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Growth and Secular Trend in School-Children from Cento, Ferrara, Italy

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A B S T R A C T

Growth parameters were surveyed in a sample of 296 Italian children, 6–9 years old, from Cento (Ferrara, Emilia--Romagna). The comparison with children from the same town measured in 1974–75 show changes in some parameters, suggesting an ongoing secular trend. To better understand the observed weight increase and the sex difference, we also evaluated body composition and motricity. The analysis of the present sample is a preliminary part of a longitudinal study dealing with modifications of body composition and motor capacity induced by growth. In our sample the children are growing according to the Italian reference standard. The females present weight, height and Body Mass Index (BMI) values comparable to the 50th centile, while the males present higher values of weight, skinfold thicknesses and BMI. Sex differences in the motor performance were noted. A methodological comparison of obesity assessments based on BMI and percentage of body fat (%F) shows similar conclusions but somewhat different results.

Key words: *secular trend, children, body composition, nutritional status*

Introduction

Numerous studies have been carried out in Italy to evaluate variations of the principal anthropometric characteristics in relation to growth[1]. Height data for 6–12 year-old Italian children suggest that the intensity of the secular height increase is tending to diminish in Italy, while weight shows a greater increase[1]. The greater increase of weight than height agrees with literature reports of a high incidence of nutritional disorders such as overweight and obesity[1–7].

Obesity is a major public health problem throughout most of the world, but in some areas both obesity and undernutrition coexist. Although overweight and obesity in Italian children have received attention, there is a need for information about the other extreme, underweight.

Many studies have confirmed the strong association between obesity and the high risk of chronic health problems such as coronary artery disease risk factors[8], non--insulin diabetes[9,10] and psychological problems[11]. The prevalence of obesity in children is increasing; in fact, the average child in the 1980s was fatter than the average child of 20 years earlier[12]. One of the worrying aspects of childhood obesity is the increased risk of obesity in adulthood, with its well established health complications[13–15]. The cause of childhood obesity has not been completely clarified, although a complex interaction of genetic, environmental and behavioral factors seems to be responsible[16].

The hallmark of obesity is excess body fat**.** Increased fatness in an individual or an increased frequency of overweight in a population can occur only as a result of a sustained positive balance, i.e. when energy intake exceeds energy expenditure[17]. Several factors are suspected in this trend, including increased food intake, reduced physical activity in childhood, and a pattern of food intake in which high-calorie fast food plays an important role.

The notion that obesity is caused by excess energy intake is not generally supported in the scientific literature. However, recent research suggests that the composition of the diet, including high fat and low carbohydrate intakes, may play a role in overweight[16], even though this conclusion is debatable[18]. A number of studies suggest a significant relationship between physical activity and obesity[19–24], but other studies refute such a relationship[25,26]. Indeed, the issue is clouded by the wide variety of methods used to assess children's activity levels.

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Despite widespread concern about obesity, the development of standard definitions of obesity for screening and intervention remains problematic. Valid and practical methods based on health-related criteria for obesity screening in children and adolescents are not available. Therefore, because simple, accurate methods for the direct assessment of body fat are lacking, anthropometric indexes such as the body mass index are often used as surrogates for body composition. However, interpretation of the results is difficult, because Body Mass Index (BMI) reflects relative leg length, body frame size and fat-free mass in addition to fatness. Consequently, two persons with the same amount of body fat can have quite different BMI values. These problems are underscored by the discordant estimates of prevalence when obesity is estimated via BMI and other anthropometric measures such as skinfold thicknesses[27].

The present study is a preliminary part of a larger longitudinal study dealing with modifications of body composition and mobility induced by growth in a sample of Italian school-children.

The purposes of this study were: 1) a preliminary assessment of the growth of school-age children of Cento (Ferrara – Emilia-Romagna, Italy); 2) evaluation of a possible secular trend in the children of Cento; 3) determination of the prevalence of underweight, overweight and obese subjects; 4) evaluation of motricity and strength in relation to sex; and 5) comparison of the assessment of obesity on the basis of different methodologies.

Materials and Methods

In 2001–2002, we surveyed a sample of 296 Italian children (147 males, 149 females, 6–9 years) from Cento (Tables 1 and 2) to evaluate body composition and motricity during growth. Each age class incorporate children from x.5 to (x+1).49 years of age, where x equals a given

