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original article

Changes in adiposity levels in schoolchildren according to nutritional status: analysis over a 30-year period

Modificações da adiposidade em escolares de acordo com o estado nutricional: análise de 30 anos

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Abstract – The aim of this study was to analyze changes in adiposity levels over a 30-year period in schoolchildren according to nutritional status. This study is part of *Projeto Misto Longitudinal de Crescimento, Desenvolvimento e Aptidão Física de Ilhabela*. 1.144 schoolchildren of both sexes, aged between 10 and 11 years, met the following inclusion criteria: (a) have at least one complete evaluation in one of the analyzed periods; (b) be in the prepubertal stage of sexual maturation; and (c) be apparently healthy. Analyzed periods were 1978/1980 (Baseline), 1988/1990 (10 years), 1998/2000 (20 years), 2008/2010 (30 years). Analyzed variables were: body mass (kg), height (cm) and adiposity levels (mm). Children were classified into three categories: eutrophic, overweight and obese, according to nutritional status, using World Health Organization (WHO) body mass index (BMI) curves for age and sex. For a comparison between periods, Two-Factor Analysis of Variance and Bonferroni's test were used. In both sexes, the most significant increase in adiposity levels occurred among the eutrophic group, followed by the overweight group and obese group. Results showed an increase in adiposity levels over a 30-year period, even with nutritional status control. It shows that individuals with a similar BMI may vary in proportion and distribution of subcutaneous adipose tissue.

Key words: Adipose tissue; Schoolchildren; Skinfolds thickness; Obesity.

Resumo – *O objetivo do estudo foi analisar as modificações da adiposidade de escolares, durante 30 anos, de acordo com o estado nutricional. O estudo faz parte do "Projeto Misto Longitudinal de Crescimento, Desenvolvimento e Aptidão Física de Ilhabela". Uma amostra de 1.144 escolares de ambos os sexos, de 10 e 11 anos, atenderam aos seguintes critérios de inclusão: (a) pelo menos uma avaliação completa em um dos períodos analisados; (b) estar no estágio pré-púbere de maturação sexual; (c) ser aparentemente saudável. Os períodos analisados foram 1978/1980 (linha de base), 1988/1990 (10 anos), 1998/2000 (20 anos), 2008/2010 (30 anos). As variáveis analisadas foram: massa corporal, estatura e adiposidade, pela análise individual de cada dobra cutânea. Os indivíduos foram classificados em eutróficos, excesso de peso e obesos, mediante as curvas propostas pela Organização Mundial da Saúde (OMS) de índice de massa corporal para idade e sexo. Para comparar os períodos, foi utilizada a Análise de Variância com Dois Fatores seguida pelo método Bonferroni. Em ambos os sexos, o maior aumento significante ocorreu no grupo de escolares eutróficos, seguido pelos grupos excesso de peso e obeso. Houve modificações da adiposidade, mesmo com o controle do estado nutricional, durante o período de 30 anos analisado, mostrando que os indivíduos que têm semelhantes índices de massa corporal podem variar em proporção e distribuição de tecido adiposo subcutâneo.*

Palavras-chave: *Obesidade; Pré-escolar; Pregas cutâneas; Tecido adiposo.*

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INTRODUCTION

In some countries, demographic, socioeconomic and epidemiological changes occurred alongside changes in eating and nutritional patterns[1,2]. Several factors, such as changes in lifestyle, diet and increased stress associated with technological, economic and social advances over the past decades, led to an increase in obesity, turning it into a worldwide public health problem[3]. In 2009, one in three (33.5%) Brazilian children were overweight, and 16.6% of boys and 11.8% of girls were obese. These numbers represent a jump in the prevalence of overweight in children over a 34-year period. The increase was of 10.9% in 1974-1975, 15% in 1989, and 34.8% in 2008-2009 among boys, and of 8.6% in 1975-1975, 11.9% in 1989, and 32% in 2008-2009 among girls[4].

