Jurnal Kesehatan Lingkungan
Journal of Environmental Health
Vol. 17 No. 2
DOI: 10.20473/jkl.v17i2.2025.127-135
ISSN: 1829 - 7285 | E-ISSN: 2040 - 881X
Journal Home Page: https://e-journal.unair.ac.id/JKL
ORIGINAL RESEARCH Open Access

ASSOCIATION OF HOUSEHOLD ENVIRONMENT AND FAMILY HABITS WITH RESPIRATORY ALLERGY SYMPTOMS IN CHILDREN

Lilis Sulistyorini[1], Corie I Prasasti[1]*, Ririh Yudhastuti[1], Hasnur Z Arna[1]

[1]Department of Environmental Health, Faculty of Public Health, Universitas Airlangga, Surabaya 60115, Indonesia

Corresponding Author:
*) prasasti_corie@fkm.unair.ac.id

Article Info
Submitted : 7 November 2024
In reviewed : 25 November 2024
Accepted : 7 December 2024
Available Online : 30 April 2025

Keywords : *Family habits, Household environment, Respiratory allergy symptom*

Published by *Faculty of Public Health Universitas Airlangga*

Abstract

Introduction: *Respiratory allergy symptoms in children still pose challenges in Indonesia regions, including big cities such as Surabaya. Several studies have found a relationship between household environment and family habits. The study aimed to identify the relationship between household environment and family habits with the incidence of respiratory allergies in children.* ***Methods:*** *This study used a cross-sectional design and was conducted on children aged 5-15 years with respiratory problems in the past three months. A questionnaire adapted from the International Childhood Asthma and Allergy Research (ISAAC) was used to see the respiratory allergy symptoms occurring in children. For statistical tests, this study used the Chi-square test, Fisher exact test, and logistic regression.* ***Results and Discussion:*** *The data obtained showed a significant relationship between home furniture and building condition with respiratory allergy symptoms in children with OR values of 3.667 (CI: 1.068-12.586) and 3.747 (CI: 1.149-12.221), respectively. The use of air fresheners and insect repellent at home was also significantly related to respiratory allergy symptoms in children with OR values of 3.286 (CI: 1.063-10.152), and 4.200 (CI: 1.270-13.892), respectively.* ***Conclusion:*** *Household environment and family habits are associated with respiratory allergy symptoms in children. Household environment and family habits should be considered carefully, especially home furniture and building condition, also the habits of using fresheners and insect repellent should be avoided to prevent respiratory allergy symptoms in children. Conducting similar research and examination that involve larger samples to explore the cause-and-effect relationship between household environment and family habits with respiratory disease are very needed.*

INTRODUCTION

Allergy is a global health problem that is increasing in prevalence. Approximately 10-30% of the world's population currently suffers from allergic disorders, showing a significant increase temporally (1). Allergy prevalence is higher in preschool-aged children, with a higher incidence in developed countries compared to developing countries. This phenomenon reflects changes in lifestyle, environment, and genetic factors that influence people's predisposition to allergic reactions (2). Among the general population, respiratory allergies are extremely prevalent, particularly among youngsters. Studies and data indicate that the prevalence of respiratory allergies in children is still rising. This is concerning since it may affect the health and quality of life of children (3). According to the findings of the EuroPrevall-iFAAM (Integrated Approaches to Food Allergen and Allergy Risk Management) birth cohort study, 13.3% of 5,572 school-aged children aged 6–10 years had a diagnosis of allergic rhinitis (AR), 12.0% had eczema, 8.1% had asthma, and 7.0% had allergic multimorbidity, which is defined as having at least two allergic diseases concurrently. Given their ubiquity, it is likely that children with respiratory allergies also have additional underlying medical issues that call for more thorough care and close observation (4).

Cite this as :
Sulistyorini L, Prasasti CI, Yudhastuti R, Arna HZ. Association of Household Environment and Family Habits with Respiratory Allergy Symptoms in Children. *Jurnal Kesehatan Lingkungan*. 2025;17(2):127-135. https://doi.org/10.20473/jkl.v17i2.2025.127-135

The prevalence of allergic rhinitis in Indonesia is estimated to be around 10-20% with an average age of onset of 8-11 years (5). Based on a survey conducted by the Indonesian Ministry of Health (Kemenkes RI) in 2018, the prevalence of asthma in Indonesia was 2.4% (6). Based on the 2018 Basic Health Research, the highest prevalence of asthma in children is the age category 5-14 years, which is around 1.9% in 2018. Based on demographic data, asthma is more prevalent in children aged 3-14 years with asthma prevalence in 2011 of 3.81% and in 2013 it increased to 5.8% (7). Several school children in Surabaya showed the most common allergic diseases are asthma, rhinitis, food allergy, and atopic dermatitis or eczema (8). It was further known that a lower prevalence of asthma was found in suburban areas compared to urban areas (9).

Household environment significantly impacts children's respiratory allergies. Allergens may be present throughout the home, making it crucial to maintain a healthy environment. According to Kepmenkes No. 829 of 1999, a healthy home requires proper building materials, spatial arrangements, lighting, air quality, ventilation, pest control, safe water and food storage, waste management, and appropriate occupancy density (10). The rapid pace of modernization and urbanization has profoundly altered living conditions and lifestyles. Innovations in construction techniques, particularly the implementation of tighter building designs that restrict natural ventilation, along with the prevalent utilization of composite materials, have adversely affected indoor air quality. Research conducted under the China, Children, Homes, Health (CCHH) initiative has identified several environmental factors, including proximity to major roads and highways, the introduction of new furniture, dampness, and the presence of pests such as cockroaches and mosquitoes, as being associated with an elevated risk of asthma and rhinitis in children (11). According to several studies, building characteristics and exposure to the household environment such as house ownership, location, building area, construction period, total residential floor, floor and wall materials, distance from house to pollutant sources, home furnishings, and ventilation are associated with respiratory allergies in children (12–14) .

