ORIGINAL ARTICLE

Second-Hand Smoke and Early Allergic Manifestation in Children

Sitisalma Amirah Dzakiyyah[1], Anang Endaryanto[2*], Linda Dewanti[3], Azwin Mengindra Putera[2], Anisa Ayu Maharani[4]
[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Pediatrics, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Hospital, Surabaya, Indonesia.
[3]Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[4]Faculty of Medical Sciences, Newcastle University, Newcastle, United Kingdom.

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ABSTRACT

Introduction: The interaction between genetic and environmental factors plays an important role in shaping the early development of allergies, including exposure to cigarette smoke. This study aimed to determine the relationship between second-hand smoke exposure and early allergic manifestations in children.
Methods: This was an observational analytic study with a cross-sectional design. Pediatric patients who suffered from allergies in the allergy outpatient clinic at the Department of Pediatrics, Dr. Soetomo General Hospital, Surabaya were included in this study. Data were obtained through medical records.
Results: This study involved 190 patients and showed that 50% of the patients have families who smoke at home, the most common early manifestations were at 11-20 months old (32.10%), and the most common early manifestations were respiratory manifestations (98.42%). There was a significant relationship between the presence of a family member who smoked at home with the age of early manifestation, respiratory manifestation, and skin manifestation in allergic pediatric patients (all $p < 0.05$). There was no significant relationship between the presence of family members who smoked at home with gastrointestinal manifestations in allergic pediatric patients ($p = 0.301$).
Conclusion: There was a significant relationship between the presence of family members who smoke at home with age, respiratory tract, and skin manifestations in allergic pediatric patients.

INTRODUCTION

An allergy is a systemic immune disease that mostly manifests in certain organs, especially those related to the environment, such as the skin, respiratory tract, and digestive tract, where mucosal tolerance is initiated and regulated to determine the pattern of systemic immunity.[1] The increasing prevalence of allergic diseases affects 30-40% of the world's population, which is currently affected by one or more allergic conditions.[2] Genetics and environmental factors play an important role in shaping early development and modifying the risk of effects on the immune system and developing organ systems.[1,3]

According to World Health Organization (WHO), nearly half of all children worldwide are exposed to second-hand smoke, and 65,000 children die from illnesses related to second-hand smoke exposure every year. Globally, second-hand smoke caused an estimated 165,000 deaths due to lower respiratory infections and 1,150 deaths due to asthma in children. Additionally, second-hand smoke exposure in childhood substantially increases the risk of respiratory infections, worsens asthma, and slows lung growth in the short term.[4]

*Corresponding author: anang.endaryanto@fk.unair.ac.id

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Second-hand smoke exposure has been considered a key modifiable risk factor for morbidity and mortality among children. It is a serious public health challenge worldwide. Although the prevalence of second-hand smoke exposure at home is decreasing, the prevalence in public areas is increasing or remains unchanged in most countries.[4]

The prevalence of second-hand smoke exposure at home is 57.3% and in public places reaches 60%. Smoking affects innate and adaptive immunity, exacerbates pathogenic immune responses, or weakens immune defences. The complex role of cigarette smoke has resulted in various diseases, including cardiovascular, respiratory and autoimmune diseases, allergies, cancer, and others. Th2 cells are affected by smoking which causes an increase in IL-4, IL-5, and IL-13. In addition, smoking also increases the frequency of memory B cells which causes an increase in the production of IgE, which plays an important role in the incidence of allergies.[3,5]

Previous studies also show a significant relationship between second-hand smoke exposure and the incidence of allergies in early life.[3,6] This study aimed to analyze the relationship between second-hand smoke exposure and the age and types of early allergic manifestations in children.

METHODS

This was an observational analytic study using a cross-sectional design. This study was performed in the allergy outpatient clinic at the Department of Pediatrics, Dr. Soetomo General Hospital Surabaya from September 2020 to November 2021. The population of this study were pediatric patients who suffered from allergies in the allergy outpatient clinic at the Department of Pediatrics, Dr. Soetomo General Hospital Surabaya. This study was approved by Dr. Soetomo General Hospital Ethical Committee with signed ethical approval number 0388/105/XI/2020.

