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学位論文内容の要旨

博士の専攻分野の名称　　博士（医　学）　　氏 名　　叢　石

学 位 論 文 題 名

The association between mechanical ventilation, flue use in heaters and asthma symptoms

（暖房の排気、および室内換気と児童喘息との関連）

Abstract

Background and purpose: The prevalence and burden of asthma and allergic symptoms in children have increased in recent decades in the world. In Japan, the prevalence of asthma in children has been steadily increasing. Epidemiological evidence suggests that environmental factors are major risk factors for asthma in children. Children spend more time at home than adults, thus, indoor environmental health is more important to children than adults.

According to previous studies, the use of fume emitting heaters such as gas, coal, and wood heaters for home heating were associated with increased asthma symptoms in children. And the use of electric heaters might be not associated with asthma symptoms in children, compared with fume emitting heaters. However, in past research, detailed classification of heating fuel systems was lacking, and one type of fuel heater was not set as a reference when comparing other fuel heaters.

Compared with unflued heaters, the use of flued heaters is thought to decrease asthma symptoms in children. This is because flue use might decrease the effect of heating pollutants on asthma. Furthermore, improved mechanical ventilation might decrease the levels of NO_2 produced by gas stoves and be a useful way to decrease indoor air pollution. However, it is unclear whether the combination of flue use in heaters and mechanical ventilation can reduce asthma symptoms in children.

No study exists that investigates the association between heater use and asthma in children in Japan. According to previous data, about 90% of households use kerosene or gas heaters for home heat in Sapporo. In particular, Sapporo winters last for at least 4 months and houses in Sapporo city are typically airtight. However, the association between these heating systems and asthma remains unknown.

This study aimed to determine whether an association exists between the combination of ventilation and flue use in heaters and asthma symptoms among 1st–6th grade (6-12 year old) Japanese school children in Sapporo who were exposed to fume emitting fuel heaters during the winter in poorly aerated houses.

Material and Methods: This cross-sectional study was conducted in public elementary schools in Sapporo city, Japan. A total of 6393 children in grades 1 to 6 (6-12 years old) received a questionnaire from their teachers, with instructions for their parents to complete the questionnaires between November 29th 2008 and January 30th 2009. Classroom teachers collected the questionnaires from the children. Parents completed questionnaires regarding their house environment and their children's asthma symptoms. Basic demographic data was also collected. I used the ISAAC questionnaire to assess asthma symptoms in

children. Five combinations of heaters and ventilation were assessed: electric heaters, flued heaters with ventilation, flued heaters without ventilation, unflued heaters with ventilation, and unflued heaters without ventilation. The $\chi 2$ test was used to analyze the association between asthma, participant characteristics and house environment. Logistic regression analyses were used to calculate odds ratios (ORs) and 95% confidence intervals (95% CIs) for the effects of house heating systems and ventilation on asthma. In the multivariate analyses, I controlled for relevant confounding factors. These were: sex, school grade, parental history of allergies, schools, residence <200 meters from a main road, presence of wall-to-wall carpeting in the house, presence of a smoker in the house, and presence of indoor dampness. Indoor dampness is an important risk for asthma in children, and is associated with the use of unflued gas heaters and low ventilation in the home. It is possible that the association between unflued heaters or the absence of ventilation and asthma symptoms is mediated by dampness. Therefore, a stratified analysis according to indoor dampness was also conducted.

Results: In total, the parents of 4445 (69.5%) children replied to the questionnaires. After excluding incomplete responses, data on 3874 children (60.6%) were analyzed. The prevalence of asthma was 12.8%, and in boys and girl was 15.6% and 10.1%, respectively. Asthma tended to occur more frequently in boys and in children with a parental history of allergies Distribution of the prevalence of asthma was also statistically different for each school grade or each school. Among 3874 households, 89.9% households used fume emitting heaters (kerosene or gas), only 16.7% households used non-fume emitting electric heaters, and the remaining 3.4% used unknown fuels. The use of kerosene heaters (OR = 1.58; 95% CI, 1.03-2.49) and unflued heaters (OR = 1.29; 95% CI, 1.02-1.63) was significantly associated with asthma, compared with electric heaters and the use of flued heaters, after adjusted for confounders. After adjusting for potential confounding factors, the use of flued heaters without ventilation (OR = 1.62; 95% CI, 1.03-2.64) was significantly associated with asthma. The use of unflued heaters was also significantly associated with asthma in the presence (OR = 1.77; 95% CI, 1.09-2.95) or absence of ventilation (OR = 2.23; 95% CI, 1.31-3.85) compared with the use of electric heaters. Dampness was associated with the use of kerosene heaters and low ventilation. However, regardless of dampness, unflued heaters were significantly associated with asthma in both the presence and absence of ventilation.

Discussion and conclusion: Unflued heaters were significantly associated with asthma in both the presence and absence of ventilation, regardless of dampness. Thus, while a pathway through dampness might exist, it is possible that air pollution from fume-emitting heaters also can explain the association between the use of unflued heaters with or without ventilation and asthma symptoms. It might be possible that NO_2, SO_2, PM, etc. from the combustion of fuel heaters leads to asthma symptoms in children. In the cases of not using flue heaters or the absence of ventilation, asthma-related NO_2, SO_2, PM could not be emitted to the outside. Thus, Compared with the use of electric heaters, the use of unflued fume-emitting kerosene or gas heaters was associated with asthma, and this association was stronger among participants who lived in houses using unflued kerosene or gas heaters in the absence of ventilation. In northern cities like Sapporo, particular attention needs to be paid to the use of fuel heaters, especially those that have no flue or ventilation, since there might be an association with asthma in children. I plan to assess the duration and frequency of heater use in the home and the duration of time children spend at home in further studies.