Research has indicated that both humidity and temperature also play critical roles in human health, specifically emphasizing their influence on respiratory conditions and the prevalence of allergens. Elevated global temperatures have the potential to significantly disrupt ecosystems and adversely affect human well-being. This is particularly pronounced in the context of respiratory illnesses, such as asthma, which may be exacerbated by changes in environmental conditions (15–16). As temperatures rise, the frequency and severity of respiratory disorders are likely to increase, thereby posing a substantial public health challenge. Numerous academic investigations have demonstrated that certain household practices, particularly the regular use of hygienic incense, mosquito coils, and air fresheners, are significantly associated with diminished lung function in children, as well as an increased incidence of respiratory diseases. Specifically, the habitual utilization of hygienic incense and mosquito coils has been shown to elevate the risk of developing asthma in children by a factor of 2.58 and to increase the likelihood of bronchitis by 1.42 times (17–19).

The most widely used types of insect repellent are insect coils and insect spray (20). Fragranced products, such as air fresheners, have been identified as significant sources of human exposure to volatile organic compounds (VOCs) and contribute to both indoor and urban outdoor air pollution. The health implications of these exposures are concerning, leading to a variety of issues such as respiratory difficulties, migraine headaches, exacerbated asthma, mucosal irritation, skin rashes, and neurological disorders (21). Additionally, the use of combustible insect repellents, like mosquito coils, has been linked to health problems including asthma, wheezing, rhinitis, and eczema. Allergic responses to these substances often affect the respiratory system, resulting in symptoms like persistent cough and difficulty breathing (22).

Estimates from the World Health Organization (WHO) indicate that around half of the world's children, approximately 700 million, have been exposed to environmental tobacco smoke (ETS), primarily in their homes (23). Similar to the harmful effects of air pollution, prenatal exposure to ETS is linked to an increased likelihood of respiratory issues in children. Children exposed to second-hand smoke face significantly increased risks of lower respiratory tract infections (LRTI), asthma, and diminished lung function (24). ETS exposure is linked to chronic bronchitis, frequent wheezing, and various respiratory symptoms, including cough, phlegm, and breathlessness (25). It is well-established that ETS plays a major role in increasing the incidence of both acute and chronic respiratory conditions among young children (26). Parental smoking, particularly that of mothers, is a common source of ETS exposure for children (27). Maternal smoking is particularly concerning, as mothers tend to smoke more in the home environment and spend more time with their children than other household

members, potentially amplifying the negative health impacts on their offspring during critical developmental stages (25).

The purpose of this study was to identify the relationship between household environment and family habits with the incidence of respiratory allergy symptoms in children.

METHODS

Ethics

The current research has been given ethical approval by the Health Research Ethics Committee, Faculty of Public Health, Universitas Airlangga No: 176/ EA/KEPK/2019.

Study Design

It was a cross-sectional study with a random sampling technique.

Settings of the Study

This study was conducted in Rungkut District, Surabaya, East Java Province, Indonesia. Rungkut District consists of 6 villages. The area of Rungkut is 21.02 km^2 with a total population of 123,757 people. The number of children aged 5-15 years is 10,869 (male) and 10,203 (female).

Eligibility Criteria

Respondents are households with children aged 5 to 15 years who have experienced respiratory problems (cough, cold, and flu) in the past three months.

In this study, the researchers used simple random sampling to select some respondents from primary healthcare centers. Data collection was carried out from June to July 2019. From a total of 115 children with respiratory problems, only 80 met the eligibility criteria.

Variable

Respiratory allergy symptoms

This study used a questionnaire as informed by the International Childhood Asthma and Allergy Research (ISAAC) to see the respiratory allergy symptoms that occurred in children (no = 1, yes = 2). The questions from the questionnaire are:

"Has your child ever had sneezing and a runny or blocked nose without being sick with a cold or flu?"

"Over the past year, has your child experienced sneezing along with a runny or congested nose without having a cold or flu?"

Household environment and characteristics

The personal characteristics that were asked include gender and age. Meanwhile, characteristics regarding household environment asked include home furniture materials (risk to health/ no risk), floor and wall coating materials (risk to health/ no risk), temperature (qualified/ unqualified), humidity (qualified/ unqualified), lighting, (qualified/ unqualified), ventilation (qualified/ unqualified), and distance from house to pollutant sources (qualified/ unqualified). All of the characteristics were measured based on the guidelines provided by the Regulation of the Indonesian Minister of Health No. 1077 of 2011 regarding Guidelines for Indoor Air Sanitation as well as Housing and Health Guidelines provided by the World Health Organization (WHO) (28).

Family habits

Family habits asked in the questionnaire include the use of air fresheners (yes/ no), the use of spray or burn insect repellent (yes/ no), and smoking family members (yes/ no).

Statistical Methods

Data were input into excel and exported to IBM Statistical Package for the Social Sciences (v.25). Statistical tests were performed using the Chi-square test and Fisher exact to identify the relationship between household environment and family habits with respiratory allergies in children. Furthermore, the binary logistic regression test was performed to analyze the degree of the relationship between household environment and family habits with respiratory allergiy symptoms in children with a 95% Odds Ratio (OR) and 95% Confidence Intervals (CI).

