AEROBIC FITNESS AMONG CAUCASIAN, AFRICAN-AMERICAN, AND LATINO YOUTH

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Objective: The prevalence of obesity and related comorbidities has dramatically increased in the pediatric population in recent years, and youth from ethnic minorities appear to be disproportionately affected. Although several factors play a role in these ethnic health disparities, evidence suggests fitness may also be an important mediator of disease risk in children. Therefore, the purpose of the present investigation was to compare aerobic fitness (VO_{2peak}) in healthy Caucasian (C), African-American (AA), and Latino (L) youth and to evaluate differences after controlling for gender, maturational stage, and body composition.

Measures: Seventy-three healthy boys and girls [C (n=18), AA (n=19), and L (n=36)] aged 7–14 years participated in the study. VO_{2peak} was evaluated using an all-out, progressive treadmill protocol, total body composition was estimated via dual-energy x-ray absorptiometry, and ethnicity was determined via parental questionnaire.

Results: VO_{2peak} relative to total body mass (mL/kg/min) was significantly lower in Latinos compared to either Caucasian or African-American children. Further, after controlling for gender, maturational stage, and body composition, L (1.68 ± 0.05 L/min) and AA (1.57 ± 0.05 L/min) youth had significantly lower VO_{2peak} compared to C (1.84 ± 0.04 L/min; P<.05) children.

Conclusion: These results suggest that Latino and African-American children have lower aerobic fitness levels than Caucasian children and this effect is independent of gender, maturation, and body composition. (*Ethn Dis*. 2006;16:120–125)

Key Words: Adolescents, Body Composition, Children, Ethnicity, Fitness, Peak VO_2

INTRODUCTION

Obesity is one of the most pressing public health challenges in the pediatric population, and it disproportionately affects youth from ethnic minority groups, such as African Americans and Latinos. The prevalence of overweight (BMI ≥95th percentile) among all youth has dramatically increased in recent years; the most recent national survey reported rates of 20.5% among African Americans, 22.2% among Latinos, and 13.6% among non-Latino Whites age 6–19 years.[1] Coupled with the increased prevalence of overweight in boys and girls from minority populations is an increased risk of metabolic comorbidities such as the metabolic syndrome, impaired glucose tolerance, and type 2 diabetes.[2–4] Youth from certain ethnic groups, including African Americans and Latinos, are at increased health risk. While a number of lifestyle factors likely play roles in this trend of increasing adiposity, it has recently been shown in a biracial (African-American and Caucasian) longitudinal study that aerobic fitness predicts increasing fat mass in youth.[5] Given that a higher degree of physical fitness provides health benefits (at least among adults) for normal-weight and overweight individuals alike,[6] arriving at a greater understanding of aerobic fitness levels, especially among different ethnic groups who may be at increased health risk, is of great public health interest.

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Numerous studies in children and adults (both untrained and trained) demonstrate that individuals of African descent have reduced aerobic fitness levels compared to Caucasians.[7–11] Presently, little information is available regarding aerobic fitness levels among Latinos, and more specifically Latino youth, and how they compare to children from other ethnic groups. According to the US Census Bureau, Latinos are the fastest growing minority group in the United States; thus investigations including this group of at-risk youth are of great public health concern.[12] Therefore, the purpose of the present investigation was to examine aerobic fitness levels in a group of Caucasian, African-American, and Latino youth and to compare fitness levels after controlling for the potential confounding effects of gender, maturation, and body composition.

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METHODS

Participants

Seventy-three healthy Caucasian (n=18), African-American (n=19), and Latino (n=36) children 7–14 years of age were invited to participate in the current investigation. The present analysis on 73 children represents a subsample of youth from a larger cohort who either had all relevant data collected (ie, fitness, body composition, and Tanner stage) and/or were of nonmixed ethnic descent (see ethnicity criteria below). Children were recruited from the greater Los Angeles area by use of flyers, advertisements, and word of mouth and were excluded if they were taking medications known to affect body composition or physical activity or were diagnosed with Cushing syndrome, Down syndrome, type 1 or 2 diabetes, or hypothyroidism. This study was approved by the University of Southern California Institutional Review Board on the Health Sciences Campus. Informed written consent and assent were obtained prior to testing from all parents and children, respectively.

