Body Image Perception and Body Composition in Early Adolescents: A Longitudinal Study of an Italian Cohort

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Abstract

Background: Adolescence is a period of life in which students face physical and psychological changes that can destabilise them, and that is characterised by specific health and developmental needs and rights. The aim of this study was to evaluate the longitudinal association between anthropometric, weight status, body composition changes, and body image perception, keeping into account sex and maturity differences in adolescents.

Methods: A sample of 134 children (64 males and 70 females) attending secondary school in the Emilia Romagna region (northern Italy) have been followed longitudinally for three consecutive years. Sports practice was assessed by questionnaire, and maturity status was detected. Anthropometric measurements, body composition, and body image perception were carried out. The discrepancy between the actual figure and the ideal figure was used to determine the degree of body image dissatisfaction, while improper perception of weight status was evaluated by means of Feel weight status minus Actual weight status Inconsistency (FAI).

Results: A high percentage of the sample (about 90% in both sexes) practiced sport during the three years. In males, since they were approaching the PHV, leg length growth was prevalent. In females, height increment was lower than the one observed in males, such as the sitting height increment was higher than that of leg length. Connected with sexual dimorphism is also the trend of skinfold thicknesses, which generally showed a decrease in males and increase in females during the three years. Percentage of body fat followed the same trend. In both sex, body image perception did not show significant variations with age, and FAI score indicated no inconsistency in weight status perception. A difference in the perception of body image was observed in subjects of different weight status categories in each class.

Conclusions: As demonstrated by the present study, the body image perception did not seem to change with age, but associations were found between body image perception and weight status. Monitoring perception in young adolescents, as well as taking into account their maturity and weight status is a priority to prevent nutritional disorders.

Background

The early adolescence is generally considered the period between 10 and 14 years [1] and starting from this period, during the middle school, most students face physical and psychological changes that can destabilise them. This early stage of adolescence is characterised by growth spurt and is soon followed by the development of secondary sexual characteristics. These external changes are often noticeable and can be a source of anxiety, excitement or pride for the individual whose body is undergoing transformation. According to the World Health Organization (WHO), adolescence is a period of life with specific health and developmental needs and rights. It is also a time to develop knowledge and skills, learn to manage emotions and relationships, and acquire attributes and abilities that will be important to enjoy the adolescent years and assuming adult roles. In many ways, adolescent development drives the changes in the disease burden between childhood to adulthood. Many of the health-related behaviours that arise during adolescence have implications for both present and future health and development. For example, obesity in early adolescence

not only compromises adolescent development but it also predicts health-compromising obesity in later life, with serious implications for public health [2].

The fast morphological and psychosocial changes occurring during this period greatly influences body perception [3, 4]. Adolescence represents a critical stage in the development of positive or negative body image [5, 6]. Rapid changes during adolescence in shape and weight due to puberty interact with socio-cultural contexts to influence body image perceptions [5]. Weight misperception, a perceptual aspect of body image relating to over- or under-estimation of weight, is a separate construct from body dissatisfaction [7–12]. Among adolescents, there is often a desire and constant search for physical characteristics other than reality [13], which can cause body image dissatisfaction [14, 15, 4]. Such behaviour, according to its magnitude, may contribute to the occurrence of eating [13, 15, 16] and mental [17] disorders, which might compromise their social relations [13] and quality of life. In today's societies, there is an idealisation of a perfect body, which, in adolescents, if not achieved, could lead to body image disorders, in addition to the effects on health and behaviour [18, 16, 19].

Findings from researches on pre-adolescents and adolescents indicate that psychological characteristics, including negative affect [20], self-esteem [21], perfectionism [22] and internalisation of appearance ideals [23], as well as larger body size [21], may confer risk for the development of body image concerns [24].Moreover, it is to be considered that the adolescents' lifestyle is often not healthy. They frequently follow eating and behavioural patterns characterised by high-energy (mainly fat) food, skipping daily meals, low fruit and vegetables consumption and an increasingly sedentary routine with many hours in front of the computer and television screen and fewer hours of physical exercise [25]. As a consequence, this determines a greater effort to maintain a lean body and achieve the ideal standard of beauty imposed by the media and society [26].

