RESPIRATORY SYMPTOMS IN RELATION TO HOME AIR CONDITIONING AMONG OFFICE WORKERS IN MALÉ, MALDIVES

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ABSTRACT: This was a cross-sectional study aimed to find out the associations of home air conditioning (home AC) with respiratory symptom and illness prevalence among adults residing in Malé, Maldives. Data were collected during March 2010 using a self administered questionnaire at participants' offices. Out of the 498 questionnaires distributed 353 questionnaires were returned, resulting in a 70.9% response rate. Symptom and illness prevalences were the outcome variables in this study (total 11 outcomes). In multiple logistic regression models, prevalences of cough, phlegm, and doctor-diagnosed sinus trouble were positively associated with presence of home AC. Respectively, these associations were statistically significant (p=0.030), marginally significant (p=0.054), and non-significant (p=0.292). The other 8 types of prevalence were not appreciably associated with presence of home AC. Home dampness was a stronger respiratory risk factor than was home AC. Further research is needed to characterize risks of home AC in Malé and elsewhere, and to describe biological mechanisms through which home AC exerts respiratory risk.
Keywords: Indoor Air Quality, air conditioning, respiratory symptoms, Malé

INTRODUCTION: Indoor air quality (IAQ) is one of the major public health concerns worldwide[1]. As people spend most of their time indoors in homes, offices, schools, health care centers or other buildings, the quality of the air they breathe indoors is very important for their health and well being[1]. Proper ventilation can help improve the indoor air quality by controlling humidity and airborne contaminants, both of which can act as health hazards[1].

Air-conditioning systems are increasingly in use in hot, tropical countries to promote thermal comfort and IAQ for residents and workers[2]. Few studies have compared the people living as well as working in buildings with Heating Ventilation and Air conditioning (HVAC) systems and natural ventilation. The major complaints the researchers found in association with HVAC are rhinitis, sinusitis, allergic wheeze, cough, and breathlessness[1].

Malé is the capital of Maldives where approximately 80,000 people live. Average temperatures vary throughout the year between 25oC and 32oC and the humidity ranges from 73-85%. Almost all the office buildings and around 40% of the homes in Malé according to the 2006 census are air conditioned[3]. To the best of my knowledge, this issue has not been studied previously in Maldives.

The aim of this study was to evaluate whether respiratory symptoms, among the office workers are associated with air conditioning in homes and offices. Other potential respiratory risk factors, such as presence of home dampness and smoking, were also assessed.

MATERIALS AND METHODS: This study was a cross-sectional study done among the office workers in Malé, the capital city of Maldives. The data for this study was collected at government and private-sector offices.

Stratified random sampling was used. The office buildings were stratified into two sub-groups, private and government buildings. Out of 30 buildings, 6 buildings were randomly selected from each sector. The floors of a building varied from 4 to 8 and the number or workers in a floor varied from 20-70 One floor from each building was then selected randomly, and all the workers in the selected floor were chosen as the study participants. Basement and ground floor of the all the buildings selected were excluded.

Study participants who were men and women from 20 to 60 years old, who worked at the office for at least 8 hours a day. A total of 353 persons participated in the study. A self-

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administered questionnaire was developed from respiratory symptom questionnaires which have been widely used previously, especially the American Thoracic Society standardized questionnaire4). The questions were directed toward gaining information about socio-demographic characteristics, home environment, workplace characteristics and symptom and illness prevalences.

Data were processed and analyzed using SPSS version 16 for windows. Descriptive statistics including frequency and percentage were used primarily to summarize the 25 independent variables and 11 dependent variables. Associations were tested first with bivariate analysis of each outcome in relation to each independent variable. Multiple logistic models were then constructed for outcomes for which $p \leq 0.15$ for home AC in bivariate analysis. For each such outcome, a semi-final logistic model included all independent variables for which $p \leq 0.15$ in bivariate analysis. Final logistic regression models were then constructed, which included home AC and all other independent variables for which $p \leq 0.15$ in semi-final models. Statistical significance was assumed at $p \leq 0.05$ and marginal significance at p value between 0.05 and 0.10.

