ASSOCIATION BETWEEN FEELING COLD IN THE BEDROOM AND THE INCIDENCE OF UPPER RESPIRATORY INFECTION SYMPTOMS

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Abstract. A cold ambient temperature in the house may be associated with risk of respiratory infection. In this study, we aimed to determine if there is a significant association between a perception of a cold bedroom and the presence of upper respiratory infection symptoms in order to inform efforts to reduce the incidence of upper respiratory infections in the study population. For this study, subjects were purposely selected from employees and their spouses of a single company in Kyushu, Japan. The study was conducted from December 2018 to March 2019. Each subject was asked to complete a self-administered questionnaire and which best classified how they felt at bedtime: never, sometimes or always. Each subject was also asked whether they had upper respiratory tract infection symptoms, whether they took over-the-counter medication or saw a physician for their symptoms. Between-group differences were examined for significance using the Chi square test. Logistic regression analysis was used to evaluate the potential association between the level of perceived coldness and the likelihood of having an upper respiratory tract infection and its consequences. A total of 1196 subjects were included in the study, 64% male (826 employees (89% male) and 370 spouses (8% male)). The mean age of study subjects was 44 (±12) years. Of the total subjects, 44%, 44% and 12% never/rarely felt cold at bedtime, sometimes felt cold at bedtime and often/always felt cold at bedtime, respectively. Of the total subjects, 52% had upper respiratory tract infection symptoms. When compared with subjects who never/rarely felt cold, subjects who always/often felt cold had significantly greater odds of having upper respiratory tract infection symptoms (adjusted odds ratio (adjusted OR) = 2.56; 95% confidence interval (CI): 1.33-4.91; $p = 0.005$), having taken over-the-counter drugs for upper respiratory tract infection symptoms (adjusted OR = 1.90; 95% CI: 1.95-2.91; $p = 0.003$), having taken sick leave for an upper respiratory tract infection (adjusted OR = 3.54; 95% CI: 1.63-7.69; $p = 0.001$) and having visited a doctor for upper respiratory tract infection symptoms (adjusted OR = 3.22; 95% CI: 1.18-8.80; $p = 0.022$). In our study population, feeling cold in the bedroom at nighttime was significantly associated with having upper

respiratory tract infection symptoms, visiting a doctor and taking sick leave. A change in the room temperature at nighttime should be considered for those who feel cold at nighttime. Further studies are needed to determine if changing the temperature of the bedroom so the person does not feel cold at nighttime will result in fewer episodes of upper respiratory tract infections or not.

Keywords: sick leave, cold temperature, housing, respiratory tract infections

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INTRODUCTION

Studies have found mortality rates are higher in winter than non-winter months (The Eurowinter Group, 1997; Gasparrini *et al*, 2015; Healy, 2003; Bhaskaran *et al*, 2013; Wilkinson *et al*, 2001). A previous study also found mortality rates are higher among residents of colder than warmer houses (Wilkinson *et al*, 2001). These higher mortality rates are due to respiratory and cardiovascular diseases (Oberg *et al*, 2000; Wolf *et al*, 2009; Davie *et al*, 2007). Exposure to cold air and residing in a cold house have been reported to have a detrimental effect on human health (Wilkinson *et al*, 2001).

Previous studies of the effect of winter and cold air on health have primarily obtained data from hospital admissions and causes of death (The Eurowinter Group, 1997; Bhaskaran *et al*, 2013; Wilkinson *et al*, 2001; Wolf *et al*, 2009). These studies usually do not study the effect of cold room temperature on minor outcomes, such as quality of life, thermal comfort, psychological health and social wellbeing (London School of Hygiene and Tropical Medicine, 2014) and specific minor health conditions (Howden-Chapman, 2004; Sundell, 2004). The incidence and severity of respiratory tract infections has often been assumed to be due to the level of cold exposure. The risk for infection increases with the duration of cold exposure (Mourtzoukou and Falagas 2007). Although the effect of exposure to cold temperature on health has been studied, what has been less studied is the effect of living or sleeping in a cool environment on health.

