ORIGINAL ARTICLE

BMI from nutritional surveillance of 8-9 years old children in Tuscany (Italy)

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Key words

Childhood • Nutritional status • Obesity • Overweight • Underweight

Summary

Introduction. *The latest increase in childhood obesity focused attention on the important consequences that this phenomenon may have on public health in relationship to the increasing risk that an obese child may become an obese adult. To deal with this problem, there is necessary to assess systematically the distribution of childhood nutritional status at different levels: international, regional and local. In this paper are presented data on underweight, overweight and obesity prevalence in third grade primary school children, aged 8/9 years in Tuscany (2008) and its distribution in relationship to the demographic breadth of their place of residence.*
Methods. *Data from statistic sample of 2109 (1.091 males, 1.018 females), 8/9 years school-children were collected; weight and height were measured using standardised personnel and instruments. Exact month age was calculated between the data of measurement and that of birth. Body Mass Index (BMI) classes were calculated using Cole et al.'s epidemiologic cut-off for children and adolescents. Residence areas were divided into four classes based on the number of inhabitants (< 10.000; 10.000-50.000; > 50.000; > 50.000 metropolitan).*
Results. *The prevalence of underweight was 0.88% (0.76% in males and 1.01% in females), the prevalence of overweight was 23.43% (22.33% in males and 24.65% in females), the prevalence of obese was 7.95% (9.08% in males, 6.70% in females). The lowest prevalence of obese (6.46%) was found in towns with over 50.000 residents (metropolitan).*
Conclusion. *The obesity prevalence in Tuscany children is still lower than that of the Italian National Survey, while the overweight prevalence it's the same. Obesity prevalence (10.71%) is higher in municipalities with low residents number (< 10.000).*

Introduction

The prevalence of obesity is increasing rapidly for all age groups in most European countries [1]. In particular, the childhood obesity is increasing worldwide. It is one of the several risk factors, responsible for cardiovascular diseases and other chronic diseases including hyperlipidaemia, hyperinsulinemia, hypertension and early atherosclerosis and diabetes type II [2-5]. Furthermore, reviews of the studies on long-term mortality in relationship to overweight during childhood show a consistent increase in the risk of Chronic Heart Disease (CHD) mortality and overall mortality [6].
Even though the epidemiological studies do not always agree with the identifying criteria to define different classes of nutritional status in childhood and adolescence, many studies have emphasized high prevalence of obesity.
The Nutritional surveillance system (NSS) in the Tuscany Region, functional since 2001, is a monitoring system established to help in prevention of childhood obesity and its related chronic diseases [7] in participation with a multiregional pilot project.
By the end of 2007, the Centre for Disease Control (CDC) within the Italian Ministry of Health commissioned the creation of a national system to evaluate the nutritional status and key modifiable behaviours associated with childhood in pre-obese and obesity and to monitor trends over time at the local and regional level. In 2008, a national and local surveillance system, "OKkio alla Salute" was started to furnish reliable information on the prevalence and the temporal trend of obesity in this evolutionary age. This is the first population-based and national representative nutrition survey involving more than 45,000 third-grade students of 18 regions [8].
This paper presents the regional data of the nutritional status of primary school children (aged 8/9 years) and its distribution in relation to the demographic breadth of their places of residence during the year 2008.

Methods

The protocol for the study was developed by the National Institute of Health and reviewed in collaboration with the regional coordinators, and information about the members of the technical committee is described elsewhere [9]. This study design is a cross sectional survey in which specially trained and standardised personnel, using appropriate and standardized instruments, measured height and weight of the children [10].
From the 125 classes (2,387 children) selected for the survey, 96.6% (2,305 children) expressed their willingness to participate in this study. A total of 90.4%

(2,109 children including 1,091 males and 1,018 females) present enough data to be included in our analysis.