TABLE 1
DESCRIPTIVE STATISTICS OF THE ANTHROPOMETRIC VARIABLES IN FEMALE SAMPLE

	6 yrs. (N=15)		7 yrs. (N=58)		8 yrs. (N=55)		9 yrs. (N=21)	
	X	SD	X	SD	X	SD	X	SD
Height (cm)	119.45	4.62	122.61	5.18	127.66	5.94	132.72	6.69
Weight (kg)	24.00	4.54	25.52	5.01	28.37	5.81	29.45	6.72
Body mass index (BMI, kg/m^2)	16.77	2.67	16.84	2.39	17.29	2.65	16.63	3.15
Sitting height (cm)	64.41	2.64	65.98	2.64	67.67	3.12	70.01	4.01
Chest circumference normal (cm)	59.47	4.65	60.67	5.04	62.73	5.42	64.24	6.21
Chest circumference maximum (cm)	62.89	4.74	64.41	4.91	66.58	5.40	68.33	5.76
Chest circumference minimum (cm)	58.03	4.58	58.97	4.89	61.09	5.33	62.60	6.06
Relaxed arm circumference (cm)	18.67	2.13	18.96	2.37	19.77	2.37	19.82	2.98
Contracted arm circumference (cm)	19.75	2.32	19.99	2.29	20.83	2.55	20.99	2.87
Wrist circumference (cm)	12.60	1.15	12.90	1.60	13.41	1.70	14.44	5.26
Thigh circumference (cm)	34.57	3.33	35.85	3.70	37.31	3.99	37.33	4.20
Calf circumference (cm)	25.53	2.27	26.18	2.63	27.31	2.57	27.71	2.89
Humerus breadths (mm)	4.99	0.83	4.96	0.49	5.20	0.63	5.22	0.36
Femur breadth (mm)	7.26	0.79	7.46	0.59	7.71	0.63	7.93	0.51
aspalphaBiceps skinfold (mm)	6.93	2.80	6.41	3.34	6.83	3.40	7.64	4.24
Triceps skinfold (mm)	10.10	3.31	10.13	3.45	11.19	4.21	10.43	4.85
Subscapular skinfold (mm)	8.07	3.83	7.30	3.41	7.96	3.85	8.19	4.62
Supraspinal skinfold (mm)	7.00	4.00	7.51	4.00	8.45	4.70	8.83	5.85
Suprailiac skinfold (mm)	10.47	5.18	9.97	4.87	11.51	5.21	11.93	6.38
Thigh skinfold (mm)	18.73	3.39	18.38	4.95	20.13	5.14	19.67	5.73
Medial calf skinfold (mm)	12.77	3.53	12.54	3.66	14.06	4.14	14.57	5.01
Lateral calf skinfold (mm)	12.97	2.69	12.05	3.29	13.51	3.77	13.07	2.99
Fat free mass (FFM, kg)	19.80	2.84	21.20	3.12	23.10	3.57	24.10	3.99
Fat mass (FM, kg)	4.20	2.11	4.40	2.18	5.20	2.62	5.30	3.32
Percentage fat (%F)	16.80	5.22	16.20	5.25	17.50	5.88	16.80	6.98
Sit-and-reach (cm)	41.23	6.02	42.09	5.42	40.97	5.50	41.84	4.45
Hand grip strength (kg)	8.70	2.40	9.60	2.16	11.40	2.98	13.70	3.02

N – number of children by age

years of age at the time of the measurement. This is in agreement with the indications of Tanner[28], Malina et al.[29] and other studies on growth.

The anthropometric characters examined were: height, sitting height (Raven magnimeter), weight (scale), eight circumferences (normal chest, maximum chest, minimum chest, arm relaxed and contracted, wrist, thigh and calf)(inelastic tape), humerus and femur breadths (small sliding calliper), eight skinfold thicknesses (biceps, triceps, subscapular, suprailiac, supraspinal, thigh, lateral and medial calf)(Lange calliper). All measurements were taken according to standard techniques described by Weiner and Lourie[30], on the left side of the body by an expert technician. Physiometric characters included general flexibility (sit-and-reach test) (Dietosystem, Milan) and hand grip strength (Takei Scientific Instruments Co., Japan).

In addition, the BMI was calculated and body composition parameters (Fat Free Mass, Fat Mass, Percentage Fat) were computed with the skinfold equations of Slaughter[31].

Questionnaire was used to asses the frequency and the number of hours of extra-curricular physical activity. Questionnaire was filled out by the parents of the youngster.

The mean values of height, weight, sitting height and chest circumference in the present sample (2001–2002) were compared with the corresponding values reported by Facchini and Gualdi[32] for Cento school-children measured in 1974–75 (Tables 3 and 4). The differences were analyzed by Student's t-test. The growth of the children in the present sample was evaluated according to the reference standard proposed for the Italian population[33].