The period of greatest risk for the incidence of obesity is the transition between adolescence and the early stages of adulthood in both sexes and various ethnical groups[5].

Excess weight is an important risk factor for cardiovascular diseases[6]. Although clinical manifestations of these diseases occur at maturity, studies have shown that comorbidities such as dyslipidemia, hypertension and insulin resistance may be present in childhood and adolescence[6,7], being responsible for the increased risk of morbidity and mortality in adulthood[8,9].

The early development of non-transferable chronic diseases, such as cardiovascular disease, hypertension, high levels of low density lipoproteins, among others, is associated with high levels of adiposity[10]. Excess weight in childhood increases chances of obesity in adulthood[5]. Sabo et al. [11] analyzed data on body mass index (BMI) and blood pressure (BP) from individuals during childhood and adulthood. This study identified a higher BP in adults who were obese during their childhood than in those who were eutrophic during that period[11].

Results of some national and international studies have been showing changes in adiposity levels over the years[6-8]. For a better understanding of the behavior of adiposity in a population over time, studies analyzing this phenomenon decade by decade provide a more adequate view of it[12,13]. In the case of Brazil, there are few studies that analyze changes in adiposity levels in different parts of the body according to nutritional status over the years. In a 20-year period analysis, with reviews in 1990/91, 2000/01 and 2010/11, overweight schoolchildren from 7 to 10 years old had higher increase in adiposity levels, mainly in the abdomen area, when compared with schoolchildren classified as eutrophic and obese[13].

Variation in the anatomical distribution of adiposity is an important morphological indicator related to endocrine and metabolic complications, predisposing to the emergence and development of cardiovascular diseases[9]. Individuals with centripetal disposition of body adiposity tend to have higher incidence of diabetes[14], hypertension[15], metabolic syndrome and adverse changes in plasmatic lipoprotein profile[16]. Thus, the aim of this study was to analyze changes in adiposity levels of schoolchildren from Ilhabela over a 30-year period, according to nutritional status.

METHODOLOGICAL PROCEDURES

This study is part of Projeto Misto-Longitudinal de Crescimento, Desenvolvimento e Aptidão Física de Ilhabela, developed by Centro de Estudos do Laboratório de Aptidão Física de São Caetano do Sul (CELAFISCS) since 1978, with reviews every six months, always on April and October. The project has completed 66 evaluation periods, the deepest and most extensive study carried out in a developing country in this area of knowledge whose main characteristic is the use of not sophisticated materials and not complex techniques, and the ease and simplicity of the method that allows its application in large groups. All reviews were held within three consecutive days by health professionals highly trained in order to analyze the anthropometric, metabolic and neuromotor variables, levels of physical activity and nutritional levels of children, aged from seven years onwards, from the city of Ilhabela (São Paulo – Brazil), through a battery of tests and measures standardized by our center.

Sample

The city of Ilhabela is located on the north coast of the state of São Paulo (Brazil), with a land area of 348 km^2. According to Instituto Brasileiro de Geografia e Estatística (IBGE), surveys from 1980, 1991, 2000 and 2010 conducted among children aged from 10 to 11 years were considered. Ilhabela's population in 1980 was 7,800 inhabitants, among whom 394 schoolchildren from the studied age group. In 1991, Ilhabela had 13.538 inhabitants, among whom 641 schoolchildren. In 2000, the city's population consisted of 20.836 inhabitants, among whom 803 schoolchildren. In 2010, Ilhabela's population consisted of 28.176 inhabitants, among whom 1.036 schoolchildren in the studied age group. The sample survey participants (10 and 11 years old) represented 47% of the city's population in 1978/1980, 1988/1990 and 1998/2000, and 52% in 2008/2010.

