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Cross-sectional epidemiological study

Low handgrip strength levels among adolescents in a city in southern Brazil

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ABSTRACT

Objective: To estimate the prevalence of low handgrip strength (HGS) levels and sociodemographic characteristics, health behaviours and body fatness status related in adolescents.
Method: Cross-sectional epidemiological study with 636 adolescents aged 14–19 years in a city in southern Brazil. HGS was measured by dynamometer. Sociodemographic and behavioural data were collected using self-report questionnaires. Body mass and height was measured by Body Mass Index.
Results: Prevalence of low HGS levels was 47% (63.5% boys, 37.7% girls). Boys aged 14–16 years were more likely to have low HGS levels. Girls who were of higher socioeconomic status and who were less physically active were more likely to have low HGS levels. Overweight girls were less likely to have low HGS levels.
Conclusions: High prevalence of low HGS levels was observed in adolescents. Increased HGS levels should be focused on younger boys and normal-weight girls with higher socioeconomic status and lower levels of physical activity.

1. Introduction

Muscle strength is considered to be an important component of physical fitness related to health, regardless of age and clinical condition (Cohen et al., 2014; Ortega et al., 2012). Low muscle strength levels are directly associated with high blood pressure, higher concentrations of triglycerides and elevated C-reactive protein levels (Cohen et al., 2014). In contrast, high muscle strength levels are associated with lower risk of premature mortality from cardiovascular disease in adolescence and adulthood, regardless of body mass index (BMI) and blood pressure (Ortega et al., 2012).

Among the ways of assessing muscle strength, handgrip strength (HGS) is used as an indicator of muscle strength in clinical studies and physical fitness batteries (Cohen et al., 2014; Ruiz et al., 2011). HGS level is a measurement technique that is both accurate and noninvasive (Leong et al., 2015). Thus, Low handgrip strength levels, besides causing limitations related to the loss of physical function, is associated with increased health recovery time after illness or surgery, malnutrition, type II diabetes, cardiovascular complications and overall mortality (Leong et al., 2015; Montalcini et al., 2013). Previous researchers have tested HGS levels in adolescents, but they did not use cutoffs to classify the strength scores obtained (Artaria, 2010; Cohen et al., 2014; Ortega et al., 2012; Phadke et al., 2014; Valter Filho et al., 2014), making it difficult to compare the findings. Among these, a study with schoolchildren aged 8–14 years in Colombia aimed at identifying the association between muscular strength and metabolic risk factors in adolescents found that participants classified in the first quartile of HGS (weaker) were three times more likely (OR: 3.00; 95% CI: 1.81–4.95) to present cardiometabolic risk compared to those

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classified in the last quartile (stronger) (Cohen et al., 2014). A study conducted with adolescents aged 15–19 years in Canada using cutoff points for the classification of HGS scores based on beneficial health areas, reported a prevalence of low HGS levels at 59% for boys and 47% for girls (Tremblay et al., 2010). In addition to the high prevalence of low HGS levels, the authors demonstrated a decrease in strength scores during the period from 1981 to 2008 in this population (Tremblay et al., 2010).

Epidemiological studies have shown a progression of strength levels from 6 to 19 years of age in both sexes, with higher values for males in all age groups (Artaria, 2010; Tremblay et al., 2010). Body fatness status was also found to be associated with muscle strength levels, with overweight adolescents having lower levels of HGS compared to those of normal weight (Leena et al., 2014). Moreover, aspects related to economic status (economic level and family head schooling) and physical activity have been studied to deepen understanding of the factors that influence muscle strength (Artaria, 2010; Jiménez-Pavón et al., 2010; Matsudo et al., 2014; Valter Filho et al., 2014).

Most studies aimed at identifying factors related to HGS in adolescents did not include criteria associated with health problems to categorize HGS (Artaria, 2010; Cohen et al., 2014; Ortega et al., 2012; Valter Filho et al., 2014). Thus, the present study differs from others by using cutoff points for adolescents in relation to beneficial health zones to classify them in terms of HGS. In addition, the identification of factors related to HGS levels in adolescents is useful for planning strategies and actions to minimize low strength levels (Valter Filho et al., 2014). The aim of this study was to estimate the prevalence of low HGS levels and the association with the sociodemographic characteristics (age, economic status, family head schooling), health behaviours (physical activity and eating habits) and body fatness status in adolescents from a city in southern Brazil.

