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Association between excess peripheral, central and general adiposity and different contexts of physical activity among adolescents from Southern Brazil

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ABSTRACT. The aim of this study was to investigate the association between excess peripheral, central and general adiposity and different contexts of physical activity (Physical Education classes, school recess, commuting, leisure time and participation in sports teams) in adolescents from Southern Brazil. Across-sectional study was developed with 1.132 adolescents (16.50 ± 1.14 years) of both sexes. Peripheral adiposity (triceps skinfold) and central adiposity (subscapular skinfold) were classified as high based on the 90th percentile of the Centers for Disease Control and Prevention reference distribution. For excess general adiposity, triceps and subscapular skinfold thicknesses above the 90th percentile were simultaneously considered. The different contexts of physical activity were obtained through self-reported questionnaire. Covariates were: age, economic level, eating habits measured through self-administered questionnaire and sexual maturation (self-reported, following Tanner's procedures). Binary logistic regression was used with significance level < 0.05. Male adolescents little active during leisure time were 2.25 (95%CI: 1.17; 4.50) times more likely of having excess peripheral adiposity, 3.10 (95%CI: 1.56; 6.13) times more likely of having excess central adiposity and 2.38 (95% CI: 1.08; 5.26) times more likely of having general adiposity when compared to peers active during leisure time. For female adolescents, no context of physical activity was associated with excess peripheral, central and general adiposity. Male adolescents little active during leisure time are more likely of having excess peripheral, central and general adiposity. For female adolescents, no context of physical activity was associated with excess peripheral, central and general adiposity.

Keywords: body composition; obesity; overweight; adolescent health; physical fitness.

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Introduction

Overweight in childhood and adolescence over the last four decades has increased by eight times in females and 8.6 times in males, demonstrating a worrying global public health problem (Abarca-Gómez et al., 2017). In 2016, according to the World Health Organization (WHO), more than 340 million children and adolescents aged 5-19 were overweight or obese (World Health Organization [WHO], 2016). The World Obesity Federation estimated that 206 million children and adolescents in the same age group will be diagnosed with obesity in 2025 and 254 million in 2030 (Lobstein & Brinsden, 2019).

In Brazil, the prevalence of excess weight in schoolchildren in 2015 exceeded 20%, with the southern region being the highest (28.2%), highlighting an alarming scenario for this population in the country (Pesquisa Nacional de Saúde do Escolar: 2015, 2016). Weight gain in childhood and adolescence will possibly lead to psychosocial disorders caused by the stigma of obesity during these two phases, increased risk for cardiovascular and metabolic diseases such as type II diabetes, high blood pressure, dyslipidemia and atherosclerosis in adulthood and at older ages (Bloch et al., 2016; World Health Organization [WHO], 2020).

Most studies have associated excess body adiposity with health outcomes due to the predictive power of skinfold measures (Liang et al., 2015; Carrión-Martínez et al., 2022). Subscapular skinfold is related to trunk fat and is more predictive of obesity-related diseases such as cardiovascular diseases and metabolic syndrome (Liang et al., 2015; Carrión-Martínez et al., 2022). Triceps skinfold expresses peripheral fat and is associated with low cardiorespiratory fitness and both skinfolds constitute general adiposity (Gualteros, Torres, Umbarila-Espinosa, Rodríguez-Valero, & Ramírez-Vélez, 2015; Agata & Monyeki 2018; Carrión-Martínez et al., 2022). Although there are studies in literature that used the skinfold method, these were not associated with outcomes related to lifestyle characteristics such as different contexts of physical activity (Liang et al., 2015; Agata & Monyeki, 2018; Carrión-Martínez et al., 2022).

Studies that have investigated excess adiposity in children and adolescents have concluded that the prevalence of overweight and obesity is related to modifiable lifestyle factors such as physical activity (PA) and diet, considered determinants of obesity for this population (Silva et al., 2017; Jongenelis, Scully, Morley, Pratt, & Slevin, 2018). In relation to PA, different contexts surround adolescents and understanding how these contexts (Physical Education classes, school recess, commuting, leisure time and participation in sports teams) relate to body fat distribution can be useful to promote actions related to better lifestyle habits.

