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Urban air and tobacco smoke in benzene exposure in a cohort of traffic policemen

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Abstract

Benzene (B) is a typical micro-pollutant present in air, especially urban air. In this study a possible correlation between personal benzene exposure and S-phenylmercapturic acid (S-PMA) as a biomarker of internal dose was evaluated in a cohort of traffic policemen. The results confirm that S-PMA is significantly correlated to benzene measured in personal air. B and S-PMA were analyzed considering seasonality, work quarters, time spent indoors, outdoors, and directing traffic, but no significant differences were recorded.

Keywords: Benzene; Traffic policemen; Biomarkers; Urinary S-phenylmercapturic acid

1. Introduction

Benzene (B) is an ubiquitous micro-pollutant present primarily in air (99%). In particular, active smoke represents the most important source of B exposure for smokers, while, for nonsmokers, B exposure is principally due to outdoor ambient air, where B pollution is caused by auto exhaust or gasoline vapor emissions [1] and to indoor air where the presence of B is largely due to environmental tobacco smoke. B air pollution is a very important topic for environmental health due to its carcinogenic properties by all routes of exposure.

The aim of this study is to search for a possible correlation between personal passive exposure to B and levels of urinary S-phenylmercapturic acid (S-PMA) in a cohort of traffic policemen that, for their specific working functions, spend their time indoors and outdoors. Due to the presence of B in tobacco smoke, urinary cotinine as a confounding factor was also investigated in all the subjects.

2. Materials and methods

The present study enrolled 206 volunteers among traffic policemen working in Turin, a city with 900,000 inhabitants located in north-western Italy. The enrolled

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subjects were also administered a questionnaire with questions including their smoking habits and the time spent during work in three kinds of environment: offices (indoor), in the streets (outdoor) and directing traffic (outdoor, close to high traffic volume).

The sampling period lasted from March 2002 to April 2003. Each Thursday, six policemen wore a personal diffusive sampler able to measure air B exposures for a whole working shift. At the end of the working shift a questionnaire was administered and a urine sample was collected to measure S-PMA and cotinine as biomarkers of benzene and of tobacco smoke respectively.

B was analyzed using a gas chromatograph (GC) Carlo Erba 5300 Mega Series equipped with a flame ionization detector (FID) and capillary column DB-624 30 m × 0.318 mm i.d., film 1.8 μm. Each sample was eluted using ultrapure carbon disulfide (CS2 99.9% low benzene content, Aldrich 34.227-0) (3 ml for air samples, 2 ml for personal monitor samples). A calibration curve was prepared from known concentrations of benzene, toluene, and xylenes. The GC thermal program was 45 °C for 4 min, increase of 10 °C/min, from 45 to 145 °C, then 145 °C for 2 min [2,3].

Urinary S-PMA was measured by a method already described elsewhere [4] and slightly modified in order to improve sensitivity. Briefly, samples were purified by a two-step protocol with reversed-phase (C18-EC) and with strong anionic exchange (SAX) solid-phase extraction cartridges. Then they were deacetylated by means of porcine acylase. After centrifugal ultrafiltration with disposable units (cut-off 10,000), the de-proteinized samples were derivatized for 5 min with the *o*-phthaldialdehyde/2-mercaptoethanol (OPA-MCE) reagent and the fluorescent derivatives were separated by high-performance liquid chromatography (HPLC) on a reversed phase column. The limit of detection of the method was 0.2 μg/l of S-PMA in urine.

Urine samples were stored at −70 °C until cotinine analysis was performed, within 6 months. In a centrifuge tube, 1 ml of NaOH 5 M, 8.5 g NaCl and 5 ml of chloroform were added to 25 ml of urine. The methodology for cotinine analysis and quality control was published previously [5]. Instrumental analysis was performed using a gas chromatograph (GC) equipped with a flame ionization-nitrogen-selective detector (NPD) using an oven programmed temperature rising from 100 to 250 °C. The external quality control for the GC technique consisted in a re-analysis for 20 times of a cotinine standard solution added to a pool of nonsmokers' urine samples [6]. Results show a coefficient of variation (CV) of 4.3%, a detection limit below 1 ng/ml, and recovery around 100%. Pyridine was used as an internal standard for quality control.

3. Results

The sites of work of the 206 policemen covered the entire municipal area of Turin involving both residential and traffic-congested areas. Subjects declared through a questionnaire their age (years 38 ± 7), gender (male 60%), length of service (years 8.7 ± 8). A general Pearson correlation analysis between number of cigarettes smoked per day and urinary cotinine showed that urinary cotinine is a sensitive and specific internal dose marker of tobacco smoke exposure (Fig. 1). Furthermore, the cotinine level in smokers and nonsmokers were 671 and 25 ng/ml, respectively ($p < 0.0001$).

A general statistical distribution of B and S-PMA values are shown in Table 1. Linear regression and Pearson's coefficient *r* of the two parameters are reported in Fig. 2.

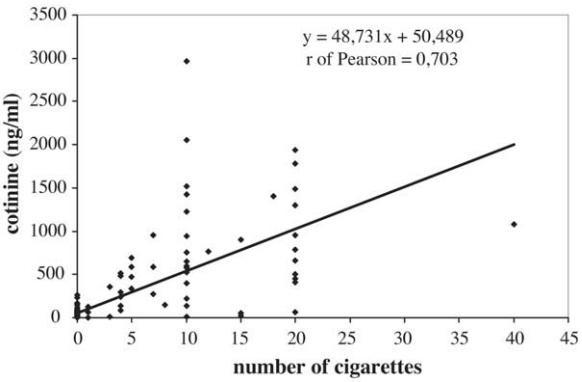

Fig. 1. Regression analysis between number of cigarettes smoked per day and urinary cotinine for all the 206 subjects.

Table 1
General statistical distribution of B and S-PMA values

	N	Min	Max	Mean	S.D.
Benzene (μg/m^3)	206	0.1	65.0	8.8	8.1
S-PMA (μg/g of creatinine)	206	0.3	8.1	1.5	1.0