For sample composition, a database consisting of more than 16.000 schoolchildren of both sexes, aged from 7 to 18 years, was analyzed, and 1.144 of them (Table 1: 635 boys, 509 girls), aged between 10 and 11 years, met the following inclusion criteria: (a) have a complete evaluation in at least each one of the studied periods; (b) be aged between 10 and 11 years; (c) be regularly enrolled in a public school from Ilhabela; (d) be apparently healthy; (e) their responsibles or guardians should sign a term of informed consent, according to Resolution 196/96 of Conselho Nacional de Saúde. The project was approved by the Ethics Committee of Universidade Federal de São Paulo under protocol n° 0056/10.

The 1.144 schoolchildren were evaluated in one of these four data collection periods: a) 1978-1980 (Baseline), 64 boys and 57 girls; b) 1988-1990 (10 years), 149 boys and 138 girls; c) 1998-2000 (20 years), 191 boys and 161 girls; and d) 2008-2010 (30 years), 231 boys and 153 girls. For those children who underwent two or more evaluations, we adopted the first evaluation criterion.

Methods

Variables analyzed were: body mass (kg), height (cm), and adiposity levels (mm) through the individual analysis of each skinfold (SF), according to CELAFISCS standardization[8].

Body mass (kg) was obtained using a scale (Filizola® Personal Life model) with a digital precision of 100g, with the individual wearing light clothes. Each individual was placed in the center of the platform, standing with his gaze fixed on a point in front. The average between three measurements was considered. Height was obtained with the use of a stadiometer with fixed base and movable cursor, with the individual in the standing position, barefoot and with feet together, trying to touch the measuring instrument with his posterior surface of the heels, pelvic girdle, scapular girdle, and occipital region. The measuring was made with the individual in inspiratory apnea, to minimize possible variations on this anthropometric variable. The head should be in the Frankfurt plane, parallel to the ground. The measuring was made with the cursor at a 90 degree angle relatively to the scale and was calculated considering the average of three measurements.

For BMI calculation, we used the two measurements aforementioned, classifying individuals into three categories: eutrophic, overweight and obese (Table 1), using BMI curves for age and sex proposed by the World Health Organization (WHO)[19]. This classification has been used to identify the risk or the actual condition of obesity among populations[1,7,15]. However, there are other criteria to identify changes in nutritional status related to adiposity levels. One of the methods used for this purpose is the skinfolds (SFs) measurement, since it has shown significant changes in the pattern of adiposity[8].

Adiposity levels (mm) was obtained through the determination of seven SFs (biceps, triceps, subscapular, suprailiac, midaxillary, abdomen and calf), which was performed by the same examiner in all project evaluations. Measurements were made in the right hemisphere of the evaluated individual. Three successive measurements were made at the same location, and the average value of these three was the adopted value[18]. The compass model used was Harpenden^Ò^, previously calibrated.

Values of objectivity and reproducibility of each measuring made over the years ranged from 0.96 to 0.99 in body mass, from 0.97 to 0.99 in height, and from 0.81 to 0.99 in SFs.

To determine the stage of biological maturation, Tanner method[20] was used, a technique of self-assessment for secondary sexual characteristics according to sex, already validated (0.60 to 0.71) in Projeto Ilhabela itself[21].

Statistical analysis

We used descriptive statistics, mean ($\bar{x}$), standard deviation (s), frequency (f), and percentage (%). Variations in adiposity levels when comparing Baseline with other periods over a 30-year period were measured by the percentage delta (Δ%). To assess distribution of data, Kolmogorov-Smirnov test and homogeneity of variances test[22] were used. As results were >0.05, we used the Two-Factor Analysis of Variance (evaluation period), followed by Bonferroni's multiple comparison method for comparing different evaluation periods with the dependent variables. For comparison of categorical data, chi-square test (x^2) was used. Calculations were performed by the Statistical Package for the Social Sciences (SPSS) software, version 18.0, and the significance level was set at p <0.01[23].

