over and you have finished transcribing a window will open asking you to save or not. Please save and make sure it was save in the correct file.

Section A.5 QC/QA Protocol

QC/QA PROTOCOL

ARTIFICIAL TURF STUDY

University of Arizona, College of Public Health

Written 10/13/17

Adapted from Stanford/CHAMCOS protocol

Introduction

The objective of this protocol is to outline the steps to be taken by personnel in using inter-observer and intra-observer agreement as a means to maintain the consistency and quality of translations for this project. Inter-observer agreement will be determined through random checks conducted on about **10% of a translator's translated files**, by experienced researchers, to check for **at least a 90% agreement** in object, location, and activity designations between the translator and spot-checker. These checks will be hereafter referred to as spot-checks. Translators have been trained to use Video TE software to translate for the activity patterns of children. Spot-checkers are researchers who have played a leadership role in translator's training process and have had some experience in using the software program. The details of how these spot-checks are conducted and how the results from these spot-checks are processed are discussed below. The intra-observer agreement will be determined by randomly choosing video segments to be re-transcribed by the same translator.

Procedure for Spot check (Inter-observer)

Step 1:

Spot-check will be done for at least ***20 minutes of every 10 - 12 hours*** of translated videos. Segments for spot-checking should be picked at random (e.g. throwing a die).

Be sure to read the assumptions sheets for each segment (assumptions sheets are attached at the end of this document). Assumption sheets contain specific problems and questions that a translator encountered during translation of that segment and the assumptions for the decisions made. **Include the word SPOT after the three-letter designation for the body part when saving the file.** *Follow the Translation Protocols on how to save files.* Start the translation at the beginning of the segment to be spot-checked. Be sure to exceed 10 minutes of translation to ensure that a full 10 minutes is captured.

Step 2: What to spot-check

Apply spot-check protocol for each of the three different translated body parts **(right hand, left hand, and mouth) and the** *macro-activity patterns* **(walking, running, etc) for each child.**

Step 3: How to pass

In order to pass spot-check, there must be ***less than 10 percent discrepancy*** between the spot-checker's and the translator's translation files. The spot-checker will run a script in R studio to compare the files between the spot-checker and the translator. Output of the results will be printed and placed in a "Spot-check Folder". Remember that translations for the same body part, for the same segment of tape, are being compared.

Step 4: What to do if there is > 10% difference

If there is more than 10 percent discrepancy between the spot-checker's and the translator's translation files, the spot-checker and the translator will work together to discover where the discrepancy occurred. If it is agreed upon that in fact it is the translator who has made the error(s), try to find out what type of error(s) are occurring. Some possible errors are listed below.

1. ***Mis-designations****:* Translator has designated something incorrectly (e.g. designated a "During the game" as "Before the game" or called a "Metal structure" a "Water bottle").
2. ***Lack of attention****:* Translator is forgetting to change designations for location, activity, or object as the child changes their activity pattern (the translator is basically falling asleep and not paying attention).
3. ***"Not-in-View"****:* There is difference in the time allotted to "Not-In-View" between the translator and the spot-checker. One person is being generous with the use of "Not-In-View" and does not think that they can make a guess as to what the body part is touching.
4. **"*Nothing*"*:*** There is a difference in the time allotted to "Nothing" between the translator and the spot-checker. One person does not think that the body part is in contact with something else.

Note: If the spot-checker made the error(s), redo the 10 minutes and compare the files again.

Correcting disagreements that are greater than 10%

Rule 1: The errors that occur due to 3 and 4 can often be due to judgment calls, especially in the case where the percentage **disagreement is between 0-20%**. Here, neither the spot-checker nor the translator is wrong but some of the assumptions made should be discussed. It is **not necessary to correct the file in this case** where translation is very subjective. Both translator and spot-checker should sign and date the results.

If the error is greater than 20%, due to differences in "Nothing" and "Not-In-View", then it is probable that some assumptions being made by the translator can be corrected according to translation protocols.

Rule 2: In general, if the translator has made a mistake in location, activity, or object designation due to mistake 1, then *sometimes* the file can be easily corrected. It will be done throughout the **entire file**. For example, if the translator has called a section of the "Artificial turf" "Soccer ball", then replace "Artificial turf" with "Soccer ball" throughout the file. Remember that this can only be done if "Artificial turf" is not a legitimate designation anywhere in the file. The researcher in charge will make the necessary correction by using the **"Replace" function** on the output file in Microsoft Word. Save the file as a text only file. The spot-checker will discuss this mistake with the translator and both will sign and date the output results. The researcher in charge of translations will need to look at the output files for translation of other body parts from the same half hour section of videotape and other videotape sections of that child to see if the same mistake was made. Correct these files accordingly.

Rule 3: If the error in location, activity, or object designation is not easily corrected and this is likely to occur in the case of mistake 2, then the translator will have to **re-translate the file** after a full discussion and clarification with the spot-checker. An example of such a mistake is where the translator forgot to change location at certain sections throughout the file. It is difficult to accurately find these sections and correct them. Remember that the spot-checker and translator will need to sign and date all output results

Correcting and Saving Files

It is important to keep the original files (files that contain mistakes in translation) for future reference and for Quality Assurance purposes. **Save the original files with the word "copy"** at the end of the original file name and save it in a special folder called **(TURF_error)** on the hard drive of the computer.

A list will be compiled with all the file names that were corrected. If a segment of videos for a particular body part has been re-translated, then this file will need to be compared again with the output file created by the spot-checker to make sure the error has been resolved. **This second set of output results will include the word "redo"** and need to be signed and dated by the spot-checker and translator. These same rules apply if a spot-check has been redone by the spot-checker; put "**copy**" on the old spot-check and print new output results.

Procedure for Intra-observer Check

The same for procedure that will be conducted for the Spot check for inter-observer QC/QA will be conducted for intra-observer check. For the intra observer check, the randomly selected video will be review by same translator.

Conclusion

Spot-checks are a means to check for inter-observer and intra-observer agreement on the translation of children's micro-activity patterns using the Video TE software. This spot-check protocol by no means covers all the possible circumstances that can occur when a translator has been checked for errors in translation. However, this protocol will serve to guide researchers on how to handle most errors, thereby maintaining the quality of translation. In correcting files manually, an effort will be made not to jeopardize the quality, consistency, and accuracy of translation.

Not only do spot-checks maintain the quality of translation (since translators are likely to stay alert during translations if they know that any of their files could be checked), but they also check for the effectiveness of our training program. Spot-checks also provide an additional means of communication and clarification between everyone on the project and are also meant to bring to light ways of making translations simple and effective.

Appendix B: Data summarized by event schedule (moment/time), location, and glove use

Section B.1.1. Activity patterns during games/practice

Table B.1.1.1 Both hands contact frequency (event/h) during game/practice (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	3.86	4.72	0.00	0.99	2.16	4.13	13.99	18.39	18.69
Body	11.66	9.86	1.29	4.25	9.48	14.38	33.75	41.19	42.39
Clothes	68.17	36.92	13.12	40.56	62.92	85.55	137.93	169.52	183.75
Field Structures	5.62	5.24	0.00	1.81	4.17	8.09	16.19	20.39	21.73
Footwear	4.99	5.84	0.00	1.64	3.44	5.90	12.66	26.63	34.16
Head/face/hair	29.10	26.01	3.38	11.29	19.39	38.07	80.75	104.19	112.86
Shin guards	1.00	2.35	0.00	0.00	0.00	0.79	4.05	10.21	11.92
Soccer ball	20.40	29.26	0.70	3.68	9.97	21.15	68.26	128.19	130.86
Water bottle	2.44	4.01	0.00	0.00	1.25	2.84	10.42	17.13	17.31
Dietary Objects	2.47	4.05	0.00	0.00	1.25	3.06	11.13	17.13	17.31
Non-dietary Objects	155.81	69.89	48.06	113.33	147.29	180.40	290.38	363.83	376.64
All Objects	158.29	70.10	48.06	114.74	148.23	182.51	290.47	365.59	378.46

Table B.1.1.2 Both hands contact duration (min/h) during the game/practice (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.20	0.27	0.00	0.01	0.09	0.33	0.60	1.07	1.34
Body	0.92	1.35	0.02	0.12	0.32	0.83	3.61	5.02	5.81
Clothes	12.00	12.99	0.50	3.59	7.43	17.08	34.94	49.49	55.06
Field Structures	0.54	0.74	0.00	0.09	0.23	0.75	1.96	2.92	3.42
Footwear	0.44	0.54	0.00	0.07	0.23	0.59	1.85	2.00	2.03
Head/face/hair	1.02	1.48	0.04	0.32	0.66	1.28	2.17	6.56	9.24
Shin guards	0.09	0.32	0.00	0.00	0.00	0.02	0.40	1.38	1.97
Soccer ball	0.83	1.10	0.01	0.20	0.41	0.85	4.05	4.38	4.52
Water bottle	0.42	0.98	0.00	0.00	0.10	0.42	1.87	4.34	5.76
Dietary Objects	0.42	0.99	0.00	0.00	0.10	0.43	1.90	4.34	5.76
Non-dietary Objects	16.71	13.16	0.93	7.10	13.38	22.91	41.66	54.25	58.65
All Objects	17.13	13.20	1.42	7.35	13.54	23.01	41.67	54.33	58.72