RESULTS

Demographic Data and the Prevalence of Respiratory Allergy Symptoms

Table 1 presents demographic data. From a total of 80 respondents, female respondents account for the dominant group. In terms of age, this research was dominated by respondents aged 7-12 years (65%). The majority of respondents (80%) experienced respiratory allergy symptoms such as coughs, colds, and flu. Around 81.3% of the respondents were exposed to health risks due to home furniture, while 77.5% due to the building. For the household environment, 63.8% did not meet the temperature requirements; 61.8% did not meet the humidity requirements; 66.3% did not meet the lighting requirements; 67.5% did not meet the ventilation

requirements; and 41.3% did not meet the requirements for the ideal distance from house to pollutant sources. For other variables, 66.3% of households used air fresheners, 78.8% used insect repellent, and 43.8% had family members who smoke at home.

Table 1. Demographic Data and the Prevalence of Respiratory Allergy Symptoms in Children

Variables	Frequency	%
Sex		
Male	37	46.2
Female	43	53.8
Age		
5-6	15	18.8
7-12	52	65
13-15	13	16.2
Respiratory Allergy Symptoms		
Yes	64	80
No	16	20
Home Furniture		
Risk to health	65	81.3
No risk	15	18.8
Building Condition (Floor and Wall Materials)		
Risk to health	62	77.5
No risk	18	22.5
Temperature		
Qualified (18°C -30°C)	29	36.3
Unqualified	51	63.8
Humidity		
Qualified (40%-60%)	31	38.8
Unqualified	49	61.3
Lighting		
Qualified (Minimum of 60 Lux)	27	33.8
Unqualified	53	66.3
Ventilation		
Qualified	26	32.5
Unqualified	54	67.5
Distance from House to Pollutant Sources (Traffic)		
Qualified (>100m)	47	58.8
Unqualified (<100m)	33	41.3
Use of Air Fresheners		
Yes	53	66.3
No	27	33.8
Use of Insect Repellent (Burn or Spray)		
Yes	63	78.8
No	17	21.3
Presence of Smoking Family Members		
Yes	35	43.8
No	45	56.3

Household Environment and Respiratory Allergy Symptoms in Children

Table 2 shows that home furnishings and house building conditions (p<0.005) are associated with respiratory allergy symptoms in children at OR values of 3.667 (CI: 1.068-12.586) and 3.747 (CI: 1.149-12.221), respectively. Meanwhile, house temperature, humidity, lighting, ventilation, and distance from house to pollutant sources (p > 0.005) were not related to respiratory allergy symptoms in children.

Table 2. The Relationship between Household Environment and Family Habits With Respiratory Allergy Symptoms in Children

Exposures or Risk Factors[a)]	Respiratory Allergy Symptoms		x^2 Test
	Prevalence (%)	OR, 95% CI[b)]	
Home Furniture (Materials)			
Risk to health	84.6	3.667, (1.068-12.586**)	0.066
No risk	60.0		
Building Condition (Floor and Wall Materials)			
Risk to health	85.5	3.747, (1.149-12.221**)	**0.041***
No risk	61.1		
Temperature			
Qualified	82.8	0.758, (0.235-2.446)	0.862
Unqualified	78.4		
Humidity			
Qualified	83.9	0.664, (0.206-2.138)	0.688
Unqualified	77.6		
Lighting			
Qualified	85.2	0.594, (0.172-2.056)	0.595
Unqualified	77.4		
Ventilation		1.842, (0.599-5.668)	0.438
Qualified	73.1		
Unqualified	83.3		
Distance from House to Pollutant Sources (Traffic)			
Qualified	85.1	0.467, (0.154-1.416)	0.281
Unqualified	72.7		
Use of Air Fresheners			
Yes	86.8	3.286, (1.063-10.152**)	0.067
No	66.7		
Use of Insect Repellent (Burn/Spray)			
Yes	85.7	4.200, (1.270-13.892**)	**0.035***
No	58.8		
Presence of Smoking Family Members			
Yes	82.9	1.381, (0.448-4.255)	0.778
No	77.8		

Description:
a. The number before and after "vs" refers to the prevalence of respiratory allergy symptoms for the related influence factors. The latter was taken as the reference item in the binary logistic analysis.
b. OR odds ratio, CI confidence interval. The bold data indicate the significance statistically according to the chi-square test (0.01≤p≤0.05) and logistic regression test (0.01≤p≤0.05**).*

Family Habits and Respiratory Allergy Symptoms in Children

The use of air fresheners and insect repellent (p<0.005) was associated with respiratory allergy symptoms in children at OR values of 3.286 (CI: 1.063-10.152) and 4.200 (CI: 1.270-13.892), respectively. Meanwhile, the presence of smoking family members was not associated with respiratory allergy symptoms in children

DISCUSSION

Household Environment and Respiratory Allergy Symptoms in Children

This study highlights a significant relationship between furniture and the condition of housing structures and the incidence of respiratory allergy symptoms in children. Older homes often have issues such as peeling paint, while new constructions typically emit strong odors from fresh paints and materials used in modern furniture, including plastics, rubbers, woods, and leathers. The incorporation of these scented items has been linked to increased rates of asthma and rhinitis (9). Moreover, research has identified laminated flooring as a notable risk factor, with emulsion paint use significantly associated with the onset of asthma. Homes in newly developed communities are often recently decorated and filled with new furniture, which may further contribute to indoor air pollution (29). Various household items, including furniture, sealants, and paints, release harmful chemicals, leading to chronic exposure to indoor air pollutants and associated adverse health effects, particularly impacting vulnerable groups like children (30).

