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ORIGINAL

ASSOCIATIONS BETWEEN PHYSICAL FITNESS AND ADIPOSITY AMONG SCHOOL-AGE CHILDREN FROM MONTERIA, COLOMBIA

ASOCIACIÓN ENTRE CONDICIÓN FÍSICA Y ADIPOSIDAD EN ESCOLARES DE MONTERÍA, COLOMBIA

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ABSTRACT

Low physical fitness levels have been associated with elevated adiposity. Both conditions may predict cardiovascular and metabolic alterations. The objective was to analyze the associations between health-related physical fitness and adipose. A cross-sectional study in 534 school-age children aged 6-12 in Monteria, Colombia.

Measurements included cardiorespiratory fitness (CCR), flexibility, explosive strength of lower limbs (ESLL), abdominal strength endurance (ASE), body mass index (BMI), percentage of adipose mass (PAM), and waist circumference (WC). The associations between adiposity and physical fitness were calculated by logistic regression models. Results indicate that overweight is associated with low CCR (aOR = 2.7, p<0.0001). Elevated PA was associated with low ASE (aOR = 2.2, p<0.02), and with low CCR (aOR = 3.3, p<0.001). Elevated PMA was associated with low CCR (aOR=2.7, p<0.0001). In conclusion, physical fitness is associated with adiposity.

KEYWORDS: physical fitness, adiposity, childhood, health

RESUMEN

Los niveles bajos de condición física se han asociado con adiposidad elevada. Ambas condiciones pueden predecir alteraciones cardiovasculares y metabólicas. El objetivo fue analizar la relación entre la condición física y los indicadores antropométricos de adiposidad. Estudio transversal, en 534 escolares de 6 a 12 años de edad del municipio de Montería. Se midió la condición cardiorrespiratoria (CCR), flexibilidad, fuerza explosiva de miembros inferiores (FEMI), fuerza resistencia abdominal (FRA), Índice de Masa Corporal (IMC), masa adiposa (PMA), y perímetro abdominal (PA). Las asociaciones entre adiposidad y la condición física se analizaron con modelos de regresión logística. Se encontró que el sobrepeso está asociado a baja CCR (ORa = 2,7, p<0,0001); el PA elevado está asociado a baja FRA (ORa = 2,2, p<0,02), y a baja CCR (ORa = 3,3, p<0,001); el PMA elevado está asociado a baja CCR (ORa = 2,7, p<0,0001). Conclusión, la condición física está asociada a la adiposidad.

PALABRAS CLAVE: capacidad funcional, adiposidad, infancia, salud

INTRODUCTION

Physical fitness (PF) is an indicator of the level of organic functioning of the body. Through it you can estimate the level of structural adaptation (anatomical), functional (physiological) organ systems of the body. PF and adiposity are considered important markers of health status and well-being at any age (1). Between PF and adiposity, there is an interdependent relationship between structure-function, understanding that in both, physical activity plays a mediating role; while increasing the level of physical activity decreases adiposity and increases the PF (2, 3). There is evidence that the CF of teenagers has been declining in recent decades (4-6) and in Colombia and obesity in children and adolescents has increased about 25% in the period between 2005 and 2010 (7).

Each component of the PF has been associated with various aspects of health. For example, cardiorespiratory fitness (CRF) has been associated with lower adiposity (8) and with better cardiovascular profile (9) in children and adolescents. They have associated low levels of flexibility with low back pain in adolescents (10) and with increased risk of low back pain in adulthood (11). A recent study examined muscle strength with mortality from cancer and found that those subjects located in the first tercil had higher cancer mortality rates compared with the upper tercil (12). Similarly, low levels of muscle strength in adolescence are associated with poor metabolic profile (1) and with disease and all causes of death in adulthood (13). Meanwhile, excessive adiposity has been associated with cardiovascular and metabolic risk. For example, elevated BMI in adolescence have been associated with increased risk of diabetes and heart disease in adulthood (14). Similarly, critical levels in the percentage of adipose mass (PAM) of 25% in children and 35% in girls, have been associated with elevated levels of lipoproteins, cholesterol and blood pressure in children and adolescents (15). And high waist circumference (WC) is considered a strong predictor of cardiovascular and metabolic disorders (16, 17).

