KJFM Korean Journal of Family Medicine

Review Article

eISSN: 2092-6715
Korean J Fam Med
https://doi.org/10.4082/kjfm.25.0275

Current guidelines and future directions in comprehensive obesity assessment

Sinyoung Cho[1], Hyuktae Kwon[1,2,*]

[1]Department of Family Medicine, Seoul National University Hospital, Seoul, Korea
[2]Department of Family Medicine, Seoul National University College of Medicine, Seoul, Korea

ABSTRACT

Obesity is a chronic systemic disease with multifactorial causes that poses a substantial health and economic burden worldwide. In Korea, obesity is a significant public health concern owing to the increasing prevalence of obesity-related comorbidities and mortality. Obesity is defined as excess adiposity that poses health risks. Adiposity can be assessed using direct and indirect methods, among which body mass index (BMI) is the most widely used anthropometric measurement in epidemiological studies and clinical practice. However, limitations of BMI-centric obesity assessments have been noted in previous studies. Simple adiposity measures cannot capture obesity-related medical conditions, daily functional status, or mental health. Therefore, medical associations worldwide have increasingly emphasized the need for comprehensive obesity assessments, including the 2020 Canadian Adult Obesity Clinical Practice Guidelines, American Association of Clinical Endocrinologists/American College of Endocrinology 2023 Guidelines, 2024 European Association for the Study of Obesity diagnostic framework, and 2025 Lancet Commission's Clinical Obesity Diagnostic Criteria. Recent perspectives have emphasized multidimensional approaches to obesity assessment to capture individuals' overall health status. This review aims to evaluate the limitations of BMI-centric obesity diagnosis, summarize emerging recommendations from recent international guidelines, and highlight potential alternative approaches for improving the assessment of obesity and related health outcomes.

Keywords: Obesity; Evidence-Based Practice; Body Mass Index; Risk Assessment

Introduction

Obesity is the abnormal or excessive accumulation of body fat that contributes to significant health risks [1]. According to the World Health Organization, 43% of adults were overweight and 16% were obese in 2022 [2]. According to the Korean Society for the Study of Obesity (KSSO), the prevalence of obesity is expected to increase from 30.6% in 2013 to 38.4% in 2022 [3]. Obesity is a chronic and complex disease that imposes a substantial health burden worldwide [4-6], contributing to the development of type 2 diabetes mellitus [7], cardiovascular disorders [8], certain cancers [9], and mortality [10] while also exerting a considerable economic burden [11].

Body mass index (BMI), calculated by dividing weight (kg) by height squared (m^2), is the most widely used anthropometric measurement for obesity in epidemiological studies and clinical practice [12]. Although BMI is considered an indicator of overall obesity, total body weight cannot distinguish muscle from fat mass and does not reflect regional or ectopic fat deposition [13]. The general trend in international guidelines recommends us-

Received: September 15, 2025, **Revised:** September 30, 2025, **Accepted:** October 14, 2025, **Published online:** December 4, 2025

*Corresponding Author: Hyuktae Kwon https://orcid.org/0000-0002-0312-3650
Tel: +82-2-2072-7495, Fax: +82-2-766-3276, E-mail: ezkel1@snu.ac.kr

ing measures in addition to BMI to define and diagnose obesity. Comprehensive assessments encompass a multidimensional approach that combines adiposity measures with functional health status indicators. Prior research has provided evidence supporting the need for this approach [14]. This review aims to evaluate the limitations of BMI-centric obesity diagnosis, summarize emerging recommendations from recent international guidelines, and highlight potential alternative approaches for improving the assessment of obesity and related health outcomes.

Limitations of the Body Mass Index-Centric Approach

The association between BMI and metabolic diseases, including hypertension, type 2 diabetes mellitus, dyslipidemia, and cardiovascular disease, has been extensively investigated [15]. Epidemiological studies have consistently reported a U-shaped association between BMI and mortality. A 12-year prospective cohort study of 1,213,829 Korean adults (aged 30–95 years) showed significant associations of higher BMI with cardiovascular and cancer mortality, regardless of smoking history [16]. Furthermore, a recent prospective cohort study among Korean adults showed that individuals with a BMI greater than or equal to 30.0 kg/m^2 are at an increased risk of mortality, and significant positive associations were also shown in those with a BMI below 21.0 kg/m^2 [17].

