Potential Exposure to RSP, NO_2 and VOCs for Taxi Professional Driver

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Abstract

Vehicle occupant exposure to air pollutants has been a subject of concern in recent years because of higher levels of air pollutants inside gasoline or diesel-using vehicle, comparing to the surrounding atmosphere. This study evaluated the potential exposure to respirable suspended particulate (RSP), nitrogen dioxide (NO_2) and volatile organic compounds (VOCs), comparing weekday (Monday and Thursday) and weekend (Saturday). Indoor mean concentrations of RSP inside vehicle were 51.2 ug/m^3 and 75.52 ug/m^3 in weekday and weekend, respectively. Measured indoor NO_2 concentrations were 14.8 ppb and 20.8 ppb, respectively. Benzene and toluene mean concentrations inside vehicle were 5.4±2.4 ppb and 23.8±33.8 ppb, respectively.

Introduction

Despite of wide distribution of air pollutants sources in environment, indoor pollutants concentrations may be the dominant risk factor to personal exposure because most people spend over 90% of their times in indoors and about two-thirds of the day inside their homes (Levy et al., 1998). Indoor NO_2 concentration was responsible for 75% of the variation in the total personal NO_2 exposure of office workers (Lee, Yang, & Bofinger, 2000). Therefore indoor exposure might affect more harmful health because indoor concentrations of many pollutants are often higher than those typically encountered outside (US EPA, 1990).

Vehicles, especially diesel-using, are a major source of airborne particulate matter (PM), volatile organic compounds (VOCs), and nitrogen dioxide (NO_2) in metropolitan cities such as Seoul. Vehicle emissions can form a major contribution to pollution of the indoor as well as the outdoor environment (Perry & Gee, 1994). Population who work or live at indoor environment near busy road can be highly affected to air pollutants from exhausted emissions from vehicles (Hansen, Raaschou-Nielsen, & Olsen, 1998; Janssen, Vliet, Aarts, Harssema, & Brunekreef, 2001). This means that occupational location and type can influence the workers' health by exposure to ambient outdoor pollutions as well as indoor air pollutions by working environment.

Some studies have been conducted to measure the occupational exposure to several air pollutants from vehicle exhaust such as carbon monoxide (CO), NO_2, VOCs for parking garage employers, police officer, and roadside storekeepers (Atimtay, Emri, Bagci, & Demir, 2000; Nitta et al., 1993; Jo & Song, 2001). These studies reported that the workers were exposed to highly elevated levels compared with ambient levels because these working groups routinely work near the air pollutants sources.

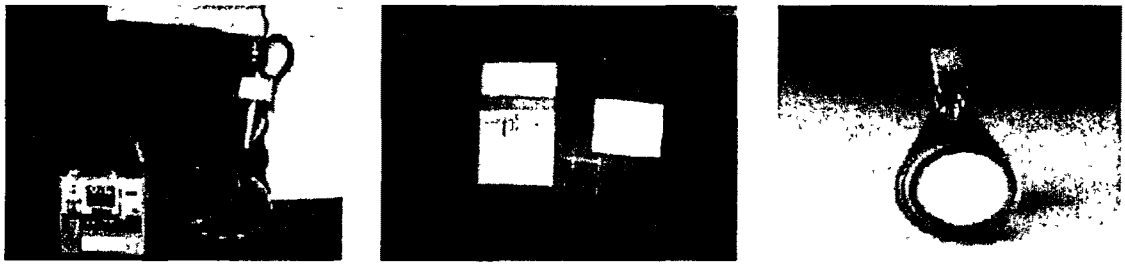
Vehicle occupant exposure to air pollutants has been a subject of concern in recent years because of higher levels of air pollutants inside gasoline or diesel-using vehicle, comparing to the surrounding atmosphere. Exposure studies of professional drivers may provide a good basis for evaluating whether air pollutant related to traffic involves a health risk to human, as drivers are exposed to traffic exhaust at significantly higher concentrations than the general urban population. Furthermore, taxi drivers spend more time in city traffic, where the population is highest that bus and lorry drivers who cover the entire road grid, including suburban and rural areas. Even within metropolitan areas, the concentrations of pollutants may be higher inside cars than inside buses (Hansen et al., 1998). The purposes of this study were to characterize the potential exposure to RSP, NO_2 and VOCs (benzene, toluene) for taxi professional drivers.

