EPA Tools & Resources Webinar | Q&A
U.S. Federal Research Action Plan on Recycled Tire Crumb Rubber Used on Synthetic Turf Playing Fields and Playgrounds: Exposure Characterization Final Report (Part 2) Findings and Conclusions

1. **Bacteria was found in the samples - does it mean bacteria can grow and multiply in such rubber samples/ tire crumbs?**

   All tire crumb rubber samples collected from the 40 synthetic turf fields tested positive for a universal bacterial gene (16s rRNA). This is not surprising, as bacteria are present in soil and on surfaces in indoor environments. Bacteria have been reported at similar concentrations in indoor air, outdoor air and on common household items. More detailed information is available in the Part 1 report.

2. **Can you expand on bullet 4 in slide 17 "with the exception of 2-hydroxynaphthalene" - is that important? How?**

   A comparison of creatinine-adjusted PAH concentrations among the general U.S. population using data from the National Health and Nutrition Examination Survey (NHANES) indicated that urinary PAH concentrations have markedly decreased over time, except for 2-hydroxynapthalene (2-NAP). Differences in creatinine-adjusted urinary 2-NAP were detected in pre- and post-activity samples from the supplemental biomonitoring study as well as the pilot-scale study. In both the pilot and supplemental biomonitoring studies, the creatinine adjusted 2-NAP concentration (geometric mean) was higher pre- and post-activity when compared to the general population based on available NHANES data. In the supplemental biomonitoring study, this observation held for all age groups except for youth (participants aged 10-12 years). Previous urinary biomarker investigations utilizing NHANES have also indicated naphthalene, the parent PAH of 2-NAP with widespread presence in ambient and indoor air, as the dominant PAH in the U.S. population. Of note, data from the pilot-study, however, indicated low levels of naphthalene in tire crumb rubber infill, field air, field dust, field wipe, and drag sled samples.

3. **Is it safe for a child aged 4 to be exposed to loose-fill tire mulch for an hour each day 5 times a week for the whole school year?**

   The FRAP is not a risk assessment nor can the information in the FRAP report be used to identify a level above which health effects could occur.

4. **Was there a difference in the ages of the synthetic turf fields sampled?**

   Yes, installation dates of fields included in the study ranged from 2004 to 2016. See the Report Part 1 for more information.

5. **Are there any plans to look into exposures from 3D printing TPU filaments that use recycled tire material?**

EPA is not planning any research related to exposures from 3D printing TPU filaments that use recycled tire material. This was not part of the FRAP study scope and EPA is not currently planning any work related to this topic.

6. **Are you planning to look at cancer rates between young adults who grew up with tire crumb fields versus young adults who grew up with grass fields?**

   This was not part of the FRAP study scope and EPA is not currently planning any work related to this topic.

7. **This was a one-time exposure testing – do you anticipate doing it for a full season (e.g., 5 days exposure for 20 weeks)?**

   EPA and ATSDR are not planning additional work at this time.

8. **Given your findings of limited exposures, it seems like the benefits of being able to provide places for physical activity may outweigh potential exposure risks. Would you agree? How would you advise sharing this information with the public / community that may continue to be concerned about artificial turf health risks?**

   The FRAP was not designed to consider the question of physical activity benefits. This was not part of the FRAP study scope and EPA is not currently planning any work related to this topic.

9. **I've seen some concerns about PFAS in synthetic turf fields (possibly as an extrusion aid for the plastic). Did your work touch on PFAS at all?**

   The FRAP did not specifically test for the presence of any PFAS target analytes. No PFAS chemical was identified in the non-targeted analyses of tire crumb rubber. No additional PFAS characterization of rubber or other turf components is planned.

10. **Does the report break out biomonitoring and other sampling results for the indoor facility only?**

    The Part 1 report provides results comparing chemical and microbiological tire crumb measurement results for the 25 outdoor and 15 indoor fields. The Part 2 report generally does not break out results by field type since there were only two outdoor fields and one indoor field. Measurement results for next-to field air samples are shown graphically for several metal, SVOC, and VOC analytes at the three different fields in the Part 2 report.

11. **How do your study results compare to the OEHHA crumb rubber study?**

    The FRAP characterized tire crumb rubber from recycling plants, indoor, and outdoor fields across the United States, while our understanding is that Cal-OEHHA focuses on tire crumb rubber from outdoor fields in California. Many of the same metal and organic chemicals were being measured in the studies, with some differences in measured chemicals across the studies that will broaden our understanding of the chemical landscape. Altogether, approximately 75 fields are included across the two studies, improving our understanding about the range and

variability of chemicals associated with tire crumb rubber. The FRAP study includes indoor fields while our understanding is that the OEHHA study does not. Both studies are examining the bioaccessibility of some chemicals. OEHHA is studying the particles in air at fields during active play in more detail.

