

## Food allergies in children: a comparison of parental reports and skin prick test results

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### Abstract

**Background** Food allergy is common in children and its prevalence is generally on the rise. Imprecise parental reports about reactions to particular foods can lead to unnecessary restrictions. Since children have specific growth requirements, such nutritional restrictions may have disturbing effects on children's growth and development.

**Objective** To compare parental reports on food reactions to skin prick test results in their children.

**Method** Retrospective, cross sectional study using patient's medical record data during one-year study period. Data were analyzed manually and statistically, to assess the degree of agreement (Kappa's coefficient) and significance (P).

**Results** We collected data from 154 subjects aged 0-18 years. For every allergen assessed, parents reported more food reactions than positive skin prick test results. Allergy incidence were caused, in order, by cow's milk and chicken (25.3%), eggs (22.1%), chocolate (20.1%), fruits (14.3%), seafood (13%), and saltwater fish (1.9%). Kappa coefficient are all poor (<0.2) and P value are all >0.05 except for chicken (P=0.02).

**Conclusion** Most parents tend to overestimate which food cause reactions in their children, as reactions reported were not necessarily allergenic. Therefore, every patient experiencing allergy reactions should undergo skin prick testing to confirm the possibility of allergy. [Paediatr Indones. 2018;58:59-65; doi: <http://dx.doi.org/10.14238/pi58.1.2018.59-65>].

**Keywords:** food allergy; skin prick test

Food allergy is an abnormal reaction towards certain food antigens to some individual.<sup>1</sup> Food allergy is common in children. Its manifestations range from skin to respiratory system. Foods with high nutritional value such as cow's milk, eggs, chicken, and seafood may cause these adverse reactions.<sup>2</sup> Since children have increased nutritional needs for proper growth and development, the imprecision of parental estimation about particular food causing reactions can lead to unnecessary restrictions of certain food. Such restrictions may disturb children's growth and development.

Diagnostic testing is needed for food allergy diagnosis since medical history and physical examination are not sufficient. Skin prick testing is recommended<sup>3</sup> because it is fast, inexpensive, reliable, widely available, and has been widely studied. Negative test results have been shown to effectively rule out Ig-E mediated allergies.<sup>4</sup> We aimed to determine whether parental reports corresponded to the skin prick test results in children with food reactions.

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## Methods

We conducted a retrospective cross-sectional study at the Department of Pediatrics, Dr. Soetomo General Hospital, Surabaya. We reviewed medical histories of patients who visited the hospital from 1 January 2015 until 31 December 2015. There were 154 patients throughout the year. The inclusion criteria were patients aged 0-18 years old, had allergy symptoms, had parents who had reported possible food allergens, and who underwent a skin prick test in the Department of Child Health during 2015. Data were collected by total sampling.

Allergy symptoms had been collected through interviews with the parents and was written on the 'anamnesis' columns, completed with details of the symptoms. Possible food allergens were also been collected through interviews and was written on 'possible food allergens' column. Skin prick test results were performed with sterile lancets and commercial food allergens extract in the volar area of forearm, on columns which had been drawn. Seven allergens were tested: fruits, seafood, saltwater fish, cow's milk, chocolate, chicken, and egg. Control specimen used were normal saline (negative) and histamine (positive). Reactions were observed after 20 minutes. The wheal-and-flare reactions were measured with a ruler in millimeters (1 mm = 0.001 m). The vertical and horizontal diameters of the wheal-and-flare were added and divided by 2, resulting in mean diameter, which was recorded. Skin prick test results were considered to be positive if their diameter was >3mm than the negative control. The supervising pediatrician made the final diagnoses. Patient's age and sex were also collected from medical records.

The distribution pattern was shown in a descriptive table. We used SPSS software to determine the degree of agreement (Kappa's coefficient) and significance (P value). Results with P values <0.05 were considered to be statistically significant. This study was approved by the Ethics Committee of Dr. Soetomo General Hospital, Surabaya.

## Results

One hundred fifty-four children were enrolled in this study. Subject's characteristics are shown in **Table 1**.

Subjects were consists of 97 (63%) males and 57(37%) females. The majority of subjects were aged 5 to 14 years (81 subjects, 52.6%).

