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Linking mobile source-PAHs and biological effects in traffic police officers and drivers in Rawalpindi (Pakistan)

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ABSTRACT

The aim of this study was to evaluate the effect of traffic related polycyclic aromatic hydrocarbons (PAHs) on blood parameters of subjects, including traffic police officers (TP), drivers (DR) and control subjects (CN) with presumably different levels of exposure. We quantified the urinary 1-hydroxypyrene (1-OH-Pyr), α-naphthol and β-naphthol (α- and β-naph) as biomarkers of exposure to PAHs in relation with biomarkers of effect (Hb, MCV, PCV, PLT, RBCs), biomarkers of inflammation/infection (CRP, WBCs), oxidative stress (SOD) and oxidative DNA damage i.e. 8-hydroxy-2-deoxyguanosine (8-OHdG). Results showed that mean 1-OHPyr, α-naph and β-naph concentrations were significantly higher in TPs (0.98, 1.55, and 1.9 μmol mol-Cr^{-1}, respectively, $p<0.05$) than CNs (0.7, 0.6; 0.67 μmol mol-Cr^{-1} respectively, $P<0.05$). Furthermore, WBC and CRP were found in higher concentrations in TPs than CNs (7.04×10^3 μL^{-1} and 0.95 mg L^{-1} vs. 5.1×10^3 μL^{-1} and 0.54 mg L^{-1}, respectively). The urinary 8-OHdG level, a biomarker of oxidative DNA damage, was higher in TPs than both CN and DR subjects (48 ng mg-Cr^{-1}, 24 ng mg-Cr^{-1} and 33 ng mg-Cr^{-1}, respectively). Self-reported health assessment indicates that, on the basis of daily time spent in the middle of heavy traffic, TPs and DRs more frequently suffered from adverse head and respiratory symptoms. The PCA analysis evidenced the impact of traffic pollution on exposure biomarkers and DNA damage. The study suggests that traffic pollution may be associated with important health risk, in particular on the respiratory system, not only for workers exposed to traffic exhausts but also for general public. Finally, vehicular air pollution in the city of Rawalpindi should be a high-priority concern for the Pakistan Government that needs to be addressed.

1. Introduction

Road traffic is one of the most important anthropogenic emission sources in the urban environment and is associated with several human health problems, including asthma, lung cancer, cardiovascular diseases and respiratory disturbances (Lim et al., 2005; Patel et al., 2010; Katoshevski, 2011; Liao et al., 2011). The use of fossil fuel for transportation contributes to the release of many harmful substances having pro-oxidant properties (WHO, 2005), including volatile organic compounds, heavy metals and polycyclic aromatic hydrocarbons (PAHs). PAHs are ubiquitous and persistent contaminants that are mainly generated during incomplete combustion of fossil fuels (Kim Oanh et al., 1999; Zhang et al., 2006; Hu et al., 2007; Alkurdi et al., 2013) and their important urban sources include vehicle emissions, especially diesel engine exhaust (Barakat, 2002; H.E.I., 2010). PAHs have mutagenic, carcinogenic and endocrine disrupting effects in human and wildlife (IARC, 2002). The general population is exposed to PAHs via inhalation, ingestion and dermal contact pathways (Unwin et al., 2006). The toxicity of PAHs also appears to be related to their biotransformation into reactive metabolites, resulting in the generation of reactive oxygen species (ROS) that are capable of inducing lipid and protein oxidation and the depletion of endogenous antioxidants within an organism (Lodovici and Bigagli, 2011).

Several studies (Shin et al., 2011; Savitz et al., 2012) have used biomarkers to biologically monitor the uptake of individual PAHs from occupational exposures. Mono-hydroxylated-PAHs (OH-PAHs), a group of metabolites of PAHs, have been suggested as urinary biomarkers of human exposure to PAHs, including the 1-hydroxypyrene (1-OHPyr) the most commonly used biomarker (Jongeneelen, 2001).

Since the α-naphthol (α-naph) and β-naphthol (β-naph) (Kim et al., 1999) in urine samples have also been used as biomarkers of internal dose following recent exposure to PAHs (Kamal et al.,

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2011; Li et al., 2008), even if urinary naphthols (β-naph more than α-naph) reflect route-specific exposure to inhalable PAHs at low levels, as compared to 1-OHPyr, which reflects PAH-total exposure from diet, air, among others (Meeker et al., 2007).

Moreover, various studies have shown that oxidative stress can be implicated as a possible mechanism for adverse health effects associated with traffic emissions (Li et al., 2013). A suitable and commonly used oxidative DNA damage biomarker is the urinary 8-OHdG, a DNA lesion repair product, which is easy to measure. Air pollution, and in particular exposure to PAHs, have been known to be associated with systemic inflammation (Delfino et al., 2009), platelet activity (Peters et al., 1997) and their influence on the blood parameters (Lal et al., 2011). The general markers of inflammation, like CRP and WBCs, could also be associated with air pollution exposure (Banerjee et al., 2012; Dutta et al., 2012).

Many workers are exposed to PAHs in their occupations and, to date, only a few studies have investigated the effect of their interactions on hematology and oxidative damages. Therefore, we carried out a study to evaluate exposure to traffic-related PAHs of traffic police officers and drivers in the city of Rawalpindi (Pakistan), examining the relation between urinary biomarkers and the effect of PAH eposure on DNA damage, oxidative stress and blood parameters.

