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Original Article

Associations Between Sedentary Time, Physical Activity, and Dual-Energy X-ray Absorptiometry Measures of Total Body, Android, and Gynoid Fat Mass in Children

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Abstract

Negative health outcomes are associated with excess body fat, low levels of physical activity (PA), and high sedentary time (ST). Relationships between PA, ST, and body fat distribution, including android and gynoid fat, assessed using dual-energy X-ray absorptiometry (DXA) have not been measured in children. The purpose of this study was to test associations between levels of activity and body composition in children and to evaluate if levels of activity predict body composition by DXA and by body mass index percentile in a similar manner. PA, ST, and body composition from 87 children (8.8–11.8 yr, grades 3–5, 44 boys) were used to test the association among study variables. Accelerometers measured PA and ST. Body composition measured by DXA included bone mineral content (BMC) and fat and lean mass of the total body (TB, less head), android, and gynoid regions. ST (range: 409–685 min/wk) was positively associated with TB percent fat (0.03, 95% confidence interval [CI]: 0.00–0.05) and android fat mass (1.5 g, 95% CI: 0.4–3.0), and inversely associated with the lean mass of the TB (−10.7 g, 95% CI: −20.8 to −0.63) and gynoid regions (−2.2 g, 95% CI: −4.3 to −0.2), and with BMC (−0.43 g, 95% CI: 0.77–0.09). Moderate-to-vigorous PA was associated with lower TB (−53 g, 95% CI: −87 to −18), android (−5 g, 95% CI: −8 to −2]), and gynoid fat (−6 g, 95% CI: −11 to −0.5). Vigorous activity results were similar. Light PA was associated with increased TB (17.1 g, 95% CI: 3.0–31.3) and gynoid lean mass (3.9 g, 95% CI: 1.0–6.8) and BMC (0.59 g, 95% CI: 0.10–1.07). In boys, there were significant associations between activity and DXA percent body fat measures that were not found with the body mass index percentile. Objective measures of PA were inversely associated with TB, android, and gynoid fat, whereas ST was directly associated with TB percent fat and, in particular, android fat. Activity levels predict body composition measures by DXA and, in particular, android fat distribution.

Key Words: Android fat; body composition; gynoid fat; physical activity; sedentary time.

Introduction

Body composition changes as children age. Specifically, average percent body fat has been shown to increase between the ages of 8 and 14 yr in both males and females *(1)*. However, health complications related to excess body fat are known to be associated with the distribution pattern of fat in the body more so than the amount of body fat *(2)*. Android fat, located around the trunk of the body, has greater associations with metabolic dysfunctions than gynoid fat, which deposits around the hips and thighs. A recent longitudinal study found young adults with high cardiometabolic risk to have greater trunk fat mass as early as 8 yr of age *(3)*. Children 6–19 yr of age with higher waist circumferences had higher metabolic risk scores, but those with higher amounts of moderate-to-vigorous physical activity (MVPA) had lower scores *(4)*. In general, studies in children show physical activity (PA) to be inversely related

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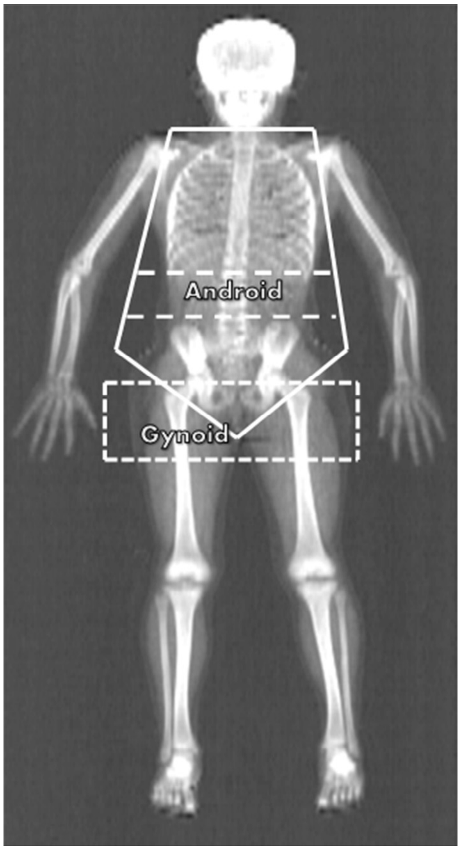

