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Body Composition Assessment in 11-16 years old children

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Abstract

Childhood and teenage obesity increase the risk of cardiovascular disease in childhood and adolescence, as well as the incidence of metabolic syndrome and CVD in adulthood. Primary goal was to assess body composition in 11 to 16 years old children from 5 different Albanian cities. 120 kids, 70 girls and 50 boys, were chosen at random. Air displacement plethysmography (BOD-POD, GS-X) was used for body composition. The average percentage of body fat is higher in boys (26.17%, SD = 13.33) compared to Girls (23.29%, SD = 7.43). Conversely, the average percentage of FFM is higher in Girls (76.72%, SD = 7.43) than in boys (73.83%, SD = 13.33). This indicates that female have a higher proportion of lean mass relative to body fat than males. Descriptive statistics of %FFM revealed that mean values for boys (M = 75.55, SD = 11.77) were comparable to those of Girls (M = 75.02, SD = 10.32). The equality of variances was not significant according to Levene's test, $F(1, 114) = 1.05$, p =. 307, and the assumption of equal variances was met. The % FFM was not significantly different between males and females as indicated by the t-test, $t(114)=0.26$, p=. 798; mean difference, 0.53 (95% CI [-3.54, 4.59]). This sample did not yield significant differences in the % FFM, suggesting that % FFM may not be influenced by gender. More studies have to be conducted with a greater number of participants in order to have more reliable data's regarding body composition in children.