Table B.1.1.3 Both hands median contact duration (s) during the game/practice

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	35	1.80	2.36	0.46	0.82	1.24	1.64	4.06	10.92	14.20
Body	40	1.40	1.01	0.45	0.80	1.15	1.48	2.56	5.05	6.52
Clothes	40	4.20	3.23	1.20	2.26	2.81	4.60	11.96	13.92	14.08
Field Structures	35	3.82	7.26	0.41	1.45	1.98	3.26	7.04	31.62	43.93
Footwear	38	3.81	3.57	0.82	1.58	2.37	5.42	10.44	15.19	15.34
Head/face/hair	40	1.36	0.50	0.60	1.05	1.17	1.62	2.27	2.81	3.09
Shin guards	12	2.75	1.76	0.90	1.58	2.10	3.52	5.79	6.57	6.76

Soccer ball	40	2.21	2.55	0.64	1.27	1.67	2.11	3.84	11.95	17.06
Water bottle	26	5.26	2.97	0.22	3.21	4.84	7.19	9.32	12.81	13.88
Dietary Objects	26	5.24	2.96	0.22	3.21	4.65	7.06	9.32	12.81	13.88
Non-dietary objects	40	2.38	1.37	1.16	1.44	1.88	2.99	4.14	7.23	7.73
All Objects	40	2.40	1.35	1.16	1.48	1.93	2.99	4.16	7.16	7.69

Table B.1.1.4. Mouthing contact frequency (event/h) during the game/practice (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.59	1.83	0	0	0	0	3.31	8	10.33
Clothes	8.77	16.41	0	0.9	3.94	12.88	22.36	70.96	99.87
Field structures	0.01	0.07	0	0	0	0	0	0.29	0.47
Footwear	-	-	-	-	-	-	-	-	-
Hands	8.53	6.12	0.94	3.6	7.49	11.48	19.59	27.14	27.56
Head/face/hair	0.03	0.16	0	0	0	0	0.02	0.74	0.91
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	0.84
Water bottle	1.49	2.57	0	0	0.29	1.97	5.13	10.51	13.24
Dietary objects	1.57	2.55	0	0	0.63	2.09	5.13	10.51	13.24
Non-dietary objects	19.18	18.5	1.08	8.57	13.91	23.82	44.11	87.1	108.19
All objects	20.76	19.42	1.08	9.6	15.47	24.99	44.92	90.92	114.44

Table B.1.1.5. Hourly mouthing duration (min/h) during the game/practice (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.01	0.05	0	0	0	0	0.08	0.22	0.27
Clothes	0.33	0.66	0	0.01	0.09	0.33	1.51	2.83	3.62
Field structures	0	0.01	0	0	0	0	0	0.02	0.04
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.41	0.85	0.01	0.1	0.18	0.35	0.97	3.71	5.28
Head/face/hair	0	0	0	0	0	0	0	0.01	0.01
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	0	0	0	0	0	0	0	0	0
Water bottle	0.09	0.14	0	0	0.01	0.11	0.37	0.47	0.52
Dietary objects	0.09	0.14	0	0	0.02	0.15	0.37	0.47	0.52
Non-dietary objects	0.78	1.06	0.02	0.19	0.39	1	2.48	4.73	5.29
All objects	0.87	1.12	0.02	0.26	0.47	1	2.98	4.99	5.69

Table B.1.1.6. Median mouthing contact duration (s) during the game/practice

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	8	1.01	0.44	0.54	0.6	0.96	1.34	1.59	1.6	1.6
Clothes	34	1.74	1.78	0.24	0.89	1.29	1.99	3.45	8.48	10.61

Field structures	1	5.18	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	40	1.29	0.72	0.62	0.87	1.11	1.42	2.36	3.89	4.76
Head/face/hair	2	1.15	0.5	0.79	0.97	1.15	1.33	1.47	1.5	1.5
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	1	0.13	-	-	-	-	-	-	-	-
Water bottle	20	3.52	1.62	1.06	2.35	3.19	4.4	6.47	6.72	6.78
Dietary objects	22	3.56	1.6	1.06	2.4	3.19	4.55	6.41	6.71	6.78
Non-dietary objects	40	1.3	0.71	0.68	0.88	1.07	1.4	2.53	3.75	4.45
All objects	40	1.4	0.74	0.68	0.94	1.18	1.49	2.57	3.77	4.45

Table B.1.1.7. Frequency (event/h) of specific actions during the game/practice (n = 40)

Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	0.53	1.76	0	0	0	0	2.11	7.99	10.11
Heading	0.39	0.7	0	0	0	0.58	2.31	2.36	2.38
Jumping	9.52	19.71	0	0.71	2.32	8.4	74.75	76.51	76.95
Slip or fall	2.17	3.44	0	0	0.81	2.21	7.52	14.4	14.98
Tackling or sliding	0.48	0.96	0	0	0	0.63	2.69	3.54	3.75

Table B.1.1.8. Hourly duration (min/h) of macro-activities during the game/practice (n = 40)

Macro-Activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	0	0	0	0	0	0	0	0.01	0.01
Rest Standing	14.95	7.13	3.89	10.07	13.85	18.26	26.3	33.33	34.11
Running	15.13	6.95	1.83	9.96	15.07	19.56	26.44	28.18	28.95
Sit on chair	2.57	5.83	0	0	0	0.44	19.37	21.97	23.57
Sit on ground	0.82	1.18	0	0.01	0.37	0.9	3.31	4.52	4.73
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	0.51	0.78	0	0	0.17	0.57	2.04	3.07	3.44
Walking	25.71	6.43	11.33	21.27	25.83	30.07	35.19	37.11	37.23

Table B.1.1.9. Hourly duration (min/h) of intensity during the game/practice (n = 40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	1.98	1.11	0.11	1.11	1.84	2.84	3.75	4.48	4.68
Moderate	13.75	5.73	3.86	9.62	13.84	17.47	23.43	25.36	26.06
Low	25.29	5.56	11.3	22.47	26.03	28.98	33.84	34.32	34.43
Resting	18.98	8.67	7.03	12.67	16.66	25.27	34.83	38.19	39.34

Section B.1.2. Data summarized when participants were warming up

Table B.1.2.1. Both hands frequency (event /h) during warming up (n = 19)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	7.30	21.10	0.00	0.00	0.00	0.00	45.30	75.70	83.30
Body	37.50	60.50	0.00	0.30	5.90	42.00	176.10	189.10	192.3
Clothes	90.60	54.50	0.00	56.70	88.30	134.50	164.40	187.70	193.6
Field Structures	8.00	18.70	0.00	0.00	0.70	5.00	29.70	68.80	78.60
Footwear	20.10	30.80	0.00	0.00	0.00	39.00	73.50	90.70	94.90
Head/face/hair	27.00	34.40	0.00	2.70	20.70	38.90	69.90	129.70	144.6
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	17.70	65.90	0.00	0.00	0.00	4.30	55.10	236.10	281.4
Water bottle	2.20	6.90	0.00	0.00	0.00	0.00	10.10	25.20	28.90
Dietary Objects	2.20	6.90	0.00	0.00	0.00	0.00	10.10	25.20	28.90
Non-dietary	212.80	1254.0	0.00	136.80	181.90	265.50	446.20	458.60	461.7
All Objects	214.90	124.40	0.00	136.80	181.90	265.50	446.20	458.60	461.7

Table B.1.2.2. Both hands contact duration (min/h) during warming up (n = 19)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.20	0.50	0.00	0.0	0.00	0.00	1.00	1.60	1.70
Body	1.20	2.20	0.00	0.0	0.10	1.20	5.80	7.30	7.70
Clothes	12.80	12.50	0.00	4.6	9.70	18.0	35.7	456.0	48.0
Field Structures	1.00	3.60	0.00	0.0	0.00	0.10	3.20	12.90	15.4
Footwear	1.00	1.70	0.00	0.0	0.00	1.30	4.70	5.00	5.10
Head/face/hair	0.70	0.80	0.00	0.0	0.50	0.80	2.20	2.40	2.50
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	0.40	1.30	0.00	0.0	0.00	0.10	1.30	4.70	5.50
Water bottle	0.20	0.60	0.00	0.0	0.00	0.00	1.50	2.00	2.10
Dietary Objects	0.20	0.60	0.00	0.0	0.00	0.00	1.50	2.00	2.10
Non-dietary Objects	17.30	12.30	0.00	11.	15.30	21.8	41.0	47.40	49.0
All Objects	17.50	12.10	0.00	11.	15.30	21.8	41.0	47.40	49.0

Table B.1.2.3. Both hands contact median duration (s) during warming up

Objects	n	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4	3.30	5.1	0.6	0.70	0.70	3.30	9.40	10.6	11.0
Body	1	1.30	0.9	0.4	0.80	1.00	1.80	3.00	3.10	3.20
Clothes	1	6.00	5.9	1.1	2.30	4.60	7.20	14.5	23.2	25.4
Field Structures	9	2.80	2.9	0.7	0.80	1.90	2.70	7.90	8.80	9.00
Footwear	8	2.60	2.8	0.7	1.40	1.50	2.40	6.90	8.80	9.30
Head/face/hair	1	1.20	0.3	0.7	1.00	1.30	1.40	1.60	1.70	1.70
Shin guards	0	-	-	-	-	-	-	-	-	-

Soccer ball	6	1.40	0.6	0.9	0.90	1.30	1.60	2.30	2.40	2.50
Water bottle	2	4.70	2.8	2.1	3.20	4.40	6.00	7.30	7.50	7.60
Dietary Objects	3	4.70	2.8	2.1	3.20	4.40	6.00	7.30	7.50	7.60
Non-dietary Objects	1	2.60	1.8	0.7	1.10	2.30	3.60	5.40	7.10	7.50
All Objects	1	2.60	1.8	0.8	1.10	2.30	3.60	5.40	7.10	7.50