Fewer dwellings in Japan are equipped with central heating than some other developed countries and dwellings in Japan typically have lower indoor temperatures than dwellings in other countries (Ministry of Land, Infrastructure, Transport and Tourism, 2018). In Japan, most modern homes are heated separately by individual wall-mounted heating units. Approximately 39% of houses in Japan are uninsulated (Ikaga, 2018). The residential energy consumption in Japan is only one quarter of the heating energy consumed by Europe (Murakami *et al*, 2009). In Japan, it is often considered wasteful to uniformly heat an entire

house or apartment. The living room is usually heated but not the bedrooms. In Japan, the average temperature of a house in winter is 17°C and the average temperature of a bedroom is 13°C (Ikaga, 2018) which are much lower than minimum temperatures recommended by the World Health Organization (WHO Regional Office for Europe, 1987) and in the United Kingdom (Jevons *et al*, 2016).

No previous studies from Japan have evaluated the association between how cool the bedroom feels and the incidence of upper respiratory tract infection symptoms. We hypothesized that feeling cold in the bedroom at night is associated with a significantly greater odds of developing upper respiratory tract infection symptoms, and its consequences, such as missing work and needing to go see a physician. Therefore, this study aimed to investigate that potential association and its effects. These results can inform efforts to reduce the frequency of upper respiratory tract infections in the study population.

MATERIALS AND METHODS

In this study, we purposely surveyed employees and their spouses of a single Japanese company in Kyushu, Japan. Inclusion criteria for study subjects were all employees who worked at the study company and their spouses, except those who met exclusion criteria. Exclusion criteria for study subjects were: being aged <20 years, having a past history of cancer or kidney disease and not completing our study questionnaire. Our study questionnaire was given to each subject in December 2018 asking about demographic data (*eg*, age, sex, type of work, vaccination history, their overall self-rated level of health and history of chronic medical problems) and whether they: (1) never/rarely felt cold at bedtime, (2) sometimes felt cold at bedtime or (3) often/always felt cold at bedtime; they were then classified into three groups accordingly. Each subject was then asked to record their responses throughout the winter, until the questionnaire was picked up in March 2019, whether they had any symptoms of an upper respiratory tract infection, visited a physician, took time off work due to upper respiratory infection symptoms, purchased any medication over-the-counter to treat upper respiratory infection symptoms and used a heating unit in the room they slept in.

Descriptive statistics were used to evaluate demographics and other selected factors, such as sex, job type, history of influenza vaccination, whether or not a heating system was used in the bedroom, self-rated health and past history of disease. The Chi square test was used to evaluate differences in variables by group. Logistic regression analysis was used to evaluate potential associations between the perceived level of coldness and the odds of having upper respiratory tract infection symptoms, seeing a doctor for an upper respiratory tract infection and taking sick leave due to an upper respiratory tract infection. The logistic regression model was adjusted for possible confounding factors, including sex, age, job type, smoking habits, self-rated health, past history of disease, heating system usage and an adjusted odds ratio (adjusted OR) was calculated. A p-value <0.05 was considered statistically significant. We

analyzed the data using STATA, version 15 (StataCorp, College Station, TX).

All subjects gave informed consent prior to participation in this study. This study was approved by the ethics committee of the University of Occupational and Environmental Health, Japan (approval number: H30-162)

RESULTS

A total of 1930 people (1333 employees and 597 spouses) were invited to participate in the study. Of them, 1196 participants (826 employees and 370 spouses) met inclusion criteria, thus, were analyzed for the study. Men accounted for 64% of all participants. The mean (±standard deviation) age of study subjects was 44 (±12) years. Forty-seven percent of subjects were desk workers. Thirteen percent of subjects stated their health was either excellent or very good; 59% stated their health was good. Fifteen percent of subjects reported a previous history of health problems (Table 1).