Keywords: Body Composition, Children, Evaluation, Fat Mass, Fat Free Mass

1. Introduction

Obesity during childhood and adolescence has been linked to increased risk for cardiovascular disease (CVD) in these years (Weiss et al., 2004). It has also been linked to increased incidence of metabolic syndrome (MetS) and CVD in adulthood, including arteriosclerosis, dyslipidaemia (DL), hypertension (HTN), and type 2 diabetes mellitus (T2DM) (Sachdev et al., 2008; Juonala et al., 2011). Along with the general prevalence of obesity, particularly in children and adolescents, the incidence of severe obesity is on the increase in Westernized countries (Ogden et al., 2016; Skinner & Skelton, 2014; Kelly et al., 2013). Adipose tissue, particularly visceral fat, has special metabolic characteristics that cause low-grade systemic inflammation and the development of metabolic and cardiovascular diseases because it generates and secretes inflammatory metabolites (Han et al. 2010; Cheng et al. 2010; Weiss 2011; Choi et al. 2013). According to Montero et al. (2012), obesity is associated with inflammation, oxidative stress, and endothelial dysfunction in youngsters as well. Compared to obese children, children who were very obese had increased risks of adult obesity, early atherosclerosis, fatty liver disease, obstructive sleep apnea syndrome, and early mortality (Kelly et al., 2013). Overweight and obesity can readily lead to cardiovascular diseases in adulthood, including hypertension, coronary heart disease, stroke, and hyperlipidaemia (Cook & Kavey, 2011; Klop et al., 2013). Additionally, adipose tissue inflammation and metabolic function dysregulation are closely linked to obese and overweight individuals with insulin resistance, raising their risk of ischemic stroke, diabetes, and cancer (Gaziano, 2010; Lee & Lam, 2018). According to Calcaterra et al. (2007) and Rank et al. (2013), children and adolescents who are significantly obese have a threefold increased chance of developing metabolic syndrome (MetS) in comparison to those who are moderately obese. A recent comprehensive analysis found that lifestyle-based weight loss programs that include 26 hours or more of intervention contact are likely to help children and adolescents lose excess weight after six to twelve months (O'Connor et al., 2017). According to Geserick et al. (2018), the majority of obese and overweight children and adolescents continue to have this symptom as adults and experience poor physical and mental health. The two main indices used to measure overweight and obesity are body mass index (BMI) and body fat percentage. It is commonly recognized that if overweight and obese children do not make the necessary lifestyle changes, such as increasing physical activity and lowering calorie consumption, more than half of them will grow up to be fat adults (Freedman et al., 2005). Since children spend more than half of their waking hours at school, school programs offer a good chance to enhance physical exercise. There are several ways to determine body composition, one of them is air-displacement plethysmography (ADP), which is often used with PEA POD on infants (less than 6 months old and/or less than 8 kg) (Ma et al., 2004; Breij et al., 2016) and BOD POD® on children (less than 6 years old) and adults (Fields et al., 2002). BOD POD as a specialized hardware considered as the “last phrase” of the advancement in technology includes a paediatric seat for children which is used to collect data for a group of youngsters weighting less than 12 kg under the age of two since 2011 (Fields & Allison, 2012). BOD POD is also designed to be used on a target group weighing from 12 kg up to 150 kg (Fields et al., 2002; Gallagher et al., 2020). Body composition parameters information like: fat free mass, fat mass percentage (FM%), body density, body volume can be assessed while using the ADP's two-compartment method mostly distinct in the inverse pressure-volume interaction (Fields et al., 2002). Body movement and crying are two factors that affect the ADP implementation procedure (Fields & Allison, 2012; Gallagher et al., 2020) As a result of this impact, special target groups respectively referring to children with intellectual disabilities and young children limits the usage of this technique. It is essential to highlight that minerals, proteins, water and fat mass are very important as key molecular components in children development life path. In the meanwhile, in adults a rise in FM is a consequence of gaining weight (Fomon et al., 1982; Fomon & Nelson, 2002). According to Wells et al., (2007) early life weight increase as a specific risk indicator in the following years health outcome is not properly considered studied unlike weight gain in general. Evaluation of body composition methods like dual X-ray absorptiometry, skinfold thicknesses, underwater weighing are especially applied in adults compared to children classified in this target group who due to their "chemically immature" body, behavioural and development issues unfit this procedure (Fields & Goran, 2000; Paineau et al., 2008; Baur, 1995). Notwithstanding all of the scientifically supported arguments, we believe that determining body composition at a young age and utilizing proper, professional methods is essential to preventing future health-related issues. This is one of the key reasons we decided to carry out these research projects. Schools are important locations for obesity prevention because instructional initiatives have a direct impact on children's food and physical activity habits. Janssen et al. (2017) underline the benefits of school-based programs that encourage physical activity and good nutrition. According to studies, adding nutrition education and physical exercise into the school curriculum may lower childhood obesity rates (Singh et al., 2019)

2. Objectives

This paper's primary goal was to evaluate the body composition of children aged 11 to 16 from several Albanian cities.

3. Methodology

A sample of 120 children, including 70 girls and 50 boys, aged 11 to 16, were selected randomly from five municipalities across Albania. Air displacement plethysmography (ADP) (BOD-POD, GS-X by COSMED) (Body Density Model, Lohman) was used to measure body composition. Before beginning the measurements batteries, the device was warmed up and calibrated. It was then operated and maintained in accordance with the supplier's handbook. Followed the manufacturer's instructions, utilized the specific paediatric software (v5.4.6) on children under the age of six, and used a 20 L calibration volume cylinder. Additionally, we have employed the Lohman density model by default (Lohman, 1989). Children were instructed to were tight-fitting underwear's and were given a swimming cap that covered their entire head while they were being measured, escorted by their instructor or a parent. During the measurement, children were told not to move. One measurement took about six to ten minutes. The same trained personnel staff and the same laboratory environment performed the measurements, which were scheduled using a joint agenda and took place in the Sport Physiology Laboratory at the Sports University of Tirana over the weekends between April and May 2024.

4. Statistical Analysis

Following data collection, the dataset was processed and analysed using IBM SPSS Statistics 26 software. Gender-stratified descriptive statistics were calculated for each variable (mean, standard deviation, and 95% confidence interval). This gave a general description of the participants. To determine if there were significant differences between the male and female participants on all health measures, further inferential statistical tests were conducted (e.g., independent samples t-tests). Statistical analyses were considered significant at $p <. 05$ equipped with a solid structure for result analysis.