It is our understanding that OEHHA is applying an exposure modeling approach. The FRAP study assessed the availability and suitability of measurement data and exposure parameter information for exposure modeling.

We look forward to OEHHA completing their study. For more information see: https://oehha.ca.gov/risk-assessment/synthetic-turf-studies.

12. **Was there any aggregation of exposures to estimate cumulative exposures of specific classes of substances, e.g., PAHs?**

    In both the Part 1 and Part 2 reports, in addition to the individual PAH measurements, results are shown for the sum of 15 PAHs that were measured. Also, a sum measure of several volatile organic compounds called 'BTEX' was reported; this includes the sum of benzene, toluene, ethylbenzene, and the three xylene compounds. Other than these summed measures, no other aggregations were assessed.

13. **For the crumb characterization study why was crumb rubber only tested to 140F when we know these crumb rubber infilled fields can easily reach 180F (even 200F) on still sunny days as is often the case in California? Did the study include fields that would experience higher heat readings in warm weather climates in the South in relation to fields that would experience colder temperatures? If so, were there any significant differences?**

    While higher and lower temperatures may occur, the temperatures chosen for the study, 25°C and 60°C (77°F and 140°F) were anticipated to reasonably cover the exposure range for most field uses in warmer weather. We selected 60 °C as an upper-bound temperature condition. It is our understanding that the ongoing California Office of Environmental Health Hazard Assessment study (see https://oehha.ca.gov/risk-assessment/synthetic-turf-studies) includes a set of high-quality field and air temperature measurements at multiple depths and heights above the field for up to 35 synthetic turf fields; these data should be informative regarding potential temperature profiles potentially affecting emissions and exposures.

14. **Were surface temperatures measured when the sun was shining on the field? What device was used to measure surface temperature? Was the ambient surface temperature of the turf factored into the study given that greater VOCs are likely to be generated at higher surface temperatures?**

    Field surface temperatures were measured at multiple times for each study period when pilot exposure study participants were playing on the field. At times the sun was shining on the fields; some participant sports practices extended into evening hours when there was little direct sunshine. Air and field surface temperature measurement results are included in the report. Field surface temperatures were measured with a thermistor device placed on the field surface with time allowed for equilibration.

Our goal for the pilot exposure study was to sample at fields during warm to hot weather. Maximum field air temperatures ranged from 82 to 95˚F, and maximum field surface temperatures ranged from 84 to 108˚F. Air and field surface measurements are described in more detail within Section 4 of the Part 2 report.

15. **Can you comment on the Table with measured differences in air vs. surface temperature for the indoor field location and for the outdoor fields' locations? Does this have anything to do with the measured results, given temperatures are in 80s to low 100s across locations, even if ventilation and/or air humidity will have potential effects on emissions from tire crumb rubber into the air?**

    Our goal for the pilot exposure study was to sample at fields during warm to hot weather because emissions of some organic chemicals from tire crumb rubber may be higher as the temperature increases. We did not have enough field measurements in the exposure pilot study to directly assess differences in measurements due to temperature. In the tire crumb rubber characterization study, we performed laboratory chamber emission tests at 25°C and 60°C (77°F and 140°F) and found emission rates for some, but not all organic chemicals were higher at the higher temperature.

16. **Did your study look at the contribution of rubber crumb particles to microplastics in the environment?**

    No, examining environmental releases of crumb rubber particles was not in the scope of the study.

17. **Does EPA intend to perform a similar evaluation for ecological toxicity or aquatic toxicity from exposure to chemicals that may leach from tire crumb such as 6PPD-quinone and the effects of particulates and micro-plastics effects on the environment?**

    Several EPA websites include information and current efforts with regards to 6PPD-quinone and microplastics, including:

    https://www.epa.gov/water-research/microplastics-research

    https://www.epa.gov/trash-free-waters

    https://www.epa.gov/chemical-research/6ppd-quinone

18. **Did you look into possible leaching into soil, or into the water cycle?**

    No, this was not part of the study scope.

19. **Did you also assess the chemicals in the artificial grass blades themselves when tire crumb infill was not used?**

    No, this was not part of the study scope.

20. **Could there be a concern for take-home exposures of tire crumb rubber, e.g., for younger siblings, via hand-mouth contact?**

    59% of exposure study participants reported often finding tire crumb rubber at home after using a synthetic turf field. This research did not further examine potential exposures from the take-home pathway.

21. **Where in the US were fields sampled? Was the 2019 study and the most recent study done on the same fields?**

    Forty fields were included in the tire crumb rubber characterization study from across the United States, including 9 in the Northeast census region, 8 in the Midwest census region, 13 in the South census region, and 10 in the West census region. The exposure pilot and supplemental biomonitoring studies were performed at three of the 40 fields.