However, previous studies have critically evaluated the limitations of BMI as a measure of adiposity. First, BMI fails to capture the "normal-weight obesity," which is defined by an elevated body fat percentage assessed using bioelectrical impedance analysis (BIA) despite a normal BMI. This phenotype is associated with increased cardiometabolic risk and mortality [18-20]. Second, BMI does not capture visceral obesity, such as central obesity, with a normal BMI. Another study also demonstrated that high waist circumference (WC) is associated with increased mortality risk, even among individuals with a normal BMI [21]. Third, the metabolically unhealthy non-obese phenotype, defined as the presence of at least one metabolic abnormality (hypertension, diabetes, or dyslipidemia) within the normal BMI range, is associated with a significantly higher risk of mortality, whereas the metabolically healthy obese group exhibits a lower mortality risk [22]. Accordingly, comprehensive assessment frameworks that extend beyond BMI are required to characterize obesity-related health risks more accurately.

Comprehensive Obesity Assessment

Canadian Adult Obesity Clinical Practice Guidelines (2020)

The Canadian Adult Obesity Clinical Practice Guidelines aim to shift the focus of obesity management toward improving patient-centered health outcomes [23]. These guidelines emphasize the need for a multidimensional, patient-centered approach to obesity diagnosis and treatment, moving beyond evaluations based on a single adiposity measurement. These guidelines underscore five key domains: recognition of obesity as a chronic disease, assessment of individuals with obesity, discussion of treatment options, personalized therapeutic goal setting, and long-term engagement in obesity treatment. The following sections provide detailed explanations of each component. First, the guidelines underscore the importance of healthcare providers recognizing obesity as a chronic disease and noting internalized weight bias (IWB) among patients with obesity. Second, the 5As framework (Ask, Assess, Advise, Agree, and Assist) is recommended for patient-centered evaluations. Utilization of the Edmonton Obesity Staging System (EOSS) is emphasized for staging obesity severity. The EOSS was proposed in 2009 as a framework to classify obesity into five stages, ranging from 0 to 4, based on the severity of obesity-related health problems [24]. The EOSS integrates anthropometric classifications with clinical evaluations, including medical history, functional assessments, disease-related evaluations, and assessments of mental health and overall well-being. A study based on data from the National Health and Human Nutrition Examination Surveys (NHANES) showed that EOSS independently predicts mortality, with higher scores associated with increased mortality, even after adjusting for BMI [25]. Third, previous psychological disorders and ongoing psychological treatments should be integrated into assessments, considering their importance in choosing treatment options. Fourth, the guidelines recommend individualized evidence-based interventions that prioritize sustainable health outcomes. Core treatment options include behavioral interventions (medical nutrition therapy and physical activity) and adjunctive therapies, including psychological, pharmacological, and surgical interventions. Rather than focusing exclusively on weight reduction, treatment goals should prioritize patient-derived intervention outcomes. Finally, the guidelines emphasize the need for ongoing follow-up and reassessments to optimize chronic disease management. Healthcare providers should sustain engagement with individuals with obesity through ongoing monitoring and supportive care.

American Association of Clinical Endocrinologists/ American College of Endocrinology 2023 Guidelines

In 2014, the American Association of Clinical Endocrinologists/American College of Endocrinology (AACE/ACE) guidelines proposed a new diagnostic strategy for obesity that incorporates BMI as a screening tool and subsequently uses WC to confirm excess adiposity and further evaluating risk, including the presence and severity of obesity-related complications [26]. Subsequently, in 2017, AACE issued a position statement introducing a new diagnostic term for obesity: adiposity-based chronic

disease (ABCD) [27]. This new term aims to underscore its chronic nature and adiposity-based pathophysiology rather than relying on a BMI-centric definition. In 2023, AACE produced a consensus to propose a framework for incorporating weight stigma, IWB, psychological disorders, and social determinants of health into the staging of ABCD severity [28].

