Research Paper:

House Dust Mite Allergen Levels of Der p1 and Der f1 in Houses of Asthmatic Children

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Citation Dabbaghzadeh A, Ghaffari J, Feridoni M, Alipour A. House Dust Mite Allergen Levels of Der p1 and Der f1 in Houses of Asthmatic Children. Journal of Pediatrics Review. 2020; 8(4):267-274. http://dx.doi.org/10.32598/jpr.8.4.28.13

http://dx.doi.org/10.32598/jpr.8.4.28.13

Article info:
Received: 11 Jan 2020
First Revision: 25 Jan 2020
Accepted: 05 Apr 2020
Published: 01 October 2020

Keywords:
Dermatophagoides farinae, Dermatophagoides pteronyssinus, Asthmatic patients, House dust mite, Pediatrics

ABSTRACT

Background: Exposure to house dust mites is an important cause of asthma among children. The main asthma-causing mites found in homes are Dermatophagoides farinae and Dermatophagoides. pteronyssinus. Der f1 or Der p1 are allergens of the mentioned mites. This study aimed to assess the levels of Der p1, and Der f1 in the homes of families that had a case of childhood asthma in a northern city of Iran and to determine the association between indoor house environment and the level of mites allergens present there.

Objectives: This study aimed to evaluate House Dust Mite Allergen Levels of Der p1 and Der f1 in Houses of Asthmatic Children.

Methods: Dust samples were collected from bedrooms of 91 homes of families that had cases of childhood asthma. Families filled a questionnaire about demographical characteristics and the indoor condition of their living environment. The levels of Der f1 and Der p1 were measured by enzyme-linked immunosorbent assay (ELISA). Statistical analysis was performed in SPSS v. 24 and a P-value less than 0.05 was considered significant.

Results: we found that Der p1 was more prevalent than Der f1 among samples. The mean concentration of Der p1 concentration was 271.35 ng/g (9 times greater than the concentration of Der f1). When the indoor environment status was evaluated, it was found that keeping pets and having old carpets are associated with Der f1 ($P<0.05$). However, no significant association was found between Der p1 and the indoor conditions of the home.

Conclusions: Our study showed that Der p1 level is higher than Der f1 level in the houses of children with asthma. We suggest removing carpets and pets from the house.

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1. Introduction

Asthma is a chronic inflammatory disease of the respiratory tract that has a higher incidence in children (1-3). Asthma creates a high burden for the families and the country health system (4). The exact cause of asthma is unknown, but genetic and environmental factors play a role (5, 6). Environmental factors include irritants; indoor and outdoor allergens play a key role in the development and stimulation of asthma symptoms (7). Exposure to indoor allergens is one of the main reasons for respiratory disease development among those with a genetic predisposition (8). The most important sources of indoor allergens include mites, pets, molds, and cockroaches (9).

Mites are eight-legged animals that are classified in the arachnid class. They can induce atopy through provoking IgE-mediated reactions (10). The main house dust mites include Dermatophagoides pteronyssinus, Dermatophagoides farinae, and Euroglyphus maynei. Der p1 and Der f1 are the two dominant house dust mite allergens belonging to Dermatophagoides pteronyssinus, and Dermatophagoides farinae, respectively (11). These allergens are structurally made up of cysteine proteases (12). The strong protease activity of these allergens is responsible for the pathophysiology of respiratory disease development (13).

Studies show that symptoms in asthmatic patients are correlated with dust mite allergen levels. Symptoms in asthmatic patients worsen after exposure to dust mites but improve by providing a mite-free environment (14-16). Therefore, conducting a study on mite prevalence and their associated risk factors can help control asthma and improve its symptoms. This study aimed at determining the prevalence of the two main dominant house dust mite allergens (Der p1 and Der f1) and their association with indoor conditions among families that had a case of childhood asthma in Sari City in northern Iran (Table 1).

2. Materials and Method

This study was conducted on 91 patients aged 3 to 18 years with childhood asthma and positive skin test for mites. The sample size was estimated according to Cazzoletti`s study (17). These patients were selected from Buali Sina Hospital outpatient clinic affiliated to Mazandaran University of Medical Sciences in the early spring of 2018. The diagnosis of childhood asthma was established by an allergist and clinical immunologist based on the global initiative for asthma (GINA) criteria (18).

