Potential Hazardous Compounds Released from LMU Turf Field

Oriana Strieleman

Mentor:
Dr. Nicole Bouvier-Brown

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Abstract:

Artificial turf fields are a relatively new replacement for natural grass fields. Turf fields are increasingly replacing grass fields due to reduced need for watering and maintenance. However, because the turf fields are made with materials not naturally found in live grass, various Volatile Organic Compounds (VOCs) and other hazardous compounds may be released into the atmosphere by the rubber granulites and synthetic grass in the fields. Previous studies have shown that polycyclic aromatic hydrocarbons (PAHs), metals, and other compounds causing various health concerns are found in air samples collected from turf fields. However, there are many variables that may affect the presence and concentration of certain hazardous compounds. This means that it is not known what hazardous compounds are released by LMU's turf field, Drollinger. This study collects and analyzes aromatic samples, as well as the physical turf granulites from Drollinger Field to determine the hazardous compounds released from LMU's turf field.

Introduction:

Artificial turf playing fields are a new and popular replacement for natural grass-fields. The grass in the turf fields are made from synthetic fibers of nylon or polypropylene and filled with small pieces of recycled rubber from ground up tires. Replacing grass-fields with artificial turf reduces maintenance costs, requires no watering, and reduces issues from overuse and thus unsafe field conditions (*Surfaces for sports areas. Synthetic turf and needle-Punched surfaces primarily designed for outdoor use*). However, little data and research has been done to test for Volatile Organic Compounds (VOCs) and other hazardous compounds released by turf fields into the air. As a student at LMU, it is alarming how little is understood about the aromatic compounds released from LMU's on campus turf field, Drollinger. Drollinger Field is used by LMU students, staff, alumni, visitors, and neighborhood families for a variety of club sports and other recreational activities on a regular basis. This study will seek to answer what types and specific kinds of hazardous compounds are released by Drollinger Field, and in what concentrations they are found in. Then, by comparing these results to the results from natural grass fields at LMU, and to the results of past studies, consider what health concerns (if any) should be considered from the findings.

Background:

The gap in knowledge on the turf fields could be dangerous if compounds detrimental to human health are being released into the atmosphere by the fields without people's knowledge. A recent study measured the concentrations of polycyclic aromatic hydrocarbons (PAHs), metals, and other compounds causing various health concerns in the air while people were using the turf field. The results showed high concentrations (above normal soil standards) of certain compounds such as zinc and BaP (a human carcinogen PAH) concentrations. However, a low excess lifetime cancer risk from the Bap was determined (1×10^{-6} for a 30-year activity under a worst-case scenario) (Menichini, 2011). Another study looked at the bioavailability of unsafe compounds from synthetic turf field grass fibers and rubber granulites. This refers to whether the dangerous compounds can be absorbed into human bodies via ingestion, inhalation, or dermal contact. The results show that high levels of PAHs, with known, probable, or possible human carcinogens, were present. However, fields with newer rubber granulites had the highest levels of PAHs, with decreasing levels as the age of the rubber increased. However, the results also determined through bioaccessibility stimulation that absorption of the PAHs tested is unlikely in ingestion (Zhang, 2008). This is similar to a more recent 2013 study that extracted compounds from the rubber granulites with artificial biofluids (lung, sweat, and digestive fluid) to estimate the potential exposure to people of hazardous compounds in the rubber. The results found that PAHs and semivolatile organic compounds (SVOCs) were not detectable or found in significantly low concentrations in the artificial biofluids. Metals were detected in higher concentrations than advised, but the risk to humans was still determined to be extremely low, with the exception of lead found in some turf fields. Lead is bioaccessible to humans (can be absorbed by the body) and is a health concern, so the study emphasizes avoiding materials with traces of lead to build the fields (Pavilonis, 2013). The few studies already conducted were introductory and despite finding hazardous compounds from the turf fields, did not find any significantly concerning health issues. However, more research on this topic is needed to better understand which and how concentrated hazardous compounds people are breathing in from turf fields are. Once more trials, techniques, compounds, and other variables are accounted for, definitive results and conclusions can be determined.

