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The Relationship Between $PM_{2.5}$ and Indoor TVOCs Exposure, Physical Environmental Factors, and Atopy History and allergic Asthma Complaints in 13-14 Years old Children at a Full-Day School in Surabaya

I Dewa Gede Deva Pradnyana Putra[1]*, Megara Maritza Tabina[2], Winarko[3]
[1,2]Department of Environmental Health, Faculty of Public Health, Airlangga University, Surabaya
[3]Department of Environmental Health, Poltekkes Kemenkes Surabaya, Indonesia
* Corresponding Author: i.dewa.gede.deva-2020@fkm.unair.ac.id

ABSTRACT

Introduction: Indoor air pollutants can cause respiratory irritants and trigger allergic asthma complaints, especially in children with a history of atopy. Previous research has found that air pollutants, including $PM_{2.5}$ and TVOCs, pose risks to respiratory allergy complaints in children. Children spend a significant amount of time at school, so the air quality in classrooms affects their health and productivity. The study was conducted at SMPN 19 Surabaya, located alongside a major road and with a variety of classroom types, potentially exacerbating asthma complaints in children. The research aimed to identify the relationship between exposure to $PM_{2.5}$, TVOCs, physical environmental factors, and atopy history with asthma complaints in 13-14-year-old children at SMPN 19 Surabaya.
Objective: The study aimed to identify the relationship between exposure to $PM_{2.5}$, TVOCs, physical environmental factors, and atopy history with asthma complaints in 13-14-year-old children at SMPN 19 Surabaya.
Method: The research was a quantitative study with an analytical observational design using a cross-sectional approach. The sample size for the study was 69 students aged 13-14 years, selected through purposive sampling from two different characteristic classes, at SMPN 19 Surabaya. An air quality detector was used to measure $PM_{2.5}$, TVOCs, temperature, and humidity in both classes as well as observe the class's physical condition. Data was collected from student interviews using the ISAAC questionnaire. Data analysis used a bivariate test.
Result: The research results showed a relationship between a history of atopy and allergic asthma complaints in children aged 13-14 years in classes 7G and 8A at SMPN 19 Surabaya (p=0.000) and (OR=23.368). However, for indoor pollutant levels $PM_{2.5}$ (OR= 1.710), TVOCs (OR=1.710), and physical environmental factors such as temperature and humidity did not show a relationship with allergic asthma complaints.
Conclusion: It can be concluded that a family history of atopy is associated with asthma complaints in classes at SMPN 19 Surabaya. Therefore, increased awareness and supervision of children with a history of atopy are necessary to prevent or manage potential asthma complaints.

Keywords: Allergic Asthma Complaints; Atopic History; Indoor Air Quality; School

INTRODUCTION

Indoor air quality has a major impact on human health, as almost 80% of human activities are done indoors. Indoor air quality is generally caused by several factors, 52% caused by lack of air ventilation, 16% by the presence of pollution in the room, 10% by pollution from the outside of the house, 5% by microbes, 4% by building materials and others by 13% (1). Indoor air pollution that can cause disease is not only caused by gases inside or outdoors but can also be caused by the physical quality of the environment and the sanitation of buildings including public facilities and also in schools.

According to the results of the Basic Health Survey in 2018, the prevalence of asthma in Indonesia is 2.4%. The prevalence of asthma in children aged 5-14 years is 1.9%, while the prevalence in East Java is 2.6%. This indicates that the rate of prevalence is still higher than the national figure. An advanced study conducted in Surabaya in 2021, has found that indoor environmental quality, such as total volatile organic compounds (TVOCs) and particles with an aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$) is significantly associated with respiratory allergy complaints in children in Surabaya, Indonesia. In addition to that, children with an atopic family history can triple the risk of developing future allergic asthma complaints (2).

According to WHO, there are 262 million identified people suffering from asthma, especially among children, with a death rate of 461,000. The European Union Environment and Health Action Plan (EHAP) in a study (3), states that environmental pollution factors such as $PM_{2.5}$ and TVOCs can cause respiratory disorders and trigger the recurrence of allergic asthma in children, even being a major risk factor of increased hospitalization for asthmatic children. This exposure is 90% from indoor air exposure, both in schools characterized by sneezing, coughing, and difficulty breathing especially in schoolchildren with a history of atopy.