**Table 1.** Subject's characteristics (N=154)

Characteristics		
Gender, n(%)		
Male	97 (63)	
Female	57 (37)	
Age, n(%)		
<1	6 (3.9)	
1- <5	63 (40.9)	
5- <14	81 (52.6)	
>14	4 (2.6)	
Allergens	Positive skin prick test	Parents reported allergy symptoms
Fruit	22	59
Seafood	20	35
Saltwater fish	3	3
Cow's milk	39	66
Chocolate	31	85
Chicken	39	48
Egg	33	53

\*one child had more than 1 allergens

From 154 subjects, 59 (38.3%) subjects' parents reported allergy symptoms to fruit. In this study, fruit was represented by orange and tomato extract. Of these 59 subjects, 22 (37.3%) had positive skin prick tests. Of the 95 subjects reported not allergic to fruit, 27 (28.4%) tested positive. In total, there were 49 (31.8%) subjects who tested positive and 105 (68.2%) subjects who tested negative (**Table 2**). Kappa coefficient revealed a very low degree of agreement (0.092) and no statistical significance (P=0.251).

**Table 2.** Conformity between parental reports and skin prick test results for fruit allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	22	37	59 (38.3)	0.251
Negative	27	68	95 (61.7)	
Total, n(%)	49 (31.8)	105 (68.2)	154 (100)	

Kappa coefficient=0.092; sensitivity=44.9%; specificity=64.8%; positive predictive value (PPV)=37.2%; negative predictive value (NPV)=71.6%; accuracy=58.4%

Thirty-five (22.7%) subjects had seafood allergies, according to parental reports. Seafood in this study excludes saltwater fish which was tested

separately. Of these 35 children, 20 (57.1%) tested positive. In addition, of the 119 subjects reported to not manifested allergy symptoms, 64 (53.8%) also tested positive. In total, 84 (54.5%) subjects tested positive, while 70 (45.5%) tested negative (Table 3). Kappa coefficient revealed a very low degree of agreement (0.022) and no statistical significance (P=0.726).

**Table 3.** Conformity between parental reports and skin prick test results for seafood allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	20	15	35 (22.7)	0.726
Negative	64	55	119 (77.3)	
Total, n(%)	84 (54.5)	70 (45.5)	154 (100)	

Kappa coefficient=0.022; sensitivity=23.8%; specificity=78.5%; positive predictive value (PPV)=57.1%; negative predictive value (NPV)=46.2%; accuracy=48.7%

Only 3 (1.9%) subjects were reported allergic to saltwater fish by their parents, and all of them had positive skin prick test. Of the 151 subjects who were reported not allergic to saltwater fish, 76 (50.3%) also tested positive. In total, 79 (51.3%) subjects tested positive and 75 (48.7%) tested negative (Table 4). Kappa coefficient revealed a very low degree of agreement (0.037) and not statistical significance (P=0.088).

**Table 4.** Conformity between parental reports and skin prick test results for saltwater fish allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	3	0	3 (1.9)	0.088
Negative	76	75	151 (98.1)	
Total, n(%)	79 (51.3)	75 (48.7)	154 (100)	

Kappa coefficient=0.037; sensitivity=3.8%; specificity=100%; positive predictive value (PPV)=100%; negative predictive value (NPV)=49.7%; accuracy=50.6%

Sixty-six (42.9%) subjects were reported allergic to cow's milk by their parents. Of these 66 children, 39 (59.1%) had positive skin prick test. Of the 88 subjects who were reported not allergic, 46 (52.3%) tested positive. In total, 85 (55.2%) subjects tested positive and 69 (44.8%) tested negative (Table 5). Kappa

coefficient revealed a very low degree of agreement (0.066) and no statistical significance (P=0.400).

**Table 5.** Conformity between parental reports and skin prick test results for cow's milk allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	39	27	66 (42.9)	0.4
Negative	46	42	88 (57.1)	
Total, n(%)	85 (55.2)	69 (44.8)	154 (100)	

Kappa coefficient=0.066; sensitivity=45.9%; specificity=60.9%; positive predictive value (PPV)=59.1%; negative predictive value (NPV)=47.7%; accuracy=52.6%

Eighty-five (55.2%) subjects were reported by their parents to manifest allergic reactions to chocolate. Of these 85 children, 31 (36.5%) tested positive. Of 69 subjects who were reported to not have allergies to chocolate, 22 (31.9%) also tested positive. In total, 53 (34.4%) subjects tested positive to chocolate allergens, while 101 (65.6%) were negative (Table 6). Kappa coefficient revealed a very low degree of agreement (0.044) and no statistical significance (P=0.551).

