

This article was downloaded by: [Uppsala University Library]

On: 9 November 2009

Access details: Access Details: [subscription number 786945401]

Publisher Informa Healthcare

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Journal of Asthma

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713597262>

Association of Overweight with Asthma Prevalence in Adolescents in Rio de Janeiro, Brazil

Fábio Chigres Kuschnir ^{ab}; Antônio Ledo Alves da Cunha ^c

^a Graduate Program in Internal Medicine, Federal University of Rio de Janeiro, Brazil ^b Health in School Program. Health and Civil Defense Secretariat, Rio de Janeiro, Brazil ^c Department of Pediatrics, School of Medicine, Instituto de Puericultura e Pediatria Martagão Gesteira, Federal University of Rio de Janeiro, Brazil

Online Publication Date: 01 November 2009

To cite this Article Kuschnir, Fábio Chigres and da Cunha, Antônio Ledo Alves(2009)'Association of Overweight with Asthma Prevalence in Adolescents in Rio de Janeiro, Brazil',Journal of Asthma,46:9,928 — 932

To link to this Article: DOI: 10.3109/02770900903231566

URL: <http://dx.doi.org/10.3109/02770900903231566>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

ORIGINAL ARTICLE

Association of Overweight with Asthma Prevalence in Adolescents in Rio de Janeiro, Brazil

FÁBIO CHIGRES KUSCHNIR, M.D., PH.D.,^{1,2,*} AND ANTÔNIO LEDO ALVES DA CUNHA M.D., PH.D.³

¹Graduate Program in Internal Medicine, Federal University of Rio de Janeiro, Brazil

²Health in School Program. Health and Civil Defense Secretariat, Rio de Janeiro, Brazil

³Department of Pediatrics, School of Medicine, Instituto de Puericultura e Pediatria Martagão Gesteira, Federal University of Rio de Janeiro, Brazil

Objective: To evaluate the relationship between asthma and overweight in adolescents. **Methods:** Cross-sectional study including 13–14-year-old adolescents in Rio de Janeiro, Brazil. Asthma was defined according to the International Study of Asthma and Allergies in Childhood (ISAAC). Body Mass Index (BMI) was calculated; overweight was defined as BMI $\geq$ 85th percentile. The distribution of asthma and associated symptoms were compared according weight category using the χ^2 test for linear trend. The association between asthma and overweight, controlling for confounding variables, was studied using odds ratios (OR), confidence intervals (95% CI) and logistic regression, stratified by sex. **Results:** 2,858 (50.1% female) adolescents were studied; 458 (16.1%) were overweight and 13.3% asthmatic. Average BMI was higher among asthmatics ($p = 0.01$). When stratified, this difference remained only among girls ($p = 0.03$). Asthma prevalence increased with higher BMI ($p = 0.02$). Asthma was associated to overweight (OR = 1.51; 95% CI: 1.07–2.13), irrespective of sedentary lifestyle, smoking mother and presence of dog in the domicile, but only among the girls. **Conclusions:** In Rio de Janeiro adolescents, we found a positive association between asthma and overweight, exclusively among girls. This suggests that health policies related to asthma and overweight/obesity in this age group need to take sex into consideration.

Keywords asthma; obesity; adolescents; epidemiology; ISAAC

INTRODUCTION

In industrialized countries, a concomitant increase in the prevalence of asthma and obesity has been described in the past two decades (1, 2). Studies suggest that these chronic conditions can be associated in adults and in children (3–6). It has also been noted that loss of weight is associated with clinical pulmonary function improvement in obese asthmatics (7).

To better understand a possible causal relationship between these two conditions, several hypotheses have been proposed, such as alterations in the mechanics of the airways and the immune response, hormonal influences, genetic-ambient factors, and the influence of medicines used in the treatment of asthma (8–11). Although the real nature of this association is still not well understood, it seems to be more frequent in the female sex (12, 13).

Few studies have examined the association between asthma and obesity in Latin America (14) or, more specifically, in Brazil, where asthma is an important public health problem among adolescents (15). The prevalence of active asthma in 13- to 14-year-old adolescents assessed by the International Study of Asthma and Allergies in Children (ISAAC) in Rio de Janeiro State, varied from 12% to 19% (16, 17).

