The Relationship between Socioeconomic Status, Family Income, and Measures of Muscular and Cardiorespiratory Fitness in Colombian Schoolchildren

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Objective To determine the associations between socioeconomic status (SES) and physical fitness in a sample of Colombian youth.

Study design Prueba SER is cross-sectional survey of schoolchildren in Bogota, Colombia. Mass, stature, muscular fitness (standing long-jump, handgrip), and cardiorespiratory fitness (20-m shuttle run) were measured in 52 187 schoolchildren 14-16 years of age. Area-level SES was categorized from 1 (very low) to 4 (high) and parent-reported family income was categorized as low, middle, or high.

Results Converting measures into z scores showed stature, muscular, and cardiorespiratory fitness were significantly (z = 0.3-0.7) below European values. Children in the mid- and high SES groups jumped significantly further than groups with very low SES. Differences were independent of sex but became nonsignificant when adjusted for anthropometric differences. Participants in the mid-SES and high-SES groups had better handgrip scores when adjusted for body dimension. There were, however, no significant between-group differences in cardiorespiratory fitness, which was strongly clustered by school and significantly greater in students from private schools.

Conclusions Area-level SES is associated with measures of muscular fitness in Colombian schoolchildren. These associations were largely explained by the large differences in body dimensions observed between SES groups. When area-level SES is considered, there was no evidence that family income influenced fitness. The clustering of outcomes reaffirms the potential importance of schools and area-level factors in promoting fitness through opportunities for physical activity. Interventions implemented in schools, can improve academic attainment; a factor likely to be important in promoting the social mobility of children from poorer families. *(J Pediatr 2017;185:81-7).*

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The negative gradient between socioeconomic status (SES) and prevalence of noncommunicable disease in adulthood has prompted investigation of potential foundations based in childhood.[1] Because children rarely present with clinical manifestations of chronic disease, risk factors that track from early life into adulthood are used as surrogate indicators future health status.[1,2] Excess adiposity and poor physical fitness and low cardiorespiratory or muscular fitness in particular are associated independently with poor cardiometabolic health in children.[2] Fluctuations in fitness predominantly are the result of changes in habitual physical activity, modulated by genetic and early life (epigenetic) factors.

The relatively poor tracking of physical activity from childhood into adulthood hampers attempts to determine the associations between childhood physical activity and adult health.[3] Compared with physical activity, physical fitness is a more potent indicator of cardiometabolic health status,[2-4] which also tracks more strongly from childhood into adulthood.[3]

Children from families with high and middle SES designations tend to perform better on physical fitness tests than those from low SES backgrounds.[5-7] Reports of the association between SES and fitness appear to vary according to the method of fitness assessment[8] and the classification of SES[9] used. Far less is known of the association between SES and fitness in low- to middle-income countries.[10] Petroski et al[10] found Brazilian children from families of low SES were 40% less likely to meet criterion-referenced standards for multicomponent fitness. Urban-dwelling youth from Ecuador[11] and Chile[12] were found to be fitter than those from rural

BMI	Body mass index
SES	Socioeconomic status
SISBEN	System of Identifying Potential Beneficiaries of Social Programs

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Supported by Secretary of Education District of Bogotá-SED (300-2014) and University of Rosario (671-2014). The content of this report reflects the authors' views alone, and the Colombian Community or the Universidad del Rosario is not liable for any use that may be made of the information contained herein. The authors declare no conflicts of interest.

http://dx.doi.org10.1016/j.jpeds.2016.12.058

areas. Because there are greater concentrations of higher SES neighborhoods within urban areas in both countries, these data also suggest a positive association between SES and physical fitness. In contrast, a recent report on Colombian children and adolescents found that greater SES was associated with a lower handgrip strength.[13]

Much of Latin America is undergoing a change in nutritional habits with associated reductions in population-level physical activity.[13] In high-income countries, low SES is a recognized risk factor for childhood and adult obesity. In transitional countries, residents of high SES neighborhoods commonly adopt "Westernized lifestyles,"[11,12] which can have negative as well as positive impacts on health through changes in physical activity, body composition, and fitness.

The primary aim of this study was, therefore, to determine whether physical fitness is associated with SES in a large sample of schoolchildren from the district of Bogota, Colombia, a rapidly developing high-middle income country, and whether any associations were independent of any differences in body size identified between SES groups. Second, we aimed to determine whether fitness was associated with family income and other sociogeographic factors and whether associations were independent of SES and differences in body size.