Weight stigma refers to social devaluation and discriminatory attitudes directed toward individuals who are perceived to have excess body weight [29,30]. IWB occurs when individuals apply these negative weight-related stereotypes to themselves and engage in self-derogation because of their body weight. The Stigmatizing Situations Inventory and the Weight Bias Internalization Scale are the most widely used tools to quantify weight stigma and IWB [31]. A systematic review of 74 studies reported strong associations between IWB and mental health outcomes, including depression, anxiety, and reduced quality of life [32]. A few studies have investigated physical health outcomes in adults; however, their findings have been inconsistent. Nonetheless, IWB has been shown to hinder healthcare engagement, thereby leading to delays in seeking treatment, missed opportunities for early diagnosis, and poor adherence to medical recommendations [33]. These factors collectively compromise continuity of care and may attenuate the effectiveness of obesity management interventions [34]. Weight stigma and IWB not only impair the quality of life of patients with ABCD but also exacerbate ABCD severity and further compromise treatment efficacy. Some recommendations are supported by consensus, including screening for the presence and degree of weight stigma and IWB, and further incorporating them into the staging framework. Furthermore, screening should be provided for psychological disorders, considering their strong association with stigma and IWB. Additionally, mental health and social determinants of health should be incorporated into the staging framework.

European Association for the Study of Obesity 2024

The 2024 European Association for the Study of Obesity (EASO) guidelines reinforce obesity as a chronic, relapsing, and multifactorial disease that requires long-term multidisciplinary management [35]. The EASO has reached a consensus on proposing a new framework for the diagnosis, staging, and management of obesity in adults. According to the 2024 EASO guidelines, the diagnosis of obesity includes both anthropometric and clinical components. WC is recommended as an indicator of visceral fat accumulation and cardiometabolic risk, whereas waist-to-height ratio (WHtR) is recommended as an indicator of excessive fat accumulation.

Systematic evaluations of the clinical component of obesity should encompass medical, functional, and psychological complications, including mental health disorders and eating behavior pathology. Medical complications and metabolic risk factors should be assessed through clinical interviews, standardized questionnaires, and exercise testing. Assessment of body composition using dual-energy X-ray absorptiometry (DXA) and estimation of body fat percentage based on BIA are recommended. Sarcopenic obesity should be addressed using diagnostic assessments that incorporate muscle strength, physical performance, and body composition. Psychometric tests for eating behavior disorders and routine screening for obesity-related cancer are recommended.

2025 Lancet Diabetes & Endocrinology Commission

Lancet Diabetes & Endocrinology has published its commission on the definition and diagnostic criteria of clinical obesity [36]. Obesity is defined as excess adiposity, with or without abnormal distribution or function of adipose tissue. Preclinical obesity refers to a state of excess adiposity in which the function of other tissues and organs is preserved, but with a generally increased risk of progressing to clinical obesity and other non-communicable diseases. Preclinical obesity can be specifically defined as the presence of increased adiposity quantified by anthropometric indices or body composition measures without evidence of obesity-related metabolic derangements or end-organ damage. Clinical obesity is a chronic systemic illness in which excess adiposity impairs organ and tissue function. Clinical obesity is characterized by excess adiposity with evidence of obesity-related comorbidities or end-organ damage, such as type 2 diabetes, hypertension, dyslipidemia, obstructive sleep apnea, nonalcoholic fatty liver disease, and osteoarthritis. The Commission further established objective diagnostic criteria to guide clinical decision-making and public health strategies. According to the Commission, BMI-based definitions should only be regarded as surrogate indicators of obesity-related health risks. Excess adiposity should ideally be assessed by direct measures of body fat or at least one anthropometric index, such as WC, waist-to-hip ratio (WHR), or WHtR, in addition to BMI, or by at least two anthropometric criteria (WC, WHR, or WHtR), regardless of BMI. If excess adiposity is confirmed, clinical obesity should be evaluated. The diagnosis of clinical obesity requires evidence of impaired organ or tissue function attributable to obesity or substantial functional limitations in daily activities, including basic activities of daily living, in addition to anthropometric criteria or direct body fat measurements. For patients with clinical obesity, timely implementation of evidence-based treatment is necessary to prevent or reduce obesity-related organ damage. A preventive approach is recommended for individuals with preclinical obesity, and the application of health counseling, level of care, and type of intervention should be guided by individual health risk assessments. Finally, the Committee highlighted the role of policymakers and health authorities in ensuring adequate and equitable access to diagnostic assessments, monitoring, and care for individuals with preclinical obesity. Furthermore, mitigation of weight-based bias and stigma is crucial in society and the healthcare system through public health strategies supported by academic institutions, pro-

https://doi.org/10.4082/kjfm.25.0275

fessional organizations, the media, and public health authorities. Distinguishing between preclinical and clinical obesity in clinical settings is feasible because routine examinations already include anthropometric measurements, blood pressure, fasting glucose, and lipid profiles. These data allow for the early identification of individuals with preclinical obesity who have not yet developed obesity-related comorbidities, thereby creating an opportunity for targeted preventive interventions.