Overweight and obesity are public health problems and the prevalence among 11-year-olds was greater than 10% for boys in four countries in Europe (Croatia, Greece, Portugal and the Former Yugoslav Republic of Macedonia), but only two countries (Greece and Italy) had a prevalence of more than 5% of overweight and obese girls. The lowest levels of obesity were found in the Netherlands and Norway. Obesity prevalence was higher among younger than older adolescents and generally was higher in boys. These patterns reflect those observed for overweight, with higher rates among boys and younger adolescents. Average prevalence of overweight and obesity (combined) in Europe was 19%, with the highest levels mainly in southern European countries [27]. Obesity during adolescence is associated with morbidities during this phase and also throughout adult life, with eating disorders (ED) being the third most common chronic disease in adolescence, losing only to obesity and asthma [28, 29].

Body dissatisfaction is considered a predictor of ED and adolescence is a crucial phase for the positive or negative development of body image [5].Distortion and dissatisfaction with body image may form a link between overweight and obesity, as excessive preoccupation with appearance and unremitting pursuit of the perfect, lean body can generate negative feelings and devaluation, resulting in a change in the eating behaviour, leading to overweight or the development of ED [30].Surveillance of body image satisfaction among adolescents is necessary, since they may perceive their own body differently from its real size, shape and weight. Body image dissatisfaction may be a risk factor for the development of psychopathologies and

as a mediator of the relation between nutritional status and emotional health [14, 17, 4]. Considering the negative results in health, it is important to understand the body dissatisfaction among young people, its change over time and the factors that can influence it.

Longitudinal studies appear to be more adequate for better understanding of the changes of physical and psychological variables over adolescence. Therefore, the overall aim of this study is to evaluate the longitudinal association between anthropometric, weight status and body composition changes and body image perception, keeping into account sex and maturity differences in adolescents aged 11–14 years.

Methods

Participants and design

A longitudinal study design was chosen, and data were collected and analysed in a sample of 134 children (64 males and 70 females) attending 1st to 3rd class of secondary school in the Emilia Romagna region (northern Italy) during three consecutive years. Only children who received parental written consent and agreed to participate were allowed to take part in the study. The study was approved by the Bioethics Committee of the University of Bologna (approval n. 2.18).

General information about demographic (e.g. sex and age) and sport participation (sport practice - considered as club sports, namely planned sports activities led by staff - and the amount involved (hours per week) were collected. Sport practice frequency of each subject was determined by the hours of sport training during a typical week as declared by the subject.

Procedures

Anthropometric characteristics (height, weight, lengths, waist and hip circumferences and skinfold thicknesses) were collected according to standardised procedures [31, 32]. Height and sitting height were measured to the nearest 0.1 cm using a stadiometer (GPM, Zurich, Switzerland), and leg length was derived by the subtraction of sitting height from height. Body weight was measured to the nearest 0.1 kg (light indoor clothing, without shoes) using a calibrated electronic scale. Circumferences were measured to the nearest 0.1 cm with a non-stretchable tape. Skinfold thicknesses were measured to the nearest 0.1 mm using a Lange skinfold caliper (Beta Technology Inc., Houston, TX, USA).

Body mass index (BMI) was calculated as weight (in kilograms) divided by the square of height (in metres). This index was used to assess the weight status of each participant according to Cole cut-off values by sex and age [33,34].

Cormic index was calculated as sitting height (in centimetres) divided by height (in centimetres).

Waist/Hip ratio (WHR) and Waist/height ratio (WHtR) were calculated, and for the last index children were stratified into two categories (≤0.5 and >0.5); the value of 0.5 was chosen as cut-off of cardiovascular risk [35-37].

Body composition parameters (percentage of fat mass (%F), Fat mass (FM) and Fat free mass (FFM) were calculated using the skinfold equations developed by Slaughter and colleagues [38].

In girls, maturity status was detected by asking the girls if they have already reached menarche, and in case of an affirmative answer, the date was recorded. In boys, an estimation of the years from peak height velocity, which is an indicator for the adolescent growth spurt, was made using the equation for boys developed by Mirwald and colleagues [39], which is able to predict maturity offset in youth athletes [40-41]. According to Mirwald et al [39] boys were classified as early, average and late matures.

Maturity offset = −9.236 + 0.0002708 (leg length ∗ sitting height) − 0.001663 (age ∗ leg length) + 0.007216 (age ∗ sitting height) + 0.02292 (weight/height).

Since maturity offset represents the time before or after peak height velocity (PHV), years from PHV were calculated by subtracting age at PHV from chronological age.