Several studies show that children between the ages of 13 and 14 spend most of their time (about 80%) indoors, in school classrooms (>30%) where they study (4). Preliminary research results show significant differences between $PM_{2.5}$ and TVOCs concentrations as well as temperature and humidity in two classes in SMPN 19 Surabaya. This is because there are differences in the characteristics of class, buildings, and the presence of air pollutant sources in the class. $PM_{2.5}$ can worsen the air quality in that class as well as increase the risk of allergic asthma complaints in the place where they study (5). A study (6) also showed that humidity as well as exposure to TVOCs resulted in poor air quality in school environments by up to 50%.

SMP Negeri 19 Surabaya consists of 36 classrooms, each classroom uses furniture to support teaching and learning activities. The study was conducted at SMP Negeri 19 Surabaya to investigate allergic asthma complaints in children aged 13-14 years (grades 1-2 High School) for several reasons. First, the location of the school is on the side of the road which can potentially affect children's respiratory health. The analysis of two classes with different characteristics at the school aims to identify whether outdoor air pollution, such as motor vehicle emissions and $PM_{2.5}$ particles, are a significant risk factor in the development of respiratory diseases, including asthma.

Besides that, classroom furniture can also be a source of volatile organic compounds (VOCs) that pollute indoor air. These VOCs can come from materials such as desks, chairs, and tables. Previous studies have shown that exposure to indoor VOCs can affect children's respiratory health. Therefore, choosing a school with classroom furniture that might be a source of VOCs can explore the relationship between indoor air quality and allergic asthma complaints.

Overall, the selection of SMP Negeri 19 Surabaya as the location of the study was based on factors such as school location on the side of the road, the presence of classroom furniture that could potentially pollute indoor air, and a family history of atopy, all of which are important variables in the study of allergic asthma in children aged 13-14 years.

METHOD

The study used a quantitative method with an observational approach, carried out in February 2024. In this study the research design used is cross-sectional. The population was 765 students out of all 7th and 8th-grade students aged 13-14 who attended school at SMPN 19 Surabaya as a full-day school. In this study, the use of purposive sampling techniques involves non-probability samplings. This technique is used to take samples focusing on specific criteria, which were students aged 13 and 14 years in two classes with different characteristics. The samples were taken from students in classes 7G and 8A SMPN 19 Surabaya of 69 people because the two classes have differences in the age of students and they study in classes with different characteristics.

Data analysis methods are descriptive and analytical, descriptive by describing each research variable by the distribution and presentation of each variable as well as data analysis using a bivariate test with a (α=5% or 0,05) to identify the relationship of exposure to $PM_{2.5}$, TVOCs, physical environmental factors, and atopy history with asthma complaints in 13-14-year-old children at SMPN 19 Surabaya.