Korean Clinical Practice Guideline for Obesity 2024

The KSSO developed the 2024 Clinical Practice Guidelines for the Diagnosis and Pharmacologic Treatment of Overweight and Obesity (ninth edition) to provide evidence-based recommendations for the diagnosis, evaluation, and treatment of obesity [37]. These guidelines adopt a chronic disease framework, emphasizing that obesity is not only a risk factor but also a chronic, relapsing condition requiring long-term management [38]. The 2024 guidelines introduce the concept of clinical obesity, which is defined as excess adiposity that causes organ or tissue dysfunction or increases the risk of related complications. Diagnosis relies primarily on BMI and WC; however, the guidelines emphasize the need to move beyond anthropometry alone by incorporating metabolic comorbidities and functional impairment into the diagnostic process. Furthermore, the guidelines highlight the importance of the early identification of individuals at risk (including those with preclinical obesity) and timely interventions. Functional health foods and their role in weight management are addressed in a newly added section. The guidelines include expanded recommendations on anti-obesity medications, providing clear indications for initiation, continuation, and discontinuation based on efficacy and tolerability. Shared decision-making is emphasized by incorporating patient preference, cost, and risk-benefit considerations. The KSSO guidelines highlight the importance of early assessment of treatment response and recommend adjustments in cases of insufficient weight loss or poor treatment adherence. Compared to earlier editions, the 2024 guidelines offer a more precise diagnostic framework and expand the scope of pharmacological treatment recommendations. The adoption of the concept of clinical obesity represents a paradigm shift toward complication-centric care aligned with global trends. Table 1 presents a comparison of the diagnostic frameworks of the major guidelines. International guidelines increasingly emphasize mental health, weight stigma, and IWB as integral components of obesity assessment. In contrast, the KSSO guidelines only partially incorporate mental health considerations, primarily in the context of bariatric surgery evaluation. Weight stigma and bias remain insufficiently addressed in the Korean clinical framework. Potential reasons for this gap include limited local evidence, lack of standardized assessment tools, and challenges related to implementation in routine clinical practice. Thus, further research is required to address this gap.

Alternatives to the Body Mass Index-Centric Approach

Other anthropometric measurements

Several anthropometric measurements have been proposed, and extensive epidemiological evidence supports their association with metabolic disease and mortality. WC, a measure of abdominal obesity, is correlated with visceral adipose tissue and positively associated with mortality, independent of BMI [39]. A study of 8,796,759 participants from the Korea National Health Screening Examination showed a positive association between abdominal

Table 1. Comparative summary table: presenting the diagnostic frameworks of the major guidelines

Feature	Canadian Adult Obesity Clinical Practice Guidelines (2020)	AACE/ACE 2023 Guidelines	EASO 2024	Korean Clinical Practice Guideline for Obesity 2024	2025 Lancet Diabetes & Endocrinology Commission
Core definition	To change the focus of obesity management toward improving patient-centered health outcomes	Obesity framed as ABCD; Propose a framework to incorporate weight stigma, IWB, psychological disorder, and social determinants of health into the staging of ABCD severity	Obesity as a chronic, relapsing, and multifactorial disease that requires long-term, multidisciplinary management	To adopt a chronic disease framework, emphasizing that obesity is not merely a risk factor but a chronic, relapsing condition requiring long-term management	Definition and diagnostic criteria of clinical obesity
Clinical implication	Obesity as a chronic disease; diagnosis anchored to health impairment	Complications-centric staging embedded in the ABCD model	Proposing a new framework for the diagnosis, staging, and management of obesity in adults	Risk stratification via body mass index, waist circumference, and comorbidities in guideline algorithms	Distinguishes preclinical and clinical obesity

AACE/ACE, American Association of Clinical Endocrinologists/American College of Endocrinology; EASO, European Association for the Study of Obesity; ABCD, Adiposity-Based Chronic Disease; IWB, internalized weight bias.