Of the total subjects, 44%, 44% and 12% never/rarely felt cold at bedtime, sometimes felt cold at bedtime and often/always felt cold at bedtime, respectively. Of the total subjects, 52% had upper respiratory tract infection symptoms, 43% used medication to treat their symptoms, 24% missed work due to their symptoms and 13% saw a physician for their symptoms (Table 2).

Of those who often/always felt cold, 59% had upper respiratory tract infection symptoms and 52% bought medication to treat their upper respiratory infection symptoms.

Twenty-one percent of subjects who never/rarely felt cold in their bedroom went to see a doctor for their upper respiratory tract infection symptoms while 25% of those who often/always felt cold did. Eleven percent, 14% and 18% of those who never/rarely, often and always felt cold in their bedroom at night took sick leave for their upper respiratory tract infection symptoms, respectively (Table 2).

Subjects who reported often/always feeling cold had significantly greater odds than those who never/rarely felt cold of having upper respiratory tract infection symptoms (adjusted OR = 2.56; 95% confidence interval (CI): 1.33-4.91; p <0.0005), taking over-the-counter drugs for upper respiratory tract infection symptoms for ≥3 days (adjusted OR = 1.90; 95% CI: 1.25-2.91; p <0.0003), seeing a doctor for upper respiratory tract infection symptoms ≥3 times (adjusted OR = 3.22; 95% CI: 1.18-8.80; p <0.022), being absent from work due to upper respiratory tract infection symptoms for ≥3 days (adjusted OR = 2.06; 95% CI: 1.07-3.96; p <0.031) and often/always being absent from work due to upper respiratory tract infection symptoms for ≥3 days (adjusted OR = 3.54; 95% CI: 1.63-7.69; p <0.001) (Table 3).

DISCUSSION

In our study, subjects who felt cold in their bedroom at night were significantly more likely to have upper respiratory infection symptoms, see a doctor and miss work due to having upper respiratory infection symptoms. Howden-Chapman *et al* (2007) reported a warmer bedroom was associated with lower odds of having self-reported poor health, taking

Table 1
Characteristics of study subjects (n = 1196)

Characteristics of the participants	Number	Percent
Age group, years [mean ± SD = 44 ± 12]		
20-29	229	19
30-39	117	10
40-49	365	30
50-59	455	38
60 <	31	3
Gender		
Male	762	64
Female	434	36
Structure of participants		
Company employees	826	69
Spouses	370	31
Smoking history		
Never	658	55
Past smoker	259	22
Current smoker	279	23
Work type		
Unemployed	163	14
Mainly desk work	568	47
Mainly involving interpersonal communication	290	24
Mainly involving physical labor	175	15
Previous history of influenza vaccination	570	48
Heating system use in the bedroom	712	60
Self-rated health		
Excellent	23	2
Very good	130	11
Good	709	59
Fair	270	23
Poor/Very poor	64	5
Past history of disease		
Diabetes	34	3
Hypertension and/or cardiovascular disease	94	8
Allergic rhinitis	36	3
Chronic obstructive pulmonary diseases and/or asthma	20	2

SD: standard deviation

Table 2

Association between feeling cold in the bedroom at night and selected variables

Upper respiratory infection symptoms and its consequences	Perception of feeling cold in bedroom at night			Percent based on total number of subjects	*p*-value*
	never/rarely *n* = 528 (44.1%)	sometimes *n* = 522 (43.7%)	often/always *n* = 146 (12.2%)		
Upper respiratory infection symptoms during the study period (%)					<0.001
never	53	44	41	48	
1-2 times	42	51	46	46	
3 times or more	5	5	13	6	
Medication for upper respiratory infection symptom (%)					0.007
never	60	56	48	57	
1-2 days	21	19	20	20	
3 or more days	19	25	32	23	
Physician visits during study period for upper respiratory infection symptoms (%)					0.003
never	79	72	75	75	
1-2 times	19	26	19	22	
3 times or more	2	2	6	2	
Days of sick leave due to upper respiratory infection symptoms (%)					0.013
never	89	86	82	87	
1-2	8	8	8	8	
≥3 or more days	3	6	10	5	

