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Prevalence of asthma symptoms and association with obesity, sedentary lifestyle and sociodemographic factors: data from the Hellenic National Action Plan for the assessment, prevention and treatment of childhood obesity (MIS301205)

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ABSTRACT

Objectives: To evaluate the prevalence of asthma symptoms in a representative sample of Greek schoolchildren and to evaluate its association with overweight/obesity as well as other socioeconomic, demographic, and lifestyle factors. **Methods:** This is a cross-sectional study conducted from 10/2012 to 12/2013 on a pre-selected, representative elementary school cohort. Parents completed standardized questionnaires evaluating among others socioeconomic and sedentary activity habits. Students were measured with high sensitivity methods. Socioeconomic status (SES) index (range: 0–13) was calculated on years of parental education, rented versus owned residence, size of residence evaluated as meters squared per person (m²/person), and number of vehicles. Asthma was defined according to the approved Greek version of the International Study on Allergies and Asthma in Childhood (ISAAC) criteria. **Results:** The prevalence of any asthma symptoms was documented in 31% of population. The odds of presenting any asthma symptoms decreased with increase in age (odds ratio: 0.96, 95% CI: 0.94–0.98) and increased with overweight (odds ratio: 1.13, 95% CI: 1.03–1.25), obesity (odds ratio: 1.27, 95% CI: 1.11–1.46) and sedentary lifestyle. **Conclusion:** This is the first representative survey of prevalence of asthma symptoms in children and adolescents in Greece indicating its continuous increase. A strong association between presence of asthma symptoms and obesity and sedentary activities was documented irrespectively of socioeconomic and regional factors. The findings stress the importance of public health policies toward obesity prevention and enhancement of physical activities in pediatric populations.

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Introduction

There is a considerable variation in the prevalence of asthma and its symptoms in childhood between and within countries, due to geographical variations and methodological differences in defining asthma [1]. However, there is an increasing evidence that its prevalence is increasing with time, especially in regions where prevalence was previously low [2].

Until 1990, there was no standardized method for assessing and comparing asthma prevalence among different countries. In 1991, the International Study of Asthma and Allergies in Childhood (ISAAC) set up uniform diagnostic criteria (the ISAAC questionnaire) [3].

In 1994–1995 ISAAC Phase I was carried out, including 56 countries and reporting the prevalence of asthma symptoms in 6- to 7-year-old children and 13- to 14-year-old adolescents [1]. The prevalence of wheezing varied between 4.1% and 32.1% in the younger age group and between 2.2% and 32.2% in the older age group, the variation between populations being attributed to environmental factors. Greece was among the countries with the lowest asthma prevalence at that time [1].

At the same time, the prevalence of obesity in childhood is increasing worldwide [4]. This parallel increase in prevalence of asthma and obesity in childhood has

led to an increasing body of evidence about a possible link between the two conditions [5–9].

Despite the growing research over the obesity/asthma relationship, there was only limited data on the association of objectively measured weight and height, with standardized questionnaire reports on the prevalence of respiratory symptoms and allergic disease.

A recent report from the (ISAAC) Phase III revealed associations between overweight and obesity and symptoms of asthma [10] and analysis of data from ISAAC Phase II confirmed the strong relation of body mass index (BMI) with wheezing especially in affluent countries [11].

Possible links between asthma and obesity have been postulated in many studies: common genetic factors, low-grade systemic and airway inflammation, environmental factors (dietary, lack of physical activity), mechanical (changes in elastic property of chest wall) as well as non-inflammatory mechanisms as airway bronchoconstriction due to increased parasympathetic signaling in airway smooth muscles as a result of lack of leptin signaling in the brain [12].

Physical activity is a factor that may be related to both obesity and asthma.

While physical activity levels are clearly associated with obesity [13], the relationship between asthma diagnosis and level of physical activity is less clear [14,15]. In the presence of asthma, exercise-induced bronchoconstriction may lead to decreased physical activity which is associated with increase in body weight. On the other hand, increased body weight constitutes an additional factor for physical activity restriction in asthmatic children. An inverse relationship between asthma symptoms and leisure-time physical activity has been reported [16].

Socioeconomic status (SES) has been shown to influence the asthma occurrence and prognosis as an etiologic factor per se or as a surrogate of environmental risk factors [17,18]. In other studies, asthma and asthma-related symptoms occur more frequently in urban than in rural areas, and the difference correlates with environmental risk exposures, SES, and healthcare access [19]. Finally, an increasing allergy prevalence with decreasing distance from the Equator has been reported with latitude closest to the Equator, associated with increased odds of asthma and other allergic diseases [20].

In the context of the Hellenic National Action Plan for the Assessment, Prevention and Treatment of Childhood Obesity, a large epidemiological study carried out in 2012–2013, the prevalence of asthma symptoms was evaluated and its association with

obesity and sociodemographic factors was assessed in a representative countrywide sample of elementary school children in Greece.