Table B.1.2.4. Mouthing frequency (event/h) while warming up (n = 19)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.10	0.42	0.00	0.00	0.00	0.00	0.18	1.49	1.82
Clothes	8.75	16.31	0.00	0.00	0.00	12.20	35.83	59.65	65.60
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	7.27	11.16	0.00	0.00	0.00	11.69	26.87	38.85	41.85
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	0.29	1.25	0.00	0.00	0.00	0.00	0.55	4.49	5.47
Dietary objects	0.29	1.25	0.00	0.00	0.00	0.00	0.55	4.49	5.47
Non-dietary	16.40	17.95	0.00	5.67	12.77	21.31	54.99	63.48	65.60
All objects	16.69	17.94	0.00	5.67	13.74	21.55	54.99	63.48	65.60

Table B.1.2.5. Mouthing hourly duration (min/h) while warming up (n = 19)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.04
Clothes	0.17	0.28	0.00	0.00	0.00	0.21	0.76	0.95	0.99
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.13	0.18	0.00	0.00	0.00	0.27	0.42	0.55	0.58
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.08	0.10
Dietary objects	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.08	0.10
Non-dietary objects	0.31	0.28	0	0.12	0.27	0.42	0.83	0.96	0.99
All objects	0.32	0.28	0	0.12	0.27	0.42	0.83	0.96	0.99

Table B.1.2.6 Mouthing median duration (s) while warming up

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	1	1.20	-	-	-	-	-	-	-	-
Clothes	8	1.30	0.90	0.70	0.80	0.90	1.30	2.80	3.10	3.20

Field structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	9	1.30	0.90	0.40	0.70	1.10	1.30	2.60	3.30	3.40
Head/face/hair	0	-	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-
Water bottle	1	0.90	-	-	-	-	-	-	-	-
Dietary objects	1	0.90	-	-	-	-	-	-	-	-
Non-dietary objects	15	1.42	0.99	0.45	0.81	0.94	1.62	3.31	3.41	3.44
All objects	15	1.41	0.99	0.45	0.81	0.94	1.57	3.31	3.41	3.44

Table B.1.2.7. Frequency (event/h) of actions while warming up (n =16)

Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	0.89	3.56	0	0	0	0	3.56	12.1	14.23
Heading	-	-	-	-	-	-	-	-	-
Jumping	15.11	19.69	0	0	0	26.76	47.43	49.34	49.82
Slip or fall	5.56	22.24	0	0	0	0	22.24	75.6	88.94
Tackling or sliding	-	-	-	-	-	-	-	-	-

Table B.1.2.8. Hourly duration (min/h) of macro-activities while warming up (n =16)

Macro-activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	-	-	-	-	-	-	-	-	-
Rest Standing	11.62	8.26	0.97	4.79	11.95	16.44	23.65	25.02	25.36
Running	19.77	12.6	0	11.05	15.27	28.54	39.23	40.97	41.4
Sit on chair	-	-	-	-	-	-	-	-	-
Sit on ground	0.49	0.83	0	0	0	0.89	2.15	2.46	2.54
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	8.36	11.41	0	0	1.69	12.79	27.67	32.89	34.2
Walking	19.14	7.43	5.78	14.16	21.01	24.36	28.97	29.34	29.43

Table B.1.2.9. Hourly duration (min/h) of intensity while warming up (n =16)

Intensity	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	11	4.75	5.99	1.14	1.85	3.08	4.80	13.74	20.55	22.26
Moderate	16	3.66	2.60	0.98	1.57	3.62	4.04	8.11	10.54	11.15
Low	16	4.15	2.65	1.45	2.44	3.00	4.72	9.31	10.36	10.62
Resting	16	6.49	5.18	1.38	4.05	5.30	7.77	13.19	21.51	23.59

Section B.1.3. Data summarized for participants on before/after/break time

Table B.1.3.1. Both hands frequency (event /h) on before/after/break time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4.30	13.00	0.00	0.00	0.00	3.40	15.40	54.90	79.40
Body	19.40	19.40	0.00	4.30	13.70	30.80	62.50	66.80	68.00
Clothes	111.10	58.20	31.80	67.10	100.00	129.00	225.80	286.60	309.50
Field Structures	17.90	23.60	0.00	4.10	9.60	18.70	61.60	99.00	115.80
Footwear	11.00	14.80	0.00	0.00	6.90	15.30	41.10	54.60	61.20
Head/face/hair	25.80	23.70	0.00	12.00	20.00	32.40	75.40	100.10	114.70
Shin guards	3.70	9.70	0.00	0.00	0.00	0.90	21.00	41.80	52.40
Soccer ball	16.40	20.80	0.00	0.00	3.60	32.20	57.00	69.70	76.00
Water bottle	49.40	60.90	0.00	14.90	31.70	52.80	146.90	263.70	324.00
Dietary Objects	49.60	61.00	0.00	14.50	32.30	52.80	146.90	263.70	324.00
Non-dietary Objects	227.30	81.70	80.10	181.00	205.80	280.10	382.20	433.20	451.00
All Objects	276.90	90.60	89.90	215.80	262.70	324.70	423.90	514.30	526.50

Table B.1.3.2. Both hands hourly duration (min/h) on before/after/break time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.50	1.60	0.00	0.00	0.00	0.10	3.40	7.10	8.30
Body	2.90	4.40	0.00	0.10	0.60	3.80	11.60	16.20	18.40
Clothes	15.30	9.20	2.80	8.40	12.80	20.30	34.20	37.10	38.30
Field Structures	2.20	3.50	0.00	0.16	0.50	2.20	11.10	14.10	14.10
Footwear	1.40	2.60	0.00	0.00	0.40	1.80	6.80	10.60	11.10
Head/face/hair	1.00	1.30	0.00	0.30	0.60	1.20	2.80	6.20	7.00
Shin guards	0.40	0.90	0.00	0.00	0.00	0.00	1.80	4.10	5.00
Soccer ball	1.00	1.70	0.00	0.00	0.10	1.40	3.60	7.30	8.90
Water bottle	8.10	8.00	0.00	3.60	5.30	11.80	21.30	33.20	33.90
Dietary Objects	8.10	8.00	0.00	3.60	5.40	12.10	21.30	33.20	33.90
Non-dietary Objects	26.50	11.00	7.40	18.20	24.80	35.90	43.80	49.80	53.50
All Objects	34.60	11.30	12.70	27.20	33.30	42.00	52.90	59.30	59.70

Table B.1.3.3. Both hands median duration (s) on before/after/break time

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	14	5.60	12.30	0.50	1.00	2.00	2.60	24.00	42.50	47.20
Body	32	3.40	2.80	0.20	1.30	2.60	4.10	9.70	10.80	11.00
Clothes	40	4.60	1.80	2.10	3.30	4.20	5.90	7.30	9.60	10.80
Field Structures	33	4.70	3.60	1.10	2.70	3.40	6.30	9.60	17.00	20.00
Footwear	25	4.50	2.40	1.10	3.00	3.90	5.30	9.10	9.30	9.30
Head/face/hair	36	1.60	0.70	0.60	1.10	1.40	1.80	2.70	3.50	3.90
Shin guards	10	5.40	5.10	1.20	2.40	3.50	5.20	14.90	16.30	16.70
Soccer ball	22	2.40	1.90	0.80	1.50	1.80	2.30	6.70	8.20	8.50

Water bottle	36	7.90	3.60	2.30	5.80	7.30	9.20	15.00	17.20	18.20
Dietary Objects	36	7.80	3.60	2.30	5.80	7.00	9.00	15.00	17.20	18.20
Non-dietary Objects	40	3.40	1.20	1.60	2.50	3.20	3.90	5.90	6.30	6.30
All Objects	40	3.80	1.30	2.00	2.80	3.50	4.60	6.10	6.30	6.40

Table B.1.3.4. Mouthing frequency (event/h) on before/after/break time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.42	1.84	0	0	0	0	0.42	8.34	8.35
Clothes	10.96	21.81	0	0	5.74	11.05	53.58	98.34	113.14
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	10.57	13.17	0	0	5.72	14.72	35.36	50.17	51.91
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	34.81	44.22	0	8.67	25.85	39.61	91.89	197.96	239.85
Dietary objects	35.59	43.82	0.00	9.31	25.85	39.61	91.89	197.96	239.85
Non-dietary objects	22.96	25.10	0.00	8.33	16.54	30.62	59.18	107.06	119.43
All objects	58.55	44.57	2.79	28.32	48.35	85.80	128.04	197.96	239.85

Table B.1.3.5. Mouthing hourly duration (min/h) on before/after/break time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.01	0.03	0	0	0	0	0	0.13	0.15
Clothes	0.27	0.5	0	0	0.11	0.26	1.71	2.01	2.02
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.47	0.98	0	0	0.14	0.35	2.19	4.35	4.9
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	2.4	3.22	0	0.65	1.15	3.06	8.04	14.04	14.78
Dietary objects	2.45	3.20	0.00	0.65	1.25	3.06	8.04	14.04	14.78
Non-dietary objects	0.80	1.13	0.00	0.14	0.37	0.84	2.52	4.72	4.90
All objects	3.25	3.26	0.07	1.18	2.36	4.36	9.00	14.33	14.78

