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The Benefits of Body Mass Index and Waist Circumference in the Assessment of Health Risk

Mary T. Imboden
George Fox University

Alexander H.K. Montoye
Ball State University

Leonard A. Kaminsky

THE BENEFITS OF BODY MASS INDEX AND WAIST CIRCUMFERENCE IN THE ASSESSMENT OF HEALTH RISK

by Mary S. Tuttle, M.S.; Alexander H.K. Montoye, Ph.D.; and Leonard A. Kaminsky, Ph.D., FACSM

Learning Objectives:

The reader will gain greater understanding of the effectiveness of emphasizing the use of body mass index and waist circumference within health and fitness settings to assess weight-related health risk. In addition, insight will be gained into how these assessments can be used to track change effectively in weight and fat distribution through time. Alternative methods for assessing weight-related health risk populations with high amounts of fat-free mass will be discussed.

Key words: Obesity; Weight Loss; Body Composition; Anthropometric Measurements; Overweight

THE VALUE OF BODY MASS INDEX AND WAIST CIRCUMFERENCE

INTRODUCTION

Obesity is an epidemic in the United States. Most health and fitness (H&F) professionals are familiar with reports showing that 69% of American adults are overweight, and an estimated 36.5% are obese, defined as having a body mass index (BMI) of 25 kg/m^2 or higher and 30 kg/m^2 or higher, respectively. Thus, 78.6 million American adults are considered to have excess weight that is detrimental to their health (16,17,19). In 2014, there was not a single state with a prevalence of obesity of less than 20%, and 19 states were reported to have an obesity prevalence of more than 30%. This is a remarkable change since 1990, when the prevalence of obesity was only 12%, and no state had an obesity prevalence of more than 15% (6). Obesity raises the risk of early mortality and other chronic diseases and is associated with increased health care costs, placing a large financial burden on the United States.

BMI is the method most commonly used to classify individuals into specific weight categories (*i.e.*, underweight, normal, overweight, obese) to determine an individual's weight-related health risk. A waist circumference (WC) of 102 cm or more in men or 88 cm or more in women also designates obesity. The calculation of BMI and values for each category can be seen in sidebar 1. These categorical ranges are well established and accepted by essentially all major national and international health organizations, including the American College of Sports Medicine (ACSM), American College of Cardiology (ACC), Centers for Disease Control and Prevention, The Obesity Society (TOS), and the American Heart Association (AHA). In addition, several studies have shown BMI to correlate well with measures of body composition (*i.e.,* percent fat and fat-free mass) and

future obesity-related health complications, especially in the general adult population (7,8). The 2013 AHA/ACC/TOS *Guideline for the Management of Overweight and Obesity in Adults* reported that there is a direct dose-response relationship between BMI and the risk of fatal and nonfatal disorders (9). For example, an increase in BMI of 1 kg/m^2 more than 22 kg/m^2 was associated with a 10% increase in coronary heart disease (11). Furthermore, Wolf and Colditz found that obese individuals with a BMI of 35 kg/m^2 or higher had a 42-fold greater risk for developing type II diabetes, and those with a BMI of 40 kg/m^2 or higher had a 53-fold greater risk than those of normal weight status (18.5 to 24.9 kg/m^2) (22).

Sidebar 1

BMI = weight (kg) / [height (m)]^2.
Standard Weight Status Categories for Adults Associated with BMI Ranges. (20)
• Underweight: <18.5
• Normal: 18.5–24.9
• Overweight: 25.0–29.9
• Obese: ≥30.0.

Because of the high prevalence of obesity and its associated health complications, it is not a surprise to H&F professionals that one of the main motivations for clients joining a fitness facility is to lose weight with the goal of improving overall health (1). This statement is supported by enrollment data obtained from Ball State University's Adult Physical Fitness Program. During the enrollment process, participants are asked to rank their priority reasons for joining the fitness program. Of 1,247 participants surveyed, 1,103 participants (88.5%) listed weight loss as a priority reason. The focus of this article is to demonstrate how the simple measures of height and weight (used to calculate BMI) along with WC can be used as effective tools for identifying individuals with an elevated health risk and for tracking changes as these individuals undergo lifestyle modification. We will first discuss the advantages of using BMI and WC in the assessment of weight-related health risk in most American adults. Afterward, we will address situations in which these measures may be less sensitive in predicting health risk and the alternative methods that can be used in these situations.