The sample in this study met the inclusion criteria: pediatric patients aged 0-5 years old who suffered from allergies and were treated at the allergy outpatient clinic. The exclusion criteria were patients with incomplete medical record data. The minimum sample size required in this study was 169 samples. This study used the total sampling method by taking all members of the population who met the inclusion and exclusion criteria.

The subjects were assessed based on the age of early allergic manifestation, type of early allergic manifestation, number of family members who smoke at home, family history of allergies, gender, delivery method, history of exclusive breastfeeding and early feeding, recent education, parental education and occupations, and pets. The research instrument used in this study was the medical record of allergic pediatric patients at Dr. Soetomo General Hospital Surabaya who met the inclusion criteria. The data was analyzed using SPSS. The normal distribution test was not performed. Outcome measures between groups were distributed and compared using univariate and bivariate analysis, namely the One-way ANOVA Test and Chi-Square Test. $p < 0.05$ was considered statistically significant.

RESULTS

Characteristic sample of the study is shown in Table 1. One-way ANOVA test analysis showed that five variables had significance: the number of smokers at home, gender, parental education, parental occupation, and family atopy history (Table 2). Furthermore, the variable number of smokers, parental education, and parental occupation were further analyzed using post hoc analysis. There was no need for a post hoc analysis on the variables of gender and family atopy history because there were only two groups. In contrast, a post hoc analysis could be performed if there were more than two groups.

Based on the results of post hoc analysis, the patients who do not have a family of smokers had a higher age of manifestation than those who have a family of smokers. Meanwhile, the patients who have a smoking family, either only one or all of the family, had no significant difference. Patients with parental education who graduated from junior high school had a higher age of manifestation than the others. Meanwhile, the lowest were patients with families with a master's degree education. Patients whose parents are private employees had a higher age of manifestation than others. Meanwhile, the lowest were patients with families whose parents work as entrepreneurs.

The Chi-square test on respiratory tract manifestations showed that five variables significantly affected respiratory tract manifestations: the number of smokers at home, delivery methods, parental education, pets, and family atopy history (Table 3).

Table 1. Sample characteristics

Sample Characteristics	n (%)
Gender	
Female	65 (34.2%)
Male	125 (65.8%)
Parents' last education	
JHS	11 (5.8%)
SHS	22 (11.6%)
Bachelor	54 (28.4%)
Master	94 (48.5%)
Doctoral	9 (4.7%)
Parents' occupation	
Farmer	22 (11.6%)
Private sector employee	80 (42.1%)
Government employee	9 (4.7%)
Entrepreneur	79 (41.6%)
Age (months)	
1-10	36 (18.94%)
11-20	61 (32.10%)
21-30	57 (30%)
31-40	25 (13.15%)
41-50	9 (4.73%)
51-60	2 (1.05%)
Delivery methods	
Normal	175 (92.1%)
CS	15 (7.9%)
Duration of exclusive breastfeeding and early feeding	
>6 months	17 (8.9%)
<6 months	173 (91.1%)
Family atopic history	
None	159 (83.7%)
Yes	31 (16.3%)
Pets	
None	18 (9.5%)
Yes	172 (90.5%)
Number of smokers at home	
None	95 (50%)
One of the family members	85 (44,7%)
All the family members	10 (5.3%)
Early clinical manifestation	
Respiratory tract	
None	3 (1.6%)
Cough and runny nose	105 (55.3%)
Cough, runny nose, and wheezing	79 (41.6%)
Runny nose	3 (1.6%)
Gastrointestinal tract	
None	186 (97.9%)
Yes	4 (2.1%)
Skin	
None	175 (92.1%)
Yes	15 (7.9%)

JHS = junior high school; SHS = senior high school; CS = Caesarean section.

