

## Body mass index, atopy, and allergic diseases

Afnita Lestary, Lily Irsa, Tiangsa Sembiring, Rita Evalina, Meiviliani Sinaga

### Abstract

**Background** Prevalence of atopy, allergic diseases, and obesity are increasing. Atopy is an individual and/or familial tendency to sensitization in response to ordinary exposure to allergens. Studies on association of BMI with atopy and allergic diseases in children were limited, with inconclusive results.

**Objective** To assess associations of BMI with atopy and allergic diseases in children.

**Methods** A cross-sectional study was conducted in school children aged 6-12 years in Lhokseumawe City, Aceh, June 2012. Children were assessed for BMI, skin prick test, and *International Study of Asthma and Allergies in Childhood* (ISAAC) questionnaire. Statistical analyses included Chi-square, Fisher exact, and logistic regression.

**Results** The subjects consisted of 137 (85.6%) normoweight, 12 (7.5%) overweight, and 11 (6.9%) obesity. Skin prick test results were positive in 44 (27.5%) and negative in 116 (72.5%) subjects. Allergic manifestations were allergic rhinitis (AR) 17 (10.6%), bronchial asthma 6 (3.8%), and atopic dermatitis (AD) 3 (1.9%). There was significant association of obesity with atopy, compared with normoweight (OR=3.78; 95%CI 1.08 to 13.19; P=0.037), but no significant association found when family history of atopy also assessed. There was significant association of obesity with bronchial asthma (OR=9.92; 95%CI 1.46 to 67.18; P=0.004) and AR (OR=6.49; 95%CI 1.64 to 25.66; P=0.015), compared with normoweight children. Significant association of overweight with atopy and allergic disease were not found.

**Conclusion** Obese children are more likely to have atopy, bronchial asthma, and allergic rhinitis, but overweight and normoweight children are not. [Paediatr Indones. 2016;56:221-5. doi: 10.14238/pi56.4.2016.221-5].

**Keywords:** body mass index; atopy; bronchial asthma; allergic rhinitis; atopic dermatitis

Allergic diseases, such as asthma, allergic rhinitis (AR), atopic dermatitis (AD), allergic conjunctivitis, and food allergy, are hypersensitivity reactions initiated by specific immunologic mechanisms. Atopy is an individual and/or familial tendency to sensitization, with production of IgE antibodies in response to ordinary exposure to allergens.<sup>1</sup> A person with atopic constitution may or not have allergic symptoms. A recently accepted paradigm is allergic diseases are due to a disturbed balance of T helper 1 cell (Th1) and T helper 2 cell (Th2), leading to greater expression of Th2 cytokines features.<sup>2</sup>

In recent decades, allergic disease prevalence in developed and developing countries have increased. The *International Study of Asthma and Allergies in Childhood* (ISAAC) in 2002 revealed increasing in bronchial asthma, AR, and AD prevalences, mainly in children aged 6 to 7 years.<sup>3</sup> Prevalence of obesity and overweight also increase recently.<sup>4</sup> Rising prevalence of allergic diseases, atopy, obesity, and overweight

---

This study was presented at *Pertemuan Ilmiah Tahuman Ilmu Kesehatan Anak VI/PIT IKA VI* (The 6<sup>th</sup> Child Health Annual Scientific Meeting), Solo, Central Java, Indonesia, October 8–10, 2013.

From the Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik Hospital, Medan, North Sumatera, Indonesia.

**Reprint requests to:** dr. Afnita Lestary, Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik Hospital. Jl. Bunga Lau No. 17, Medan 20136. Tel. +62-61-8361721 – 8365663; Fax. +62-61-8361721; E-mail: Afnita\_L@yahoo.com.

suggest a possibility relationships between BMI and atopy<sup>5,6</sup> and allergic diseases.<sup>7-11</sup> Nevertheless, studies in children were limited and had various results. The aimed of this study was to assess associations of BMI with atopy and bronchial asthma, AR, and AD in children.