Adolescents' participation in Physical Education classes demonstrated better indicators of levels of PA and sedentary behavior throughout the day and greater engagement in other extra-class activities, such as sports (Silva et al., 2018b). Furthermore, in the context of school PA, school recess, although short in duration, is capable of promoting opportunities to enhance health benefits, given the possibility of practicing PA during this period (Silva, Santos Silva, & Petroski, 2010), breaking sedentary behavior.

In the adolescent's out-of-school context, leisure can provide an opportunity to practice PA in this period characterized as ‘free time’, usually performed after school shifts. A study carried out in 2013 in the state of Pernambuco, with adolescents aged 14-19 years, found that participation in a sports team is included in this context and can represent 25% of PA preference in this population (Hardman et al., 2013). Another out-of-school activity, transportation or commuting (from home to school or vice versa), is considered one of the PA domains and can enhance daily PA recommendations (Larouche, Saunders, Faulkner, Colley, & Tremblay, 2014).

The contexts of PA that surround young people can directly interfere with body composition during school years (Silva et al., 2010; Silva et al., 2018a). Measuring individual modifiable lifestyle factors is not simple, as both variables are complex behaviors that also depend on sociodemographic and lifestyle factors (Gonçalves & Silva, 2016). Thus, age, sex and sexual maturation, for example, may mean related factors influencing body composition and PA practice in the different contexts surrounding adolescents.

Therefore, the present study aimed to investigate the association between excess peripheral, central and general adiposity and different contexts of physical activity (Physical Education classes, school recess, commuting, leisure time and participation in sports teams) in adolescents from Southern Brazil.

Material and methods

This cross-sectional, school-based study is part of a macro project (blind peer review), approved by the Human Research Ethics Committee (blind peer review) under Protocol No. (blind peer review). Adolescents who returned the signed Assent Form, together with the Free and Informed Consent Form signed by parents (< 18 years old) or by themselves (⩾ 18 years old), participated in the research.

The sampling process was carried out in two stages: the first consisted of stratifying school density (size: small, with less than 200 students; medium, with 200 to 499 students; and large, with 500 students or more) and the second considering the study shift and the school grade. Eligibility was defined as being enrolled in the state education network, age between 14 and 19 years, being in the classroom at the time of data collection and willing to participate in the study.

To determine the sample size, confidence level of 1.96 (95% confidence interval–95% CI), tolerable error of five percentage points, prevalence of 50% and design effect of 1.5 were adopted, adding 20% for losses and refusals and another 20% to control possible confounding variables. Calculations were performed using the G*Power software version 3.1 (Franz Faul, University of Kiel, Germany). Since 5.182 students were enrolled in high schools in the city of São José, SC, the sample size was estimated at 751 adolescents. However, due to cluster sampling, all students were invited to participate in the research, resulting in 1.132 students.

Dependent variables were: peripheral (triceps skinfold), central (subscapular skinfold) and general body adiposity (triceps and subscapular skinfold). Triceps and subscapular skinfolds were collected using Cescorf® scientific adipometer (Porto Alegre, Brazil). Measurements were collected by evaluators certified by the International Society for the Advancement of Kinanthropometry (ISAK) using the same protocol (Marfell-Jones, Stewart, & Ridder, 2012).

Peripheral and central adiposity was classified as high based on value corresponding to the 90^{th} percentile of the reference distribution for sex and age of the Centers for Disease Control and Prevention (CDC) curve (Addo & Himes, 2010). Values below the 90^{th} percentile were considered normal adiposity. CDC curves do not present reference values for general body adiposity through skinfold measures. However, this study analyzed this variable according to Silva, Pelegrini, Lima e Silva, & Petroski (2011), considering as having high general body adiposity adolescents who presented, concomitantly, skinfold thickness values in the triceps and subscapular region above the 90^{th} percentile.

Independent variables were different contexts of PA (Physical Education classes, school recess, commuting, commuting time, leisure-time PA and participation in sports teams) measured through self-reported questionnaires. PA in the context of Physical Education classes was analyzed through the weekly frequency of PE classes. This question belongs to the Youth Risk Behavior Surveillance System (YRBSS) questionnaire, which was translated and validated for Brazil (Guedes & Lopes, 2010). Adolescents were classified as 'non-participant' (when they do not participate in any Physical Education class), 1-2 classes and 3-4 classes.

