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Body Composition Indices and Single and Clustered Cardiovascular Disease Risk Factors in Adolescents: Providing Clinical-Based Cut-Points

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ABSTRACT

The aims of the present study in adolescents were 1) to examine how various body composition-screening tests relate to single and clustered cardiovascular disease (CVD) risk factors, 2) to examine how lean mass and body fatness (independently of each other) relate to clustered CVD risk factors, and 3) to calculate specific thresholds for body composition indices associated with an unhealthier clustered CVD risk. We measured 1089 European adolescents (46.7% boys, 12.5–17.49 years) in 2006–2007. CVD risk factors included: systolic blood pressure, maximum oxygen uptake, homeostasis model assessment, C-reactive

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protein (n = 748), total cholesterol/high density lipoprotein cholesterol and triglycerides. Body composition indices included: height, body mass index (BMI), lean mass, the sum of four skinfolds, central/peripheral skinfolds, waist circumference (WC), waist-to-height ratio (WHtR) and waist-to-hip ratio (WHR). Most body composition indices are associated with single CVD risk factors. The sum of four skinfolds, WHtR, BMI, WC and lean mass are strong and positively associated with clustered CVD risk. Interestingly, lean mass is positively associated with clustered CVD risk independently of body fatness in girls. Moderate and highly accurate thresholds for the sum of four skinfolds, WHtR, BMI, WC and lean mass are associated with an unhealthier clustered CVD risk (all AUC > 0.773). In conclusion, our results support an association between most of the assessed body composition indices and single and clustered CVD risk factors. In addition, lean mass (independent of body fatness) is positively associated with clustered CVD risk in girls, which is a novel finding that helps to understand why an index such as BMI is a good index of CVD risk but a bad index of adiposity. Moderate to highly accurate thresholds for body composition indices associated with a healthier clustered CVD risk were found. Further studies with a longitudinal design are needed to confirm these findings.

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Cardiovascular (CV) diseases (CVD) usually occur during adulthood although it might have its origin already in childhood or adolescence.[1,2] Some body composition indices seem to predict CVD risk and are recommended as possible screening tools in the absence of other CV risk measures.

From a methodological perspective, clustering of CVD risk factors seems to be a much stronger measure of CV health than single risk factors in children, as a subject with CVD risk may present high levels of several risk factors simultaneously.[3] There is controversy as to which body composition indices are the best when screening youths and adults for cardio metabolic risk, with some studies suggesting the use of body mass index (BMI) or body fat (BF) percentage (%).[4] while others suggesting waist circumference (WC) and skinfolds.[5]

Most research to date has focused in finding an association between CVD risk factors and adiposity. However, little research has included lean mass (independent of BF) as a possible body composition index associated with single CVD risk factors[6] and no one has focused on understanding the association between lean mass and clustered CVD risk factors. Recently, several lines of evidence have also implicated chronic inflammation in CVD and, some inflammatory markers, such as C-reactive protein (CRP) have received much attention since elevated serum CRP concentrations have been associated with CVD risk.[7,8] As a consequence, its use to predict CVD risk has been supported.[9]

Therefore, the aims of the present study in adolescents are 1) to examine how various body composition-screening tests relate to single and clustered CVD risk factors, 2) to examine how lean mass and BF (independently of each other) relate to clustered CVD risk factors, and 3) to calculate specific thresholds for body composition indices associated with an unhealthier clustered CVD risk.

Methods

Study design and study sample

The current report is based on data derived from the Healthy Lifestyle in Europe by Nutrition in Adolescence cross-sectional study (HELENA-CSS). Participants were recruited at schools in 10 European cities: Stockholm (Sweden), Athens and Heraklion (Greece), Rome (Italy), Zaragoza (Spain), Pecs (Hungary), Ghent (Belgium), Lille (France), Dortmund (Germany) and Vienna (Austria). To ensure that the heterogeneity of social background of the population would be represented, schools were randomly selected after stratification by school zone or district. In cases where the selected schools refused to participate, a second list of substitute schools had already been drawn up. Up to three classes from two grades were selected per school. A class was considered eligible if the participation rate was at least 70%. Detailed descriptions of the HELENA sampling and recruitment approaches, standardization and harmonization processes, data collection, analysis strategies, quality control activities and inclusion criteria have been described in detail elsewhere.[10] An extended and detailed manual of operations was designed for and thoroughly read by every researcher involved in the field work before data collection started.

Data collection took place between October 2006 and December 2007 and the age range considered valid for the HELENA study was 12.5–17.49 years (n = 3528). One-third of the school classes were randomly selected in each center for blood collection, resulting in a total of 1089 adolescents. However, valid data for CRP were only available in 748 adolescents. In order to make a better use of the data, sample sizes may vary depending on the outcome since the study samples did not differ in sex distribution, mean age and mean BMI from the whole HELENA sample (all $p > 0.05$).

The study was approved by the Research Ethics Committees of each city involved (for most this was the country's ministry of health) and was performed following the ethical guidelines of the Declaration of Helsinki, 1961 (revision of Edinburgh 2000).[11] We obtained written informed consent from the parents of the adolescents and the adolescents themselves.

Blood pressure (BP)

Systolic BP (SBP) has been consistently used as an individual CVD risk factor in youths.[12,13] We measured SBP with an automatic

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