In Brazil, 2002–2003, the prevalence of overweight and obesity among adolescents 10 to 19 years of age was

estimated to be 16.7%, and to be respectively, 21.5% and 18% for boys and girls in Rio de Janeiro City (18). The aim of this study was to examine the association between excess weight and asthma and its related symptoms in adolescents.

METHODS

Setting

The study was conducted in Nova Iguaçu, a municipality located in the metropolitan area of Rio de Janeiro State, in the Southeastern region of Brazil, at an altitude of 25 meters, and with a tropical climate. Its population of 754,485 inhabitants is constituted largely of low-income socio-economic classes, with a literacy rate of around 85% and whose principal economic activities are in industry and commerce. At the time of the study, there were about 32,000 adolescents in the age range of interest, distributed among 103 public and 75 private schools.

Study Design and Sample

This cross-sectional study focused on adolescents aged 13 and 14, included in Phase III of the ISAAC, and followed its methodological guidelines (19). Schools were randomly selected and used as units. The total number of schools was determined by the number of students 13 and 14 years of age in each up to completion of the suggested sample size of 3,000 students. All 13- to 14-year-old adolescents, irrespective of school level, present at school on the day the data were collected, were asked to participate.

*Corresponding author: Fábio Chigres Kuschmir, Rua Álvaro Ramos 405, apt 1306, bl 01 Botafogo, Rio de Janeiro, Brazil 22280-110. E-mail: fabkuschnir@predialnet.com.br

Study Definitions and Instruments

The prevalence of asthma was defined by the score proposed by Solé et al., who validated the asthma module of the self-applicable ISAAC questionnaire (QE) for adolescents in Brazil and attributed to each question points ranging from 0 to 2, up to a maximum score of 14. Adolescents with an overall score ≥ 6 were considered asthmatic. The sensitivity and specificity of this score to the clinical diagnosis of current asthma in Brazilian adolescents 13 to 14 years of age were, respectively, 91% and 97% (20). The prevalence of wheezing "ever at any time in the past" and after physical exercise was also evaluated (19).

Those with ≥ 4 attacks and/or ≥ 1 night with sleep disorder and/or speech disorder caused by wheezing in the last year were considered to have severe asthma (21). Exposure to tobacco at home, the presence of pets in the domicile, and a sedentary lifestyle had been evaluated by self-applicable ISAAC QE "Environmental Questionnaire - 13- to 14-year age group" (22). For the purpose of this study, the sedentary were considered to be those who watched 3 or more hours of television per day and who went out to work less than three times a week (23).

Weight was measured by a pre-calibrated Plenna digital balance (Plenna®, Sao Paulo, Brazil) with a maximum capacity of 150 kg and sensitivity of 100 g, with participants wearing light clothes and barefoot. Stature was measured with the adolescent barefoot using a metallic ruler, manually held against the wall. The average of 2 consecutive measurements was adopted. For each adolescent, the Body Mass Index (BMI) was calculated (weight [kg]/height [m]²) and compared with the ideal percentiles for the age on Growth Charts from the CDC (24). Adolescents were then classified in three weight categories: underweight (BMI <5th percentile); normal weight (BMI ≥ 5 and <85th percentile), and overweight (BMI ≥ 85 th percentile) using the cut-off points proposed, respectively, by the World Health Organization and the International Obesity Task Force (25, 26).

Data Collection and Analysis

Data were collected by interviewers trained in QE application and anthropometric measurements, under supervision. Categorical variables were described using frequency distributions and continuous ones by means and 95% confidence intervals (95% CI).

The mean BMI was compared between males and females and between asthmatics and non-asthmatics using the Student's *t* test. The prevalence of asthma and associated symptoms was compared among adolescents classified according to the weight categories using a Chi Square test for linear trend. A bivariate analysis was used to assess the association between asthma (y/n) and overweight (yes = BMI ≥ 85 th percentile; no = BMI <85th percentile) and asthma and environmental/lifestyle variables, using the odds ratio (OR) and 95% CI. Multivariate logistic regression was used to study this association, controlling for potential confounders (27). The level of significance was set at $p < 0.05$. EPI-INFO version 6.04 (CDC, Clifton Rd, Atlanta, GA, USA) was used to enter data and STATA version 7.0 (Stata Corp., College Station, TX, USA) for the analysis.

