Research Paper

Air Humidity in the Houses of Asthmatic Children in Mashhad, Northeast Iran

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Citation Moazzen N, Nateghi Rivashi M, Gaffari J, Khakzad MR, Rafrishi R, Ahanchian H. Air Humidity in the Houses of Asthmatic Children in Mashhad, Northeast Iran. Journal of Pediatrics Review. 2025; 13(3):263-268. http://dx.doi.org/10.32598/jpr.13.3.1171.1

http://dx.doi.org/10.32598/jpr.13.3.1171.1

Article info:
Received: 18 Feb 2025
First Revision: 25 Mar 2025
Accepted: 03 Apr 2025
Published: 01 Jul 2025

Key Words:
Children, Asthma, Humidity, House dust mite

ABSTRACT

Background: Considering the high prevalence of asthma in children and the role of indoor air humidity in the onset and exacerbation of asthma due to increased house dust mites and indoor molds, the optimal humidity range for houses with asthmatic individuals is 10 to 45%. This study was conducted to determine the indoor air humidity levels in the houses of asthmatic children living in Mashhad, northeast Iran.

Methods: This cross-sectional study was conducted from July 2018 to June 2019 at the Allergy Clinic of Akbar Children's Hospital, Mashhad, Iran. Sixty asthmatic children aged between 2 and 14 years were enrolled in the study. All patients who met the eligibility criteria were asked to place a device for humidity measurement in different rooms, including the bedroom, kitchen, and living room.

Results: Sixty patients were recruited in this study. The mean age was 6.83±3.0 years (ranging from 2 to 14 years), with forty-one male patients (68.3%). The mean age of the buildings was 14.8±17.5 years. The mean air humidity levels were 34.4±7.4% in the living room, 36±8% in the bedroom, and 36.1±8.1% in the kitchen. Thirty-nine percent of the participants used air humidifiers, with most of them using cool mist-producing devices.

Conclusions: Air humidity in Mashhad was within the optimal range for asthmatic patients. According to our study, most asthmatic patients with air humidity levels exceeding 50 percent were using air humidifiers. It seems parents should be educated on the fact that using humidifiers, especially in the bedroom, may worsen asthma control.

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Introduction

Asthma is a chronic inflammatory airway disease that can be induced by environmental exposure in a susceptible host. Viral infections, allergens, tobacco smoke, and air pollution cause pathogenic inflammation and aberrant repair in premature airways [1, 2]. Exposure to indoor allergens in sensitized patients can induce hypersensitivity to other allergens and irritants, subsequently increasing disease severity and persistence. The elimination of such allergens can improve asthma control [3, 4].

One of the most important indoor allergens is the house dust mite. This allergen increases in old houses with dampness problems, wall-to-wall carpets, a lack of air exchange, and sometimes excessive use of humidifiers [5]. Humidifiers increase air humidity and may elevate two main allergens, including house dust mites and indoor fungi. An increase in house dust mites and fungi can occur due to water leakage or any other situation that raises humidity levels. Additionally, carpeting can serve as a reservoir for mites, fungi, and animal dander. Their effects on airway inflammation can vary in different rooms of the house, with the bedroom being the most significant. Other contributing factors to indoor allergens concentrations include the infrastructure area, number of rooms, window accessibility, heating tools, carpeting, frequency of washing bed covers, use of special dust mite covers for pillows and mattresses, and any habitual activities or hobbies that can increase allergens, such as weaving carpets, painting, woodcarving, etc. [6, 7].

There is no information regarding humidity in asthmatic houses in Mashhad, Northeast of Iran. In this study, we investigated air humidity in the rooms of asthmatic children living in Mashhad.

Methods

This cross-sectional study was conducted between July 2018 and June 2019 at the Allergy Clinic of Akbar Hospital, Mashhad, Iran. Sixty individuals aged between 2 and 14 years with asthma were enrolled in the study. At baseline, patients signed informed consent. Their asthma was confirmed with history and physical examination, and if possible, with pulmonary function tests conducted by an allergist-clinical immunologist according to GINA guidelines. All patients who met the eligibility criteria were asked to place a device for humidity measurement in their rooms, including the bedroom, kitchen, and living room. A checklist was filled out for every asthmatic patient, and demographic information, asthma severity, symptom control, maintenance medications, and additional information about the buildings they lived in were collected.

Results

Sixty patients were recruited in this study. Their mean age was 6.83±3 years (min-max: 2-14), and 41 patients were male (68.3%) (Table 1).

We evaluated asthma severity before the study; forty participants had mild persistent asthma according to the EPR-3 classification (Table 2).

