

Editorial

Reporting Weight Loss 2007

Introduction

Weight loss, although certainly not the only criterion, is an important outcome measure after bariatric surgery. However, as the years go by and health conditions in society change, it is important to review the current situation.

The "Ideal" Weights

In 1959, the Metropolitan Life Insurance Company released tables of the best weight for each height for longevity, based on collected insurance data.¹ These were called the "desirable" weights.

In 1983, the Metropolitan Life Insurance Company in New York released the "ideal" weights for greatest longevity (or for lowest mortality).² These were based on the Build Study of 1979, determined by the Society of Actuaries in Chicago, on patients followed for 18 years (1954-1972).³ This data was collected from 25 life insurance companies in the USA and Canada, representing 4.2 million insured individuals, and is still by far the largest study available. The "ideal" weights were higher than the prior "desirable" weights, and this was attributed to an increase in muscle mass due to improved fitness.² The average weights in the population are higher than the ideal weights for survival.

The criticisms of the 1983 Height and Weight Tables were:⁴ 1) the insured population tended to be affluent and white; 2) 10% of the weights were self-reported; 3) the weights included indoor clothing, estimating 5 lbs for men and 3 lbs for women, and shoes with 1 inch heels in both men and women; 4) individuals with known heart attacks, cancer, diabetes and hypertension were excluded.

The ideal weight was based on the mean weight of the insured individuals age 25-59, but ideal weight for survival actually increased up to age 54.³

The Metropolitan Tables included *small*, *medium* and *large* frames, based on elbow-girth using calipers,⁵ because the elbows do not develop adi-

posity. The elbow-girth from the 15th to 85th percentile was termed the *medium* frame.

The Tables presented weight ranges for height, sex and body frame, associated with the lowest mortality. The mid-point of the ideal weight range for the medium frame for each height was selected as the ideal weight for calculations.

Excess weight (initial weight – "ideal" weight) was the weight above "ideal" weight. From this, the widely used equation became available: percent excess weight loss (using the initial excess weight) or

$$\%EWL = \frac{\text{preoperative weight} - \text{current weight}}{\text{preoperative weight} - \text{ideal weight}} \times 100.$$

An easy formula to calculate the "ideal" weight is shown in Table 1.⁶

%EWL has been widely used. However, this is based on 1979 data. People are now living longer. The ideal weight associated with maximal longevity has increased,⁷ likely due to earlier diagnoses, medications, improvements in public health and medical care, and the effect of the fitness industry on muscle mass.

However, this current finding of increased longevity at higher weights may in the future become negated due to the occurrence today of obesity and its related morbidities in adolescents and teenagers,⁸ where we now have a generation which may not live as long as its parents.⁹ In any event, the %EWL, widely used in the USA and many other countries by bariatric surgeons, has lost considerable accuracy by 2007.

Table 1. Formula for calculation of Ideal Weight^{6*}

Adult Female: 5 ft. tall = 119 lb. For each additional inch, add 3 lb.
 Adult Male: 5 ft. 3 inches tall = 135 lb. For each additional inch, add 3 lb.
 1 foot = 30.4 cm; 1 inch = 2.54 cm.
 Divide lb. by 2.2 to change to kg.

*Formula corresponds to mid-point of medium frame of the Metropolitan Tables, with accuracy within 1%. To convert to ideal weight for small or large frame, decrease or increase the result by 10%. Patients *without* shoes.

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The Society of Actuaries (SOA) does not plan to perform an updated study, and indeed weight information is no longer collected by some insurance companies (personal communication, Jack Luff, SOA, Chicago, July 12, 2005). Also, the Metropolitan Life Insurance Company is not aware of any future update of the Metropolitan Height and Weight Tables (personal communication, Brittany L. Eklebury, MPH, MetLife Wellness & Fitness Services, New York, July 13, 2005). As such, %EWL has less relevance for the bariatric surgical community.

Percent of Initial Weight Lost

Percent of the initial weight lost has been used in some medical papers. It is problematic in that it does not relate to a given height or degree of "fatness", which is germane to any weight and population study.

Body Mass Index (BMI)

Studies were made, starting in the early 20th Century, for an index of relative body weight – i.e. body weight in proportion to some function of height, to provide an index number of body "fatness". Studies were made with W/H , W/H^2 (Quetelet's index) and W/H^3 (with W = Weight in kg and H = Height in m). It was found that W/H^2 gave the most accurate index when compared to body hydro-densitometry studies.¹⁰ Actually, for men the optimal index was W/H^2 and for women $W/H^{1.5}$ (women have an increased proportion of body fat),¹¹ but W/H^2 has been used for both sexes because of its simplicity. Comparing W/H^2 calculation ("body mass index" or BMI) to the Metropolitan Tables for "ideal" weight, and researching the optimal BMI to avoid obesity-related diseases, the range of 20-24.9 kg/m² was found.¹² It was found that there was increased risk of mortality with BMI <18.5 kg/m², and that BMI <17.5 suggested anorexia nervosa¹³ or cachexia. BMI of 18.5-20 may be suspicious of an eating disorder.