RESULTS
Characteristics of Respondents

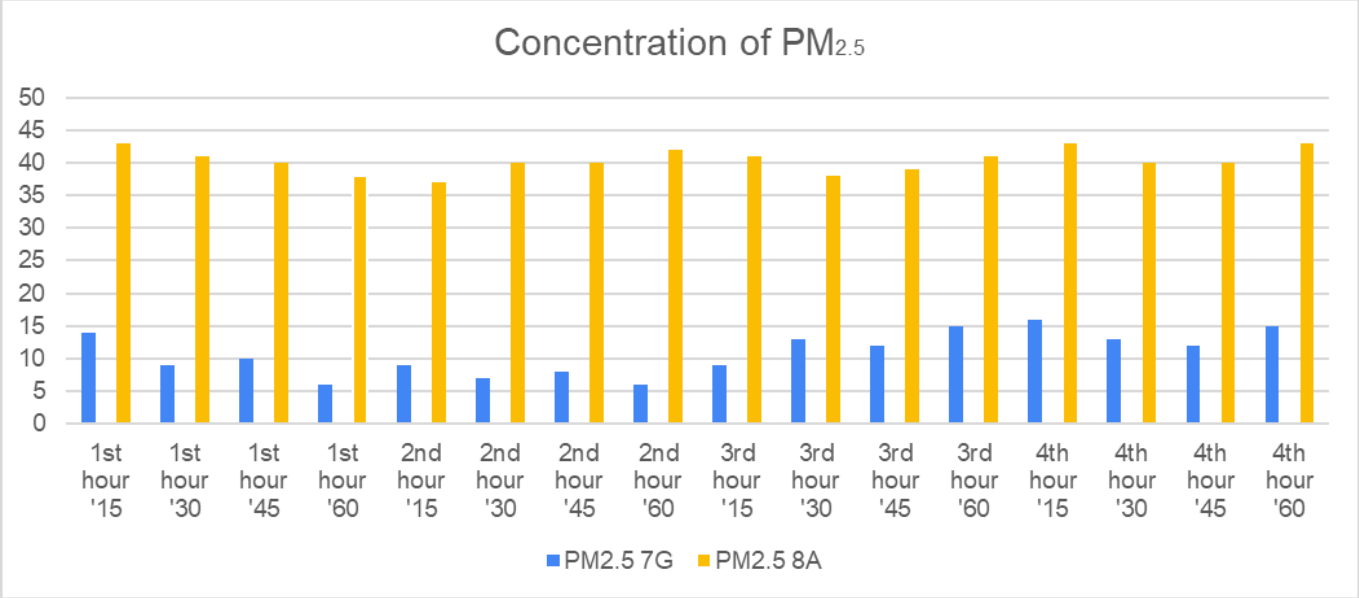
Table 1. Characteristic of Respondents

Characteristic	Frequency	Percentage
Grade		
Grade 7 (7G)	34	49%
Grade 8 (8A)	35	51%
Age		
13	34	49%
14	35	51%
Gender		
Male	37	54%
Female	32	46%
Total	69	100%

Source: Primary Data, 2024

Based on the table above, the respondents were divided into groups of 7th grade 34 students (49%) and 8th grade 35 students (51%). The age ranges from 13 to 14, with details of 34 students (49%) aged 13, and 35 students (51%) aged 14. There were 37 male students (54%) and 32 female students (46%). So, the total of respondents in this study was 69 students.

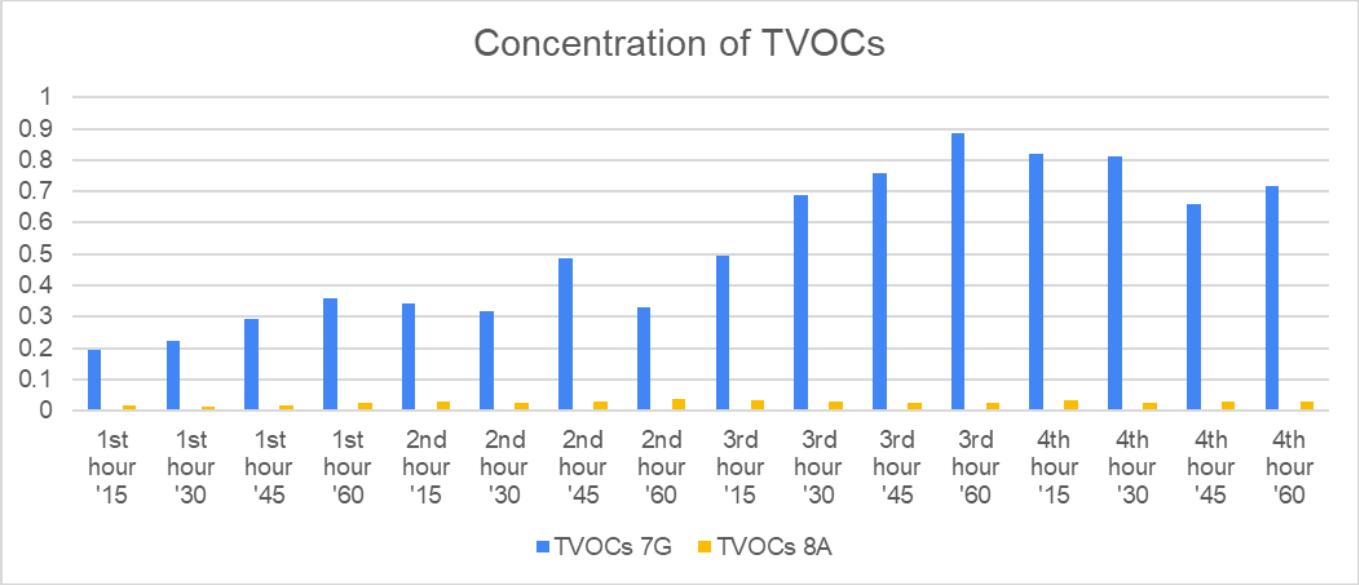
Indoor Air Quality
PM2.5 (Particulate Meter 2.5)



Source: Primary Data, 2024

The $PM_{2.5}$ measurements taken over 4 hours in each class yielded 16 datasets, recorded every 15 minutes. In class 7G, the $PM_{2.5}$ levels ranged from 6-16 µg/m³ with an average of 11 µg/m³, while in class 8A, the levels ranged from 37-43 µg/m³ with an average of 40 µg/m³. Therefore, the PM2.5 levels in class 7G are lower than those in class 8A, which exceed the standard of 25 µg/m³.

