Thesis

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Human body composition: reference data and anthropometric equations, the metabolic syndrome and risk

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Aims

The aims of this thesis were: (I) to establish population-based gender- and age-specific reference data with respect to dual-energy X-ray absorptiometry (DEXA)-determined body composition; (II) to examine whether individual rather than fixed total body potassium/fat-free mass (TBK/FFM) ratios could improve FFM determinations; (III) to establish and validate optimal weight-for-height indices for prediction of body fat; and (IV) to analyse associations between three definitions of the metabolic syndrome and mortality and atherosclerotic morbidity.

Subjects and methods

The study groups of all four parts of this thesis were randomly selected participants of the cross-sectional Swedish Obese Subjects (SOS) reference study including 524 men and 611 women, 37–61 years of age. The study sample of part III also included 149 obese men and women (30–58 years) from the XENical in the prevention of Diabetes in Obese Subjects (XENDOS) study. Body mass index (BMI) ranged from 17.6 to 46.1 kg m^{-2}.

Body composition was measured by DEXA and TBK was determined by whole-body counting of the potassium-40 isotope. Anthropometric measurements performed were: height, weight, waist and hip circumference and sagittal trunk diameter. Biochemical analyses were diabetes and cardiovascular risk factors and hepatic function tests. Systolic and diastolic blood pressures were also measured in each individual.

Results and discussion

I: Dual-energy X-ray absorptiometry-determined reference data

There was a linear relationship between DEXA-determined body fat (kg) and BMI in men, while a weak non-linear relationship was found in women (1). Relative body fat was non-linearly related to BMI in both men and women. At BMI 25 kg m^{-2}, relative and (absolute body) fat was 24% (19 kg) in men and 36% (25 kg) in women. Waist circumference was 90 cm in men and 85 cm in women, and sagittal trunk diameter was 21 cm in men and 19 cm in women.

During the sampling period (August 1994 to December 1999), waist circumference and sagittal trunk diameter increased significantly in women but not in men. The secular changes in women corresponded to +0.4 cm per year in waist circumference and +0.2 cm per year in sagittal trunk diameter after adjustment for age and BMI.

II: Potassium in fat-free mass

TBK/FFM ratios were calculated using individually determined TBK and DEXA-determined FFM. TBK/FFM was regressed by age, weight and height (2). Age and height were negatively related to the measured ratio, indicating a lower ratio with advancing age and in taller subjects. In contrast, weight was positively related to TBK/FFM. The results showed that the TBK/FFM ratio and TBK alone could be estimated with gender-specific equations based on height, weight and age with precision errors <7%.

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III: Predictions of body fat

Body fat (kg) was found to be optimally and linearly predicted by weight/height^1, i.e. W/H, in both men and women (3). Percentage body fat was optimally and non-linearly predicted by weight/height^2, i.e. BMI. Relative body fat asymptotically approached 51.6% [95% confidence interval (CI) 49.4 to 53.9] of body weight in women. The body fat asymptote implied that percentage body fat in women increased only marginally from approximately 35 kg m^{-2} and upwards. The asymptote for percentage body fat was similar in men (56.0%, 95% CI 31.9 to 80.1) and women, despite a narrower BMI range in men. Body fat (kg) predicted from W/H compared with DEXA-determined body fat showed lower absolute differences and within-subjects CV than when BMI was used in the predictive equations. Percentage body fat predictions seemed to be associated with larger errors than body fat (kg) predictions.

IV: Definitions of the metabolic syndrome

Age-adjusted mortality was higher in those who had the metabolic syndrome than in those who did not, according to the World Health Organization (WHO) definition [hazard ratio (HR) 2.98, 95% CI 1.07 to 8.28, $p = 0.04$], but not according to the European Group for the study of Insulin Resistance (EGIR) (HR 1.93, 95% CI 0.67 to 5.55, $p = 0.23$) or the National Cholesterol Education Program Adult Treatment Panel III (ATPIII) definition (HR 0.88, 95% CI 0.20 to 3.89, $p = 0.87$) (4). There were no significant survival differences by gender, after adjusting for metabolic syndrome and age at the time of the initial examination.

When analysed together, incident atherosclerotic disease was significantly associated with the metabolic syndrome according to WHO and EGIR definitions, but not according to ATPIII. Self-reported diabetes mellitus and hypertension was associated with all three definitions of the metabolic syndrome. Self-reported previously experienced myocardial infarction and/or stroke were related to the metabolic syndrome according to WHO, but not according to the ATPIII or EGIR definitions.

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