Household renovations are known to generate a range of harmful chemical pollutants and heavy metals, with formaldehyde being one of the most concerning substances (31). Research indicates that the concentration of formaldehyde released from newly manufactured furniture and modern building materials is significantly greater than that found in older structures (32–35). Notably, formaldehyde not only exhibits elevated concentrations but also demonstrates a slower rate of decay compared to other volatile organic compounds (VOCs). This persistent nature of formaldehyde pollution implies that contamination within residential environments can endure for extended periods, potentially lasting for many years (35). Therefore, the introduction of new furniture into living spaces is likely to play a crucial role in exacerbating formaldehyde-related pollution, thereby raising health concerns for occupants.

Multiple studies have established a link between the quality of building materials, specifically those used for floors, walls, and roofs and the incidence of acute respiratory infections (ARI) in children. Research indicates that children living in homes constructed with poor-quality materials, such as hard-packed mud and thatch, face a significantly higher risk of adverse health outcomes compared to those in houses built with more durable materials like concrete, tiled roofs, and fired mud brick walls (36–39). Despite housing quality being a fundamental human right essential for overall well-being, it remains largely neglected in global health initiatives. Problems linked to insufficient housing, including lack of safe water, poor sanitation, indoor air pollution, and overcrowding, are identified as significant risk factors for numerous diseases such as acute respiratory infections, diarrhea, malaria, pneumonia, and tuberculosis (40–42).

The results of the statistical analysis revealed no significant correlations between environmental factors—such as temperature, humidity, lighting, ventilation, and the distance from pollutant sources—and the occurrence of respiratory allergy symptoms in children. This finding contrasts with previous studies that have indicated such factors are linked to respiratory allergies in pediatric populations (15,43–44). The optimal temperature range of 18°C to 30°C, particularly highlighting 25°C as most beneficial (45). Historical data suggest that higher temperatures are more closely associated with asthma than with rhinitis. Moreover, other studies have found that both extreme heat and cold can increase asthma risk in children through differing physiological mechanisms (46–48).

The optimal humidity level for indoor environments is generally considered to be between 40-60%. Maintaining appropriate humidity contributes to a denser atmosphere, which hinders the survival of bacteria, viruses, and pollutants (9). An excess of airborne pollutants can lead to respiratory issues, including asthma. Insufficient lighting can lead to discomfort and create conditions conducive to the proliferation of viruses, bacteria, and parasites, thereby increasing the risk of respiratory diseases (46,49). Furthermore, effective ventilation is essential for ensuring proper air circulation, which can help eliminate pathogenic bacteria responsible for acute respiratory infections as well as improve air quality. Rooms characterized by low humidity tend to be more favorable for bacterial growth (50). However, this can be mitigated through adequate ventilation (43).

Residing within a distance of 200 meters from major roadways has been linked to a decreased likelihood of developing asthma. This distance is considered optimal as it provides a buffer zone between residential structures and the pollutants emitted from dense traffic (51–53) . Traffic-related pollution can contribute to a variety of allergic responses through mechanisms that include the interaction between airborne pollen particles and environmental pollutants, the development of inflammation, and exposure to emissions from diesel vehicles. Understanding these dynamics is crucial for public health, as they highlight the potential impact of traffic pollution on respiratory ailments, particularly in urban settings where exposure levels can be significantly higher (12).

Family Habits and Respiratory Allergy Symptoms in Children

In this current study identified a notable association between the utilization of air fresheners and insect repellents and the manifestation of respiratory allergy symptoms in children. Air fresheners are known to contain volatile organic compounds (VOCs) such as toluene, limonene, benzene, and ethylene, which exhibit toxicological effects. Notably, spray air fresheners incorporate organic solvents such as ethanol and isopropanol, along with propane and butane as propellants, which are regarded as more hazardous than gel or powder formulations of air fresheners (19). The chemical constituents from these air fresheners enter the human body primarily through the nasal passages, trachea, and bronchi (49). Respiratory tract irritations can be categorized into two types: upper respiratory tract irritations, which include conditions such as rhinitis, whooping cough, croup, throat infections, ear infections, and the common cold; and lower respiratory tract irritations, which encompass ailments like acute bronchitis, bronchiolitis, and pneumonia (54).

The increasing incidence of illnesses such as dengue fever, malaria, and yellow fever has led to a rising reliance on insect repellents. However, the application of these repellents is not without adverse effects (20). Combustion of insect repellents generates aldehydes and particulate matter (PM), both of which may contribute to respiratory diseases (13,19,55–56). A specific experimental study has indicated that the combustion of a single insect repellent can yield PM2.5 levels equivalent to smoking between 75 and 137 cigarettes. Moreover, the release of formaldehyde from burning insect repellent can be comparable to the emissions produced by smoking 51 cigarettes (57). Children, given their more vulnerable physiological development, are particularly at risk from environmental toxins, likely due to their still-maturing lungs. Consequently, it is imperative for parents to oversee and mitigate the risks associated with pesticide exposure.

