原著論文

Effect of Different Activity Patterns on Weekday and Weekend Nitrogen Dioxide Exposure for University Students

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Abstract

Indoor and outdoor NO_2 concentrations were measured and compared simultaneously with personal NO_2 exposures for 25 university students for 2 days each on weekdays and weekends. House characteristics and activity patterns were used to determine the impacts of these factors on personal exposure. During the 48-hour monitoring period, mean indoor and outdoor NO_2 concentrations were 26.1 ppb and 32.9 ppb on weekdays, respectively, and personal exposure was 29.7 ppb. While mean indoor and outdoor NO_2 concentrations on weekends were 38.1 ppb and 39.6 ppb respectively personal exposure was 44.3 ppb. Since university students spent most of their time indoors, their NO_2 exposures were associated with indoor NO_2 levels rather than outdoor NO_2 levels both weekdays and weekends in spite of different time activity patterns. Using a time-weighted average model, personal NO_2 exposures of the university students were estimated by NO_2 measurements indoors at home, indoors at school, and outdoors at home. Estimated personal NO_2 exposures were significantly correlated with measured personal NO_2 exposures (Spearman r = 0.72). However, estimated personal NO_2 exposures by the time-weighted average model were significantly underestimated, compared with the measured personal NO_2 exposures. This suggests that the personal NO_2 exposure of university students is affected by other factors such as transportation.

Key words: personal exposure, nitrogen dioxide, time-weighted average, transportation

1. INTRODUCTION

Nitrogen dioxide (NO_2) is a by-product of high temperature fossil fuel combustion. Anthropogenic NO_2 emissions from indoor and outdoor combustion sources are some of the most ubiquitous pollutants in the urban environment[1]. Despite of the wide distribution of sources, the indoor NO_2 concentration is the dominant risk factor for personal exposure. Individuals were found to spend about 90% of their days indoors and about two-thirds of the day inside their home[2].

Nitrogen dioxide is a corrosive and highly oxidizing gas with a characteristic pungent odor, which has been described as stinging, suffocating, and irritating. A variety of human experimental studies under controlled conditions suggest that NO_2 may increase airway response[3]. Some chamber studies with volunteers have shown a small effect on airway response in asthmatics exposed to NO_2 concentrations similar to those near home combustion appliances[4].

The usage of a gas range has been identified as one of the major factors contributing to indoor and personal NO_2 exposures. The use of a gas range provided a mean indoor/outdoor (I/O) NO_2 concentration ratio of 1.19, compared with 0.69 for those homes without gas ranges[5]. To date, personal exposure to NO_2 has not been characterized in Korea, though the use of a gas range is common.

Since certain human activities stand out as higher exposure risks, studies of human activity patterns have recently taken on an increased emphasis[6]. In this study, indoor and outdoor NO_2 concentrations were measured and compared simultaneously with personal exposures for 25 university students on weekdays and weekends. The purpose of this study was to estimate the personal NO_2 exposure by a time-weighted average and to assess the personal NO_2 exposure from different time activity patterns on weekdays and weekends, considering university students have varying activity patterns.

2. METHODS

Time activities of 25 university students with simultaneous NO_2 measurements were investigated during a 2-day period in May 2000 in Onyang, Korea. Participants, who all belonged to the same department of Soonchunhyang University, filled out an activity diary (Table 1) about their homes and their surroundings during the course of the study and a questionnaire regarding house characteristics. The activity diary consisted of half-hour time bands during the daytime and one-hour time bands from midnight to 6 a.m. During a 2-day study period, participants were asked to report in this diary whether they were indoors at home, school or elsewhere; outdoors at home, school or elsewhere; or in transit in any kind of motor vehicle or public transportation.

Microenvironments where NO_2 concentrations were measured were indoors and outdoors of their residence, and indoors and outdoors of their school. During the same period, personal NO_2 exposures were measured for the 25 university students. Each student wore a personal sampler on their chest during

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