obesity and mortality, even in participants with increased WC and normal BMI [21]. A pooled analysis of three population-based Korean prospective cohort studies involving 153,248 adults demonstrated significant positive associations of WC with cardiovascular disease, cancer, and all-cause mortality over a follow-up period of up to 18 years [40]. WHR is an additional anthropometric measurement. Research utilizing data from the Canadian Heart Health Follow-Up Study (1986–2004) showed a positive association between elevated WHR and cardiovascular, cancer, and all-cause mortality [41]. A cohort study of 387,672 adults in the United Kingdom reported that WHR had the strongest association with cause-specific and all-cause mortality compared to BMI and fat mass index [42]. A recent prospective cohort study among Korean adults demonstrated that men with a WHR greater than or equal to 0.95 showed a hazard ratio of 1.28 for all-cause mortality [15]. A meta-analysis demonstrated that a high WHtR was associated with a 16% higher risk of all-cause mortality and a 19% higher risk of cardiovascular mortality [43]. A recent study of 47,741 adults from the NHANES database showed a positive association between WHtR and cause-specific mortality [44]. Other anthropometric indices, such as the body roundness index (BRI) and a body shape index (ABSI), have been proposed to better capture central adiposity and cardiometabolic risk. BRI is a geometrically derived anthropometric index that estimates body shape and fat distribution using WC and height [45]. ABSI is calculated using WC, BMI, and height to produce a waist-to-body-size–adjusted index [46]. Studies suggest that BRI has good discriminatory power for metabolic syndrome, type 2 diabetes, and cardiovascular risk [47], while ABSI has been associated with cardiometabolic events independent of BMI [48].

Direct fat measurements, rather than estimates based on anthropometric measurements, provide more precise information about adiposity. Body fat can be measured directly and indirectly. Hydrodensitometry, or underwater weighing, has historically been regarded as a reference method for measuring body density [49]. This technique involves individuals sitting on a chair suspended within a constructed tank and measuring their body density based on the displacement of water after exhalation while submerged. Despite its high accuracy, this method is impractical because it is highly influenced by the patient's water confidence and is not applicable to individuals who are pregnant, those with disabilities, or older adults. Air displacement plethysmography is an alternative technique for measuring body volume based on the displacement of air within a sealed chamber [50]. Although previous studies have shown moderate agreement with hydrodensitometry, the accuracy of this technique is affected by environmental and surrounding factors [51]. DXA assesses a three-compartment body composition model with relatively low operational costs and short measurement time [52]. However, assumptions regarding fat-free mass hydration [53] and body fat derived from the sum of other tissues and not adipose tissue exclusively limit its accuracy [54]. Computed tomography (CT) enables the direct quantification of adipose tissue depots, including visceral and subcutaneous fat; however, radiation exposure restricts repeated measurements [55]. Although magnetic resonance imaging (MRI) can accurately quantify adiposity without radiation exposure [56], it is expensive and time-consuming. BIA measures body water compartments and estimates body composition by measuring electrical current changes in body compartments [57]. Hydration status, dietary intake, and physical activity affect the accuracy of BIA, and differences in algorithms across devices and manufacturers further limit its reproducibility.

Clinical implications and practical limitations

The implementation of a comprehensive obesity assessment framework has important clinical implications but is constrained by practical limitations. Although advanced imaging modalities (e.g., DXA, MRI, and CT) and detailed body composition analyses provide precise measures of adiposity distribution, they are often limited by high costs, prolonged procedure times, and limited accessibility in routine clinical settings. Similarly, psychosocial assessments, including evaluations of weight stigma and IWB, require validated instruments and trained personnel that may not be available in all clinical settings.

From a pragmatic standpoint, clinicians may adopt a tiered approach to integrate the key elements of comprehensive assessment. BMI and WC can serve as readily obtainable baseline indicators for initial risk stratification. These measures may then be supplemented with selected staging components, such as the presence of cardiometabolic comorbidities, functional status evaluation, and mental health screening, to capture disease severity more accurately and guide individualized management.

Conclusion

Several guidelines confirm the need to use at least two anthropometric criteria, such as WC, WHR, or WHtR, to confirm excess or abnormal adiposity, in addition to BMI or direct body fat measurements. The diagnosis of obesity requires clinical, psychological, and social aspects, in addition to the confirmation of excess or abnormal adiposity. Comprehensive evaluations can provide a more accurate reflection of an individual's health status and guide personalized management strategies. Despite the limited literature on the association between comprehensive obesity assessments and health outcomes, future studies are required to evaluate the association between comprehensive obesity assessments and long-term health outcomes. Comprehensive assessments are expected to improve long-term outcomes and enhance cost-effectiveness through timely and appropriate evidence-based interventions. A paradigm shift toward recognizing obesity as a chronic disease is essential and should be accompanied by discussions on pragmatic approaches to integrate comprehensive

https://doi.org/10.4082/kjfm.25.0275

frameworks into clinical practice for adults with obesity. Support from targeted policy actions and public health is indispensable for active implementation in clinical practice. Finally, weight-based bias or stigma remains prevalent in both society and the healthcare system, posing a major barrier to effective prevention and management of obesity, thereby underscoring the need for targeted public health strategies.