Moreover, no correlation was found between smoking family members and respiratory allergy symptoms in children, supporting previous studies that indicate no significant relationship between parental smoking and pediatric respiratory illnesses, likely due to parents smoking away from their children (23). In contrast, other research has demonstrated that second-hand smoke exposure significantly increases the risk of respiratory infections, similar to active smoking (58). Additionally, passive smokers may experience conditions such as rhinallergosis and tracheitis/bronchitis. Untreated respiratory symptoms like rhinitis can lead to sleep disturbances, while other symptoms such as nasal congestion, itching, and sneezing may disrupt children's daily activities and academic performance (11).

ACKNOWLEDGMENTS

The authors would like to thank the Institute for Research and Innovation, Universitas Airlangga, for providing financial support. Moreover, the authors would also like to thank all participants involved in this study.

AUTHORS' CONTRIBUTION

We affirm that we have engaged significantly in the intellectual development, conceptualization, and design of this study, as well as in the analysis and interpretation of the data, where relevant. Furthermore, we have contributed to the manuscript's writing and are willing to accept public accountability for its content. We have also consented to have our names included as contributors. LS: development of concepts, design, definition of intellectual property, conducting literature reviews, gathering data, analyzing data, performing statistical analysis, preparing manuscripts, editing manuscripts, and reviewing manuscripts. CIP: development of concepts, design, conducting literature reviews, analyzing data, performing statistical analysis, preparing manuscripts, editing manuscripts, and reviewing manuscripts. RY: development of concepts, conducting literature reviews, analyzing data, preparing manuscripts, editing manuscripts, and reviewing manuscripts. HZA: conducting literature reviews, analyzing data, preparing manuscripts, editing manuscripts, and reviewing manuscripts.

CONCLUSION

Respiratory allergy symptoms in children can be influenced by household environments and family habits. In this study, variables related with respiratory allergy symptoms in children were home furniture (floor and wall coating materials), house building conditions (temperature, humidity, lighting, ventilation, and the distance from pollutant sources), use of air fresheners, and use of insect repellent with each OR values of 3.667 (CI: 1.068-12.586), 3.747 (CI: 1.149-12.221), 3.286 (CI: 1.063-10.152), and 4.200 (CI: 1.270-13.892).

Limitations of this study include the small sample size and the potential for recall bias as well as incorrect recall. Questionnaires were filled out by parents without any physical examination or screening tests to assess respiratory allergies in children. However, this study can be referred as a preliminary study for future research in the same field.

For research strengths, the ISAAC questionnaire has been validated, and risk factor analysis has been carried out in several previous studies (13–14) . Adding new knowledge, this study showed a strong relationship between furniture, house building conditions, use of air fresheners, and use of insect repellent with respiratory allergy symptoms in children.

This study can be used as the basis for future analysis and anticipation of respiratory problems in children in planning appropriate health interventions. Finally, based on these findings, the household environment and family habits should be considered carefully, especially home furniture and building condition, also the habits of using fresheners and insect repellent should be avoided to prevent respiratory allergy symptoms in children. Further research and examination involving other potential risk factors, such as the presence of microbes like germs/bacteria, viruses, and fungi in the air. Monitoring is needed to explore the cause-and-effect relationship between household environment and family habits with respiratory diseases.

