Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes

Letizia Marsili1, Daniele Coppola1, Nicola Bianchi1, Silvia Maltese1, Massimo Bianchi2 and Maria Cristina Fossi1

1Department of Physical Sciences, Earth and Environment, Siena University, Via Mattioli 4, 53100 Siena, Italy
2Department of Political Science and International, Siena University, Via Mattioli 10, 53100 Siena, Italy

Corresponding Author:
Letizia Marsili
Department of Physical Sciences
Earth and Environment, Siena University
Via Mattioli 4, 53100 Siena, Italy
Tel: +39 0577 232917
Fax: +39 0577 232930
E-mail: marsili@unisi.it

Received November 22, 2014; Accepted January 20, 2015; Published January 25, 2015


Copyright: © 2015 Marsili L et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract
Synthetic turf, made with an infill of rubber crumb from used tyres or virgin rubber, is now common in many sporting facilities. It is known that it contains compounds such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals. We evaluated in nine samples of rubber crumb the total content of some heavy metals (Zn, Cd, Pb, Cu, Cr, Ni, Fe) normally found in tyres by microwave mineralization and the levels of the 14 US EPA priority PAHs by Soxhlet extraction and HPLC analysis. The results showed high levels of PAHs and zinc in all rubber crumb samples compared to rubber granulate limits set by Italian National Amateur League (LNO). Following the precautionary principle, a risk assessment at 25°C was done, using the Average Daily Dose (ADD) assumed by athletes, expressed in terms of mass of contaminant per unit of body weight per day (mg/kg day), and the lifetime Average Daily Dose (LADD) and then evaluating the Hazard Index (HI) and the Cumulative Excess Cancer Risk (ECR). In the different rubber granulates samples the HI ranges from a minimum of 8.94x10^-7 to a maximum of 1.16x10^-6, while the ECR ranges from a minimum of 4.91x10^-9 to a maximum of 1.10x10^-8. Finally, the aim of this study was to estimate the "hazard" for athletes inhaling PAHs released at the high temperatures this synthetic turf may reach. Then a sequence of proofs was carried out at 60°C, a temperature that this rubber crumb can easily reach in sporting facilities. It is known that it contains compounds such as polycyclic aromatic hydrocarbons (PAHs) and  heavy metals. We evaluated in nine samples of rubber crumb the total content of some heavy metals (Zn, Cd, Pb, Cu, Cr, Ni, Fe) normally found in tyres by microwave mineralization and the levels of the 14 US EPA priority PAHs by Soxhlet extraction and HPLC analysis. The results showed high levels of PAHs and zinc in all rubber crumb samples compared to rubber granulate limits set by Italian National Amateur League (LNO). Following the precautionary principle, a risk assessment at 25°C was done, using the Average Daily Dose (ADD) assumed by athletes, expressed in terms of mass of contaminant per unit of body weight per day (mg/kg day), and the lifetime Average Daily Dose (LADD) and then evaluating the Hazard Index (HI) and the Cumulative Excess Cancer Risk (ECR). In the different rubber granulates samples the HI ranges from a minimum of 8.94x10^-7 to a maximum of 1.16x10^-6, while the ECR ranges from a minimum of 4.91x10^-9 to a maximum of 1.10x10^-8. Finally, the aim of this study was to estimate the "hazard" for athletes inhaling PAHs released at the high temperatures this synthetic turf may reach. Then a sequence of proofs was carried out at 60°C, a temperature that this rubber crumb can easily reach in sporting installations, to see whether PAH release occurs. The toxicity equivalent (TEQ) of evaporates from rubber crumb is not negligible and represents a major contribution to the total daily intake of PAHs by different routes.