PA in the context of school recess was analyzed through the type of activity performed during this period (i.e., sitting; standing, standing or walking; running or playing a little; running or playing much; running or playing intensely at most of the time). This question originates from the PAQ-C questionnaire, translated and used in Brazil (Rosendo da Silva & Malina, 2000). Adolescents were classified into active and inactive behavior during school recess.

PA in the context of commuting from home to school (and vice versa) was firstly analyzed by the type of transport that the student used for this journey. Based on response options, adolescents were classified as physically active (on foot or bicycle) or inactive (car/motorcycle or bus). Additionally, for those who commuted actively, it was verified how long this journey takes (< 10 minutes; 10-19 minutes; 20-29 minutes; ≥ 30 minutes). These questions originated from the Santa Catarina Adolescents Behavior Questionnaire (COMPAC) (Silva et al., 2013).

Leisure-time PA was analyzed using two questions. The first concerns the student's preferred leisure activity, in which the answer options are physically active activities (sports, dancing and others), and activities in the sitting position (i.e., little physically active, such as board games, watching TV, computer games and video games). This item is part of the COMPAC questionnaire (Silva et al., 2013). The second question analyzed whether the student participates in any sports team and was categorized into no sports team or one or more sports teams. This item is part of the YRBSS questionnaire (Guedes & Lopes, 2010).

Control variables were: age, economic level, sexual maturation and eating habits. Age was collected as a discrete quantitative variable (complete years) and used continuously, ensuring the identification of specific aspects of each age due to transformations arising from the adolescence phase. To define the economic level, the questionnaire proposed by the Brazilian Association of Research Companies was used, which estimates the purchasing power of families (Associação Brasileira de Empresas de Pesquisa [ABEP], 2014). Economic level is characterized in decreasing order according to purchasing power, accumulation of material goods, housing conditions, number of domestic employees and schooling of the head of the family. This variable was dichotomized into 'High' ('A1'; 'A2'; 'B1'; 'B2') and 'Low' ('C1'; 'C2'; 'D').

Sexual maturation was self-assessed according to criteria proposed by Tanner, consisting of five stages of development for each secondary sexual characteristic (breast development and genitals) (Tanner, 1962). The indication of stages was carried out through self-assessment after individual and prior explanation of the instrument by the researcher, always of the same sex as the adolescent.

Students marked the number corresponding to the stage they were in relation to breast (female) and genital (male) development after observing the corresponding photographs. Stage 1 represents the childhood state characterized as pre-pubertal. Stages 2, 3 and 4 represent the maturational process, categorized in this study as 'pubertal' and stage 5 indicates the mature state, classified as 'post-pubertal' (Tanner, 1962). Due to the low frequency of adolescents who declared themselves as pre-pubertal (0.2%), this variable was categorized into: 'pre-pubertal/pubertal' and 'post-pubertal'.

Information regarding eating habits was obtained through the following question: "Do you eat a balanced diet?" Balanced diet was considered as the consumption of grains and cereals (5 to 12 servings per day); fruits and vegetables (5 to 10 servings per day); meats and similar (2 to 3 servings per day); milk and dairy products (3 to 4 servings up to 16 years old, 2 to 4 servings over 16 years old). This variable is part of the 'Fantastic Lifestyle' questionnaire, prepared by the Canadian Society for Exercise Physiology, translated and validated for Brazil (Silva, Brito, & Amado, 2014).

Analyses were carried out stratified by sex. For sample characterization, descriptive statistics were used (mean, standard deviation, absolute and relative frequency). In inferential statistics, the independent T test was used for continuous variables and the Chi-square test was used for categorical variables with Cohen'D and Cramérs effect size analysis. Binary logistic regression was used to examine associations between the outcome (contexts of PA) and exposure (peripheral, central and general adiposity) by estimating odds ratio (OR) and 95% confidence interval.

In the adjusted analysis, all variables (age, economic level, sexual maturation and eating habits) were introduced into the model, regardless of p-value of the crude analysis. The significance level was set at 5%. Analyses were carried out using the Statistical Package for the Social Sciences software (IBM SPSS Statistics, Chicago, United States), version 22.0.