TABLE 2
DESCRIPTIVE STATISTICS OF THE ANTHROPOMETRIC VARIABLES IN MALE SAMPLE

	6 yrs. (N=15)		7 yrs. (N=58)		8 yrs. (N=55)		9 yrs. (N=21)	
	X	SD	X	SD	X	SD	X	SD
Height (cm)	118.14	4.97	123.72	5.16	129.60	6.45	135.05	4.30
Weight (kg)	23.39	4.54	27.54	6.20	29.40	6.52	35.05	7.11
Body mass index (BMI, kg/m^2)	15.69	4.35	17.90	3.09	17.39	3.02	19.14	3.36
Sitting height (cm)	64.48	3.31	66.38	3.12	69.03	3.53	70.99	2.35
Chest circumference normal (cm)	59.31	4.00	63.09	5.75	64.90	5.42	67.57	5.14
Chest circumference maximum (cm)	62.96	3.86	66.70	5.34	68.55	5.40	71.58	5.13
Chest circumference minimum (cm)	57.76	3.84	61.29	5.51	63.13	5.12	66.27	5.09
Relaxed arm circumference (cm)	18.13	2.17	19.63	2.77	20.02	2.61	21.56	2.90
Contracted arm circumference (cm)	19.27	2.30	20.72	2.91	21.15	2.56	22.76	3.29
Wrist circumference (cm)	12.67	0.85	13.32	0.97	13.76	0.99	13.91	0.94
Thigh circumference (cm)	34.33	3.52	36.75	4.24	37.56	4.20	40.63	3.84
Calf circumference (cm)	25.67	2.51	27.21	3.13	27.48	2.74	29.39	2.78
Humerus breadths (mm)	5.14	0.74	5.23	0.36	5.41	0.47	5.60	0.58
Femur breadth (mm)	7.47	0.79	8.02	0.54	8.10	0.74	8.42	0.80
Biceps skinfold (mm)	5.79	2.68	6.71	3.70	6.48	3.76	9.23	5.24
Triceps skinfold (mm)	9.00	3.40	10.22	4.40	10.03	4.33	13.02	5.57
Subscapular skinfold (mm)	6.71	3.51	7.58	4.57	7.45	4.22	9.43	6.57
Supraspinal skinfold (mm)	5.95	2.95	7.71	4.83	8.41	5.07	11.04	6.33
Suprailiac skinfold (mm)	8.61	4.85	10.61	6.09	11.51	6.95	15.32	7.00
Thigh skinfold (mm)	16.24	4.69	18.42	5.87	18.38	6.22	22.41	8.01
Medial calf skinfold (mm)	11.21	3.15	13.05	4.68	13.56	5.60	16.34	6.30
Lateral calf skinfold (mm)	11.68	3.01	12.60	3.51	12.99	4.43	15.61	5.46
Fat free mass (FFM, kg)	18.60	5.20	22.60	3.84	24.20	3.64	27.40	3.17
Fat mass (FM, kg)	3.60	2.35	4.90	3.13	5.20	3.37	7.60	4.62
Percentage fat (%F)	15.00	5.96	16.70	6.90	16.50	7.17	20.40	7.61
Sit-and-reach (cm)	39.13	4.83	39.14	4.44	38.58	5.73	37.96	5.45
Hand grip strength (kg)	9.50	2.71	11.10	2.23	12.20	3.32	15.20	3.30

N – number of children by age

TABLE 3
COMPARISON BETWEEN FEMALES OF THE PRESENT SAMPLE AND THAT OF 1974 AND PERCENTAGE OF INCREMENT.

	2001/02 sample		1974 sample		p	% increment
	X	SD	X	SD		
Height						
6 yrs.	119.45	4.62	115.74	5.01	**	3.10
7 yrs.	122.61	5.18	120.79	5.13	**	1.50
8 yrs.	127.66	5.94	125.84	5.77	**	1.40
9 yrs.	132.72	6.69	131.67	592		0.80
Weight						
6 yrs.	24.00	4.54	21.72	3.31	*	9.50
7 yrs.	25.52	5.01	24.09	4.20	*	5.60
8 yrs.	28.37	5.81	26.82	5.23	*	5.50
9 yrs.	29.45	6.72	30.09	6.28		–2.20
Sitting height						
6 yrs.	64.41	2.64	64.32	2.78		0.14
7 yrs.	65.98	2.64	66.61	2.73	*	–0.95
8 yrs.	67.67	3.12	69.00	3.12	**	–1.97
9 yrs.	70.01	4.01	71.30	3.03		–1.84
Chest circumference						
6 yrs.	59.47	4.65	56.33	3.00	**	5.30
7 yrs.	60.67	5.04	58.23	3.89	**	4.00
8 yrs.	62.73	5.42	60.07	4.39	**	4.30
9 yrs.	64.24	6.21	62.57	5.12		2.60

*p=0.05, **p=0.01, ***p=0.001

TABLE 4
COMPARISON BETWEEN MALES OF THE PRESENT SAMPLE AND THAT OF 1974 SAMPLE WITH PERCENTAGE OF INCREMENT

	2001/02 sample		1974 sample		p	% increment
	X	SD	X	SD		
Height						
6 yrs.	118.14	4.97	115.98	4.26	*	2.30
7 yrs.	123.72	5.16	120.27	5.07	**	2.80
8 yrs.	129.60	6.45	126.19	5.50	**	2.60
9 yrs.	135.05	4.30	131.38	6.28	**	2.70
Weight						
6 yrs.	23.39	4.54	21.55	3.21	*	7.90
7 yrs.	27.54	6.20	23.72	3.88	**	13.90
8 yrs.	29.40	6.52	26.20	4.80	**	10.90
9 yrs.	35.05	7.11	30.00	5.66	**	14.40
Sitting height						
6 yrs.	64.48	3.31	63.98	3.40		0.77
7 yrs.	66.38	3.12	66.18	2.92		0.30
8 yrs.	69.03	3.53	68.70	3.42		0.47
9 yrs.	70.99	2.35	71.28	3.31		–0.41
Chest circumference						
6 yrs.	59.31	4.00	57.15	2.95	**	3.60
7 yrs.	63.09	5.75	59.23	3.75	**	6.10
8 yrs.	64.90	5.42	60.70	4.96	**	6.50
9 yrs.	67.57	5.14	63.62	4.63	**	5.80

