Bedroom environment in relation to respiratory and asthma symptoms among urban primary school children in Thailand

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Nawarat Apichainan
College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand; Department of Health, Ministry of Public Health, Nonthaburi, Thailand

Nutta Taneepanichskul
College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand

Abstract

Purpose - This study sought to examine the association between bedroom environments with respiratory and asthma symptoms among primary school children in urban area of Bangkok, Thailand.

Design/methodology/approach - A cross-sectional study was conducted among 658 primary school children aged 6 to 10 years during April - May 2018. Self-reported questionnaire from child's parent was used as a measurement tool. Children's history of respiratory and asthma symptoms within 1 year was modified from International Study of Asthma and Allergies in Childhood (ISAAC). Binary logistic regression models were performed to find the associations.

Findings - Running nose without cold symptom was the highest reported respiratory and asthma symptom in the past 12 months (52.7%). Having doll in bedroom was significantly associated with dry cough at night (AOR = 2.610; 95%CI 1.720-3.959), phlegm (AOR = 2.375; 95%CI 1.618-3.488), shortness of breath (AOR = 2.440; 95%CI 1.164-5.114), and running nose without cold symptoms (AOR = 2.265; 95%CI 1.558-3.291). Wall dampness near children's bedroom was significantly associated with shortness of breath (AOR = 3.435; 95%CI 1.297-9.098), and running nose without cold symptoms (AOR = 2.331; 95%CI 1.034-5.257).

Originality/value - Children's bedroom environments including doll, window, and wall dampness were positive significantly associated with respiratory and asthma symptoms. Further intervention to improve child's bedroom environment should be considered to reduce respiratory and asthma symptoms.

Keywords Primary school children, Respiratory symptoms, Asthma, Bedroom environment, Thailand

Paper type Research paper

Introduction

Environmental exposure causes premature deaths among children worldwide. World Health Organization (WHO) reported more than a quarter of 5.9 million children mortality were attributable to unhealthy environments [1]. The majority cause of unhealthy environment contributed to respiratory disease and its complication are poor quality of indoor air and outdoor air. Asthma is a burden of respiratory disease among children worldwide [2] which attacked about 300 million children annually [3]. In developing countries, prevalence of respiratory and asthma symptoms are continuously increasing [4]. The symptoms were characterized by repeated attacks of wheezing, breathlessness, and dry cough at night which presented differently in children [3]. The symptoms interrupt children daily activities, sleeplessness, absence of school, and death among severe cases [3, 5]. In Thailand, mortality rate of respiratory disease and asthma for all ages was 64.7% and 29.4%, respectively [6, 7]. A high prevalence was found among children whose age 6-7 years in Bangkok area [7, 8].

Several epidemiological studies have found an association between indoor environmental factors in relation to respiratory disease and asthma. However, the fundamental cause of asthma is still unclear. A combination of genetic predisposition

and environmental exposure to inhaled substances and particles may possibly stimulate allergic reactions or irritate to developing asthma [2]. Concerning on respiratory disease and housing environment, there were many studies found significant associations with respiratory and asthma symptoms [9]. Pets especially cats and dogs are very close to people while they are a leading cause of respiratory complication among young adult. Brunekreef et al. found people who exposed to cat and dog in their early-stage of life (during 6 to 7, 13 to 14 years old) had a higher risk of asthma symptoms, rhino conjunctivitis, and eczema [10]. Furthermore, exposure to dust mites, mold, dampness, and other allergens in home are a cause of asthma exacerbation [11-13].

Inner-city homes had higher indoor pollutants especially particulate matter than in non–inner-city homes [14]. Kumar et al. found the highest indoor suspended particulate matter (SPM) in house located in industrial area. Level of SPM was significantly associated with asthma in children's houses ($p < 0.001$) [15]. According to previous studies, respiratory and asthma symptoms in children were associated with housing environment. However, few of those previous studies focused on children's bedroom environments. Given an increased understanding of respiratory and asthma symptoms among urban children, it is crucial to gain a better linkage between bedroom environments and risk of respiratory and asthma symptoms in urban area.