The mean age of the buildings was 14.8±17.5 years. Twenty-three patients (39%) were using air humidifiers, with most of them (60.9%) utilizing cool mist-producing devices. The mean duration of using air humidifiers was 2.5±2.8 years. The characteristics of home furniture are provided in Table 3.

The heating systems of the houses were as follows: Heater (68.3%), boiler (21.7%), and other (10%). Using the chi-square test, there was no significant correlation between household characteristics, use of humidifiers, pet ownership, and asthma severity (Table 4).

The mean humidity in the living room was 34.5±7.4% (range: 19-56). In three patients' houses, humidity was above 50%, and none of them were using a humidifier. The mean humidity in the bedroom was 36±8% (range: 20-60). In eleven participants, humidity exceeded 50%, of which four patients were using air humidifiers. The mean humidity in the kitchens was 36.6±8.1% (range: 15-55), and it was above 50% in five asthmatic participants, three of whom were using air humidifiers (Figure 1).

Because other variables, like humidity in bedroom and living room, birth weight, and duration of breastfeeding, showed no normal distribution, we used the Kruskal-Wallis test to evaluate the correlation between asthma severity and these variables; however, no significant correlation was found (P>0.05; Table 5).

The mean humidity in the kitchens of participants using air humidifiers was 63.5±9.5%, while in those who did not use humidifiers, it was 63.9±7.4%. There was no significant difference between these groups according to the t-test (P=0.86).

Table 1. The participants' baseline characteristics

Parameters	No. (%)/Mean±SD
Sex (male/female)	41/19
Age (y)	6.88±3
Birth weight (g)	3000±937
Breastfeeding duration (m)	21.8±4.3
Symptom duration (y)	3.93±1.4
Allergic rhinitis	42(73.7)
Family history of asthma	32(55.2)

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Table 2. Asthma severity according to EPR-3 classification

Asthma Severity	No. (%)
Mild intermittent asthma	8(13.3)
Mild persistent asthma	40(66.7)
Moderate persistent asthma	10(16.7)
Severe persistent asthma	2(3.3)

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Table 3. Characteristics of furniture in houses of asthmatic children

Characteristics	No. (%)
Wooden furniture	59(98.3)
Wool carpet	13(21.7)
Pet	7(11.7)
Planting at home	31(51.7)

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Using the Mann-Whitney U test, there was no significant correlation between humidity in the living room (P=0.35) or bedroom (P=0.19) and the use of air humidifiers.

Discussion

This study assessed air humidity in asthmatic children's rooms and showed that air humidity in the living room was 34.4%, in the bedroom was 36%, and in the kitchen was 36.1%.

The optimal humidity level for asthmatic patients is between 10 to 45 percent. Humidity levels exceeding 50% can elevate the levels of house dust mites and indoor molds, such as *Aspergillus* [8, 9]. Conversely, low humidity levels below 10 percent can trigger bronchoconstriction [10, 11]. We showed that in Mashhad City, the humidity is within the optimal range, and there is no need to recommend the use of humidifiers, which, unfortunately, is common advice (Figure 1). In our study, 39% were using air humidifiers, with most of them using cool mist-producing devices.

The most common species of mites, *Dermatophagoides farinae*, grows optimally at 70–75% relative humidity (RH) and 23–30 ˚C [4, 5]. Since the critical humidity for the survival of mites ranges from 40 to 45% RH, the installation of systems to reduce indoor humidity has

Table 4. Household characteristics and asthma severity

Characteristics		Asthma Severity				P
		Step 1	Step 2	Step 3	Step 4	
Sex (M/F)		4/4	29/11	7/3	1/1	0.596
Using wooden furniture (yes/no)		8/0	39/1	10/0	2/0	0.917
Keeping pets in the house (yes/no)		0/8	4/36	3/7	0/2	0.196
Wool carpet in the house (yes/no)		3/5	10/30	0/10	0/2	0.19
Planting at home (yes/no)		4/4	19/21	6/4	2/2	0.487
Using air humidifiers (yes/no)		4/4	14/25	4/6	1/1	0.88
Home heating system	Boiler Gas heater Others	2 5 1	9 26 5	2 8 0	0 2 0	0.857
Residency floor	Basement Other floors	1 7	8 32	3 6	1 1	0.552

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Table 5. Correlation between asthma severity and air humidity in the living room and bedroom

Humidity	Chi-square Test	Confidence Intervals (CI)	P (Kruskal-Wallis Test)
Living room	0.92	3	0.82
Bedroom	0.74		0.86

