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Original Research

Relationships Among Metabolic-Risk, Body Fatness, and Muscular Fitness in Young Obese Latino Children

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ABSTRACT

International Journal of Exercise Science 13(3): 488-500, 2020. Given the high prevalence of obesity in Latino children and potential health risks, the purpose of this study was to: 1) evaluate relationships among metabolic-risk, fitness, and body fatness; 2) determine sex differences in cardio-metabolic risk factors and fitness of obese children of Latino descent. Sixty children (boys, $n = 39$, 7.8 ± 1.5 years; girls, $n = 21$, 7.2 ± 1.5 years; body mass index, 97.8 ± 2.5th percentile) completed assessments of height, weight, and body fat, prior to fasted blood draws and a battery of fitness tests. Cardio-metabolic markers were analyzed, and a metabolic risk score created. Correlations and regression analyses evaluated the relationships among body fatness, metabolic-risk, and fitness. Independent samples t-tests determined sex differences ($p < 0.05$). Body fat related negatively to lower body power ($p < 0.016$), but positively to upper body power ($p = 0.049$). After controlling for age and sex, body fat ($p < 0.001$) was a positive predictor of variance in metabolic-risk scores, ($R^2 = 0.39$, $p < 0.001$). Further, the association between body fat and metabolic-risk was not moderated by sex. Metabolic-risk scores and body fat were similar for both sexes, but boys performed better on muscular fitness tests, even after accounting for fat free mass ($p < 0.05$). Higher body fatness in obese Latino children may result in greater metabolic-risk and difficulty performing weight-bearing tasks. Therefore, culturally adapted weight management programs should employ a multifaceted approach to improve metabolic-risk and fitness.

KEY WORDS: Pediatric obesity, Hispanic, muscular strength, sex differences, body composition, blood pressure, cholesterol, body mass index

INTRODUCTION

Ethnicity minority children are disproportionally affected by obesity and associated co-morbidities. In fact, Latino children are 3-fold more likely to be obese compared to their white counterparts (27). The obesity levels of children can be influenced by culture, environment, behaviors, and low socioeconomic status (7). It is also well recognized that sedentary lifestyles in children can lead to obesity, cardiovascular disease, and metabolic syndrome (3, 16). There is also a strong negative association between aerobic fitness and emergent cardio-metabolic risk factors, indicating the need to obtain desirable cardiorespiratory fitness levels during childhood (28). Further, fat mass appears to mediate the association between cardiorespiratory fitness and various metabolic risk factors (2, 32). A more holistic view of cardio-metabolic health has been obtained from calculating a validated metabolic risk score through a combination of metabolic risk factors (12). However, the relationships among muscular fitness, fat mass, and metabolic risk remain understudied in younger children, as well as in ethnic minority populations.

Muscular fitness during childhood may be a predictor of metabolic syndrome in adulthood, (15) and other cardiorespiratory diseases (9, 11, 14). However, young children aged 6-11 years seem to exceed the physical activity guidelines of at least 60 minutes of moderate physical activity (18) regardless of ethnicity (3). Yet, after 11 years of age, physical activity significantly drops to about half the recommended guidelines (3) and according to a recent review, Hispanic populations have low rates of leisurely physical activity (33). Thus, the decline in physical activity across age ranges may be due to insufficient prerequisite levels of fitness and motor skills needed in order to encourage participation in sports teams or physical activities (23). Thus, it is highly recommended that neuromuscular deficiencies be evaluated and addressed early in life because stronger children may have a higher level of enjoyment and be better prepared for physical activity (14, 25). As children develop and their foundational movement abilities become more important as a requisite for physical activity, children who are at increased risk for not meeting fitness goals need to be identified. Recently, others have presented sex specific cut points to determine who may be at risk of cardiovascular disease in the future (8). Yet, it is unknown how motor skill performances of overweight/obese Latino children compare to these cut off values and whether sex differences in motor skill performances exist in this population.