The relationship between the CF and adiposity in children and adolescents has been reported in the scientific literature on the subject. For example, BMI showed a negative association with CRF (18, 19), with explosive strength (18, 20) and abdominal strength (19). Waist circumference was negatively associated with CRF values (21, 22) and explosive strength (22). Peripheral adiposity was negatively associated with CRF (23, 24) and explosive strength (22). In two of them (18, 19) flexibility was measured but the associations with adiposity were not significant.

Despite these findings, the link between adiposity and physical condition is not entirely clear and requires further study. Therefore, the objective of this study was to analyze the relationship between health-related physical fitness and anthropometric indicators of adiposity in school children between six and twelve years of the municipality of Monteria.

MATERIAL AND METHODS

This is a quantitative study with a correlational cross-sectional design. Data collection was carried out using instruments that were applied only once to measure the study variables. The associations were established using statistical procedures. The present study is a secondary analysis was performed in the framework of the project entitled "Fitness and physical activity habits in schoolchildren from Monteria" implemented by GRECIA'S research group at the University of Cordoba, Colombia.

Population and sample

For the year 2007, the population of the city of Monteria according to data from the government of Córdoba, amounts to 286 575 persons in urban areas and 92,395 in rural areas, for a total of 378970 inhabitants, which represents a little more 20% of the total population of the department (25). The sample frame consists of children of the municipality of Monteria enrolled in schools and of which there is records in the secretary of education for the year 2007. According to these records, the school population was estimated at about 103 629 students (74.2% in urban areas) in 136 schools (77.2% located in urban areas). Sampling was carried out in three stages. First sampling was carried clusters of schools, taking into account the type and location of the schools, result showed 14 schools. Then the sample was calculated and it was determined the number of subjects in the sample at 385. Finally, a simple random sampling of schoolchildren in the age required was conducted, based on the records of enrollment by institution, with sampling fractions allowed complete the required sample for each age group and sex, in proportion to the total number of enrollments. Oversampling was applied in order to ensure the minimum number of study subjects. In total, the sample consisted of 534 schoolchildren 6-12 years of age (270 girls, 50.6%).

Those apparently healthy schoolchildren between 6 and 12 years old were included, formally enrolled in selected educational institutions, whose parents approve their participation by signing the informed consent. Students with physical or mental disability making it impossible their participation in the study and those students who voluntarily chose not to participate in the project were excluded.

Measurements

Data collection was performed by applying specific protocols for each type of measurement. These include anthropometric measurements to determine adiposity (BMI, PAM and WC) and field tests for the assessment of CRF, flexibility, abdominal strength endurance and explosive strength of lower limbs. All measurements were performed by previously trained physical education teachers. Evaluators were assigned to specific stations, therefore, each member thereof measured variables on the development of data collection. The valuations were performed in sequential stations in the following order: weight, height, waist circumference, skinfold thickness, flexibility, lower limb explosive strength, strength abdominal endurance and cardiorespiratory fitness.

Adiposity

Body Mass Index: A Health-o-Meter scale 200g precision was used to measure weight. Children were weighed without shoes and in a standing position, upright and good location on the scale, with eyes straight ahead and completely still, after taking the measure was recorded in kilograms.

Height was measured to the nearest millimeter in bare feet with a transportable stadiometer (SECA), located at a height of 2 meters on a flat wall, with the boy without shoes and erect, with arms in anatomical position, proceeded to place the base of the board on the subject's head, after asking him to conduct an inspiration and hold up the air for a few seconds. High was recorded in meters and centimeters.

BMI was calculated as body mass (kg) divided by height (m) squared. Overweight was identified using the criterion proposed by the Centers for Disease Control and Prevention (CDC) in which use specific BMI percentile for sex and age (≥P 85) (26).