Table B.1.3.6. Mouthing median duration (s) on before/after/break time

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	2	0.9	0.34	0.66	0.78	0.9	1.02	1.11	1.13	1.14
Clothes	25	1.59	0.95	0.57	0.89	1.27	1.86	3.24	4.43	4.74
Field structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	26	1.68	1.19	0.28	0.98	1.31	1.92	4.33	4.65	4.7
Head/face/hair	0	-	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-
Water bottle	33	3.76	1.51	1.35	2.63	3.85	4.46	6.33	6.88	6.9
Dietary objects	35	3.66	1.53	1.35	2.50	3.70	4.43	6.25	6.88	6.90
Non-dietary objects	28	1.67	1.15	0.18	0.90	1.27	1.99	4.06	4.73	4.74
All objects	38	2.61	1.47	0.28	1.59	2.28	3.37	5.61	6.55	6.90

Table B.1.3.7. Frequency (event/h) of actions on before/after/break time (n = 40)

Activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	-	-	-	-	-	-	-	-	-
Heading	-	-	-	-	-	-	-	-	-
Jumping	2.05	6.53	0	0	0	0	8.34	29.56	34.43
Slip or fall	0.7	2.26	0	0	0	0	4.95	9.81	11.48
Tackling or	0.12	0.54	0	0	0	0	0.1	2.48	2.73

Table B.1.3.8. Duration (min/h) of macro-activities on before/after/break time (n = 40)

Macro-activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	0.02	0.1	0	0	0	0	0	0.37	0.61
Rest Standing	31.22	10.57	10.59	24.56	30.4	36.45	47.95	50.43	50.92
Running	3.1	4.23	0	0.35	1.69	3.62	12.4	16.65	17
Sit on chair	2.15	5.76	0	0	0	0.46	15.71	24.12	26.43
Sit on ground	3.14	6.19	0	0	0.02	2.99	14.01	25.44	26.5
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	0.19	0.47	0	0	0	0	0.96	1.91	2.32
Walking	20.12	9.99	4	12.36	20.51	25.57	39.03	40.38	40.63

Table B.1.3.9. Duration (min/h) of intensity on before/after/break time (n = 40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	1.22	1.47	0.00	0.00	0.45	2.26	3.96	4.92	5.27
Moderate	2.66	3.28	0.00	0.42	1.76	3.92	9.63	13.55	14.13
Low	18.86	9.10	3.92	11.55	19.13	24.29	38.52	39.35	39.59
Resting	37.26	9.61	15.37	32.01	37.00	43.42	53.86	54.98	55.52

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Section B.1.4. Data summarized by other combined time (warming up and on before/after/break time)

Table B.1.4.1. Both hands frequency (event/h) on other combined time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	5.5	14.3	0.0	0.0	0.0	4.8	23.9	64.7	74.8
Body	23.5	27.1	0.0	3.5	13.7	36.0	74.9	102.1	118.3
Clothes	110.0	58.1	29.9	68.1	98.6	139.9	225.8	286.7	309.5
Field Structures	16.0	21.2	0.0	3.4	8.5	18.3	45.7	89.7	100.5
Footwear	13.7	18.1	0.0	0.0	6.1	21.8	39.7	70.5	76.4
Head/face/hair	24.6	23.2	0.0	10.2	19.3	31.6	62.0	100.4	116.4
Shin guards	3.5	9.5	0.0	0.0	0.0	0.9	19.7	41.8	52.3
Soccer ball	20.1	30.8	0.0	0.0	6.3	32.0	60.8	129.9	164.3
Water bottle	43.2	61.8	0.0	9.6	25.1	41.6	146.9	263.7	324.0
Dietary Objects	43.40	61.80	0.00	9.60	25.10	41.60	146.90	263.70	324.00
Non-dietary Objects	230.90	87.60	80.10	191.20	206.40	272.20	383.90	446.00	451.00
All Objects	274.30	98.00	89.90	207.50	262.70	325.10	441.00	514.30	526.50

Table B.1.4.2. Both hands hourly duration (min/h) on other combined time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.40	1.40	0.00	0.00	0.00	0.10	2.30	5.80	7.80
Body	2.80	4.30	0.00	0.10	0.70	3.90	11.30	16.20	18.50
Clothes	15.60	9.30	2.60	7.80	13.60	20.90	34.20	37.10	38.30
Field Structures	2.00	3.60	0.00	0.10	0.40	1.80	11.10	14.40	14.70
Footwear	1.30	2.20	0.00	0.00	0.40	1.70	5.80	9.10	11.10
Head/face/hair	0.90	1.20	0.00	0.30	0.60	0.90	2.70	5.30	6.70
Shin guards	0.30	0.90	0.00	0.00	0.00	0.00	1.80	3.90	4.70
Soccer ball	1.10	1.70	0.00	0.00	0.20	1.60	3.60	7.10	8.90
Water bottle	6.90	8.00	0.00	1.50	4.30	8.20	21.30	33.10	33.90
Dietary Objects	6.90	8.00	0.00	1.50	4.30	8.20	21.30	33.20	33.90
Non-dietary Objects	25.70	11.00	7.40	16.50	24.00	35.00	43.80	49.80	53.50
All Objects	32.70	12.20	13.30	22.80	30.00	41.10	52.90	59.30	59.70

Table B.1.4.3. Both hands median duration (s) on other combined time

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	15	2.50	4.30	0.50	0.70	1.10	2.20	6.70	16.00	18.20
Body	33	3.10	2.80	0.20	1.20	2.00	3.70	9.70	10.80	11.00
Clothes	40	4.60	1.90	1.40	3.30	4.50	5.80	7.30	9.60	10.80
Field Structures	33	4.40	3.60	0.90	2.40	3.40	6.20	9.60	17.00	20.00
Footwear	27	3.70	2.30	1.10	2.00	3.20	5.20	8.30	9.10	9.30
Head/face/hair	36	1.50	0.60	0.60	1.10	1.30	1.60	2.70	3.50	3.90
Shin guards	10	5.40	5.10	1.20	2.40	3.50	5.20	14.90	16.30	16.70

Soccer ball	26	2.10	1.50	0.80	1.40	1.70	2.30	3.90	7.40	8.50
Water bottle	37	7.70	3.60	2.10	5.10	7.20	9.10	14.10	17.20	18.20
Dietary Objects	37	7.60	3.60	2.10	5.10	6.80	8.90	14.10	17.20	18.20
Non-dietary Objects	40	3.10	1.20	1.30	2.40	2.90	3.60	5.70	6.00	6.30
All Objects	40	3.40	1.30	1.30	2.50	3.20	4.00	5.80	6.10	6.30

Table B.1.4.4. Mouthing frequency (event/h) on other combined time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.30	1.40	0.00	0.00	0.00	0.00	1.70	6.60	8.40
Clothes	10.50	20.90	0.00	0.00	5.30	11.10	29.40	98.30	113.10
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	9.90	11.00	0.00	0.00	6.80	13.50	29.40	41.10	46.20
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	29.30	42.50	0.00	5.60	22.70	31.90	79.60	198.00	239.90
Dietary objects	29.8	42.2	0.0	8.5	22.7	31.9	79.6	198.0	239.9
Non-dietary objects	11.8	20.8	0.0	0.0	6.4	11.5	29.4	98.3	113.1
All objects	41.6	44.8	0.0	17.1	29.6	47.0	122.1	198.0	239.9

Table B.1.4.5. Mouthing duration (min/h) on other combined time (n = 40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20
Clothes	0.30	0.40	0.00	0.00	0.10	0.30	1.10	1.90	2.00
Field structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.40	0.80	0.00	0.00	0.20	0.30	2.20	3.20	3.30
Head/face/hair	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	2.00	2.80	0.00	0.40	1.10	2.10	6.80	12.10	14.80
Dietary objects	2.0	2.7	0.0	0.4	1.1	2.1	6.8	12.1	14.8
Non-dietary objects	0.3	0.4	0.0	0.0	0.2	0.3	1.1	1.9	2.0
All objects	2.3	2.7	0.0	0.6	1.5	2.7	7.1	12.1	14.8

Table B.1.4.6. Mouthing median duration (s) on other combined time

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	3	1.00	0.30	0.70	0.90	1.10	1.20	1.20	1.20	1.20
Clothes	25	1.50	0.90	0.70	0.90	1.30	1.80	3.20	4.40	4.70

Field structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	28	1.60	1.20	0.40	0.90	1.20	1.80	4.30	4.60	4.70
Head/face/hair	0	-	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-
Water bottle	33	3.80	1.50	1.40	2.60	3.80	4.50	6.30	6.90	6.90
Dietary objects	35	3.7	1.5	1.4	2.5	3.7	4.4	6.2	6.9	6.9
Non-dietary objects	29	1.8	2.0	0.2	0.9	1.2	1.9	4.1	9.5	11.3
All objects	38	3.0	1.6	0.7	1.7	2.6	4.1	5.9	6.6	6.9

Table B.1.4.7. Frequency (event/h) of actions on other combined time (n = 40)

Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	0.19	1.17	0	0	0	0	0	4.53	7.43
Heading	-	-	-	-	-	-	-	-	-
Jumping	4.95	9.18	0	0	0	5.6	23.48	30.42	34.43
Slip or fall	1.86	7.57	0	0	0	0	7.4	32.8	46.43
Tackling or	0.11	0.51	0	0	0	0	0.1	2.34	2.51

Table B.1.4.8. Duration (min/h) of macro-activities on other combined time (n = 40)

Macro-activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	0.01	0.06	0	0	0	0	0	0.21	0.35
Rest Standing	27.96	11.44	10.59	17.59	26.39	36.22	46.73	50.43	50.92
Running	5.83	5.95	0	1.01	3.5	10.24	16.15	20.86	23.32
Sit on chair	1.99	5.72	0	0	0	0.22	15.27	24.12	26.43
Sit on ground	2.98	5.98	0	0	0.21	2.76	14.01	24.78	25.41
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	1.7	4.53	0	0	0	0.81	12.86	18.93	19.85
Walking	19.34	9.33	4	12.36	17.6	24.94	39.03	40.38	40.63