REFERENCES

1. Lv JJ, Kong XM, Zhao Y, Li XY, Guo ZL, Zhang YJ, et al. Global, Regional and National Epidemiology of Allergic Disorders in Children From 1990 To 2019: Findings from the Global Burden of Disease Study 2019. *BMJ Open*. 2024;14(4):1-12. https://doi.org/10.1136/bmjopen-2023-080612
2. Gilaberte Y, Pérez-Gilaberte JB, Poblador-Plou B, Bliek-Bueno K, Gimeno-Miguel A, Prados-Torres A. Prevalence and Comorbidity of Atopic Dermatitis in Children: A Large-Scale Population Study Based on Real-World Data. *J Clin Med*. 2020;9(6):1-12. https://doi.org/10.3390/jcm9061632
3. Hamelmann E, Csonka P, Roberts G, Vogelberg C, Cichocka-Jarosz E, Just J, et al. High Burden of Respiratory Allergy in Children Warrants Early Identification and Treatment with Allergen Immunotherapy. *Respir Med*. 2024;234(1):1-10. https://doi.org/10.1016/j.rmed.2024.107812
4. Sigurdardottir ST, Jonasson K, Clausen M, Lilja Bjornsdottir K, Sigurdardottir SE, Roberts G, et al. Prevalence and early-life risk factors of school-age allergic multimorbidity: The EuroPrevall-iFAAM birth cohort. *Allergy: European Journal of Allergy and Clinical Immunology*. 2021;76(9):2855–2865. https://doi.org/10.1111/all.14857
5. Kairavini NA, Ariani GAT, Utami S, Hikmallah N. Hubungan Tungau Debu Rumah Terhadap Angka Kejadian Rinitis Alergi yang Berobat di Poli THT Rsud Bangli Tahun 2019. *Jurnal Kedokteran*. 2020;5(2):57–68. http://dx.doi.org/10.36679/kedokteran.v5i2.237
6. Setiabudi J, Kawuryan DL, Putra DA. Hubungan antara Kejadian Penyakit Alergi dengan Prestasi Akademik Siswa SMP. *Plexus Medical Journal*. 2022;1(5):198–205. https://doi.org/10.20961/plexus.v1i5.463
7. Putri AA, Rahmawati I, Mardihusodo HR. Prevalence and Risk Factor that Caused Asthma in Children at Sumbang 1 Public Health Center Period of January 2018-December 2020. *Mandala of Health*. 2022;15(1):1-90. https://doi.org/10.20884/1.mandala.2022.15.1.5559
8. Soegiarto G, Abdullah MS, Damayanti LA, Suseno A, Effendi C. The Prevalence of Allergic Diseases in School Children of Metropolitan City in Indonesia Shows A Similar Pattern to That of Developed Countries. *Asia Pac Allergy*. 2019;9(2):1-10. https://doi.org/10.5415/apallergy.2019.9.e17
9. Wang J, Zhang Y, Li B, Zhao Z, Huang C, Zhang X, et al. Asthma and Allergic Rhinitis Among Young Parents in China in Relation to Outdoor Air Pollution, Climate and Home Environment. *Science of the Total Environment*. 2021;751(1):1-9. https://doi.org/10.1016/j.scitotenv.2020.141734
10. Husna R. Gambaran Lingkungan Rumah dan Perilaku Orang Tua dalam Pencegahan Alergi Pernapasan pada Anak di Wilayah Kerja UPT Puskesmas Batipuh I Kabupaten Tanah Datar Provinsi Sumatera Barat. *Jurnal Kedokteran Syiah Kuala*. 2022;22(1):1-10. https://doi.org/10.24815/jks.v22i1.24868
11. Huang S, Garshick E, Weschler LB, Hong C, Li J, Li L, et al. Home Environmental and Lifestyle Factors Associated with Asthma, Rhinitis and Wheeze in Children in Beijing, China. *Environmental Pollution*. 2020;256(1):1-23. https://doi.org/10.1016/j.envpol.2019.113426
12. Sultész M, Horváth A, Molnár D, Katona G, Mezei G, Hirschberg A, et al. Prevalence of Allergic Rhinitis, Related Comorbidities and Risk Factors in Schoolchildren. *Allergy, Asthma and Clinical Immunology*. 2020;16(1):1-11. https://doi.org/10.1186/s13223-020-00495-1
13. Norbäck D, Lu C, Zhang Y, Li B, Zhao Z, Huang C, et al. Sources of Indoor Particulate Matter (PM) and Outdoor Air Pollution in China in Relation to Asthma, Wheeze, Rhinitis and Eczema Among Pre-School Children: Synergistic Effects Between Antibiotics Use and PM_{10} and Second Hand Smoke. *Environ Int*. 2019;125(1):252–260. https://doi.org/10.1016/j.envint.2019.01.036
14. Riyanto A, Juariah L, Maharani RF, Megasari M. Risk Factors of Acute Respitatory Infection in Children Under Five in Banjaran Bandung Regency. *KnE Medicine*. 2022;2(2):1-45. https://doi.org/10.18502/kme.v2i2.11066
15. Guarnieri G, Olivieri B, Senna G, Vianello A. Relative Humidity and Its Impact on the Immune System and Infections. *International Journal of Molecular Sciences*. 2023;24(11):1-11. https://doi.org/10.3390/ijms24119456
16. Le Souëf PN, Adachi Y, Anastasiou E, Ansotegui IJ, Badellino HA, Banzon T, et al. Global change, climate change, and asthma in children: Direct

and indirect effects - A WAO Pediatric Asthma Committee Report. *World Allergy Organization Journal*. 2024;17(11):1-13. https://doi.org/10.1016/j.waojou.2024.100988