TVOCs (Total Volatile Organic Compounds)



Source: Primary data, 2024

The TVOCs measurements taken over 4 hours in each class yielded 16 datasets, recorded every 15 minutes. In class 7G, the TVOCs levels ranged from 0.193 mg/m³ to 0.886 mg/m³ with an average of 0.524 mg/m³. It was observed that after the first 45 minutes, all measurements exceeded the standard of 0.3 mg/m³. In class 8A, the TVOCs concentrations ranged from 0.013 mg/m³ to 0.037 mg/m³ with an average of 0.027 mg/m³. Therefore, the TVOCs levels in class 7G are significantly higher than in class 8A.

Environmental Factors

Temperature

Table 2. Temperature Measurement

Location	Minimum (°C)	Maximum (°C)	Temperature Standard
7G	31	32	18-30°C
8A	25	27	

Source: Primary Data, 2024

The measurement results show that the temperature in class 7G is higher than in class 8A. The minimum temperature in class 7G exceeded the standard set by the Minister of Health Regulation No. 2 of 2023, which is 31°C, reaching 32°C during the measurement. In class 8A, the temperature ranged from 25-27°C, thus falling within the standard category with a maximum limit of 27°C.

Humidity

Table 3. Humidity Measurement

Location	Minimum (%)	Maximum (%)	Humidity Standard
7G	55	58	40-60%
8A	71	75	

Source: Primary Data, 2024

The table shows that the humidity in class 8A is significantly higher than in class 7G. The humidity in class 8A ranges from 71-75%, exceeding the standard set by the Minister of Health Regulation No. 2 of 2023, which is 40-60%. Meanwhile, the humidity in class 7G ranges from 55-58%, which is still within the standard indoor air quality category.

Atopic History

Table 4. Student's Atopic History

Atopic History	Frequency	Percentage
Yes	13	19%
No	56	81%
Total	69	100%

Source: Primary Data, 2024

Based on the table above, only 13 students (19%) have an atopic or allergic history inherited from the family. While the other 56 students (81%) have no atopic or allergic history inherited from the family.

Allergic Asthma Complaints

Table 5 Student's Allergic Asthma Complaints

Allergic Asthma Complaints	Frequency	Percentage
Yes	31	45%
No	38	55%
Total	69	100%

Source: Primary Data, 2024

Based on the table, out of a total of 69 students surveyed using the ISAAC questionnaire, 31 students (44.9%) reported allergic asthma complaints, while 38 students (55.1%) did not. In class 7G, 21 students (61.7%) did not report asthma complaints, whereas 13 students (38.3%) did. In class 8A, 17 students (48.6%) did not report asthma complaints, while 18 students (51.4%) did. Therefore, allergic asthma complaints were more frequently identified in class 8A than in class 7G at SMPN 19 Surabaya.

Bivariate Analysis

The Relationship Between $PM_{2.5}$ Exposure and Allergic Asthma Complaints

Table 6. The Relationship Between PM2.5 Exposure and allergic Asthma Complaints

PM 2.5	Allergic Asthma Complaints				Total		OR	*p-value*
	No		Yes					
	n	%	n	%	n	%		
≥25 µg/m³	21	1,8	13	38,2	34	100	1,710	0,390
<25 µg/m³	17	48,6	18	51,4	35	100		
Total	38	55,1	31	44,9	69	100		

Source: Primary Data, 2024

Based on the table, the number of students who have allergic asthma complaints and live in classes with $PM_{2.5}$ levels are less than the standard of 13 students (38.2%). The number of pupils who have $PM_{2.5}$ complaints and stay in classrooms with excess $PM_{2.5}$ exposure above the standard has a higher number of 18 students (51.4%). The air pollutant $PM_{2.5}$ has an OR value of 1,710. Thus, children who have allergic asthma complaints in classes 7G and 8A SMPN 19 Surabaya when exposed to $PM_{2.5}$ have a 1.7 or 2 times greater risk compared to children who do not have allergic asthmas.

