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Validity of body mass index in determining prevalence of overweight and obesity among Syrian late adolescents boys

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ABSTRACT

Obesity is rising among adults and children worldwide, including populations living in developing countries. The published data related to Syria are insufficient to address this issue. Therefore, the aim of this study is to determine the prevalence of overweight and obesity, and to determine appropriate cut-off points of the body mass index (BMI) for defining overweight and obesity among Syrian adolescents. We record body weight (kg), height (m^2), and body mass index (kg/m^2). The total body fat mass (BFM) was determined by deuterium oxide dilution (DD). The total sample was used in a split-sample internal cross-validation. The BMI was integrated to multiple regressions and Bland and Altman's procedure was used to analyze the data. Receiver operating characteristics (ROC) curve was drawn to determine appropriate cut-off points of the BMI for defining overweight and obesity. The prevalence of overweight and obesity was 24.5% by BMI and 46.5% by body fat content. Receiver operating characteristics (ROC) curve analysis defined a BMI of 22.34 kg/m^2 as a cut-off for overweight with sensitivity of 84.0%, 80.9% specificity, and BMI of 24.71 kg/m^2 with 82.80% sensitivity and 93.0% specificity for obesity. The results of our study suggest lower BMI cut-offs for overweight and obesity in Syrian population than those of recommended by WHO.

1. Introduction

Overweight and obesity is caused fundamentally by chronic quantitative imbalance between the energy intake and energy expenditure leading to excessive accumulation of adipose tissue within the body (Veldhuis et al., 2012). Prevalence estimates for overweight and obesity reached 1.4 billion adults over the past 20 years, with obesity alone covering over 10% of the world population (WHO, 2013). It is estimated that about one-fifth of the world population is overweight and about 300 million people are obese (Sahani, Chakrabarty, & Bharati, 2010). Over the past two decades, the prevalence of obesity has risen within developed countries (Pouliou & Elliot, 2010), e.g., developing countries in the Asia-Pacific region (Sahani et al., 2010), Middle East countries (Cherkaoui Dekkaki et al., 2011; Ma et al., 2011), and in China (Memari, Kordi, Ziaee, & Mirfazeli, 2012). The Middle East region is experiencing some of the greatest challenges (Bessesen, 2008). Somewhat more recently, many developing countries have undergone epidemiologic and demographic transitions affecting their population's nutritional status and have created environments that contribute to an increase in obesity, a health problem that often co-exists with under nutrition in these types of nations (Amani & Boustani, 2008; Galal, 2003; Salazar et al., 2006).

Anthropometric measurements such as weight, height, and body mass index (BMI) are widely used worldwide as growth indicators in childhood and adolescence (WHO,

Abbreviations: BMI, body mass index; FFM, free fat mass; FM, fat mass; BF, body fat; DDT, deuterium dilation technology; TBW, total body water; ROC, receiver operating characteristics; EHN, European Heart Network; WHO, World Health Organization; CDCP, Centers of Disease Control Prevention; AUC, area under the curve; IDECG, International Dietary Energy Consultancy Group.

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2011, 2013). BMI is widely used to define cut-off thresholds for overweight or obesity and there is a large literature on relations between BMI and measures of body fat (Baratta, Degano, Leonardi, Vigneri, & Frittitta, 2006). These cut-off thresholds are based primarily on European data, but it is known that Polynesian adults of the same body size as Europeans have higher fat free mass (FFM) and lower fat mass (Rush, Plank, Laulu, & Robinson, 1997).

According to the World Health Organization (WHO) and the Centers of Disease Control and Prevention (CDCP), overweight and obesity are defined by a BMI of 25–29.9 kg/m^2 and ≥30 kg/m^2, respectively (CDC, 2011; WHO, 2011). Several studies have raised the suspicion that the BMI cut-off for overweight as defined by the WHO may not adequately reflect the actual overweight status (Kesavachandran, Bihari, & Mathur, 2012). However, for different populations around the world, the use of these BMI cut-offs has been questioned as these do not correlate well with the percentage for both fat and other risks. As a result, for example, recommendations for Asians are lower than western populations for overweight BMI ≥23 kg/m^2 and for obesity BMI ≥25 kg/m (Sharma, 2013).