Results

Overall, 1.132 adolescents aged 14-19 years of both sexes participated in this study. Female adolescents had higher mean triceps ($p < 0.01$) and subscapular ($p < 0.01$) skinfold thicknesses compared to male adolescents. In relation to contexts of PA, it was observed that female adolescents participate less in school Physical Education classes ($p < 0.01$), are less active during school recess ($p < 0.01$), when commuting to school ($p<0.01$) and during leisure time ($p < 0.01$), and participate less in sports teams ($p < 0.01$) when compared to male adolescents (Table 1).

Little physically active male adolescents had higher prevalence of peripheral ($p = 0.01$) and general ($p < 0.01$) adiposity when compared to physically active adolescents. Female adolescents inactive during school recess had higher prevalence of high peripheral adiposity compared to active adolescents ($p = 0.01$). Furthermore, female adolescents who did not participate in school Physical Education classes had higher prevalence of high central adiposity compared to adolescents who participated in school Physical Education classes ($p = 0.04$) (Table 2).

Adjusted logistic regression analyses demonstrated that male adolescents little active during leisure time were 2.25 (95% CI: 1.17; 4.50) times more likely of having high peripheral adiposity, when compared to adolescents active during leisure time. For female adolescents, no context of PA was associated with high peripheral adiposity (Table 3).

Male adolescents little active in leisure time were 3.10 (95% CI: 1.56; 6.13) times more likely of having high central adiposity, when compared to adolescents active in leisure time in the adjusted analysis. For female adolescents, no context of PA was associated with high central adiposity (Table 4).

Adjusted logistic regression analyses demonstrated that male adolescents little active in leisure time were 2.38 (95% CI: 1.08; 5.26) times more likely of having high general adiposity, when compared to adolescents active in leisure time. For female adolescents, no context of PA was associated with high general adiposity (Table 5).

Table 1. Characteristics of the investigated sample (n = 1.132).

	Total Sample (1.132)	Male (513)	Female (619)	
Variables	Mean (sd)	Mean (dp)	Mean (sd)	p
Age (years)	16.15 (1.14)	16.26 (1.18)	16.06 (1.10)	0.01
Triceps skinfold thickness (mm)	14.95 (7.32)	10.75 (5.11)	18.72 (6.96)	<0.01
Subscapular skinfold thickness (mm)	13.28 (6.65)	10.78 (4.85)	15.53 (7.22)	<0.01
	n (%)	n (%)	n (%)	
Economic level				0.03
High	666 (69.5)	314 (47.1)	352 (52.9)	
Low	292 (30.5)	116 (39.7)	176 (60.3)	
Study shift				0.10
Morning	510 (45.4)	239 (46.9)	271 (53.1)	
Afternoon	220 (19.6)	95 (43.2)	125 (56.8)	
Nightly	300 (26.7)	147 (49.0)	153 (51.0)	
Integral	93 (8.3)	33 (35.5)	60 (64.5)	
Sexual Maturation				0.08
Pre-pubertal/pubescent	803 (71.5)	380 (74.1)	423 (69.3)	
Post-pubertal	320 (28.5)	133 (25.9)	187 (30.7)	

Balanced diet				0.02
Frequent	177 (15.7)	85 (16.5)	92 (15.0)	
Less frequent	946 (84.23)	427 (83.5)	519 (85.0)	
Peripheral adiposity				0.37
Normal	811 (87.2)	391 (47.9)	426 (52.1)	
Excess	117 (12.6)	49 (43.4)	64 (56.6)	
Central adiposity				0.04
Normal	681 (75.4)	394 (48.6)	417 (51.4)	
Excess	102 (11.3)			
General adiposity				0.13
Normal	846 (91.0)	407 (48.1)	440 (51.9)	
Excess	79 (8.5)	31 (39.2)	48 (60.8)	
Physical Education classesFísica				0.01
No participation	74 (6.6)	21 (28.4)	53 (71.6)	
1-2 classes	948 (84.9)	441 (46.5)	507 (53.5)	
3-4 classes	95 (8.5)	49 (51.6)	46 (48.4)	
School recess				<0.01
Active	475 (42.6)	266 (56.0)	209 (44.0)	
Inactive	640 (57.4)	243 (38.0)	397 (62.0)	
Commuting				<0.01
Active	522 (47.3)	262 (50.2)	260 (49.8)	
Inactive	582 (52.7)	240 (41.2)	343 (58.8)	
Commuting time				
<10 minuts	346 (30.9)	162 (46.8)	184 (53.2)	
10 a 19 minuts	399 (35.7)	170 (42.6)	229 (57.4)	
20 a 29 minuts	184 (16.5)	89 (48.4)	95 (51.6)	0.51
≥ 30 minuts	189 (16.9)	88 (46.6)	101 (53.4)	
Leisure Physical Activity				<0.01
Active	476 (44.1)	258 (54.2)	218 (45.8)	
Less Active	604 (55.9)	238 (39.4)	366 (60.6)	
Sport team				<0.01
None	542 (48.9)	187 (34.5)	355 (65.5)	
One ou more	566 (51.1)	318 (56.2)	248 (43.8)	

Sd: standard deviation; sauhsauhsau.

