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# PAH exposure and oxidative stress indicators of human cohorts exposed to traffic pollution in Lahore city (Pakistan)

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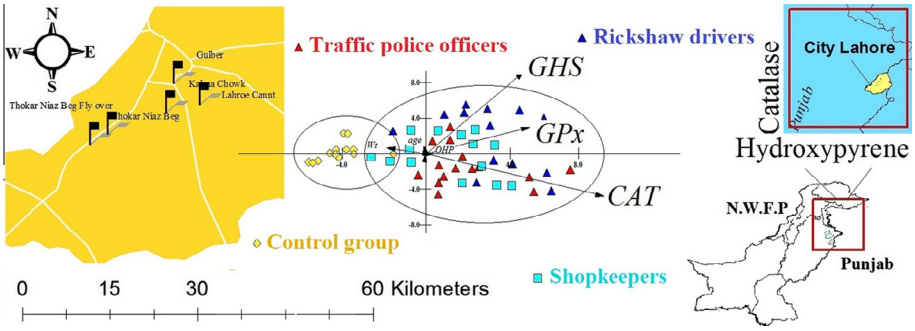
## HIGHLIGHTS

- First study reporting urinary 1-OHP concentration in exposed subjects from Pakistan.
- High exposure of traffic police officers and rickshaw drivers to PAHs.
- High concentration of oxidative stress indicator in exposed subjects.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Pollution from road traffic is not only a major source of exposure to polycyclic aromatic hydrocarbons (PAHs) but also a growing problem in the city of Lahore (Pakistan). In this study, we evaluated exposure to traffic-related PAHs, among subjects including traffic police officers (TPs), rickshaw drivers (RKs) shopkeepers working near main roads (SKs) and a control group (CN) for comparative analyses. We monitored the 1-hydroxypyrene (1-OHP) as biomarkers of exposure to PAHs and its probable association with catalase (CAT), glutathione (GSH) glutathione peroxidase (GSHPx) activity as biomarkers of oxidative stress in selected cohorts from the city Lahore. Results showed that median 1-OHP concentration was significantly higher in TPs than CN (*med* 1.21 vs. 0.51 μmol mol-$C^{-1}$ respectively, $P = 0.046$), followed by RKs (0.68 μmol mol-$C^{-1}$, $P = 0.19$ vs. CN). Furthermore, GSH, GSHPx, and CAT activities were also higher in exposed subjects than CN, which indicated that they experienced oxidative stress. Similar, but less severe observations were recorded in SKs. Observation of self-reported health status showed that, on the basis of daily time spent in the middle of heavy traffic, TPs and RKs most frequently suffered from adverse head and respiratory symptoms. The study shows that increasing traffic pollution can be associated with important health risk factor not only for the workers in transport industry but also for the public. Finally, the issue of traffic pollution in Lahore city needs to be addressed on priority.

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## 1. Introduction

Air pollution is a constant problem through the world (Jr et al., 2008), and it has given rise to many different health problems. Traffic is the most important contributor to the outdoor air pollution, because it is associated with adverse effects on human health (World Health Organization, 2005). The pollution from the traffic

*Abbreviations:* *, significant at $P < 0.05$; μmol mol-$C^{-1}$, micro-mole per mole creatinine; 1-OHP, 1-hydroxypyrene; BMI, body mass index; CAT, catalase; GSH, glutathione; CN, control group; EDTA, ethylenediaminetetraacetic acid; GSHPx, glutathione peroxidase; h d-1, hours per day; KMO, Kaiser–Meyer–Olkin value; ns, non-significant; PAH, Polycyclic aromatic hydrocarbons; PCA, principal component analysis; RKs, rickshaw drivers; SKs, shopkeepers; TPs, traffic police workers.

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contains high proportion of polycyclic aromatic hydrocarbons (PAHs) which is a group of over a hundred different organic compounds (IARC, 2010). The main source of PAHs in the environment is incomplete combustion of organic material; however, they are also released from the vehicle exhaust during incomplete combustion of diesel and petrol (HEI, 2010; Valavanidis et al., 2008). PAHs have gained attention of the scientific community because of their persistence and carcinogenic properties (Oanh et al., 1999). They enter the human body via lungs, ingestion and cutaneous routs of absorbption (Unwin., 2006). In human biomonitoring studies, the urinary 1-hydroxypyrene (1-OHP) a metabolite of pyrene is a most widely used biomarker of internal dose of PAH and represents an internal dose of PAHs (Jongeneelen, 2001). It is also a potential biomarker of exposure to mixtures of PAHs (Li et al., 2008). A good correlation between the PAH concentration in air and urine 1-OHP has been observed in the several occupational studies. Urinary 1-OHP is also suitable biomarker for exposure of bus drivers, traffic police workers and other cohorts exposed to PAHs from traffic pollution (Hansen et al., 2004). The urinary level of 1-OHP is often greatly increased in the population of polluted areas than that of less polluted sites (Hansen et al., 2004; Ruchirawat et al., 2005). In addition to direct occupational exposure the indirect exposure to the outdoor environment is also a cause of increased urinary 1-OHP concentration (Hansen et al., 2005).