METHODS AND ADVANTAGES FOR USING BMI AND WC

BMI and WC have many advantages that make them appealing for use in H&F settings for clients for whom weight loss is a common goal. Both BMI and WC use readily available and inexpensive equipment, can be administered easily, and are understood easily by clients. BMI and WC can be used as initial screening tools to identify those at an elevated health risk because of excess body weight and poor distribution of fat mass. As mentioned earlier, BMI and WC have a direct relationship with common chronic diseases including cardiovascular disease (CVD) and diabetes; therefore, further evaluation for the presence of disease is warranted for individuals classified as above the normal ranges for BMI (*i.e.*, ≥25 kg/m^2) and/or WC (≥102 cm for men or ≥ 88 cm for women) (18,20).

Another key advantage of using BMI for determining weight-related health risk is that the measures needed for its calculation — height and weight — can be taken with high accuracy when performed using standardized procedures. These procedures are easy to follow and can be applied with minimal technician training. The methods involved in the measurement of height and weight, for calculation of BMI, can be found in sidebar 2.

Sidebar 2

Weight Measurement
• The scale must be calibrated before the measurement.
◦ To calibrate, place objects of known weight on the scale.
• A reasonable standard is to have the client wear light athletic attire or a paper robe.
• Instruct the client to remove his or her shoes and empty pockets.
• Take all measurements when the client is in a similar hydration status and at a similar time of day.
• Record the weight measure to the nearest 0.1 kg or 0.25 lb (21).
Height Measurement
• A wall-mounted stadiometer should be used.
• Instruct the client to remove his or her shoes, stand up straight with heels together, look straight ahead, and hold a deep inspiration during the measure (18).

*Measure height initially to determine weight status by calculating BMI (weight (kg) / [height (m)]^2). For most clients, height measurements will not need to be repeated when tracking weight status because it usually does not change for adults until later in life (Typically, individuals lose approximately 1 cm every 10 years after age 40. Height loss is even more rapid after age 70) (12).

Because height in most individuals does not change, a change in body weight will correspond to a change in BMI. That being said, weight measurements are a good way to track progress during a fitness program; however, weight change is not the only indicator and even at times not the best indicator of successful progress. After beginning an exercise program, it is common for an individual to notice progress by the way his or her clothes fit around the waist, even though there may be little or no change in weight when he or she steps on a scale. Circumference measures such as WC are similar in principle to assessing how clothes are fitting, but assessing circumferences is a more precise way to capture a change in body composition. WC is a measure of the distance around the abdomen and is accepted as a practical indicator of adipose tissue distribution (24). The National Heart, Lung, and Blood Institute recommends measuring WC combined

with BMI to assess and classify weight-related health risk (2). WC offers information on health risk associated with fat distribution, which BMI alone does not. As a result, WC is commonly used in research and clinical settings to complement BMI in identifying the risk for chronic diseases (*e.g.*, CVD, diabetes, *etc.*). WC is a particularly useful tool to use in individuals with a BMI of 25 to 34.9 kg/m^2 that may be misclassified because of having a high amount of fat-free mass (*e.g.*, power athletes and some manual laborers) (15,18). However, for individuals with a BMI of 35 kg/m^{2}or higher, WC adds little predictive power on disease risk beyond that of BMI (15).

WC measurements are relatively quick to perform and can produce reliable and accurate measurements when performed by a trained and experienced technician. The methods used to measure WC are outlined in sidebar 3 (24).

Sidebar 3

Waist Circumference Measurement

- The technician should use a measurement tape with a tension gauge.
- Instruct the client to bring his or her feet together and equally distribute his or her weight through both feet (24).
- Technicians should stand to the client's side when taking the measurement.
- Place the measurement tape directly on the client's skin above the umbilicus and below the bottom of the rib cage to a location providing the smallest measurement.
- At the end of a normal expiration, gently tighten the tape measure around the client's skin without depressing the skin (tension spring-loaded handle should be extended to the standardized tension level) (13).
- Record the WC measure to the nearest 0.1 cm.
- Two measures should be taken and averaged to determine WC.
- A third measurement is necessary when the first two measures are not within 0.5 cm of each other (18).

In the H&F setting, a change in body composition can be detected by a change in weight (resulting in a BMI change), a change in WC, or both. Because of the important information gained from BMI and WC and their ease of use, the AHA/ACC/TOS recommend that physicians measure height and weight (to calculate BMI) along with WC at all annual visits, if not more frequently, to track changes in weight and fat distribution as well as identify adults who may be at an elevated risk of CVD, diabetes, and premature mortality from all causes (9). For those who have never been overweight or obese and who are at a stable weight, a one-year interval is appropriate; otherwise, more frequent reassessments of BMI would be desirable, especially for currently overweight and obese individuals. The decision for recommending weight loss is commonly determined by BMI and WC. According to the AHA/ACC/ TOS, weight loss is indicated in obese individuals or in overweight individuals with additional CVD risk factors or other obesity-related comorbidities (9).