The relationship between BMI and mortality follows a J-shaped curve.^{14,15} Overweight is designated as BMI 25-29.9, class I obesity 30-34.9, class II obesity 35-39.9, class III (or morbid) obesity ≥ 40 , super-obesity 50-60, and super-super obesity ≥ 60 kg/m².

Studies of 20,000 to 1,000,000 individuals have determined optimal adult BMIs in the range of 20-25,^{16,17} but this number differs slightly for the onset of the individual diseases of the metabolic syndrome. For example, insulin sensitivity for glucose disposal was found to be impaired in normal volunteers when a BMI of 26.8 kg/m² was reached.¹⁸

BMI is being used widely for different populations, has good accuracy, and is easy to calculate. It has been found, however, that Asians may already develop impaired glucose tolerance and elevated blood pressure at a lower BMI, e.g. 23.¹⁹⁻²² This has been attributed to an increased percentage of the BMI made up of visceral adipose tissue in Asians.

Percent of Excess BMI Lost (%EBL)

The percent of excess BMI lost (percent EBMIL or simply %EBL), is currently the best method for comparing various obesity treatments, and is becoming more widely used.¹⁷ It is calculated from the formula:

$$\%EBL = \frac{\text{preoperative BMI} - \text{current BMI}}{\text{preoperative BMI} - 25} \times 100.$$

%EBL uses BMI 25 as the upper limit of normal,¹⁶ and is not quite the same as %EWL (based on the Metropolitan Tables) which uses the mid-point of the medium frame as their "ideal" weight. %EBL is now being adopted as the standard measure for studies of many granting bodies.

Kilograms

Kg has been proposed, and used in a number of medical studies, e.g. comparing the effect of drugs.¹⁷ However, whereas in a medical study, a loss of 7 kg may be meaningful, this is generally not the goal in bariatric operations on morbidly obese patients. Also, kg by itself is not related to height, which varies considerably in populations, and the healthy weight in a tall subject will be higher than in a short subject.

Other Measures

Because body fat distribution studies have repeatedly confirmed that increased visceral (truncal) obesity is associated with the serious diseases of the

metabolic syndrome, there has been considerable interest in adipose measurements (whose relevance is also affected by physical activity, diet and heredity).²³ The primary aim of bariatric surgery is to decrease fat mass.

Waist circumference (WC) and waist-to-hip ratio (WHR) have been proposed.^{14,24-26} WC is measured midway between the lateral lowest rib margin and the iliac crest with the patient standing. The hips are measured at their largest circumference over the greater trochanters. Healthy WC in males has been stated to be ≤ 98 cm and in females ≤ 88 cm. These values have not been validated for different heights. Simply stated, normal WHR in males is < 1.0 and in females ≤ 0.8 . A high WHR in a female is designated an "apple" (android) build, whereas the lower level in an obese female is designated "pear" (gynoid) build. These precise measures vary with the authors or study. However, increased WC has major implications for aspects of the metabolic syndrome, and is associated with an increased incidence of type 2 diabetes, hypertension, dyslipidemia and cardiac disease, and is reflected in nonalcoholic fatty liver disease. WHR $> .83$ in the female and $> .9$ in the male has been associated with a three-fold increase in risk for myocardial infarction.²⁷ However, again, true severity of the measurement cannot be designated without a height.

White et al²⁸ found that BMI correlated more with elevated blood pressure than did WHR and the sum of skinfold measurements. Furthermore, BMI has greater simplicity and precision than measuring skinfold thickness.²⁹

Percentage of fat mass (%FM) can be calculated from the BMI by the formula of Gallagher et al,³⁰ but the result is inaccurate in morbidly obese patients.²⁹ Direct measurement of body composition has also been used for changes in %FM, by dual-energy x-ray absorptiometry (DEXA) and by bioelectric impedance analysis (BIA). DEXA has been confirmed to provide accurate data, while BIA was generally inaccurate.²⁹ However, DEXA is a costly study, based on absorption of x-rays. Fat measurement by ultrasound has been found to be as accurate as CT scanning, is less costly, and does not subject the individual to radiation.³¹

Conclusions

Methods used to report weight loss in the bariatric surgical literature have been multiple and occasionally contentious. There will be further changes as the science develops. **OBESITY SURGERY prefers BMI, and for comparison of weight loss within a study or between studies, this Journal strongly encourages percent of excess BMI loss (%EBL).** However, %EWL (based on the old Metropolitan Tables) has been used in many past studies, so that this measure may still be accepted to enable comparison. Body weight in kilograms can add to the description, but has no value by itself, because kg alone gives no indication of relative height.

With the effect of visceral obesity on the serious diseases of the metabolic syndrome, waist circumference or waist-to-hip ratio is becoming an important measurement in certain related studies. In some instances, more complex methods for measuring fat distribution may be relevant.

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