Skinfold thickness: This indicator was measured using a SlimGuide skinfold caliper to the nearest 0.2mm at the triceps and medial calf sites. Both sites were previously marked with pencil. All measurements were taken on the right side of the body. PAM was estimated according to gender-specific equations proposed by Slaughter et al. (27):

PAM = 0.735 * Σtriceps and medial calf skinfolds + 1.0 (for boys)
PAM = 0.610 * Σtriceps and medial calf skinfolds + 5.0 (for girls)

PAM values were categorized according to the criteria proposed by Welk and Blair, specific for age and sex (28).

Waist circumference: WC was measured with an inextensible tape at the level of the narrowest point between the lower costal border and the iliac crest. The subject was asked to perform an exhalation, and the measured was taken and recorded in centimeters. The validity and reliability of this measurement has been documented (29, 30). The WC values were classified after the z-scores calculated age-specific and sex. Those values equal to or greater than +1.28 WC were categorized as abdominal obesity. All other values were categorized as normal WC (z-score <+1.28).

All anthropometric measurements were conducted in three times. If two measurements were equal the value was recorded, otherwise, it was proceeded to calculate and record the average of the three data.

Health-related fitness

Cardiorespiratory fitness: The Course-Navette test (20 meter Shuttle run test, 20MST) was used to measure CRF. This test was designed to determine tha aerobic capacity in children, adolescents and healthy adults (31). The test consists in running back and forth between two lines, 20 meters apart, following the pace of an audio signal. The time between each signal is reduced each minute, therefore the individual must to increase the speed. The initial speed is 8.5 $km*h^{-1}$, and it is increased 0.5 $km*h^{-1}$ each minute. The test ends when the individual is not abel to follow the signal to reach the line, then the stage is registered. With this information is useful to estimate the maximum oxygen consumption (VO_{2max}), through the equation (31):

VO_{2max} = 31,025 + 3,238*(S) – 3,248*(A) + 0,1536*(V*E), where A is the age of the subject and S is the final speed, (S = 8 + 0,5 x last stage completed).
This test has been validated in previous studies to evaluate CRF (32) and it has documented reproducibility (33, 34).

Flexibility: The test of sit-and-reach (TSR), also known as Wells test because it was originally proposed by Wells and Dillon (35), was designed to measure the extensibility of hamstring muscles and joints lower back. To perform the test, the subject sits on the floor, resting the shoulder blades, head, shoulders and hips to a wall, at an angle of 90 ° at the hip joint, keeping the knees straight and feet on 90 °, so that the plant remains in contact with a drawer. The subject makes a scapular abduction with folded hands and fingers extended without the head, back and hips lose contact with the wall. In this position the evaluator sets the reference point, located in the most fingertips. From this point, the subject performs a ventral bending, reaching as far ahead with his fingers, and held this position for at least three seconds, while the evaluation measures the distance from the reference point, recording the better of two attempts (36).

However, some authors have claimed that this technique offers some biases for individuals with imbalance between arms and legs (36, 37). To solve this limitation, Hoeger et al. (36) proposed a modification to the TSR, which shifts the reference point of the rule to the point where the fingers come in contact with the rule, while the blades are in contact with the wall on which it rests back in the sitting position. This modification of the test was applied in this study makes the results are always positive, unlike the original protocol, in which negative scores could be obtained when the subject was not enough to surpass the benchmark.

To validate this test, Cornbleet y Woolsey (38) compared the results of the TSR by measuring the angle of the hip joint in 410 children and found a strong correlation between the two measurements (r = 0,76). Similarly, Castro-Piñero et al. (39) measured the flexibility of the hip using goniometers and TSR in 87 children 6-12 years of age and found no association between the results of the TSR and the flexibility of the hamstring muscles.

Strength assessment: The test commonly used to assess the explosive strength and strength endurance in children are the standing long jump test and repetitions, respectively. The long jump test (LJT) measures the explosive strength of lower limbs (ESLL). The test is to make a leap forward from a standing position and propelling only bending the knees and movement of the arms, trying to reach the greatest distance. They run three attempts and the evaluator records the best distance achieved (40). This test has adequate feasibility, reliability, and safety in school settings (40).