Sex, low income, insufficient physical activity levels, and excess body fat have been associated with low fitness levels in youth (13, 35). Yet, Latino children remain understudied, and it is unknown whether or not sex differences exist in cardio-metabolic risk, muscular fitness, and body fatness. Thus, the purpose of this study was three-fold: 1) to describe cardio-metabolic risk factors and muscular fitness of children of Latino descent who are overweight and obese and of low socio-economic status; 2) to evaluate the association between body fat percentage and metabolic risk score and fitness level; 3) to determine if sex moderates the association between body fat percentage and metabolic risk score. The authors hypothesized the presence of cardio-metabolic risk-factors and that body fat percentage would explain part of the variation in metabolic risk with sex having no influence. Additionally, boys would excel in several fitness tasks, while the fitness level would be partially related to the extent of body fatness.

METHODS

Participants

A priori power analyses were conducted with G*POWER 3.1 (Universität Kiel, Germany) and determined the minimum participants needed in the present study to be 48 under the following parameters: power = 0.80; effect size = 0.25; alpha level = 0.05. Data were collected as part of a group-based pediatric weight management program which utilizes an evidence based, multidisciplinary and family-based approach to modify children's health behaviors.

Participants were recruited from health clinics, elementary schools, and community centers which serve low-income populations. Eligibility criteria included: self-reported Latino, prepubertal (aged 4-9 years, girls absent of menstrual cycle), age- and sex-specific body mass index (BMI) ≥ 85th percentile, no prior medical or behavioral diagnoses, and not regularly taking medication. Children arrived in the morning for the baseline assessment following an overnight fast. They completed anthropometric measurements and blood draws prior to receiving a light breakfast consisting of granola bars, fruit, and water. Following 15-30 minutes, the children completed 5 minutes of dynamic stretches prior to beginning fitness testing. For each exercise test, 1-3 practice trials were allowed for children to become familiar with the exercise. Blood draws and fitness tests (~20 minutes) were respectively administered by Registered Nurses and Certified Strength and Conditioning Specialists. The University Institutional Review Board for Human Subjects approved the study and all procedures. Parents provided informed consent and children assent prior to participation. All procedures complied to the ethics statements described in previous work (26).

Protocol

Height and weight were measured using a stadiometer (Seca 869, Hamburg, Germany) and scale (Tanita Corporation of America, Model SC-3315, Arlington Heights, IL), with shoes off, to the nearest 0.1 cm and 0.5kg, respectively. Body mass index (BMI, kg·m^2) was based on age and sex according to Center of Disease Control (CDC) growth charts. The age- and sex-based BMI z-scores and percentiles were calculated, to categorize children as overweight (BMI ≥ 85th to < 95th percentile) or obese (≥ 95th percentile). Body fat was assessed via foot-to-foot single frequency bioelectric impedance (Tanita Corporation of America, Model SC-331S, Arlington Heights, IL) while children stood upright with arms freely adducted, and bare feet on the footpads. Bioelectric impedance analysis works by sending a safe electrical signal from the footpads which is transmitted through hydrated lean tissue. The impedance, induced from fat tissue, is measured and combined with the anthropometric data to estimate body composition into two compartments (fat mass and fat free mass). The testing occurred following the overnight fast with instructions including minimum liquid intake, in attempt to control hydration status and obtain valid measures. Child's waist circumference was measured at the level of the umbilicus using non-stretchable tape. Physical characteristics are in Table 1.

Table 1. Physical characteristics of participants.

	Boys (*n* = 39)		Girls (*n* = 21)		
	Mean	CI$_{95\%}$	Mean	CI$_{95\%}$	*p*-value
Age (yrs)	7.77	(5.02, 10.52)	7.24	(4.27, 10.20)	0.179
Weight (kg)	44.79	(20.41, 69.17)	40.72	(20.83, 60.60)	0.204
Height (cm)	133.09	(113.96, 152.22)	130.19	(112.71, 147.66)	0.262
Body Mass Index (BMI)	24.91	(16.68, 33.14)	23.79	(16.51, 31.07)	0.308
BMI Z-Score	2.23	(1.28, 3.18)	2.10	(1.16, 3.05)	0.340
BMI %-ile	97.74	(91.55, 103.94)	97.14	(90.84, 103.44)	0.488
Waist Circumference (cm)	79.86	(58.39, 101.90)	77.01	(60.59, 93.44)	0.267
Body Fat Percent (%)	36.88	(21.21, 52.55)	36.55	(25.76, 47.33)	0.866