Little or no research has been done on the prevalence of overweight and obesity among Syrian adolescents. To our knowledge, no study has previously been undertaken in Syria for adolescents or other groups. Therefore, the present study aims to determine the prevalence of overweight and obesity in Damascus city, an area in southern Syria, using body mass index (BMI) and using reference method (DD) to determine appropriate cut-off points of the BMI for defining overweight and obesity among Syrian adolescents.

2. Research materials and procedures

2.1. Stydy design

A cross-sectional anthropometric study was carried out according to the International Biological Program and World Health Organization (WHO) (Rakic, Bozic-Kestic, & Pavlica, 2011) in the period of 2010–2011.

2.2. Subjects

We randomly selected 2470 apparently healthy 18- to 19-year-old boys, who will serve in the army following a medical exam in the medical army center in Damascus city. Subjects were excluded if they were suffering from acute illness that would have produced abnormalities in body composition. Subjects were asked to abstain completely from consuming food and drink in the 12 h before visiting the laboratory. Fasting was performed for all subjects (213 subjects) that were included in deuterium dilution tests. All anthropometry measurements and sampling were completed during a single visit to the testing area. Anthropometric and deuterium dilution measurements were carried out by trained staff—a professional who specialized in both in anthropometry and deuterium dilution technique subjects. The study protocol was approved by the Scientific Research and the Ethical Committee of the Atomic Energy Commission of Syria (AECS). Each participant provided informed consent prior to participation after a detailed explanation of the study protocol. This study was performed in accordance with the guidelines prescribed by the Helsinki Declaration of the World Medical Association.

2.3. Anthropometry measurements

Body weight in light clothing was measured with electronic scales (Seca, Model: 7671321004; Germany; D = 0.05–0.1 kg). The accuracy of the scales was confirmed using weight of known mass (20 kg). Height was measured to the nearest 0.5 cm with a wall-mounted stadiometer (Seca, Model: 225 1721009; Germany) and without wearing shoes. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared (BMI kg/m^2).

2.4. Deuterium dilution

Total body water (TBW) was determined by deuterium dilution according to plateau method (Coward, 1990). TBW was assessed by deuterium dilution measured with mass spectroscopy (IDECG, 1990) with the use of dose equivalent to 0.05 g D_2O/kg^{-1} body weight (99.8% atom present excess; Cambridge Isotope (D_2O). laboratories, Inc., United Kingdom). Saliva samples were taken before the administration of the dose to each subject after 6–12 h of fasting and 3–4 h·after the dose administration. Absorbent salivates (Sarstedt, Rommelsdorf, Germany) were used to collect the saliva. Saliva samples were analyzed by using Isoprime Ratio Mass Spectrometry (IRMS, GV Instrument). The values obtained were expressed relative to secondary standards (low-enrichment and high-enrichment standard water were similarly prepared to normalize data against V-SMOW-SLAP-GISP, Vienna Standard Mean Ocean Water/Standard Light Antarctic Precipitation/Greenland Ice Sheet Perception). All samples were prepared and analyzed in triplicate. The mean SD deuterium analyzed was <2%. The equation used for the calculation of deuterium dilution space (N) was as follows (Halliday & Miler, 1977):
$N = (TA/a) \times ((E_a - E_t)/(E_s - E_p))$.

where, A is the amount of isotope given in grams, a is the portion of the dose in grams retained for mass spectrometer analysis, T is the amount of tap water in which the portion of a is diluted before analysis, and E_a, E_t, E_p, and E_s are the isotopic enrichments in delta units of the portion of dose, the tap water used, the pre-dose saliva sample, and the post-dose saliva sample, respectively. The deuterium dilution space was assumed to overestimate TBW by a factor of 1.04 (Forbes, 1987). Fat free mass (FFM) was calculated from TBW, assuming that FFM has a hydration constant of 0.73 (Pace & Rathburn, 1945). Fat mass was calculated as scale weight minus FFM.

2.5. Diagnosis criteria

Body mass index (BMI) ≥25 kg/m^2 was classified as overweight and ≥30 kg/m^2 as obese (WHO, 2011).