Chapter 5

ANTHROPOMETRIC OBESITY INDICES AND METABOLIC ABNORMALITIES

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INTRODUCTION

Obesity is ever-increasing throughout the world. Both adults and children are highly affected from this severe health problem. Obesity is greatly associated with many severe cardiometabolic as well as endocrine diseases. Obesity may also lead to many mood disorders such as depression and anxiety. Therefore, quite a number of ratios and indices are introduced to be able to estimate the risks confined to such metabolic abnormalities. Within this context, numerous equations are under investigation. Obesity indices are commonly used also during the evaluation of metabolic syndrome (MetS) cases (1-8).

These indices are generally divided into two groups. Those, which are derived from anthropometric measurements, and those based upon the body fat amount or distribution. The first group of indices may further be analyzed in two groups: Weight-dependent and weight-independent indices.

Names, abbreviations and the equations of the formulas used within the scope of the study were listed in Table I.

The purpose of this chapter is to give a very recent information related to each one of these indices derived from anthropometric measurements, including their formulas, their closeness to obesity degree of the individuals and the ability to determine the possible risks related to metabolic abnormalities. Within this context, two indices derived from biochemical measurements were also included.

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Table 1 Formulas Of Anthropometrıc Obesıty Indıces		
Weight-dependent Anthropometric Indices		
Abbr.	**NAME**	**Equation**
BMI	body mass index	Weight / (height)^2
HI	hip index	HC*wght $^{-0.482}$ * hght $^{0.310}$
CI	conicity index	WC/0.109 * √(wght/hght)
ABSI	a body shape index	1000 * WC*wght $^{-2/3}$ *hght $^{5/6}$
TPMI	triponderal mass index	wght/hght ^{3}
Weight-independent Anthropometric Indices		
WC	waist circumference	WC
HC	hip circumference	HC
NC	neck circumference	NC
WHR	waist C-to-hip C ratio	WC/HC
WHtR	waist C-to-height ratio	WC/Hght
WHHtR	Waist-to-hip-to-height ratio	WC/HC/Hght
(WC+HC)/2	(waist C+hip C)/2	(WC+HC)/2
PWNC	a product of WC and NC	WC * NC
BAI	body adiposity index	HC/hght $^{0.8}$
BRI	body roundness index	364.2-365.5*(1-((0.5 * WC/ p)^2/ (0.5*Hght)^2))$^{0.5}$
AVI	abdominal volume index	(2 * (WC*100)^2 + 0.7 * (WC*100-HC*100) ^{2})/1000
Indices Derived from Biochemical Measurements		
CMI	cardiometabolic index	TRG/HDL-C*WC/Hght
MetSI	metabolic syndrome index	[(INS/FBG)/(HDL-C/TRG)]*100

C=circumference, W=waist, H=hip, N=neck, wght=weight, hght=height, TRG=triglyceride, HDL-C=High density lipoprotein-cholesterol, INS=insulin, FBG=fasting blood glucose.

WEIGHT-DEPENDENT ANTHROPOMETRIC INDICES

Body Mass Index

Body mass index is one of the most commonly used indices. It requires height and weight values of the individuals. Therefore, it is a weight-dependent index. There are some objections related to its use in obesity-related studies due to the fact that this index does not contain a fat-related parameter. However, it is still used in the so-called studies efficiently. In a recent report, BMI shows a significant association with body fat percentage among university students. Therefore it is suggested that this index can be used to determine obesity in young population because it is easy to calculate (9).

Hip Index

This index uses hip circumference in addition to weight and height. However, the related equation requires numbers to be entered in superscript form. Besides, there are controversies related to the clinical utility of this index. This index has been introduced as a novel index associated with some cardiovascular risk factors and suggested as a useful anthropometric risk index for predicting MetS (10). On the other hand, it was reported that it was not an independent risk factor for diabetes mellitus (11).

Conicity Index

This index is based on the notion that people with considerable amount of fat around the abdomen are biconical, while those with less fat around the same section are cylindrical (12). Studies have pointed out the ability of CI in determining abdominal obesity (13, 14). The conicity index is reported as an independent risk factor for all-cause mortality among the non-cancer elderly (15).

A Body Shape Index

This index was introduced as a variant of conicity index not affected by the obesity paradox. A high correlation between ABSI and CI was reported. Body mass index was correlated with CI, which in turn correlated strongly with ABSI. It was also stated that ABSI may reflect the change in body shape from

cylindricity to conicity. This index was suggested as the only abdominal obesity index, which is not affected by the obesity paradox (16).

Tri-ponderal Mass Index

This index was reported as a superior index in discriminating body fat distribution more acurately than BMI (17). Tri-ponderal mass index was as effective as BMI in terms of WC, WHR, arm fat area, and body fat percentage in determining overweight and obesity in children (18).

WEIGHT-INDEPENDENT ANTHROPOMETRIC INDICES

Waist Circumference

Waist circumference along with hip circumference, head circumference and neck circumference was considered within the scope of obesity studies. It is a commonly used parameter as a component of many related ratios and indices. It was reported as a marker better than BMI and WHR in predicting Type 2 diabetes mellitus (19).