RESULTS

Table 1 shows that in both sexes the mean values of anthropometric variables remained practically the same during the study period, with no statistical difference between evaluations. Through the chi-square test, results of categorical data also showed no statistical difference between evaluations. In males, Δ% shows a decrease of 2.2% in children classified as overweight. In females, in 3 decades, the frequency of children classified as obese increased 2.7%.

In a comparison between sexes within the same nutritional status, we can identify statistical difference (p<0.01) in body mass at 10 and 30 years, height in Baseline, 10 and 30 years, and BMI only in 10 years.

Table 1. Descriptive and comparative analysis of anthropometric variables of schoolchildren of both sexes, according to the evaluation period (Baseline, 10, 20 and 30 years)

	Baseline	10 years	20 years	30 years	Δ%
Male					
Age (years)	10.61±0.48	10.50±0.50	10.49±0.50	10.42±0.49	-1.8
Body mass (kg)	34.29±8.04	33.71±6.79	35.84±8.74	34.25±7.39	-0.1
Height (cm)	140.10±7.08	139.47±8.35	141.83±7.76	140.91±7.41	0.5
BMI (kg/m^2)	17.28±2.59	17.18±2.17	17.62±2.94	17.12±2.64	-0.9
Eutrophic	48 (78.7%)	108 (76.6%)	152 (73.1%)	181 (77%)	-1.7
Overweight	9 (14.8%)	27 (19.1%)	40 (19.2%)	34 (15.1%)	0.3
Obese	4 (6.6%)	6 (4.3%)	16 (7.7%)	10 (4.4%)	-2.2
Female					
Age (years)	10.75±0.43	10.53±0.50	10.42±0.49	10.44±0.49	-2.8
Body mass (kg)	37.83±8.36	37.16±8.91*	36.16±8.05	37.02±7.88*	-2.1
Height (cm)	145.64±7.98*	142.93±8.7*	143.89±8.25	145.71±8.2*	0
BMI (kg/m^2)	17.65±2.53	17.97±2.75*	17.40±3.09	17.33±2.60	-1.8
Eutrophic	44 (78.6%)*	101 (76 %)*	125 (76.7%)*	127 (81%)*	2.4
Overweight	11(19.6%)*	25 (18.7%)*	26 (16%)*	23 (14.5%)*	-5.1
Obese	1 (1.8%)	7 (5.3%)*	12 (7.4%)*	7 (4.5%)*	2.7

*p<0.01 difference between sexes within the same nutritional status and evaluation period..

Regarding schoolchildren classified as eutrophic, Table 2 shows a significant increase in all SFs analyzed, except SFs from the triceps and calf areas in males. SFs from the biceps, subscapular, suprailiac and midaxillary areas were significantly (p<0.01) higher in 30 years and there was a linear increase of mean values over the years. Also there was significant difference (p<0.01) in SFs from the biceps, subscapular, suprailiac, midaxillary, abdomen areas and in $\bar{x}$ 7SF between 10 and 30 years. The highest increase in males (eutrophic) in percentage terms occurred in SFs from the suprailiac (30.1%) and biceps (28.4%) areas.

In females classified as eutrophic, height was significantly ($p<0.01$) different in the period between 10 and 30 years. SFs from the suprailiac and abdomen areas were significantly ($p<0.01$) different between 10 and 30 years, and mean values increased over the years. In all other SFs (biceps, triceps, subscapular, axillary, calf and $\bar{x}$7SF) analyzed, no statistical difference was found. Δ% showed that the highest increases in girls classified as eutrophic occurred in SFs from the suprailiac (15.6%) and abdomen (12.1%) areas.