TABLE 1.—Sample characteristics, Nova Iguaçu, Rio de Janeiro, 2002.

Variable	Total n = 2,858	Frequency (%)	95% CI
Sex			
Male	1,425	49.9	48.0–51.7
Female	1,433	50.1	48.2–51.9
School type			
Public	2,012	70.4	68.7–72.1
Private	846	29.6	27.8–31.2
Asthma and associated Symptoms			
Current asthma	380	13.3	12.0–14.5
Wheezing ever	749	26.2	24.5–27.8
Wheezing with exercise	463	16.2	14.8–17.6
Speech disorder	99	3.5	2.7–4.1
>4 or more attacks	48	1.7	1.2–2.2
Sleep disorder	193	6.8	5.8–7.7
Weight categories by BMI			
<5 (underweight)	234	8.2	7.2–9.2
$\geq 5a$ <85 (normal weight)	2,166	75.7	74.2–77.4
≥ 85 (overweight/obese)	458	16.1	12.0–14.6
Lifestyle			
Sedentary	991	35.2	32.9–36.4
Environmental factors			
Smoking mother	690	24.1	22.5–25.7
Smoking father	656	22.9	21.4–24.5
Dog in domicile	2,191	76.6	75.0–78.2
Cat in domicile	753	26.3	24.7–28.0

CI = confidence interval.

Ethical Issues

The school principals and those legally responsible for the students signed informed consent forms. The study was approved by the Ethics Committee of the Rio de Janeiro Federal University.

RESULTS

Between April and September 2002, 3,033 students who had correctly filled the questionnaire were involved in the study. Of these, 175 were excluded (5.8%), 18 of whom were asthmatic, because it was not possible to obtain anthropometric measures.

Table 1 presents the characteristics of 2,858 studied students from 24 public and 13 private schools, which had their BMI assessed. The prevalence of asthma was 13.3%, and that of overweight adolescents was 16.1%.

The average BMI in the total sample was 19.55, and it was higher among girls than boys (19.82 vs 19.29; $p < 0.001$). It was also higher among asthmatics compared to non-asthmatics (19.94 vs 19.50; $p = 0.015$). However, when stratified by sex, this difference remained among girls (20.23 vs 19.74; $p = 0.032$), but not among boys (19.46 vs 19.27; $p = 0.59$).

Overall, an increase in BMI categories was observed with an increase in the prevalence of asthma ($p = 0.02$), "wheezing ever" ($p = 0.006$), and "sleep disturbed by wheezing" ($p = 0.01$). Table 2 shows this analysis according to sex. This same trend was observed between overweight and asthma ($p = 0.02$) and overweight and "wheezing ever" ($p = 0.04$) but only in the females.

Table 3 presents the results of the bivariate and multivariate analyses assessing the association between asthma, overweight, and environmental and lifestyle variables among girls. In the bivariate analyses, a positive association was observed among asthma, having a smoking mother, a sedentary lifestyle, and the presence of a dog in the domicile in the last 12 months. Among girls, an overweight condition remained

TABLE 2.—Prevalence of asthma and associated symptoms in adolescents, according to weight categories, stratified by sex, Nova Iguaçu, RJ, 2002.