*p=0.05, **p=0.01, ***p=0.001

The prevalence of underweight, overweight and obese subjects was determined on the basis of BMI following the cut-off proposed by Cacciari[33]. Obesity was also evaluated using percentage fat (%F) following the cut-off proposed by Williams[34]. The data were analyzed according to the separate age classes. Since not all the characters have a normal distribution, sex differences in the present sample were assessed by the non-parametric Kolmogorov-Smirnov test. Correlations between characters were assessed by the non-parametric Spearman test.

Results

Evaluation of secular trend

Tables 3 and 4 report the descriptive statistics of the anthropometric variables for the Cento children (subdivided by sex and age class) measured in 1974–75[32] and in 2001–2002. The height values are higher in the males and females of our sample than in those measured 27 years before, with significant differences in females at 6, 7 and 8 years and in males at all ages. The difference tends to increase with age in males, ranging from 2.2 cm at 6 years (2.3%) to 3.7 cm at 9 years (2.7%), while it tends to decrease in females, from 3.7 cm at 6 years (3.1%) to 1.1 cm at 9 years (0.8%).

Weight is also significantly higher in our sample than in the children of 1974–75. The weight differences are greater than the height differences, particularly in males (significant at all ages): ranging from 1.8 kg at 6 years (an increase of 7.9%) to 5 kg at 9 years (14.4%).

In females, the differences (significant for the first three age classes) tend to decrease with age (9.5% at 6 years to –2.2% at 9 years). Sanna[1] also reported a greater increase of weight than height over time in Italian children; the percentage increases were comparable, although females showed greater increases than males. The differences in sitting height between the children of our sample and their peers of 27 years before are very slight. The differences in chest circumference are also noteworthy, again being greater in males: ranging from 2.1 cm to 4.2 cm. The higher values of the anthropometric variables in our sample than in the children measured in 1974–75 suggest an ongoing secular trend, e.g. earlier maturation in the present sample.

The means and standard deviations of the anthropometric variables are reported in Tables 1 and 2. As ex-

pected, height, weight and sitting height are always higher in males than in females. This is also true for all the circumferences and the humerus and femur breadths. In all age classes, the height values are comparable to the mean values proposed for the Italian population[33]. The mean weights of females in the present sample are comparable to the 50th centile of the Italian reference standard; however, in males, the values are always higher after 6 years of age, albeit below the 97th centile. Consequently, the mean BMI values of females vary only slightly from the Italian reference values, whereas the male values are much higher. To further explore the observed sex differences, we considered skinfold thicknesses and body composition parameters.

Between 6 and 7 years of age, males show a mean increase of 1–2 mm in the various skinfold thicknesses. The differences are slight between 7 and 8 years, but greater (2–4 mm) between 8 and 9 years. The greatest changes are in the thigh, suprailiac, biceps and triceps skinfolds, the smallest in the subscapular skinfold. Females present very slight variation in skinfold thickness between age classes: the values are fairly constant between 6 and 7 years and between 8 and 9 years, and increase slightly (by about 1 mm) between 7 and 8 years.

The skinfold thickness are similar in males and females until 8 years of age. Males always present higher values at 9 years, although the differences are not significant except for triceps. These results do not agree with the literature data, since females generally have thicker skinfolds than males in the age classes considered in the present study[29, 35].

We compared the triceps and subscapular skinfold thicknesses of the children in our sample with normative data from the National Center for Health Statistics[36]. For the triceps skinfold, the females approach the 50th centile at 6 and 8 years and the 25th centile at 7 and 9 years, while in males the values are near the 50th centile at 6 years and approach the 75th centile in later years. The subscapular skinfold approaches the 75th centile in females and the 85th in males at all the considered ages.

The differences in skinfold thickness obviously influence the body composition parameters. FM and %F follow the same trend as the skinfolds: males and females have comparable values until 8 years of age, while males show significantly higher values at 9 years. As with skinfolds, this disagrees with the literature data, where females show higher values[29,37]. Fat free mass (FFM) is similar in males and females at 6 years, but is always higher in males after that age. This reflects the greater musculo-skeletal development of males. In fact, males present wider skeletal diameters than females, suggesting more intense development of skeletal mass.