Table 2. Descriptive and comparative analysis of anthropometric variables of schoolchildren of both sexes, classified as eutrophic according to the evaluation period (Baseline, 10, 20 and 30 years)

	Baseline	10 years	20 years	30 years	Δ%
Male					
Body mass (kg)	31.64±3.96	31.55±4.42	32.13±4.28	32.37±4.28	2.3
Height (cm)	138.86±5.85	138.88±7.48	140.14±6.86	140.25±7.19	1.0
Biceps (mm)	4.60±1.68‡	4.76±1.40#	5.20±1.56	5.91±2.86	28.4
Triceps (mm)	9.07±2.69	9.33±2.63	9.06±2.59	9.87±3.49	8.8
Subscapular (mm)	5.54±1.58‡	5.78±2.10#	6.07±1.39	6.78±2.74	22.3
Suprailiac (mm)	4.97±2.05‡	5.05±1.53#	5.59±2.12	6.47±3.01	30.1
Midaxillary (mm)	4.39±1.34‡	4.37±1.01#	4.95±1.51	5.59±2.63	27.3
Abdomen (mm)	7.68±3.56	6.89±2.45#	7.86±3.55	8.72±4.19	13.5
Calf (mm)	8.98±3.13	9.07±2.75	9.40±3.28	9.86±3.83	9.7
$\bar{X}\bar{X}$ 7SF (mm)	6.46±2.11	6.47±1.52#	6.88±1.99	7.56±2.93	17.0
Female					
Body mass (kg)	34.87±5.32	33.77±5.43	33.35±4.97	35.00±5.76	0.3
Height (cm)	144.01±7.52	141.38±8.44#	142.88±7.04	145.01±8.09	0.6
Biceps (mm)	6.09±1.58	6.77±2.36	6.59±1.55	6.17±2.04	1.3
Triceps (mm)	11.71±3.19	11.95±3.27	11.52±3.00	11.54±3.38	-1.4
Subscapular (mm)	7.21±1.81	7.05±1.94	7.51±2.18	7.66±2.77	6.2
Suprailiac (mm)	7.05±2.40	6.83±2.44#	7.91±3.08	8.15±3.14	15.6
Midaxillary (mm)	5.93±1.67	5.93±2.08	6.47±2.28	6.64±2.47	11.9
Abdomen (mm)	11.38±4.10	10.21±4.08#	11.61±4.93	12.76±5.60	12.1
Calf (mm)	12.44±3.55	12.63±3.80	12.09±3.33	11.74±3.63	-5.6
$\bar{X}\bar{X}$7SF (mm)	8.83±2.21	8.77±2.43	9.09±2.43	9.24±2.83	4.6

$p<0.01$; * Baseline different from 10 years; † Baseline different from 20 years; ‡ Baseline different from 30 years; ø10 years different from 20 years; #10 years different from 30 years; $20 years different from 30 years.

Regarding schoolchildren classified as overweight, Table 3 shows that there was an increase in all variables in both sexes, except in height in females. The only statistical difference ($p<0.01$) were found in SFs from the abdomen area and in $\bar{x}$ 7SF in 10 years compared with 20 years in males. Even finding no significant difference in other SFs (biceps, triceps, subscapular, suprailiac, midaxillary and calf), the highest increases in percentage terms occurred in SFs from the biceps (62.2%) and suprailiac (60%) areas.

In females, no significant differences were found between periods in all SFs analyzed in this study. Although not statistically significant, Δ%

showed that within 30 years the highest increases among females occurred in SFs from the abdomen (42.3%) and suprailiac (30.3%) areas.

Table 3. Descriptive and comparative analysis of anthropometric variables of schoolchildren of both sexes, classified as overweight according to evaluation periods (Baseline, 10, 20 and 30 years)