The study followed World Health Organization cluster survey methodology [11] for data analysis-cluster sampling, with classes as the units of sampling. Therefore, the final population estimates were weighted to take in account the population of each local health unit or region. The Body Mass Index (BMI) was further calculated from weight and height, using the following formula:

Body Mass Index (BMI) = weight (kg)/height (m^2).

BMI classes of the children were set using the Cole et al. Method [12]; this allowed us to have specific cut-off points for males and females at every age as recommended by the International Obesity Task Force (IOTF). We thus obtained six classes of BMI: thinness grades 3, 2, 1, normal, overweight and obesity. According to the Cole's definition, the term "underweight" in children includes thinness grades 3 and 2 (underweight group) while thinness grade 1 and normal weight go into another class (normal weight group) [13] as shows in Table I.

To guarantee a maximum level of territorial diffusion in Tuscany region, all 12 Local Health Units were invited to join and to collaborate in the project. Once enrolled, all the 12 Local Health Units met to prepare an illustration of the protocol and arrange the operational formalities of the activities in Tuscany.

In order to determine the demographic size of the children's municipalities of residence, the samples were divided into four categories: < 10.000 inhabitants, 10.000-50.000 inhabitants, > 50.000 inhabitants, and > 50.000 metropolitan area, using the National Statistics Institute classification [14]. Subsequently, the distribution of underweight, normal weight, overweight, and obesity was evaluated for each of these categories. All variables were checked for normal distribution (Shapiro-Wilks's test) and statistics were performed accordingly. Descriptive statistics (e.g. mean, median, proportion, standard deviation, and inter-quartile range) were used to establish the characteristics of the sample. The chi-square (χ^2)-test with Bonferroni's correction for multiple comparisons (a multiple-comparison correction is used when several dependent statistical tests are being performed simultaneously), whenever necessary, was used to explore the relationships between the BMI classes and the demographic size of the Commune of residence. A total of 95% confidence intervals were calculated for proportions.

Differences between the groups were considered statistically significant when $p < 0.05$. The inclusion criteria in the analysis were: (i) the sample must be 8/9 years

Tab. I. Principle characteristics of the sample.

	Total		Males		Females	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Age		8.83 (8.58-9.08)		8.83 (8.58-9.17)		8,83 (8.58-9.08)
Weight (kg)		31,55 (27.80-36.70)		31,80 (28.15-37.20)		31,05 (27.30-36.20)
Height (cm)	134.04 (6.04)		134.56 (5.84)		133.47 (6.21)	

Tab. II. Nutritional status of 8-9 year old school-children in Tuscany.

		No.	%	95%IC
Underweight	Thinness 3	5	0.28	0.005-0.55
	Thinness 2	11	0.60	0.17-1.04
Normal weight	Thinness 1	103	5.08	3.89-6.26
Overweight	Normal	1302	62.66	59.90-65.42
Obese	Overweight	501	23.43	21.06-25.80
	Obese	187	7.95	6.70-9.20
	Total	2109	100	

95%CI: 95% confidence interval.

Tab. III. Nutritional status by gender.

	Males			Females		
	n	%	IC95%	n	%	IC95%
Underweight	6	0.76	0.13-1.40	10	1.01	0.31-1.71
Normal weight	725	67.82	64.12-71.53	680	67.64	64.20-71.07
Overweight	251	22.33	19.18-25.49	250	24.65	21.26-28.03
Obese	109	9.08	7.15-11.00	78	6.70	5.00-8.41
Total	1091	100		1018	100	

of age group; (ii) availability of the data in terms of age, sex, weight, and height for the calculation of BMI. All indicators were calculated using the C-Sample routines for complex survey design in Epi Info version 3.4.3 [15].