Evaluation of nutritional status

We have also considered our sample from the nutritional point of view, in light of the greater increase in weight than height observed in the comparison of the two samples of Cento children and the fact that the increase of overweight and obese individuals in recent years is a very important public health problem.

TABLE 5
NUMBER AND PERCENTAGE OF UNDERWEIGHT SUBJECTS

Age (years)	Females		Males	
	N/ Total	%	N/Total	%
6	1/19	5.3	–	–
7	1/58	1.8	2/56	3.6
8	4/55	7.3	4/44	9.1
9	3/21	14.3	–	–

N – number of subjects

There are clear sex differences in the percentages of underweight, overweight and obese children, calculated using BMI as the criterion. There are underweight females in all the age classes and the percentage increases with age (Table 5). Underweight males are present in only two age classes.

The differences between the sexes are even more evident when overweight and obesity are considered. The percentages are much higher in males than in females; in fact, obesity is only present in males (Figure 1).

We also evaluated obesity using %F values. To our knowledge, there are only two published criterion-based definitions of obesity in children and adolescents, i.e. Williams et al.[34] and Dwyer and Blizzard[38]. We used the criteria of Williams et al.[34] since these authors studied children from 5 to 18 years of age and their %F standards were defined from body density as estimated from skinfold thicknesses: obesity = %F >25% for boys and %F >30% for girls.

The higher prevalence of obese males is confirmed when %F is used to define obesity. However, it should be

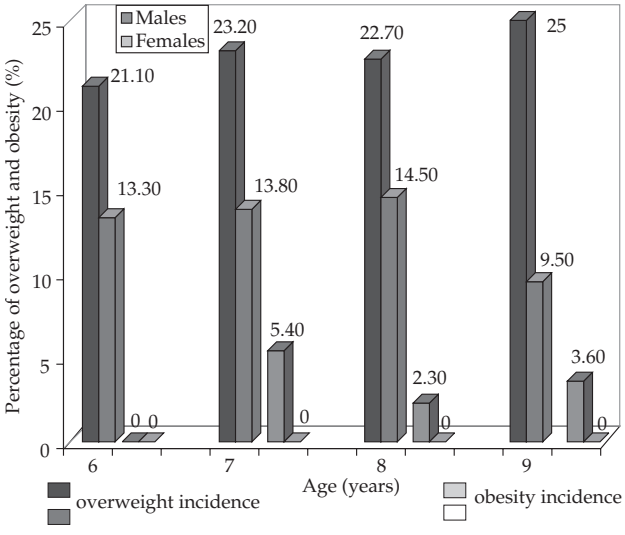

Fig. 1. Percentage of overweight and obesity in males and females by age class.

TABLE 6
PERCENTAGE OF OBESE SUBJECTS ON THE BASIS OF PERCENTAGE OF FAT (%F) AND BODY MASS INDEX (BMI)

Age (Years)	On the basis of %F		On the basis of BMI	
	Males	Females	Males	Females
6	10.53	–	–	–
7	10.71	–	5.4	–
8	18.18	1.82	2.3	–
9	21.43	9.52	3.6	–

%F – percentage fat, BMI – body mass index

underlined that the cut-offs proposed in the literature do not discriminate between obesity and overweight. For this reason, the percentages of obese subjects are higher than those based on BMI (Table 6).

Comparison of the two classifications of overweight and obesity (using %F or BMI) reveals the following situation:

Obese according to %F:

6 years: 2 of the 19 males ▸ 2 overweight on the basis of BMI

7 years: 6 of the 56 males, ▸ 4 overweight on the basis of BMI
2 obese on the basis of BMI

8 years: 8 of the 44 males, ▸ 2 normal weight on the basis of BMI
5 overweight on the basis of BMI
1 obese on the basis of BMI

8 years: 1 of the 55 females, ▸ 1 overweight on the basis of BMI

9 years: 6 of the 28 males, ▸ 2 normal weight on the basis of BMI
3 overweight on the basis of BMI
1 obese on the basis of BMI

9 years: 2 of the 21 females, ▸ 1 normal weight on the basis of BMI
1 overweight on the basis of BMI

Nevertheless, the subjects of normal weight on the basis of BMI are at the limit of the distribution, i.e. very near the lower limit of overweight.

Although the two methods generally agree regarding the determination of the prevalence of obesity in males, they do not show close correspondence. This highlights the need to develop appropriate standards of obesity for screening and intervention.

The analysis of hours of physical activity practiced after school is shown in Tables 7 and 8. In both sexes, there are no differences in the hours of activity practiced by normal weight and overweight subjects.