**Table 6.** Conformity between parental reports and skin prick test results for chocolate allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	31	54	85 (55.2)	0.551
Negative	22	47	69 (44.8)	
Total, n(%)	53 (34.4)	101 (65.6)	154 (100)	

Kappa coefficient=0.044; sensitivity=58.5%; specificity=46.5%; positive predictive value (PPV)=36.5%; negative predictive value (NPV)=68.1%; accuracy=50.6%

Forty-eight (31.2%) subjects were reported allergic to chicken meat. Of these, 39 (81.3%) had positive skin prick test results. Of the 106 subjects who were reported not allergic, 59 (55.7%) also tested positive. In total, 98 (63.6%) subjects tested positive and 56 (36.4%) tested negative (Table 7). Kappa coefficient revealed a low degree of agreement (0.199) but was statistically significant (P=0.02).

For egg allergens, data were collected from 149 subjects. Fifty-three (35.6%) subjects were reported allergic to eggs. Of these, 33 (62.2%) subjects had positive test results. From 96 subjects who were

**Table 7.** Conformity between parental reports and skin prick test results for chicken allergen

Parental report (N=154)	Skin prick test result (N=154)		Total, n (%)	P value
	Positive	Negative		
Positive	39	9	48 (31.2)	0.02
Negative	59	47	106 (68.8)	
Total, n(%)	98 (63.6)	56 (36.4)	154 (100)	

Kappa coefficient=0.199; sensitivity=39.8%; specificity=83.9%; positive predictive value (PPV)=81.3%; negative predictive value (NPV)=44.3%; accuracy=55.8%

reported to not have allergies, 53 (55.2%) had positive test results. In total, 86 (57.7%) subjects had positive test results and 63 (42.3%) had negative results (Table 8). Kappa coefficient revealed a very low degree of agreement (0.062) and no statistical significance ( $P=0.404$ ).

**Table 8.** Conformity between parental reports and skin prick test results for egg allergen

Parental report (N=149)	Skin prick test result (N=149)		Total, n (%)	P value
	Positive	Negative		
Positive	33	20	53 (35.6)	0.04
Negative	53	43	96 (64.4)	
Total, n(%)	86 (57.7)	63 (42.3)	149 (100)	

Kappa coefficient=0.062; sensitivity=38.4%; specificity=68.3%; positive predictive value (PPV)=62.3%; negative predictive value (NPV)=44.8%; accuracy=49.4%

## Discussion

Food allergy is defined by an abnormal reaction of the immune systems toward certain foods.<sup>5</sup> The reason why some individual show this kind of reaction are not fully understood. Multiple factors may contribute to the condition.<sup>6</sup> In our study, 97 (63%) of 154 subjects were male, similar to previous report recorded by Ebert *et al.*, in 2011. Food allergies, especially to cow's milk are more common in male than female.<sup>7</sup> Boys also tend to have asthma or another atopic diseases more than girls, with ratio 1.8:1.<sup>8</sup>

Allergy prevalence varies worldwide. Discrepant results may be due to different methods, population,<sup>9</sup> geography, and possibly race.<sup>10</sup> An epidemiologic study by *European Academy of Allergy and Clinical Immunology* (EAACI) from 2000 to 2012 recorded a 6.9% prevalence for children aged 0 to 17 years.

Allergy prevalence is also tend to be 6 times higher when based on parental reports compared to the real prevalence.<sup>9</sup>

The largest age group of subjects was between 5 to 14 (81 children) year-old. Food sensitization is more common in children because their immature bowel lack protection.<sup>6</sup> Moreover, young age (1-19 years) has been defined as a significant risk factor for food allergies.<sup>8</sup> Allergy incidence was also reportedly decreased with increased age, possibly due to the resolution of several allergies.<sup>11</sup> Children less than 3 years old have the highest risk of disturbed growth and development due to inadequate nutritional intake. Elimination diets should be taken carefully to ensure sufficient nutritional intake.<sup>9</sup>

Positive skin prick test does not always indicate food allergy. It is necessary to connect results to clinical manifestations. However, parents tend to incorrectly deduce the probable food causing the allergy manifestation.<sup>12</sup>