Table 2. Excess peripheral, central and general adiposity associated with physical activity contexts in male and female adolescents.

	Male						Female					
	High peripheral adiposity		High central adiposity		High general adiposity		High peripheral adiposity		High central adiposity		High general adiposity	
	n (%)	p	n (%)	p	n (%)	p	n (%)	p	n (%)	p	n (%)	p
Physical Education classes		0.85		0.36		0.52				**0.04**		0.75
No participation	02 (14.3)		03 (21.4)		02 (14.3)		07 (15.2)		12 (26.7)		06 (13.0)	
1-2 classes	43 (11.1)		38 (9.9)		26 (6.8)		52 (12.8)		57 (14.0)		39 (9.6)	
3-4 classes	03 (8.8)		04 (11.8)		03 (8.8)		05 (15.2)		03 (9.1)		03 (9.1)	
School recess		0.09		0.11		0.07		**0.01**		0.42		0.08
Active	19 (8.5)		31 (18.5)		11 (4.9)		31 (18.5)		28 (16.7)		22 (13.2)	
Inactive	28 (13.5)		33 (10.4)		19 (9.3)		33 (10.4)		44 (14.0)		26 (8.3)	
Commuting		0.29		0.93		0.73		0.47		0.93		0.42
Active	29 (12.5)		32 (14.9)		23 (9.9)		26 (12.1)		32 (14.9)		19 (8.8)	
Inactive	18 (9.3)		40 (15.2)		21 (10.9)		38 (14.3)		40 (15.2)		29 (11.0)	
Commuting time		0.80		0.69		0.97		0.94		0.69		0.88
<10 minutes	17 (12.5)		26 (17.3)		15 (11.1)		21 (13.9)		26 (17.3)		17 (11.3)	
10 - 19 minutes	17 (11.4)		22 (12.6)		15 (10.1)		24 (13.8)		22 (12.6)		11 (7.4)	
20 - 29 minutes	06 (8.7)		12 (15.6)		07 (10.1)		09 (11.7)		12 (15.6)		4 (5.8)	
≥ 30 minutes	07 (9.1)		12 (14.3)		07 (9.1)		07 (9.1)		12 (14.3)		07 (8.3)	
Leisure PA		**0.01**		0.08		**<0.01**				0.08		0.56
Active	17 (7.5)		17 (10.3)		13 (5.7)		19 (11.5)		17 (10.3)		14 (8.5)	
Little active	29 (15.2)		48 (16.2)		30 (15.8)		40 (13.4)		48 (16.2)		30 (10.1)	
Sport team		0.06		0.06		0.11		0.34		0.98		0.19
None	23 (15.2)		22 (14.6)		15 (10.0)		34 (12.1)		42 (15.0)		24 (8.5)	
One or more	25 (9.0)		23 (8.3)		16 (5.8)		90 (15.1)		30 (15.1)		24 (12.2)	

PA: Physical activity; Chi-square test; n: absolute frequency; %: relative frequency.

Table 3. Crude and adjusted logistic regression analysis between peripheral adiposity and physical activity contexts in adolescents of both sexes.