Materials and methods

Study design and study participants

A cross-sectional study was conducted among 658 primary school children age 6 - 10 years during April - May, 2018. Eight hundred and fourteen children who enrolled in 2 primary schools and lived in Din Daeng district at least 1 year were invited and purposively selected to participate in this study. Din Daeng district was purposively selected because it locates in inner city and accounted as the highest polluted city in Bangkok. In 2017, Pollution Control Department (PCD) of Thailand reported that monthly average particulate matter 10 micrometers or less in diameter (PM_{10}) was ranged between 37 – 90 $\mu g/m^3$. It documented that few days during dry season (January – February) had an exceed limit of air quality standard [16]. General characteristic of residential features in this area are mostly old building including small rental room which was accessed by walk-through survey during data collection period. This study was approved by Ethics Review Committee of Chulalongkorn University (COA No. 085/2561).

Questionnaire

A self-reported questionnaire was provided for children's parent to evaluate respiratory and asthma symptoms during a past year and children's bedroom environments on the parents meeting day at school. Screening questionnaire was used for screening inclusion criteria. Respiratory and asthma symptoms were modified from the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaires. The symptoms were considered for wheezing, dry cough at night, phlegm, shortness of breath, and running nose without cold symptoms in the past 12 months. Each symptom was set a question "Have your child had wheezing or whistling in the chest in the past 12 months?". If parent reported "Yes", their child was considered as having those respiratory and asthma symptoms. Children who had experienced in wheezing or whistling in the chest during the past 12 months were also considered as having asthma according to World Allergy Organization (WAO) to diagnosis asthma symptoms of children [17].

Children bedroom environment conditions were reported by child's parent. The

conditions were included using cooling devices (air conditioner/ fan/ misting fans), number of windows (≤ 2 window(s) / >2 windows), have curtain (yes/ no), have carpet (yes/ no), bring pet into bedroom (yes/ no), have doll (yes/ no), number of dolls (<5 dolls/ ≥ 5 dolls), have doll on the bed (yes/ no), and presence of wall dampness near children's bedroom (yes/ no).

Statistical analysis

SPSS version 22 (licensed by the University) was performed all statistical analysis. In descriptive statistic, categorical data was reported by frequency and percentage. Continuous data was presented as mean and standard deviation (SD). If data was skewed, median and interquartile rank (IQR) was reported. Chi-square and Fisher's exact test were used for testing association of categorical data in bivariate analysis. Continuous variables were tested for difference against having and not having respiratory and asthma symptoms by Student's t-test or Mann–Whitney U test. Multivariate analysis was performed using binary logistic regression. Adjusted model also performed using selected variables which had significant value less than 0.2 in bivariate analysis. The potential confounders age, gender (Male/Female) and family history of asthma (Yes/No) were included into each model. Adjusted odd ratio (AOR) and 95% confidence interval were presented. All reported p-values are two-sided and defined as significant at 5% level.

Results

Children characteristics and respiratory and asthma symptoms

A total of 658 primary school children both male (50.2%) and female (49.8%) were included in this study. Table 1 shows no significant association of respiratory and asthma symptoms between gender. Most of children (64.6%) had exercise regularly while only 2.3% had family history of asthma. The highest prevalence of respiratory and asthma symptoms in the past 12 months was running nose without cold symptom (52.7%) (Table 2). Children stayed at residence on weekend more than school day. Most of children (53.0%) stayed at their home around 24 hours during weekend whereas 76.0% of children stayed at residence around 13-14 hours during school day. Majority of children (69.5%) spent most of their time in bedroom more than other rooms.

Children's bedroom environment and respiratory/asthma symptoms

Most of child's bedroom (94.5%) had misting fan as a cooling device. Only half of them (41.8%) had air conditioner. Using misting fan was associated with having phlegm (p=0.017), and shortness of breath (p=0.037). Number of windows in child's bedroom was associated with phlegm (p=0.001), and running nose without cold (p<0.001). Dolls in child's bedroom were significantly associated with respiratory and asthma symptoms including dry cough at night, phlegm, shortness of breath and running nose without cold (p<0.05). In addition, number of dolls presented in bedroom was associated with phlegm (p=0.008). Wall dampness near child's bedroom was associated with all symptoms (p<0.05) (Table 3).