22. **Can you discuss uncertainty in the study design with respect to exposure times as they were only 1 to 4 days for soccer and football players?**

    The exposure measurement study was a pilot study with measurements for each participant taken only for one day of sports activity per participant. Research limitations are described in Section 2 of the report. Additional discussion of uncertainties is included in Section 5 for Exposure Modeling Assessment.

23. **Was there any relationship between athlete's field exposure and their concentrations of metal in blood or PAH metabolites in urine (e.g., were shorter athletes - who are closer to the ground - more likely to have higher concentrations of metals/PAHs?)**

    Blood samples were collected as part of the pilot-study from 13 participants; limited statistical analyses could be performed to examine associations. For the supplemental biomonitoring study, pre- and post-activity urine samples were analyzed from 160 participants. As noted in the supplemental biomonitoring study report (Appendix A of the exposure characterization report), the best predictor of a participant's post-activity urinary PAH concentration was their pre-activity concentration. Factors such as height, BMI, and activity type were not associated with pre-activity concentration nor with pre- and post- activity differences. Age-group was associated with pre-activity specific gravity adjusted PAH concentrations, but this was not specific to field type. While this finding could be interpreted as body size potentially having an impact on urinary PAH concentrations, we mention that any observed differences in pre- and post-activity concentrations could also be due to unmeasured variables, such as changes in hydration level through perspiration. It is unknown whether a participant drank fluids between the two specimen collections, nor how much fluid they lost due to intensity of activity. Moreover, the report mentions how although information including the time recorded between samplings and general patterns of activity were captured in the supplemental biomonitoring study, these data may not directly correspond to the level of activity each participant exerted on the field.

24. **It seems like the conclusion is that exposure is essentially the same on synthetic fields versus natural grass outdoor fields. Is that a fair assessment?**

    Recycled tire crumb rubber infill users and natural grass field users experienced similar differences in pre- and post-activity PAH concentrations. Specifically, statistically significant mean concentration differences in specific gravity-adjusted pre- and post-activity PAHs were observed, regardless of field type. Though not nationally generalizable, this study contributes to the portfolio of research activities needed to better understand the potential for exposure to chemicals found in recycled tire crumb rubber.

25. **How did you choose representative sample sizes, like the number of fields to study or athletes, etc.?**

    Representative sampling designs were not included in this research effort. A representative sampling design was considered for the tire crumb rubber characterization, but the time required to develop and implement a study based on a national sampling frame of synthetic turf fields was beyond the scope of the research effort. The exposure study was a pilot study, while the larger supplemental biomonitoring study was a convenience sample based on availability and participation of athletes using the study fields.

26. **Thank you for this work. Can you please summarize the take home message? Should athletes/parents be concerned about health risks from using these fields? Aren't some chemicals in recycled tire crumb rubber carcinogenic? Are you concluding that human exposure to chemicals from tire crumb are not of concern?**

    Toxicological reference information was compiled for potential tire crumb rubber chemical constituents. A summary table was published along with the Part 1 Tire Crumb Characterization Report.

    In general, the findings from the FRAP study on playing fields (Parts 1 and 2 combined) support the conclusion that although chemicals are present (as expected) in the tire crumb rubber and exposures can occur, they are likely limited; for example:

    - ✓ *Generally, only small amounts of most organic chemicals are released into the air through emissions. For many analytes measured during active play at the outdoor fields, next-to-field concentrations in air were not different than background samples while others were somewhat higher.*
    - ✓ *For metals, only small fractions (average mean about 3% for gastric fluid and <1% for saliva and sweat plus sebum) are released from tire crumb rubber into simulated biological fluids compared to a default assumption of 100% bioaccessibility.*
    - ✓ *In the biomonitoring pilot study, concentrations for metals measured in blood were similar to those in the general population.*
    - ✓ *No differences in (polycyclic aromatic hydrocarbons) PAH metabolites in urine were observed in the supplemental biomonitoring study between study participants using natural grass fields and those on synthetic turf fields with tire crumb rubber infill.*

27. **Did you do any study on pour-in-place rubber surfaces (for example playgrounds)? Was there specific exposure evaluation done on playgrounds in addition to the sports fields with crumb rubber infill?**

    The field studies conducted by U.S. EPA and CDC did not include any measurements on playgrounds. They focused on tire crumb rubber on synthetic turf fields. CPSC staff are aware of poured-in-place (PIP) playground surfacing. CPSC staff has not yet performed detailed exposure evaluations of PIP playground surface, but exposure of playground users to tire rubber is expected to be lower than exposure on synthetic turf sports fields.

28. **Is there a way to get notified when the Consumer Product Safety Commission publishes their study that you just mentioned?**

    Any new information on recycled tire rubber in playground surfaces will be posted at the CPSC's Crumb Rubber Safety Information Center web page (https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Crumb-Rubber-Safety-Information-Center).