	High peripheral adiposity							
	Male				Female			
	Crude analysis		Adjusted analysis *		Crude analysis		Adjusted analysis *	
	OR (CI 95%)	p	OR (CI 95%)	P	OR (CI 95%)	p	OR (CI 95%)	p
Physical Education classes								
No participation	1.72 (0.25; 11.62)	0.57	1.36 (0.17; 10.44)	0.76	1.00 (0.28; 3.49)	0.99	0.93 (0.26; 3.38)	0.92
1-2 classes	1.29 (0.38; 4.41)	0.67	1.08 (0.30; 3.81)	0.90	0.82 (0.30; 2.21)	0.69	0.62 (0.22; 178)	0.62
3-4 classes	1		1		1		1	
School recess								
Active	1		1		1	1	1	
Inactive	1.68 (0.91; 3.12)	0.96	1.78 (0.94; 3.37)	0.07	0.51 (0.30; 1.87)	0.06	0.53 (0.39; 1.85)	0.06
Commuting								
Active	1		1		1		1	
Inactive	0.72 (0.38; 1.34)	0.30	0.81 (0.42; 1.54)	0.30	1.21 (0.71; 2.07)		1.18 (0.66; 2.09)	0.56
Commuting time								
<10 minutes	1.50 (0.56; 3.99)	0.41	1.07 (0.38; 3.01)	0.88	1.21 (0.53; 2.81)	0.64	2.08 (0.76; 5.31)	0.15
10 - 19 minutes	1.05 (0.33; 3.29)	0.93	1.01 (0.31; 3.32)	0.97	1.02 (0.39; 2.66)	0.96	1.64 (0.55; 4.85)	0.36
20 - 29 minutes	1.35 (0.50; 3.59)	0.54	1.05 (0.38; 2.92)	0.91	1.20 (0.53; 2.73)	0.64	1.74 (0.66; 4.54)	0.25
⩾ 30 minutes	1		1		1		1	
Leisure physical activity								
Little active	2.22 (1.18; 4.18)	0.01	2.25 (1.17; 4.50)	0.01	1.19 (0.66; 2.13)	0.55	1.30 (0.71; 2.40)	0.38
Active	1		1		1		1	
Sport team								
None	1.81 (0.98; 3.21)	0.06	1.30 (0.67; 2.51)	0.42	0.77 (0.45; 1.31)	0.34	0.83 (0.49; 1.43)	0.51
One or more	1		1		1		1	

OR: *Odds ratio*; CI95%: Confidence Interval; *: Analysis adjusted for age, economic level, sexual maturation and eating habits.

Table 4. Crude and adjusted logistic regression analysis between central adiposity and general physical activity contexts in adolescents of both sexes.

	High central adiposity							
	Male				Female			
	Crude analysis		Adjusted analysis *		Crude analysis		Adjusted analysis *	
	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p
Physical Education classes								
No participation	2.04 (0.39; 10.63)	0.39	1.53 (0.24; 9.63)	0.64	3.63 (0.93; 14.14)	0.62	3.20 (0.81; 12.65)	0.97
1-2 classes	0.82 (0.27; 2.45)	0.72	0.62 (0.20; 1.96)	0.42	1.62 (0.48; 5.51)	0.43	1.31 (0.38; 4.53)	0.66
3-4 classes	1		1		1		1	
School recess								
Active	1		1		1		1	
Inactive	1.65 (0.87; 3.11)	0.12	1.80 (0.93; 3.49)	0.08	0.81 (0.48; 1.36)	0.42	0.81 (0.47; 1.40)	0.46
Commuting								
Active	1		1		1		1	
Inactive	1.11 (0.59; 2.08)	0.73	1.33 (0.68; 2.58)	0.39	1.01 (0.61; 1.69)	0.93	0.96 (0.55; 1.67)	0.89
Commuting time								
<10 minutes	1.10 (0.42; 2.85)	0.83	0.83 (0.30; 2.28)	0.71	1.13 (0.53; 2.39)	0.73	1.56 (0.67; 3.63)	0.29
10 - 19 minutes	0.88 (0.29; 2.66)	0.82	0.74 (0.23; 2.38)	0.61	0.90 (0.37; 2.15)	0.81	1.08 (0.41; 2.82)	0.87
20 - 29 minutes	0.99 (0.38; 2.55)	0.98	0.73 (0.27; 2.00)	0.55	0.78 (0.36; 1.67)	0.53	0.89 (0.49; 1.60)	0.80
⩾ 30 minutes	1		1		1		1	
Leisure physical activity								
Little active	3.10 (1.56; 6.13)	**<0.01**	3.10 (1.56; 6.13)	**<0.01**	1.67 (0.93; 3.02)	0.08	1.67 (0.93; 3.02)	0.08
Active	1		1		1		1	
Sport team								
None	1.87 (1.00; 3.49)	0.06	1.22 (0.62; 0.41)	0.55	0.99 (0.59; 1.65)	0.98	0.94 (0.53; 1.64)	0.82
One or more	1		1		1		1	

OR: *Odds ratio*; CI95%: Confidence Interval; *: Analysis adjusted for age, economic level, sexual maturation and eating habits.