5. Results

Compared to girls, boys were generally taller and heavier, with higher fat mass and a somewhat higher fat-free mass. Conversely, girls have a higher proportion of fat-free mass compared to total body mass. Such differences could reflect biological variances between sexes and discussion could extend to health and fitness factors.

5.1. Descriptive Statistics

Age: The average age of girl's participants is 13.45 years (SD = 1.24), slightly older than the average age of Boys participants, which is 12.80 years (SD = 1.62).

Height: Boys are somewhat taller than girls, with an average height of 162.79 cm (SD = 10.88) compared to 160.80 cm (SD = 8.63) for girls. According to the confidence intervals, the real mean height for females is probably between 155.59 and 166.01 cm, while the range for boys is between 157.20 and 168.39 cm.

Body Composition (% Fat and % FFM): Boys had a greater average body fat percentage (26.17%, SD = 13.33) than girls (23.29%, SD = 7.43). In contrast, girls have a greater average percentage of fat-free mass (FFM) (76.72%, SD = 7.43) than boys (73.83%, SD = 13.33). Our results suggest that, generally speaking, girls in our group had a larger percentage of lean mass in relation to body fat than boys.

Fat Mass: Boys had a larger average fat mass of 15.51 kg (SD = 8.85) than females 12.90 kg (SD = 5.58). According to this, guys in the sample may have a higher total fat mass than girls on average.

Fat-Free Mass (FFM): Boys participants' average FFM is 43.47 kg (SD = 10.76), while girls' participants' average FFM is 41.47 kg (SD = 5.98). This discrepancy implies that boys have a little bit more lean body mass than girls.

Body Mass: In comparison to girls (54.37 kg, SD = 8.79), boys have a greater average body mass (58.98 kg, SD = 9.95). In terms of height and fat mass, this is consistent with the findings that males often weigh more overall.

Body Volume (L): The average body volume for males was 57.10 (SD=9.83), whereas the average for girls was 52.39 (SD=8.89). This indicates that boys had a larger body volume than girls.
Body Density (BD) (kg/L): In contrast, the average body density for males was 1.03, SD = 0.03 and for girls it was 1.04, SD = 0.02. This suggests that girls in this group had a somewhat greater average body density.

5.2. Gender-specific descriptive statistics

Table 1. Gender-specific descriptive statistics

Variable	Gender	Mean	Standard Deviation	95% Confidence Interval for Mean
Age (years)	Girls	13.45	1.24	[12.70, 14.20]
	Boys	12.80	1.62	[11.97, 13.64]
Height (cm)	Girls	160.80	8.63	[155.59, 166.01]
	Boys	162.79	10.88	[157.20, 168.39]
Height (in)	Girls	63.31	3.40	[61.26, 65.36]
	Boys	64.08	4.29	[61.87, 66.29]
% Fat	Girls	23.29	7.43	[18.80, 27.77]
	Boys	26.17	13.33	[19.32, 33.03]
% FFM	Girls	76.72	7.43	[72.23, 81.21]
	Boys	73.83	13.33	[66.98, 80.68]
Fat Mass (kg)	Girls	12.90	5.58	[9.53, 16.27]
	Boys	15.51	8.85	[10.96, 20.06]
Fat Mass (lb)	Girls	28.44	12.30	[21.01, 35.88]
	Boys	34.20	19.51	[24.17, 44.23]
Fat Free Mass (kg)	Girls	41.47	5.98	[37.86, 45.08]
	Boys	43.47	10.76	[37.94, 49.00]
Fat Free Mass (lb)	Girls	91.42	13.18	[83.46, 99.39]
	Boys	95.83	23.72	[83.64, 108.03]
Body Mass (kg)	Girls	54.37	8.79	[49.06, 59.69]
	Boys	58.98	9.95	[53.87, 64.10]
Body Mass (lb)	Girls	119.87	19.39	[108.15, 131.58]
	Boys	130.04	21.93	[118.76, 141.31]
Body Volume (L)	Girls	52.39	8.89	[47.02, 57.77]
	Boys	57.10	9.83	[52.04, 62.15]
BD (kg/L)	Girls	1.04	0.02	[1.03, 1.05]
	Boys	1.03	0.03	[1.02, 1.05]