Methods:

This study will be conducted by determining and analyzing the aromatic compounds from the turf field at LMU. This will be done using air quality testing techniques developed by work in Dr. Bouvier-Brown's lab. This technique uses a tripod to hold an air filter connected to a glass cartridge that collects compounds from the air. An adsorbent in the cartridge collects the aromatic compounds (Bouvier-Brown, 2014). The compounds collected on the adsorbent are then transferred or extracted to a liquid solution and tested using gas chromatography (GC) and mass spectrometry (MS). The GC separates the compounds, then the MS identifies the type and amount of compounds present in the sample. The method used in the GC-MS was developed from a method described in a study focused on determining the best extraction systems and methods for PAHs using GC (Zhang, 2008). The GC-MS results will then be analyzed to determine if any PAHs, VOCs, or other hazardous compounds are present in the sample. During analyzation, identifying the types of PAHs, VOCs, and other hazardous compounds found in samples during similar studies (see background section for specific studies) will be specifically targeted. Samples will be taken on the turf field at LMU during the morning with no field use and at the same time in another location on LMU campus with natural live grass. Two separate tripod set-ups would be used simultaneously at both the turf and grass sites (total of 4 tripod setups). Additionally, the trials would be taken for the same duration of time on the same date and begin at the same time of day (for consistency). Variables like temperature, wind speed, and wind direction would be recorded at each location. The results from the turf field and the live grass samples will then be compared to find similarities and differences in compound type and concentration. Different variables could also be manipulated such as, collecting on multiple days, at different times of day, during different weather/temperature, and more to determine trends in the data. In addition to the aromatic compounds sampled from the turf site, we will collect physical rubber granulites and bring them back to the lab. The compounds are extracted from the rubber granulites using cyclohexane. This solution can then be tested in the GC-MS to analyze the compounds released by the rubber into the solution. This is another way to determine what compounds are in the rubber on the turf field and as a comparison to the aromatic sample compounds.

Expected Results:

After the aromatic and turf samples have been extracted and run in the GC-MS, the results will show what compounds are present in the air and from the actual rubber granulites on the turf field. The expected results from the GC-MS test is that some of the PAHs, VOCs, or other hazardous compounds found in aromatic samples on turf fields in previous studies will be found in the samples from LMU's turf field. However, we do expect that there will likely not be all the hazardous compounds the past studies found and may even be some totally different compounds those studies did not detect at all. These differences will be due to the differences in the location of LMU's turf field, the age of the field, the exact materials used to make the field, the time of year, temperature outside, weather, and other factors. However, when comparing only the the turf samples to each other (and only the grass samples to each other), we would expect them to have nearly identical compounds because they would be collected the same day, at the same time, and in the same place.

Conclusion:

The use of turf playing fields has many advantages, but also includes risks due to relatively new and under researched potential aromatic hazards. Though past studies have detected the presence of hazardous aromatic compounds released from turf fields, the concentrations of these compounds released has been estimated to have little to no effect on people's health. However, there have been few studies done, and many variables and unknowns have yet to be accounted for. So I ask the question, what types and specific kinds of hazardous compounds are released by LMU's turf field? Additionally, in what concentrations are those compounds found, and how do these compounds compare to those released from natural grass fields at LMU? Finally, are these results consistent with past studies and what health concerns (if any) should be considered from the findings. These questions will be answered by collecting aromatic compound samples and turf granulite samples from LMU's turf field, then testing them with GC-MS, and analyzing the results to identify any hazardous compounds present. Overall, this will show the types and concentrations of hazardous compounds released from LMU's turf field; as well as, increase knowledge on these concerns for more variables and provide general data on turf field compound hazards.

Budget: $0*

Materials:

- Tripods (4)
- Air filters (4)
- Glass cartridges (4)
- Flow meters (4)
- Portable pumps (4)
- GC-MS equipment (machine)

*No funding is needed because all materials and equipment is already available and prepared in Dr. Bouvier-Brown's lab.

Timeline*:

Week 1:
Assemble and calibrate the 4 tripod setups (each tripod setup includes: a tripod, air filter, flow meter, portable pump, and clean glass cartridge).

Week 2:
1.Field data collection: collect both aromatic compound samples from a designated site on LMU's turf field and a site on LMU's grass field. Two setups used at each site, resulting in two samples collected from each site. Additionally, collect rubber granulites from LMU turf field (one sample from area on turf field with no paint and the other from an area without paint).
2.Extract compounds from samples in cartridges and from rubber granulites into a liquid solution.
3.Run samples in GC.

Week 3:
View and analyze (identify compounds in samples).

Week 4:
Compare aromatic compounds from GC results between locations samples were collected on LMU campus (turf field versus grass field), between turf granulite results and turf aromatic compound results, and turf results to similar past studies (from background).

Week 5-7:
Additional field data collection with similar conditions to first data collection. Repeat steps following field data collection from week 2-week 4. New samples/results can be compared to first data collection results for consistency.

Week 8:
Decide on next step depending on results and findings from results to this point (may include more field data collection, further analyzation of results, or the addition of completely new parts to the study).

*One week correlates to a total of around four hours of work (not including additional time for machines to run).

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