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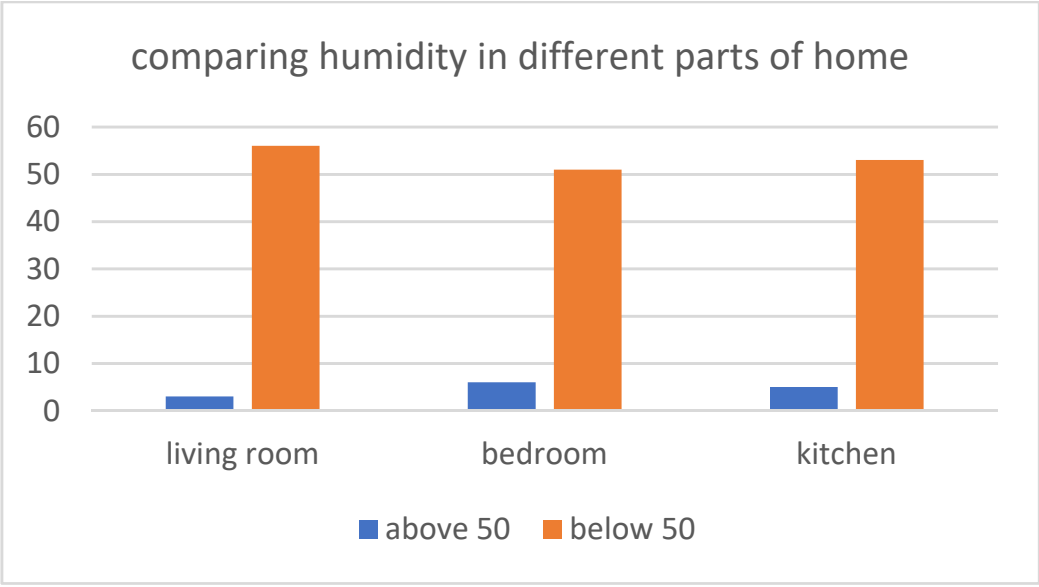

Figure 1. Humidity in the living rooms, bedrooms, and kitchens of asthmatic children

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been suggested as a method for controlling house dust mite populations [12].

There is an association between inducing asthma in young children aged 1-6 years old and harmful levels of humidity in the home. Identifying the relationship between humidity and asthma induction or triggering bronchoconstriction can lead to better asthma control and fewer exacerbations. This can result in lower costs and improved quality of life [3].

A study from Massachusetts, the northeastern U.S., showed that the major mite allergen Der f 1 concentration in dust from the main living area was significantly increased in houses with lower living area temperatures, in the presence of cloth-upholstered furniture, in houses without air conditioning, in older houses, in houses with electric heating, in houses with more than seven rooms, and in houses compared to apartments. Surprisingly, humidifiers were used in 59% of these houses [13].

In another study in Poland, factors such as free-standing buildings, the presence of flowers, employed housewives, typical beds (with mattresses), carpeted floors, higher levels (floors I-IX), PVC windows, pillows, higher cleaning frequency (times per week), and signs of dampness were significantly associated with rhinitis, atopic dermatitis, and higher IgE levels for both *Dermatophagoides pteronyssinus* and *D. farinae* [12].

We evaluated asthma severity before the study; 40 participants had mild persistent asthma according to EPR-3 classification (Table 2). The chi-square test showed no significant correlation between household characteristics, using humidifiers, and keeping pets and asthma severity (Table 4).

Considering the available evidence, adult in most countries spend most of their time in their houses or other buildings. We can conclude that indoor air quality has a significant impact on health, particularly on the respiratory system [14]. While older buildings may have various problems with heating and cooling systems, water leakage, and other interior appliances, air quality can be adversely affected by these issues. Additionally, the construction materials used in older buildings may be harmful [14, 15]. However, there were no statistically significant differences between home characteristics and asthma severity in our study (Tables 3 and 4). This may be due to the relatively new construction of the buildings included in the study.

Air humidity should be measured across different seasons. The results of our study would likely be more valuable if the mean air humidity were evaluated in all seasons or if there were an investigation of the relationship between outside humidity and inside humidity.

Conclusion

The humidity in the different rooms of asthmatic children living in Mashhad is within the optimal range for asthmatics, indicating that there is no need for the use of air humidifiers. Using these devices may increase humidity beyond 50%, thereby raising the level of indoor allergens.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Local Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflicts of interest

The authors declared no conflict of interest.

Acknowledgements

The authors appreciate the corporation of the participants.

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