Indoor airborne concentration of culturable bacteria and its species in various public facilities

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Keywords: organic dust, biological contaminants, pathogenic bacteria, children daycare center

1 Introduction
The indoor environment is an important source of exposure to biological contaminants, including aeroallergens and pathogenic microorganism (Jones, 1999). It has been shown that inhalation of organic dusts containing bacteria, fungi, or animal danders could exacerbate or elevate the occurrence of respiratory illness (Martinez et al. 2006). Many studies have examined the impact on health of exposure to biological contaminants in non-industrial indoor environments such as children daycare centers, elderly nursing homes, or department stores (Bröms et al. 2006). We recently reported these public facility workers’ immunological characteristics involved with development of respiratory allergic diseases (Heo et al. 2010).

In the present study, we analyzed the magnitude of bacterial contamination with identification of major bacterial species in the various public facilities’ indoor air.

2 Materials and Methods
Indoor air samples were collected from various public facilities in Seoul metropolitan area of Korea; 7 elderly care facilities, 7 children daycare centers, 4 hypermarkets, 4 university hospitals, 4 subway stations, and 4 express bus terminals. Samplings were undertaken two times (morning and afternoon) at 2 spots from each facility. One-stage impactor was used, at which tryptic soy agar or blood agar petri dish was attached for total bacteria (TCB) or pathogenic bacteria (PB) assessment, respectively. Those petri dishes were incubated at 37°C for 24 hours. After colony counting, identification of bacterial species has been performed using Vitek 32 Microbial Identification System (BioMerieux, France).

Meteorological information including temperature, humidity, and air current was obtained using IAQ-Calc indoor air quality meter (Model 8762, TSI, U.S.A.). Data are expressed with geometric mean (GM) and geometric standard deviation (GSD). Statistical analyses were performed using SPSS (version 12.0) software.

3 Results and Discussion
The TCB in the indoor air samples was highest at the children daycare center (200±2 CFU/m³) followed by the hospital (124±1 CFU/m³), the elderly care facility (95±3 CFU/m³), the express bus terminal (76±2 CFU/m³), the subway station (72±2 CFU/m³), and lowest at the hypermarket (67±2 CFU/m³). The TCB at the children daycare centers or the hospitals demonstrated a significant difference (p<0.05) from the other facilities. The indoor air samples from the hospitals exhibited the highest concentration of PB (142±1 CFU/m³) and the lowest at the express bus terminal (80±2 CFU/m³). The other facilities showed similar levels of PB; subway station (113±1 CFU/m³), children daycare center (112±2 CFU/m³), hypermarket (111±1 CFU/m³), and elderly care facility (102±2 CFU/m³). The hospital and children daycare center, which showed higher concentration of TCB and PB than the other facilities, also demonstrated higher level of endotoxin originated from those microorganisms.
ET was highest at the hospital (9.8±5.8 EU/m$^3$) followed by the children daycare center (7.5±3.6 EU/m$^3$), hypermarket (6.6±2.5 EU/m$^3$), elderly care facility (6.5±5.0 EU/m$^3$), subway station (3.3±2.4 EU/m$^3$), and the lowest at the express bus terminal (1.2±3.0 EU/m$^3$) without statistical significances.

Among environmental variables for the public facility including temperature, humidity, air current, number of daily user, and construction age of facility building, temperature and humidity were positively correlated with the concentration of TCB ($r=0.42$ for temperature, $r=0.38$ for humidity) and PB ($r=0.35$ for temperature, $r=0.30$ for humidity) (p<0.05).

Among 70 PB species identified in the indoor air samples, Staphylococcus, Enterococcus, Streptococcus, and Pasteurella were the predominant genera. S.aureus was the most detected species (25 samples) in Staphylococcus genera, E. faecium was the most one (11 samples) in Enterococcus genera, S. uberis (4 samples) for Streptococcus, and P. haemolytica (8 samples) for Pasteurella.

Considering our previous report showing no significant association of genetic predisposition with occurrence of respiratory allergic diseases to the workers from those public facilities (Kim et al. 2006), exposure to microbiological contaminants could be a substantial risk of suffering from respiratory allergy for those workers. Even though we did not investigate exposure to hazardous chemicals including metals or organic compounds in the public facilities, exposure to certain chemicals through inhalation may be an additional factor contributing to respiratory illness to those employees.

4 Conclusion
Considering the indoor airborne concentration of TCB, PB, or ET, children daycare center and hospital are the public facilities which need more concerns on biological health hazard than the other facilities investigated. Since major occupants of these facilities are children or patients who may be more susceptible to microbial infection than healthy adults, management of good indoor air quality in those facilities should be empathized with higher priority.

[This work was supported by grant R01-2004-000-10427-1 from the Basic Research Program of the National Research Foundation of Korea]