Methods

The Hellenic Action Plan for the Assessment, Prevention and Treatment for Childhood Obesity was a school-based survey conducted at a national level in Greece during the school years of 2012–2013.

Approval to conduct the study was granted by the Greek Ministry of National Education and the Greek Ministry of Health. The study population comprised school children attending all grades of primary and secondary schools located in several municipalities in Greece (including rural areas and islands). The sampling of schools was stratified by the type of school (i.e., primary or secondary) proportionally to the total number of pupils attending these schools. Following this procedure, an appropriate number of schools was randomly selected from each one of these municipalities.

Prior to acceptance of children's participation to the study, an extended letter explaining the objectives of the study were provided to all parents or guardians whose children were attending these schools and a consent form was signed from those who approved participation of their children in the study. Signed parental consent was collected from 25942 out of 38.100 children (response rate: 68.1%).

Anthropometric measurements were conducted to all children by the same trained team. Body weight was measured to the nearest 100 g using a Tanita digital scale (Tanita BWB800 μ A). Pupils were weighed without shoes in the minimum clothing possible. Height was measured to the nearest 0.1 cm using a commercial stadiometer (Charder HM 200 P Portstad) which was standardized against a Harpenden portable stadiometer.

BMI was calculated and International Obesity Task Force (IOTF) cutoffs were used to classify the children [21]. Parents were asked to fill a structured questionnaire which has been previously validated [22].

SES index was calculated based on the SES index used by Moschonis et al. 2012 [23]. SES variables are as follows: years of paternal and maternal education, residence status (rented vs. owned residence), size of residence assessed as surface m^2 per family member, and number of cars owned by the family. The values of the total SES index score were ranging between 0 and 13, with higher values indicating higher SES of the family.

Time spent on sedentary activities (e.g., watching television, working on a computer, playing video games) was also assessed.

The Greek version of the ISAAC core questionnaire was validated in study protocols, including those for the use and translation of questionnaires, and stringent quality control measures for participation in ISAAC Phase I [1]. The evaluation of presence and duration of asthma symptoms was assessed by the approved core questionnaire which consisted of eight questions according to ISAAC classification: (1) if children ever had wheezing or whistling, (2) if they had wheezing or whistling during the last 12 months, (3) the number of wheezing attacks they had the last 12 months, (4) if they had disturbed sleep due to wheezing in the last 12 months, (5) if they had wheezing severe enough to limit their speech in the last 12 months, (6) if they ever had asthma, (7) if their chest sounded wheezy enough during or after exercise in the last 12 months, and (8) if they ever had dry cough at night, except in case of cold or chest infection in the last 12 months [1,24].

Full data on anthropometric, sociodemographic, and asthma symptoms were collected from 11,751 children and adolescents aged from 5.8 to 12.5 years.

Statistical methods

Asthmatic symptoms were treated as the main factor (dependent variable) for the analysis. The following variables were tested as potential risk factors for asthmatic symptoms: sex, rural–urban status (urban; semi-urban vs. rural), overweight/obese (vs. normal weight), age (years), latitude of the prefecture (degrees), SES index, and sedentary activities (hours).

To examine its associations with the aforementioned, potential risk factors, a standard two-step procedure was followed, namely univariate and multivariate logistic regression analysis. At the multivariate analysis, only the factors that were proven significant at the univariate approach were entered and backward elimination procedure was used for variable selection [25]. The level of statistical significance was set at 0.05. Statistical analysis was performed using STATA/SE version 13 (Stata Corp., College Station, TX, USA).

Results

Table 1 shows the age-sex distribution of the study sample. The mean (SD) age was 9.1 years (1.7), 49.3% males. Overall, prevalence of asthma symptoms at the time of our study was in 33.2% of boys and 28.8% of

girls ($p < .001$). Table 2 illustrates the prevalence of asthma symptoms in our sample.

10.5% of children in our study sample were obese and 26% were overweight. The parents reported that children devoted a mean time of 6.4 h per week in sedentary activities (watching television or playing video games) (Table 1).

We then performed univariate logistic regression analysis with the presence of any asthmatic symptoms being the dependent variable and sex, rural–urban status (urban; semi-urban vs. rural), overweight/obese (vs. normal weight), age (years), latitude of the prefecture (degrees), SES index, and sedentary activities (hours) as the independent potential risk factors. Only age, sex, BMI, and hours of sedentary activities were proven significant in the univariate analysis (Table 3).

We then performed multivariate analysis entering by backward selection the above variables. Boys were 1.22 (CI: 1.13–1.33) times more likely to present with asthma symptoms. Overweight (odds ratio: 1.13, 95% CI: 1.03–1.25) and obesity (odds ratio: 1.27, 95% CI: 1.11–1.46) were related to the presence of asthma symptoms.

