Second-Hand Smoke and Early Allergic Manifestation in Children

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ABSTRACT

Introduction: Allergic diseases have a high morbidity rate worldwide. The interaction between genetic and environmental factors plays an important role in shaping the early development of allergies, including exposure to cigarette smoke. The prevalence of children in Indonesia who are exposed to cigarette smoke is high. Thus, it is suspected that this will affect the emergence of allergies in children. 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 involving 190 pediatric patients who suffered from allergies in the allergy outpatient clinic at the Department of Pediatrics, Dr. Soetomo General Hospital Surabaya. Data were obtained through medical records.

Results: This study 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

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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 and 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, a referral hospital, 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 were patients who met the inclusion criteria, which were 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 then compared using univariate and bivariate analysis, namely the One-way ANOVA Test and Chi-Square Test. p < 0.05 was considered statistically significant.

RESULTS

One-way ANOVA test analysis showed that five variables had significance, namely 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 was 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, whereas 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, namely 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%) |
| Smoker in the house    |       |
| 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%) |
| CS = caesarean section; JHS = junior high school; SHS = senior high school

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

| Variables                        | Mean     | Std. Deviation | p  |
|----------------------------------|----------|----------------|---|
| Numbers of smokers at home       | <0.001*  |                |   |
| None                             | 29.80    | 9.689          |   |
| One of them                      | 14.72    | 7.829          |   |
| All of them                      | 15.40    | 5.502          |   |
| Gender                           | 0.014*   |                |   |
| Female                           | 19.48    | 10.633         |   |
| Male                             | 23.76    | 11.686         |   |
| Delivery methods                 | 0.289    |                |   |
| Normal                           | 22.55    | 11.102         |   |
| CS                               | 19.27    | 15.489         |   |

Table 3. The relationship between sample characteristics with respiratory manifestation

| Variables                        | Mean     | Std. Deviation | p  |
|----------------------------------|----------|----------------|---|
| Number of smokers at home        | 0.040*   |                |   |
| None                             | 3        | 92             | 0  |
| One of them                      | 0        | 12             | 73 |
| All of them                      | 0        | 1              | 6  |
| Gender                           | 0.111    |                |   |
| Female                           | 0        | 26             | 39 |
| Male                             | 3        | 79             | 40 |
| Delivery methods                 | <0.001*  |                |   |
| Normal                           | 0        | 102            | 70 |
| CS                               | 3        | 3              | 9  |
| Duration of exclusive breastfeeding and early feeding|       |
| >6 months                        | 0        | 1              | 16 |
| <6 months                        | 3        | 104            | 63 |
| Parental education               | 0.001*   |                |   |
| JHS                              | 3        | 8              | 0  |
| SHS                              | 0        | 14             | 8  |
| Bachelor                         | 0        | 28             | 26 |
| Master                           | 0        | 48             | 43 |
| Doctoral                         | 0        | 7              | 2  |
| Parental occupation              | 0.149    |                |   |
| Farmer                           | 0        | 22             | 0  |
| Private sector employee          | 0        | 65             | 15 |
| Government employee              | 0        | 9              | 0  |
| Entrepreneur                     | 3        | 9              | 64 |
| Pets                             | <0.001*  |                |   |
| None                             | 3        | 8              | 7  |
| Yes                              | 0        | 97             | 72 |
| Family atopy history             | 0.001*   |                |   |
| None                             | 0        | 92             | 64 |
| Yes                              | 3        | 13             | 15 |
The Chi-square test on skin manifestations showed three variables that significantly affected skin manifestations, namely 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). 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. 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).

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). The difference in the findings between the previous study and this study is caused by differences in the characteristics of the research subjects. 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.

**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 has a greater probability of being compared to the male gender. 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.

**Delivery Methods**

This study found that there was no relationship between the method of delivery 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 that there was no relationship between the method of delivery and allergic manifestations in toddlers.

**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 that there was no significant difference between the incidence of allergies in children who were breastfed and children who were breastfed and formula-fed. 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.

**Parental 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 having a higher level of awareness regarding their children's health. Therefore, when the symptoms appear, they will seek help by bringing their child to a healthcare facility.

**Parental 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 in high socioeconomic status than in children in 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 not only affects clinical allergy but also 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

**LIMITATIONS**

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 with 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 RECOMMENDATIONS**

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 and designing: SAD and AE. Providing access to the data: AE. Collecting the data: SAD and AE. Statistical analysis: SAD and LD. All authors were involved with report writing, revising the manuscript, and approving the final version of the article.
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