Body image perception was assessed using Body Silhouette Chart [42]. Children were shown nine male or female silhouettes, ordered in morphology from emaciation to obesity. Subjects were asked to select the silhouette which they believed was most similar to their own (actual figure) as well as the silhouette which they most desired (ideal figure). Using the classification reported by Sánchez-Villegas et al. [42], the silhouette series were divided into four categories (underweight, normal weight, overweight and obese). The discrepancy between the actual figure and the ideal figure represents the degree of body image dissatisfaction (FID or Feel minus Ideal Discrepancy) [43]. The FID index was calculated by subtracting the score of the figure selected by children as the ideal figure from the one selected as their actual figure. A positive FID score indicates the actual figure was bigger than the ideal figure and a negative score indicates the actual figure was thinner than the ideal figure. A FID score of 0 indicates no discrepancy (same figure chosen as actual and as ideal).

Improper perception of weight status was evaluated by means of FAI (Feel weight status minus Actual weight status Inconsistency) [44]: we calculated the inconsistency score FAI by subtracting the conventional code assigned to the actual weight status of the participant (1 = underweight; 2 = normal weight; 3 = overweight; 4 = obese) from the code of her/his perceived, using the classification recommended by Sánchez-Villegas et al. [42]. A FAI score of zero indicates no inconsistency in weight status perception; a positive score indicates that weight status is overestimated, and a negative score indicates that weight status is underestimated.

Statistical analysis

The data analysis was performed using Statistica for Windows, version 8.0 (Stat Soft Italia SRL, Vigonza, Padua, Italy). Variables normality was verified with the Shapiro–Wilk test. The means and SD of the baseline data (1^{st}class) and in the following years (2nd and 3rd classes) were calculated. Percentage frequency was determined for qualitative variables (weight status).Paired ANOVA was used to assess differences between the values carried out on subjects in each of the three years of measurement (from first class to third class), whereas differences in the frequencies were tested by the chi-squared test (with Fisher's exact text and Bonferroni correction pair wise comparison, when appropriate).

Results

Table 1 shows the anthropometric, body composition, and body image characteristics of males during the three consecutive years.

According to equation of Mirwald et al. [39] the mean age at PHV of the sample was 14.00 years (SD = 0.62). The majority of the boys were average matures (91.9%), only 3.2% of the children were early matures, and 4.8% late matures. In the 3rd class about the 93% of the children were approaching the PHV (distance from PHV = ± 0.5 years).

The 92% of males practiced club sports. This percentage was constant in the first two years, with a slight decrease (90%) in the 3rd class. Hours of sports increased with age, with significant difference between the 1st and 3rd class.

Height, weight, lengths and circumferences significantly increased with age, with differences among all the considered age classes. From the 1st to the 3rd class height increment was of 13.43 ± 4.24 cm, sitting height increment of 6.21 ± 3.48 cm, leg length increment of 7.23 ± 2.45 cm and weight increment of 11.03 ± 4.15 kg.

Cormic index and BMI did not show significant variation with age, even if a slight tendency to the decrease in cormic index and a slightly increase in the BMI were observed. On average, WHtR remained stable in the three years: a small percentage of boys presented WHtR values higher than the 0.5 cut-off (7.69% in the 1st class; 9.52% in the 2nd and 3rd classes). WHR showed a significant decrease with age.

In general, skinfold thicknesses remained quite stable over the three years, with a general tendency to decrease. However, the decrease observed for biceps, triceps and thigh skinfolds was significant.

%F significantly decreased with age, moreover between the1st and the 3rd class, while FFM significantly increased.

Table 1
Descriptive statistics and ANOVA for males.