Procedure

Upon arrival, children were admitted to the USC General Clinical Research Center. Ethnicity was determined by parental self-report; all four grandparents were identified as the same ethnicity as the child. A complete medical history and examination was performed by a physician and included the assessment of maturational stage according to the criteria of Marshal and Tanner.[13]

Anthropometry and Body Composition

Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer, and weight was measured to the nearest 0.1 kg by using a medical balance beam scale. Total body composition was determined by dual-energy x-ray absorptiometry (Hologic QDR 4500W; Bedford, Mass).

Cardiovascular Fitness

Children completed an all-out, progressive, treadmill test to exhaustion as previously described.[14] Briefly, after being familiarized with the equipment, participants practiced walking on the motorized treadmill until they were able to walk without holding the railings. Once comfortable, the children walked for 4 min at 0% grade at 4 km/hour, after which the treadmill grade was raised to 10%. Each ensuing work level lasted 2 minutes, during which the grade was increased by 2.5%. The speed remained constant until a 22.5% grade was reached; beyond that point, speed increased by 0.6 km/hour every 2 minutes until the subject reached exhaustion. Respiratory gasses were collected and measured with open circuit spirometry and analyzed on a MedGraphics CardiO_2 combined exercise system (St. Paul, Minn). Heart rate was measured continuously throughout the test with a Polar Vantage XL heart rate monitor (Port Washington, NY). VO_{2peak}, peak RER, and peak heart rate were established at the point when each participant refused to continue the exercise test despite continued verbal encouragement from research staff. In order to include the entire cohort in the fitness data analysis, VO_{2peak} data were used in lieu of VO_{2max}, as VO_{2peak} represents a maximal index of aerobic fitness in children,[15,16] and generally a substantial proportion of children are unable to meet objective criteria for maximal effort.[17]

Fitness Data Expression

Cardiovascular fitness is a general term often used to characterize an individual's performance during a standardized exercise test or protocol. The highest amount of oxygen consumed relative to some index of body size (eg, VO_2 divided by total body mass) is typically the primary outcome measure. Much debate exists surrounding appropriate units of expression when comparing individuals of varying body composition, stature, and age. For this reason, we present cardiovascular fitness data in three ways: 1) expressed as the ratio of the volume of oxygen consumed per minute relative to total body mass (mL/kg/min); 2) expressed as the ratio of the volume of oxygen consumed per minute relative to total fat-free mass (mL/kg/FFM/min); and 3) expressed in absolute terms (L/min) after statistically adjusting for gender, Tanner stage, and body composition. The latter method provides a means of comparing fitness data across groups which is independent of the variables adjusted for.[18]

Statistical Analysis

Ethnic differences in physical characteristics, body composition, and unadjusted peak fitness data were examined with analysis of variance. Fitness differences (adjusted for gender, Tanner stage, and body composition) were analyzed with analysis of covariance. All pairwise analyses included Bonferonni adjustments for multiple comparisons. Variables that were not normally distributed were log transformed (ie, $VO_{2peak,}$ total fat mass, total fat-free mass, percent body fat). Untransformed data are presented for ease of interpretation. All statistical analyses were performed by using SPSS for Windows (v. 11.0; SPSS Inc, Chicago, Ill). Significance level for all tests was set at $P<.05$.

RESULTS

Descriptive characteristics for the three ethnic groups are shown in Table 1. All groups were similar in age, Tanner stage, height, weight, and body mass index (BMI). In addition, body composition (total fat mass and total fat-free mass) was similar across all ethnic subgroups. An overall trend towards significance for percent body fat was observed, but pairwise comparisons of individual ethnicities did not reveal any significant between-group differences.