29. **Please explain how your conclusion is supported when the passive air sampling was not successful and volatile organic compounds (VOCs) were not included in the 6 chemicals chosen.**

    Although the personal sampling for VOCs was not successful, next-to-field measurements of VOCs were obtained and are reported in the pilot study. For many analytes measured during active play at the outdoor fields, next-to-field concentrations in air were not different than background samples, while others were somewhat higher. Methyl isobutyl ketone and benzothiazole were among the several chemicals for which next-to-field concentrations in air were somewhat higher than background air levels. These two VOCs were among the six chemicals chosen for exposure modeling, with results included in the Part 2 report.

30. **Could the exposure data be analyzed on a "per field contact" basis? For example, some soccer goalkeepers impact with the field 100+ times in a practice session. If you had a "per contact" exposure value you could extrapolate to estimate the exposure for players such as these.**

    The exposure measurement and biomonitoring results are not suitable for direct use on a "per field contact" basis.

31. **Can any of this exposure data be quantified to a long-term exposure? What is the possibility that a similar study could look at athletes over a longer period of time, for instance 6 months to a years' time frame rather than one point in time?**

    A long-term study was not part of the FRAP design. Exposure modeling could be applied to estimate exposures for different scenarios and time frames. As an example, the Part 2 report includes exposure estimates as average daily doses for people playing at synthetic turf fields over the course of a year for some age-based scenarios of exposure frequency, duration, and intensities.

32. **Given that the short time between exposure and post-activity assessment of urinary metabolites (on the order of < 1 hr to slightly more than 1 hr) may be much lower than the half-life of elimination of specific chemicals, did researchers consider that this might explain the absence of a meaningful difference in the concentrations of chemical metabolites in players exposed to artificial turf fields vs. natural grass fields?**

    The participants in the supplemental biomonitoring study spent an average of 1 hour and 39 minutes between samplings, with a range of 40 minutes to 2 hours and 58 minutes. There was a high correlation between pre- and post-activity PAH measurements. It is possible that the concentrations of urinary PAH metabolites captured were influenced by other sources, or that the metabolism of PAHs to their urinary metabolites was slow relative to the duration of the activity. However, the sample collection methods were performed consistently among participants who played on both synthetic turf and natural grass. Additionally, multiple studies have indicated the relatively short half-life of urinary PAH metabolites (e.g., Li et al., 2012, "Excretion Profiles and Half-Lives of Ten Urinary Polycyclic Aromatic Hydrocarbon Metabolites after Dietary Exposure") and measured urine concentrations soon after a known exposure to PAHs (e.g., Hoppe-Jones et al., 2021, "Evaluation of Fireground Exposures Using Urinary PAH Metabolites").

33. **Did you analyze for antioxidants and antiozonants often used in tires?**

    6PPD is a component of automotive tires that prevents them from breaking down, helping them last longer. When 6PPD is exposed to air, it reacts with ozone to create 6PPD-quinone. Neither 6PPD nor 6PPD-quinone were target analytes in the FRAP research study. 6PPD was included as a suspect screening compound in the study and was tentatively identified in tire crumb rubber samples from tire recycling plants and in tire crumb rubber infill samples. At the time the study was conducted, 6PPD-quinone had not been previously reported or identified as a chemical of potential interest. With the techniques used, no chemical with the 6PPD-quinone formula was identified in the non-targeted analyses.

34. **Can you clarify what is meant by "low levels", providing the exact figure for the measurements?**

    There are many examples. We refer you to Section 2.3 “Detailed Summaries of Research Results” of the Part 2 report, with further details in Section 4, “Exposure Characterization Results” and Section 5 “Assessing Exposure Pathway Modeling.”

35. **Given that the most vulnerable population to the effects of chemical exposures are developing children and youth (who also have different play habits, had-to-mouth, and are much smaller and closer to the ground) what was the age of the study participants?**

    Because many children spend time participating in sports and other activities on synthetic turf fields, it was important to include children in the exposure research efforts. Specifically, children were included in the exposure pilot study and the supplemental biomonitoring study. Twenty-five children ages 7 to 17 years old, or their parents for the younger participants, provided answers to a questionnaire about field use, activities, and hygiene. Twenty-two of the pilot study

children also participated in personal sample collection (skin wipe samples), 17 participated in video-based activity assessments, and 11 provided a urine or blood biomarker sample that was analyzed for metals and polycyclic aromatic hydrocarbon metabolites. In the supplemental biomonitoring study, 102 children ages 7 to 17 years old provided urine samples.

When there was sufficient data to make a comparison between the child and adult participants, we did not see any significant differences for their various study components (i.e., activity information, biomarker samples).