17. Saijo Y, Yoshioka E, Sato Y, Azuma H, Tanahashi Y, Ito Y, et al. Relations of Mold, Stove, and Fragrance Products on Childhood Wheezing and Asthma: A Prospective Cohort Study from the Japan Environment and Children's Study. *Indoor Air*. 2022;32(1):1-9. https://doi.org/10.1111/ina.12931
18. Sharma V, Sharma A, Joshi S, Ojha P, Soni S, Saxena A, et al. Human Health Risks to the Use of Chemical Mosquito Repellents: A Review. *Int J Mosq Res*. 2024;11(1):161–167. https://doi.org/10.22271/23487941.2024.v11.i1c.757
19. Li W, Liu Q, Chen Y, Yang B, Huang X, Li Y, et al. Effects of Indoor Environment and Lifestyle on Respiratory Health of Children in Chongqing, China. *J Thorac Dis*. 2020;12(10):6327–6341. https://doi.org/10.21037/jtd.2020.03.102
20. Baluch N, Gallant M, Ellis AK. Exposomal Research in the Context of Birth Cohorts: What Have They Taught Us?. *Annals of Allergy, Asthma & Immunology*. 2020;125(6):639–645 https://doi.org/10.1016/j.anai.2020.09.006
21. Steinemann A, Goodman N. Fragranced Consumer Products and Effects on Asthmatics: An International Population-Based Study. *Air Qual Atmos Health*. 2019;12(6):643–649. https://doi.org/10.1007/s11869-019-00693-w
22. Dwimawati E, Yanuaringsih GP, Pangaribuan R, Olivia N, Gurning FP, Pratama Y. Smoke Exposure at Home to the Incidence of Pneumonia in Children Under 5 Years Old. *Indian Journal of Forensic Medicine & Toxicology*. 2020;15(1):1872-1877. https://doi.org/10.37506/ijfmt.v15i1.13683
23. Zhuge Y, Qian H, Zheng X, Huang C, Zhang Y, Li B, et al. Effects of Parental Smoking and Indoor Tobacco Smoke Exposure on Respiratory Outcomes in Children. *Sci Rep*. 2020;10(1):1-9. https://doi.org/10.1038/s41598-020-60700-4
24. Rivera Rivera NY, Tamayo-Ortiz M, Mercado García A, Just AC, Kloog I, Téllez-Rojo MM, et al. Prenatal and Early Life Exposure to Particulate Matter, Environmental Tobacco Smoke and Respiratory Symptoms in Mexican Children. *Environ Res*. 2021;192(1):1-18. https://doi.org/10.1016/j.envres.2020.110365
25. Dai S, Chan KC. Associations of Household Environmental Tobacco Smoke Exposure with Respiratory Symptoms and Utilisation of Medical Services in Healthy Young Children in Hong Kong. *Tob Induc Dis*. 2020;18(2):1-9. https://doi.org/10.18332/tid/114461
26. Jung J, Park HJ, Jung M. Association between Parental Cotinine-verified Smoking Status and Childhood Asthma: A Population-based Nationally Representative Analysis. *J Korean Med Sci*. 2021;36(30):1–13. https://doi.org/10.3346/JKMS.2021.36.E193
27. Li Y, Huang X, Liu Q, Li W, Yang B, Chen Y, et al. Changes in Children's Respiratory Morbidity and Residential Exposure Factors Over 25 Years in Chongqing, China. *J Thorac Dis*. 2020;12(10):6356–64. https://doi.org/10.21037/jtd-19-crh-aq-005
28. Mo Z, Lu S, Shao M. Volatile Organic Compound (VOC) Emissions and Health Risk Assessment in Paint and Coatings Industry in the Yangtze River Delta, China. *Environmental Pollution*. 2021;269(1):1-25. https://doi.org/10.1016/j.envpol.2020.115740
29. Ren J, Xu J, Zhang P, Bao Y. Prevalence and Risk Factors of Asthma in Preschool Children in Shanghai, China: A Cross-Sectional Study. *Front Pediatr*. 2022;9(1):1-10. https://doi.org/10.3389/fped.2021.793452
30. Alford KL, Kumar N. Pulmonary Health Effects of Indoor Volatile Organic Compounds—A Meta-Analysis. *Int J Environ Res Public Health*. 2021;18(4):1–12. https://doi.org/10.3390/ijerph18041578
31. Lv X, Jiang Y, Wang R, Li L, Liu R, Wang M. The Association Between Self-Reported Household Renovation and Semen Parameters Among Infertile Men: A Cross-Sectional Study. *Am J Mens Health*. 2023;17(1):1-7. https://doi.org/10.1177/15579883231156310
32. Gao Y, Han M. Efficiency Evaluation of Commonly Used Methods to Accelerate Formaldehyde Release and Removal in Households: A Field Measurement in Bedroom. *Build Environ*. 2025;268(1):1-8. https://doi.org/10.1016/j.buildenv.2024.112348
33. Vardoulakis S, Giagloglou E, Steinle S, Davis A, Sleeuwenhoek A, Galea KS, et al. Indoor Exposure to Selected Air Pollutants in The Home Environment: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2020;17(23):1–24. https://doi.org/10.3390/ijerph17238972
34. Yan M, Zhai Y, Shi P, Hu Y, Yang H, Zhao H. Emission of Volatile Organic Compounds from New Furniture Products and Its Impact on Human Health. *Human and Ecological Risk Assessment*. 2019;25(7):1886–1906. https://doi.org/10.6084/m9.figshare.9862394.v1
35. Liang X, Zhang B, Wang K, Ji X, Geng Z, Chen C. Indoor Formaldehyde Pollution and Its Influencing Factors of Newly Decorated Residential Buildings in Kunshan City, Jiangsu Province. Current Urban Studies. 2022;10(2):263–274. https://doi.org/10.4236/cus.2022.102016
36. Pombu Senggunawu T. The Relationship Between Physical Sanitation of The House and The Incidence of ARI in Children Under Five in The Working Area of the Naioni Public Health Center in 2021. *International Journal of Research Publications*. 2022;99(1):160-171. https://doi.org/10.47119/ijrp100991420223085
37. Sabde YD, Trushna T, Mandal UK, Yadav V, Sarma DK, Aher SB, et al. Evaluation of Health Impacts of the Improved Housing Conditions on Under-Five Children in the Socioeconomically Underprivileged Families in Central India: A 1-Year Follow-Up Study Protocol. *Front Public Health*. 2022;10(1):1-9. https://doi.org/10.3389/fpubh.2022.973721
38. Aftab A, Noor A, Aslam M. Housing Quality and

Its Impact on Acute Respiratory Infection (ARI) Symptoms Among Children in Punjab, Pakistan. *PLOS Global Public Health*. 2022;2(9):1-14. https://doi.org/10.1371/journal.pgph.0000949