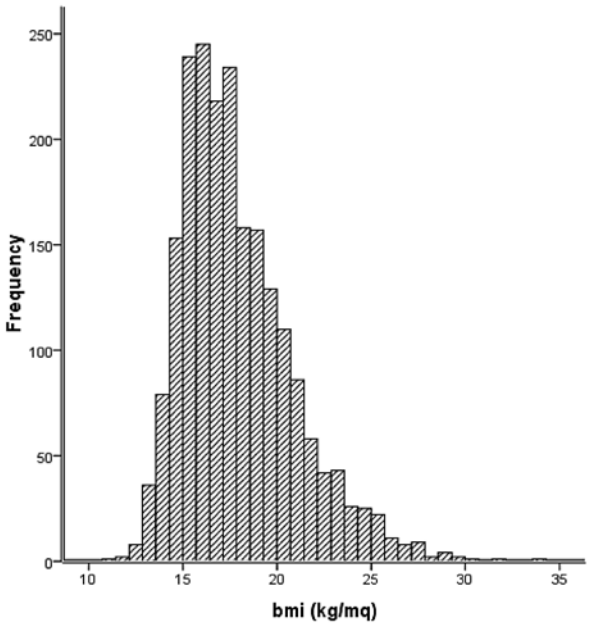
Results

The principal distinguishing characteristics of both male and female samples are reported in Table II. It shows homogeneity of the sample with respect to age, weight, and height. Figure 1 shows the distribution of BMI frequency along with an indication of the BMI median values. Looking at the nutritional status by different classes we can see that the prevalence of underweight is 0.88% (0.76% in males and 1.01% in females), the prevalence of overweight is 23.43% (22.33% in males and 24.65% in females), and the prevalence of obesity is 7.95% (9.08% in males *vs.* 6.70% in females) (Tabs. II, III). The prevalence of underweight females (1.01%) was higher than that of males (0.76%); but it is statistically not significant (p = 0.53, Tab. III).

The lowest percentage (6.46%) of obese children were found in Metropolitan area with more than 50.000 inhabitants. Relatively higher percentages (0.96%) of underweight children were found in Metropolitan area with less than 50.000 and more than 10.000 inhabitants. By contrast, the lowest percentage (0.31%) of underweight children and higher percentage of obese children (10.71%) were found in municipalities with less than 10.000 inhabitants (p = 0.0083) (Table IV).

The differences in the prevalence of normal weight and overweight children from different demographic breadth of their place of residence are statistically significant (p = 0.002). Multiple comparisons (using the χ^2-test with Bonferroni's correction) also confirmed statistically significant differences in prevalence of overweight children in: (i) municipalities with less than 10.000 inhabitants and non-Metropolitan areas with > 50.000 inhabitants (p = 0.008); (ii) municipalities with less than 10.000 inhabitants and Metropolitan areas with > 50.000 inhabitants (p = 0.0002); and (iii) municipalities with 10.000-50.000 inhabitants and non-Metropolitan area with > 50.000 inhabitants (p = 0.006). The normal weight prevalence of children were found in: (i) municipalities with less than 10.000 inhabitants and in non-Metropolitan area with > 50.000 inhabitants (p = 0.003); (ii) municipalities with less than 10.000 inhabitants and in Metropolitan area with > 50.000 inhabitants (p = 0.0002); and (iii) municipalities with 10.000-50.000 inhabitants and Metropolitan areas with > 50.000 inhabitants (p = 0.007) (Tab. IV).

Fig. 1. Distribution of BMI.



Discussion

With the implementation of the "OKkio alla Salute" national project in 2008, in coordination with the Centre for Epidemiology, Surveillance, and Health Promotion within the National Institute of Health, the Tuscany Region took the opportunity and joined the project. The possibility of sharing the same methodology with other regions, was experimented on 2001, which facili-

Tab. IV. BMI classes of children and population of Commune (municipality).