Table 1. Descriptive physical characteristics

Variable	Caucasian *n*=18	African-American *n*=19	Latino *n*=36	ANOVA (*P* value)
Gender (boy/girl)	(12/6)	(8/11)	(21/15)	
Age (years)	10.6 ± 1.8	10.7 ± 1.9	10.3 ± 2.1	NS
Tanner stage (*n*)				
1	12	9	25	
2	4	2	2	
3	2	4	4	
4	0	3	4	
5	0	1	1	
Height (m)	1.42 ± 0.1	1.45 ± 0.1	1.42 ± 0.1	NS
Weight (kg)	41.9 ± 15.0	48.6 ± 18.7	49.0 ± 20.1	NS
BMI (kg/m^2)	20.1 ± 4.5	22.4 ± 6.0	23.2 ± 6.1	NS
Total lean mass (kg)	28.5 ± 7.8	32.9 ± 9.2	30.7 ± 10.3	NS
Total fat mass (kg)	11.4 ± 7.5	13.4 ± 9.6	16.1 ± 10.4	NS
Body fat (%)	25.1 ± 9.5	24.8 ± 9.9	30.4 ± 9.6	.055

All values are means ± standard deviation.
NS=not significant; BMI=body mass index; ANOVA=analysis of variance.

A summary of the peak fitness data is displayed in Table 2. No significant effect of ethnicity was observed for peak heart rate or RER. Latino children exhibited lower VO_{2peak} relative to total body mass (mL/kg/min) than Caucasian youth, and a trend was observed for African-American youth to have lower VO_{2peak} compared to Caucasians (P=.07). No significant differences were found between Latinos and African Americans. VO_{2peak} relative to fat-free mass (mL/kg-FFM/min) was significantly lower in both Latinos and African Americans compared to their Caucasian counterparts; no between-group differences were noted when comparing Latino and African-American children.

In addition, a model was constructed to adjust for several covariates (ie, gender, Tanner stage, and body composition) known to influence aerobic fitness in youth. These data are illustrated in Figure 1. No significant group differences were observed between Latinos and African Americans when peak VO_2 data were analyzed. However, Caucasian children exhibited significantly higher VO_{2peak} levels compared to both African Americans and Latinos.

DISCUSSION

The purpose of this investigation was to compare aerobic fitness between Caucasian, African-American, and Latino youth. We found that, after controlling for gender, maturational stage, and body composition, African-American and Latino children had significantly lower VO_{2peak} compared to Caucasian children. These findings are in accordance with previous work in youth that compared fitness levels of African Americans to Caucasians.[9,14,17] The inclusion of Latino children in the present analyses expands the current knowledge on fitness as it relates to children of different ethnic groups.

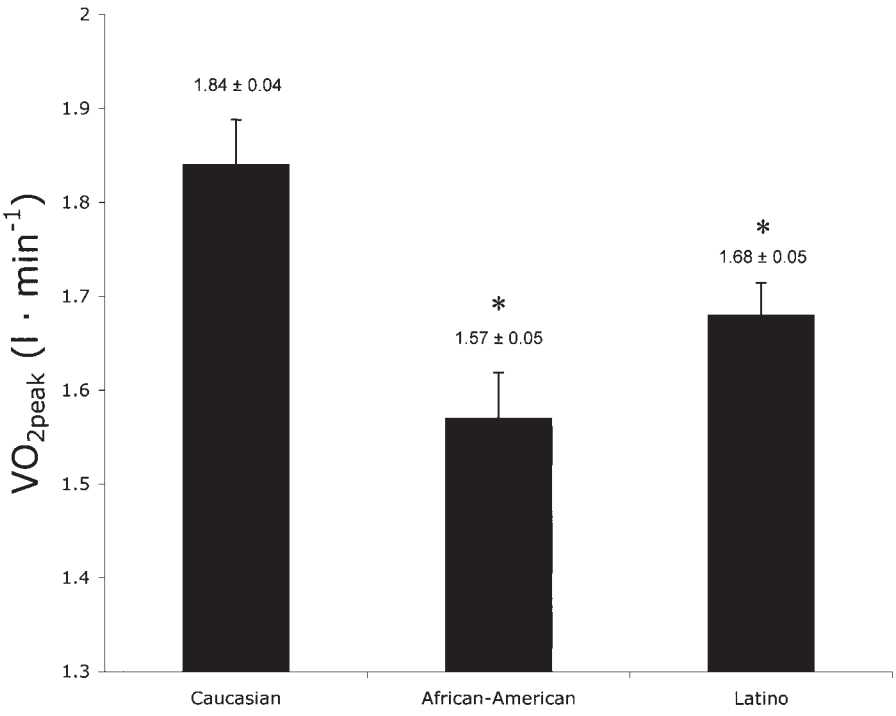
We have previously demonstrated that prepubertal African-American children have a lower (≈15%) maximal aerobic capacity (VO_{2max}) compared to their Caucasian peers.[14] Differences between African Americans and Caucasians were found regarding absolute VO_{2max}, which persisted after adjusting for soft lean tissue mass, fat mass, total energy expenditure, and/or physical activity-related energy expenditure. Pivarnik and colleagues[9] noted a similar ethnic difference with African-American adolescent girls exhibiting lower relative VO_{2max} than Caucasian girls (31.8 ± 5.8 mL/kg/min vs 38.5 ± 6.8 mL/kg/min), respectively. They also demonstrated that African Americans had a lower ability to use oxygen during maximal exercise at a given fat-free mass. The authors suggested that the decreased ability to use oxygen for