Materials and Method

To estimate the potential exposure of air pollutants of taxi professional dirvers, we simultaneously measured the respirable suspended particles (RSP), NO_2, and VOCs concentrations of indoor vehicle for working hours. And questionnaire in relation to personal life-style, working load, and disease condition was investigated. Indoor samplers were placed inside each participant's vehicles at mid-location in February 2005. Monday and Thursday in weekday and Saturday in weekend were selected.

Cyclone samplers (SKC, cut-point; 3.5um) connected with high volume air sampler with 2.5 L/min were used with PVC filter (diameter 37mm) to measure the RSP concentration. Flow rates were measured at the beginning and end of each sampling period with calibrated rotameters and elapsed time indicators were used to calculate the sampled volumes. RSP in the air were collected on the filter, which was weighted before and after sampling with microbalance (Satorious R200D), and the average concentration over the sampling period was calculated. Limit of detection (LOD) was calculated as three times the standard deviation of the 7 field blanks. Passive filter badges (Toyo Roshi, Ltd.) were utilized for all NO_2 measurements. The filter badges are small (5x4x1 cm^3) and light (15 g), and have a high sensitivity of detection limit of 66 ppb-hr (Yanagisawa and Nishimura, 1982). The filter badges absorb NO_2 on a triethanolamine solution on a cellulose fiber filter. The use of a mass transfer coefficient of 0.10 cm/sec results in a measurement error of under 20% (Lee, Yanagisawa, & Spengler, 1993). The exposed NO_2 badges were analyzed with a spectrophotometer with 545 nm wavelength (Shimadzu UV-1201). VOCs concentrations in shoe-stalls were simultaneously measured with RSP and NO_2. Three target VOCs (benzene, toluene, o-xylene, and m/p-xylene) were analyzed. The VOCs concentrations were measured by trapping with activated charcoal tube connected with low volume air sampler (0.12 L/min). Measured charcoal samplers were desorbed by adding 2 mL of

carbon disulfide (CS_2), agitating and allowing the charcoal to stand for 30 to 45 minutes. The desorbate was then sealed in auto-sampler vials and analyzed by GC/MS. The GC oven was programmed to hold at 31°C for 3 minutes, heat at 5°C/minute to 100°C, then heat at 50° C/minute to 200°C and hold for 1 minute. Field blank samples for target VOCs were opened in the shoe-stall, locked again immediately and transported together with the other samples to the study center. Half of the respective limit of detection (LOD) for each compound was used in analyses for samples in which the compound was not detected (Daisey, et al., 1994).



(a) (b) (c)

Figure 1. Instruments used in this study for measurement a) RSP, b) NO_2 and c) VOCs.

Results and Discussion

A total of 10 participants were solicited and recruited in Daegu, Korea. General information about the participants was collected by questionnaires. One indoor RSP measurement is missing due to a pump malfunction. Mean RSP concentrations inside taxi on Thursday, Saturday and Monday were 51.13 ug/m^3, 50.83 ug/m^3 and 75.53 ug/m^3, respectively, as shown Figure 2. Measured NO_2 concentrations were 15.76 ppb, 20.78 ppb and 13.19 ppb, respectively.