TABLE 7
COMPARISON BETWEEN %F OF THE PRESENT STUDY AND THAT OF OTHER STUDIES

	Present sample		De Lorenzo et al. (1995)[49]		Toselli et al. (1995)[52]	
	X	SD	X	SD	X	SD
Females						
6 yrs.	16.80	5.22	17.50	3.20	23.65	7.61
7 yrs.	16.20	5.25	19.10	4.20	23.90	9.59
8 yrs.	17.50	5.88	19.70	4.10	26.81	12.00
9 yrs.	16.80	6.98	21.80	4.70	29.67	10.87
Males						
6 yrs.	15.00	5.96	16.70	2.80	15.09	4.87
7 yrs.	16.70	6.90	17.30	2.90	17.68	6.50
8 yrs.	16.50	7.17	17.80	4.10	19.07	7.88
9 yrs.	20.40	7.61	18.00	4.44	19.33	7.98

%F – percentage fat

TABLE 8
COMPARISON BETWEEN TRICEPS SKINFOLD OF THE PRESENT STUDY AND THAT OF DE LORENZO STUDY

	Present sample		De Lorenzo et al. (1995)[49]	
	X	SD	X	SD
Females				
6 yrs.	10.10	3.31	9.60	2.70
7 yrs.	10.13	3.45	11.20	3.70
8 yrs.	11.19	4.21	12.40	3.70
9 yrs.	10.43	4.85	14.30	4.80
Males				
6 yrs.	9.00	3.40	8.10	2.40
7 yrs.	10.22	4.40	9.20	3.00
8 yrs.	10.03	4.33	10.40	4.10
9 yrs.	13.02	5.57	11.00	4.40

Among the obese subjects in the sample, only one 7 year-old male engaged in at least 2 hours of physical activity/week. This child's parents were conscious of his nutritional problem.

Physiometric characters

As expected, hand grip strength is always higher in males than in females. There are few comparative literature data and none for the Italian population. However, some comparisons with European and extra-European populations suggest an intermediate position of our sample. In contrast, flexibility is always higher in females, as reported in the literature[29,35]. There is no significant correlation between flexibility and height, weight, %F or FFM at any age. The only noteworthy ones are the nega-

tive correlations with weight in males of 7 years (r=–0.4) and with height in males of 9 years (r=–0.5).

There are positive correlations between hand grip strength and the other characters. Of note are the correlations between hand grip strength and both height and FFM at all ages. Thus we can hypothesize that, at these ages, musculo-skeletal development influences physical strength more than weight in general. The correlations between hand grip strength and weight and %F are weaker, although sometimes with fairly large r values (strength-weight: r=0.3–0.8, strength – %F: r=0.004–0.6).

Conclusions

For centuries, the economy of the town of Cento (in the province of Ferrara) was almost entirely agricultural and based on a particular institution, the »*partecipanza*«. In 1974–75, handicrafts and manufacturing were beginning to spread, in addition to agriculture and breeding. In the last 30 years, these sectors have expanded and there has been strong economic growth. Industrial activities are more dynamic, with an increase in the building, computer (information) and financial sectors. We believe that the economic changes and increased quality of life are among the causes of the greater growth of today's children with respect to their peers of about 30 years ago. In fact, we observed a secular trend in height, weight and chest circumference. Since there were no differences in sitting height, the height increase of the Cento children over almost 30 years was mainly due to an increase in leg length. This agrees with other studies reporting that the secular increase in height was mainly due to increased leg length[2,7,39–44], rather than proportional increases in leg length and sitting height, as proposed by others[45–47]. Moreover, our study supports the presence of an ongoing secular trend in height, in contrast to the decreasing tendency reported by Sanna[7] for the Italian population.

The children in our sample are growing according to the reference standards proposed for the Italian population by Cacciari et al.[33]. However, males and females have different growth trends: males present higher levels of obesity than females, with higher values of weight, BMI and %F. Moreover, the male values are higher than the reference standards reported by Cacciari et al.[33], and their triceps and subscapular skinfold thicknesses are greater than the standards reported by Frisancho[36]. A possible reason for this could be the different concern about body weight shown by males and females at these ages, as revealed by our current research on body image.

In our sample, the hours of after-school physical activity did not differ between overweight and normal weight children. Hence, the difference in weight was not related to a difference in physical activity. However, only 1 of the 5 obese subjects engaged in extra-curricular physical activity. Importantly, the parents of this child stated that they were aware of their son's obesity problem and were trying to help him resolve it.

A comparison with other samples of Italian children is possible only for certain characters. However, the criterion used to subdivide the age classes (x) was not always the same as ours (x-1).5-x.5); instead, x.00–x.99 was sometimes used. In this case, the children in our age classes are systematically younger.

The height values (Figures 2 and 3) in our sample are comparable to those reported for children from Latium[48] and from Modena, Cosenza and Foggia[49]. They are slightly lower than those from Pescara[50] and L'Aquila[51]. However, the different criterion of age classification (x.00–x.99) in the last three studies means that the values of our sample are relatively underestimated.