2. Materials and methods

2.1. Study area description and selection of hotspots

Rawalpindi is a rapidly growing city in the Pothohar region of northern Punjab (Pakistan). It is located 14 km south from Islamabad city (the capital of Pakistan) and 275 km north-west from Lahore City. Rapid urban growth (4% per year) (Shabbir and Ahmad, 2010) has been accompanied with rising urbanization, an increase in the private ownership of motor vehicles and urban congestion. Insufficient /narrow roads, the large number of vehicles and routine traffic jams contribute strongly to the air pollution in the city. According to the Rawalpindi department of excise and taxation (2014), during 2014 the number of registered vehicles in the city included diesel powered trucks (534), tractors (1146), buses (185), motorcycles (253012) and gasoline/diesel powered car/jeeps/wagons (11914) (Rawalpindi, 2014).

In this study, we have selected 10 hotspots (areas with very high traffic density) along the Murree-road, which is one of the busy roads in Rawalpindi, connecting many areas along its length. Traffic- related air pollution hotspots were identified at the major intersections: Faiz-abad, Shams-abad, Sixth-road, Rehman-abad, Chandni Chowk, Waris-khan, Committee Chowk, Moti Mahal, Marir Hassan and GPO-Saddar (Fig. 1).

2.2. Selection of subjects and documentation of self reported health status

All the study participants answered a short questionnaire, which was used to collect confidential information on their work-related parameters, health and socio-demographic status (such as age, height, body mass index (BMI), education, previous medical record and present symptoms, lifestyle factors, such as frequency and amount of smoking and alcohol consumption). In particular the participants had to report if they had experienced more than three respiratory disturbances, such as coughing, sneezing, fatigue, upper respiratory congestion and rhinitis, during working hours.

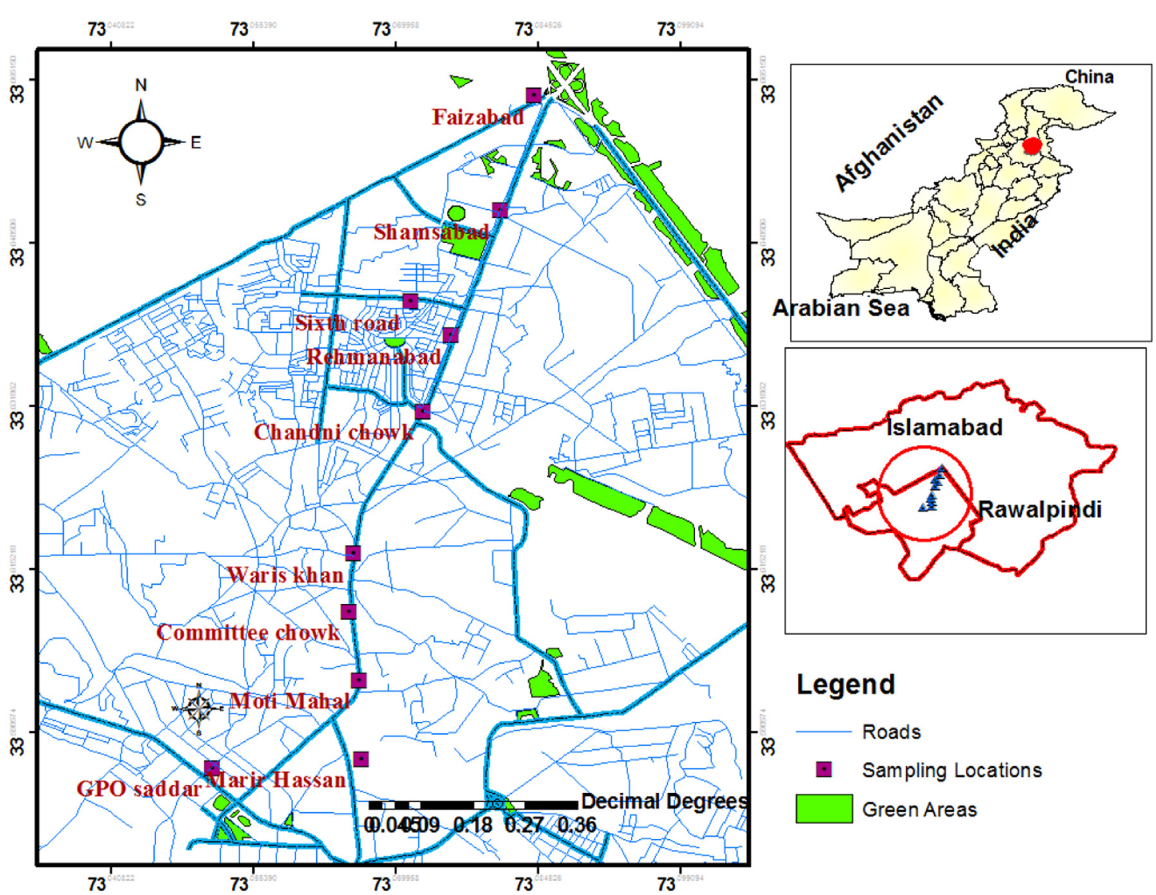

Fig. 1. Sampling sites on Murree road, Rawalpindi (Pakistan).