Moreover, 1 year increase in age increased the odds of asthma symptoms by 9.6% reduced odds of asthma symptoms (CI: 0.94–0.98) and an increase in 5 h/week of sedentary activities increased the odds of asthma by 10.7% (CI: 1.01–1.13) (Table 4).

Discussion

To our knowledge, this is the first epidemiological study reporting prevalence of asthma symptoms in a representative sample of school-aged children from all over Greece. The presence of any asthma symptoms

Table 1. Description of the study sample ($n = 11,751$).

Categorical variables	N (%)
Sex	
Boys	5798 (49.3)
Girls	5953 (50.7)
Asthmatic symptoms	
Yes	3643 (31.0)
No	8108 (69.0)
Rural–urban status	
Urban	3765 (32.1)
Semi-urban	3470 (29.5)
Rural	4516 (38.4)
BMI status	
Normal weight	7473 (63.6)
Overweight	3050 (26.0)
Obese	1228 (10.5)
Continuous variables	Mean $\pm$ SD (range)
Age (years)	9.1 $\pm$ 1.7 (5.8–12.5)
Latitude (degrees)	39.0 $\pm$ 1.6 (35.2–41.2)
SES index	7.2 $\pm$ 2.3 (0–13)
Sedentary activities (hours)	6.4 $\pm$ 3.9 (0–36)

Table 2. Frequency (%) of asthma symptoms reported in normal weight, overweight, and obese children.

	Current Wheeze	Ever had wheeze	No of current wheezing attacks (≥ 4)	Wheeze disturb sleep	Wheeze limiting speech	Exercise wheeze	Night cough	Ever had asthma	Any asthma symptoms
Normal weight	6.1%	21.0%	1.6%	3.6%	0.8%	2.0%	11.2%	9.2%	29.7%
Overweight/obese	6.3%	23.2%	3.8%	3.2%	1.0%	2.5%	12.7%	12.0%	33.2%
<i>p</i> -value	0.57	0.05	0.004	0.27	0.47	0.005	0.024	<0.001	<0.001

Table 3. Results of the univariate logistic regression analysis regarding risk factors for asthmatic symptoms in the examined population ($n = 11\,751$).

	Prevalence of asthmatic symptoms in the compared groups	Category or increment	OR (95% CI)	<i>p</i>
Sex	1926/5798 vs. 1717/5953	Male vs. female	1.22 (1.13–1.33)	<0.001
Rural/urban status				
Urban	1225/3765 vs. 1395/4516	Urban vs. rural	1.08 (0.98–1.18)	0.109
Semi-urban	1023/3470 vs. 1395/4516	Semi-urban vs. rural	0.94 (0.85–1.03)	0.174
BMI				
Overweight	996/3050 vs. 2222/7473	Overweight vs. normal weight	1.15 (1.05–1.25)	0.003
Obese	425/1228 vs. 2222/7473	Obese vs. normal weight	1.25 (1.10–1.42)	0.001
Age	Not applicable	1 year increase	0.97 (0.95–0.99)	0.006
Latitude	Not applicable	1 degree increase	0.99 (0.97–1.02)	0.653
SES index	Not applicable	1 point increase	1.01 (0.99–1.03)	0.435
Sedentary activities (hrs)	Not applicable	5 hours increase	1.08 (1.02–1.14)	0.004

The significance of bold values appears in the adjacent column.

Table 4. Results of the multivariate logistic regression analysis regarding risk factors for asthmatic symptoms in the examined population ($n = 11,751$).

	Category or increment	OR (95% CI)	<i>p</i>
Male sex	Male vs. female	1.22 (1.13–1.33)	<0.001
BMI			
Overweight	Overweight vs. normal weight	1.13 (1.03–1.25)	0.010
Obese	Obese vs. normal weight	1.27 (1.11–1.46)	<0.001
Age	1 year increase	0.96 (0.94–0.98)	<0.001
Sedentary activities (hrs)	5 hours increase	1.07 (1.01–1.13)	0.013

was reported in 33.2% of boys and in 28.8% of girls using the validated for Greece version of ISAAC questionnaire.

In 2006, the PANACEA study, an epidemiological cross-sectional study on 10- to 12-year-old school children in the greater region of Athens, reported prevalence of any asthma symptoms in 27.6% of boys and 20.4% of girls, using the same methodology [26]. The slight increase in reported prevalence in this study, may indicate the continuing increase in the prevalence of childhood asthma in Greece. These trends are supported by reports stating increase in asthma hospital admissions of children in Athens by 271% from 1978 to 2000 [27] and increase in asthma prevalence among school children in the Greek city of Patras from 1.5% to 6.9% over a period of 25 years, from 1978 to 2003 [28].