Table 2. The relationship between sample characteristics with age onset of allergic manifestation

Variables	Mean	Std. Deviation	p
Number of smokers at home			
None	29.80	9.689	< 0.001*
One of them	14.72	7.829	
All of them	15.40	5.502	
Gender			
Female	19.48	10.633	0.014*
Male	23.76	11.686	
Delivery methods			
Normal	22.55	11.102	0.289
CS	19.27	15.489	
Duration of exclusive breastfeeding and early feeding			
>6 months	18.06	5.031	0.111
<6 months	22.71	11.865	
Parents' last education			
JHS	33.73	10.910	
SHS	21.36	10.635	
Bachelor	21.94	11.216	0.013*
Master	21.15	11.438	
Doctoral	24.67	10.700	
Parents' occupation			
Farmer	24.45	9.159	
Private sector employee	26.26	11.709	< 0.001*
Government employee	25.22	9.705	
Entrepreneur	17.34	10.272	
Pets			
None	24.06	14.968	0.496
Yes	22.11	11.104	
Family atopy history			
None	23.27	11.275	0.008*
Yes	17.29	11.461	

*Significance if p < 0.005; JHS = junior high school; SHS = senior high school; CS = Caesarean section.

Table 3. The relationship between sample characteristics with respiratory manifestation

Variables	None, n	Cough and runny nose, n	Cough, runny nose, wheezing, n	Runny nose, n	p
Number of smokers at home					
None	3	92	0	0	0.040*
One of them	0	12	73	0	
All of them	0	1	6	3	
Gender					
Female	0	26	39	0	0.111
Male	3	79	40	3	
Delivery methods					
Normal	0	102	70	3	< 0.001*
CS	3	3	9	0	
Duration of exclusive breastfeeding and early feeding					
>6 months	0	1	16	0	0.451
<6 months	3	104	63	3	
Parents' last education					
JHS	3	8	0	0	
SHS	0	14	8	0	0.001*
Bachelor	0	28	26	0	
Master	0	48	43	3	
Doctoral	0	7	2	0	
Parents' occupation					
Farmer	0	22	0	0	0.149
Private sector employee	0	65	15	0	
Government employee	0	9	0	3	
Entrepreneur	3	9	64	3	
Pets					< 0.001*
None	3	8	7	0	
Yes	0	97	72	3	
Family atopy history					
None	0	92	64	3	0.001*
Yes	3	13	15	0	

JHS = junior high school; SHS = senior high school; CS = Caesarean section.

Table 4. The relationship between sample characteristics with gastrointestinal manifestation

Variables	No, n	Yes, n	p
Number of smokers at home			
None	92	3	0.301
One of them	84	1	
All of them	10	0	
Gender			
Female	65	0	0.065
Male	121	4	
Delivery methods			
Normal	174	1	0.001*
CS	12	3	
Duration of exclusive breastfeeding and early feeding			
>6 months	17	0	0.384
<6 months	169	4	
Parents' last education			
JHS	8	3	
SHS	22	0	0.010*
Bachelor	54	0	
Master	93	1	
Doctoral	9	0	
Parents' occupation			
Farmer	22	0	
Private sector employee	79	1	0.468
Government employee	9	0	
Entrepreneur	76	3	
Pets			
None	15	3	0.001*
Yes	171	1	
Family atopy history			
None	159	0	<0.001*
Yes	27	4	

*Significance if $p < 0.05$; JHS = junior high school; SHS = senior high school; CS = Caesarean section.

The Chi-square test on the manifestations of the digestive tract showed four variables that significantly influenced the digestive manifestations, namely delivery methods, parental education, pets, and family atopy history (Table 4).

Table 5. The relationship between sample characteristics with skin manifestation

Variables	No, n	Yes, n	p
Number of smokers at home			
None	92	3	0.301
One of them	84	1	
All of them	10	0	
Gender			
Female	65	0	0.065
Male	121	4	
Delivery methods			
Normal	174	1	0.001*
CS	12	3	
Duration of exclusive breastfeeding and early feeding			
>6 months	17	0	0.384
<6 months	169	4	
Parents' last education			
JHS	8	3	
SHS	22	0	0.010*
Bachelor	54	0	
Master	93	1	
Doctoral	9	0	
Parents' occupation			
Farmer	22	0	
Private sector employee	79	1	0.468
Government employee	9	0	
Entrepreneur	76	3	
Pets			
None	15	3	0.001*
Yes	171	1	
Family atopy history			
None	159	0	<0.001*
Yes	27	4	

*Significance if $p < 0.05$; JHS = junior high school; SHS = senior high school; CS = Caesarean section.