The Relationship Between Indoor TVOCs Exposure and allergic Asthma Complaints

Table 7. The Relationship Between PM2.5 Exposure and allergic Asthma Complaints

TVOCs	Allergic Asthma Complaints				Total		OR	*p-value*
	No		Yes					
	n	%	n	%	n	%		
≥ 0,3 mg/m³	17	48,6	18	51,4	34	100	0,585	0,390
< 0,3 mg/m³	21	1,8	13	38,2	35	100		
Total	38	55,1	31	44,9	69	100		

Source: Primary Data, 2024

Based on the table, the number of students who had allergic asthma complaints and were in the class had a rate of TVOCs above the standard of 13 students (38.2%) compared with those who were in class with TVOCs below the standard as much as 18 students (51.4%). Meanwhile, students who did not have asthmatic complaints and were in the class that TVOC's above the standard of 21 students (61.8%). TVOCs as a category of indoor pollutants potentially have a one-time greater risk for children who have allergic asthma complaints especially children aged 13-14 years in class 7G and 8A SMPN 19 Surabaya with an OR rating of 0.585. However, exposure to TVOC in the room is not related to allergic asthmatic complaints in children aged 13-14 in SMPN 19, Surabaya.
The Relationship Between Physical Environmental Factors and Allergic Asthma Complaints

The Relationship Between Physical Environmental Factors and allergic Asthma Complaints

Table 8. The Relationship Between Temperature and Allergic Asthma Complaints

Temperature	Allergic Asthma Complaints				Total		OR	*p-value*
	No		Yes					
	n	%	n	%	n	%		
≥ 18-30°C	17	48,6	18	51,4	34	100	0,585	0,390
< 18-30°C	21	1,8	13	38,2	35	100		
Total	38	55,1	31	44,9	69	100		

Source: Primary Data, 2024

Based on the Table it can be seen that the temperature in the classroom is divided according to the standard guidelines of the standard indoor air quality, i.e. the temperature is categorized as less than the standard and above the standard. There were 13 students (38.2%) who had asthma complaints and lived in a classroom with temperatures above the standards, while there were 18 students (51.4%) who were living in classrooms with lower temperatures, whereas there were 21 students (61.8%). The temperature in the classroom has a potential one-time greater risk for children with allergic asthma complaints especially children aged 13-14 years in classes 7G and 8A SMPN 19 Surabaya with an OR value of 0.585. However, the temperature of the room is not associated with asthma allergic complaints in children ages 13-14 in SMPN 19, Surabaya.

Table 9. The Relationship Between Humidity and Allergic Asthma Complaints

Humidity	Allergic Asthma Complaints				Total		OR	*p-value*
	No		Yes					
	n	%	n	%	n	%		
≥ 40-60%	21	1,8	13	38,2	35	100	1,710	0,390
< 40-60%	17	48,6	18	51,4	34	100		
Total	38	55,1	31	44,9	69	100		

Source: Primary Data, 2024

Based on table 9, the humidity levels in the classrooms are grouped into lower than standard humidities and higher than standard. There were 18 students (51.4%) who had allergic asthma complaints and lived in classrooms with excessive humidity. Meanwhile, the number of students who did not have an asthmatic complaint and stayed in a classroom with exceeding humidities was 17 students (48.6%). Humidity that exceeded the 76 standards had a twice greater risk (OR=1.710) for students who had allergic asthma complaints compared to those who had no allergics in classes 7G and 8A. However, there was no correlation between the level of classroom moisture and the allergy of children aged 13-14 years in SMPN 19 Surabaya.

The Relationship Between Atopy History and allergic Asthma Complaints

Table 10. The Relationship Between Atopy History and Allergic Asthma Complaints

Atopy history	Allergic Asthma Complaints				Total		OR	*p-value*
	No		Yes					
	n	%	n	%	n	%		
No	37	66,1	19	33,9	56	100	23,368	0,000
Yes	1	7,7	12	92,3	13	100		
Total	38	55,1	31	44,9	69	100		

Source: Primary Data, 2024

Based on table 10 can be identified students 13-14 years SMPN 19 Surabaya who have an atopic history of the family with asthma complaints as many as 12 students (92.3%) and have no history of asthmatic complaints as much as 19 students (33.9%). The odds ratio value was 23.368 which means that children who have a history of atopy in classes 7G and 8A of SMPN 19 Surabaya tend to have 23 times more asthma complaints than children who do not have any history. Based on the results of the statistical tests, showing a p-value <0,05. Then it can be concluded that there is a relationship between the history of atopic and allergic asthma complaints due to a p-value < 0,05.