Prick skin test was performed for all patients and only those with a positive result of House Dust Mite (Der P and Der F) were included. Those who were sensitive to non-mite allergens or received invasive therapeutically intervention were excluded from the study.

A house environment questionnaire was filled for each family to obtain information about the type of dwelling, age and type of carpets, education status of the patients and parents, heating and cooling system, sweeping/vacuuming methods, family history of allergic diseases, use of beds with pillows and blanket, use of lint dolls, using asthma drugs, having individual rooms, number of family members, drying the bedsheets under sun exposure, duration between each bed sheet change and duration between each time of house cleaning.

During the spring of 2018, dust samples were collected from each child's bedroom. One week before the sample collection, families were asked not to clean the bedrooms. The house dust allergens were extracted according to the previous protocol, published by Fereidouni (19).

The concentration of Der p1 and Der f1 were determined by enzyme-linked immunosorbent assay (ELISA) kits (Indoor Biotechnologies, Charlottesville, USA) according to the manufacturer's instructions. The levels of Der p1 and Der f1 were expressed as ng/g (Table 2).

The results were expressed as the Mean±SD. The Kolmogorov-Smirnov test was used to evaluate the normal distribution of the data. For the variables with the normal distribution, the t test and the Pearson test were applied to evaluate the correlation. The Mann-Whitney U test and Spearman were used for those variables with non-normal distribution. $P<0.05$ was considered statistically significant. All analysis was performed in SPSS v. 16.0 (SPSS, Chicago, IL, USA).

3. Results

Among 91 samples, 4 samples were excluded due to insufficient mass, and 87 were eligible for experimental procedures; the mean age of the children was 7.56 years. Most of the children had their own private bedrooms and were not allowed to keep pets in their houses. The results showed that patients changed their bed sheets every 30 days and cleaned their houses every 1.44 days.

4. Discussion

The results showed that the prevalence of Der p1 was higher than Der f1. A significant correlation was found

Table 1. The association between the mean concentration of Der p1 and Der f1 with indoor conditions

Variables		No. (%)	Mean±SD	
			Der f1	Der p1
Gender	Male	45 (51.7)	43.91±201.62	167.30±334.30
	Female	42 (48.3)	2.25±112.50	385.53±1295.80
	P value		0.67	0.60
Education status	Lower than diploma	50 (57.5)	19.84±103.21	378.33±1188.70
	Higher than diploma	37 (42.5)	52.22±21.49	122.86±272.15
	P		0.33	0.36
Type of dwelling	Apartment	53 (60.90)	53.25±208.24	295.33±1129.21
	house	34 (39.10)	2.4±10.3	234.27±492.18
	P		0.72	0.52
Type of carpets	Machine made	69 (79.30)	25.22±122.24	313.27±1032.12
	Hand made	18 (20.70)	65.17±273.28	111.53±258.75
	P		0.84	0.24
Vacuum cleaner	Electrical	74 (85.10)	38.81±177.62	297.01±1000.51
	Mechanical	13 (14.90)	3.80±12.53	127.07±245.15
	P		0.91	0.68
Cooling system	AC	72 (82.80)	29.81±160.41	138.91±276.36
	Fan	15 (17.20)	51.39±185.88	952.42±2147.15
	P		0.83	0.12
Heating system	Radiator	16 (18.40)	0.51±1.53	237.34±429.59
	Gas heater	71 (81.60)	41.08±181.19	279.16±1009.57
	P		0.49	0.43
Water used for washing bed sheets	Hot water	75 (86.20)	38.91±176.33	296.67±994.56
	Cold water	12 (13.80)	0.23±0.65	115.47±225.95
	P		0.45	0.94