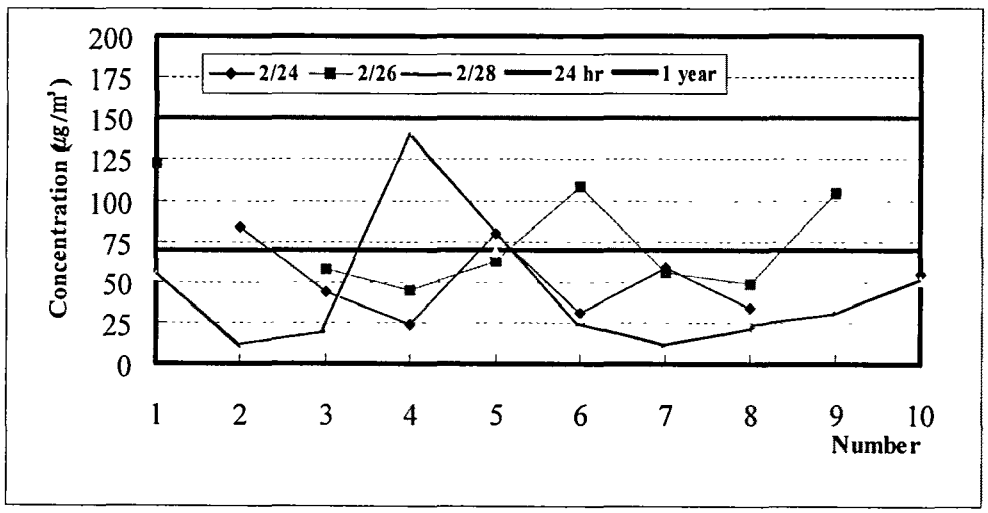


Figure 2. Measured RSP concentrations inside vehicle.

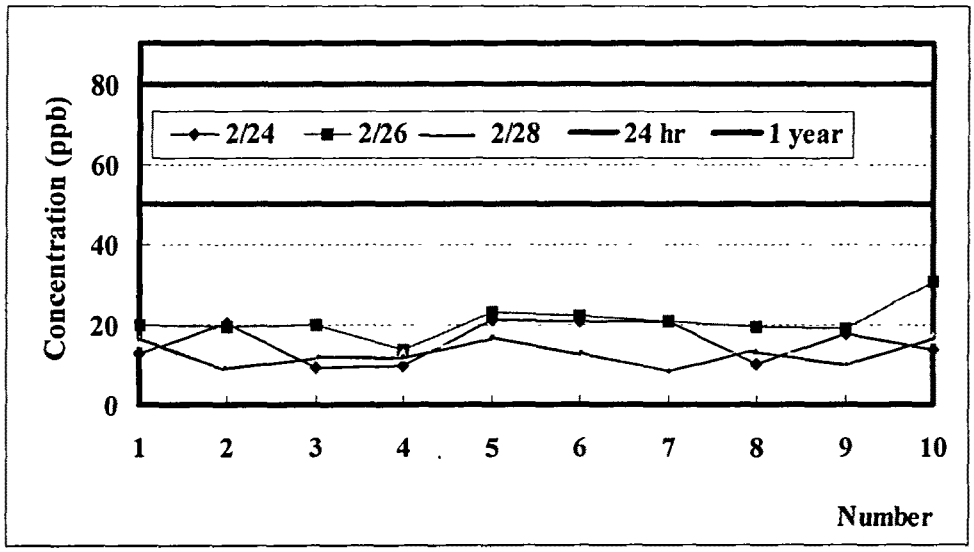


Figure 3. Measured NO_2 concentrations inside vehicle.

Target organic materials, benzene and toluene, in volatile organic compounds mean concentrations inside vehicle were 5.4±2.4 ppb and 23.8±33.8 ppb, respectively. Traffic volume may be thought to be the major sources of ambient air pollution because a few major industrial sources of ambient air pollution are located in Daegu. According to Weisel et al., average concentration of carbon monoxide (CO) to which vehicle commuters in Los Angeles were exposed was approximately 10 ppm, whereas the exposures at home, at work, and at the nearest outdoor, fixed site monitoring station were two or three times lower. Further studies may be needed to assess the exposure to and risk from air pollution for professional drivers.

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