	1st class		2nd class		3rd class			
Variable	mean	SD	mean	SD	mean	SD	F	p
Age (yrs)	11.81	0.28	12.80	0.27	13.82	0.27		
Amount of club sports (h/w)	3.74	1.52	4.53	2.23	4.85	1.98	5.08	<0.01
height (cm)	151.03	7.11	157.67	8.00	164.30	8.90	43.63	<0.01
sitting height (cm)	77.36	3.74	80.15	4.63	83.49	5.19	28.68	<0.01
leg length (cm)	73.66	4.48	77.52	4.42	80.81	4.74	38.94	<0.01
weight (kg)	44.13	8.07	49.34	8.62	55.06	9.50	29.30	<0.01
Comic index	51.24	1.40	50.83	1.33	50.81	1.33	1.86	0.15
BMI (kg/m^2)	19.53	2.89	19.75	2.61	20.29	2.52	2.38	0.09
waist circumference (cm)	67.10	6.62	69.53	6.50	71.62	7.13	9.15	<0.01
hip circumference (cm)	81.40	7.20	84.19	6.70	86.99	6.91	13.02	<0.01
WHR	0.71	0.10	0.65	0.05	0.65	0.05	14.16	<0.01
WHtR	0.44	0.04	0.44	0.04	0.44	0.04	0.62	0.53
biceps skinfold (mm)	8.02	3.80	7.05	3.76	6.37	3.34	4.25	0.01
triceps skinfold (mm)	12.73	3.50	11.90	3.69	10.86	3.52	2.97	0.04
subscapular skinfold (mm)	9.58	4.04	8.71	3.78	8.61	3.77	2.44	0.09
supraspinal skinfold (mm)	10.41	5.58	9.32	5.18	9.77	5.63	1.15	0.32
suprailiac skinfold (mm)	11.88	5.20	11.37	5.87	11.60	5.89	0.80	0.45
medial calf skinfold (mm)	11.70	4.15	11.83	4.19	10.69	4.20	2.10	0.12
lateral calf skinfold (mm)	12.33	3.45	12.50	3.89	12.05	3.70	0.75	0.47
thigh skinfold (mm)	16.63	4.61	15.54	4.68	14.59	4.93	3.29	0.04
sum of skinfolds (mm)	93.25	29.36	88.53	31.38	83.93	30.12	2.20	0.11
%F	20.93	5.77	19.48	5.79	17.21	5.71	5.94	<0.01
FM (kg)	9.49	3.81	9.88	4.17	9.74	4.26	0.11	0.89
FFM (kg)	34.64	5.38	39.38	5.90	45.32	7.03	26.36	<0.01
Actual figure	4.19	1.58	4.08	1.41	3.81	1.37	1.37	0.25
Ideal figure	3.98	1.34	3.86	1.12	3.76	1.09	0.94	0.39
FID (score)	0.27	1.45	0.22	0.96	0.05	0.79	0.40	0.67

FAI (score)	-0.49	0.71	-0.44	0.64	-0.54	0.64	0.36	0.70

Body image parameters did not show significant variations with age. In all the three years, on average males chose normal weight silhouettes both for the actual and the ideal figure. As consequence, FID score indicated no dissatisfaction, especially in the 3rd class, such as FAI score indicated no variations with age, even if a tendency to underestimate the weight status perception is observed in all the three considered years.

With reference to females (Table 2), data regarding age at menarche show that in the 1st class, the 29.0% of the sample has reached it; this percentage increased to 62.9% in the 2nd class and to 74.3% in the 3rd class. The mean age at menarche was 11.97 (SD = 0.94 years).

Sports were practiced by 89.9% of the girls in the first class, passing to 87.1% in the second class and to 90% in the 3rd class. Hours of sports slightly increased during the three years, but not significantly.

A significant increase with age was observed for height, weight, lengths and circumferences. Height, weight, waist and hip circumferences showed significant differences among all the considered age classes, while the other parameters only between the 1st and the 3rd class. From 1st to the 3rd class, height increment was of 7.32 ± 3.51 cm, sitting height increment of 4.40 ± 2.55 cm, leg length increment of 2.92 ± 2.45 cm and weight increment of 8.88 ± 4.15 kg. Cormic index did not show significant variation with age, even if a tendency to increase was observed. BMI showed a significant increase, while WHR a significant decrease with age. WHtR did not show significant differences during the three years, and also the subjects with values above the cut off remained stable in the three years (9.52%).

Almost all skinfold thicknesses showed a significant increase, except for biceps, subscapular and medial calf. This influenced body composition parameters, which significantly increased with age. In particular, %F increased from 19.55% in the 1st class to 22.19% in the 3rd class.

Table 2
Descriptive statistics and ANOVA for females.