	Baseline	10 years	20 years	30 years	Δ%
Male					
Body mass (kg)	40.14±5.05	39.93±6.64	43.35±5.88	42.50±4.02	5.8
Height (cm)	141.77±7.79	141.63±9.74	146.01±8.28	145.33±5.29	2.5
Biceps (mm)	6.41±2.16	7.83±3.40	10.21±3.49	10.40±3.35	62.2
Triceps (mm)	13.16±3.58	14.59±4.16	17.44±4.76	17.05±4.80	29.5
Subscapular (mm)	8.23±2.93	8.84±3.14	11.29±3.77	11.47±4.00	39.3
Suprailiac (mm)	7.97±3.76	10.49±5.98	14.33±5.35	12.75±5.16	60.0
Midaxillary (mm)	6.89±2.67	7.24±3.12	10.89±5.37	10.65±4.18	54.5
Abdomen (mm)	14.82±8.35	14.54±7.80º	21.69±7.61	19.55±8.21	32.0
Calf (mm)	12.28±3.55	14.66±4.31	17.07±4.78	16.18±5.31	31.7
$\bar{X}\bar{X}$7SF (mm)	9.97±3.70	11.17±4.22º	14.70±4.17	14.05±3.96	41.0
Female					
Body massa (kg)	45.65±6.10	45.32±6.39	43.85±5.92	47.97±5.62	4.8
Height (cm)	151.09±7.50	147.07±8.02	145.62±7.61	148.24±6.91	-1.8
Biceps (mm)	9.67±2.23	10.87±3.09	10.54±3.07	10.30±3.16	6.5
Triceps (mm)	16.09±3.05	17.57±3.37	17.53±4.70	18.13±4.18	12.6
Subscapular (mm)	12.63±7.63	13.24±4.87	14.48±5.45	13.50±3.91	6.5
Suprailiac (mm)	11.87±4.08	14.93±5.46	17.62±6.16	15.47±5.75	30.3
Midaxillary (mm)	10.01±2.64	11.28±4.89	13.82±5.49	12.17±4.73	21.7
Abdomen (mm)	17.11±3.77	21.43±8.62	22.63±6.10	24.35±7.77	42.3
Calf (mm)	18.05±4.58	19.51±3.87	18.82±5.64	18.85±5.04	4.4
$\bar{X}\bar{X}$7SF (mm)	13.75±2.98	15.55±4.11	16.49±4.12	15.99±3.70	16.2

pp<0.01; * Baseline different from 10 years; † Baseline different from 20 years; ‡ Baseline different from 30 years; º10 years different from 20 years; #10 years different from 30 years; $20 years from 30 years.

Regarding schoolchildren classified as obese, Table 4 shows a significant increase in SFs analyzed in this study in both sexes, except in SFs from the triceps, suprailiac, midaxillary and calf areas in males. SFs from the subscapular and abdomen areas, and $\bar{x}$ 7SF were significantly different (p<0.01) between 10 and 20 years. In addition to the aforementioned SFs, SFs from the biceps area also had mean values significantly (p<0.01) different in the period between 10 and 30 years. In percentage terms, the highest increases occurred in males in SFs from the triceps (10%) and subscapular (7.5%) areas. Although no statistical differences were found in absolute values in females at any SF analyzed, Δ% showed that in percentages terms there were high increases in SFs from the subscapular (34.5%) and suprailiac (34.3%) areas.

For comparing changes in adiposity levels within each group, mean Δ% of all SFs was calculated. In males, the highest increase occurred in the overweight group (44.1%), followed by the eutrophic group (20.0%) and the obese group (10.9%). In women, the highest increases occurred in the obese group (29.6%), followed by the overweight group (19.1%) and the eutrophic group (6.3%).