In the case of the test of repetitions, students were asked to perform abdominal exercises for 30 seconds, time in which the abdominal strength endurance (ASE) is assessed. For the test, the subject is placed in supine position with knees bent and arms crossed on his chest. The subject performs elevations trunk (ventral flexion) as many times as possible for 30 seconds maintaining upright head and neck during movement and performing a climbing expiration and inspiration to get off. It records the number of complete repetitions performed. For this test has been documented activation of the abdominal muscles by electromyography (41) values and reproducibility with intra-classes correlation coefficient of 0.59 ($p<0,05$) (42).

Socio-demographic variables: These variables included gender, age, geographic location (rural or urban) and character of the institution (public or private).

Analysis of information

Data was analyzed using STATA v10 to apply statistical procedures with a significance level of 0.05.

For continuous variables, we calculated the mean and standard deviation, comparisons between subgroups were performed using Student's t test.

For categorical variables, proportions were calculated and comparisons between subgroups were made using the Chi-squared test. Procedures were applied to the analysis program for complex samples containing clusters (schools) and strata (sex, age group, location, nature of the institution), which are useful for the estimation of the odds ratio in the models of logistic regression.

Associations between health-related fitness and anthropometric indicators of adiposity were performed under logistic regression models. Three models were constructed, one for each measure of adiposity. In each model, the socio-demographic and health-related fitness were entered as dichotomous. For fitness variables, the high fitness group was the reference group.

RESULTS

Results were grouped into two sections. The first one describes the characteristics of the subjects, and the second one describes the logistic regression models based on the association between health-related fitness and anthropometric indicators of adiposity.

Table 1 describes the characteristics of sample stratified by sex. In anthropometric data, PAM was significantly higher in girls that in boys (t= 5.2; IC 95%: 1.7 – 3.7; p <0.001).

Meanwhile the children had better performance in all fitness tests, except in flexibility (no statistically significant differences between boys and girls). Boys had better performance on ESLL (t = -9.3; 95% CI -23.5 to 15.3; p <0.001), ASE (t = -4.8; 95%: -3.1 to 1.3; p <0.001), and CRF tests (t = -6.6; 95% CI -3.2 to 1.7; p <0.001), than girls.

For overweight, it was found an overall prevalence of 13.5% (CDC 2000) being marginally higher in children, 16.3%. The prevalence of abdominal obesity (≥ *z*-score of +1.28) and high PAM (FITNESSGRAM) was 11.6% and 10.3%, respectively, and no differences were found between boys and girls. Similar results for prevalence of low fitness levels, it was found no significant differences between boys and girls.

Table 1. Sample characteristics by gender

Characteristics	All (n=534) Mean and SD	Girls (n=270) Mean and SD	Boys (n=264) Mean and SD	p – value
Age (years)	9.7 ± 2.0	9.6 ± 2.0	9.8 ± 2.0	0.43
Weight (kg)	30.8 ± 9.7	30.4 ± 9.8	31.1 ± 9.6	0.40
High (cm)	132.6 ± 13.4	132.4 ± 13.6	132.7 ± 13.2	0.86
BMI (kg/m^2)	17.1 ± 2.9	16.9 ± 2.7	17.4 ± 3.1	0.08
Waist circumference (cm)	60.0 ± 8.7	59.1 ± 8.9	60.4 ± 8.3	0.07
Percentage of adipose mass	15.2 ± 6.1	16.6 ± 5.9	13.9 ± 6.0	0.001
Flexibility (cm)	29.2 ± 5.8	29.4 ± 5.8	28.7 ± 5.8	0.17
ESLL (cm)	130.4 ± 25.9	120.9 ± 22.8	140.4 ± 25.2	0.001
ESA (repeticiones)	16.2 ± 5.4	15.1 ± 5.3	17.3 ± 5.3	0.001
CRF ($VO_{2máx}$)	44.2 ± 4.4	43.0 ± 4.0	45.5 ± 4.5	0.001
Overweight (%)	13.5	10.7	16.3	0.06
Abdominal obesity (%)	11.6	11.5	11.7	0.92
High PAM (%)	10.3	9.6	11.0	0.60
Low flexibility (%)	38.4	38.5	38.3	0.51
Low ESLL (%)	37.6	36.7	38.6	0.35
Low ASE (%)	33.5	34.8	32.2	0.30
Low CRF (%)	40.4	41.1	39.8	0.41

SD: standard deviation; ESLL: explosive strength of lower limbs; ASE: abdominal strength endurance; PAM: percentage of adipose mass; CRF: cardiorespiratory fitness.