Article Information

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

None.

Data availability

Not applicable.

ORCID

Sinyoung Cho: https://orcid.org/0009-0000-7991-3715
Hyuktae Kwon: https://orcid.org/0000-0002-0312-3650

Author contribution

Conceptualization: SC, HK. Methodology: SC, HK. Writing–original draft: SC. Writing–review & editing: SC, HK. Final approval of the manuscript: SC, HK.

References

1. WHO consultation. Obesity: preventing and managing the global epidemic. World Health Organ Tech Rep Ser 2000;894:1-253.
2. World Health Organization. Obesity and overweight [Internet]. World Health Organization; 2025 [cited 2025 Oct 10]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
3. Cho S, Jung JH, Nam GE, Cho IY, Park KY, Jeong SM, et al. 2024 obesity fact sheet in Korea: prevalence of obesity, abdominal obesity, obesity defined by body fat percentage, and underweight in adults in Korea from 2013 to 2022. J Obes Metab Syndr 2025;34:405-13.
4. Mechanick JI, Garber AJ, Handelsman Y, Garvey WT. American Association of Clinical Endocrinologists' position statement on obesity and obesity medicine. Endocr Pract 2012;18:642-8.
5. James WP. WHO recognition of the global obesity epidemic. Int J Obes (Lond) 2008;32 Suppl 7:S120-6.
6. Bray GA, Kim KK, Wilding JP. Obesity: a chronic relapsing progressive disease process: a position statement of the World Obesity Federation. Obes Rev 2017;18:715-23.
7. Abdullah A, Peeters A, de Courten M, Stoelwinder J. The magnitude of association between overweight and obesity and the risk of diabetes: a meta-analysis of prospective cohort studies. Diabetes Res Clin Pract 2010;89:309-19.
8. Dwivedi AK, Dubey P, Cistola DP, Reddy SY. Association between obesity and cardiovascular outcomes: updated evidence from meta-analysis studies. Curr Cardiol Rep 2020;22:25.
9. Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K. Body fatness and cancer: viewpoint of the IARC working group. N Engl J Med 2016;375:794-8.
10. Global BMI Mortality Collaboration, Di Angelantonio E, Bhupathiraju SH, Wormser D, Gao P, Kaptoge S, et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. Lancet 2016;388:776-86.
11. Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. Lancet 2011;378:815-25.
12. Cornier MA, Despres JP, Davis N, Grossniklaus DA, Klein S, Lamarche B, et al. Assessing adiposity: a scientific statement from the American Heart Association. Circulation 2011;124:1996-2019.
13. Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, et al. Accuracy of body mass index in diagnosing obesity in the adult general population. Int J Obes (Lond) 2008;32:959-66.
14. Liu XY, Ge SY, Liu CA, Yin B, Bu ZT, Zheng X, et al. Validation of the 2024 European Association for the Study of Obesity diagnostic criteria: a comprehensive assessment of obesity-related mortality risks. Diabetes Obes Metab 2025;27:2405-17.
15. Kyrou I, Randeva HS, Tsigos C, Kaltsas G, Weickert MO. Clinical problems caused by obesity. In: Feingold KR, Ahmed SF, Anawalt B, Blackman MR, Boyce A, Chrousos G, et al., editors. Endotext. MDText.com Inc.; 2000.
16. Jee SH, Sull JW, Park J, Lee SY, Ohrr H, Guallar E, et al. Body-mass index and mortality in Korean men and women. N Engl J Med 2006;355:779-87.
17. Cho S, Shin A, Choi JY, Lee JK, Kang D. Impact of body mass index and waist-to-hip ratio on mortality in middle-aged Koreans: a prospective cohort study based on a health examinees study. Epidemiol Health 2024;46:e2024073.
18. Gomez-Ambrosi J, Silva C, Galofre JC, Escalada J, Santos S, Millan D, et al. Body mass index classification misses subjects with increased cardiometabolic risk factors related to elevated adiposity. Int J Obes (Lond) 2012;36:286-94.
19. Romero-Corral A, Somers VK, Sierra-Johnson J, Korenfeld Y, Boarin S, Korinek J, et al. Normal weight obesity: a risk factor for cardiometabolic dysregulation and cardiovascular mortality. Eur Heart J 2010;31:737-46.
20. Batsis JA, Sahakyan KR, Rodriguez-Escudero JP, Bartels SJ, Somers VK, Lopez-Jimenez F. Normal weight obesity and mortality in United States subjects ≥60 years of age (from the Third National Health and Nutrition Examination Survey). Am J Cardiol 2013;112:1592-8.
21. Cho GJ, Yoo HJ, Hwang SY, Choi J, Lee KM, Choi KM, et al. Differential relationship between waist circumference and mortality according to age, sex, and body mass index in Korean with age of 30-90 years; a nationwide health insurance database study. BMC Med 2018;16:131.
22. Yang HK, Han K, Kwon HS, Park YM, Cho JH, Yoon KH, et al. Obesity, metabolic health, and mortality in adults: a nationwide population-based study in Korea. Sci Rep 2016;6:30329.
23. Wharton S, Lau DCW, Vallis M, Sharma AM, Biertho L, Camp-