Average resting blood pressure was taken with an automatic sphygmomanometer (OMRON Healthcare Inc.). A fasted venous blood sample was collected for assessment of glucose and lipids (Cholestech LDX analyzer, Alere, Waltham, MA) and hemoglobin A1C (A1CNow+, PTS Diagnostics, Indianapolis, IN), and point-of-care analyses were completed within the first 5 minutes of blood withdrawal. Serum and plasma were separated and stored at -80 degrees Celsius for subsequent batch analysis of insulin (enzyme-linked immunosorbent assay (ELISA), 80-INSHU-E01.1, ALPCO, Salem, NH). Following blood draws, a light breakfast was provided prior to fitness measures.

A metabolic risk score was calculated based on a summary of the following metabolic risk factors: insulin, blood glucose, high density lipoprotein (HDL) cholesterol, triglycerides, waist circumference, and systolic and diastolic blood pressure. Standardized values (z-score) were independently obtained for all variables using the equation: standardized value = (original value – mean) / standard deviation. Due to low HDL levels being a high risk, the standardized HDL value was multiplied by -1 for proper representation in the metabolic risk score. To create a single blood pressure variable, mean arterial pressure was calculated: mean arterial pressure = ((2 x diastolic blood pressure) + systolic blood pressure) / 3. The sum of all six z-scores represented the metabolic risk score, with a higher score being unfavorable. These calculations were completed according to previous literature in children (5, 12).

Handgrip strength was used to assess maximal isometric strength via a standard hand-held digital dynamometer (JAMAR Plus, Sammons Preston, Bollingbrook, IL). The children were instructed to hold the dynamometer forward with a straight arm by having shoulders flexed (arms parallel to the floor), adducted and neutrally rotated. They were asked to squeeze the handle "as hard as possible" and were verbally encouraged through the 3-second trial. Three trials were allowed for each limb in alternating order, and the maximal value was used for analysis.

To evaluate lower body explosive strength, children completed a vertical jump and standing long jump. The vertical jump was performed on a jump mat that measures jump height from flight time (30). Children were instructed to use a countermovement of the legs, but to keep hands on hips and legs straight during the jump until landing. If the child tucked their legs in the air, the trial was nullified. The standing long jump was performed on a mat with measurement units and starting points displayed. Each child stood behind the line in a fully erect position and was instructed to quickly squat using a countermovement of their legs and arms to propel themselves ahead for maximal distance (10, 30, 34). For a trial to be valid, balance had to be maintained with both feet in constant contact with the floor upon landing. Measurements were taken from the heel of the trail leg. Three attempts were made on each test with the greatest score used for analysis.

To assess upper body explosive strength, the seated medicine ball throw was administered. The children were seated with the backside of their trunk flush with a wall. On the "go" command, the child lifted the medicine ball to chest height with arms extended followed immediately by a "basketball pass" style throwing motion. The instruction was to throw the ball (2kg) forward "as far as possible." Inflection of the hip and separation between the trunk and wall was prohibited. If the ball release height varied from the appropriate angle (approximately 45 degrees) or form was broken, an additional trial was attempted. The distance (cm) from the wall to the ball's initial contact with the ground was recorded for each trial and the highest greatest score was used for analysis (10, 21).

Two cones were placed ten meters apart. The children began at one cone and were instructed to run as fast as possible to the second cone, then return to the starting line. This was repeated once more to cover a total distance of 40 meters (4 x 10 meters) (30). They were instructed to touch the cone while crossing the line each time; however, if the child circled the cone, the trial was nullified and repeated following sufficient rest. Once the child crossed the finish line with one foot the trial was complete. Time was recorded using a stopwatch to the nearest 0.1 second.

