評估身體組成的良機和臨床需要

Clinical needs and opportunities in assessing body composition

Vichai Tanphaichitr MD, PhD, FACP, FRACP and Preeya Leelahagul DSc

Division of Nutrition and Biochemical Medicine, Department of Medicine and Research Center, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand.

Protein-energy malnutrition (PEM) and obesity are hazardous to health with high morbidity and mortality rates. The assessment of body composition is essential to prevent, diagnose and determine the severity of these disorders as well as their response to therapy.

Body weight is the sum of fat and fat-free mass (FFM) whereas its chemical model consists of triglyceride, protein, water, and minerals. Thus one must recognize the appropriate method to assess each compartment of body composition. In clinical practice, the method must be simple, accurate, noninvasive and inexpensive. Body mass index (BMI) is a practical anthropometric parameter to assess protein-energy status in adults because it can easily be calculated from weight in kg divided by (height in meter)^2, and correlates with fatness and mortality. Total body fat can be estimated by measuring the amount of subcutaneous fat by measuring the thickness of the subcutaneous fat layer at different sites of the body by a skinfold caliper or near-infrared interactance. A high waist-over-hip circumference ratio (WHR) can be used to diagnose abdominal obesity. Upper arm muscle circumference can be employed to measure muscle mass. However, whenever these methods are used to assess body composition their limitations should be recognized.

Introduction

Changes in body composition can affect the health of individuals. This is well illustrated in both protein-energy malnutrition (PEM) and obesity[1]. The assessment of body composition is essential to diagnose and to determine the severity of these disorders as well as their response to therapy.

Human body composition

Body weight is the sum of fat and fat-free mass (FFM) whereas its chemical model consists principally of triglyceride, protein, water and minerals and some carbohydrate as glycogen[2]. Though now there are available methods which can assess each compartment of the chemical model directly or indirectly[2–4], in clinical practice the method must be simple, accurate, noninvasive and inexpensive. The technique should also be easily performed by physicians themselves or their staff. This paper presents our clinical experience in assessing body composition in adults with PEM and obesity by body mass index (BMI), direct measures of body fat, the waist (or abdominal)-over-hip circumference ratio (WHR)* and upper arm muscle circumference (UAMC).

BMI

BMI or Quetelet's index derived from body weight/(height)^2 in kg m^{-2} is a practical anthropometric parameter to assess protein and energy status in individual adults[1,5]. This is for at least five reasons. First, it can easily be calculated from weight and height for any individual adult, each of which can be accurately measured. Second, it has the least possible dependency on height. Third, it correlates with total body fatness, especially when greater than 20 kg m^{-2}. Keys et al.[6] found a correlation between BMI and the skinfold thicknesses of r=0.611 in Japanese farmers and of r=0.850 in Minnesota students. Durnin and Womersley[7] found the correlation between BMI and percentage of body fat measured by densitometry: r=0.49–0.62 among men and r=0.64–0.91 among women of various ages. In our study of 453 Thai women aged 19–61 years, a correlation coefficient of 0.672 between BMI and percentage of body fat measured by near-infrared interactance was found. Fourth, it correlates with mortality with a J-shaped curve, where the minimum mortality for both men and women is for a BMI of 22–25 kg m^{-2}. At the two extremes of the J-shaped relationship between BMI and mortality, the causes of death are different. Some cancers and respiratory and digestive diseases are the cause of death in underweight individuals (BMI <20 kg m^{-2}) whereas cardiovascular diseases, diabetes mellitus, gall bladder disease and cancer of the colon and reproductive system are the causes of death in obese individuals (BMI ≥25 kg m^{-2}).[9] For increasing degrees of fatness, BMI cut-off points of 20.0–24.9, 25.0–29.9, 30.0–40.0, and >40.0 kg m^{-2}, normal, grades 1, 2 and 3 of obesity by Garrow[5] are generally used[1]. PEM which is common in developing countries, is also

Correspondence address: Professor Vichai Tanphaichitr, Division of Nutrition and Biochemical Medicine, Department of Medicine and Research Center, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand.

* **Editor's Note:** The WHO report on Anthropometry (1994) recommends that the use of the term waist be restricted to the narrowest abdominal circumference with umbilical or other abdominal circumferences. The term 'abdominal circumference' will apply to that measured midway between the lower rib cage and the iliac crest.

categorized into grades 1, 2, and 3 based on BMIs of 17.0–18.4, 16.0–16.9, and <16.0 kg m^{-2}, according to WHO[1]. Fifth, BMI can be used as a guide to therapy in patients with underweight or obesity.

As in Western reports, we have shown in Thailand that men and women with BMI ≥25.0 kg m^{-2} have higher serum total cholesterol (TC), LDL-C, triglyceride, uric acid, and fasting blood glucose (FBG) levels but lower serum HDL-C levels, than those with BMI <25 kg m^{-2} [10]. Thus, BMI can be employed as a risk factor for the development of CHD. However, the limitation of BMI must be recognized in subjects with edema and ascites, massive organomegaly, pregnant women and body builders.

Total body fat by skinfolds or near-infrared interactance

Total body fat is located both internally and subcutaneously and can now be measured by several advanced techniques[2,3]. However, in the clinical setting, to minimize the expense, measurement of skinfold thickness is still useful, based on the assumption that there is a constant relationship between subcutaneous fat and body fat. The amount of subcutaneous fat can be estimated by measuring the thickness of the subcutaneous fat layers at different sites of the body with a skinfold caliper, eg Harpenden skinfold caliper. The most frequently used locations are triceps, biceps, subscapular, and suprailiac skinfold thicknesses. The sum of these four skinfolds are then used to estimate body fat by specific equations developed by Durnin and Womersley[7]. However, measuring skinfolds requires a properly trained and experienced individual to obtain an accurate result. Besides, the subjects have to be partly undressed. Thus we have recently used near-infrared interactance to measure body fat to minimize these problems. The correlation coefficient between the body fat in kg measured by near-infrared interactance[8] (Futrex-5000A) and by Harpenden skinfold calipers[7] in 35 men and 62 women, aged 17–75 years, is 0.922.

WHR

Recent Swedish analysis of the effect of different patterns of body fat distribution on mortality confirms earlier clinical observations that an abdominal rather than a gluteal distribution of fat increases susceptibility to health hazards including cardiovascular diseases and diabetes mellitus. Therefore distribution of fat should be analysed in its own right, independent of overall obesity. This can be done clinically by obtaining the WHR. Abdominal obesity is present when the WHR is over 1.0 in men and over 0.8 in women[10,11]. Our study has shown that men with a WHR >1.0 have significantly higher serum TC, LDL-C, but lower HDL-C concentrations, than those with a WHR ≤1.0[10].

UAMC

In the clinical setting, UAMC gives an indication of the body muscle mass and hence its somatic protein status. It is derived from the measurement of mid upper arm circumference (MUAC) and triceps skinfold thickness (TST), using the equation UAMC=MUAC-3.1428 TST[4]. In the Thai experience, UAMC is a useful index of the efficacy of nutrition therapy in PEM and in obesity, where the preservation of muscle mass is a consideration.

Conclusion

The assessment of protein-energy status should be part of clinical practice. BMI, total body fat, WHR and UAMC are body compositional indices which can be obtained without much difficulty and yet are useful indicators of health status, provided their limitations are recognized.

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