## Methods

A cross-sectional was performed among school children at Lhokseumawe City, Nanggroe Aceh Darussalam in June 2012. Subjects were 160 students aged 6 to 12 years, with BMI greater than or equal to 5<sup>th</sup> percentile, did not consumed antihistamines in the 3 days or steroids at least one day before the study, without chronic systemic diseases. Children rejected skin prick test, had congenital dysmorphic diseases were excluded. Subjects' parents were informed consent. This study was approved by Ethics Committee of University of Sumatera Utara Medical School.

Subjects' parents were explained about the study. Basic data were obtained from parent interviews and questionnaire. Body weight (BW) measurement was done by *Camry*® scales with 0.1 kg precision, while the children were wearing minimal clothing without shoes or sandals. Body height (BH) measurements was done by microtoise with nearest 0.1 cm, with children standing straight, feet parallel, heels, buttocks, and back of the head touching the wall. The BMI was calculated by BW (in kg) divided by BH (in m) squared, and classified as normoweight, overweight, or obesity, according to the 2000 *Centers for Disease Control and Prevention* (CDC) growth charts. Subject were skin prick tested (produced by Dr. Soetomo Hospital, Surabaya) to 19 common allergens include tomato, crab, orange, cow's milk, shrimp, fresh fish, peanut, snapper, tuna, chicken, chocolate, egg yolk, egg white, chicken, mold, dog hair, chicken feathers, kapok, and house dust mites.<sup>12-16</sup> Subjects' parents were interviewed and fulfilled modified ISAAC questionnaires to assess manifestations of allergic diseases, include asthma, AR and AD.

Data were analyzed by Chi-square, Fisher exact, or logistic regression to assess associations of BMI with atopy and allergic diseases. Atopy was defined as a positive skin test to any of allergens tested. Odds ratio (OR) was used to assess higher BMI as the risk factors

for atopy and allergic diseases. P values < 0.05 and 95% confidence intervals (CI) were considered statistically significant. Other risk factors influenced association of BMI with atopy were also analyzed bivariat; P values < 0.25 then analyzed with logistic regression. Data processing used *SPSS software version 15.0*.

## Results

There were 9,286 elementary students in the sub-district. We selected one school with the largest number of students located in the center of the sub-district. Of 840 students, 410 students fulfilled the inclusion criteria. One hundred and sixty students were enrolled in this study.

**Table 1** shows the characteristics of subjects consisted of 137 (85.6%) normoweight, 12 (7.5%) overweight, and 11 (6.9%) obesity. Skin prick test results were positive in 44 (27.5%) and negative in

**Table 1.** Characteristics of subjects

Characteristics	N=160
Gender, n(%)	
Male	79 (49.4)
Female	81 (50.6)
Median age (SD), years	9.5 (1.71)
Median body weight (SD), kg	29.4 (7.52)
Median body height (SD), cm	129.9 (9.73)
BMI, n(%)	
Normoweight	137 (85.6)
Overweight	12 (7.5)
Obese	11 (6.9)
Skin prick test, n(%)	
Positive	44 (27.5)
Negative	116 (72.5)
Allergic diseases, n(%)	
Allergic rhinitis	17 (10.6)
Bronchial asthma	6 (3.8)
Atopic dermatitis	3 (1.9)
None	134 (83.7)
Pet care, n(%)	
Yes	30 (18.7)
No	130 (81.3)
Family history of atopy, n(%)	
Moderate-high risk	22 (13.8)
Low risk	138 (86.2)
Cigarette smoke exposure, n(%)	
Yes	48 (30)
No	112 (70)
Number of siblings, n(%)	
>3	73 (45.6)
≤3	87 (54.4)

116 (72.5%) subjects. Allergic disease manifestations were found in 26 (16.3%) subjects, namely AR in 17 (10.6%), bronchial asthma in 6 (3.8%), and AD in 3 (1.9%) subjects. One subject had both AR and bronchial asthma.