Binary logistic regression model was used to assess the association between child's bedroom environments and respiratory and asthma symptoms in the past 2 months (Table 4). The result found that having more than 2 windows in children's bedroom were increased 2.104-fold odds of having wheezing or whistling in the chest (asthma) (AOR = 2.104; 95%CI 1.115-3.967; p=0.022), 1.853-fold odds of having phlegm (AOR = 1.853; 95%CI 1.180-2.909; p=0.007), and 1.914-fold odds of having running nose without cold (AOR = 1.914; 95%CI 1.203-3.044; p=0.006) compared to less number of windows. Having doll in bedroom was increased 2.610 -fold odds

Table 1. Children characteristics and respiratory symptoms (12 months)

Children Characteristics	Total (n=658)	Wheezing or whistling in the chest (asthma)		Dry cough at night		Phlegm		Shortness of breath		Running nose without cold	
	n (%)	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value
Age (years); Median (IQR)	8 (2.0)	8 (2.0)	0.308[a]	8 (2.0)	0.129[a]	8(2.0)	0.277[a]	8 (2.0)	0.232[a]	8 (2.0)	*0.725*[a]
Gender (Male)	330 (50.2)	43 (13.0)	0.186[b]	113 (34.2)	0.345[b]	135(40.9)	0.212[b]	30 (9.1)	0.980[b]	166 (50.3)	0.210[b]
Height (cm); Median (IQR)	122 (10.0)	123 (10.0)	0.815[a]	120 (10.0)	0.008[a]	122(10.0)	0.743[a]	120 (10.0)	0.648[a]	123 (10.0)	0.835[a]
Weight (kg);											
Present (kg); Median (IQR)	26 (7.0)	26 (7.0)	0.757[a]	26 (8.0)	0.164[a]	26(7.0)	0.742[a]	26 (8.4)	0.328[a]	26 (7.0)	0.737[a]
At birth (kg); Median (IQR)	3 (0.3)	3 (0.2)	0.330[a]	3 (0.3)	0.892[a]	3(0.3)	0.435[a]	3 (0.4)	0.003[a]	3 (0.3)	0.802[a]
Family history of asthma (Yes)	15 (2.3)	2 (13.3)	0.685[c]	6 (40.0)	0.580[c]	10(66.7)	0.065[b]	2 (13.3)	0.639[c]	11 (73.3)	0.106[b]
Exercise (Yes)	319 (64.6)	38 (11.9)	0.726[b]	93 (29.2)	0.090[b]	130(40.8)	0.152[b]	26 (8.2)	0.776[b]	163 (51.1)	0.244[b]

Note: [a] Mann -Whitney U test; [b] Pearson Chi-Square test; [c] Fisher X'act test

Table 2. Prevalence of respiratory and asthma symptoms

Symptoms	Yes: n (%)	No: n (%)
Respiratory and asthma symptoms in the past 12 months		
Wheezing or whistling in the chest	75 (11.4)	583 (88.6)
Dry cough at night	214 (32.5)	444 (67.5)
Phlegm	285 (43.3)	373 (56.7)
Shortness of breath	60 (9.1)	598 (90.9)
Running nose without cold	347 (52.7)	311 (47.3)