Table B.1.4.9. Duration (min/h) of intensity on other combined time (n = 40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	1.73	1.90	0.00	0.00	1.32	2.67	5.33	6.72	6.91
Moderate	6.09	6.34	0.00	0.98	4.00	10.29	17.23	22.46	23.22
Low	18.74	8.94	4.00	11.55	18.45	23.78	38.52	39.35	39.59
Resting	33.43	11.91	14.73	22.43	34.95	42.00	52.46	54.87	55.52

Section B.2. Data summarized according to location:

Section B.2.1. Data summarized ON the Field

Table B.2.1.1 Both hands contact frequency (event/h) on the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4.40	5.30	0.00	1.10	2.61	5.00	18.50	19.60	20.10
Body	12.30	11.80	1.50	4.30	9.10	16.20	32.30	54.10	62.00
Clothes	70.80	35.40	13.60	49.40	65.70	89.70	137.00	170.40	180.10
Field Structures	6.20	5.30	0.00	2.10	5.20	8.20	15.60	21.60	22.80
Footwear	5.70	5.50	0.60	2.40	4.40	6.40	14.00	25.10	30.30
Head/face/hair	29.00	25.30	2.60	12.10	20.50	34.90	81.10	104.30	112.30
Shin guards	1.40	3.50	0.00	0.00	0.00	0.80	5.80	15.20	20.10
Soccer ball	22.10	31.00	0.00	3.00	9.10	27.80	90.60	125.10	128.50
Water bottle	2.40	2.70	0.00	0.00	1.70	4.00	7.00	9.50	10.00
Dietary Objects	2.40	2.80	0.00	0.00	1.70	4.00	7.00	10.00	10.90
Non-dietary Objects	162.90	70.10	66.40	116.30	150.90	183.80	299.30	354.90	368.30
All Objects	165.30	70.80	67.30	118.70	151.10	185.20	299.60	358.70	371.00

Table B.2.1.2 Both hands hourly contact duration (min/h) on the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.20	0.40	0.00	0.00	0.10	0.30	0.80	1.80	2.40
Body	0.90	1.30	0.00	0.10	0.30	1.10	3.80	4.80	5.30
Clothes	11.70	12.00	1.30	4.70	8.40	13.50	35.30	49.50	55.10
Field Structures	0.60	0.80	0.00	0.10	0.30	1.00	2.10	2.80	3.10
Footwear	0.40	0.40	0.00	0.10	0.30	0.50	1.20	1.60	1.80
Head/face/hair	1.00	1.40	0.00	0.30	0.70	1.10	2.30	6.40	9.00
Shin guards	0.10	0.40	0.00	0.00	0.00	0.10	0.70	1.70	2.20
Soccer ball	0.90	1.10	0.00	0.14	0.50	1.2.	3.80	4.20	4.40
Water bottle	0.40	0.50	0.00	0.00	0.40	0.70	1.10	1.70	2.00
Dietary Objects	0.40	0.50	0.00	0.00	0.40	0.70	1.10	1.70	2.10
Non-dietary Objects	16.40	12.20	0.90	8.90	13.00	19.50	42.10	54.10	58.70
All Objects	16.80	12.20	1.90	9.50	13.30	20.30	42.20	54.30	58.70

Table B.2.1.3 Both hands contact median duration (s) on the field

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	35	1.50	1.20	0.20	0.80	1.10	1.60	4.40	5.00	5.10
Body	40	1.30	1.00	0.40	0.80	1.10	1.60	2.40	4.90	6.30
Clothes	40	4.40	3.60	1.60	2.40	3.20	4.70	9.50	17.70	19.60
Field Structures	39	3.60	3.80	0.40	1.60	2.40	4.40	8.40	18.00	20.00
Footwear	40	3.30	2.80	0.80	1.60	2.50	4.40	8.40	12.90	14.90
Head/face/hair	40	1.30	0.50	0.60	1.10	1.20	1.60	2.10	2.80	3.10
Shin guards	15	4.60	5.00	0.90	1.50	2.40	4.80	15.90	16.50	16.60

Soccer ball	40	2.00	1.60	0.60	1.20	1.60	2.00	3.90	8.10	10.60
Water bottle	24	8.20	5.10	2.10	4.90	7.00	10.00	17.10	22.10	23.50
Dietary Objects	25	7.90	5.20	1.60	4.10	6.70	10.00	17.00	22.00	23.50
Non-dietary Objects	40	2.30	1.30	1.20	1.60	2.00	2.90	4.10	6.80	6.90
All Objects	40	2.40	1.30	1.20	1.60	2.00	2.90	4.20	6.80	7.00

Table B.2.1.4 Mouthing contact frequency (event/h) on the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.6	2.06	0	0	0	0	2.35	9.13	12.27
Clothes	8.37	15.96	0	1.19	3.57	10.34	24.78	70.01	96.81
Field Structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	8.09	5.85	0.84	3.78	6.99	11.21	19.07	26	26.33
Head/face/hair	0.01	0.07	0	0	0	0	0	0.29	0.47
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	0.02	0.1	0	0	0	0	0	0.38	0.63
Water bottle	1.44	1.9	0	0	0.27	2.64	5.29	5.68	5.7
Dietary objects	1.64	1.94	0.00	0.00	0.80	2.73	5.64	6.02	6.23
Non-dietary objects	18.31	17.91	2.40	9.05	12.68	21.92	44.29	85.99	104.01
All objects	19.95	18.13	2.40	9.80	14.99	24.21	45.08	86.97	105.61

Table B.2.1.5 Mouthing hourly contact duration (min/h) on the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.01	0.05	0	0	0	0	0.05	0.24	0.31
Clothes	0.2	0.3	0	0.03	0.08	0.23	0.69	1.22	1.52
Footwear	-	-	-	-	-	-	-	-	-
Field Structures	-	-	-	-	-	-	-	-	-
Hands	0.26	0.29	0.01	0.09	0.16	0.31	0.85	1.1	1.21
Head/face/hair	0	0	0	0	0	0	0	0.01	0.01
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	0	0	0	0	0	0	0	0	0
Water bottle	0.09	0.13	0	0	0.01	0.16	0.36	0.41	0.41
Dietary objects	0.10	0.13	0.00	0.00	0.05	0.20	0.36	0.41	0.41
Non-dietary objects	0.51	0.43	0.03	0.19	0.37	0.70	1.39	1.63	1.63
All objects	0.61	0.47	0.03	0.24	0.42	0.88	1.45	1.68	1.72

Table B.2.1.6 Mouthing median duration (s) on the field (n =40)

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	9	1.04	0.41	0.54	0.60	0.98	1.26	1.59	1.60	1.60
Clothes	35	1.56	1.67	0.24	0.88	1.28	1.66	2.61	7.95	10.61

Field Structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	40	1.23	0.61	0.36	0.85	1.02	1.41	2.53	2.97	3.15
Head/face/hair	1	1.50	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	1	0.13	-	-	-	-	-	-	-	-
Water bottle	20	3.53	1.37	0.93	2.73	3.52	4.34	5.59	5.70	5.73
Dietary objects	22	3.48	1.43	0.93	2.35	3.41	4.44	5.57	5.70	5.73
Non-dietary objects	40	1.15	0.46	0.61	0.87	1.03	1.21	1.98	2.70	2.82
All objects	40	1.26	0.51	0.61	0.90	1.19	1.39	2.11	2.83	2.98

Table B.2.1.7 Actions frequencies (event/h) on the field (n =40)

Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	0.62	1.94	0	0	0	0	3.65	8.43	11.12
Heading	0.37	0.68	0	0	0	0.51	2.24	2.3	2.34
Jumping	9.79	19.37	0	0.7	4.08	8.47	68.67	79.77	84.64
Slip or fall	2.6	4.39	0	0	0.84	2.28	13.54	17.7	19.53
Tackling or sliding	0.48	0.91	0	0	0	0.6	2.73	3.25	3.37

Table B.2.1.8 Macro-activities duration (min/h) on the field (n =40)

Macro-activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	0	0.02	0	0	0	0	0	0.06	0.1
Rest Standing	16.11	6.2	5	12.56	15.66	18.62	29.8	31.3	31.67
Running	15.23	6.44	2.5	10.48	14.67	19.3	25.56	26.75	27
Sit on chair	0.51	2.06	0	0	0	0	2.14	9.46	10.26
Sit on ground	0.66	1.01	0	0.02	0.48	0.87	1.69	4.45	5.95
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	0.69	1.37	0	0	0.24	0.6	3.2	6.14	6.89
Walking	26.46	6.04	13.65	21.9	27.19	30.54	33.8	36.91	37.28

Table A.2.1.9 Intensity duration (min/h) on the field (n = 40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	2.12	1.25	0.10	1.18	2.16	2.82	4.02	5.19	5.52
Moderate	13.86	5.30	4.18	10.47	13.88	17.92	22.16	22.75	22.83
Low	26.05	5.10	13.63	22.60	27.26	29.13	33.42	34.08	34.29
Resting	17.96	6.62	8.83	13.18	17.33	20.97	29.90	35.65	38.38