Table 2. Peak fitness data for Caucasian, African-American, and Latino youth

	Caucasian *n*=18	African-American *n*=19	Latino *n*=36	*P* value
Peak HR (bpm)	196 ± 10	191 ± 12	191 ± 16	NS
Peak RER	1.12 ± 0.09	1.10 ± 0.08	1.08 ± 0.10	NS
VO_{2peak} (L/min)	1.77 ± 0.47	1.69 ± 0.46	1.66 ± 0.61	NS
VO_{2peak} (mL/kg/min)	43.9 ± 8.6	36.9 ± 9.4	35.2 ± 9.2	C>AA, *P*=.07 C>L, *P*=.005
VO_{2peak} (mL/kg-FFM/min)	62.3 ± 6.2	52.0 ± 9.5	53.7 ± 8.1	C>AA, *P*=.001 C>L, *P*=.001
Treadmill time to VO_{2peak} (min)	10.5 ± 1.8	9.7 ± 2.2	11.2 ± 3.7	NS

Values are means ± standard deviation.
HR=heart rate; bpm=beats per minute); RER=respiratory exchange ratio; VO_2=volume of oxygen consumed; FFM=fat-free mass; NS=not significant; C=Caucasian; AA=African-American; L=Latino.

We found that, after controlling for gender, maturational stage, and body composition, African-American and Latino children had significantly lower VO_{2peak} compared to Caucasian children.



Data are means ± SEM after controlling for gender, Tanner stage, and body composition.

*P < 0.05 Caucasian compared to African-American or Latino.

Fig 1. Adjusted fitness levels in Caucasian, African-American and Latino youth.

a given fat-free mass might be an indication of a reduced metabolic function of the fat-free mass in the African-American girls compared to the Caucasian girls. Furthermore, in a longitudinal study of 2500 youth, McMurray et al[19] found African Americans to have a lower predicted VO_{2max} relative to body weight when compared to Caucasian youth. They attributed the difference to the increased fat mass of the African-American participants but did not statistically control for differences in lean tissue mass or body composition.

Presently, little information is available regarding aerobic fitness levels among Latino youth and how they compare to boys and girls from other ethnic groups. Finkenberg and DiNucci[20] examined the health-related physical fitness status of 10- to 14-year-old Caucasian, African-American, and Latino students in a rural Texas school. Researchers used the timed mile run component of the American Alliance of Physical Education, Recreation, and Dance Physical Best test as an estimate of aerobic fitness and observed the mean times of African Americans to be higher than either the Caucasian or Latino children. The increased time to completion of the mile run in the African-American children may be an indication of reduced fitness levels in this subgroup; no differences were found between the Caucasian and Latino children. Recently, Beets and Pitetti[21] explored the relationship between ethnicity and cardiovascular fitness in a large sample of California youth. The authors analyzed performance scores for the one-mile run/walk test administered as part of a state mandated test of physical performance. The final analysis included >750,000 children 10–15 years of age. Children were stratified by gender and age, and fitness scores were adjusted for height and weight. The results revealed that across every age group (regardless of gender), African-American and Latino children had significantly lower fitness scores compared to their Caucasian peers. Although the authors could not accurately control for body composition or maturation, these data are in agreement with the findings of our investigation.