DISCUSSION

The Relationship Between $PM_{2.5}$ Exposure and Allergic Asthma Complaints

$PM_{2.5}$ exposure in classes 7G and 8A SMPN 19 Surabaya has a 2 times greater risk for children with allergic asthma with a value of OR = 1,710. However, the statistical test showed that exposure to $PM_{2.5}$ was not related to allergic asthma complaints, as the p-value was >0,05. The result showed no relationship on this variable due to the fluctuating $PM_{2.5}$ concentration and students were not fully (4 hours) in the classroom as there are other activities outside of the classroom such as Sholat Dhuha and 15-minute break hours. This is in line with the Haryanto study (2016), there was no relationship between $PM_{2.5}$ levels and the prevalence of asthma p=0.64, as well as no link between the $PM_{2.5}$ level and pulmonary dysfunction p= 0.86. Because indoor air also does not necessarily represent 84 of the total air inhaled, people may be spending a lot of time outside (7).

According to other studies, there is also no association between $PM_{2.5}$ levels and allergic asthma complaints, as demonstrated by the results of Khalili's study (2018), which showed that there is no link between $PM_{2,5}$ and allergy asthma in children over 5 years of age, unless the child is under the age of 5 and is a child with low birth weight, then the child has a risk of being affected by $PM_{2.5}$ concentrations although such effects are not significant (8). As for the Nur (2019) study, it was found that $PM_{2.5}$ exposure of 45.5% with a black carbon concentration of 62 μg/m3 had no significant association with pulmonary dysfunction with a p-value of 0.79 > 0.05 (9). Later, other studies also found that there was no relationship between $PM_{2.5}$ concentrations and Peak Expiratory Flow (PEF) or the ability of the lungs to extract maximum air in a single exhalation that often inhibited the process in cases of asthma complaints (10).

$PM_{2.5}$ exposure has a two times greater risk in children with allergic asthma, especially in school environments. The school is rated as a crucial location because it is located close to the main highway as a contributor of air pollutants from motor gas and community activity around it. However, the absence of a correlation between $PM_{2.5}$ and asthma complaints can occur 85 because the asthmatic complaint comes not only from $PM_{2.5}$ exposure, but is also influenced by various other factors, such as genetics, allergy history, lifestyle, and the environment. In previous studies, it was found that there was a major link between genetics and asthma occurrences that the polymorphisms of the arginase I and II genes were associated with asthmatic complaints as well as atopy in children, the variations of arginases 1 and 2 were related to the severity of Asthma and responses to beta 2 agonists & steroids. Not only that, certain groups of genes such as haplogroup "U" in the mitochondrial genome are closely associated with increased IgE and the incidence of allergic asthma (11).

According to other studies, the risk factors for respiratory disorders such as asthma are not only exposure to air pollution such as $PM_{2.5}$ but also high temperature and body mass index (12). Based on these studies, it can be found that the risk factors of $PM_{2.5}$ are high and the reason for the lack of connection with asthma complaints is due to the presence of other interacting factors that have not been studied in this study.

The Relationship Between Indoor TVOCs Exposure and Allergic Asthma Complaints

Air pollutants from total volatile organic compounds (TVOCs) that are vaporizable have a one-time higher risk (OR=0,585) for children in classes 7G and 8A who have a history of allergies. Based on bivariable analysis, the p-value that appears is (p=0.390) so it can be said that there is no relationship to this variable because each student has a different limit of adaptation and tolerance so it does not show an allergic reaction to any component of the volatile organic compound. However, it has a one-time higher risk factor in children with allergic asthma. Besides, the lack of this relationship is because the child not only spends time in class but also at home and in other neighborhoods. The exposure of TVOCs in these places may be more significant than the exposure in schools, making the contribution of TVOCs in the classroom to allergic asthma more difficult to identify.

This is also consistent with previous research specifically dealing with the gas components of TVOCs through systematic evidence that there is inconsistent evidence about the relationship between exposure to volatile organic compounds (VOCs) in the indoor environment and the risk of asthma and allergies. Although some studies show a link between exposure to VOCs and the risk of asthma and allergies, some studies do not find such a link (13). In addition, the data obtained from these studies have varied methodological qualities, so it cannot provide

sufficient evidence to support or disprove the hypothesis that exposure to VOCs in indoor environments increases the risk of asthma and allergies.