Table 4. Descriptive and comparative analysis of anthropometric variables of schoolchildren of both sexes, classified as obese according to evaluation periods (Baseline, 10, 20 and 30 years)

	Baseline	10 years	20 years	30 years	Δ%
Male					
Body mass (kg)	54.41±4.77	47.00±10.29	55.08±7.39	57.62±7.57	5.5
Height (cm)	153.70±4.44	141.48±15.24	148.65±7.63	146.14±6.00	-4.9
Biceps (mm)	16.00±3.33	8.63±4.44$^{\#}$	15.08±3.65	16.46±3.56	2.8
Triceps (mm)	23.47±4.25	17.06±6.83	21.59±3.64	26.07±1.28	10.0
Subscapular (mm)	21.58±2.82	11.85±5.50$^{ø\#}$	21.85±5.87	23.35±3.62	7.5
Suprailiac (mm)	27.10±4.10	14.35±9.09	28.07±7.73	25.83±8.63	-4.6
Midaxillary (mm)	16.95±2.91	11.76±7.10	20.18±5.76	19.74±3.99	1.6
Abdomen (mm)	36.77±2.45	20.38±11.73$^{ø\#}$	35.43±6.61	36.90±5.30	0.3
Calf (mm)	21.75±7.80	17.65±9.66	21.36±7.19	20.72±6.54	-4.7
$\bar{X}\bar{X}$7SF (mm)	24.00±0.85	14.52±7.26$^{ø\#}$	23.37±3.68	23.52±3.38	-2.0
Female					
Body mass (kg)	55.00±3.89	58.80±7.94	53.21±4.27	53.15±8.89	-3.3
Height (cm)	147.00±5.56	151.32±6.46	146.39±6.27	147.64±9.91	0.4
Biceps (mm)	13.62±1.25	12.79±5.72	15.93±2.73	16.60±3.40	17.9
Triceps (mm)	22.38±3.68	18.63±5.28	24.82±3.56	26.80±6.06	16.4
Subscapular (mm)	17.22±2.80	17.97±7.60	24.81±3.46	26.30±4.50	34.5
Suprailiac (mm)	23.66±3.45	22.45±10.80	30.58±8.32	36.05±6.05	34.3
Midaxillary (mm)	18.24±5.89	15.26±7.19	22.05±7.01	25.30±2.55	28.0
Abdomen (mm)	29.68±5.67	25.88±11.09	34.48±4.84	35.50±9.58	16.3
Calf (mm)	22.66±4.61	22.90±11.57	25.19±6.35	34.10±6.98	33.5
$\bar{X}\bar{X}$7SF (mm)	21.06±5.88	19.39±7.57	25.41±2.98	28.66±3.43	26.5

$p<0.01$; * Baseline different from 10 years; † Baseline different from 20 years; ‡ Baseline different from 30 years; ø10 years different from 20 years; #10 years different from 30 years; $20 years different from 30 years.

DISCUSSION

Results of this study showed that the accumulation of subcutaneous central fat has increased more highly than total body adiposity assessed from BMI, ie, even in populations in which there was no change in BMI, unfavorable changes toward a profile associated with higher risks of diseases may occur in body composition and body fat distribution. In males, the overweight group had higher increase in SFs than the obese group. However, we must highlight that there was an increase in SFs even in the group classified as eutrophic. In females, results showed a higher increase in SFs thickness in the obese group and the overweight group when compared to the eutrophic group, indicating that taking nutritional status as the only criterion for classification may not clearly reflect changes in accumulation of adipose tissue or obesity increase.

Corroborating findings of this study, Ferrari et al.[13] conducted a 20-year period analysis of schoolchildren aged from 7 to 10 years, participants in Projeto Misto-Longitudinal de Crescimento, Desenvolvimento e Aptidão Física de Ilhabela. Authors found that, in males, the highest increase in SFs after a period of 20 years occurred in the overweight group, followed by the obese group and the eutrophic group. In females, the highest increase occurred similarly in the overweight group and the eutrophic group, followed by the obese group. Authors also found that, in both sexes, the increase was higher in central SFs when compared with peripheral SFs.