	1st class		2nd class		3rd class			
Variable	mean	SD	mean	SD	mean	SD	F	p
Age (yrs)	11.86	0.26	12.85	0.26	13.86	0.27		
Amount of club sports (h/w)	3.53	2.45	4.22	2.72	4.06	2.53	1.43	0.24
height (cm)	153.11	6.31	157.92	5.94	160.55	5.52	18.02	<0.01
sitting height (cm)	79.14	3.80	82.03	3.04	83.59	2.68	23.05	<0.01
leg length (cm)	73.98	3.84	75.89	3.77	76.96	3.83	6.35	<0.01
wei weight (kg)	44.30	6.98	48.87	6.66	53.36	6.76	18.21	<0.01
Comic index	51.69	1.41	51.96	1.10	52.08	1.17	1.40	0.24
B BMI(kg/m^2)	18.85	2.44	19.59	2.46	20.75	2.65	6.39	<0.01
Wa waist circumference (cm)	64.31	5.64	66.05	5.28	67.88	5.93	4.32	0.01
hip circumference (cm)	84.19	6.40	88.10	6.31	91.88	5.48	18.18	<0.01
WHR	0.72	0.05	0.70	0.04	0.70	0.04	7.17	<0.01
WHtR	0.42	0.04	0.42	0.04	0.42	0.04	0.10	0.90
biceps skinfold (mm)	7.73	2.88	7.79	2.84	8.39	3.21	0.73	0.48
triceps skinfold (mm)	12.13	3.36	12.16	2.79	14.16	3.68	7.93	<0.01
subscapular skinfold (mm)	9.29	3.63	9.59	3.32	11.02	3.88	2.19	0.11
supraspinal skinfold (mm)	10.32	3.80	10.41	3.58	12.82	5.15	4.87	<0.01
suprailiac skinfold (mm)	12.22	4.67	13.36	4.38	15.74	5.23	6.04	<0.01
medial calf skinfold (mm)	11.96	3.55	12.30	3.45	13.78	3.63	2.25	0.10
lateral calf skinfold (mm)	12.26	3.17	12.49	3.29	15.14	4.30	7.64	<0.01
thigh skinfold(mm)	17.66	4.50	17.76	4.63	20.58	5.39	3.78	0.02
sum of skinfolds (mm)	93.57	23.71	95.86	23.38	111.63	28.56	5.87	<0.01
%F	19.55	4.39	19.89	4.04	22.19	4.04	6.10	<0.01
FM (kg)	8.83	2.91	9.95	3.06	11.99	3.26	11.32	<0.01
FFM (kg)	35.48	4.97	39.18	4.59	41.38	4.49	16.02	<0.01
Actual figure	4.59	1.49	4.56	1.39	4.79	1.43	0.83	0.43
Ideal figure	4.12	1.18	4.01	1.04	4.24	1.10	0.64	0.53
FID (score)	0.54	1.26	0.54	0.79	0.54	0.88	0.92	0.40

FAI (score)	-0.09	0.78	-0.04	0.62	-0.04	0.67	0.10	0.90

On average, the actual figure chosen by girls belonged to normal weight category, but it was in the upper extremity (nearly overweight). Also, the mean ideal figure chosen falls in the normal weight category, but presented lower values than the actual figure, as testified by positive mean values of FID, indicating a desire of being thinner. FAI score approximated zero, indicating no inconsistency in weight status perception, even if with a slight tendency to underestimation, testified by negative mean values. In general, no significant differences are observed in body composition parameters among the three years that were analysed.

Considering the prevalence of weight status in males (Table 3), no significant differences were observed among the three years. Normal weight prevailed in all the considered classes, showing an increasing trend with age. A small percentage of obese boys were observed in the 1st class, but this category disappeared in the following years, such as a reduction of overweight subjects is observed.

The body image perception of the subjects with the same weight status categories did not present significant change with age (Table 3). On the contrary, if we consider the differences among the weight status categories in each school class, significant differences emerged. Actual figure increased with weight status categories and significantly differed between normal weight and overweight subjects (1st class $F = 6.39$, $p = 0.003$; 2nd class $F = 17.85$, $p = 0.000$; 3rd class $F = 10.62$, $p = 0.002$). A significant trend in underestimation of weight status with the increase of BMI categories detected by FAI index was observed in boys of 1st and 3rd class (1st class $F = 7.01$, $p = 0.002$; 3rd class $F = 4.64$, $p = 0.035$). In 2nd and 3rd classes also FID significantly differed between normal weight and overweight subjects (2nd class $F = 19.98$, $p = 0.000$; 3rd class $F = 8.88$, $p = 0.004$): in normal weight subjects, a tendency to indicate an actual figure thinner than the ideal figure was observed, while in overweight subjects, a positive FID score was shown, indicating a desire to be bigger.

Table 3
Prevalence of weight status in the different class and body image perception according to weight status in males.

	1st class %		2nd class %		3rd class %		p (χ2 test)
normal weight	68.75		76.19		77.80		0.23
overweight	26.56		23.81		22.20		
obese	4.69						
	Mean	SD	Mean	SD	Mean	SD	p (ANOVA)
normal weight							
Actual figure	3.76	1.40	3.71	1.24	3.53	1.26	0.74
Ideal figure	3.75	1.25	3.75	1.10	3.63	1.07	0.84
FID (score)	0.01	1.57	-0.04	0.80	-0.10	0.71	0.94
FAI (score)	-0.33	0.56	-0.40	0.64	-0.45	0.61	0.78
overweight							
Actual figure	5.06	1.75	5.27	1.28	4.79	1.31	0.68
Ideal figure	4.47	1.46	4.20	1.15	4.21	1.05	0.78
FID	0.59	1.12	1.07	0.96	0.57	0.85	0.30
FAI	-0.71	0.85	-0.60	0.63	-0.86	0.66	0.63
obese							
Actual figure	5.33	0.58					
Ideal figure	4.33	1.53					
FID	1.00	1.00					
FAI	-1.67	0.58					

Also, in females the weight status prevalence did not significantly differ among the three years and normal weight subjects prevailed (Table 4). Contrarily to males, in the 1st and 2nd classes a small percentage of underweight girls were observed. Even if the differences were not significant, a slight increase in the prevalence of overweight in the 3rd class was observed.