Table 5. Crude and adjusted logistic regression analysis between general adiposity and general physical activity contexts in adolescents of both sexes.

	High general adiposity							
	Male				Female			
	Crude analysis		Adjusted analysis *		Crude analysis		Adjusted analysis *	
	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p	OR (CI 95%)	p
Physical Education classes								
No participation	1.72 (0.25; 11.62)	0.57	1.29 (0.16; 10.32)	0.80	1.50 (0.34; 6.48)	0.58	1.41 (0.31; 6.32)	0.64
1-2 classes	0.75 (0.21; 2.62)	0.65	0.56 (0.15; 2.06)	0.38	1.06 (0.31; 3.65)	0.92	0.77 (0.21; 2.73)	0.68
3-4 classes	1		1		1		1	
School recess								
Active	1		1		1		1	
Inactive	1.97 (0.91; 4.26)	0.08	2.16 (0.96; 4.84)	0.06	0.59 (0.32; 1.08)	0.08	0.63 (0.40; 1.10)	0.08
Commuting								
Active	1			1	1		1	
Inactive	0.58 (0.26; 1.27)	0.17	0.69 (0.30; 1.58)	0.39	1.27 (0.69; 2.35)	0.42	1.26 (0.66; 2.39)	0.47
Commuting time								
<10 minutes	1.30 (0.39; 4.30)	0.66	0.79 (0.22; 2.85)	0.72	1.07 (0.44; 2.62)	0.86	1.80 (0.62; 5.22)	0.27
10 - 19 minutes	1.14 (0.29; 4.44)	0.84	1.16 (0.28; 4.85)	0.83	0.77 (0.26; 2.24)	0.63	1.19 (0.35; 4.09)	0.77
20 - 29 minutes	1.29 (0.39; 4.22)	0.66	0.96 (0.27; 3.36)	0.95	0.86 (0.35; 2.10)	0.75	1.27 (0.43; 3.72)	0.65
⩾ 30 minutes	1		1		1		1	
Leisure physical activity								
Little active	2.38 (1.08; 5.26)	**0.03**	2.38 (1.08; 5.26)	**0.03**	1.21 (0.62; 2.36)	0.56	1.39 (0.69; 2.78)	0.35
Active	1		1		1		1	
Sport team								
None	1.80 (0.86; 3.76)	0.11	1.27 (0.55; 2.93)	0.56	0.67 (0.37; 1.22)	0.19	0.71 (0.39; 1.30)	0.27
One or more	1		1		1		1	

OR: *Odds ratio*; CI95%: Confidence Interval; *: Analysis adjusted for age, economic level, sexual maturation and eating habits.

Discussion

The aim of the present study was to investigate the association between different contexts of PA (Physical Education classes, school recess, commuting or transportation, leisure-time PA and participation in sports teams) with peripheral, central and general adiposity. The results found were: 1) male adolescents little active during leisure time were more likely of having excess peripheral, central and general adiposity and 2) for female adolescents, no context of PA was associated with excess peripheral, central adiposity and general.

In the present study, male adolescents little active during leisure time were more likely of having excess peripheral, central and general adiposity. This result is consistent with other studies that demonstrated that male adolescents who do not perform leisure-time PA had higher fat percentage (sum of triceps and subscapular skinfolds) when compared to groups that practiced PA (Freitas et al., 2012; Agata & Monyeki, 2018).

The availability of technologies, added to barriers to leisure-time physical activities such as urban violence and the lack of free spaces, drastically reduce the opportunities for a more active lifestyle, favoring sedentary behaviors such as activities in sitting position using cell phone, watching television and playing video games, which require low energy expenditure (Luciano, Bertoli, Adami, & Abreu, 2016). Excess adiposity is associated with imbalance between long periods of activities that do not require associated physical effort, diet rich in high-calorie components and low levels of PA (Silva et al., 2018a).