Methods

This was a cross-sectional survey of ninth grade students participating in the 2015 "40 × 40 Curriculum" and Prueba SER Survey,[14] administered by the District Secretary of Education in November 2015. Participants were recruited from public and private schools in all 20 "localidades" (municipalities) within the District Capital of Bogota (Cundinamarca Department, Andean Region of Colombia). This is a predominantly urban area with 7 862 277 inhabitants[4] between 2500 and 3250 m above sea level. The Review Committee for Research Human Subjects at the University of Rosario (Code no. CEI-ABN026-000262) approved the study. The nature and purpose of the study were communicated to potential participants and their parents or guardians, with the explanation that data would be available to the Colombian Health Authorities in accordance with the Law of Data Protection (Resolution 8430/93).

Data were collected in schools by 20 teams of trained researchers (n = 6 per team). Before data collection, researchers completed 6 theoretical and practical training sessions to standardize the assessment process and to minimize interobserver variability.

Anthropometric Measurements

All assessments were performed between 7:00 a.m. and 10:00 a.m., following an overnight fast. During all anthropometric measurements, students wore light clothing and were barefoot. During body mass measurements, the student stood on the scale for 5 seconds with feet hip-width apart. Mass was measured to the nearest 0.1 kg. During standing height (stature) measurement, the student stood with heels together and heels touching the base of the stadiometer and head positioned in the Frankfort plane with eyes looking straight ahead. Stature was measured to the nearest 0.1 cm. Decimal age was calculated by subtraction of participants' date of birth from the LMSgrowth macro (Harlow Healthcare, Tyne & Wear, United Kingdom),[15] and body mass, stature, and body mass index (BMI) were expressed as z scores based on global reference date.[16] BMI was classified as underweight, normal weight, overweight, or obese by use of the criteria of the International Obesity Task Force.[17]

Physical Fitness

The test protocols used are appropriate for use in this age group in and have acceptable levels of validity[8] and reliability.[9] We used standing long-jump (Jump) to assess lower body muscular fitness. Students were instructed to jump as far as possible using a 2-footed takeoff and landing technique. They were encouraged to flex then extend their knees, ankles, and hips and to swing their arms to maximize performance. Jump performance was calculated as the distance between the toes at takeoff to the heels at the landing point. The best score from 2 correctly performed jumps was used.

We used isometric handgrip dynamometry (Handgrip) as an indicator of upper-body muscular fitness with an adjustable analog handgrip dynamometer T-18 TKK SMEDLY III (Takei Scientific Instruments Co, Ltd, Niigata, Japan). Students watched a brief demonstration of technique and were given verbal instructions on how to perform the test. If necessary, the dynamometer was adjusted according to the child's hand size according to predetermined protocols. Monthly, each dynamometer was tested via a standardized calibration procedure that showed that the device was within 1 kg of accuracy over the whole measuring range (from 0 to 100 kg), and with a 100-g sensitivity.

Cardiorespiratory fitness was assessed with the 20-m shuttle-run test as described by Ortega et al.[2] Participants ran between 2 lines 20 m apart in time with prerecorded signals. The initial speed of 8.5 $km \cdot h^{-1}$ increased by 0.5 $km \cdot h^{-1}$ each minute, and the test was terminated when participants failed to reach the end lines (keep pace) on 2 consecutive occasions or when the subject stopped due to volitional fatigue. The protocol tends to elicit a maximal response in children and adolescents, irrespective of which criterion results in termination of the test.[2] Performance was reported as running speed ($km \cdot h^{-1}$) at the final completed stage. Valid cases were those with valid data for Jump, Handgrip, and accompanying anthropometric and demographic information.

We removed 83 participants because of missing age data or invalid birth date. A further 168 cases were removed because of missing data for either mass or stature; 437 cases because of missing Handgrip; and 1758 because of missing or invalid Jump data. We rejected a further 1265 cases identified as duplicates (identical school roll number and name). The final sample with complete anthropometric and muscular fitness analysis comprised 52 204 participants age 15 (±1) years, of whom 51 % (n = 26 630) were male. These data were expressed as continuous z scores based on a combination reference data[18-20] to provide reference values for the entire age range. There are no agreed-on criterion references standards