Analogously to males, in females belonging to same weight status categories, body image perception did not present significant change with age (Table 4). Significant differences emerged among subjects of different weight status categories within each school class both in actual figure (1st class: $F = 8.87$, $p = 0.000$; 2nd class: $F = 17.31$, $p = 0.000$; 3rd class: $F = 33.50$, $p = 0.000$) and in ideal figure (1st class: $F = 4.03$, $p = 0.010$; 2nd class: $F = 5.59$, $p = 0.006$; 3rd class: $F = 5.86$, $p = 0.018$). Both actual and ideal figure increased with increasing

weight status. FID index showed a significant trend, with increasing values with the increase of the weight status category in all the considered classes (1st class: $F = 3.72$, $p = 0.001$; 2nd class: $F = 14.94$, $p = 0.000$; 3rd class: $F = 34.46$, $p = 0.000$). Only underweight girls had a strong desire to gain weight because they had a good perception of their body (FAI = 0.0), meanwhile the other three weight categories demonstrated a desire of lose weight, especially obese girls, despite the tendency in underestimate their weight in any case, FAI index did not show significant difference among the different weight status categories.

Table 4
Prevalence of weight status in the different class and body image perception according to weight status in females.

	1st class (%)		2nd class (%)		3rd class (%)		p (χ2 test)
underweight	1.47		1.43		0 (0.0)		0.89
normal weight	82.35		85.71		82.90		
overweight	14.71		12.86		17.10		
obese	1.47						
underweight	Mean	SD	Mean	SD	Mean	SD	p (ANOVA)
Actual figure	1.00		2.00				
Ideal figure	3.00		2.00				
FID	-2.00		0.00				
FAI	0.00		0.00				
normal weight							
Actual figure	4.32	1.28	4.30	1.18	4.41	1.12	0.92
Ideal figure	3.95	1.06	3.92	1.00	4.10	1.00	0.70
FID	0.37	1.22	0.38	0.67	0.31	0.71	0.88
FAI	-0.11	0.65	-0.07	0.65	-0.05	0.63	0.89
overweight							
Actual figure	6.30	1.16	6.56	0.73	6.58	1.44	0.83
Ideal figure	5.20	1.32	4.89	0.78	4.92	1.31	0.81
FID	1.10	1.20	1.67	0.71	1.67	0.78	0.29
FAI	-0.10	0.74	0.11	0.33	0.00	0.85	0.80
obese							
Actual figure	5.00						
Ideal figure	3.00						
FID	2.00						
FAI	-2.00						

Discussion

The present study considered the longitudinal changes in anthropometric characteristics, body composition, and body image perception in early adolescents of both sexes over the three years of the middle school. To our knowledge, this study is the first to evaluate the longitudinal association between body image perception and body size and composition in young Italian adolescents.

A high percentage of the sample (about 90% in both sex) practiced sport during the three years. The percentages were quite stable in all the years that were taken into consideration. The hours of sport practice tended to increase with age, with significant difference between the first and third class in males. These data are positive and do not confirm what the Health Behaviour in School-aged Children (HBSC) Survey in Italia and in countries in the WHO European Region, which found a decrease of sport practice with age and reported that girls across all countries and age groups are less active than boys, with the gender gap increasing with age. According to Guthold [45], from the global data collected through questionnaires and the accelerometer, less than one fifth of adolescents comply with the WHO [46], physical activity recommendations, according to which school-aged children should participate daily in at least 60 minutes of moderate to vigorous physical activity (MVPA). Farooq et al.[47], in agreement with most of the recent studies on physical activity (PA), reported that the decline in PA begins around the time of school entry and continues through adolescence. It is also well documented that insufficient childhood PA track from adolescence into adulthood [48]. Even if the present data regarded the declared extracurricular sport practice, the results are encouraging.