The Chi-square test on skin manifestations showed three variables that significantly affected skin manifestations: the number of smokers at home, gender, and family atopy history (Table 5).

DISCUSSION

The findings of this study showed that there was a significant relationship between the presence of family members who smoked at home and the age at which the early manifestations appeared in allergic pediatric patients ($p < 0.05$). This is also supported by the results of post hoc analysis, which showed that patients who do not have smoking families had a higher age of manifestation than those who have smoking families. These findings are in line with a previous study by Goudarzi in Japan, which showed that exposure to cigarette smoke was associated with the onset of allergic manifestations in children.[7]

The findings of this study also showed that there was a significant relationship between the presence of family members who smoked at home with early respiratory tract manifestations and early skin manifestations in allergic pediatric patients (each $p < 0.05$). Meanwhile, there was no significant relationship between family members who smoked at home and early gastrointestinal manifestations in allergic pediatric patients ($p = 0.301$).

These findings are in line with a study conducted by Tanaka in Japan which found that children exposed to cigarette smoke during the prenatal period had a 1.18-times higher risk of developing atopic dermatitis (95% CI 0.34-3).[8] Similar findings were also obtained in Ramadhona's study in Palembang, South Sumatra, which showed that exposure to cigarette smoke was one of the factors that influenced the occurrence of allergies in toddlers ($p = 0.007$).[9]

A previous study conducted by Levin in South Africa found that a child will have an up to 18 times greater risk of developing asthma if his mother smokes ($p < 0.001$) and a 42.2 times greater risk of developing

asthma if they have a father who smokes ($p < 0.001$).[10] A study conducted by Sun in China also showed a relationship between exposure to cigarette smoke in the early years of a child's life and an increased risk of developing asthma in childhood.[11] Xie's study in the United States found that children living in the same household as smokers were 30% more likely to develop asthma (95% CI 1.09-1.52).[12]

Different findings were obtained in a study conducted by Arifans in Surakarta, Central Java which found that there was no relationship between exposure to cigarette smoke and the incidence of asthma ($p = 0.654$), allergic rhinitis ($p = 0.146$), and atopic dermatitis ($p = 0.217$).[13] Differences in the characteristics of the research subjects cause the difference in the findings between the previous study and this study. Arifans' study used school-age children, generally aged 10-12 years old, as research subjects, while this study used preschool-age children.

Family atopy history

This study found a relationship between a family history of allergies and the age at which the early allergic manifestations appeared in allergic pediatric patients ($p = 0.008$). This study also found a relationship between a family history of allergies and the appearance of allergic manifestations in the respiratory tract, digestive tract, and skin (all $p < 0.05$). This finding is in line with a previous study which found that children who have parents with a history of allergies will have a greater risk of experiencing allergies than children who do not have parents with a history of allergies.[14]

Gender

This study found a relationship between gender and the age at which the early allergic manifestations appeared in allergic pediatric patients ($p < 0.05$). This study also found that there was a relationship between gender and the appearance of allergic manifestations on the skin ($p < 0.05$), but it was not associated with allergic manifestations in the respiratory tract ($p = 0.111$) and digestive tract ($p = 0.065$). The findings showed a significant relationship between gender and allergic rhinitis ($p = 0.003$). The female gender is more likely to be compared to the male gender.[15] At a young age, more boys develop asthma, which changes rapidly as girls mature. It is seen that testosterone appears to play a protective role, while oestrogen exacerbates asthma.[16]

Delivery methods

This study found no relationship between the delivery method and the age at which the early allergic manifestations appeared in allergic pediatric patients ($p = 0.289$). This study also found that there was a relationship between the method of delivery and the appearance of allergic manifestations in the respiratory system ($p < 0.05$) and digestive system ($p < 0.05$) but not with the allergic manifestations on the skin ($p = 0.109$). A previous study found no relationship between the delivery method and allergic manifestations in toddlers.[14]