This systematic review emphasizes the importance of developing a more definitive evidence base to examine the gap between exposure to VOCs and allergic asthma, in order to provide information for public policy and clinical treatment. The research also highlights the need for more high-quality intervention studies to clarify the relationship between exposure to VOCs and allergic asthma. In addition, the study emphasizes the importance of valid and accurate measurement of VOCs exposure to obtain reliable data in research on the relationship between VOC exposure and allergic asthma.

In previous studies, too, it was found that exposure to VOCs was not associated with asthma attacks in children (14). In other studies, it was found that the risk of complaints of respiratory impairment such as asthma arising from exposure to TVOCs tends to be uncertain, given that this is influenced by the varying levels of TVOC concentrations, the composition of TVOCs, as well as the duration or duration of exposure. The differences in these three aspects have different effects on the body's cell response that then affects respiratory conditions, so the impact of exposure to VOCs on asthma complaints, tends to be varied and uncertainty the same for each individual (15). It is consistent with other research, that the influence of exposure to VOCs on asthma complaints cannot be generalized, considering that each individual has genetic factors, exposure history, health conditions, as well as 88 different levels of sensitivity that affect the body's reaction to exposure (16).

The concentration of VOCs can still be reduced in a variety of ways. For example, the presence of pot plants in indoor, this is proved by the ability of extracts of Sanseviera sp of 30 ppm which is capable of reducing the concentration of VOCs in particular benzene compounds in the indoor to 73% (17). Not only that, according to (18) and (19), the existence of good room ventilation, as well as minimizing the use of products that produce VOCs can reduce the level of exposure and concentration of VOC in the room.

The Relationship Between Physical Environmental Factors and Allergic Asthma Complaints

Physical environmental factors, such as humidity have a 2 times greater risk (OR=1,710) for students who have allergic asthma complaints in classes 7G and 8A SMPN 19 Surabaya. Whereas temperature has a one-time higher risk factor (OR =0,585) for allergy asthmatic complaints. However, the physical environmental factor is not assessed to have a relationship with allergic asthma complaints in classes 8G and 7A SMBN 19 Surabaya with a p-value of 0,390. The absence of this relationship is due to the differences in the position of the classroom and the characteristics of classroom buildings. The magnitude of the risk also depends on the individual variation where each student has a level of tolerance and adaptation to temperature and humidity in different classes.

89 These physical environmental factors are supported by previous research, that the trigger or trigger of asthma in individuals tends to vary and is affected by the sensitivity of the individual body, in some cases individuals with high sensitivities may experience asthmatic recurrences when changes in temperature and humidity, but in some other cases some individuals do not experience asthma when there are changes in the temperature and moisture which are related to the atopic and non-atopic conditions of an individual (20). In addition, the association between the triggers of asthma, whether temperature, temperature, and certain allergies tends to vary for each individual, for the sensitive individual, the appearance of a few triggers can lead to the onset of severe complaints, while in the non-sensitive individual tends to see better complaints control/recurrence rates (21).

Research (22) mentions that differences in body sensitivities, temperature, and humidity tend to be weakly associated with asthma complaints. This is demonstrated by the negative and weak association of temperature and temperature with asthma complaints in past pandemic times, but when the conditions of recurrence are severe, then the link between temperature and new humidity will intensify.

Furthermore, in other studies, it is explained that the human body can adapt to changes in temperature and humidity, although the rate of adaptation varies (23).

In this study, it was noted that students of classes 7G and 8A had been in their class for a long time, their bodies tended to have adapted and become accustomed to temperature and temperature. Moreover, significant temperature changes generally occur only on certain days such as when it rains or when the weather is too hot and these conditions tend to be more noticeable outside than in the classroom (24). It suggests that changes in temperature and temperature in this study are not significantly related to allergic asthma complaints. The use of ingredients in class that can trigger allergy such as those derived from cleaning materials (floor cleaning or window glass), even in class 7G found paint to turn off does not have a very significant impact, considering that its use in class only on certain days when class is being cleaned. According to research by (18) minimizing the impact of asthma complaints can be done by minimizing the use of pollutants, only occasional use does not have a significant impact. Not only cleaning materials, but other materials like wall paint, as well as wooden items can also trigger asthma complaints because of the pollutant content in them.