Logistic regression analyses showed significant association of obesity with atopy (OR= 3.78; 95%CI 1.08 to 13.19; P=0.037) (Table 2). There was no significant association of overweight with atopy compared to normoweight (as reference index). Bivariate analysis of other risk factors which might influence relationship between BMI and atopy showed significant differences in atopy between subjects with cigarette smoke exposure and moderate-high family history of atopy (P<0.25). Furthermore, multivariate analysis of cigarette smoke exposure, BMI, and family

history of atopy showed that family history of atopy was the most influential risk for atopy, with adjusted OR 5.36 (95%CI 1.34 to 9.25) (Table 3). Regression logistic analysis showed significant association of obesity with bronchial asthma (OR= 9.92; 95%CI 1.46 to 67.18; P= 0.004) (Table 4). There was no significant association of overweight with bronchial asthma compared to normoweight (as reference index). There was no significant association of obesity and normoweight with AD compared with normoweight (Table 5).

Table 6 shows there was significant association of obesity with AR (OR=6.64; 95%CI 1.64 to 25.66; P=0.015), but no significant association of overweight with AR compared with normoweight as the reference index.

**Table 2.** Association of BMI with atopy (n=44)

BMI	Atopy, n		OR	95%CI	P value
	Yes	No			
Obese (n=11)	6	5	3.78	1.08 to 13.19	0.037
Overweight (n=12)	5	7	1.73	0.83 to 3.59	0.184
Normoweight* (n=137)	33	104			

\*reference index

**Table 3.** Multivariate regression analyses of cigarette smoke exposure, obesity and family history of atopy

Characteristics	aOR*	95%CI	P value
Family history of atopy	5.36	1.34 to 9.25	0.001
Cigarette smoke exposure	1.54	1.02 to 15.62	0.281
Obesity	2.79	1.82 to 9.44	0.138

\*aOR=adjusted odd ratio

**Table 4.** Association of BMI with bronchial asthma (n=6)

BMI	Bronchial asthma, n		OR	95%CI	P value
	Yes	No			
Obese (n=11)	2	9	9.92	1.46 to 67.18	0.004
Overweight (n=12)	1	11	4.06	0.39 to 42.37	0.287
Normoweight* (n=137)	3	134			

\*reference index

**Table 5.** Association between BMI and atopic dermatitis (n=3)

BMI	Atopic dermatitis, n		OR	95%CI	P value
	Yes	No			
Obese (n=11)	0	11	1.67	0.08 to 34.36	1.000
Overweight (n=12)	0	12	1.53	0.07 to 31.47	1.000
Normoweight* (n=137)	3	134			

\*reference index

**Table 6.** Association between BMI and allergic rhinitis (n=17)

BMI	Allergic rhinitis, n		OR	95%CI	P value
	Yes	No			
Obese (n=11)	4	7	6.49	1.64 to 25.66	0.015
Overweight (n=12)	1	11	1.03	0.12 to 8.76	1.000
Normoweight* (n=137)	12	125			

\*reference index

## Discussion

This study was conducted on elementary students aged 6 to 12 years. The incidence of obesity was 6.9%, overweight was 7.5%, and normoweight was 85.6%. Prevalence of atopy was 27.5%, bronchial asthma 3.8%, AR 10.6%, and AD 1.9%. Globally obesity and overweight prevalence have increased in children and adolescents. Prevalence of overweight in America's children and adolescents increased from 13.8% in 1999-2000 to 16.0% in 2003-2004. In obesity, prevalence significantly increased from 27.5% in 1999-2000 to 31.1% in 2003-2004.<sup>4</sup> There are increases in the prevalence of atopy (27%)<sup>5</sup> and the prevalence of allergic diseases: 12.13% in AR, 6.02% in bronchial asthma, and 7.83% in AD.<sup>17</sup>

It was significant association of obesity with atopy. Atopy was more likely found in obese compared to normoweight children (OR=3.78; 95%CI 1.08 to 13.19; P=0.037). Our finding was consistent with a study in 2007 on 288 children aged 5 to 16 years. Study in 2007 showed a higher prevalence of atopy in overweight and obese children (P=0.05) and showed significant association of BMI above the 85<sup>th</sup> percentile in the CDC growth chart with atopy (OR 1.70; 95%CI 1.70 to 5.03; P=0.04).<sup>18</sup> A cross-sectional study in Belgium on 1,576 school-aged children also showed an association of obesity with atopy.<sup>19</sup>