An Australian study[24] that investigated the secular trend (1985-1997-2002) of SFs from the abdominal and triceps areas in children aged from 10 to 12 years showed, over a period of 20 years, an increase of 12% in boys and 27% in girls in SFs from the abdominal area, and 3% in boys and 8% in girls in SFs from the triceps area. The present study showed a higher increase in SFs from the abdominal area over a 30-year period in boys. In girls, the increase was of 23.5%. SFs from the triceps area showed an increase of 16.2% in boys and 9.2% in girls. As in this study, in which the highest increases occurred in central SFs, data from the Australian study suggest changes in body shape, regardless of an increase in BMI, and changes toward a profile associated with increased risk of diseases[25].

Garnett et al.[26] investigated the prevalence of increased central obesity taking as references the waist circumference and height/waist ratio in schoolchildren aged from 7 to 15 years between 1985 and 2007, and also showed that in two decades of analysis, central adiposity increased at a faster rate than total fat, and that this increase was higher in females. Although authors use waist circumference and height/waist ratio, these data confirm those obtained in the present study, although a higher increase was found mainly in males in their study.

In developed countries, Olds[8] analyzed the secular trends of adiposity and its distribution in children and adolescents aged from 0 to18 years. Results showed an increase in the thickness of SFs from the triceps and subscapular areas from 1951 to 2003, whereas there was a decrease in triceps/subscapular (T/S) ratio, which represents a more centralized distribution of fat. In a comparison between sexes, this decrease was higher in girls than in boys. These data support the ones found in the present study since SFs from the subscapular (S) area had a higher increase than SFs from the triceps (T) area in eutrophic boys (S: 22.3%, T: 8.8%) and overweight boys (S: 39.3%, T: 29.5%), as in eutrophic girls (S: 6.2%, T: 1.4%) over a 30-year period. However, this study shows a higher increase in central adiposity in boys compared to girls within the eutrophic group and the overweight group.

Analyzing the behavior of the thickness of SFs from the triceps and subscapular areas in schoolchildren aged from 7 to 11 years, in 1972 and 1973, Hegg[27] showed that SFs from the triceps area was significantly higher than SFs from the subscapular area in both sexes. These data differ from those found in the present study since SFs from the subscapular area showed a higher increase when compared to SFs from the triceps area in all the four periods analyzed (Baseline, 10, 20 and 30 years) in both sexes. These results show a possible change in the distribution of subcutaneous adipose tissue over time.

Janssen et al.[28] estimated the prevalence of abdominal obesity from waist circumference in adolescents and adults in the period between 1981 and 2009, showing that abdominal obesity increased with advancing age and that it was higher in women. Authors also estimated the prevalence of abdominal obesity in adults and adolescents from BMI, classifying them as normal weight, overweight and obese. The prevalence of obesity was 2.6% in the normal weight group, 35.3% in the overweight group, and 93% in the obese group. Although participants were older than the ones composing our sample, these data were similar to those found in this study, since subcutaneous fat located in the central region had an increased prevalence over the studied period.

Although this study shows a 30-year period analysis in a mixed-longitudinal project held in a developing country and has a sizeable sample of 1.144 children, authors argue that the current research has some limitations: a) the scope of the sample, since it is limited geographically; b) lack of criteria to classify BMI of Brazilian children by age and sex; c) lack of schoolchildren classified as obese; d) indirect assessment of adiposity, even when performed by the same examiner in all analyzed periods; e) lack of control of the socioeconomic levels, although obesity is not explained by economic growth of a region[29]; f) lack of consensus on which to base the discussion on the methodological criteria to assess adiposity in children; and g) lack of lean body mass assessment.

CONCLUSION

After a 30-year period analysis, authors concluded that adipose tissue increased significantly in both sexes and in all nutritional status. There were changes in body adiposity levels, even with nutritional status control over the period of 30 years, showing that individuals may have similar BMI, but simultaneously vary in proportion and distribution of subcutaneous adipose tissue. In both sexes, the highest increase occurred in the eutrophic group, followed by the overweight group and the obese group. Central SFs showed a higher increase than peripheral SFs. Thus, results suggest a possible change in body composition, which may be experiencing an increase in fat mass index.

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