Statistical Analysis

Summary statistics for baseline characteristics are reported as mean and 95% confidence intervals for continuous variables and n (%) for categorical variables. All data were normal, as indicated by Shapiro-Wilks analyses. Independent samples t-tests were run to determine differences between boys' and girls' metabolic risk factors, fitness tests, and body fatness. Pearson product moment correlations were used to determine relationships between cardio-metabolic measures, fitness tests, and body fatness (weak, $r < 0.3$; moderate, $r = 0.3$-0.6; strong, $r > 0.6$). A two-step hierarchical regression was used to examine the control and main effects of age, sex, and body fat percentage on metabolic risk score. In step 1, age and sex were entered as control variables. In step 2, body fat percentage was entered to determine its ability to predict metabolic risk after controlling for age and sex. To evaluate whether or not there was an interaction effect of sex and body fat percentage when predicting metabolic risk score, we used the PROCESS SPSS plug in developed by Hayes and Matthes (17). All analyses were computed using SPSS statistical software (IBM, version 24; Armonk, New York). Alpha level was set at $p < 0.05$.

RESULTS

Data from 60 children (Table 1) were included in this current analysis. Most parents were born in Central America (82%), predominately El Salvador (62%) and 67% of families reported combined family income < 185% of the federal poverty line. Cardio-metabolic measures are provided in Table 2. In the current study 90% of children were above the 95th percentiles of BMI. In accordance with Dyslipidemia criteria (20), 40% had high triglyceride levels (> 100 mg/dl), 17% had evidence of high LDL cholesterol levels (≥ 130 mg/dL), 40% had low HDL levels (<40 mg/dL), and 7% had high total cholesterol (≥ 200 mg/dL). Prediabetes was defined using both fasting blood glucose and A1C according to American Diabetes Association (1), and although 3% had impaired fasting glucose levels (100-125 mg/dl), 20% had prediabetic A1C levels (5.7-6.4%). Moreover, insulin levels were borderline high (15-20 µIU/mL) in 12% and high (> 20 µIU/mL) in 5% of the children, while 30% had systolic blood pressure in the pre-hypertensive range and 20% had diastolic blood pressure in the pre-hypertensive range (90-95th percentiles).

All cardio-metabolic measures were similar in boys and girls apart from HDL being greater in boys ($p = 0.021$).

Table 2. Cardio-metabolic measures of participants.

	Boys (n = 39)		Girls (n = 21)		
	Mean	$CI_{95\%}$	Mean	$CI_{95\%}$	*p*-value
Systolic Blood Pressure (mm Hg)	107.14	(83.52, 130.76)	103.62	(88.42, 118.81)	0.220
Diastolic Blood Pressure (mm Hg)	67.43	(45.18, 89.68)	68.15	(47.32, 88.98)	0.817
Triglycerides (mg/dL)	89.26	(10.59, 167.92)	114.90	(-2.88, 232.68)	0.096
Hemoglobin A1C (%)	5.31	(4.48, 6.13)	5.39	(4.62, 6.15)	0.495
Glucose (mg/dL)	91.55	(81.06, 102.04)	91.48	(81.86, 101.09)	0.957
Total Cholesterol (mg/dL)	162.61	(103.78, 221.43)	153.00	(96.35, 209.65)	0.238
High Density Lipoprotein (mg/dL)	107.91	(54.49, 161.33)	91.00	(50.51, 131.49)	0.021*
Low Density Lipoprotein (mg/dL)	44.11	(23.81, 64.40)	40.29	(21.44, 59.13)	0.710
Insulin (µIU/mL)	8.03	(-6.54, 22.59)	9.22	(-1.38, 19.81)	0.541
Metabolic Risk Score	-0.22	(-1.23, 0.78)	0.23	(-1.16, 1.63)	0.590

Note: *, indicates statistical significance ($p < 0.05$), Metabolic Risk Score: Sum of standardized values of insulin, blood glucose, high density lipoprotein cholesterol, triglycerides, waist circumference, and systolic and diastolic blood pressure.