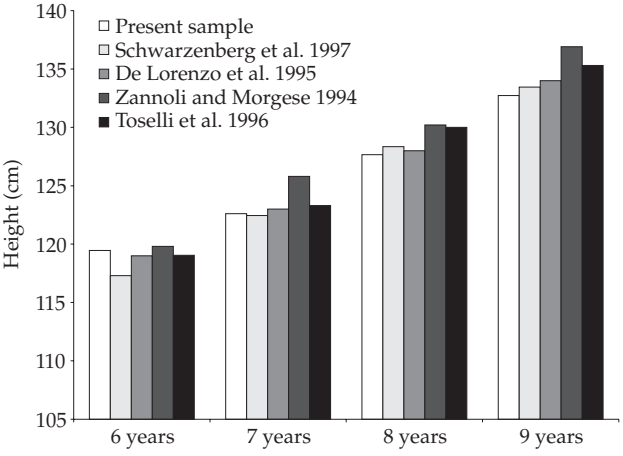

Fig. 2. Comparison between height values in our sample (females) and other studies.

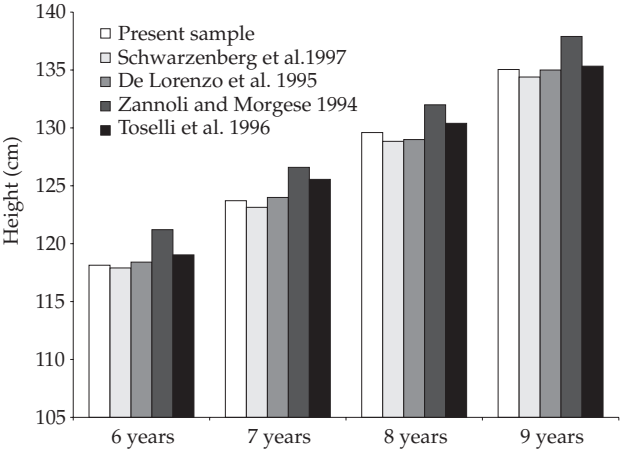

Fig. 3. Comparison between height values in our sample (males) and other studies.

The weight values (Figures 4 and 5) in our females are similar to those reported by De Lorenzo et al.[49]; however, because of the different age class criterion, ours girls are slightly younger; our males show even higher weight values than their peers.

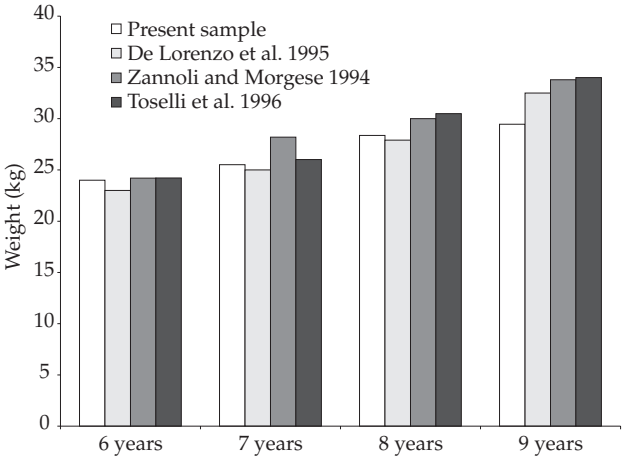

Fig. 4. Comparison between weight values in our sample (females) and other studies.

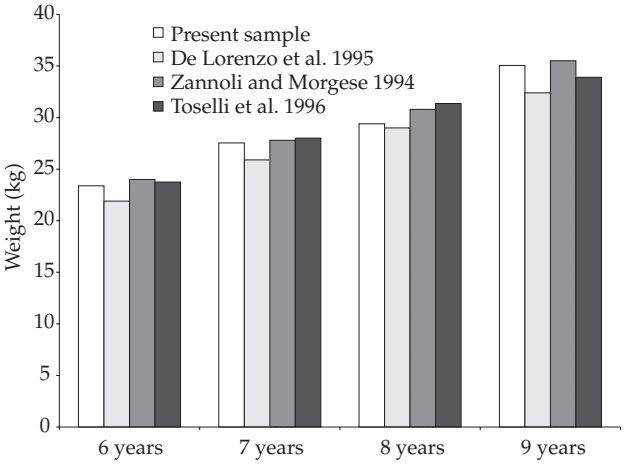

Fig. 5. Comparison between weight values in our sample (males) and other studies.

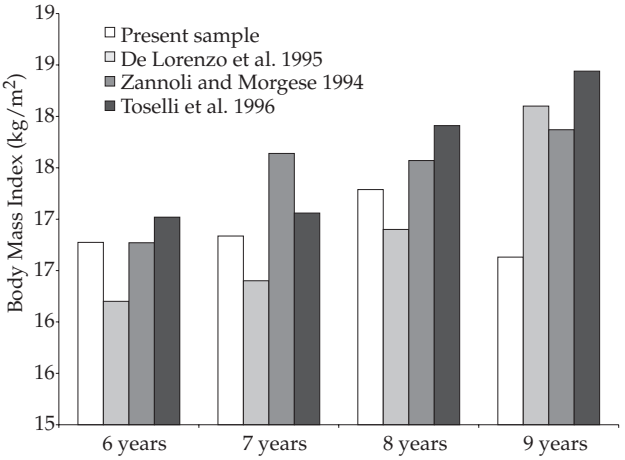

Fig. 6. Comparison between Body Mass Index values in our sample (females) and other studies.