*Derived from Chi square test

Table 3

Relationship between perception of feeling cold and upper respiratory infection symptoms and their consequences

Feeling cold in the bedroom at night	URTI symptoms ≥3 times			Medication for >3 days			Hospital visit(s) >3 times			Sick leave for >3 days[b]		
	Adjusted OR	95% CI	*p*-value[a]	Adjusted OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Never/ Rarely	reference			reference			reference			reference		
Sometimes	0.79	0.44-1.44	0.447	1.33	0.98-1.81	0.066	1.07	0.41-2.74	0.894	2.06	1.07-3.96	0.031
Often/ Always	2.56	1.33-4.91	0.005	1.90	1.25-2.91	0.003	3.22	1.18-8.80	0.022	3.54	1.63-7.69	0.001

URTI: Upper respiratory tract infection; Adjusted OR: adjusted odds ratio

[a]*p* values presented in Table 3 were derived from multi-variable model which was adjusted for sex, age, smoking, job type, self-rated health, current medical history of diabetes, hypertension and other cardiovascular disease, respiratory disease, allergic rhinitis, and heating system usage in the bedroom.

[b]Applicable to only those (n = 1033) who worked during study period (952 workers from subject company and 81 spouses)

a day off work and visiting a general practitioner.

Many international studies have reported cold housing is significantly associated with poor respiratory and general health (Howden-Chapman, 2007; Heyman *et al*, 2011; Braubach *et al*, 2008; Osman *et al*, 2010; El Ansari and El Silimy 2008; Barton *et al*, 2007; Leech *et al*, 2004; Critchley *et al*, 2007; Gilbertson *et al*, 2012). Most of these studies were among low-income communities (Howden-Chapman 2007; Critchley *et al*, 2007; Gilbertson *et al*, 2012; Heyman *et al*, 2011). Poorer households may be more likely to live in less energy-efficient housing and may be less likely to handle the negative impact of living in a cold home (Marmot Review Team, 2011). In our study, the subjects were not poor, being all employed or a spouse of an employee. In spite of this, we still observed a significant association between feeling cold in the bedroom at night and having upper respiratory tract infection symptoms. Not using a heater in the bedroom among our study subjects was not due to being poor. This may be due to cultural differences between Japan and Europe/North America. In Japan, sleeping warm means sleeping under a thick blanket, not necessarily sleeping in a warm room. People who sleep under a warm blanket yet in a cold room will inhale cold air. Inhalation of cold air can cause vasoconstriction in the respiratory tract mucosa and suppression of the immune system, which may lead to an increase in susceptibility to infections (Mourtzoukou and Falagas 2007). This may explain the findings in our study.

A strength of our study was that the questionnaire was kept with the subject throughout the winter during which the subject recorded symptoms, eliminating recall bias, a weakness in some studies.

A weakness of our study was having a homogeneous study population making it impossible to apply our results to other study populations. Another weakness was that we did not measure the temperature of the rooms. We did this study based solely on the perception of the subject, which can vary from person to person.

However, we strongly recommend that a room should be heated if people feel cold, regardless of the room temperature, as the individual susceptibility to temperature varies widely and an individual's perception has been known to be a more compelling predictor of ill health than many objective measures (Idler and Benyamini, 1997).

In our study population, feeling cold in the bedroom at night time was significantly associated with having upper respiratory tract infection symptoms, visiting a doctor and taking sick leave. A change in the room temperature at night time should be considered for those who feel cold at night time. Further studies are needed to determine if changing the temperature of the bedroom so the person does not feel cold at night time will result in fewer episodes of upper respiratory tract infections or not. Further studies measuring the temperature of the bedroom at night would be helpful to further clarify the optimal temperature needed to reduce the incidence of upper respiratory tract infection symptoms in the study population.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflicts of interest.

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