Fitness assessments are provided in Table 3. In summary, boys covered more distance during standing long jumps ($p = 0.031$), had faster shuttle run times ($p = 0.017$), and greater seated medicine ball throws ($p < 0.001$) than girls. After accounting for fat free mass, boys' performances remained greater on the standing long jump ($p = 0.049$), shuttle run ($p = 0.019$), and seated medicine ball throw ($p < 0.001$).

Table 3. Fitness tests of participants presented as mean ($CI_{95\%}$).

	Boys (*n* = 39)		Girls (*n* = 21)		*p*-value
Vertical Jump (cm)	25.5	(13.9, 37.2)	22.5	(14.8, 30.3)	0.053
Standing Long Jump (cm)	101.8	(50.3, 153.3)	86.8	(41.9, 131.6)	0.031*
Speed Shuttle Run (s)	15.6	(10.8, 20.4)	17.1	(13.1, 21.2)	0.017*
Right Hand Grip Strength (kg)	12.6	(5.3, 19.9)	11.2	(5.9, 16.4)	0.121
Left Hand Grip Strength (kg)	11.8	(5.0, 18.7)	10.5	(4.9, 16.1)	0.138
Seated Medicine Ball Throw (cm)	219.5	(109.2, 329.8)	166.0	(85.6, 246.3)	< 0.001*

Note: *, indicates statistical significance ($p < 0.05$)

Relationships of cardio-metabolic measures, BMI, body fatness, biomarkers, and fitness tests are in Tables 4 and 5. Both BMI and body fat percentage were positively correlated to the metabolic risk score ($p < 0.001$).

Table 4. Correlations among metabolic risk factors, anthropometrics, and body fat percentage.

	Body Mass	Body Mass Index	Body Fat Percentage
Systolic Blood Pressure	0.350*	0.235	0.290*
Diastolic Blood Pressure	0.122	-0.082	0.058
Triglycerides	0.192	0.267*	0.162
A1C	0.277*	0.264*	0.308*
Glucose	0.291*	0.300*	0.198
Total Cholesterol	0.029	0.098	0.108
High Density Lipoprotein	-0.143	-0.198	-0.106
Low Density Lipoprotein	0.092	0.125	0.093
Insulin	0.690**	0.688**	0.592**
Metabolic Risk Score	0.678**	0.662**	0.531**

Note: *, indicates statistical significance at ($p < 0.05$); **, indicates statistical significance at ($p < 0.01$)

Table 5. Correlations among muscular fitness, anthropometrics, and body fat percentage.

	Body Mass	Body Mass Index	Body Fat Percentage
Vertical Jump	0.119	-0.159	-0.483**
Standing Long Jump	0.116	-0.102	-0.310*
Shuttle Run	-0.188	0.097	0.370**
Right Hand Grip Strength	0.409**	0.187	-0.093
Left Hand Grip Strength	0.362**	0.188	-0.106
Seated Medicine Ball Throw	0.674**	0.448**	0.255*

Note: *, indicates statistical significance at ($p < 0.05$); **, indicates statistical significance at ($p < 0.01$)

Model 1 of the regression analysis (age and sex) was not a significant predictor of metabolic risk score $F(2,42) = 2.510$, $R^2 = 0.107$, $p = 0.093$. In model 2, age ($B = 0.555$, $p < 0.010$) and body fat percentage ($B = 0.207$, $p < 0.001$) were significant positive predictors of the variance in metabolic risk scores, $\Delta F(1,41) = 19.186$, $\Delta R^2 = 0.285$, $p < 0.001$. Using model one of the PROCESS plug in revealed that the interaction between sex and body fat percentage ($t(42) = 0.5933$; $B = 0.07$; $p = 0.5561$) was not a significant predictor of metabolic risk score. Considering the lack of significant interaction effect, the slopes of the association between body fat and metabolic risk were no different between boys and girls (Figure 1).