Table 3. Children's bedroom environment and respiratory and asthma symptoms

Factors	Total (n=658)	Wheezing or whistling in the chest (asthma)		Dry cough at night		Phlegm		Shortness of breath		Running nose without cold	
	n (%)	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value	Yes: n (%)	*p*-value
Using cooling devices											
Air conditioner	275 (41.8)	27 (9.8)	0.280[b]	88 (32.0)	0.808[b]	130 (47.3)	0.082[b]	24 (8.7)	0.768[b]	155 (56.4)	0.114[b]
Fan	511 (77.7)	62 (12.1)	0.269[b]	176 (34.4)	0.050[b]	234 (45.8)	0.017[b]	53 (10.4)	0.037[b]	279 (54.6)	0.074[b]
Misting fans	622 (94.5)	3 (8.3)	0.787[c]	9 (25.0)	0.322[b]	17 (47.2)	0.626[b]	3 (8.3)	1.000[c]	22 (61.1)	0.301[b]
Number of windows											
≤ 2	247 (37.5)	28 (11.3)	0.079[b]	75 (30.4)	0.084[b]	109 (44.1)	0.001[b]	18 (7.3)	0.444[b]	134 (54.3)	<0.001[b]
> 2	133 (20.2)	22 (16.5)		54 (40.6)		75 (56.4)		14 (10.5)		88 (66.2)	
Have curtain (Yes)	387 (58.8)	45 (11.6)	0.825[b]	136 (35.1)	0.087[b]	174 (45.0)	0.308[b]	41 (10.6)	0.116[b]	213 (55.0)	0.157[b]
Have carpet (Yes)	59 (9.0)	9 (15.3)	0.329[b]	15 (25.4)	0.222[b]	23 (39.0)	0.482[b]	7 (11.9)	0.443[b]	33 (55.9)	0.606[b]
Bringing pets into bedroom (Yes)	60 (9.1)	5 (8.3)	0.433[b]	24 (40.0)	0.195[b]	28 (46.7)	0.582[b]	8 (13.3)	0.234[b]	32 (53.3)	0.922[b]
Have dolls (Yes)	425 (64.6)	53 (12.5)	0.242[b]	163 (38.4)	<0.001[b]	218 (51.3)	<0.001[b]	49 (11.5)	0.004[b]	258 (60.7)	<0.001[b]
Number of dolls											
< 5	332 (50.5)	39 (11.7)	0.394[b]	125 (37.7)	0.574[b]	159 (47.9)	0.008[b]	34 (10.2)	0.116[b]	196 (59.0)	0.183[b]
≥ 5	93 (14.1)	14 (15.1)		38 (40.9)		59 (63.4)		15 (16.1)		62 (66.7)	
Put dolls on the bed (Yes)	180 (42.4)	25 (13.9)	0.448[b]	75 (41.7)	0.229[b]	101 (56.1)	0.089[b]	24 (13.3)	0.318[b]	118 (65.6)	0.079[b]
Wall dampness near bedroom (Yes)	40 (6.1)	10 (25.0)	0.017[c]	19 (47.5)	0.037[b]	26 (65.0)	0.004[b]	11 (27.5)	<0.001[c]	29 (72.5)	0.010[b]

Note: [b] Pearson Chi-Square test; [c] Fisher X'act test

Table 4. Binary logistic regression model association between children's bedroom environment and respiratory and asthma symptoms (n=658)

Factors	Wheezing or whistling in the chest (asthma)		Dry cough at night		Phlegm		Shortness of breath		Running nose without cold	
	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Using cooling devices										
Air conditioner			0.794 (0.543, 1.159)	0.232	1.203 (0.853, 1.696)	0.291			1.185 (0.830, 1.690)	0.350
Fan			1.104 (0.701, 1.739)	0.668	1.215 (0.798, 1.852)	0.364	1.811 (0.768, 4.272)	0.175	1.010 (0.667, 1.530)	0.962
Number of windows										
≤ 2	1.375 (0.767, 2.462)	0.285	0.821 (0.541, 1.245)	0.352	1.183 (0.805, 1.738)	0.391			1.160 (0.794, 1.695)	0.443
>2	2.104 (1.115, 3.967)	0.022	1.195 (0.747, 1.912)	0.458	1.853 (1.180, 2.909)	0.007			1.914 (1.203, 3.044)	0.006
Have curtain (Yes)			1.337 (0.912, 1.959)	0.136			1.309 (0.704, 2.433)	0.394	0.948 (0.665, 1.351)	0.766
Have doll (Yes)			2.610 (1.720, 3.959)	<0.001	2.375 (1.618, 3.488)	<0.001	2.440 (1.164, 5.114)	0.018	2.265 (1.558, 3.291)	<0.001
Bringing pets into bedroom (Yes)			1.116 (0.620, 2.009)	0.715						
Wall dampness near bedroom (Yes)	2.338 (0.946, 5.779)	0.066	1.721 (0.797, 3.715)	0.167	2.139 (0.987, 4.636)	0.054	3.435 (1.297, 9.098)	0.013	2.331 (1.034, 5.257)	0.041

