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ORIGINAL ARTICLE

Large differences in the prevalence of normal weight obesity using various cut-offs for excess body fat

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Summary
Background & aims: Normal weight obesity (NWO) has been defined as an excessive body fat (BF) associated with a normal body mass index (BMI). Still, little is known regarding the effect of differing cut-offs for %BF on the prevalence of NWO. We thus conducted a study to assess the effect of modifying the cut-offs for excessive %BF on the prevalence of NWO.
Methods: We examined a convenience sample of 1523 Portuguese adults. BF was measured by validated hand-held bioimpedance. NWO was defined as a BMI $< 25\ kg/m^2$ and a %BF $>30\%$ or according to sex- and age-specific %BF cut-offs.
Results: Prevalence of NWO was 10.1% in women and 3.2% in men. In women, prevalence of NWO increased considerably with age, and virtually all women aged over 55 with a BMI $< 25\ kg/m^2$ were actually considered as NWO. Using sex-specific cut-offs for BF (men: 29.1%; women: 37.2%) led to moderately lower prevalence of NWO in women. Using sex- and age-specific cut-offs for %BF considerably decreased the prevalence of NWO in women, i.e. 0.5–2.5% (depending on the criterion) but not in men, i.e. 1.9–3.4%.
Conclusions: In women, the prevalence of NWO varies considerably according to the cut-off used to define excess BF, whereas a much smaller variation is found in men. While further studies are needed to describe the risk associated with NWO using various %BF cut-offs, this study suggests that sex- and age-specific cut-offs may be preferred.

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Introduction

Recently, a new syndrome named normal weight obesity (NWO) has attracted much attention. This syndrome is defined as a normal body mass index (BMI) associated with a large proportion of body fat (BF).[1] Subjects with NWO were shown to have an unfavorable lipid[1] and inflammatory[2] profile compared to normal weight non-obese subjects.

To our knowledge, there is little published information on the prevalence of NWO in the general population. Moreover, it is unclear which BF percentage cut-off should be considered as excessive and used to define NWO. In previous studies,[1,2] a BF above 30% was used whatever the age and sex. However, the proportion of BF changes with age and sex.[3,4] No study on the effect of varying cut-offs for the proportion of BF on the prevalence of NWO has been conducted. In this perspective, we used the data from a cross-sectional study conducted in Lisbon to compare the prevalence of NWO using various cut-offs to define excessive BF: (1) a single cut-off for both sexes and all ages; (2) sex-specific age-independent cut-offs; and (3) sex- and age-specific cut-offs.

Methods

Sampling

Between 2002 and 2005, four series of free screening campaigns on cardiovascular heart risk factors were conducted in Lisbon, Portugal. Those campaigns took place in trade fairs, malls and public open spaces. Subjects were invited to have their height, weight, blood pressure and body composition measured, after which a summary health report was generated and information leaflets on healthy eating and physical activity were provided. Participation was voluntary and anonymous. All measurements were conducted by trained interviewers.

Measurements

Body weight and height were measured with participants standing without shoes and after removing all heavy clothes and emptying their pockets. Body weight was measured in kilograms to the nearest 100 g using an electronic Seca® scale (Hamburg, Germany). Height was measured to the nearest 5 mm using a Seca® height gauge (Hamburg, Germany). Body mass index (BMI) was defined as weight/height.[2] Percentage of body fat (BF) was assessed by bioelectrical impedance using a bipolar hand-held device (Omron BF-300®, Omron, Japan).[5] Omron BF-300® apparatuses have been used in other studies relating BF with disease[6,7] and have been shown to be reliable by comparison to dual energy X-ray absorption[5]; still, some authors have shown that the Omron BF-300® tends to slightly underestimate BF by 0.9–1.1%.[8] In this study, duplicate measurements were performed and the average was used for calculations; duplicate measurements showed a very good reproducibility ($r = 0.98$).

Normal weight obesity (NWO) was first defined as a BMI < 25 kg/m^2 and a %BF > 30% as proposed previously.[1,2] In addition, sex- and age-specific cut-offs for %BF were also used to define NWO, namely (1) fixed sex-specific values (29.1% in men and 37.2% in women), obtained by tetrapolar bioimpedance analysis (BIA) and proposed in NHANES,[9] (2) sex- and age-specific values, obtained by DEXA and derived from an international study (for white men: 26, 29 and 31% for ages 20–39, 40–59 and 60–79, respectively; the corresponding values for white women being 39, 41 and 43%),[4] and (3) sex- and age-specific 95th percentile, obtained by tetrapolar BIA and derived from the results of a study conducted in Switzerland (for men: 26.8, 28.7 and 32.6% for ages 25–34, 45–54 and 65–74, respectively; corresponding values for women being 35.4, 36.5 and 44.4%).[3]

Statistical analysis

Statistical analysis was conducted using SAS version 9.1 (SAS Institute, Cary, U.S.A.) for Windows. Categorical variables were expressed as number and (percentage); continuous variables were expressed as mean $\pm$ standard deviation. Comparisons were performed using Chi-square for categorical data and analysis of variance for continuous data. Prevalence of NWO was assessed (1) in the overall sample and (2) among subjects with a BMI < 25 kg/m^2. Statistical significance was considered for $p < 0.05$.

Results

A total of 1523 subjects (648 men and 875 women, mean age 38 ± 17 years) had anthropometric and body fat data. Women presented with higher %BF than men ($p < 0.001$) and an increase of %BF with age was noted in both sexes (Table 1). In the overall sample, using the threshold of 30% for BF led to a prevalence of NWO of 10.1% in women and 3.2% in men ($p < 0.001$, Table 1). Prevalence of NWO increased with age in both sexes. Using a sex-specific %BF cut-off led to a moderately lower prevalence of NWO in women. When sex- and age-specific %BF cut-offs were used, the prevalence of NWO decreased in both sexes and became lower in women than in men (Table 1).

When the analysis was restricted to subjects with a BMI < 25 kg/m^2, the proportion of NWO varied 20-fold (between 0.7 and 15%) in women according to the cut-off used (Table 2). Indeed, almost all women aged over 65 and two thirds of women aged between 45 and 65 with a BMI < 25 kg/m^2 had NWO when using the >30% cut-off. Using sex-specific %BF cut-offs, a majority of older men and women with a BMI < 25 kg/m^2 were still classified as NWO. The proportion was much lower when sex- and age-specific %BF cut-offs were used (Table 2). Among men with a BMI < 25 kg/m^2, the proportion of NWO varied only between 3.9 and 6.9% and the different %BF cut-offs used led to more consistent results within each age group (Table 2).

Discussion

There is little information regarding the prevalence of NWO in the general population. In agreement with other studies,[3,4] we found a higher %BF in women compared to men and that %BF increased with age. Using a fixed cut-off of