Associations between health-related fitness and anthropometric indicators of adiposity

Associations between anthropometric indicators of adiposity and health-related fitness were calculated by constructing logistic regression models, adjusted for gender, age, location, and character of the school, and the others functional capabilities. Three models were constructed, one for each anthropometric indicator of adiposity.

Table 2 shows the results of logistic regression models for overweight. Adjusted OR values for this model reveal a significant association of overweight with low CRF. The risk of having overweight is increased in children with low CRF (ORa = 2.72; 95% CI 1.6 to 4.6; p <0.0001), regardless of the other variables included in the model.

Table 2. Logistic regression of overweight and health-related fitness in 534 children aged 6-12 years old.

		ORa	CI 95%	Standard Error	p-value
Gender					
	Girls	1.0	1.0	0.43	0.065
	Boys	1.63	0.97 – 2.73		
Age groups					
	6 - 9	1.0	1.0	0.09	0.510
	10 - 12	1.06	0.89 – 1.26		
School location					
	Rural	1.0	1.0	0.50	0.464
	Urban	1.32	0.63 – 2.77		
Type of school					
	Public	1.0	1.0	0.62	0.192
	Private	1.64	0.78 – 3.43		
Flexibility					
	High	1.0	1.0	0.18	0.107
	Low	0.63	0.36 – 1.10		
Explosive strength of lower limbs					
	High	1.0	1.0	0.36	0.330
	Low	1.31	0.76 – 2.26		
Abdominal strength endurance					
	High	1.0	1.0	0.35	0.378
	Low	1.30	0.74 – 2.20		
Cardiorespiratory fitness					
	High	1.0	1.0	0.74	0.0001
	Low	2.72	1.60 – 4.64		

ORa: Adjusted odds ratio.

Logistic regression model built for abdominal obesity (Table 3) shows that the risk of abdominal obesity was higher in children of 10-12 years (AOR = 1.33; 95% CI: 1.08 to 1, 64; p <0.008), those who were enrolled in private schools (AOR = 4.94; 95% CI 2.3 to 10.5; p <0.001), those with low ASE (AOR = 2.18; 95% CI 1.15 to 4.14; p <0.02), and those with low CRF (AOR = 3.32; 95% CI 1.74 to 6.32; p <0.001).

Table 3. Logistic regression of abdominal obesity and health-related fitness in 534 children aged 6-12 years old.

		ORa	CI 95%	Standard Error	p-value
Gender					
	Girls	1.0	1.0	0.33	0.785
	Boys	1.09	0.59 – 1.99		
Age groups					
	6 - 9	1.0	1.0	0.14	0.008
	10 - 12	1.33	1.08 – 1.64		
School location					
	Rural	1.0	1.0	1.1	0.222
	Urban	1.98	0.66 – 5.92		
Type of school					
	Public	1.0	1.0	1.9	0.001
	Private	4.94	2.33 – 10.49		
Flexibility					
	High	1.0	1.0	0.20	0.126
	Low	0.60	0.31 – 1.16		
Explosive strength of lower limbs					
	High	1.0	1.0	0.53	0.121
	Low	1.64	0.88 – 3.09		
Abdominal strength endurance					
	High	1.0	1.0	0.71	0.017
	Low	2.18	1.15 – 4.14		
Cardiorespiratory fitness					
	High	1.0	1.0	1.09	0.001
	Low	3.32	1.74 – 6.32		

ORa: Adjusted odds ratio.

Finally, logistic regression model built for high PAM, shown in Table 4, indicates that children with low CRF have 2.7 times the risk of having high PAM compared with those who have normal PAM (CI 95%: 1.6 to 4.6; p <0.0001).