RESULTS: The response rate from the government sector was 79.28% (275/498) and from the private sector 60.54% (223/498). The questionnaire response rate for this study was therefore 70.88%. The mean age was 31.2 years (SD = 8.2). Majority (58.9%) of the participants were females. Among all participants, 47% of people lived in an air-conditioned home while 51% lived in a naturally or ventilated home. All the office buildings selected had air conditioning, so it was not possible to test effects of office air conditioning on respiratory symptom and illness prevalence.

Bivariate symptom prevalences in relation to the presence of home air conditioning are presented in Table 1. Out of the 11 outcome variables, cough with or without colds (55.4%), phlegm with or without colds (35.2%) and doctor-diagnosed sinus trouble (39.2%) were positively and statistically significantly associated with presence of home AC. Multiple logistic regression models were constructed for these 3 outcomes.

Table 1: Frequencies and percentages of symptoms in relation to presence of home air conditioning

Symptom	Home AC status				Bivariate p-value
	Yes		No		
	Count	%	Count	%	
Cough with or without colds	92	55.4	74	41.1	0.008
Phlegm with or without colds	58	35.2	44	24.4	0.029
Wheeze with or without colds	51	30.7	53	29.6	0.822
Diagnosed asthma	15	9.1	16	8.9	0.961
Shortness of breath	43	26.1	48	26.7	0.898
Absent from work	20	12.0	23	13.0	0.791
Rhinitis without cold	42	25.3	54	30.0	0.329
Watery/itchy eyes at home	39	23.5	52	28.9	0.255
Watery/itchy eyes in office	37	22.3	45	25.1	0.534
Diagnosed sinus trouble	65	39.2	52	28.9	0.044
Allergy to dust, food or medicine	84	50.9	83	46.4	0.400

Final logistic models are summarized in tables 2-4. Presence of home AC remained positively associated with all 3 outcomes. Its association with cough remained significant (p=0.030, table 2), its association with phlegm was marginally significant (p=0.054, table 3), and its association with sinus trouble was not significant (table 4).

Table 2: Cough with or without colds, final multiple logistic regression model. (χ^2 for model = 20.79, df = 5, p=0.001)

Variable	Modeled odds ratio	95% C.I.	p-value
Home AC (yes vs. no)	1.67	(1.05, 2.64)	0.030
Home dampness (yes vs. no)	1.73	(1.03, 2.90)	0.040
Household members (3 categories)			0.096
1-5 vs. >10	1.30	(0.67, 2.51)	0.434
6-10 vs. >10	0.71	(0.40, 1.28)	0.254
Others smoke at home (yes vs. no)	1.77	(1.10, 2.87)	0.020

Table 3: Phlegm with or without colds, final multiple logistic regression model. (x^2 for model = 14.98, df = 3, p=0.002)

Variable	Modeled odds ratio	95% C.I.	p-value
Home AC (yes vs. no)	1.61	(0.99, 2.61)	0.054
Home dampness (yes vs. no)	1.74	(1.03, 2.94)	0.038
Others smoke at home (yes vs. no)	1.75	(1.08, 2.85)	0.024

Table 4: Doctor-diagnosed sinus trouble, final multiple logistic regression model. (χ^2 for model = 28.48, df =7 , p<0.001).