Section B.2.2. Data summarized OFF the Field

Table B.2.2.1 Both hands contact frequency (event/h) off the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	4.80	12.80	0.00	0.00	0.00	1.20	33.20	53.30	61.80
Body	19.00	19.20	0.00	0.00	13.60	33.80	56.20	61.90	62.80
Clothes	96.30	62.80	0.00	61.40	81.30	122.90	219.30	264.60	268.10
Field Structures	17.40	23.30	0.00	2.10	12.00	21.00	52.20	102.70	126.70
Footwear	12.80	21.80	0.00	0.00	1.70	17.00	45.40	87.40	105.30
Head/face/hair	25.70	27.50	0.00	6.10	21.40	34.50	82.80	109.50	119.40
Shin guards	0.70	1.90	0.00	0.00	0.00	0.00	5.60	7.60	8.00
Soccer ball	33.80	60.30	0.00	4.00	14.40	38.00	93.70	273.80	343.30
Water bottle	45.50	49.80	0.00	6.70	34.40	61.10	160.80	183.50	195.90
Dietary Objects	45.70	49.80	0.00	6.70	35.20	61.10	160.80	183.50	195.90
Non-dietary Objects	226.50	100.80	0.00	156.50	214.10	304.20	374.00	389.40	395.60
All Objects	272.30	118.50	0.00	206.30	279.20	335.20	437.40	528.80	575.20

Table B.2.2.2 Both hands contact duration (min/h) off the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.30	1.00	0.00	0.00	0.00	0.00	1.20	4.30	5.60
Body	2.70	3.80	0.00	0.00	1.00	3.10	9.80	15.10	17.00
Clothes	15.00	11.40	0.00	5.00	12.00	21.80	34.20	42.60	46.20
Field Structures	1.70	3.10	0.00	0.10	0.80	1.50	5.90	13.40	17.50
Footwear	2.40	5.40	0.00	0.00	0.10	1.50	9.80	23.70	24.90
Head/face/hair	1.10	1.60	0.00	0.20	0.70	1.40	2.90	7.30	7.60
Shin guards	0.10	0.30	0.00	0.00	0.00	0.00	0.60	1.20	1.20
Soccer ball	1.50	2.00	0.00	0.10	0.70	2.20	6.30	7.40	7.90
Water bottle	7.60	8.30	0.00	0.50	4.30	13.30	21.70	27.20	29.80
Dietary Objects	7.60	8.30	0.00	0.50	4.80	13.30	21.70	27.20	29.80
Non-dietary Objects	26.40	13.20	0.00	17.80	28.40	34.40	46.10	51.90	52.50
All Objects	34.10	14.20	0.00	25.30	35.80	42.90	53.20	59.20	59.70

Table B.2.2.3 Both hands median duration (s) off the field

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	10	3.00	3.30	0.60	1.30	1.60	2.60	9.20	11.00	11.50
Body	28	4.60	6.00	0.80	1.90	2.80	5.20	11.20	26.70	32.00
Clothes	37	4.90	2.60	0.80	3.50	4.50	6.10	10.40	12.10	12.20
Field Structures	30	3.90	2.60	1.40	2.30	2.90	5.20	7.40	11.70	13.40
Footwear	20	5.30	5.80	1.00	2.50	3.20	7.50	10.30	24.00	27.40
Head/face/hair	33	1.90	1.20	0.70	1.10	1.70	2.20	4.20	5.70	6.10
Shin guards	5	7.20	5.80	2.70	3.10	4.70	8.90	15.10	16.40	16.70
Soccer ball	31	2.30	1.40	0.60	1.50	1.90	2.80	4.80	6.20	6.60

Water bottle	32	6.60	3.30	0.20	4.50	6.10	8.30	13.30	14.10	14.20
Dietary Objects	33	6.60	3.30	0.20	4.50	6.00	8.30	13.20	14.10	14.20
Non-dietary Objects	38	3.30	1.30	1.00	2.40	3.10	4.10	5.50	6.20	6.50
All Objects	38	3.60	1.40	1.00	2.60	3.40	4.50	5.60	7.00	7.70

Table B.2.2.4 Mouthing contact frequency (event/h) off the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.10	0.50	0.00	0.00	0.00	0.00	0.00	1.80	2.80
Clothes	14.00	29.00	0.00	0.00	4.80	15.40	47.70	131.70	153.80
Field structures	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.80	1.30
Footwear	-	-	-	-	-	-	-	-	-
Hands	10.60	12.90	0.00	0.00	5.90	15.90	32.70	49.50	59.00
Head/face/hair	0.10	0.60	0.00	0.00	0.00	0.00	0.00	2.30	3.60
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	39.30	53.60	0.00	3.50	25.30	46.50	120.40	228.20	251.80
Dietary objects	39.4	53.6	0.0	3.5	25.3	46.5	120.4	228.2	251.8
Non-dietary objects	25.08	31.89	0.00	4.96	15.46	35.66	70.14	138.35	164.38
All objects	64.50	65.97	0.00	22.10	41.58	92.17	213.55	270.88	282.07

Table B.2.2.5 Mouthing hourly duration (min/h) off the field (n =40)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	-	-	-	-	-	-	-	-	-
Body skin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clothes	0.60	1.20	0.00	0.00	0.10	0.50	2.40	5.10	6.60
Field structures	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.70	1.90	0.00	0.00	0.10	0.60	1.90	8.00	11.40
Head/face/hair	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	2.80	4.80	0.00	0.20	1.20	2.90	11.10	21.20	25.30
Dietary objects	2.8	4.8	0.0	0.2	1.2	2.9	11.1	21.2	25.3
Non-dietary objects	1.30	2.34	0.00	0.07	0.35	1.43	4.64	10.19	12.03
All objects	4.05	5.21	0.00	0.94	2.19	5.43	14.63	22.06	25.71

Table B.2.2.6 Mouthing median duration (s) off the field

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial turf	0	-	-	-	-	-	-	-	-	-
Body skin	1	0.66	#N/A	0.66	0.66	0.66	0.66	0.66	0.66	0.66

Clothes	22	1.99	1.78	0.72	0.93	1.35	2.34	3.43	7.8	8.96
Field structures	1	5.18	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	25	1.96	1.92	0.2	0.86	1.14	2.5	5.9	7.62	8.06
Head/face/hair	1	0.79	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-
Water bottle	31	3.61	1.79	0.99	2.61	3.19	4.14	5.92	9.28	10.69
Dietary objects	32	3.57	1.77	0.99	2.57	3.17	4.10	5.91	9.23	10.69
Non-dietary objects	24	1.70	1.24	0.20	0.87	1.28	2.40	3.31	5.43	6.25
All objects	33	2.69	1.57	0.81	1.53	2.32	3.06	6.00	7.05	7.58

Table B.2.2.7 Actions frequencies (event/h) off the field (n =40)

Actions	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Diving	-	-	-	-	-	-	-	-	-
Heading	-	-	-	-	-	-	-	-	-
Jumping	3.65	9.05	0	0	0	0	22.51	35.12	39.55
Slip or fall	0.33	1.2	0	0	0	0	3.08	5.09	5.22
Tackling or sliding	0.13	0.81	0	0	0	0	0	3.14	5.06

Table B.2.2.8 Macro-activities duration (min/h) off the field (n =40)

Activities	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Push ups	-	-	-	-	-	-	-	-	-
Resting	27.67	12.33	0.00	19.06	25.99	34.28	48.37	54.76	54.81
Running	5.23	8.00	0.00	0.79	2.68	3.94	25.40	31.48	31.60
Sit on chair	7.26	11.98	0.00	0.00	0.00	9.70	30.60	40.73	43.71
Sit on ground	4.14	6.97	0.00	0.00	0.00	6.76	18.73	26.26	29.61
Sit ups	-	-	-	-	-	-	-	-	-
Stretching	1.01	2.44	0.00	0.00	0.00	0.51	8.08	9.50	10.16
Walking	14.59	9.29	2.84	6.06	11.85	19.54	29.00	35.98	36.96

Table B.2.2.9 Intensity duration (min/h) off the field (n =40)

Intensity	Mean	SD	Min	p25	Median	p75	p95	p99	Max
High	1.53	2.36	0.00	0.00	0.56	2.07	5.35	10.13	10.26
Moderate	5.57	7.85	0.00	0.89	2.60	5.72	22.43	31.08	31.60
Low	13.43	8.20	2.73	6.68	11.66	18.12	26.81	33.37	36.41
Resting	39.47	13.02	0.00	30.12	42.12	50.65	55.22	55.64	55.81

Section B.3. Data summarized if participants were wearing gloves or not

Section B.3.1. Data summarized gloves ON

Table B.3.1.1 Both hands contact frequency (event/h) while wearing gloves (n =21)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	6.20	8.00	0.00	0.00	2.30	9.20	21.70	25.30	26.20
Body	9.60	14.40	0.00	1.60	3.20	10.80	32.30	54.20	59.70
Clothes	63.20	46.70	6.40	36.60	47.70	84.30	151.70	177.40	183.90
Field Structures	7.70	10.20	0.00	1.20	3.40	8.20	23.10	38.70	42.60
Footwear	4.10	4.90	0.00	0.00	2.30	6.80	13.20	16.40	17.20
Head/face/hair	33.10	33.10	1.60	9.70	22.40	43.20	91.80	117.80	124.30
Shin guards	0.90	1.90	0.00	0.00	0.00	0.60	4.50	6.50	7.00
Soccer ball	38.60	43.70	0.00	5.70	15.00	54.00	108.50	138.00	145.40
Water bottle	4.20	5.00	0.00	0.00	1.50	8.90	12.00	12.90	13.10
Dietary Objects	4.3	5.1	0	0	1.5	8.9	13.1	13.1	13.1
Non-dietary Objects	184.7	83	63.8	125.3	169.7	247.8	316.5	361.3	372.6
All Objects	189	84.5	65.1	128.8	170.9	247.8	316.5	370.3	383.7