Weight category Variable	BMI <5 (Underweight) <i>n</i> = 234				BMI ≥5 a <85 (Normal weight) <i>n</i> = 2,166				BMI ≥85 (Overweight) <i>n</i> = 458			
	M		F		M		F		M		F	
	<i>n</i> = 142	(%)	<i>n</i> = 92	(%)	<i>n</i> = 1,076	(%)	<i>n</i> = 1,090	(%)	<i>n</i> = 207	(%)	<i>n</i> = 251	(%)
Current asthma	18	(12.7)	12	(13)	97	(9.0)	173	(15.9)	26	(12.6)	54	(21.5)
OR	1.0		1.0		0.68		1.26		0.99		1.83 [§]	
Wheezing ever	31	(21.8)	22	(23.9)	219	(20.4)	334	(30.6)	54	(26.1)	89	(35.5)
OR	1.0		1.0		0.92		1.43		1.27		1.75 [§]	
≥4 attacks	2	(1.4)	1	(1.1)	16	(1.5)	20	(1.8)	3	(1.4)	6	(2.4)
OR	1.0		1.0		1.06		1.70		1.03		2.23	
Sleep disorder	9	(6.3)	7	(7.6)	37	(3.4)	100	(9.2)	8	(3.9)	32	(12.7)
OR	1.0		1.0		0.53		1.23		0.59		1.77	
Speech disorder	6	(4.2)	6	(6.5)	22	(2.0)	46	(4.2)	4	(1.9)	15	(6.0)
OR	1.0		1.0		0.47		0.63		0.45		0.91	
Asthma with exercise	15	(10.6)	12	(13)	86	(8.0)	186	(17.1)	23	(19.8)	45	(17.9)
OR	1.0		1.0		0.74		1.37		1.06		1.46	

M = male; F = female; OR = odds ratio; [§]*p* < 0.05 – chi-square for linear trend.

independently associated to asthma when adjusted for environment/lifestyle variables (OR = 1.51; CI 95%:1.07–2.13) and having a dog in the domicile. No association was observed among boys (results not presented).

DISCUSSION

In general, asthmatic children and asthmatic adults are more frequently overweight compared to non-asthmatic control subjects (3). We found in 13- to 14-year-old adolescents that an increase in the prevalence of asthma and related symptoms was associated with an increase in BMI in females. Also, exclusively among girls, a positive association was observed between overweight and asthma, and overweight and “wheezing ever,” controlled for environmental and lifestyle factors.

The association between asthma and obesity according to sex has been the object of controversies. Camargo et al. demonstrated that women participants in the Nurses’ Health Study II who gained weight after 18 years of age had a significantly higher risk of developing asthma in the 4 subsequent years (28). Another prospective study, conducted in California, USA, with children and adolescents between 7 and 18 years of age, showed a positive association between new cases of asthma and overweight (relative risk [RR] = 1.52; CI 95%: 1.14–2.03) and obesity (RR = 1.60; CI 95%: 1.08–2.36). However, after adjustment for sex, obese boys presented a risk 2.29 greater for asthma than the non-obese, and this was not observed among girls (6).

A cross-sectional study conducted in the city of Santa Maria, Southern Brazil, with 13- to 14-year-old adolescents participating in the ISAAC phase III, showed an association between overweight and “wheezing ever” among boys and an association between wheezing “after-exercise” and presence of “asthma ever” only among girls (14). Also, in accordance with our findings, no association was found between asthma severity and overweight.

Additional studies are needed to establish if differences in the association of asthma with overweight/obesity according to sex results from underlying causative factors linked to men and women. Some authors suggest that the diagnosis of asthma and related symptoms in adolescents and adults, based on self-reported questionnaires, may differ by gender, with males tending to underestimate, and young females to

overestimate their symptoms. The possibility that the diagnosis of asthma and related symptoms differs among obese men and women may exist (29, 30).

More recently, leptin, a hormone produced by the adipose tissue that has important pro-inflammatory properties, has been linked to the occurrence of asthma (31). In general, its concentration is low in the pre-puberty phase. However, it gradually increases in both sexes until the beginning of the puberty, after which it decreases in boys while it increases in girls. Serum leptin levels correlate with BMI and reflect the adipose tissue mass, which are high in overweight and obese individuals (32).

A study conducted in children 5 to 9 years of age in Istanbul, Turkey, showed higher leptin levels in asthmatic compared to non-asthmatic controls, only among boys (33). Interestingly, longitudinal studies have shown an increasing risk for the development of asthma in infancy among boys, which is reverted during adolescence, the period when this illness predominates in females (34).