It is noteworthy that a few years ago, prevalence of asthma in Greece was ranking among the lowest worldwide from its participation in ISAAC Phases I and II [1,11].

At the same time, the prevalence of overweight Greek children is alarmingly elevated, with the

overweight rates rising continuously [29]. This is again in accordance with the worldwide data, recognizing childhood obesity as an epidemic in most developed and developing countries [4].

Data from our study confirm the increased prevalence of overweight and obesity among school children with 10.5% of study population being obese and another 26% overweight. Moreover, the association between asthma and obesity was demonstrated in a representative sample of elementary school children, since being overweight and especially obese increased the odds of having any asthma symptoms.

Obesity and asthma are believed to be connected in a multifactorial fashion, including common genetic determinates [30] and environmental factors. It has also been suggested that obesity results in a distinct asthma phenotype [31], characterized by more severe disease, with increased rates of exacerbation and poorer steroid responsiveness. The strong association of wheezing with overweight/obesity, reported particularly in countries of Northern-Central Europe [32], was confirmed in our study and may possibly reflect an increased prevalence of the obesity-related asthma phenotype. Moreover,

wheeze with exercise, dry cough at night not following infection or a cold, were found more frequently among overweight and obese children compared to healthy children in our study. These can also reflect differential patterns of asthma phenotypes between normal weight as opposed to overweight/obese children.

Moreover, several studies have shown that exercise has a protective role on the development of certain diseases such as asthma, implying that limited physical activity and sedentary life style may be linked to asthma as independent factors [14]. In a cohort of 607 Greek schoolchildren 10- to 12-years old, decreased levels of physical activity were associated with exercise-induced bronchoconstriction irrespectively of BMI [33]. A systematic review of epidemiological studies on children assessing the association between sedentary lifestyle and asthma revealed a positive association and an excess risk of asthma during childhood due to sedentary lifestyle [16]. In this study, 5 h increase in sedentary activities per week resulted in a statistically significant increase in the odds of presenting asthma symptoms, confirming the association of asthma and sedentary lifestyle independently of body weight.

Not any association was proved by our data regarding the association of asthma symptoms with regional (latitude, urban vs. rural) or socioeconomic factors. Although the association between socioeconomic factors and mortality, morbidity, and access to health services is well established [34], these factors can have varying importance in different countries due to cultural differences and structure of healthcare systems. Lifestyle and standards of living may also contribute to conflicting results among studies, and may also reflect partly differences in regional confounding factors such as on breastfeeding, diet, infections, etc. [32].

We verified that asthma prevalence in general was higher among boys than girls. However, the association of overweight and obesity with asthma symptoms was independent of gender. The influence of sex as a potential effect modifier on the asthma–obesity relationship in children has not yet been determined. Results are conflicting, with some cross-sectional and longitudinal studies, reporting gender differences [35,36] while others do not [10,37].

Possible limitations of the study need to be considered. We used parental report of asthma symptoms and physician's diagnosis of asthma, rather than more objective measures such as pulmonary function testing. However, large epidemiologic studies such as the National Health and Nutrition [38] have used the same methodology which was proved to be reliable estimate of asthma prevalence.

Also because of the cross-sectional design of our study, a causal relationship between overweight and asthma cannot be defined. As the exact mechanisms linking asthma and obesity are still unknown, longitudinal cohort studies as well as weight loss studies are needed to provide more information about the pathophysiological mechanisms and factors contributing to the asthma–obesity phenotype.

On the other hand, important strengths of our study are the large representative sample of the population, the use of the standardized ISAAC questionnaires, and the precision in anthropometric measurements for defining BMI.

Conclusions: key findings

In a representative sample of Greek pediatric population, the prevalence of asthma symptoms was rather high at 31%, indicating the continuous increase in childhood asthma prevalence in Greece. From all studied parameters, the presence of asthma symptoms was related to overweight/obesity and sedentary lifestyle irrespectively of socioeconomic or regional (urban vs. rural) factors. Considering that children with asthma account for three times the healthcare expenses compared to children without asthma [39], combined to the economic burden of childhood obesity on healthcare systems [40], our findings underline the necessity of planning public health policies toward preventing childhood obesity and enhance physical activity in pediatric populations.

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Author's contribution

F Karachaliou, E Vlachopapadopoulou, T Psaltopoulou, Y Manios, D Koutsouki, G Bogdanis, V Carayanni, T Sergeantanis, A Hatzakis, and S Michalacos contributed to the design of the study, data collection, and data management. T Sergeantanis led the statistical analyses with the contribution and input from F Karachaliou and T Psaltopoulou. All authors contributed to the writing of the manuscript, critically reviewed and approved the final version of the manuscript for publication.

Compliance with ethical statements

Conflict of interest

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

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Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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