According to *Alergologica* in 2015, fruits and nuts are the most common food causing allergies in patients aged >5 years.<sup>6</sup> This allergy is common in children and adults.<sup>13</sup> In our study, we found that 22 subjects were diagnosed allergic to fruits, by both parents and skin prick test results. In a Hong Kong study of 352 allergy patients, fruit was on the 4<sup>th</sup> highest position with 30 (8.5%) reports.<sup>14</sup> Higher results were recorded in a study of 461 people with self-reporting allergy compared to diagnostic test, with fruit in the 1st position with 41.86%.<sup>15</sup>

There were 37 subjects with non-IgE mediated/food intolerance that clinical manifestations appear similar but negative skin prick test to fruit. These subjects should continue elimination and provocation procedure.<sup>16</sup> Certain fruits such as strawberries, oranges, and tomatoes, are thought to directly stimulate mast cells to release histamine.<sup>17</sup> Subjects with no clinical manifestations but positive skin prick test were sensitized to fruits. A few fruit allergens have similarities to pollens and grass.<sup>12</sup> Fruit allergens have thermolability which can also result in absent clinical manifestation.<sup>18</sup> We found a very low degree of agreement and lack of statistical significance between parental reports and skin prick test results for fruit. Generally, parental reports tend to incorrectly deduce the cause of allergies. Similarly, a study of 78 reports of allergies, only 28 showed positive results by skin



prick test.<sup>12</sup> It is difficult to identify fruit allergies as fruit is often mixed in consumption with other substances.<sup>17</sup>

Seafood is one of eight most common allergens due to IgE-mediated allergy and is a common cause of food allergy anaphylaxis. The allergenicity of seafood is highly affected by processing method.<sup>19</sup> The high incidence of seafood allergy is in line with its high consumption worldwide. This allergy is also a common comorbid for cow's milk allergy.<sup>20</sup> Most seafood allergy manifests in adults.<sup>21</sup> In our study, there was a very low degree of agreement and lack of statistical significance between parental reports and skin prick test results for seafood. Only 20 subjects (57.1%) tested positive out of 35 reported to have seafood allergies by parents. A study of 37 food-allergic children reported that 43.2% were allergic to seafood.<sup>22</sup> Clinical manifestations may also result from hidden ingredients such as food proteins, additives, or parasites.<sup>19</sup> We also noted that 64 subjects (76.2%) showed sensitization without symptoms, which may have resulted from cross-sensitization with house dust mites. House dust mites and seafood share one similar allergen, tropomyosin.<sup>23</sup>

Saltwater fish is a common diet in various communities. Allergies may occur through inhalation, contact, and ingestion.<sup>21</sup> In contrast to cow's milk and egg allergies, fish allergies tend to last for a lifetime and careful diet restriction is needed.<sup>24</sup> The prevalence of fish allergy varies worldwide. In Scandinavian countries, it is ranked 3<sup>rd</sup>, after egg and milk allergy in infants. In Spain, approximately 30% of 355 children were allergic to fish.<sup>21</sup> However, there were little data on the South East Asian region. In Hong Kong, 0.32% of children aged 2 to 7 years were reported to have fish allergies.<sup>25</sup> In our study, there was a very low degree of agreement and lack of statistical significance between parental reports and skin prick test results for saltwater fish. Only 3 out of 154 subjects' parents reported fish allergies, and all three subjects tested positive. The sensitization rate (positive skin prick test) was also high (79 children, 51.3%), in line with the high consumption of fish in this population. Cross-sensitization between certain fish species, also put individuals at risk for multiple fish allergies.<sup>26</sup>

Cow's milk allergy is most common in children, with a prevalence reaching 2.5%.<sup>27</sup> A study by *Food and Agriculture Organization* (FAO) stated that