Table B.3.1.2 Both hands hourly contact duration (min/h) while wearing gloves (n =21)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.26	0.51	0.00	0.03	0.11	0.31	0.79	2.24	3.05
Body	1.25	1.72	0.03	0.16	0.39	2.03	4.56	6.25	6.99
Clothes	13.06	11.38	1.62	5.74	9.02	16.84	35.19	47.61	52.73
Field Structures	0.80	0.87	0.03	0.18	0.44	1.29	2.43	3.20	3.30
Footwear	0.57	0.57	0.01	0.16	0.30	0.86	1.85	1.98	1.98
Head/face/hair	1.01	1.36	0.03	0.35	0.65	1.25	2.15	6.09	8.57
Shin guards	0.12	0.34	0.00	0.00	0.00	0.08	0.66	1.51	
Soccer ball	0.87	0.97	0.01	0.22	0.57	1.19	3.50	3.89	4.09
Water bottle	1.22	1.25	0.00	0.42	0.89	1.76	2.74	5.48	6.77
Dietary Objects	1.22	1.25	0.00	0.42	0.91	1.76	2.74	5.48	6.77
Non-dietary Objects	18.70	11.73	5.40	11.13	15.02	22.65	42.63	52.64	56.91
All Objects	19.92	11.87	5.83	12.22	15.92	24.87	43.15	54.50	58.83

Table B.3.1.3 Both hands contact median duration (s) while wearing gloves

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	15	1.50	1.00	0.50	0.80	1.00	2.00	3.30	3.50	3.50
Body	18	1.50	1.00	0.40	0.80	1.20	2.00	3.90	3.90	3.90
Clothes	21	2.70	1.30	1.20	1.70	2.30	3.20	4.90	5.30	5.30
Field Structures	18	2.50	1.40	0.50	1.30	2.80	3.30	4.60	5.20	5.30
Footwear	13	2.40	1.40	0.90	1.60	1.70	3.70	4.80	5.30	5.40
Head/face/hair	21	1.30	0.70	0.60	1.00	1.10	1.60	2.30	3.20	3.40
Shin guards	6	2.20	1.20	0.90	1.50	1.90	2.80	3.90	4.10	4.20
Soccer ball	19	1.80	0.70	0.80	1.50	1.80	2.10	2.90	3.40	3.60

Water bottle	13	6.90	3.90	2.50	3.90	5.90	9.80	13.40	14.70	15.00
Dietary Objects	13	6.9	3.9	2.5	3.9	5.9	9.8	13.4	14.7	15
Non-dietary Objects	21	1.9	0.8	1.1	1.3	1.8	2.3	3.8	4.2	4.3
All Objects	21	1.9	0.9	1.1	1.3	1.8	2.3	3.8	4.2	4.4

Table B.3.1.4 Mouthing frequency (event/h) while wearing gloves (n =21)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	-	-	-	-	-	-	-	-	-
Body	2.33	7.74	0.00	0.00	0.00	0.00	12.39	29.68	34.00
Clothes	10.03	27.80	0.00	0.00	1.26	5.04	21.82	106.88	128.14
Field Structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	4.93	7.49	0.00	0.00	1.88	5.76	19.36	25.50	27.04
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	2.05	2.11	0.00	0.00	1.89	4.13	4.81	5.61	5.81
Dietary Objects	2.50	2.20	0.00	0.00	3.11	4.53	5.64	5.78	5.81
Non-dietary Objects	21.94	31.98	0.00	6.46	9.68	27.64	61.54	126.78	143.09
All Objects	24.45	32.38	0.00	7.52	12.74	29.10	61.54	130.20	147.36

Table B.3.1.5 Mouthing hourly duration (min/h) while wearing gloves (n =21)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	-	-	-	-	-	-	-	-	-
Body	0.06	0.21	0	0	0	0	0.36	0.78	0.89
Clothes	0.25	0.49	0	0	0.05	0.17	1.33	1.77	1.88
Field Structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.26	0.6	0	0	0.03	0.25	0.87	2.31	2.67
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	0.13	0.14	0	0	0.14	0.23	0.34	0.42	0.44
Dietary Objects	0.16	0.17	0.00	0.00	0.14	0.25	0.44	0.56	0.59
Non-dietary Objects	0.66	0.94	0.00	0.17	0.27	0.92	2.13	3.66	4.04
All Objects	0.82	0.98	0.00	0.32	0.56	1.14	2.38	3.92	4.31

Table B.3.1.6 Mouthing median duration (s) while wearing gloves (n =21)

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0	-	-	-	-	-	-	-	-	-
Body	3	0.87	0.31	0.54	0.67	0.84	1.03	1.21	1.25	1.26
Clothes	15	2.02	2.47	0.62	1.00	1.34	1.58	5.71	9.63	10.61

Field Structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	13	1.92	1.61	0.67	0.95	1.41	2.29	4.25	6.31	6.82
Head/face/hair	0	-	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-
Water bottle	12	3.71	1.16	1.71	3.21	3.45	4.18	5.57	5.70	5.73
Dietary Objects	14	3.66	1.24	1.71	2.70	3.41	4.68	5.54	5.69	5.73
Non-dietary Objects	19	1.65	1.28	0.67	0.85	1.16	2.09	3.56	5.48	5.96
All Objects	19	1.83	1.11	0.77	1.08	1.34	2.25	4.01	4.57	4.70

Section A.3.2. Data summarized Gloves OFF

Table B.3.2.1 Both hands contact frequency (event/h) while NOT wearing gloves (n = 39)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	3.60	7.90	0.00	0.00	1.70	3.50	13.30	35.10	47.90
Body	14.90	11.70	0.00	5.20	14.50	18.30	35.80	49.50	54.40
Clothes	86.20	47.40	17.60	54.80	72.50	112.90	162.90	221.00	227.10
Field Structures	8.30	7.60	0.00	3.10	6.00	10.70	19.60	33.20	33.60
Footwear	6.90	7.60	0.00	2.00	5.00	8.90	17.20	34.10	36.20
Head/face/hair	28.30	22.80	0.00	12.50	21.10	36.40	75.40	88.70	94.90
Shin guards	1.30	3.40	0.00	0.00	0.00	0.80	6.00	15.20	18.80
Soccer ball	12.30	18.40	0.00	2.60	6.60	16.00	34.30	80.20	106.20
Water bottle	11.10	24.70	0.00	2.60	5.60	11.00	21.00	105.20	156.70
Dietary Objects	11.10	24.70	0.00	2.60	5.70	11.00	21.00	105.20	156.70
Non-dietary Objects	173.40	67.80	73.90	127.20	169.30	198.80	306.20	363.40	368.30
All Objects	184.60	77.90	80.70	133.30	169.30	210.40	374.30	3972.00	409.90

Table B.3.2.2 Both hands hourly contact duration (min/h) while NOT wearing gloves (n = 39)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0.30	0.90	0.00	0.00	0.10	0.20	1.00	3.80	5.50
Body	1.30	1.60	0.00	0.20	0.50	1.90	4.20	6.30	7.00
Clothes	16.50	14.30	1.80	6.50	10.40	20.30	47.80	51.70	52.70
Field Structures	0.90	1.10	0.00	0.20	0.40	1.20	3.50	4.30	4.50
Footwear	0.70	0.70	0.00	0.10	0.40	1.00	2.00	2.30	2.50
Head/face/hair	1.00	1.00	0.00	0.40	0.60	1.50	2.40	4.50	5.80
Shin guards	0.10	0.40	0.00	0.00	0.00	0.10	0.70	1.80	2.30
Soccer ball	0.60	0.80	0.00	0.10	0.30	0.80	1.80	3.50	3.60
Water bottle	1.90	4.00	0.00	0.40	0.90	2.00	6.00	17.70	24.30
Dietary Objects	1.90	4.00	0.00	0.40	0.90	2.00	6.00	17.70	24.30
Non-dietary Objects	22.40	1.60	6.20	12.50	17.90	26.60	54.90	57.50	57.90

All Objects	24.30	15.40	6.70	13.20	19.50	29.80	55.90	58.70	58.80

Table B.3.2.2 Both hands contact median duration (s) while NOT wearing gloves

Objects	n	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	27	1.60	1.20	0.50	0.90	1.30	1.60	4.40	5.00	5.10
Body	38	1.80	1.80	0.50	1.00	1.20	1.80	3.70	9.00	9.80
Clothes	39	4.70	2.60	1.90	3.00	3.90	5.30	9.30	12.60	13.60
Field Structures	38	3.70	3.40	0.40	1.80	2.70	4.70	7.00	15.40	20.00
Footwear	35	4.00	3.50	1.00	1.80	2.80	5.00	11.20	15.20	15.30
Head/face/hair	38	1.40	0.60	0.60	1.10	1.20	1.60	2.60	3.30	3.50
Shin guards	12	5.20	4.80	1.30	2.30	3.80	5.50	14.50	16.30	16.70
Soccer ball	35	2.00	1.00	0.60	1.20	1.60	2.40	3.80	4.10	4.20
Water bottle	35	7.00	3.10	1.20	4.80	6.80	8.40	13.50	13.80	13.80
Dietary Objects	35	6.90	3.10	1.20	4.80	7.00	8.30	13.50	13.80	13.80
Non-dietary Objects	39	2.90	1.40	1.20	1.90	2.60	3.40	5.90	6.90	6.90
All Objects	39	3.00	1.40	1.20	2.00	2.70	3.40	6.10	6.90	6.90