2. Material and methods

2.1. Design

This epidemiological cross-sectional analytical study was conducted in the second half of 2007 in the city of Florianopolis, Santa Catarina, Brazil (IBGE, 2011).

2.1.1. Procedures for sample calculation

The sample design included public school selection, which was determined in two stages based on 1) stratification by geographic region and 2) class conglomerates. In the first stage, the city was divided into five geographical regions: downtown, continent, east, north and south. The largest schools in each region in terms of number of students were selected. In each school, sufficient classes to achieve representativeness of the geographical area were selected. In the second stage, all adolescents who were present in the classroom on the day of data collection were invited to participate in the study.

For the sample size calculation, a(n) unknown prevalence for the outcome (50%), tolerable error of 5 percentage points, 95% confidence interval and design effect of 1.5 were adopted, with 10% added to account for possible losses and refusals. Thus, it was necessary to evaluate 634 students. Due to the characteristics of the sampling process, which involved all individuals belonging to conglomerates, the sample comprised 636 adolescents. The calculation with these parameters was performed using the statistics software package Epi Info version 3.4.1 (Atlanta, USA).

2.1.2. Eligibility criteria

For this investigation, eligible participants were students enrolled in state schools who were present in the classroom on the day of data collection. The exclusion criteria were (a) age below 14 years and above 19 years and (b) pregnancy. Adolescents who refused to participate were classified as refusals.

2.1.3. Ethical issues

The study was approved by the Ethics Committee on Human Research of the Federal University of Santa Catarina (Opinion No. 372/2006). All adolescents surveyed returned the Informed Consent Form signed by their parents (younger than 18 years of age) or that they signed themselves (18 years of age).

2.1.4. Sociodemographic and anthropometric variables

The following sociodemographic and anthropometric data were obtained: sex (male and female); age (collected and subsequently categorized into 14–16 years and 17–19 years); schooling of the head of household ($\leq$8 years and >8 full years); economic level (high and low); body mass (kg); height (cm); and BMI (kg/m^2).

2.2. Procedures

2.2.1. Strength measurement

The dependent variable was HGS, which was measured according to the recommendations of the Canadian Society of Exercise Physiology (2004). The test was performed with participants in the standing position with their arms extended beside their body. Strength was measured in three repetitions while alternating the limb evaluated, starting with the right hand and, shortly thereafter, switching to the left hand. The time interval between one attempt and another was one minute to limit muscular fatigue (Firrell and Crain, 1996). At each measurement, a maximum hold was performed for five seconds. The highest value of the three attempts to the right and to the left side was considered. To determine the overall score, the highest values of the right and the left hand were summed. To evaluate physical ability, a Jamar® (Indiana, USA) manual dynamometer, which has a strength scale in pounds and/or kilograms was utilized. Male and female adolescents were classified as having adequate or inadequate (low) levels of HGS health (Physiology, 2004). The cutoff points used in this study, which vary according to sex and age, were suggested by the Canadian Society of Exercise Physiology (2004). Based on the ages of the adolescents in this study, total score values $\geq$ 90 kg for males and $\geq$53 kg for females were considered to be adequate HGS levels. Values below those described above were considered to be low HGS levels.

2.2.2. Economic measurement

Economic level was identified in accordance with the recommendations of the Brazilian Association of Research Companies (Brazil, 2006), which employs a system of scores that together serve to divide the Brazilian population into economic classes, according to their purchasing power. The five classes, “A”, “B”, “C”, “D” and “E”, are ordered from greatest to lowest purchasing power. Upon inspection of the preliminary frequency distribution, classes “A” and “B” were collapsed and called high, whereas classes “C”, “D”, and “E” were collapsed and called low.

2.2.3. Lifestyle measurements

Information on physical activity level was collected via the short version of the International Physical Activity Questionnaire (IPAQ). This instrument was considered to be appropriate for use with Brazilian adolescents (Guedes et al.), with rho = 0.59 for reproducibility and rho = 0.29 for validity in recall of daily activities (Bouchard et al., 1983). Adolescents who engaged in physical activities of moderate and/or vigorous intensity for fewer than 300 min per week were considered to be a little physically active.