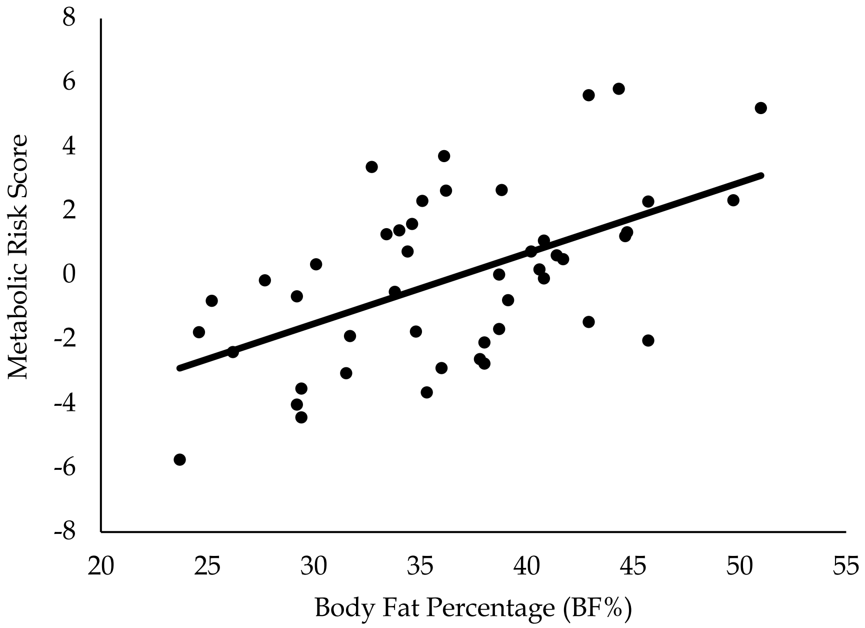

Figure 1. Multiple linear regression of body fat percentage to metabolic risk after controlling for age and sex (r2 = 0.45). The regression equation with standardized Beta coefficients is: y = -12.105 + 0.334(age) + 0.023(sex) + 0.535(BF%). The unstandardized coefficients equation is as follows: y = -12.105 + 0.555(age) + 0.123(sex) + 0.207(body fat percentage). Age (*p* = 0.010) and body fat percentage (*p* < 0.001) were significant predictors in the model, while sex was not (*p* = 0.855).

DISCUSSION

The purpose of this study, which evaluated obese children of Latino descent and low socioeconomic status, was to 1) describe cardio-metabolic risk factors and muscular fitness; 2) evaluate the association between body fat percentage and metabolic risk score and fitness level; 3) to determine sex differences. The main finding was that cardio-metabolic risk factors were already present in this young, low income, obese Latino childhood cohort and were positively related to body fatness regardless of age and sex. Further, the boys and girls did not differ in body size or metabolic risk, but boys did perform greater in some muscular fitness tasks.

Based upon triglyceride and HDL levels, 40% of children in the current study had dyslipidemia, 20% had prediabetic A1C levels, and 30% and 20% had systolic and diastolic blood pressure in the pre-hypertensive range, respectively. Comparing results from the current study to those of previous literature is challenging due to the underserved nature of this population, however, the cardio-metabolic measures in the current study appear consistent with prior findings in older obese Latino adolescents, highlighting the importance of early intervention. With the exception of total cholesterol, cardio-metabolic measures in the current study were comparable to those previously reported in normoglycemic obese Hispanic children aged 10-18 (6). In a group of normoglycemic Hispanic children aged 10-18 years, A1C, glucose, diastolic blood pressure, and cholesterol levels were similar between the lean and overweight groups, but systolic blood pressure and triglycerides were higher in the overweight group compared to the lean group (6). The cardio-metabolic profile was similar between boys and girls in the current study, although LDL cholesterol was higher in boys. In previous findings, Latino boys (11.1 ± 1.7 years) and girls (11.0 ± 1.8 years) had comparable fasting insulin levels but different blood glucose values (2). Although low mortality rates may exist in the Hispanic population compared to Caucasian counterparts, cardiovascular disease is more common and the leading cause for death in Hispanic populations (24), and while previous research has identified this risk in children, the present study is the first to do so with children younger than 10 years. Therefore, according to these findings, early intervention may be of great importance in attempt to prevent cardiovascular disease from developing in adulthood.