Variables		No. (%)	Mean±SD	
			Der f1	Der p1
Having private rooms	Yes	65 (74.70)	33.17±168.98	291.56±1049.02
	No	22 (25.30)	34.96±152.80	212.65±418.85
	P		0.54	0.65
Drying bed sheets under sun exposure	Yes	72 (82.80)	396.95±1800.15	302.60±1010.43
	No	15 (17.20)	4.9412.98	110.61120.01
	P		0.82	0.22
Family history of asthma	Yes	71 (81.60)	41.01±181.11	312.67±1019.76
	No	16 (18.40)	0.60±1.67	90.51±221.50
	P		0.91	0.29
Using standard bed and pillows	Yes	70 (80.50)	38.61±182.03	321.04±1029.96
	No	17 (19.50)	12.96±36.66	69.74±87.96
	P		0.50	0.84
Presence of always boiling kettle and/or Samovar	Yes	32 (36.80)	2.26±8.62	148.85±290.37
	No	55 (63.20)	51.84±204.86	343.98±1147.04
	P		0.31	0.62
Using lint doll	Yes	7 (8)	0.41±1.21	372.57±612.59
	No	80 (92)	36.56±170.98	263.73±949.14
	P		0.51	0.33
Asthma drug consumption	yes	79 (90.80)	36.73±172.05	292.26±971.66
	No	8 (9.20)	3.108.74	67.6587.34
	P		0.99	0.72
Correct use of Mmedication	Yes	76 (87.40)	38.00±175.30	302.06±989.06
	No	11 (12.60)	3.16±7.56	62.01130.22
	P		0.11	0.15
Keeping pets	Yes	6 (6.90)	20.84±25.46	314.35±748.16
	No	81 (93.10	34.53±170.01	268.15±943.36
	P		0.006	0.53

Table 2. The association between mean values of indoor condition and concentration of mites

Variables	Mean±SD	Der f1	Der p1
Age of the patients	7.56±3.38	r=-0.03 P=0.76	r=0.09 P=0.39
Age of the carpets	4.37±2.75	r=0.21 P=0.04	r=0.03- P=0.75
Number of family members	3.75±0.78	r=0.11- P=0.28	r=-0.12 P=0.26
Duration between each bed sheets change (d)	30.39±12.05	r=0.14 P=0.18	r=-0.07 P=0.48
Duration between each time of house cleaning (wk)	1.44±0.80	r=-0.12 P=0.26	r=-0.18 P=0.08

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between Der f1 and some indoor conditions such as pets and old carpets. The age of the carpets correlated with Der f1; meaning that the older carpets the higher amount of Der f1. Keeping pets was also significantly associated with Der f1 concentration; therefore, families who kept pets in their houses had a higher concentration of Der f1.

Moghtaderi et al. conducted their study on the prevalence of mite allergen among asthmatic children in Shiraz, showing that Der f1 level was higher in comparison to Der p1 (20). Ferreidoni et al. also confirmed their results (19). Other studies conducted in humid climates such as India (21), China (22), Spain (23), and Turkey (24) showed that Der p1 level was higher in these countries. On the other hand, Der f1 level was higher in regions with hot and dry climates such as Shiraz City, Iran (20), and Pakistan (25). According to the hypothesis explained in previous studies, Der p1 is more potent to grow in humid climates like Sari (20-24). However further studies are needed to confirm this hypothesis. In previous studies with the skin prick test in allergic patients in this area, the prevalence of D. farinae and D. pteronyssinus was equal (7, 26, 27).

Previous studies showed that the optimum temperature for mite growth is between 20°C to 30°C and the moisture content should be higher than 60%. In other words, mite concentration increase with higher moisture (22, 27, 28). Sari City has an optimum climate for mite growth. However reports from Kuwait (29), southeastern Iran (30), and Pakistan (25) showed that mites can be found in dry climates, too. However, the concentration of mites in hot and dry climates were lower in comparison to wet and moderate climates. For example, Moghtaderi et al. (20) showed that the concentrations of Der p1 and Der f1 were respectively 3.7 ng/g and 16.9 ng/g in Shiraz, a city with a dry climate. However, our results were 271.35 ng/g and 33.64 ng/g for Der p1 and Der f1, respectively. The concentrations of Der p1 and Der f1 were 11900 ng/g and 1500 ng/g in Spain respectively (23) which were dramatically higher in comparison to Shiraz and our study, due to its higher humidity.

In a similar study conducted by Fereidouni et al. (19) in seven cities throughout Iran in 2012, the levels of Der f1 and Der p1 were 2873 ng/g and 252 ng/g, respectively. Although the results of this study were near to our results as it was in the same region like ours, there was still a significant difference between the two studies. This can be attributed to 3 reasons. First, Fereidouni's study was conducted in late summer, but ours was in done early spring when the mites had not started their growth cycle (31). Second, we conducted our study on asthmatic patients who were educated to clean their houses to prevent mite growth. However, the Fereidouni study was conducted on the normal population. The third reason can be attributed to a drop in humidity as a result of recent droughts which have influenced the moister content of the air and as a result the mite growth cycle. Climate changes have resulted in new trends in mite growth (32).