bell-Scherer D, et al. Obesity in adults: a clinical practice guideline. CMAJ 2020;192:E875-91.
24. Sharma AM, Kushner RF. A proposed clinical staging system for obesity. Int J Obes (Lond) 2009;33:289-95.
25. Padwal RS, Pajewski NM, Allison DB, Sharma AM. Using the Edmonton obesity staging system to predict mortality in a population-representative cohort of people with overweight and obesity. CMAJ 2011;183:E1059-66.
26. Garvey WT, Garber AJ, Mechanick JI, Bray GA, Dagogo-Jack S, Einhorn D, et al. American Association of Clinical Endocrinologists and American College of Endocrinology position statement on the 2014 advanced framework for a new diagnosis of obesity as a chronic disease. Endocr Pract 2014;20:977-89.
27. Garvey WT, Mechanick JI, Brett EM, Garber AJ, Hurley DL, Jastreboff AM, et al. American Association of Clinical Endocrinologists and American College of Endocrinology comprehensive clinical practice guidelines for medical care of patients with obesity. Endocr Pract 2016;22 Suppl 3:1-203.
28. Nadolsky K, Addison B, Agarwal M, Almandoz JP, Bird MD, DeGeeter Chaplin M, et al. American Association of Clinical Endocrinology consensus statement: addressing stigma and bias in the diagnosis and management of patients with obesity/adiposity-based chronic disease and assessing bias and stigmatization as determinants of disease severity. Endocr Pract 2023;29:417-27.
29. Puhl R, Brownell KD. Bias, discrimination, and obesity. Obes Res 2001;9:788-805.
30. Puhl RM, Heuer CA. The stigma of obesity: a review and update. Obesity (Silver Spring) 2009;17:941-64.
31. Durso LE, Latner JD. Understanding self-directed stigma: development of the weight bias internalization scale. Obesity (Silver Spring) 2008;16 Suppl 2:S80-6.
32. Pearl RL, Puhl RM. Weight bias internalization and health: a systematic review. Obes Rev 2018;19:1141-63.
33. Papadopoulos S, Brennan L. Correlates of weight stigma in adults with overweight and obesity: a systematic literature review. Obesity (Silver Spring) 2015;23:1743-60.
34. Puhl R, Suh Y. Health consequences of weight stigma: implications for obesity prevention and treatment. Curr Obes Rep 2015;4:182-90.
35. Busetto L, Dicker D, Fruhbeck G, Halford JCG, Sbraccia P, Yumuk V, et al. A new framework for the diagnosis, staging and management of obesity in adults. Nat Med 2024;30:2395-9.
36. Rubino F, Cummings DE, Eckel RH, Cohen RV, Wilding JP, Brown WA, et al. Definition and diagnostic criteria of clinical obesity. Lancet Diabetes Endocrinol 2025;13:221-62.
37. Clinical Guidelines Committee of the Korean Society for the Society of Obesity. Clinical Practice Guideline for Obesity 2024. 9th ed. Korean Society for the Society of Obesity; 2024.
38. Bae JH, Haam JH, Jeon E, Kang SY, Song S, Park CY, et al. 2024 clinical practice guidelines for the diagnosis and pharmacologic treatment of overweight and obesity by the Korean Society for the Study of Obesity. J Obes Metab Syndr 2025;34:322-43.
39. Jacobs EJ, Newton CC, Wang Y, Patel AV, McCullough ML, Campbell PT, et al. Waist circumference and all-cause mortality in a large US cohort. Arch Intern Med 2010;170:1293-301.
40. Jang H, Kim R, Lee JT, Lee DH, Giovannucci EL, Oh H. Overall and abdominal obesity and risks of all-cause and cause-specific mortality in Korean adults: a pooled analysis of three population-based prospective cohorts. Int J Epidemiol 2023;52:1060-73.