	Commune population											
	< 10.000			10.000-50.000			> 50.000 Non-metropolitan (Nm)			> 50.000 Metropolitan/Peri-metropolitan (M/Pm)		
	n	%	IC95%	n	%	IC95%	n	%	IC95%	n	%	IC95%
Under-weight	2	0.31	0.19-0.81	4	0.96	0.01-1.93	7	0.92	0.13-1.70	2	0.76	0.35-1.27
Normal weight*	212	60.20	53.91-66.49	337	65.12	60.24-70.00	649	68.68	65.03-72.33	196	74.52	65.62-70.40
Over-weight**	88	28.78	22.93-34.62	126	27.13	22.54-31.72	232	21.86	18.62-25.10	48	18.25	21.08-25.42
Obese	41	10,71	6.75-14.67	34	6.79	4.17-9.41	93	8.54	6.37-10.71	17	6.46	6.55-9.30
Total	343	100		501	100		981	100		263	100	

*p = 0,002 (< 10.000 ***vs.*** > 50.000 ***Nm,*** p = 0.003; < 10.000 ***vs.*** > 50.000 ***M/Pm,*** p = 0.0002; 10.000-50.000 ***vs.*** > 50.000 ***Nm,*** p = 0.007); **p = 0,002 (< 10.000 ***vs.*** > 50.000 ***Nm,*** p = 0.008; < 10.000 ***vs.*** > 50.000 ***M/Pm,*** p = 0.0002; 10.000-50.000 ***vs.*** > 50.000 ***Nm,*** p = 0.006).

tated a comparison of the national and other regional data.

The 2008 survey data permits to monitor the nutritional status of Tuscan children after seven years. The BMI median values, stable over the time, are higher if compared with those of the IOTF reference group and lower when compared with those of the 2008 Italian National Survey [9]. The differences between the northern, central and southern Italy describe an incremental geographic trend. This geographic gradient in paediatric obesity is typical of a wide variety of other paediatric health indicators in Italy, with the highest prevalence of most adverse outcomes occurring in eight regions of southern Italy, intermediate levels in four central regions, and low levels in seven regions and two autonomous provinces of the north [9].

To better understand and explain the reasons of these geographic differences, it will be useful to conduct more detailed and in depth investigation on some others important predictors of childhood obesity like birth weight, breast feeding history, or parental weight status etc., in future [16, 17].

Regarding the distribution of childhood obesity estimated in relationship to the demographic breadth of the commune (municipalities) of residence, we observed that the lowest prevalence rate occurred in the communes with more than 50.000 inhabitants in the metropolitan area. At this moment, we need further information on the same indicators to interpret and hypothesize these differences based on the influence of some social variables that are known to influence the nutritional status of children [17-20]. Some of these indicators, for example, are: (i) socioeconomic status of the family; (ii) educational background of parents,; (iii) physical activity; and (iv) lifestyles, in towns of different sizes. We have explored these possibilities, keeping in mind that this is an investigation of nutritional surveillance. The highest prevalence of parents with university degrees occurred in towns with more than 50.000 inhabitants (as evident from the 11.5% parents in regions with < 10.000 inhabitants, 12.8% parents in regions with 10.000-50.000 inhabitants, 17.0% parents in regions with > 50.000 inhabitants, and 17.1% parents in regions with > 50000 inhabitants in metropolitan area). It confirms the importance of social variables from within the group of factors that influence the obesity level in paediatric age. Further detail and in-depth studies are necessary in this direction in future for establishing these aspects clearly.

Based on the results of this study, we conclude that the overweight and obesity prevalence rates are not increased over time, rather they remain steady. The 2008 survey allowed us to examine more specifically the thinness evaluation. Since the Cole's study [12] that established the cut off level for prevalence of underweight [13], several other papers have published data on underweight prevalence using the new cut off points. Notwithstanding, there are still some differences about the interpretation of the terms, thinness and underweight. To better explicit our references, we have defined the different categories of underweight as shown in Table II.

These data are indicative of a situation that confirms the importance of preventive interventions in pediatric age, without producing alarming reactions regarding the actual entity of the phenomenon of childhood obesity in Tuscany.

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