The Physical Activity Guide for the Brazilian Population and the World Health Organization recommend that children and adolescents participate in moderate/vigorous intensity PA for, at least, an average of 60 minutes per day for health benefits and reduction in the incidence of chronic diseases that will manifest in adulthood (Umpierre et al., 2022; WHO, 2020). Participation in Physical Education classes, in addition to participation in sports teams, can promote the practice of PA and a healthier lifestyle (Silva et al., 2018b). However, only Physical Education classes seem not to be enough to reach the daily PA recommendation regarding the weekly frequency, mostly twice a week, low intensity and often the only opportunity where adolescents are involved with PA (Drake et al., 2012; Nahas, 2017). Even so, they are important, as physical activities, even at light levels, contribute to daily energy expenditure and, therefore, can provide health benefits (Nettlefold et al., 2011).

In addition to Physical Education classes, school recess is another opportunity for adolescents to be active. Defined as a short break period between classes (15-20 minutes), it has little contribution to achieving moderate/vigorous PA guidelines for adolescents (average 60 minutes/day) (Umpierre et al., 2022; WHO, 2020). A systematic review carried out in 2016 that listed studies that measured level of PA during school recess showed that school adolescents spent only seven minutes on average in moderate/vigorous PA (Reilly, Johnston, McIntosh, & Martin, 2016).

A Spanish study with school children found that the level of PA among adolescents during school recess is low, and less than 10% of all adolescents spent half of the school recess in moderate/vigorous PA (Grao-Cruces et al., 2019). Furthermore, other studies also demonstrate that excess adiposity may not be associated with levels of PA during school recess, which is consistent with results of this study (Martinez-Gomez et al., 2014; Vega & Viciana, 2015). Although participation in school recess and Physical Education classes are not associated with the dependent variables of this study, they are capable of promoting health benefits, considering the possibility of participating in PA even in a short period of time, frequency and light intensity (Silva et al., 2010; Nettlefold et al., 2011).

In the out-of-school context, commuting is another strategy to be used to increase levels of PA; however, it may not make a significant difference in the anthropometric indicators of obesity according to our findings. Corroborating our results, a systematic review carried out in 2014 analyzed the association of body composition in adolescents and active commuting from home to school (and vice versa) in 68 articles and obtained conflicting results. Of these, 22 studies (56.4%) showed that there was no significant difference between active and passive commuting, 14 studies (35.9%) observed that adolescents in active commuting had better body composition and three studies (7.7%) reported that active commuting was positively associated with excess adiposity. Of the eight studies that used skinfold thickness as anthropometric method, four found no significant difference between these variables (Larouche et al., 2014).

In the present survey, 47.3% of adolescents used passive commuting to and from school. Of these, only 33.4% had commuting time greater than 20 minutes, which explains the lack of association with excess adiposity. Therefore, it could be concluded that contexts of PA suggest a dose-response between commuting time and intensity, which would increase levels of PA, so that there is a difference in the adolescent's body composition.

In the present study, for female adolescents, no context of PA was associated with excess peripheral, central and general adiposity. A possible explanation for this result is the lower participation of females in all contexts of PA, and this may impact their body composition, especially adipose tissue (Silva et al., 2018a). Furthermore, even in the absence of significant differences in the maturational stage in the present research, female adolescents reach puberty earlier when compared to males, which influences biopsychosocial changes such as changes in body composition, eating habits and PA (Piola, Bacil, Pacifico, Camargo, & Campos, 2020). Other variables not investigated in this study, such as genetic factors, sedentary behavior, sleep duration and quality, can influence the body composition of both sexes (Narciso et al., 2019).

The limitations of the present study are: the use of subjective measures to verify the level of physical activity may have underestimated or overestimated the results, the lack of information regarding the distance between the adolescent's home and school, which could have helped to understand the relationship found with variable time and the cross-sectional characteristic of the study, which does not allow establishing a cause-effect relationship, resulting in possible reverse causalities between associations. However, among strengths, the sample size stands out, and the low-cost method used to assess body composition allows replicating this study in other regions of the country, and the investigation of different contexts of physical activity in a single study. Furthermore, the standardization and training of researchers for data collection can also be considered a strength.

Conclusion

It could be concluded that male adolescents little active during leisure time were more likely to have excess peripheral, central and general adiposity. Other contexts of PA such as commuting, school recess, Physical Education classes and participation in sports teams were not associated with excess peripheral, central and general adiposity in adolescents from southern Brazil.

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