Fig. 1. Approximate android and gynoid regions for Hologic whole-body images. The solid white borders represent the trunk region—all boundaries were positioned by the operator. Android region—the lower boundary is positioned by the operator at the pelvic cut line, while the upper boundary is positioned by the software at 20% of the distance from the pelvic cut line to the neck cut line. Gynoid region—boundaries are positioned by the software. The upper boundary is below the horizontal cut line at a distance 1.5 times the height of the android region box. The lower boundary is positioned below the upper gynoid boundary at a distance 2.0 times the height of the android region box.

and sedentary time (ST) to be directly related with weight and fatness *(5–8)*. ST can be measured objectively using accelerometers, and fat and lean mass can be estimated from whole-body scans obtained using dual-energy X-ray absorptiometry (DXA). Current software (Hologic APEX 3.0; Hologic, Inc., Bedford, MA) has the ability to analyze fat and lean mass of android and gynoid regions (Fig. 1).

Limited studies in children have measured activity using accelerometers in conjunction with body fat measured by DXA *(9–12)*, and we found no studies reporting associations between ST measured by accelerometers and body fat, specifically android and gynoid body fat measured by DXA. Therefore, the purpose of the present study was to test associations between levels of activity measured using accelerometers and body composition including android and gynoid regions measured by DXA in children.

We hypothesized that higher amounts of time spent in MVPA and vigorous physical activity (VPA) would be associated with lower total body (TB), android, and gynoid fat mass and higher lean mass in these compartments. Likewise, higher amounts of ST would be associated with higher TB, android, and gynoid fat mass and lower lean mass. In addition to examining these hypotheses, we evaluated if PA and ST can be used to predict android and gynoid fat and lean mass assessed by DXA, and if similar associations would be found between activity level and body mass index (BMI) percentile.

Methods

The present study was cross-sectional in design and girls and boys in grades 3–5 were recruited from 2 area schools. Letters informing parents of the study and consent forms were sent home with the children. Signed consent was obtained from both the parent and the child. There were no exclusion criteria for participation. The study was approved by the South Dakota State University Institutional Review Board.

Height was measured to the nearest 0.5 cm in duplicate using a portable stadiometer (SECA Model 225; SECA, Hanover, MD), and was repeated if measurements differed by more than 0.5 cm. Weight was recorded to the nearest 0.1 kg using a digital scale (SECA Model 770) in light clothing while shoes were removed. BMI (kg/m^2) was calculated using measured height and weight and plotted on sex-specific Centers for Disease Control and Prevention BMI-for-age growth charts to obtain the BMI percentile.

PA and ST were assessed using ActiGraph accelerometers (G3TX+; ActiGraph LLC, Pensacola, FL). Accelerometers were initialized using the manufacturer's software to collect raw data at a sampling rate of 30 Hz. Accelerometers were positioned on the right hip and attached to the participant by means of an elastic belt. Children were instructed to wear the belt during all waking hours, with the exception of times when the instrument could come in contact with water.

Following 7 d of PA assessment, accelerometer data were downloaded and integrated into 10-s epochs. Using SAS (version 9.3; SAS Institute, Cary, NC), data from each participant were screened to identify children who did not meet the minimum standard for wear time compliance. Compliance standards required that children wear the accelerometer for at least 3 valid weekdays and 1 valid weekend day. One day was considered valid if the child had a minimum of 10 h of wear time during waking hours (7:30 a.m.–9:30 p.m.). Nonwear time was defined as at least 60 consecutive minutes of 0 activity counts. Age-appropriate activity count cut points developed by Evenson et al *(13)* were linearly scaled to accommodate 10-s epochs and were used to quantify daily minutes of ST, light physical activ-