FACTORS TO CONSIDER WHEN INTERPRETING BMI

Although BMI by itself is effective for determining weight-related health risk in many contexts, there are situations when the use of BMI alone is limited in its ability to appropriately classify individuals into the proper weight category. Scenarios where BMI may not be a suitable method of assessing and tracking weight-related health risks include:

- Measuring individuals with a large amount of fat-free mass (*e.g.*, power athletes, some manual laborers).
- Assessing clients after a resistance training program who increased their muscle mass (fat-free mass), masking a possible decrease in fat mass (resulting in no initial change in body weight or BMI).

In these scenarios, BMI may classify these individuals with *excess weight*, caused by a large amount of fat-free mass, as overweight or obese. This would be an inaccurate risk classification because fat-free mass is associated with healthy metabolic functioning. Although, as previously discussed, the addition of WC to complement BMI would help to properly classify these individuals as being at a reduced weight-related health risk compared with those with a high BMI and excess abdominal fat.

Having excess fat mass is associated with several health risks, whereas having high fat-free mass provides health benefits. Therefore, for athletes or individuals who participate in heavy resistance training or manual labor, assessment methods that estimate body composition (*i.e.*, the proportion of fat and fat-free mass in the body) may be more appropriate for determining if their high body weight is a result of excess fat mass (health risk) or high fat-free mass (not a health risk). In the next section, we discuss some known limitations of body composition measurements. However, it is worth noting that it is only a select subset of individuals joining an H&F setting who may benefit from knowing their body composition (*i.e.*, percent body fat), as

opposed to their health risk as captured from BMI and WC. In normal circumstances, to have high muscle fat-free mass, individuals would need a highly physically active lifestyle, a physically demanding job, or to participate in resistance training regularly. Because of the increasingly sedentary nature of jobs in the United States and the low participation in physical activity (less than 5% of adults meet physical activity recommendations (23), and less than 20% of adults report participating in resistance training (1)), very few individuals fit the *muscular* build, where BMI and WC could provide misleading assessments of weight-related health risk. In addition, many adults gain weight in adulthood and seek to join an H&F facility to lose this excess weight. As a result, the number of individuals likely to be misclassified by BMI because of increased muscle mass, and thus increased fat-free mass, is low (18).

An example of the effectiveness of BMI and WC as sufficient tools used to classify and track changes in weight-related health risk can be observed in the following case study.

- A 54-year-old man joined the Adult Physical Fitness Program at Ball State University with the goal to lose excess weight.
- He completed a body composition assessment before starting the exercise program and again after 4 months of exercise training.
- At both assessments, height and weight were measured to calculate BMI, and WC, along with a variety of body composition tests, were completed by trained technicians. The values are presented in the following table:

CASE STUDY FROM THE ADULT PHYSICAL FITNESS PROGRAM AT BALL STATE UNIVERSITY

Screening Method	Baseline	4-Month Follow-up
Dual energy x-ray absorptiometry	34.5%	31.1%
Air displacement plethysmography	36.0%	33.4%
Skinfolds	28.6%	29.0%
Bioelectrical impedance	30.1%	27.5%
WC	103.5 cm	98.25 cm
BMI	30.3 kg/m^2	28.2 kg/m^2
Height	69.7 inches	69.7 inches
Weight	208.9 lb	195.0 lb

BMI and WC were the only methods needed in this case study to classify this man as obese and at an elevated risk for obesity-related diseases. In addition, the BMI and WC measurements taken after 4 months of participating in the Adult Physical Fitness Program indicate that this man has made progress toward his weight loss goals. When analyzing the body composition measurements, it is important to reemphasize that there are no accepted standards for %BF, making interpretation difficult. An additional challenge in the interpretation is the substantial disagreement shown between the methods when estimating %BF, as well as the disagreement in the change in these measurements after the initiation of an exercise program.

LIMITATIONS OF BODY COMPOSITION ASSESSMENT METHODS

Estimation of fat and fat-free mass, central components of interest when assessing body composition, provides an alternative way to determine and clarify if an elevated BMI is caused by excess fat mass or high fat-free mass. Although body composition methods provide estimates of body fat and fat-free mass, they require trained technicians and expensive equipment. When performed correctly, body composition methods only predict percent body fat (%BF) to within 2 to 5 percentage points of their *true* %BF value (compared with a criterion method). These errors in the estimation of %BF should be considered in determining the usefulness of the method. For example, consider an individual with a true %BF of 21% having a body composition assessment with a predicted body fat of 25%. Although the absolute error in the unit of measurement is only 4%, the proportional error is 19% ([4 / 21] × 100) (4). In addition, interpretation of the results obtained from body composition assessments can be challenging for several reasons. First, there is no clear criterion method for measuring body composition, and the various methods differ in their accuracy, leading to differing results for the same person across methods. Moreover, it is well known that prediction error, whether for body composition, physical activity, blood pressure, or any other physiologic measure, makes it difficult to detect changes in the measurement (*e.g.*, changes in body composition with lifestyle modification) through time because it is unclear if an increase or decrease in the measure is caused by true change or caused by the error inherent in the measurement (4).