To date, only one other study has investigated differences in aerobic fitness among children of Caucasian, African-American, and Latino ethnicity by using a maximal treadmill test and expired gasses while controlling for accurate measures of body composition. Treuth and colleagues[22] explored physical activity and fitness differences in normal-weight Caucasian, African-American, and Latino pre-pubertal girls. After adjusting for fat mass and fat-free mass, VO_{2peak} in African-American girls tended to be lower than both the Caucasian and Latina girls, but differences did not reach the level of significance. However, the study population was limited to normal-weight prepubertal girls; therefore the inclusion of a broader range of children (in terms of gender, degree of adiposity, and maturation) in the present investigation may partially explain the different findings.

Ethnic differences in VO_{2peak} may reflect physiologic variations in skeletal muscle properties related to whole body oxygen uptake. Recently, Hunter et al[7] examined whether racial differences in hemoglobin concentrations and muscle aerobic capacity were related to the reduced fitness (VO_{2max}) observed in African-American women compared to Caucasians. Their findings indicated that African-American women displayed both a lower hemoglobin concentration and reduced muscle oxidative capacity

(using ^{31}P magnetic resonance spectroscopy) compared to Caucasians, and that these differences contributed independently and significantly to overall differences in VO_{2max}. Ama et al observed less type I oxidative skeletal muscle fibers and more type IIa muscle fibers in muscle biopsies of African-American sedentary males compared to their Caucasian counterparts.[23] Collectively, the ethnic differences in muscle oxidative capacity, hemoglobin concentrations, and skeletal muscle fiber type may be contributory mechanisms for the reduced whole-body fitness levels observed in African Americans compared to Caucasians. Although data regarding skeletal muscle oxidative capacity and muscle fiber type are limited in the pediatric population, evidence does suggest that children of African-American heritage have lower hemoglobin concentrations compared to Caucasians.[9,24] Lower hemoglobin concentrations may partially explain lower fitness levels in this minority group due to reduced oxygen transport and extraction from the blood to the working muscles. However, the present study population is tri-ethnic, so we are hesitant to infer that similar differences existed in our sample. Further, ethnic differences in aerobic fitness are likely multifactorial, with potentially different explanatory mechanisms for various ethnic groups.

The strengths of our study include a direct measure of VO_{2peak}, accurate determination of body composition, and physician assessment of maturational stage. We acknowledge several limitations of this study. First, the cohort studied was comprised primarily of children from the greater Los Angeles area and hence may not be representative of a national sample. Furthermore, accurate physical activity data on the boys and girls may have aided in the explanation of the observed fitness differences between groups. Although ethnic differences in the exercise patterns of children have been reported in the literature,[25] the correlation between fitness and habitual physical activity in children is generally low[26] and thus may not be a determinant of fitness differences in pediatric populations.

In summary, these data indicate that the African-American and Latino youth in the current investigation exhibit lower levels of aerobic fitness compared to their Caucasian peers. Further studies are necessary to investigate the physiologic mechanisms contributing to this difference and what the long-term health implications may be. This information may be helpful in developing appropriate treatment and prevention strategies for minority populations of youth at increased disease risk.

ACKNOWLEDGMENTS

The authors gratefully acknowledge all of the children and their families who participated in this investigation. This study was supported by the National Institutes of Health (MIG: R01 HD/HL 33064), and in part by the General Clinical Research Center, National Center for Research Resources, Grant # MO1 RR 00043.

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Acquisition of funding: Goran
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