Hip Circumference

Waist circumference and hip circumference are both strongly associated with obesity. Their association with risk of death was also reported. In a recent report, it was pointed out that consideration of both waist and hip circumference in the clinical setting could help to best identify those at increased risk of death (20).

Neck Circumference

Neck circumference is a simple and reliable measurement, which correlates with other anthropometric measurements. It was stated that this parameter was not affected by external factors (21). It was reported that NC can be considered for screening overweight and abdominal obesity and was the most preferred anthropometric method (22).

Waist-to-Hip Ratio

This ratio is being used commonly in obesity studies. In a study, it has been stated that WHR, as an anthropometric index, outperformed both BMI and WC in T2DM patients (23). In another report, it was reported that BMI and WC showed better performance for the identification of cardiometabolic risks than

WHR (24). Waist-to-hip ratio causes anthropometric inconsistency and bias in predicting myocardial infarction (25).

Waist-to-Height Ratio

This ratio is described as a hallmark of central obesity, one of the potential obesity indicators for determining the presence of cardio-metabolic risk (26, 27) and appears to be more closely related to diabetes than BMI and WHR (28, 29). It was suggested as the best index to discriminate metabolic abnormalities (30), an effective indicator for detecting adiposity (31). It was also recommended for home-based obesity screening studies among the pediatric population (32).

Waist-to-Hip-to-Height Ratio

This ratio is also an abdominal obesity indicator such as WC and is suggested as one of the predictor for CVD mortality than BMI (33). Along with WHtR, this ratio were reported as more valuable indices than BMI and WC for the prediction of cardiovascular disease risk factors (34).

Waist Circumference+Hip Circumference/2

Both WC and HC are commonly used athropometric measurements. Both parameters increase steadily as the severity of obesity increases. In recent studies, (WC+HC)/2 has been introduced as a new obesity marker to be used in routine clinical practices. Also significant associations were found between (WC+HC)/2 ratio and (trunk fat+leg fat)/2 (TF+LF)/2 ratio. This point was important because it reflects the association between an anthropometric and a fat-based indices (35, 36).

A Product of Waist and Neck Circumferences

Both WC and NC are valuable parameters during the evaluation of obesity studies. A product of waist and neck circumferences was reported as a superior index to traditional anthropometric parameters such as WC, BMI or WHR as an obesity indicator for the presence of MetS with diabetes mellitus (37).

Body Adiposity Index

Among the other obesity indicators this index was not effective for discriminating high cardio-metabolic risk (27). This index was also suggested as inapplicable due to its low validity for estimating body fat (38).

Body Roundness Index

This index is the only index, which requires π in addition to WC and height of the individuals for calculation. It was found to be shown superior performance and significant association with cardiometabolic risk factors among some other obesity indicators such as BAI or ABSI (27). This is suggested as one of the best indices fot MetS prediction (8, 39).

Abdominal Volume Index

This index was reported as one of the strongest anthropometric discriminators of MetS (40, 41). It is known that obesity is a risk factor for mood disorders such as depression and anxiety. As an indirect measure of abdominal obesity along with WC and body fat, it was also suggested as a useful parameter for the prediction of the relationship between obesity and depression and/or anxiety (7).

INDICES DERIVED FROM BIOCHEMICAL MEASUREMENTS

Cardiometabolic Index

This index is a rather new index for predicting obesity-related diseases. Individuals with metabolically obese normal weight (MONW) phenotype may be under extremely high-risk for unfavorable health consequences. However, they may not be detected due to normal BMI. Cardiometabolic index was suggested as a valuable indicator to identify the individuals with this phenotype (42).

Cardiometabolic index can be used as a reference predictor due to its strong association with the risk of metabolic associated fatty liver disease (MAFLD) and is of clinical value for the early identification and screening of MAFLD (43).

Metabolic Syndrome Index

This is a recently developed index (44). Since the related formula contains biochemical components, which should be considered during MetS diagnosis, it is called MetS index. These components are also important from the cardiovascular point of view. Therefore, this index may be of clinical use for the prediction of both cardiovascular and MetS risk during childhood obesity.

CONCLUSION

In this chapter, the equations introduced for the interpretation of obesity development were presented. Their potential clinical uses for various disease states other than obesity were emphasized. The structures of formulae were given. The advantages and disadvantages of these formulae were explained under the light of recent scientific and medical reports.

The common feature of all formulae was their attempts to determine the body fat profile of the individuals although they use anthropometric measurements. Body mass index, TPMI, WC/HC, WHtR, WHHtR, PWNC and (WC+HC)/2 were easy-to-calculate ratios and indices. The remaining part of the list was composed of equations, which require complicated mathematical processes. Considering the fact that each formula may also be helpful for the evaluation of many other clinical abnormalities, these sophisticated formulae may be in use for the specific purpose.

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