Table 4. Logistic regression of high percentage of adipose mass and health-related fitness in 534 children aged 6-12 years old.

	ORa	CI 95%	Standard Error	p-value
Gender				
Girls	1.0	1.0	0.43	0.065
Boys	1.63	0.97 – 2.73		
Age groups				
6 - 9	1.0	1.0	0.09	0.510
10 - 12	1.06	0.89 – 1.26		
School location				
Rural	1.0	1.0	0.50	0.464
Urban	1.32	0.63 – 2.77		
Type of school				
Public	1.0	1.0	0.62	0.192
Private	1.64	0.78 – 3.43		
Flexibility				
High	1.0	1.0	0.18	0.107
Low	0.63	0.36 – 1.10		
Explosive strength of lower limbs				
High	1.0	1.0	0.36	0.330
Low	1.31	0.76 – 2.26		
Abdominal strength endurance				
High	1.0	1.0	0.35	0.378
Low	1.30	0.74 – 2.20		
Cardiorespiratory fitness				
High	1.0	1.0	0.74	0.0001
Low	2.72	1.60 – 4.64		

ORa: Adjusted odds ratio.

DISCUSSION

This study examined the relationship between health-related fitness components (the structural and functional) and adiposity in a sample of 534 students with a mean age of 9.7 years the municipality of Monteria.

A prevalence of overweight of 13.5% was found, which is above the national prevalence of 10.3% in subjects between 10 and 17 years, reported in the National Nutrition Survey carried out in Colombia in 2005 (ENSIN 2005) (43). However, in the latest ENSIN (2010) (7) was found a national prevalence of overweight in children between 5 and 17 years is 17.5%, indicating an increase of the prevalence of overweight in this age.

The mean for abdominal circumference was 60.4 cm. in boys and 59.1 cm. in girls, values lower than those found in American children of the same age, 64.5 cm. in boys and 64.7 cm. in girls (44), Even though, this comparison is somehow limited given that Colombian children have less size than Americans, as they have different behavioral patterns in nutrition and physical activity.

As for PAM, higher values were found in girls, these results are consistent with previously documented studies (24, 45), in which adiposity was measured by anthropometry.

Due to methodological heterogeneity between studies that have measured fitness and the use of different cutoffs to classify it, it is necessary to interpret and compare the results in an approximated way. The results of this study show no statistically significant differences in the flexibility test between boys and girls, which are contradictory with other studies (18, 46). Probably, the decline in the levels of participation in physical activity for girls may be affecting their physical condition. In the other measured variables of health-related fitness, boys performed better than girls, and results that are consistent with the literature (18, 24, 47, 48). No differences were found between boys and girls in the prevalence of low flexibility (38.4%), low ESLL (37.6%), low ASE (33.5%), and low CRF (40.4%).

Globally, it is known that fitness levels in children and adolescents have been declining. This was documented in an extensive review of studies conducted in 27 countries, Tomkinson and Olds (4) documented a secular declination of CFR between 1958 and 2003, the results showed an increase until the early 70s, after which the decline is consistent. Until about 1990, an increase in muscle strength was reported and this was attributed to improvements in height, body mass and early maturation (49). However, recent studies have found a decrease in muscle strength in English children in a period of ten years (6).

These changes have occurred in a short period of time, therefore they should not be attributed to changes in the genetic composition but to environmental and behavioral factors which led to reduced levels of physical activity (50), thereby causing fitness reduction and adiposity increment.

In performing the analysis according to the classification of BMI, central adiposity and PAM, it was found that subjects classified with excess adiposity, in the three indicators, had a significantly lower performance on tests explosive strength of lower limb and CRF. Similar results have been reported by other studies showing lower physical performance in overweight children (8, 46), with abdominal obesity (8), and higher PMA (51). This lower performance in children with high body fat may be due to the fact that excess adiposity is an overload to your body, demanding more effort at the time of moving, characteristic of both tests, in fact, in the other two fitness tests, which does not require scrolling, no significant differences were found.