Duration of exclusive breastfeeding and early feeding

This study found no relationship between a history of exclusive breastfeeding and early feeding with the age at which the early allergic manifestations appeared in allergic pediatric patients ($p = 0.111$). This study also found that there was no relationship between a history of exclusive breastfeeding and early feeding with the appearance of allergic manifestations in the respiratory system ($p = 0.451$), digestive system ($p = 0.384$), and skin ($p = 0.087$). This finding is in line with a previous study which found no significant difference between the incidence of allergies in breastfed children and those who were breastfed and formula-fed.[17] Previous studies have also found something in line with this, that there is no relationship between the pattern of giving complementary feeding and breastfeeding with the incidence of allergies in children. However, this finding differs from a study conducted by Rachma, *et al*. in Dr. Soetomo General Hospital Surabaya, who concluded that exclusive breastfeeding duration correlated with the severity of asthma.[18]

Parents' last education

This study also found a relationship between the parents' last education and the age at which the early allergic manifestations appeared in allergic pediatric patients ($p = 0.013$). This study also found that there was a relationship between the last education of parents with the appearance of allergic manifestations in the respiratory system ($p = 0.001$) and digestive system ($p = 0.010$), but not with allergic manifestations on the skin ($p = 0.348$). This study found that 48.5% of the sample had parents with a master's degree. This is probably due to parents with higher education having easier access to health services and a higher awareness of their children's

health. Therefore, they will seek help when the symptoms appear by bringing their child to a healthcare facility.

Parents' occupation

This study found a relationship between parental occupation and the age at which the early allergic manifestations appeared in allergic pediatric patients (p= 0.000). This study also found that there was no relationship between parental occupation and the appearance of allergic manifestations in the respiratory system (p = 0.149), digestive system (p = 0.468), and skin (p = 0.657). Previous studies found that the prevalence of a skin prick test (SPT) for each aeroallergen was significantly higher in children of high socioeconomic status than in children of low socioeconomic status (p < 0.001).[19]

Pets

This study found a relationship between pets and the age at which the early allergic manifestations appeared in allergic pediatric patients (p = 0.008). This study also found that there was a relationship between gender and the appearance of allergic manifestations in the respiratory system (p < 0.05) and digestive system (p < 0.05), but not associated with allergic skin manifestations (p = 0.077). In theory, having a pet during childhood is associated with fewer allergies. The protective effect of keeping animals increases as the number of animals kept increases. The protective effect affects clinical allergy and sensitization to animals and pollen through a "mini farm" mechanism. This mechanism explains that the induction of tolerance to allergens in animals requires close contact with animals. Subsequently, children are exposed several times to microbes and microbial endotoxins from these animals. When pets are kept outdoors more often, allergens from cats and dogs will still spread inside the house and cause sensitization, but no microbial endotoxin exposure occurs. Therefore, the risk of allergies will increase.[20]

LIMITATION

The limitation of this study was that the samples were obtained from Dr. Soetomo General Hospital Surabaya, a tertiary hospital that mostly accepts referrals from patients undergoing immunotherapy. Therefore, the findings of this study might differ from what is happening in general society. This study also did not classify the period of exposure to cigarette smoke, such as the prenatal or postnatal period. Lastly, this study did not identify the severity of smoking, such as a light smoker, intermittent smoker, or heavy smoker.

CONCLUSION

There was a significant relationship between the presence of family members who smoke at home and the early age of allergic manifestations, early respiratory tract manifestations, and early skin manifestations. Based on the results, it is known that patients who do not have a smoker family member had a higher age of allergic manifestation than those who have a smoker family member. It means that second-hand smoke exposure accelerates the appearance of allergic manifestations and is associated with allergic manifestations of the respiratory tract and skin in children.

FUTURE RECOMMENDATION

This study suggests avoiding cigarette smoke exposure in children because it relates to early allergic manifestations based on age and types of allergies. It is also crucial for health workers to educate parents on preventing cigarette smoke exposure to their children. Thus, the incidence of allergies can be prevented. For further research, it is necessary to classify the time of exposure to cigarette smoke and the severity of smokers.

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Conflict of Interest
The author declared there is no conflict of interest.

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Authors' Contributions
Concepting, designing, and collecting the data: SAD and AE. Providing access to the data: AE. Analyzing statistics: SAD and LD. Reviewing and revising: AMP and AAM. All authors contributed and approved the final version of the manuscript.

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