Studies have shown that house cleaning plays a vital role in reducing mite concentration. Marks et al. (33) showed that cleaning furniture with tannic acid/acaricidal spray and using an impenetrable cover on the pillows significantly reduced mite concentration. Nevertheless, mite levels returned to their base concentration after

three months; so regular cleaning is necessary to avoid a high concentration of mites. However, our study did not show a significant correlation with a duration between each time of house cleaning and concentration of mites.

This may be attributed to the short follow-up of our study. A larger study with a long-term follow-up duration may be needed to confirm these results. Our study showed that regular cleaning of the carpets was not sufficient to avoid mite growth; however, the age of the carpets was significantly associated with Der f1 levels. This may be due to the presence of allergens in the carpets which cannot be removed by ordinary vacuum cleaning.

Arbes et al. (34) showed a significant relationship between family income and mite levels. Also, they showed that higher educational status was associated with a lower concentration of mites which was contradictory to our results. Besides, they showed that the use of a dehumidifier could significantly reduce mite growth following the reduction in air moisture content. However, our study showed no significant association between mite concentration and the presence of always boiling kettle and/or Samovar. This may be due to the low production of water vapor.

On the contrary, Arbes showed that the use of a radiator was more effective in increasing the mite concentration (P=0.001). In addition, no significant relationship was found between keeping pets and mite concentration. Contradictory to our findings, Demirtas et al. (8) reported that keeping pets had no significant effect on mite concentration. This could be attributed to different cultures of animal care between Iran and other countries. This finding was dramatically different from other studies and may be attributed to the small sample size of the study or location of the study. To confirm these results designing a study with a larger sample size and longer follow-up duration is recommended. Our comparison between an asthmatic population and the normal population can be useful in determining indoor risk factors.

5. Conclusion

Our study revealed that Der p1 was higher than Der f1. Also, there was a significant association between Der f1 with older carpets and the keeping pets. Therefore, removing pets and carpets is the best way to decreasing Der f1. Finally, if you do not remove the carpet and pets, regular cleaning and rinsing are the second-best options.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles were observed in this article, and all patients signed an informed consent form.

Funding

This research was performed by funding support of the Deputy of Research and Technology of Mazandaran University of Medical Sciences (Code: IR.MAZUMS.1397.1558.REC). All patients signed an informed consent form.

Authors contributions

All authors contributed in preparing this article.

Conflicts of interest

The authors declared no conflict of interest.

Acknowledgements

The authors would like to thank the Deputy of Research and Technology of Mazandaran University of Medical Sciences for financial support.

References

1. Ghaffari J, Aarabi M. The prevalence of pediatric asthma in the Islamic Republic of Iran: A systematic review and meta-analysis. Journal of Pediatrics Review. 2013; 1(1):2-11. http://jpr.mazums.ac.ir/article-1-31-en.html

2. Zamanfar D, Gaffari J, Behzadnia S, Yazdani-Charati J, Tavakoli S. The prevalence of allergic rhinitis, eczema and asthma in students of guidance schools in Mazandaran Province, Iran. Open Access Macedonian Journal of Medical Science. 2016; 4(4):619-23. [DOI:10.3889/oamjms.2016.112] [PMID] [PMCID]

3. Ghaffari J. Prevalence of asthma, allergic rhinitis and eczema in elementary schools in Sari (Iran). Caspian Journal of Internal Medicine. 2012; 3(1):372-6. [PMID] [PMCID]

4. Ghaffari J, Hadian A, Daneshpoor SMM, Khademloo. Asthma burden in the hospitalized patients in North of Iran. International Journal of Pediatrics. 2014; 2(4.1):257-66. [DOI:10.22038/IJP.2014.3250]

5. Hatami H, Ghaffari N, Ghaffari J, Rafatpanah H. Role of cytokines and chemokines in the outcome of children with severe asthma. Journal of Pediatrics Review. 2019; 7(1):17-28. [DOI:10.32598/jpr.7.1.17]