Variable	Modeled odds ratio	95% C.I.	p-value
Home AC (yes vs. no)	1.28	(0.78, 2.10)	0.292
Age (years)	1.05	(1.01, 1.09)	0.019
Gender (male vs. female)	0.45	(0.27, 0.77)	0.003
No. of children (3 categories)			0.157
None vs. >1	1.74	(0.81, 3.76)	0.159
1 vs. >1	2.05	(0.98, 4.30)	0.057
Office floor covering (tiles vs. others)	0.44	(0.22, 0.89)	0.022
Dampness in office (yes vs. no)	1.83	(1.03, 3.24)	0.039

Similar bivariate and multiple logistic regression analyses were conducted for presence of home dampness (data not shown). There were 7 outcomes for which p≤0.15 in bivariate analysis for home AC and/or home dampness. Final logistic regression models for these outcomes are summarized in table 5. The table shows that home dampness was a stronger and more consistent respiratory risk factor than was home AC.

Table 5: Summary of final multiple logistic model results for home air conditioning and home dampness

	Home AC		Home dampness	
Outcome	Direction	p>0.05 ?	Direction	p>0.05 ?
Cough with or without colds	Positive	Yes	Positive	Yes
Phlegm with or without colds	Positive	Marginal	Positive	Yes
Wheeze with or without colds	NA*	NA*	Positive	Yes
Shortness of breath	NA*	NA*	Positive	No
Rhinitis	NA*	NA*	Positive	Yes
Eye irritation at home	NA*	NA*	Positive	Yes
Sinus trouble	Positive	No	NA*	NA*

*NA: Was not entered in multiple logistic regression model because p>0.15 in the bivariate analysis

DISCUSSIONS: This study suggests that home air conditioning is associated with elevated prevalences of respiratory symptoms. In this study 47% of the homes and 100% of the office buildings were air conditioned. Therefore, the researcher was not able to carry out a comparable comparison in the workplace. The symptom prevalences in this study show some consistency with other similar studies done in Brazil[1, 5, 6]. The intervention study done in Brazil, showed higher prevalences of symptoms before the intervention which decreased subtantially after the intervention[6].

Various studies in different parts of the world have reported relationships between home or workplace air conditioning and lower and upper respiratory symptoms, eye and skin symptoms, headache and other allergic symptoms. The rationale behind this is that moisture in the air conditioner allows the growth of microorganisms which spread in the indoor causing allergenic and toxic reactions among those who are exposed[7]. The people who have the history of allergies and respiratory symptoms are at more risk, however making the healthier people also at risk due to these hazardous exposures. Among the studied symptoms, cough with and without cold (p=0.008), phlegm with and without cold (p=0.029), and sinus trouble (p=0.044) was found to be significantly associated with home air conditioning in the bivariate analysis. The association of cough and sinusitis in response to AC was similar to the Brazil study[1]. However, unlike the Brazil study, sinus trouble did not show any significant association with home AC.

Wheezing and asthma did not show any significant association with air conditioning in this study. This is in accordance with the similar study done in Brazil[1]. Consistent with a US study, home air conditioning did not show any

significant association with being absent from work. The reason for this could be the strict monitoring of attendance in the government and private sectors. In contrast to this study, a cohort study done in France showed a higher prevalence in the sickness absence and medical visits due to the symptoms related to air conditioning[8].

There are several limitations in this study. The study will not be generalizable to the whole population of Maldives; due to the difference of the development status in the other inhabited islands. Use of self administered questionnaires can lead to bias and lead to lot of missing values which affects the result of the study. The respondents might have given over estimated or under estimated answers and there may be possible selection bias due to the refusal of some participants who might have complaints of the respiratory symptoms mentioned above. Also uncontrolled exposures in the work area (e.g. dust, chemicals, etc) might be a confounding factor, which might have changed the results.

In summary, this study suggested that home AC was a limited respiratory risk factor. Presence of home dampness was a stronger risk factor than was home AC. Further studies are needed to confirm the findings in this study, in order to give suggestions to the people that may allow the reduction of the symptoms. Removing AC is not a practical solution to reduce the exposures. However, suggestions of proper maintenance of AC systems may prevent indoor air pollution and hence reduce harmful exposures.

ACKNOWLEDGEMENT: I am grateful to the study participants, without whom this study would not have been possible.

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