Result of this study showed that obesity more likely developed atopy than normoweight, but after adjustment for family history of atopy, number of siblings, pet care, and cigarette smoke exposure by multivariate analysis, it was shown that the association was influenced by family history of atopy (P< 0.005). In addition to obesity and a family history of atopy, another factor considered to be a predisposing factor for atopy was cigarette smoke exposure.<sup>20</sup>

This study also assessed association of BMI with manifestations of allergic diseases. Obesity significantly associated with asthma (OR=9.92; 95%CI 1.46 to

67.18; P= 0.044) and AR (OR=6.49; 95%CI 1.64 to 25.66; P= 0.015), but not with AD. Study in 2007 showed an association of BMI above the 85<sup>th</sup> percentile with asthma, but he found no association with AR and AD.<sup>18</sup> A retrospective cohort of children and adolescents in New York showed prolonged obesity 2.5 to 5 years was a risk factor for AD (95%CI 1.13 to 6.18; P= 0.03).<sup>21</sup> It found no association of BMI with AD in either obesity or overweight, but further monitoring with long-term follow up (cohort design study) still required. It did not find association of overweight to atopy and allergic disease. Because it used BMI to indirectly estimate the fatty tissues of the body, it could not assess the distribution of fat accumulation, since BMI can not distinguish between subcutaneous and visceral fat. The BMI can not be used to predict the risk of morbidity and mortality.<sup>22</sup> No association of overweight with atopy and allergic diseases in this study might had been due to differences in fat distribution.

A limitation of this study, it was cross-sectional design, which can not address causal mechanisms. It also did not analyze how long obesity or how many weight loss/gain changes may be risk factors for atopy and allergic diseases. In addition, it did not evaluate role of adipokines, as leptin and adiponectin, known to influence association of BMI with atopy and allergic diseases.<sup>23</sup> Another limitation was questionnaire method to diagnose of bronchial asthma, AR, and AD, which might cause a recall bias. Nonetheless, the ISAAC questionnaire translation has been validated and standardized for use in epidemiological studies worldwide.<sup>24</sup>

In conclusion, obese children are more likely to have bronchial asthma and AR. There is no significant association of overweight with atopy and allergic diseases.

## Conflict of interest

None declared.