The theory of (19) explains that it is important to pay attention to the renovation time of the classroom, to make sure that students use the room when the room has been long since renovated or has been worthy of habitation and is not filled with contamination of pollutants with high concentrations. It is known that in 91 classes 7G and 8A, there is no information related to the recent renovation of the room so the possibility of contamination concentrations of contaminants from both paint and wooden furniture (table and chairs) is not in high concentration hazardous.

The Relationship Between Atopy History and allergic Asthma Complaints

Children aged 13-14 in classes 7G and 8A SMPN 19 Surabaya who have a history of atopic asthma have 23 times higher risk scores with an allergic asthma complaint 82 compared to those who have no history of atopic. This is a significant risk (OR=23.368) because of 13 students who have a history of asthma, 12 of whom have asthmatic complaints (93.3%). In addition, an atopic history has been associated with allergic asthma complaints in children marked by a p=0,000 value. In previous studies, it was explained that the history of atopy is associated with asthma because the latter has similar pathogenic mechanisms, through the T Helper 2 immune response that stimulates the production of IgE by B cells known as allergy triggers (25). Following this explanation, (26) suggest that the mechanism of the history and development of asthmatic atopy in children occurs as a result of the activation of Type 2 helper T cells, Type 2 primary cytokines, such as IL-4 and IL-3, which play a role in the onset of asthma complaints. This is supported by research (2), that an atopic history of both infancy and family experience can triple the risk of developing future asthma complaints. The findings are consistent with research (27) that an atopic history in the family and maternal periods has a significant relationship to the risks of asthmatic, multiple to atopic dermatitis in the offspring up to 77%. However, this family or maternal history of atopic disease is not related to food allergies in descendants. An atopic history of parents including a history of atopic dermatitis as well as asthma has been associated with the risk of asthmatics in children.

Analysis suggests that children with both mothers and fathers who have a history of 83 atopy tend to have a higher risk for their offspring to develop asthma complaints, especially during childhood and the first 2 years of life with the odds ratio or relationship reaching 95% (28).

Other research also revealed that a family history of atopic causes an increased risk of uncontrolled asthma in children and a much higher severity of asthmatic disease (29). Based on the explanation, it is known that the history of atopy in both infancy and childhood, as well as from the family, plays an important role and has a significant link to allergic asthma complaints in children.

CONCLUSION

It can be concluded that out of a total of 69 students in classes 7G and 8A at SMPN 19 Surabaya, 13 students (18.8%) have a family history of atopy. A total of 31 students (44.9%) from both classes have allergic asthma complaints, with 13 students (38.2%) from class 7G and 18 students (51.4%) from class 8A. The study's findings indicated a significant association between a history of atopy and the occurrence of allergic asthma complaints among children and a 23 times greater risk of allergic asthma complaints aged 13-14 years in classes 7G and 8A at SMPN 19 Surabaya. The statistical analysis revealed a p-value of 0.000 and an odds ratio (OR) of 23.368, underscoring a strong link. Conversely, indoor pollutant levels, specifically $PM_{2.5}$ and Total Volatile Organic Compounds (TVOCs), each with an OR of 1.710, along with physical environmental factors such as temperature and humidity, were not found to be significantly related to allergic asthma complaints in these children.

SUGGESTION

The study recommends that the school increased awareness and monitoring of children with an atopic history to prevent or manage possible allergic asthma complaints, conduct further evaluation of indoor air levels such as the use of effective room ventilation, create a program of greening the school area by adding plant pots as air pollution neutralizers in each classroom, as well as to educate students, parents, and school staff on the management of allergic asthma, including signs and complaints, avoidance of triggers, use of medicines, and emergency measures to be taken in case of asthmatic attacks or other respiratory diseases.

This study has several research limitations. Therefore, future researchers are advised to conduct further studies to broaden the scope by considering additional factors, especially individual factors such as children's habitual behaviors that may contribute to allergic asthma complaints in children aged 13-14 years. These could include variables like genetic factors, diet, physical activity, behaviors outside of school, and psychosocial factors. Research related to indoor air pollution can expand the analysis by including biological pollutants, such as the presence of mold, bacteria, and dust mites in the air, as biological air pollution factors. Moreover, to enhance the generalizability of the results, it is recommended to involve more than two classes in related research, thereby representing the 13-14-year-old population in a school more comprehensively.

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