Interestingly, body fat may serve as a mediator in the association between cardiovascular fitness and metabolic health among Latino youth who are overweight/obese (2, 36). In the current study, BMI was associated with triglycerides, A1C, glucose, insulin, and metabolic risk score in this homogenous sample of obese Latino children. Furthermore, A1C, insulin, systolic blood pressure, and metabolic risk score were positively related to body fat percentage. Body fat percentage also explained 39.2% of the variance in metabolic risk scores after controlling for age and sex. Therefore, children with higher body fat percentage would have seemingly greater metabolic risk, regardless of the child's sex. It is recommended these children participate in physical activities of moderate-vigorous intensity, not only for the direct effects on metabolic health, but also for the indirect benefit of reduced body fat (19).

Prior to performing physical activities with youth, a strategic plan may need to be implemented to promote consistent participation. A major finding of the current study is the relationship of body fatness to fitness parameters; such that, tests requiring the carrying of body weight were negatively influenced by body fat percentage. These findings are in support of others who found increased adiposity or BMI to create difficulty for children when performing motor tasks that require vertical loading on the body, such as running (20 meter dash, hurdle run)(4, 10, 21, 38) and jumping tasks (standing long jump and vertical jump)(10, 38). Further, the boys in the current study had better performances in the standing long jump, shuttle run, and seated medicine ball throw, which is in agreement with previous findings (22). After controlling for fat free mass, the sex differences in fitness assessments remained, which may suggest neuromuscular differences. Thus, it may be particularly beneficial for young girls to focus upon physical activity practices with an emphasis upon high-intensity neuromuscular activities (i.e. sprinting, jumping). To increase the adherence of obese children to exercise programs, it is recommended to consider the difficulty of performing weight baring tasks when designing exercise programs.

Upper extremity, non-weight-bearing, tasks were either unrelated (i.e. handgrip strength) or positively related (i.e. seated medicine ball throw) to body fatness, which supports previous findings on the lack of relationship between handgrip strength and body fatness, (31) as well as the positive relationship between body mass and handgrip strength (10). It has been suggested that the greater strength in obese children can be explained by increased fat-free mass due to the muscular requirement to carry the excess body mass as adiposity increases (10). Therefore, it is reasonable to suggest non-weight bearing activities or resistance-training be included in intervention programs for obese children.

Although further research is necessary, recently published findings support the association of muscular fitness with metabolic risk factors, independent of cardiovascular fitness (15). Recent research in children has reported cut points for grip strength and standing long jump tests, such that individuals below the cut points have shown increased cardiovascular risk scores two years later (8). When comparing the current data to the aforementioned cut points, 32 of 39 boys (82%) and 14 of 21 girls (67%) fell below the hand grip strength cut point, while 19 of 39 boys (48%) and 10 of 21 girls (48%) fell below the standing long jump cut point. These findings lend support to the notion that muscular fitness intervention programs may prove useful in the fight against cardiovascular disease in youth. However, as previously mentioned, body fatness has a direct influence on metabolic risk factors after controlling for age and sex. Therefore, intervention programs may require a multidisciplinary approach with emphasis on reducing the body fatness and increasing the muscular fitness levels of children.

A potential for low levels of physical activity within populations of low socioeconomic status and minority backgrounds is the absence of available facilities that promote fitness while being affordable (29). However, in terms of obesity, some have found no evidence of income, parental education, or diet to relate to the higher prevalence of obesity in Hispanic children and suggest that other factors such as genes may be pertinent (37). Therefore, a critical need exists for preventative and culturally adapted weight management programs for Latino populations as indicated by the cardio-metabolic risk factors present in this young childhood cohort. Moreover, the children's metabolic risk was positively related to body fatness, independent of age and sex, affirming the importance of reducing body fatness. Aside from metabolic risk, body fatness may hinder children's ability to perform well in movements requiring them to overcome their body mass but may excel in non-weight-bearing tasks. Therefore, the use of a multifaceted approach, which includes weight management and neuromuscular training, is recommended. For these populations with low socioeconomic status, it is crucial to make affordable programs which promote physical activity available.

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