In the urban environment of developing countries, the traffic pollution can be observed on traffic jams, while many studies provided evidence that because of these events, traffic police workers are highly exposed to PAHs (Burgaz et al., 2002; Hu et al., 2010). A literature review of past shows that both PAHs present in the traffic pollution cause significant oxidative stress, which is characterized by an increased synthesis of free radical. Oxidative stress arises during the imbalance between the syntheses of free radicals and antioxidants (Terada, 2006). It seems that PAHs may be considered as one of the major factor present in the automobile exhaust, which induce oxidative stress, because exposure to PAHs is associated with the increased production of the free radicals (Rossner, 2008). Oxidative stress, on the other hand, may be one of the mechanisms behind many adverse health effects related with air pollution (Singh et al., 2008). In the past, only a few studies have shown the association of PAHs with oxidative stress in public exposed to traffic pollution (Li et al., 2008). Others have studied such an association in the environmentally exposed children and occupationally exposed cohorts (Singh et al., 2008; Jeng et al., 2010; Wei et al., 2010; Bae et al., 2010), however it is well known nowadays that traffic pollution is related with a number of morbidities in human (Ito et al., 2010; Liao et al., 2011). In Pakistan, health and worker safety has always been neglected, because occupational surveillance studies have never been prioritized (Kamal et al., 2011). Despite the fact that a large number of workers are exposures to PAHs in several occupations, no information related to the assessment of risk in occupational groups, and the likely adverse results is currently available in Pakistan. This study aimed to quantify urinary 1-OHP levels as exposure biomarkers of PAHs in workers related with public transport, and any probable relation of such exposure with oxidative stress biomarkers.

## 2. Materials and methods

### 2.1. Study area description and selection of hotspots

Lahore is the capital of province Punjab (Pakistan), and is one of the old city, with a population around 10 million people, and a population growth rate of 4 percent per annum (Ali and Athar, 2010). Geographically it lies between 31°32′59″N and 74°20′37″E, in the semi-arid zone, highly exposed to different environmental problems associated with the industry, occupational and transport pollution (Ali and Athar, 2010). Incoherent mass transit system running in city Lahore is responsible for huge amount of air pollution; especially the release of PAHs from the combustion system of automobiles is an unsought aspect of air pollution in this city. Due to narrow roads and the large number of vehicles, the frequent traffic jams at signals are common throughout Lahore city. In this study, a total of four sampling sites were selected for the sampling of exposed subjects; the sites include the Kalma Chowk, Thokar Niaz Baig, Gulberg whereas Lahore Cantonment (Cannt) area was selected as control sampling site (Fig. 1).

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

A total of sixty male participants was recruited, excluding those who suffered from any chronic disease, or subjects on current

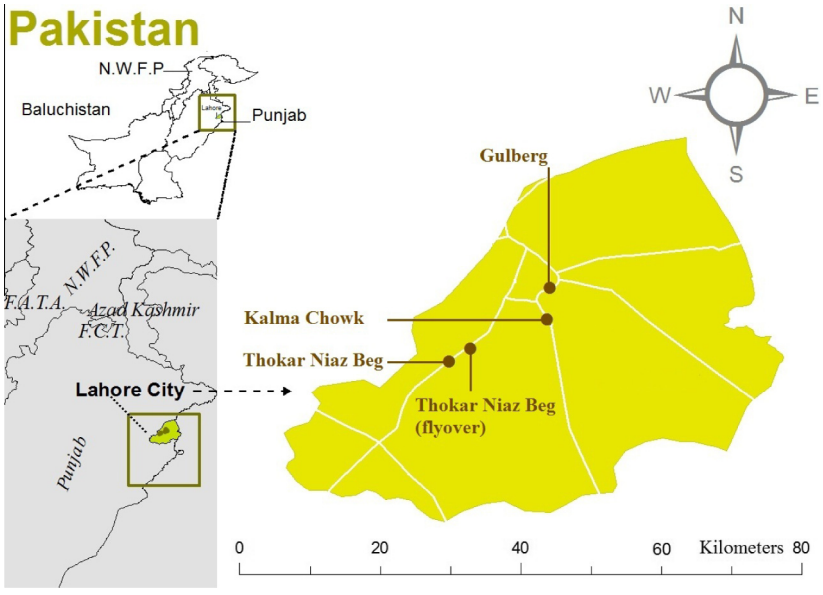


**Fig. 1.** Sampling sites in Lahore city (Pakistan).

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