The t-test analysis indicates that the % Fat does not significantly differ between boys and girls in this sample ($p>.05$). During the explanation of the results, it was seen that the overall body fat percentage was not seen differing between boys and girls. The statistical value of the test was $t(114) = -0.257$, and p-value = .798.

6. Discussion

This paper's main objective was to evaluate the body composition of youngsters aged 11 to 16 from five different Albanian cities. Overall, every child who participated in the study reported that BOD-POD as a simple method and as a comfortable equipment. This fact was also in accordance with one research on eating disordered teens, where subjects reported the BOD-POD evaluation to be agreeable and enjoyable (Williams et al., 2018). Results revealed that the average body volume in girls (52.39 L (SD = 8.89)), and in boys (57.10 L (SD = 9.83)), and on the other side body density, with girls having an average density of 1.04 kg/L (SD = 0.02) and boys at 1.03 kg/L (SD = 0.03), showing a similarity between genders, are suggesting that while boys have a greater volume, their body density remains relatively comparable to girls. Also, descriptive statistics of %FFM revealed that mean values for boys (M = 75.55, SD = 11.77) were comparable to girls (M = 75.02, SD = 10.32). The equality of variances was not significant according to Levene's test, F(1, 114) = 1.05, p =. 307, and the assumption of equal variances was met. The % FFM was not significantly different between boys and girls as indicated by the t-test, t(114)=0.26, p=. 798; mean difference, 0.53 (95% CI [-3.54, 4.59]). This sample did not yield significant differences in the % FFM, suggesting that % FFM may not be influenced by gender. These results were in contrast, research by Sztandera et al. (2017) revealed that 1.02% of respondents were obese, 14.4% were underweight, 14.81% were overweight, and 69.75% of children were of normal body weight. As the study conducted by Finkelstein et al. (2009) which demonstrated that obesity prevention programs may have long-term financial benefits by reducing medical costs in addition to improving the health of children. Furthermore, as childhood obesity affects healthcare expenditures and the long-term cost of obesity-related disorders such type 2 diabetes, cardiovascular disease, and certain malignancies (Andreyeva et al., 2010), preventing childhood obesity initiating with proper evaluation techniques and equipment's, through may reduce chronic diseases and save money on healthcare (Finkelstein et al., 2009).

7. Conclusions

The children's reports lead us to the conclusion that the BOD-POD approach is really straightforward and non-invasive for this age group. Still, evaluating body composition especially in children and teenagers utilizing BOD-POD body composition analysis is much more accurate providing complete knowledge about other body components like % of body fat, muscle mass, body water, etc. Furthermore, this study approach can be used as an example to inform parents, PE teachers, sport coaches and other health specialists to better understand the importance of body composition assessment and that beyond traditional methods (such as BMI, height, weight, waist circumference, skin-fold thickness using callipers, etc.), new modern equipment's and new technologies (for example; BIA analysis, body scans, BOD-POD, etc.), are available and based on their possibilities, can be used as a core component for children's education and future disease prevention, related with obesity. Policymakers (regional or central) might use the findings of this research to lobby for more financing for preventive projects like community-based programs aimed at reducing obesity and health education in educational institutions. Aiming at a healthy childhood generation to prevent future health issues related to overweight and obesity, legislators may also start any process of developing new approaches that encourage the assessment of body composition, so enabling trends across many districts and advice local and national authorities to improve PA activity and nutrition programs. To obtain more consistent information on body composition in youngsters, additional research has to be done with more people. More research with a higher subject count in this age group is required to improve the general picture of local and national body composition situation of these age group and boost the dependability of data outcomes.

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