Note: AOR = Adjusted Odds Ratio; CI = Confidence Interval

of having dry cough at night (AOR = 2.610; 95%CI 1.720-3.959; p<0.001), 2.375 -fold odds of having phlegm (AOR = 2.375; 95%CI 1.618-3.488; p<0.001), 2.440 -fold odds of having shortness of breath (AOR = 2.440; 95%CI 1.164-5.114; p=0.018), and 2.265 -fold odds of having running nose without cold (AOR = 2.265; 95%CI 1.558-3.291; p<0.001) compared to room without doll. Presenting of wall dampness near children's bedroom was increased 3.435 -fold odds of having shortness of breath (AOR = 3.435; 95%CI 1.297-9.098; p=0.013), and 2.331-fold odds of having running nose without cold (AOR = 2.331; 95%CI 1.034-5.257; p=0.041) compared to without wall dampness.

Discussion and conclusion

Around 1 in 4 of primary school children in this area reported respiratory and asthma symptoms in the past 12 months. The most reported symptom was running nose without cold and the less reported symptoms was shortness of breath. Having more windows in bedroom was significantly associated with respiratory and asthma symptoms. Dolls in child's bedroom were associated with respiratory and asthma symptoms. Dampness of wall near child's bedroom was significantly associated with shortness of breath, and running nose without cold symptoms.

Our study was evaluated an association between children's bedroom environment in urban area where is located in the highest air pollution concentration in Bangkok, Thailand [16]. We found that the common respiratory and asthma symptoms among primary school children was running nose without cold. Around 11% of children were reported having wheezing symptoms which was lower than other urban areas. Similar percentage was found among other urban area of low to middle income countries. Given an example of India, Mathew et al. found 12.7% – 17.7% of Delhi children presented respiratory symptoms [18].

Exposures to poor quality of indoor air are the most important concern for causes of respiratory diseases and asthma among children [2, 18]. Our study found that dampness of wall near child's bedroom was associated with respiratory and asthma symptoms including shortness of breath and running nose without cold symptoms. Our results was consistency with Chen et al. [11], Nguyen et al. [12], and Wang et al. [19]. Dampness can cause of mold growing that mold is known as respiratory allergen to respiratory and asthma symptoms [19]. Children who had dolls in bedroom were a predominant risk of respiratory and asthma symptoms because significant associations were found among all symptoms. Dust was accumulated in child's doll [20]. However, type of doll was not accessed in this study. We found that the more number of windows was increased a risk of respiratory and asthma symptoms than less number of windows. Since our study was conducted in high pollution area of Bangkok [16], having windows may be possible to increase a contamination of outdoor air pollution. Source of outdoor pollutants are mainly emitted from on-road and off-road vehicles in urban areas [21]. In addition, Baek et al. studied the Indoor/ Outdoor relationships in Korean urban areas confirmed the importance of ambient air in determining the quality of indoor air [22]. Although having curtain and bringing pets into bedroom were not statistical significance with respiratory and asthma symptoms which was inconsistent with other studies [10, 11].

Several limitations would be pointed out for our study. First, self-reported questionnaire was used as measurement tool which may lead to information bias. Further study should consider to use hospital base records for respiratory and asthma disease diagnosis. Second, only 2 primary schools in Din Daeng district under control by Bangkok Metropolitan Administration were selected. Therefore, this study could not generalize to other urban area in Bangkok. Lastly, respiratory

and asthma symptoms in this study were considered for long term (12 months) which may lead to recall bias. Collecting of indoor air quality in child's bedroom would be benefit to confirm association between indoor air quality and the symptoms.

In conclusion, our study found that child's bedroom environments including dolls, number of windows, and wall dampness were associated with respiratory and asthma symptoms. An appropriate guidance to provide knowledge of bedroom environment improvement for primary school children and their family should be considered to reduce respiratory and asthma symptoms. Collecting indoor air quality in children's bedroom would be benefit to confirm the association between indoor air quality and respiratory symptoms. Intervention study for improving children's bedroom may take into consideration for further study.

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Corresponding author

Nutta Taneepanichskul can be contacted at: nutta.taneepanichskul@gmail.com