Another limitation of using body composition methods for the assessment of weight-related health risk is that there are no set standards for healthy body composition values. For example, ACSM suggests a healthy %BF to be 10% to 22% for men and 20% to 32% for women (5), but the American Council on Exercise suggests that a healthy %BF range is 18% to 24% for men and 25% to 31% for women (14). Without agreement on healthy ranges of %BF, the meaning of the values obtained from the body composition measurement is unclear. In addition, these standards do not account for age, a factor that has been shown to affect body composition (10). Furthermore, many of the body composition methods are not feasible for routine practice because they are technically demanding, require expensive equipment, and result in higher costs for the client (a comparison of common methods for assessing body composition is displayed in the Table.). Therefore, because body composition methods have several limitations, both in their use as well as in the interpretation

TABLE: Factors to Consider When Choosing a Body Composition Assessment Method

Method of Assessment	Equipment Cost	Technician Expertise	Accuracy of Measure	Cost to Patient
Anthropometry				
BMI (scale for weight and stadiometer for height)	$$-$$$	+	++++	$
Circumferences	$	++	+++	$
Body composition methods				
Skinfolds	$-$$	+++	++	$
Hydrostatic weighing	$$$-$$$$	++++	++++	$$$
Bioelectrical impedance	$$-$$$	++	++	$
Dual energy x-ray absorptiometry	$$$$	++++	++++	$$$$
Air displacement plethysmography	$$$$	++++	++++	$$$

For anthropometry, accuracy of measure does not refer to the accuracy in measuring body fat percentage; rather, it refers to the accuracy in measuring weight, height, and WC.

Price description ($) is based off prices found at Web sites advertising high-quality body composition assessments and are approximations of what a typical measurement would cost.

Equipment cost: $ indicates less than 100 US dollars (USD); $$, 100–1,000 USD; $$$, 1,001–25,000 USD; and $$$$, more than 25,000 USD.

Cost to patient: $ indicates less than 25 USD; $$, 25–75 USD; $$$, 76–125 USD; and $$$$, more than 125 USD.

Technician expertise and accuracy of measure: + indicates low; ++, moderate; +++, high; and ++++, very high.

of results, they have less practicality for use in the general population.

CONCLUSIONS

In conclusion, most individuals who join an H&F facility are aware that they are overweight and are trying to lose some of their weight (3). For these individuals, BMI and WC are valuable tools to identify weight-related health risks and determine appropriate weight loss goals for an H&F program. In addition, BMI and WC are useful tools for tracking weight and fat-distribution changes as these individuals undergo lifestyle modification. H&F professionals should consider calculating BMI and obtaining WC on all new participants to identify those at risk for weight-related diseases and early mortality. It also is suggested that H&F professionals use the recommendations proposed by the AHA/ACC/TOS and encourage assessing BMI and WC routinely on clientele to track weight loss progress and/or to continue to monitor health risk (9).

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Mary S. Tuttle, M.S., *is a doctoral student in the Human Bioenergetics program at Ball State University, studying clinical exercise physiology. Her research interests include the effect of exercise interventions on aging, obesity, and heart failure.*

Alexander H.K. Montoye, Ph.D., *is an assistant professor of Clinical Exercise Physiology in the School of Kinesiology at Ball State University. His research interests lie in the area of physical activity assessment. Specifically, he studies the accuracy of accelerometer-based activity monitors for measurement of physical activity and sedentary behavior.*

Leonard A. Kaminsky, Ph.D., FACSM, *is the John & Janice Fisher Distinguished Professor of Wellness, professor of Exercise Science, and director of the Fisher Institute for Wellness and Gerontology at Ball State University. His research has focused on the role of physical activity and exercise in the prevention and rehabilitation of chronic disease. He currently is leading a project to establish a registry for cardiorespiratory fitness in the United States.*

BRIDGING THE GAP

Body mass index and waist circumference can be used as effective tools to assess weight-related health risk in health and fitness (H&F) facilities. These measures are simple, inexpensive, and can be performed with high precision; therefore, the current recommendations suggest that physicians use these measures at least annually to identify adults who may be at an elevated risk for cardiovascular disease, diabetes, and other health risks. Similarly, all H&F facilities should perform these measurements on all new clients to effectively identify each individual's weight-related health risk. Body mass index and waist circumference also can be used to track changes in weight and fat distribution throughout an individual's exercise program.