## References

1. Johansson SG, Bieber T, Dahl R, Friedmann PS, Lanier BQ, Lockey RE, *et al*. Revised nomenclature for allergy for global use: Report of the Nomenclature Review Committee of the World Allergy Organization. *J Allergy Clin Immunol*. 2004;113:832-6.
2. Liu AH, Martinez FD, Taussig LM. Natural history of allergic diseases and asthma. In: Leung DYM, editor. *Pediatric allergy: principles and practice*. 2nd ed. New York: Elsevier; 2010. p. 9-18.
3. Asher MI, Montefort S, Björkstén B, Lai CK, Strachan DP, Weiland SK, *et al*. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multi-country cross-sectional surveys. *Lancet*. 2006;368:733-43.
4. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA*. 2006;295:1549-55.
5. Visness CM, London SJ, Daniels JL, Kaufman JS, Yeatts KB, Siega-Riz AM, *et al*. Association of obesity with IgE levels and allergy symptoms in children and adolescents: results from the National Health and Nutrition Examination Survey 2005-2006. *J Allergy Clin Immunol*. 2009;123:1163-9.
6. Leung TF, Kong AP, Chan IH, Choi KC, Ho CS, Chan MH, *et al*. Association between obesity and atopy in Chinese schoolchildren. *Int Arch Allergy Immunol*. 2009;149:133-40.
7. Magnusson JÖ, Kull I, Mai XM, Wickman M, Bergstrom A. Early childhood overweight and asthma and allergic sensitization at 8 years of age. *Pediatrics*. 2012;129:70-6.
8. Mai XM, Nilsson L, Axelson O, Braback L, Sandin A, Kjellman NI, *et al*. High body mass index, asthma and allergy in Swedish schoolchildren participating in the International Study of Asthma and Allergies in Childhood: Phase II. *Acta Paediatr*. 2003;92:1144-8.
9. Vlaski E, Stavric K, Isjanovska R, Seckova L, Kimovska M. Overweight hypothesis in asthma and eczema in young adolescents. *Allergol Immunopathol*. 2006;34:199-205.
10. Eldin LB, Algamal HA, El-Dory GF, Rashad M, El-Arab SE, Al-ella NAA, *et al*. Relation between obesity, lipid profile, leptin and atopic disorders in children. *Egypt J Pediatr Allergy Immunol*. 2008;6:27-34.
11. Irene AL, Klipstein-Grobusch K, Amoah AS, Obeng BB, Wilson MD, Yazdanbakhsh M, *et al*. High body mass index is not associated with atopy in schoolchildren living in rural and urban areas of Ghana. *BMC Public Health*. 2011;11:469-78.
12. Apandi PR, Setiabudiawan B, Sukadi A. Correlation between obesity with atopy and family history of atopy in children. *Paediatr Indones*. 2011;51:227-33.
13. Kumar R, Singh BP, Srivastava P, Sridhara S, Arora N, Gaur SN. Relevance of serum IgE estimation in allergic bronchial asthma with special reference to food allergy. *Asian Pac J Allergy Immunol*. 2006;24:191-9.
14. Rona RJ, Keil T, Summers C, Gislason D, Zuidmeer L, Sodergren E, *et al*. The prevalence of food allergy: a meta-analysis. *J Allergy Clin Immunol*. 2007;120:638-46.
15. Sidabutar S, Munasir Z, Pulungan AB, Hendarto A, Tumbelaka AR, Firman K. Sensitisasi alergen makanan dan hirupan pada anak dermatitis atopik setelah mencapai usia 2 tahun. *Sari Pediatri*. 2011;13:147-51.
16. Singh AB, Shahi S. Aeroallergens in clinical practice of allergy in India- ARIA Asia Pacific Workshop report. *Asian Pac J Allergy Immunol*. 2008;26:245-56.
17. Stipičić-Marković A, Pevec B, Pevec MR, Custović A. Prevalence of symptoms of asthma, allergic rhinitis, conjunctivitis and atopic eczema: ISAAC (International Study of Asthma and Allergies in Childhood) in a population of schoolchildren in Zagreb. *Acta Med Croatica*. 2003;57:281-5.
18. Silva MJ, Ribeiro MC, Carvalho F, Oliveira GJM. Atopic disease and body mass index. *Allergol Immunopathol*. 2007;35:130-5.
19. Gysel VD, Govaere E, Verhamme K, Doli E, Baets DF. Body mass index in Belgian schoolchildren and its relationship with sensitization and allergic symptoms. *Pediatr Allergy Immunol*. 2009;20:246-53.
20. Borrego TJ, Teran MAB, Mendoza MC. Prevalence and associated factors of allergic rhinitis and atopic dermatitis in children. *Allergol Immunopathol*. 2008;36:90-100.
21. Silverberg JI, Kleiman E, Lev-Tov H, Silverberg NB, Durkin HG, Joks R, *et al*. Association between obesity and atopic dermatitis in childhood: a case-control study. *J Allergy Clin Immunol*. 2011;127:1180-6.
22. Speiser PW, Rudolf MC, Anhalt H, Hubner CC, Chiarelli F, Eliakim A, *et al*. Childhood obesity. *J Clin Endocrinol Metab*. 2005;90:1871-87.
23. Lago F, Dieguez C, Reino GJ, Gualillo O. The emerging role of adipokines as mediators of inflammation and immune responses. *Cytokine Growth Factor Rev*. 2007;18:313-25.
24. Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F, *et al*. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J*. 1995;8:483-91.