Logistic regression models indicate that overweight is associated with low CRF. Similar findings have been documented (20, 45). Similarly, it was found that elevated central adiposity is associated with low CRF and low ASE, showing consistency with previous studies (21, 24); and, finally, high PAM is associated to low CRF, this is consistent with previous results (23, 52). According to the results of the regression models, the CRF plays an important role in the accumulation of adipose tissue, hence it is considered a strong predictor of cardiovascular and metabolic disease (53, 54). Although there is no general consensus for the detection of central obesity in children, which makes these prevalence difficult to compare worldwide.

In the literature have been postulated mechanisms by which the excess in adiposity is associated with a lower CRF. CRF is determined by the intake of maximum oxygen, $VO_{2máx}$, i.e. the body's ability to take in, distribute and use oxygen in the transformation of energy in the aerobic metabolic pathway into the mitochondria, mainly muscle cells (55), hence in subjects with high adiposity oxygen consumption values for the weight is less than in subjects with less fat. Another mechanism suggests that sedentary behavior may be mediating the association. It is known that sedentary is associated with increased caloric intake (56), while shifting the time for physical activity (57), leading to CRF reduction (8, 58), and an increase in the adiposity (59). The genetic composition is another proposed mechanism, it suggests that the genetic composition partly explains the association between excess adiposity and low CRF, and is based on the presence of a genetic polymorphism for adiposity and fitness, in fact, already found genes related with the CRF (60) and with excessive adiposity (61).

Of particular importance is the fact that these risk factors developed during childhood and adolescence tend to persist into adulthood. For example, obese adolescents are more likely to continue as obese adults adolescents with normal weight (62). Some studies have found that the CRF in childhood is a good predictor of physical activity (63), fitness and cardiovascular risk profile in adulthood (65).

Additionally, the results show that children who are enrolled in private schools have 4.9 times more risk of elevated central adiposity, and this could be because the acquisition and procurement capacity of the students of these institutions is higher and at the same time the products sold in cafeterias in private schools are different from those offered in public schools, which is also high in calories.

Given the above, it is necessary to implement public policies, from the field of education and health, in order to improve the environment, increase program quality and health promotion, and take special interest in the population disadvantaged. From Physical Education is necessary to rethink content and methodologies, transcending beyond the classroom. Obviously, with the intensity that characterizes time in physical education it is derisory to expect substantial changes in fitness from classes, but learning that form in pedagogical spaces may be reflected in the physical activity done in the free time of schoolchildren, and therefore positively impact body weight and health-related fitness. However, it could suggest a transdisciplinary approach that includes areas such as social and biological sciences to develop healthy school projects to modify not only physical activity habits but eating and other behaviors that can affect health, as well as stipulating goals that can be met given the strategies proposed by the WHO Global Strategy document on Dietary regime, Physical Activity and Health.

The present study has some limitations that deserve mention. The research design is cross-sectional, so it is impossible to establish causal relationships between adiposity and functional capacity. The study did not include the analysis of behavioral variables in physical activity and inactivity, or the measurement of demographic factors such as educational level and socioeconomic status of the parents with what could have been enriching the regression models. Physical tests to measure fitness require a high degree of motivation from the participants, the study did not apply any technique to monitor motivation and it was assumed that the subjects performed their maximum effort in the implementation of the test.

Among the strengths of the study it is important to mention the sampling design thus ensured the representativeness of the sample, the models were adjusted for variables considered important predictors of adiposity and the measurements were performed by trained personnel following specific protocols. Although the variables were measured using indirect techniques, the estimates are consistent.

CONCLUSIONS

Findings of this study indicate that overweight is associated with low cardiorespiratory fitness, elevated central adiposity was associated with lower abdominal strength endurance and low cardio respiratory fitness, and high percentage of adipose mass is associated with low cardiorespiratory fitness. Overall, it is urgent to initiate surveillance and control programs of the physical activity in children to formulate intervention strategies from school to raise awareness and habits of the importance of physical activity as a key element in the development and maintenance of health of all individuals.

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