6. Kardan M, Ghaffari J, Valadan R, Rafiei A, Soltani M, Aghajani M et al. [T-bet and GATA-3 gene expression in children with allergic asthma and healthy controls (Persian)]. Journal of Mazandaran University of Medical Sciences. 2017; 26(146):9-21. http://jmums.mazums.ac.ir/article-1-9632-en.html

7. Ghaffari J, Khademloo M, Saffar MJ, Rafiei A, Masiha F. Hypersensitivity to house dust mite and cockroach is the most common allergy in north of Iran. Iranian Journal of Immunology. 2010; 7(4):234-9. [PMID]

8. Demirtaş N, Ceylan E, Kirdar S, Karadag F, Çildag O. The effect of indoor environmental characteristics on the detection of house dust mite der p2 and der f2 in asthmatics. Meandros Medical And Dental Journal. 2016; 17(3):129-37. [DOI:10.4274/meandros.2668]

9. Chabra R, Gupta M. Asthma, allergic and environmental. StatPearls. Treasure Island [Internet]. [Update: August 10, 2020]. StatPearls Publishing StatPearls Publishing LLC.; 2018. Available at: www.ncbi.nlm.nih.gov › books › NBK526018

10. Miller JD. The role of dust mites in allergy. Clinical Reviews in Allergy & Immunology. 2019; 57(3):312-29. [DOI:10.1007/s12016-018-8693-0] [PMID]

11. Fereidouni M, Fereidouni F, Hadian M, Asghari Z, Zojaji SM. The level of mite dermatophagoides' allergens (Der-p 1 and Der-f 1) in Birjand. Zahedan Journal of Research in Medical Sciences. 2014; 16(4):38-40. https://sites.kowsarpub.com/zjrms/articles/1637.html

12. Pomés A, Davies JM, Gadermaier G, Hilger C, Holzhauser T, Lidholm J, et al. WHO/IUIS Allergen Nomenclature: Providing a common language. Molecular Immunology. 2018; 100:3-13. [DOI:10.1016/j.molimm.2018.03.003] [PMID] [PMCID]

13. Reithofer M, Jahn-Schmid B. Allergens with protease activity from house dust mites. International Journal of Molecular Sciences. 2017; 18(7):1368. [DOI:10.3390/ijms18071368] [PMID] [PMCID]

14. Platts-Mills TAE, Mitchell EB, Nock P, Tovey ER, Moszoro H, Wilkins SR. Reduction of bronchial hyperreactivity during prolonged allergen avoidance. The Lancet. 1982; 320(8300):675-8. [DOI:10.1016/S0140-6736(82)90709-7]

15. Chan-Yeung M, Manfreda J, Dimich-Ward H, Lam J, Ferguson A, Warren P, et al. Mite and cat allergen levels in homes and severity of asthma. American Journal of Respiratory and Critical Care Medicine. 1995; 152(6 Pt 1):1805-11. [DOI:10.1164/ajrccm.152.6.8520740] [PMID]

16. van der Heide S, De Monchy JG, De Vries K, Dubois AE, Kauffman HF. Seasonal differences in airway hyperresponsiveness in asthmatic patients: Relationship with allergen exposure and sensitization to house dust mites. Clinical & Experimental Allergy. 1997; 27(6):627-33. [DOI:10.1046/j.1365-2222.1997.d01-554.x] [PMID]

17. Cazzoletti L, Marcon A, Corsico A, Janson C, Jarvis D, Pin I, et al. Asthma severity according to Global Initiative for Asthma and its determinants: An international study. International Archives of Allergy and Immunology. 2010; 151(1):70-9. [DOI:10.1159/000232572] [PMID]

18. Global Initiative for Asthma. 2020 GINA report, global strategy for asthma management and prevention [Internet]. 2018. Available from: https://ginasthma.org/gina-reports/#:~:text=2020%20GINA%20Report%2C%20Global%20Strategy,on%20the%20GINA%20Science%20Committee.