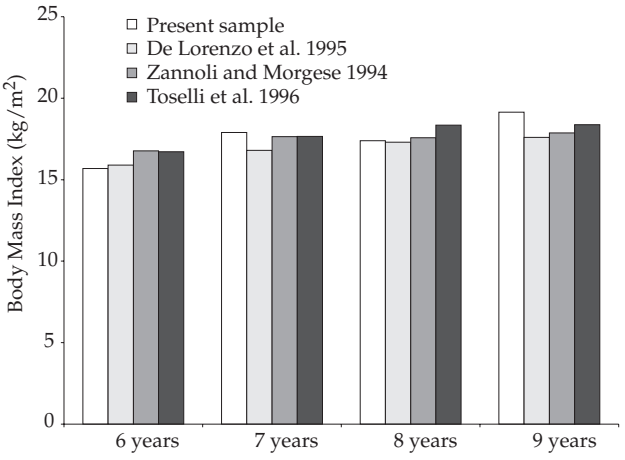

Fig. 7. Comparison between Body Mass Index values in our sample (males) and other studies.

The weight values of our females are lower than those reported by Zanolli and Morgese[50], while those of the males are similar. The weights in our sample are comparable to those in the sample studied by Toselli et al.[51] for the first two age classes in both sexes, but lower in the last two classes (except males 9 years old). Nevertheless, any interpretation of the comparisons with the last two studies must consider the different age class criteria.

The BMI values (Figures 6 and 7) in our sample are quite similar to those reported by De Lorenzo et al.[49] and Toselli et al.[51], except at 9 years where our females have lower values and our males have higher values. The BMI values reported by Zannolli and Morgese[50] are slightly higher than ours, although our 9 year-old males present higher values.

The %F values (Table 7) in our sample are generally lower than those reported by De Lorenzo et al.[49], although again our 9 year-old males have higher values. Comparison with the data of Toselli et al.[52] reveals much lower %F values in our females; the differences between the males of the two samples are smaller, although the values of our males are slightly lower at 7 and 8 years and higher at 9 years.

The triceps skinfold thicknesses (Table 8) are slightly lower in our females than in those studied by De Lorenzo et al.[49], except at 9 years where they are much lower. The opposite is observed in males, with higher triceps values in our sample, especially at 9 years.

Therefore, in our males, the 9 years age class is marked by very high values of adiposity.

It must be emphasized that the differences between our children and the children from the other Italian cities are affected by the different criteria of age classification: our children are always underestimated since they are systematically younger.

The sex differences observed in the motor performance parameters (higher flexibility in females, greater

hand grip strength in males) agree with the literature data[34]. As expected, hand grip strength is positively correlated with height and FFM.

One of our aims was to compare the applicability of two different methods of evaluation of overweight and obesity. Although the two methods yielded the same general conclusions, the results were somewhat different. Children classified as obese using the % body fat criterion were not always classified as obese according to the BMI cut-off; sometimes they were only overweight or even normal weight. This is due to the methodological problems inherent in the two techniques. Indeed, BMI is not completely representative of fat mass[53]. Body composition could be a valid alternative, but the lack of appropriate standards limits its use.

As mentioned previously, this study is a preliminary part of a larger longitudinal study. Further research in the next few years on the later age classes will be necessary to thoroughly explore these topics, especially the changes in the various parameters during growth and the trend of nutritional status with time.

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RAST I SEKULARNI TREND U ŠKOLSKE DJECE IZ CENTA, FERRARA, ITALIJA

S A Ž E T A K

U uzorku od 296 talijanske djece u dobi od 6–9 godina iz Centa (Ferrara, Emiglia-Romagna) istraživani su parametri rasta. Usporedba s djecom iz istog grada mjerenom u 1974–75 godini pokazuje promjenu u određenim parametrima što sugerira postojanje sekularnog trenda. U cilju boljeg razumijevanja porasta tjelesne težine spolnog dimorfizma, procijenjen je sastav tijela i motoričke sposobnosti djece. Analiza ovog uzorka preliminarni je dio longitudinalne studije sastava tijela i motoričkih sposobnosti tijekom rasta i razvoja. U ispitivanom uzorku, djeca rastu u skladu s talijanskim referentnim vrijednostima. Kod djevojčica se težina, visina i indeks tjelesne mase kreću oko 50. percentila, dok dječaci pokazuju više vrijednosti težine, kožnih nabora i indeks tjelesne mase. Uočene su spolne razlike u motoričkim sposobnostima. Metodološka usporedba procjene debljine tijela bazirane na indeksu tjelesne mase i postotku tjelesne masti daje slične zaključke, ali nešto drugačije rezultate.