39. Bakchi J, Rasel RA, Shammi KF, Ferdous S, Sultana S, Rabeya MR. Effect of Housing Construction Material on Childhood Acute Respiratory Infection: A Hospital Based Case Control Study in Bangladesh. *Sci Rep*. 2024;14(1):1-11. https://doi.org/10.1038/s41598-024-57820-6
40. Musiime AK, Krezanoski PJ, Smith DL, Kilama M, Conrad MD, Otto G, et al. House Design and Risk of Malaria, Acute Respiratory Infection and Gastrointestinal Illness in Uganda: A Cohort Study. *PLOS Global Public Health*. 2022;2(3):1-19. https://doi.org/10.1371/journal.pgph.0000063
41. Tustingi LS, Gething PW, Gibsoni HS, Greenwoodi B, Knudseni J, Lindsayi SW, et al. Housing and Child Health in Sub-Saharan Africa: A Cross-Sectional Analysis. *PLoS Med*. 2020;17(3):1-18. https://doi.org/10.1371/JOURNAL.PMED.1003055
42. Wimalasena NN, Chang-Richards A, Wang KIK, Dirks KN. Housing Risk Factors Associated with Respiratory Disease: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2021;18(6):1–26. https://doi.org/10.3390/ijerph18062815
43. Osibona O, Solomon BD, Fecht D. Lighting in the Home and Health: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2021;18(2):1–20. https://doi.org/10.3390/ijerph18020609
44. Liu W, Cai J, Huang C, Chang J. Residence Proximity to Traffic-Related Facilities is Associated with Childhood Asthma and Rhinitis in Shandong, China. *Environ Int*. 2020;143(1):1-9. https://doi.org/10.1016/j.envint.2020.105930
45. Eccles R. Why Is Temperature Sensitivity Important for the Success of Common Respiratory Viruses ?. *Review in Medical Virology*. 2021;31(1):1–8. https://doi.org/10.1002/rmv.2153
46. Zhang X, Xu K, Li Q, Zhu A, Yu J, Liu M, et al. Exploring the Impact of Ambient Temperature on Respiratory Diseases Admissions, Length of Stay, and Hospitalization Costs in Lanzhou City, Based on Distributed Lag Non-Linear Model. *Clim Serv*. 2024;34(1):1-10. https://doi.org/10.1016/j.cliser.2024.100481
47. Lee H, Yoon HY. Impact of Ambient Temperature on Respiratory Disease: A Case-Crossover Study in Seoul. *Respir Res*. 2024;25(1):1-11. https://doi.org/10.1186/s12931-024-02699-0
48. Achebak H, Rey G, Lloyd SJ, Quijal-Zamorano M, Méndez-Turrubiates RF, Ballester J. Ambient Temperature and Risk of Cardiovascular and Respiratory Adverse Health Outcomes: A Nationwide Cross-Sectional Study from Spain. *Eur J Prev Cardiol*. 2024;31(9):1080–1089. https://doi.org/10.1093/eurjpc/zwae021
49. Warobi W, Maretha DE, Asnilawati A, Masri M. The Effect of Exposure to Liquid Air Freshener on Histological of the Bronchial Mice (*Mus musculus*). *Edubiotik : Jurnal Pendidikan, Biologi dan Terapan.* 2021;6(2):1-17. https://doi.org/10.33503/ebio.v6i02.1219
50. Qiu Y, Zhou Y, Chang Y, Liang X, Zhang H, Lin X, et al. The Effects of Ventilation, Humidity, and Temperature on Bacterial Growth and Bacterial Genera Distribution. *Int J Environ Res Public Health*. 2022;19(22):1-13. https://doi.org/10.3390/ijerph192215345
51. Capone P, Lancia A, D'Ovidio MC. Interaction between Air Pollutants and Pollen Grains: Effects on Public and Occupational Health. *Atmosphere.* 2023;14(10):1-16. https://doi.org/10.3390/atmos14101544
52. Debelu D, Mengistu DA, Aschalew A, Mengistie B, Deriba W. Global Public Health Implications of Traffic Related Air Pollution: Systematic Review. *Environ Health Insights*. 2024;18(1):1-10. https://doi.org/10.1177/11786302241272403
53. Thao NT Van, Kien TG, Tuan TA, Duc NM, Hoang PM, Vu LT. Indoor Aeroallergen Sensitization and Associated Factors in Hospitalized Children with Asthma Exacerbations. *Medical Archives*. 2023;77(5):338–344. https://doi.org/10.5455/medarh.2023.77.338-344
54. Van-Meel ER, Mensink-Bout SM, den Dekker HT, Ahluwalia TS, Annesi-Maesano I, Arshad SH, et al. Early-Life Respiratory Tract Infections and The Risk of School-Age Lower Lung Function and Asthma: A Meta-Analysis of 150.000 European Children. *European Respiratory Journal.* 2022;60(4):1-13. https://doi.org/10.1183/13993003.02395-2021
55. Adum P, Agyare VA, Owusu-Marfo J, Agyeman YN. Knowledge, Attitude and Practices of Malaria Preventive Measures among Mothers with Children Under Five Years in A Rural Setting of Ghana. *Malar J*. 2023;22(1):1-12. https://doi.org/10.1186/s12936-023-04702-3
56. Yadav VK, Malik P, Tirth V, Khan SH, Yadav KK, Islam S, et al. Health and Environmental Risks of Incense Smoke: Mechanistic Insights and Cumulative Evidence. *Journal of Inflammation Research*. 2022;15(1):2665–2693. https://doi.org/10.2147/jir.s347489
57. Sidibe A, Sakamoto Y, Murano K, Koita OA, Traore I, Dansoko Y, et al. Personal Exposure to Fine Particles ($PM_{2.5}$) in Northwest Africa: Case of the Urban City of Bamako in Mali. *Int J Environ Res Public Health*. 2022;19(1):1-17. https://doi.org/10.3390/ijerph19010611
58. Prasasti CI, Haryanto B, Latif MT. Association of VOCs, $PM_{2.5}$ and Household Environmental Exposure with Children's Respiratory Allergies. *Air Qual Atmos Health*. 2021;14(8):1279–1287. https://doi.org/10.1007/s11869-021-01018-6