In this regard, it is important to remember that the Emilia-Romagna Region has long been involved in promoting PA and a healthy nutrition, through a various number of coordinated and continuous actions addressed to the family, school and community during the first years of life of the child, at school and in the community. The Regional Prevention Plan approved with its resolution no. 2071/2010 has the specific objective of the "Elaboration of a regional organisation model for taking care of the obese children based on synergies and collaborations between all professionals involved". For this aim, with determination no. 15582/2011 the regional working group "Prevention obesity" was established, whose aim was the implementation of the provisions of the afore mentioned resolution. This was made up of different professionals and experts (nutritionist, dietician, endocrinologist, psychiatrist, psychologist, sports doctor, paediatrician) and representatives of the unions of free choice paediatricians [49].

The male sample during the three years was approaching the growth spurt, and in the last year of measurement about 93% of the boys were near the time of PHV. This is reflected in the great height increments. Moreover, considering that, according to their maturation status, the males of the present sample were approaching the PHV, they were in the phase where leg length growth is prevalent. Differential timings of growth of height, sitting height and leg length are in fact known, since with growth a change in relationship between leg length and sitting height is observed. The growth of leg length precedes the PHV, while sitting height growth occurs after PHV [50].

During the three years, the sum of skinfolds showed a tendency of decrease in males. A significant decrease was observed for biceps, triceps and thigh skinfold. Connected to skinfold change was the significant decrease of %F with age, moreover between the 1st and the 3rd class, accompanied by a significant increase of FFM. The data are in accordance with body composition and fat distribution changes that occurs during male adolescence [50].

The percentage of mature girls increased with age, starting from 29.0% in the 1st class to the 74.3% in the 3rd class. The mean age at menarche was 11.97 (SD = 0.94 years). A significant increase with age was observed for all the considered parameters, with height, weight, waist and hip circumferences showing significant differences among all the considered age classes. The height increment was lower than that observed in males, such as the sitting height increment was higher than that of leg length: this reflects the different phase of maturation of the two sex, with girls in advance in comparison with males.

Connected with sexual dimorphism is also the trend of skinfold thicknesses, which generally showed a significant increase in girls during the three years, it follows that %F significantly increased from 19.55% in the 1st class to 22.19% in the 3rd class.

The data of the present study strengthen the awareness that body composition is influenced by various moderating factors such as age and maturation status, which should be considered in studies regarding youth. Variations in fat-free mass, fatness, and relative fat distribution in late childhood and adolescence also affect body composition status [51]. Furthermore, the influences of these moderating factors vary by sex. For girls, fat mass increases more rapidly than for boys during childhood, and this trend continues throughout adolescence. Other important variations in body composition which are influenced by age and sex include BMI, subcutaneous fat and relative fat distribution [52, 53, 50]. All the indexes connected to adiposity or fat distribution, such as BMI, WHtR, remained quite stable and WHR showed a significant decrease with age. A small percentage of boys presented WHtR values higher than the cut-off, and normal weight prevailed in all the considered classes, showing an increasing trend with age. The percentage of overweight boys was not small but tending to decrease with age. The percentage of normal weight males was lower than the national data [54], which reported an incidence of 75.9% in 11 years old boys and of 78.4% in 13 years old boys, but it tended to approach these values with age. Percentages of overweight boys in the present sample were higher than the national data, while obesity is slightly higher in the 1st class, but disappeared in the following years. Contrarily to the national data, there were no underweight subjects in the present sample.

In girls, BMI showed a significant increase. Even if the weight status prevalence did not significantly differ among the three years and normal weight subjects prevailed, a reduction in underweight prevalence and a slight increase in the prevalence of overweight with age were observed. Regarding weight status, females presented a better situation than males. The percentage of normal weight girls was comparable to the national data [55], but the percentage of overweight girls is higher and obese and underweight subjects were lower. With regard to fat distribution, WHR showed a significant decrease with age and WHtR was stable during the three years, showing a 9.52% of subjects above the cut-off.

From the latest data [56] from the WHO Childhood Obesity Surveillance Initiative (COSI) emerged that in countries like Italy, Portugal, Spain and Greece, there has been an important decrease, which is attributable to a very significant effort that these countries have made in recent years into management and prevention of childhood obesity [57], although rates are still high. Despite the incidence of overweight in the present sample was high, the percentage of subjects engaged in sports practice suggests that the issue of prevention was taken into account. Low levels of PA in adolescents is a critical cause for the obesity epidemic in the developed countries [58, 59], and generally obese adolescents are less physically active (PA) than normal-weight adolescents [60]. As a consequence, increasing physical activity is probably one of the best strategies