Table B.3.2.4 Mouthing frequency (event/h) while NOT wearing gloves (n =39)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	-	-	-	-	-	-	-	-	-
Body	0.26	0.58	0.00	0.00	0.00	0.00	1.75	2.11	2.19
Clothes	9.62	16.01	0.00	1.32	4.90	11.86	27.44	71.92	92.76
Field Structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	9.71	6.90	0.00	4.56	7.10	14.32	21.32	23.95	25.44
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	7.54	13.31	0.00	1.18	5.13	8.13	17.94	58.58	81.30
Dietary Objects	7.63	13.28	0.00	1.39	5.13	8.13	17.94	58.58	81.30
Non-dietary Objects	19.75	17.53	0.00	8.67	14.83	25.50	43.63	81.68	96.88
All Objects	27.38	21.05	4.84	13.08	22.71	32.30	64.34	96.07	105.13

Table B.3.2.5 Mouthing hourly duration (min/h) while NOT wearing gloves (n =39)

Objects	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	-	-	-	-	-	-	-	-	-
Body	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.04	0.04
Clothes	0.43	1.08	0.00	0.03	0.15	0.37	1.42	4.67	6.61
Field Structures	-	-	-	-	-	-	-	-	-
Footwear	-	-	-	-	-	-	-	-	-
Hands	0.42	0.77	0.00	0.09	0.22	0.47	1.12	3.38	4.74
Head/face/hair	-	-	-	-	-	-	-	-	-
Shin guards	-	-	-	-	-	-	-	-	-
Soccer ball	-	-	-	-	-	-	-	-	-
Water bottle	0.49	0.75	0.00	0.08	0.25	0.52	1.63	3.31	3.39
Dietary Objects	0.49	0.74	0.00	0.09	0.26	0.52	1.63	3.31	3.39
Non-dietary Objects	0.87	1.34	0.00	0.18	0.42	1.07	2.51	6.25	7.03
All Objects	1.36	1.55	0.09	0.41	0.99	1.51	3.89	6.81	7.03

Table B.3.2.6 Mouthing median duration (s) while NOT wearing gloves (n =39)

Objects	N	Mean	SD	Min	p25	Median	p75	p95	p99	Max
Artificial Turf	0	-	-	-	-	-	-	-	-	-
Body	8	1.04	0.43	0.58	0.60	1.05	1.31	1.59	1.60	1.60
Clothes	32	1.51	0.83	0.62	0.87	1.35	1.88	2.95	3.92	4.17
Field Structures	0	-	-	-	-	-	-	-	-	-
Footwear	0	-	-	-	-	-	-	-	-	-
Hands	36	1.30	0.79	0.54	0.89	1.06	1.41	2.69	4.21	4.76
Head/face/hair	0	-	-	-	-	-	-	-	-	-
Shin guards	0	-	-	-	-	-	-	-	-	-
Soccer ball	0	-	-	-	-	-	-	-	-	-

Water bottle	33	3.65	1.34	1.72	2.59	3.55	4.37	5.82	6.53	6.83
Dietary Objects	33	3.60	1.35	1.72	2.59	3.41	4.34	5.81	6.52	6.83
Non-dietary Objects	39	1.36	0.73	0.74	0.87	1.10	1.59	2.62	3.90	4.45
All Objects	39	1.67	0.86	0.79	1.09	1.41	2.06	3.01	4.52	5.36

Appendix J
Synthetic Turf Scientific Advisory Panel

SYNTHETIC TURF SCIENTIFIC ADVISORY PANEL

The Synthetic Turf Scientific Advisory Panel (the Panel) is a group of expert scientists invited by the Office of Environmental Health Hazard Assessment (OEHHA) to provide advice on the design and implementation of OEHHA's synthetic turf study. The study aims to characterize the exposures and health risks from playing on synthetic turf and playground mats made from recycled tire materials. Members of the Panel were selected for their expertise in the following areas of specialization: exposure science, laboratory science and analytical chemistry, environmental monitoring, biostatistics, medicine, public health, and children's health.

The Panel will meet during the study to advise OEHHA on study plans, study progress, and reporting study results. All Panel meetings are open to the public. You can view meeting notices and other related information here: http://www.oehha.ca.gov/risk/SyntheticTurfStudies/index.html.

At each Panel meeting, there will be:

1. Opportunities for panel members to provide scientific advice and guidance on the study design and implementation.
2. Opportunities to hear from the public on study design and progress.

OEHHA intends to webcast all Panel meetings, but this is contingent on webcast facility availability.

Synthetic Turf Scientific Advisory Panel Members

- **Edward Avol** is a Professor of Clinical Preventive Medicine, Keck School of Medicine, University of Southern California, and has expertise in exposure assessment and acute/chronic respiratory and cardiovascular effects of airborne pollutants in populations at risk including children, athletes, and subjects with compromised lung function. He was the Deputy Director of the Children's Health Study and is a key investigator in multiple ongoing investigations of the effects of environmental exposures on human health. He is the co-Director of the Exposure Assessment and Geographical Information Sciences Facility Core in the National Institute for Environmental Health Sciences (NIEHS)-supported Southern California Environmental Health Sciences Center, co-Director of the Exposure Assessment and Modeling Core in the NIEHS/US Environmental Protection Agency-supported Children's Environmental Health Center, and is the principal investigator on several National Institutes of Health and regionally funded studies to assess the association of air pollution with children's respiratory and cardiovascular health. Professor Avol is also actively involved in the centers' community outreach efforts, particularly with regard to the health and air quality impacts of the Los Angeles/Long Beach Port expansions. Professor Avol received his M.S. from the California Institute of Technology.

- **John Balmes** is a Professor of Medicine at the University of California, San Francisco and the Chief of the Division of Occupational and Environmental Medicine at the San Francisco General Hospital and the Director of the Human Exposure Laboratory. He is also a Professor of Environmental Health Science at the University of California, Berkeley and the Director of the Northern California Center for Occupational and Environmental Health and the Center for Environmental Public Health Tracking. His research focuses on the adverse respiratory and cardiovascular effects of air pollutants including ozone, tobacco smoke and particulate matter. He received his M.D. from the Mount Sinai School of Medicine and completed a residency in Internal Medicine at Mount Sinai Hospital and a fellowship in Pulmonary Medicine at Yale University.

- **Deborah Bennett** is an Associate Professor in the Department of Public Health Sciences at the University of California, Davis. Her research is focused on the fate, transport, and exposure of chemicals. She uses field and modeling studies to assess and predict exposure to particulate matter and organic compounds in indoor and outdoor environments. Dr. Bennett received her B.S. in Mechanical Engineering from the University of California, Los Angeles and her M.S. and Ph.D. in Mechanical Engineering from the University of California, Berkeley.

- **Sandy Eckel** is an Assistant Professor in the Division of Biostatistics, at the Keck School Medicine, University of Southern California. Her research is on statistical methods and applications in environmental epidemiology, exhaled breath biomarkers, and clinical trials for pediatric brain tumors. She completed her Ph.D. in the Department of Biostatistics at the Johns Hopkins Bloomberg School of Public Health.

- **Amy Kyle** is on the faculty in Environmental Health Sciences at the School of Public Health at the University of California, Berkeley. Her recent research focuses on cumulative impacts, chemicals policies, persistent and bioaccumulative chemicals, children's environmental health, biomonitoring, and air pollution standards. Dr. Kyle serves as a leader of the Research Translation Core of the Berkeley Superfund Research Program funded by the National Institute for Environmental Health Sciences. She previously served as an Associate Director of the Berkeley Institute for the Environment. She has served in senior positions in environmental protection in the State of Alaska working on a wide range of environmental, health, and natural resources issues. She has served on a variety of advisory groups focused on children's health and environmental disparity, including for the US Environmental Protection Agency, World Health Organization, Centers for Disease Control and Prevention, and National Academy of Sciences. Her M.P.H. and Ph.D. in environmental health sciences and policy are from the University of California, Berkeley and B.A. in environmental sciences is from Harvard College.

- **Thomas McKone** is an international expert on exposure science and risk analysis. He retired from the position of senior staff scientist and Division Deputy for Research at Lawrence Berkeley National Laboratory and as a Professor of Environmental Health Sciences at the University of California, Berkeley, School of Public Health, but continues to work at both institutions. Dr. McKone's research interests are in the development, use, and evaluation of models and data for human-health and ecological risk assessments and in the health and environmental impacts of energy, industrial, and agricultural systems. He has authored 160 journal papers, has served on the US Environmental Protection Agency Science Advisory Board, worked with several World Health Organization committees, served on many California state advisory panels, and been a member fifteen US National Academy of Sciences committees. He is a fellow of the Society for Risk Analysis and a former president of the International Society of Exposure Science. Dr. McKone earned a Ph.D. in engineering from the University of California, Los Angeles.

- **Linda Sheldon** is an international expert in exposure assessment. She retired from the position of Associate Director for Human Health in the US Environmental Protection Agency's National Exposure Research Laboratory. Her research focuses on measuring and modeling how chemicals move through the environment and how people, particularly children, come in contact with these chemicals in their everyday lives, as well as the associated health hazards. She has served on advisory committees for international and national research centers and on workgroups for the World Health Organization in the area of exposure assessment. She earned her Ph.D. in environmental chemistry from the University of Michigan.

Appendix K
A Handy Guide to the Bagley-Keene Open Meeting Act 2004

(https://oag.ca.gov/sites/all/files/agweb/pdfs/publications/bagleykeene2004_ada.pdf)