approximately 90% of children were sensitized and/or allergic to cow's milk and egg.<sup>9</sup> Cow's milk allergy was reported to have the highest food allergy incidence in children aged less than 2 years.<sup>20</sup> Clinically, this allergy commonly appears at age 6 to 12 months, a period in which animal products are introduced.<sup>6</sup> Its prevalence rises every year in parallel with decreased breastfeeding and increased formula feeding.<sup>28</sup> Also, cow's milk allergy has tended to increase in developing countries.<sup>6</sup> We found 39 out of 154 subjects to be positive for allergy to cow's milk, based on both parental reports and skin prick test. Parental reports was used for comparison to skin prick test to determine whether it is Ig-E-mediated allergy. Confirmed diagnosis for cow's milk allergy is necessary because it affects one's quality of life and social participation more than another allergies.<sup>20</sup> Some patients experienced resolution from cow's milk allergy at about one or two years of age,<sup>28</sup> but other children take longer, up to 12 years of age.<sup>7</sup> The mechanism of tolerance is not fully understood until now. In fact, the IgE responses to protein in cow's milk are diverse and no particular structure in cow's milk protein has yet identified as causing allergenicity. Few of recognized allergens such as caseins,  $\beta$ -lactoglobulin, and  $\alpha$ -lactalbumin which is abundant in cow's milk.<sup>28</sup> A high sensitization rate was recorded in our study, as 85 (55.2%) were tested positive out of 154 subjects. Milk from another mammals has similar protein structure and biological properties to cow's milk, resulting in cross-sensitization. Moreover, protein homology between milk from cow, lamb, and goat reaches 80-90%.<sup>6</sup> In our study there was a very low degree of agreement and lack of statistical significance between parental reports and skin prick test results for cow's milk.

The consumption of chocolate and its product has risen due to its perceived health advantages, putting people with chocolate allergen sensitivity at risk of allergy. Other ingredients are added to chocolate products, such as milk, fruit, nuts, and sugar,<sup>29</sup> for the purpose of texture, flavor, or nutritional value.<sup>30</sup> Allergy is more common after consumptions of chocolate mixed with other products, than chocolate alone. Hence, food-labelling is crucial.<sup>30</sup> In fact, cocoa seeds were found to be less allergenic than tree nuts, but cross-sensitivity is common. Despite the possibility of cross-sensitivity by other nuts, varied cocoa seed processing methods often denaturalized allergenic

proteins, resulting in a low incidence of chocolate allergy.<sup>13</sup> In our study, there was a very low degree of agreement and lack of significance between parental reports and skin prick test results for chocolate.

The prevalence of chicken allergy is uncommon compared to other food such as cow's milk, egg, and fish.<sup>31</sup> Chicken allergy affects both children and adults, and can appear as primary or secondary allergy. Primarily, sensitization may result from inhalation of bird allergens (in adults) or egg allergies (in children). Secondarily, it might result from cross reaction such as in bird-egg syndrome. Published data on chicken allergy are mostly case reports.<sup>32</sup> In our study, the degree of agreement was low, but statistically significant for chicken. Even though it is a rare allergy, we noted that 48 (31.2%) of 154 subjects were reported to have clinical manifestations, and 39/48 (81.3%) of the reported subjects tested positive. In the case of chicken, careful observation by parents was good. High incidence in this study may also be affected by high consumption of chicken, processing methods, and probably through bird exposures.<sup>32</sup>

Egg is also a common cause of food allergies, after milk, in infants and children. Allergy symptoms usually appear after 6 months of age. The initial sensitization could result from exposure to egg in utero or egg protein exposure through breastfeeding.<sup>33</sup> Egg allergies can be caused by consumption of either raw or cooked egg, and egg white or egg yolk. A study indicated that the majority of patients are tolerant with cooked eggs, even though its allergenicity is not only dependent on enzymes and heating. This tolerance can result in small size of wheal in the skin prick test.<sup>34</sup> In our study, egg was ranked 2<sup>nd</sup> after both chicken meat allergy and cow's milk allergy in first position, with 22.1% out of 154 subjects are diagnosed with egg allergy by both parental reports and positive skin prick tests. There was a very low degree of agreement and lack of statistical significance between parental reports and skin prick test results for egg. Egg allergy can also result from inhaling bird allergens, and known as bird-egg syndrome. These patients are mainly allergic to serum albumin in egg yolk.<sup>34</sup> Prognosis is good, with 80% of children becoming tolerant.<sup>35</sup> However, resolution is slow. A previous study found that half of children with egg allergies developed tolerance by 12 years of age.<sup>36</sup>

Our study had several limitations, as it was retrospective in design and a non-standardized skin

prick test procedure may have biased the results. Further studies with prospective methods and a larger number of subjects should be conducted so as to limit unnecessary diet restriction in children.

In conclusion, parental reports of food allergies in children have a low conformity to skin prick test results. Therefore, we recommend performing skin prick test in every individual with allergy symptoms.

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### Conflict of interest

None declared

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