to reduce the prevalence of overweight and obesity in youth [58]. In addition, fat distribution may have more relevant implications for health than the total amount of body fat. Visceral fatness or the accumulation of intra-abdominal adipose tissue increases cardiovascular risk in children, and it has been shown that that the most active individuals have the lowest visceral fat after adjusting for total body fat. This suggests that PA may elicit a proportionally larger decrease in fat stored in the intra-abdominal cavity than in other regions in people with visceral fatness [61, 62]. Cross-sectional data also suggest that PA could promote a reduction of visceral fat and trunk al fat in pre-pubertal and pubertal children [63, 64]. In this longitudinal study, the sport practice is high and regular, and once again this can be traced back to the preventive campaigns that the region in which the study took place [49] has put in place to encourage the spread of a healthy lifestyle among children and adolescents. The large prevalence of adolescents that practice sport activities is demonstrated also when considering body image parameters.

The average FAI index of both sexes is close to 0, meaning a correct perception of their own body. In fact, if we analyse the FAI score within each weight status category, it is clear a general correct estimation in normal weight and overweight adolescents, especially in girls, even if a tendency to underestimation in weight status perception was observed in both sexes, but more pronounced in males. The higher FAI scores are shown in the extreme weight status categories in both males and females. Recent studies demonstrate the importance of PA and sport practice in body image perception in children and adolescents: indeed, sport participation is related to less negative body image and to an increase in awareness of one's own body [65–67].

In both sexes, body image perception did not show significant variations with age and both for actual and ideal figures that were chosen to fall into the category of average in normal weight silhouettes. Nevertheless, females tend to choose a thinner ideal figure than the actual, as testified also by FID.

The body image perception in the subjects of the same weight status categories was stable with age, while subjects of different weight status categories in each class showed significant differences in the perception of body image. This study confirmed the important role of weight status in body image perceptions. So, more than age, weight status is the dominant factor in the body perception. With the increase of weight status categories boys and girls chose bigger actual and ideal figures. Normal weight and overweight boys presented significant different choices: normal weight subjects showed a tendency to choose a thinner actual figure than the ideal figure, while overweight subject indicated a bigger actual figure than the ideal figure. In females, FID index showed a significant increase with the increase of the category in all the considered classes. In boys, a significant trend in underestimation of weight status with the increase of its category is detected by FAI. Sex differences in body image parameters are underlined especially in normal weight and overweight subjects. Boys had a slight tendency to underestimate their weight status, but they are in general more satisfied with their body. Instead, females were more aware of their weight status, but even normal weight females showed a desire to lose weight. Our results confirmed the literature on the topic underlining the need of an increase in investigation also in male children and adolescents, especially with regard to their body awareness [68, 69].

According to various authors [70–72], increased BMI is associated with lower self-perceptions of social acceptance and physical appearance, and children who demonstrate low perceptions of self-concept also are generally less willing to participate in activities with peers [73–75].

Conclusion

Adolescence is a complex transition stage, in which individuals may be affected by different conditions capable of a negative influence on their emotional state, determining lower self-esteem. In the present study, the body image perception did not seem to change with age, but associations were found between body image perception and weight status. Monitoring perception in young adolescents and also taking into account their maturity and weight status should be a priority in order to prevent nutritional disorders.

Abbreviations

FAI: Feel weight status minus Actual weight status Inconsistency, WHO: World Health Organization, ED: eating disorders, BMI: Body mass index, WHR: Waist/Hip ratio, WHtR: Waist/height ratio, %F: percentage of fat mass, FM: Fat mass, FFM: Fat free mass, PHV: peak height velocity, FID: Feel Ideal Discrepancy, HBSC: Health Behaviour in School-aged Children, MVPA: Moderate to vigorous physical activity, PA: Physical Activity, COSI: Childhood Obesity Surveillance Initiative.

Declarations

Ethics approval and consent to participate

The study was approved by the Bioethics Committee of the University of Bologna (approval n. 2.18).

Consent for publication

Not applicable

Availability of data and materials

Not applicable

Author Contributions

Conceptualization, S.T, A.G. and L.Z; methodology, S.T., N.R., L.Z. and F.C.; software, S.T. and F.C.; formal analysis, S.T., A.G. and L.Z.; investigation, S.T., A.G., L.Z. and N.R.; data curation, S.T.; writing—original draft preparation, S.T. and F.C; writing—review and editing, S.T, A.G., L.Z., N.R., G.B. and F.C; visualization, S.T, A.G., L.Z., N.R., G.B., W.R.G. and F.C; supervision, S.T, A.G., L.Z., N.R., G.B. and F.C. All authors have read and agreed to the published version of the manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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