Although the role of leptin in the association asthma-obesity is still not well established, our findings may contribute to the clarification of the differences in the risk of developing asthma in relation to gender. Considering that the mean age of the menarche in Brazilian girls occurs around

TABLE 3.—Association of asthma and overweight, adjusted by environmental factors in female adolescents. Results from bivariate and multivariate analysis. Nova Iguaçu, Rio de Janeiro, 2002.

Variables*	Total = 1,433		Crude OR	95% CI	Adjusted OR	95% CI
	<i>n</i>	%				
Overweight (BMI ≥85)	251	17.5	1.47	1.052–2.07	1.51	1.07–2.13
Smoking mother	348	24.3	1.39	1.02–1.90	1.33	0.97–1.82
Smoking father	321	22.4	1.10	0.79–1.53	1.02	0.73–1.44
Sedentary lifestyle	588	41	1.55	1.17–2.05	1.51	1.14–2.01
Cat in domicile	386	26.9	1.29	0.96–1.75	1.25	0.92–1.71
Dog in domicile	1,095	76.4	1.54	1.08–2.21	1.48	1.03–2.12
Type of school						
Public	1,000	69.9	0.85	0.67–1.16	0.86	0.62–1.18
Private	433	30.1	1.0		1.0	

OR = odds ratio; CI = confidence interval. *All dichotomous variables: yes/no.

12.2 years of age, the majority of our sample was constituted of post-pubescent girls (35). It is possible to speculate, therefore, that our findings restricted to the female sex could be related to a possible influence of female sexual hormones. Obesity has been associated with early menarche in girls and delayed puberty in boys (36).

Also, among participants of the Tucson Respiratory Study who became overweight or obese between 6 and 11 years of age, it was observed that in girls, but not in boys, the risk of developing asthma between the age of 11 and 13 was seven times higher. This suggests that influences acting in this specific age range, such as the increase in female sexual hormone levels, could play an important role in linking the two conditions (11). However, the possible role of estrogen on the airway hyperresponsiveness and inflammation, as evidenced in animal models, is not yet established in human beings (37).

The reduction of physical activity levels in asthmatic as well as in overweight/obese individuals could be a confounding factor in the evaluation of this association (38). Considering the hypothesis that the level of physical activity, rather than obesity, is causally related to asthma, sedentary people would have a greater possibility of developing the illness. However, if these individuals do not reduce their energy intake, there is a great probability of weight gain, and thus it would appear that incidence of asthma is causally associated to an overweight/obese condition. In our study, asthma was associated to excess weight as well as to a sedentary lifestyle in girls, irrespective of whether the mother smokes or there is exposure to a dog in the domicile. In our sample, we did not find any association between wheezing after exercise and overweight.

Our study has limitations. Definition of variables in epidemiologic studies can be difficult and differ from those used for clinical purposes (1). The QE ISAAC has proven to be a valuable instrument in epidemiologic studies with good correlation with objective measures of pulmonary function and airway hyperresponsiveness (21). BMI is considered a good indicator of thinness and overweight conditions in adolescence and is recommended for population studies by the WHO. Another difficulty is the assessment of physical activity levels, which have limitations in epidemiologic studies (38). Furthermore, there exists the possibility that factors not studied and related to the dependent variable (asthma), as well as to the exposure (overweight), such as socio-economic status (SES) and diet, could partly explain the association under study (39). Nevertheless, no significant association between SES and prevalence of asthma and related symptoms was observed among 13- to 14-year-old adolescent participants in ISAAC Phase III in Brazil (15).

However, we did control for important confounding variables in the multivariate analysis. Finally, due to the cross-sectional design, where the diagnosis of asthma and the overweight condition were assessed simultaneously, it was not possible to establish causality.

We conclude that in 13- to 14-year-old adolescents in Nova Iguaçu, there is positive association between asthma and overweight, a finding that was exclusively observed in girls, regardless of sedentary lifestyle and other environmental factors. Because it was not possible to establish causality, these results need confirmation in other settings.