19. Fereidouni M, Fereidouni F, Hadian M, Nourani Hasankiadeh S, Mazandarani M, Ziaee M. Evaluation of the level of house dust mite allergens, Der p 1 and Der f 1 in Iranian homes: A nationwide study. Allergologia et Immunopathologia. 2013; 41(6):381-6. [DOI:10.1016/j.aller.2012.10.013] [PMID]

20. Moghtaderi M, Farjadian S, Fereidouni M, Nasiri M, Nejat A. Indoor dust allergen levels in the homes of patients with childhood asthma: An experience from Southwestern Iran. Iranian Journal of Allergy, Asthma and Immunology. 2016; 15(2):132-7. [PMID]

21. Saha GK. Dust allergy: Cause & concer: Indian perspectine. In: House dust mite allergy-indian perspective. Singapore: Springer; 2016. p. 53-63. https://books.google.com/books?id=IpTNDAAAQBAJ&dq

22. Feng M, Sun W, Cheng X. Seasonal dynamics and distribution of house dust mites in China. BioScience Trends. 2009; 3(6):210-5. [PMID]

23. Boquete M, Iraola V, Fernández-Caldas E, Villaroel LA, Carballada FJ, de la Cuesta CG, et al. House dust mite species and allergen levels in Galicia, Spain: A cross-sectional, multicenter, comparative study. Journal of Investigational Allergology and Clinical Immunology. 2006; 16(3):169-76. [PMID]

24. Zeytun E, Doğan S, Özçiçek F, Ünver E. Sensitivity to house dust mites allergens in patients with allergic asthma in Erzincan Province, Turkey. Türkiye Parazitoloji Dergisi. 2017; 41(1):34-41. [DOI:10.5152/tpd.2017.5059] [PMID]

25. Shafique RH, Akhter S, Abbas S, Ismail M. Sensitivity to house dust mite allergens and prevalence of allergy-causing house dust mite species in Pothwar, Pakistan. Experimental and Applied Acarology. 2018; 74(4):415-26. [DOI:10.1007/s10493-018-0243-1] [PMID]

26. Ghaffari J, Rafatpanah H, Khalilian A, Nazari Z, Ghaffari R. [Skin prick test in asthmatic, allergic rhinitis and urticaria patients (Persian)]. 2011; 54(1):44-9. [DOI:10.22038/MJMS.2011.5362]

27. Arundel AV, Sterling EM, Biggin JH, Sterling TD. Indirect health effects of relative humidity in indoor environments. Environmental Health Perspectives. 1986; 65:351-61. [DOI:10.2307/3430203] [PMID] [PMCID]

28. Collins DA. A review on the factors affecting mite growth in stored grain commodities. Experimental and Applied Acarology. 2012; 56(3):191-208. [DOI:10.1007/s10493-012-9512-6] [PMID]

29. Gamal-Eddin FM, Aboul-Atta AM, Hamad MG, Eraki AS, Tubeileh FM. House dust mites in Kuwait: Preliminary pilot survey to shed some light on diagnosis and treatment of mite allergy. Journal of the Egyptian Society of Parasitology. 1985; 15(1):313-22. [PMID]

30. Khazaei H, Hashemi S, Aghamohammadi A, Farhoudi F, Rezaei N. The study of type 1 allergy prevalence among people of South-East of iran by skin prick test using common allergens. The Iranian Journal of Allergy, Asthma and Immunology. 2003; 2(3):165-8. https://ijaai.tums.ac.ir/index.php/ijaai/article/view/51

31. Hart BJA. Life cycle and reproduction of house-dust mites: Environmental factors influencing mite populations. Allergy. 1998; 3(48 Suppl):13-7. [DOI:10.1111/j.1398-9995.1998.tb04990.x] [PMID]

32. Chan AWM, Hon KL, Leung TF, Ho MHK, Rosa Duque JS, Lee TH. The effects of global warming on allergic diseases. Hong Kong Medical Journal. 2018; 24(3):277-84. [DOI:10.12809/hkmj177046]

33. Marks GB, Tovey ER, Green W, Shearer M, Salome CM, Woolcock A. House dust mite allergen avoidance: a randomized controlled trial of surface chemical treatment and encasement of bedding. Clinical & Experimental Allergy. 1994; 24(11):1078-83. [DOI:10.1111/j.1365-2222.1994.tb02746.x] [PMID]

34. Arbes SJ Jr, Cohn RD, Yin M, Muilenberg ML, Burge HA, Friedman W, et al. House dust mite allergen in US beds: Results from the first national survey of lead and allergens in housing. Journal of Allergy and Clinical Immunology. 2003; 111(2):408-14. [DOI:10.1067/mai.2003.16] [PMID]