41. Staiano AE, Reeder BA, Elliott S, Joffres MR, Pahwa P, Kirkland SA, et al. Body mass index versus waist circumference as predictors of mortality in Canadian adults. Int J Obes (Lond) 2012;36:1450-4.
42. Khan I, Chong M, Le A, Mohammadi-Shemirani P, Morton R, Brinza C, et al. Surrogate adiposity markers and mortality. JAMA Netw Open 2023;6:e2334836.
43. Abdi Dezfouli R, Mohammadian Khonsari N, Hosseinpour A, Asadi S, Ejtahed HS, Qorbani M. Waist to height ratio as a simple tool for predicting mortality: a systematic review and meta-analysis. Int J Obes (Lond) 2023;47:1286-301.
44. Wang G, Luo Y, Yang T, Huang J, Li J, Liu Y, et al. Association of waist-to-height ratio with all-cause and obesity-related mortality in adults: a prospective cohort study. Front Nutr 2025;12:1614347.
45. Thomas DM, Bredlau C, Bosy-Westphal A, Mueller M, Shen W, Gallagher D, et al. Relationships between body roundness with body fat and visceral adipose tissue emerging from a new geometrical model. Obesity (Silver Spring) 2013;21:2264-71.
46. Krakauer NY, Krakauer JC. A new body shape index predicts mortality hazard independently of body mass index. PLoS One 2012;7:e39504.
47. Li Z, Fan C, Huang J, Chen Z, Yu X, Qian J. Non-linear relationship between the body roundness index and metabolic syndrome: data from National Health and Nutrition Examination Survey (NHANES) 1999-2018. Br J Nutr 2024;131:1852-9.
48. Yusoff FM, Kajikawa M, Yamaji T, Mizobuchi A, Kishimoto S, Maruhashi T, et al. A body shape index as a simple anthropometric marker for the risk of cardiovascular events. Curr Cardiol Rep 2025;27:46.
49. Katch F, Michael ED, Horvath SM. Estimation of body volume by underwater weighing: description of a simple method. J Appl Physiol 1967;23:811-3.
50. Dempster P, Aitkens S. A new air displacement method for the determination of human body composition. Med Sci Sports Exerc 1995;27:1692-7.
51. Lockner DW, Heyward VH, Baumgartner RN, Jenkins KA. Comparison of air-displacement plethysmography, hydrodensitometry, and dual X-ray absorptiometry for assessing body composition of children 10 to 18 years of age. Ann N Y Acad Sci 2000;904:72-8.
52. Pietrobelli A, Formica C, Wang Z, Heymsfield SB. Dual-energy X-ray absorptiometry body composition model: review of physical concepts. Am J Physiol 1996;271(6 Pt 1):E941-51.
53. Pietrobelli A, Wang Z, Formica C, Heymsfield SB. Dual-energy X-ray absorptiometry: fat estimation errors due to variation in soft tissue hydration. Am J Physiol 1998;274:E808-16.
54. Mazess RB, Barden HS, Bisek JP, Hanson J. Dual-energy X-ray absorptiometry for total-body and regional bone-mineral and soft-tissue composition. Am J Clin Nutr 1990;51:1106-12.
55. Seidell JC, Oosterlee A, Deurenberg P, Hautvast JG, Ruijs JH. Abdominal fat depots measured with computed tomography: effects of degree of obesity, sex, and age. Eur J Clin Nutr 1988;42:805-15.
56. Thomas EL, Saeed N, Hajnal JV, Brynes A, Goldstone AP, Frost G, et al. Magnetic resonance imaging of total body fat. J Appl Physiol (1985) 1998;85:1778-5.
57. Schoeller DA. Bioelectrical impedance analysis: what does it measure? Ann N Y Acad Sci 2000;904:159-62.