However, they suggest that health policies related to asthma and overweight/obesity in this age group need to take gender into consideration.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. Ford ES. The Epidemiology of obesity and asthma. *J Allergy Clin Immunol* 2005; 115:897–909.
2. Litonjua AA, Gold DR. Asthma and obesity: Common early-life influences in the inception of disease. *J Allergy Clin Immunol* 2008; 121:1075–1084.
3. Shadeen SO, Sterne JA, Montgomery SM, Azima H. Birth weight, body mass index and asthma in young adults. *Thorax* 1999; 54:396–402.
4. Von Mutius E, Schwartz J, Neas LM, Dockery D, Weiss ST. Relation of body mass index to asthma and atopy in children: The National Health and Nutrition Examination Study III. *Thorax* 1999; 56:835–838.
5. Guerra S, Sherril DL, Bobadilla A, Martinez FD, Barbee RA. The relation of body mass index to asthma, bronchitis and emphysema. *Chest* 2002; 122:1256–1263.
6. Guilliand FD, Berhane K, Islam T, McConnell R, Gauderman WJ, Guilliand SS, Avol E, Peters JM. Obesity and the risk of newly diagnosed asthma in school-age children. *Am J Epidemiol* 2003; 158:406–415.
7. Stenius-Aarniala, Poussa T, Kvarnstrom J, Gronlund EL, Ylikahri M, Mustajoki P. Immediate and long terms effects of weight reduction in obese people with asthma: Randomized controlled study. *BMJ* 2000; 320:827–832.
8. Tantisira KG, Weiss ST. Complex interactions in complex traits: Obesity and asthma. *Thorax* 2001; 56 (suppl II):ii64–ii74.
9. Sood A. Does obesity weigh heavily on the health of the human airway? *J Allergy Clin Immunol* 2005; 115:921–924.
10. Fantuzzi GJ. Adipose tissue, adipokines, and inflammation. *Allergy Clin Immunol* 2005; 115:911–919.
11. Hedberg A, Rossner S. Body weight characteristics of subjects on asthma medication. *Int J Obes Relat Metab Disord* 2000; 24:1217–1225.
12. Castro-Rodriguez JA, Holberg JC, Morgan JW, Wrigth AL, Martinez FD. Increased incidence of asthmalike symptoms in girls who became overweight or obese during the school years. *Am J Resp Crit Care Med* 2001; 163:1344–1349.
13. Chen Y, Dales R, Tang M, Krewski D. Obesity may increase the incidence of asthma in women but not in men: Longitudinal observations from the Canadian National Population Health Surveys. *Am J Epidemiol* 2002; 155:191–197.
14. Cassol VE, Rizzato TM, Teche SP, Basso DF, Centenaro DF, Maldonado M, Moraes EZ, Hirakata VN, Solé D, Menna-Barreto SS. Obesity and its relationship with asthma prevalence and severity in adolescents from southern Brazil. *J Asthma* 2006; 43:57–60.
15. Solé D, Camelo-Nunes IC, Wandalsen GF, Mallozi MC, Naspitz CK and Brazilian ISAAC's Group. Is the Prevalence of Asthma and Related Symptoms Among Brazilian Children Related to Socioeconomic Status? *J Asthma* 2008; 45:19–25.
16. Kuschnir FC, Cunha AJL. Environmental and socio-demographic factors associated to asthma in adolescents in Rio de Janeiro, Brazil. *Pediatr Allergy Immunol* 2007; 18:142–48.
17. Boechat JL, Rios JL, Sant'Anna C, França AT. Prevalência e gravidade de sintomas relacionados à asma em escolares e adolescentes no município de Duque de Caxias, Rio de Janeiro. *J Bras Pneumol* 2005; 31:111–117.
18. IBGE - Instituto Brasileiro de Geografia e Estatística, 2006. Pesquisa de Orçamentos Familiares (POF - 2002–2003): Antropometria e análise do estado nutricional de crianças e adolescentes no Brasil. Retrieved 1 June 2009 from <http://www.ibge.gov.br>.
19. Ellwood P, Asher MI, Beasley R, Clayton TO, Stewart AW, ISAAC Steering Committee -The International Study of Asthma and Allergies in Childhood (ISAAC): Phase three rationale and methods. *Int J Tuberc Lung Dis* 2005; 9:10–16.

