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BTEX in indoor air of waterpipe cafés: Levels and factors influencing their concentrations

Sadegh Hazrati [a], Roohollah Rostami [b], Mehdi Fazlzadeh [a,*]

[a] Department of Environmental Health Engineering, School of Public Health, Ardabil University of Medical Sciences, Ardabil, Iran
[b] Department of Environmental Health Engineering, School of Public Health, Semnan University of Medical Sciences, Semnan, Iran

HIGHLIGHTS

- Benzene mean concentration of 4.96 mg/m^3 was high compared to OEL-TWA and OEL-STEL
- The expected cancer risk of 4314×10^{-6} was obtained for benzene long-term exposure
- Total hazard index for BTEX long-term exposure was considerably high (HI = 63.23)
- Fruit flavored tobacco lead to higher BTEX concentrations than regular tobacco

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ABSTRACT

BTEX (benzene, toluene, ethylbenzene and xylene) concentrations, factors affecting their levels, and the exposure risks related to these compounds were studied in waterpipe (Ghalyun/Hookah) cafés of Ardabil city in Islamic Republic of Iran. 81 waterpipe cafés from different districts of Ardabil city were selected and their ambient air was monitored for BTEX compounds. Air samples were taken from standing breathing zone of employees, ~150 cm above the ground level, and were analyzed using GC-FID. In each case, the types of smoked tobacco (regular, fruit flavored), types of ventilation systems (natural/artificial), and the floor level at which the café was located were investigated. A high mean concentration of 4.96 ± 2.63 mg/m^3 corresponding to long term exposure to benzene-related cancer risk of 4314×10^{-6} was estimated. The levels of the remaining compounds were lower than the national guideline limits, but their hazard quotients (HQ) for long term exposure to ethylbenzene (1.15) and xylene (17.32) exceeded the HQ unit value. Total hazard indices (HI) of 63.23 were obtained for non-cancer risks. Type of the smoked tobacco was the most important factor influencing BTEX concentrations in the cafés. BTEX concentrations in indoor ambient air of Ardabil waterpipe cafés were noticeably high, and therefore may pose important risks for human health on both short and long term exposures.

1. Introduction

There are growing concerns about indoor air pollution; since concentrations of indoor air pollutants are known to be frequently higher than outdoor (Guo et al., 2004; Toor et al., 2014). Furthermore, people normally spend more than 80% of their time in indoor environments (Klepeis et al., 2001) leading to intake of toxic substances, mainly via inhalation and dust ingestion pathways in contaminated atmosphere (Harrad et al., 2006).

Volatile Organic Compounds (VOCs) are important atmospheric and indoor ambient air pollutants. VOCs evaporate readily at room temperature and inhalation pathway becomes the most important route of exposure for these substances. Benzene, toluene, ethylbenzene, and xylene, known as BTEX, are environmentally important VOCs. They are released in the atmosphere from both artificial and natural sources (Caselli et al., 2010; David et al., 2013; Fazlzadeh et al., 2012; Liu et al., 2009; Sturaro et al., 2010).

BTEX compounds are known to have important impact on human health including cancer and may induce neurological disorders and symptoms such as weakness, loss of appetite, fatigue, confusion, and nausea (Hoskins, 2011). Benzene is the most toxic chemical within the BTEX family and long-term exposure to benzene may increase incidence of leukemia and aplastic anemia in human (Baker et al., 1985; Mehlman, 1990; Niri et al., 2009; Wong, 1995). International Agency for Research on Cancer (IARC) has classified benzene as an intense carcinogenic agent and ethylbenzene as a suspected carcinogenic compound (IARC, 1999).

* Corresponding author at: Department of Environmental Health Engineering, School of Public Health, Ardabil University of Medical Sciences, Ardabil, Iran.
E-mail address: m.fazlzadeh@Arums.ac.ir (M. Fazlzadeh).

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