20. Solé D; Vanna AT, Yamada E, Rizzo MC, Naspitz CK. International Study of Asthma and Allergies in Childhood (ISAAC) written questionnaire: Validation of the asthma component among Brazilian children. *Investig Allergol Clin Immunology* 1998; 8(6):376–382.
21. Camelo-Nunes IC, Wandalsen G, Melo KC, Naspitz CK, Solé D. Prevalência de asma e de sintomas relacionados entre escolares de São Paulo, Brasil: 1996 a 1999. *Rev Bras Alergia Imunopatol* 2001; 24:77–89.
22. ISAAC Phase Three Environmental Questionnaire. Instructions and Hypotheses 13–14 years. Retrieved 1 June 2009 from <http://www.isaac.auckland.ac.nz>.
23. Aaron DJ, Kriska AM, Dearwater SR, Cauley JA, Metz KF, LaPorte RE. Reproducibility and validity of an epidemiologic questionnaire to assess past year physical activity in adolescents. *Am J Epidemiol* 1995; 142:191–201.
24. NCHS. National Center for Health Statistics/National Health and Nutrition Examination Survey 2000. CDC Growth Charts: United States (2000). Retrieved 1 June 2009 from <http://www.cdc.gov/growthcharts/>.
25. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ* 2000; 320:1240–1243.
26. World Health Organization. The use and interpretation of anthropometry physical status: The use and interpretation of anthropometry: Report of a WHO expert committee. WHO Technical Report Series. 854, 1995.
27. Szklo M, Nieto JF. Measuring associations between exposures and outcomes. In: Szklo M, Nieto JF, eds. *Epidemiology – Beyond the basics*. 1st ed. Maryland: Aspen Publishers, 2000: 91–121.
28. Camargo CA Jr, Weiss ST, Zhang S, Willet WC, Speizer FE. Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. *Arch Inter Med* 1999; 159:2582–2586.
29. Fuhlbrigge AI, Jackson B. Gender and asthma. *Immunol Clin North Am* 2002; 4:753–774.
30. Adams RJ, Wilson DH, Appleton S, Taylor A, Dal Grande E, Chittleborough CR, Ruffin E. Underdiagnosed asthma in South Australia. *Thorax* 2003; 58:846–850.
31. Nagel G, Koenig W, Rapp K, Wabitsch M, Zoellner I, Weiland SK. Associations of adipokines with asthma, rhinoconjunctivitis, and eczema in German schoolchildren. *Pediatr Allergy Immunol* 2009; 20:81–88.
32. Blum WF, Englaro P, Hanitsch S, Juul A, Hertel NT, Muller J, Skakkebaek NE, Heiman ML, Birkett M, Attanasio AM, Kiess W, Rascher W. Plasma leptin levels in healthy children and adolescents: Dependence on body mass index, body fat mass, gender, pubertal stage and testosterone. *J Clin Endocrinol Metab* 1997; 82:2904–2910.
33. Guller N, Kircerleri E, Ones U, Tamay Z, Salmayenli N, Darendeliler F. Leptin: Does it have any role in childhood asthma? *J Allergy Clin Immunol* 2004; 114:254–259.
34. Martinez FD, Wright AL, Taussing LM, Holberg CJ, Halonen M, Morgan WJ. Asthma and wheezing in the first six years of life. *N England J Med* 1995; 332:133–138.
35. Colli S. A Maduración sexual de los adolescentes de São Paulo. IN: Organización Panamericana de la Salud. *La salud del adolescente y el joven en las Americas*. Washington, DC. C., 1985: OPAS-Publ. Cient 489:249–258.
36. Kaplowitz P. Delayed puberty in obese boys: Comparison with constitutional delayed puberty and response to testosterone therapy. *J Pediatr* 1998; 133:745–749.
37. Salam MT, Wenten M, Gilliland FD. Endogenous and exogenous sex steroid hormones and asthma and wheeze in young women. *J Allergy Clin Immunol* 2006; 117:1001–1007.
38. Lucas SR, Platts-Mills TA. Physical activity and exercise in asthma: Relevance to etiology and treatment. *J Allergy Clin Immunol* 2005; 115:928–934.
39. McKeever TM, Britton J. Diet and asthma. *Am J Respir Crit Care Med* 2004; 170:725–729.