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REVIEW

Beyond Single Anthropometric Measures: Integrating Waist Circumference and Body Mass Index to Stratify Obesity-Related Health Risk

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Abstract

Purpose of the review Waist circumference (WC) in combination with body mass index (BMI) provides unique opportunities to capture the heterogeneous nature of obesity and identify phenotypes that convey the greatest health risk. This review summarizes evidence supporting global recognition that WC and BMI should be routinely documented in health care. Differences in risk stratification when WC and BMI are used in categorical versus continuous models are examined, and strategies to increase routine measurement in clinical settings are discussed.

Recent Findings Leading authorities worldwide including the Lancet Obesity Commission and the European Association for the Study of Obesity recognize obesity as a heterogeneous condition requiring combined interpretation of WC and BMI to identify distinct phenotypes. Obesity-related risk differs substantially depending on whether WC and BMI are treated as categorical or continuous measures. Current risk stratification systems rely on categorical approaches that have clinically relevant limitations, including loss of risk resolution from applying a single WC cut-point across BMI categories. Evidence further shows that associations between WC and adverse outcomes strengthen after adjustment for BMI, and that when WC and BMI are modeled simultaneously as continuous variables, WC consistently emerges as a stronger predictor of health outcomes, while associations with BMI are attenuated or reversed.

Summary WC and BMI combined are simple tools that facilitate the identification of obesity heterogeneity and phenotypes associated with elevated health risk. Risk estimates differ depending on whether WC and BMI are modeled as categorical or continuous variables, with implications for how obesity-related risk is assessed and interpreted in practice. Recommendations for their optimal combined use, including a proof-of-concept nomogram to support clinical interpretation, are provided. Despite guideline recommendations worldwide, BMI and WC remain infrequently documented in clinical practice. This implementation gap represents a missed, low-cost opportunity to improve public health messaging, risk stratification, and clinical management of obesity-related risk.

Keywords Abdominal obesity · Waist circumference · Body mass index · Anthropometry

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Introduction

Current approaches to obesity assessment and risk stratification in clinical practice rely heavily on body mass index (BMI), despite well-recognized limitations in its ability to capture variation in body fat distribution and associated health risk. As a result, individuals with similar BMI may have markedly different health risk profiles, highlighting a critical gap in the identification of high-risk obesity phenotypes.

There is now substantial evidence that obesity should no longer be considered a homogeneous condition. Terms

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such as "obesities" and "obesity phenotypes" have been proposed to better reflect the heterogeneous nature of what has been traditionally defined by BMI alone. To address this limitation of the BMI, several consensus groups and organisations, including the Lancet Obesity Commission, now recommend the addition of an index of abdominal adiposity, such as waist circumference (WC), to identify distinct obesity phenotypes and accordingly, individuals at higher health risk [1].

In this review, we provide a narrative summary of recent evidence reinforcing the global recognition that WC should be routinely documented and that obesity-related health risk is best interpreted using combined measures of WC and BMI. We highlight the unique and complementary information obtained when WC and BMI are considered jointly, enabling health-risk stratification that is not achievable using either measure alone. We then describe clinically meaningful differences in risk classification when WC and BMI are analyzed using categorical versus continuous models. Finally, we examine strategies to increase the routine measurement and documentation of WC and BMI in health-care settings, and discuss how the inclusion of these measures into clinical workflows could help close the evidence-to-practice gap by improving risk stratification, informing treatment decisions, and enabling more robust monitoring of intervention effectiveness.

This narrative review synthesizes evidence identified through targeted PubMed searches and review of reference lists, emphasizing recent high-quality studies, including systematic reviews, large prospective cohort studies, and international consensus statements, while incorporating seminal earlier work where appropriate. A formal systematic search strategy and predefined inclusion or exclusion criteria were not applied.

Public Health Importance of Waist Circumference

Evidence demonstrating that abdominal obesity, as characterized by WC, is a powerful, independent predictor of morbidity and premature mortality is well established [2]. This observation has public health implications as the prevalence of abdominal obesity in adults worldwide is high and increasing [2]. Systematic reviews synthesizing data from millions of adults worldwide demonstrate that WC defined abdominal obesity is highly prevalent globally [3]. In a comprehensive global meta-analysis incorporating 288 studies of 13.2 million adults, the pooled prevalence of abdominal obesity was 41.5% (95% CI 39.9–43.2), which extrapolates to over 2.5 billion adults living with abdominal obesity worldwide. There is also substantial regional variation, ranging from approximately 31% in some low-income regions to more than 55% in parts of Europe and the Middle East [3]. Of particular concern is the observation that, based on pooled global estimates, the prevalence of abdominal obesity increases markedly with age [3]. Given that the share of the global population aged 65 years and above is projected to rise from 10% in 2022 to 16% in 2050 [4], it is likely that the prevalence of abdominal obesity will continue to increase at alarming rates.

The public health importance of WC is further reinforced by recent evidence demonstrating that it is tied to increased healthcare costs. Lee et al. employed a Mendelian-randomization approach to assess the causal impact of 15 biological risk factors on annual healthcare costs among approximately 343 000 Finnish adults [5]. WC emerged as the strongest contributor to healthcare costs. A one-standard-deviation increase in WC was associated with a 23% increase (absolute increase, €298.99 per 1 SD) in annual total healthcare costs [5]. Thus, WC is not simply a biomarker of health risk, but a key driver of healthcare expenditures. These observations provide a strong foundation for the recommendation that WC be regarded as a vital sign and measured routinely across health-care settings. At the same time, they invite an important, and often implicit question: should WC replace BMI in stratifying obesity-related health risk? Framing the issue in this way, however, reflects a false dichotomy. WC captures central adiposity, whereas BMI reflects overall body size, and when interpreted jointly, particularly as continuous variables, their combined use provides more informative and clinically meaningful risk stratification than either measure alone.

Integrating Waist Circumference and Body Mass Index to Stratify Obesity-Related Health Risk

Numerous diagnostic or staging frameworks for obesity have been published by international expert groups and professional societies (e.g., the Lancet Commission on clinical obesity and the European Association for the Study of Obesity) [1, 6–11]. Despite differences in scope and emphasis [6], these frameworks uniformly conclude that BMI alone is insufficient for the diagnosis of obesity as a risk factor. Accordingly, current frameworks recommend that an additional assessment that captures abdominal adiposity be added to BMI, reflecting the clinical importance of adipose tissue distribution for morbidity and mortality [1, 6–11]. Earlier statements commonly operationalized this approach using WC, given its long-standing use, feasibility, and established links with cardiometabolic risk, whereas some recent consensus documents suggest that WC or waist-to-height ratio (WHtR) are interchangeable as measures of abdominal obesity [1, 6–11]. Notably, within these recently published

obesity staging frameworks, the combined use of BMI and WC or WHtR represents an important first step in identifying individuals with an obesity phenotype associated with increased health risk; subsequent assessments are then used to characterize the presence and severity of obesity-related complications or functional impairment [6]. Importantly, evidence indicates that treatment targeting elevated BMI and/or WC is associated with clinical benefit irrespective of whether overt obesity-related disease or functional impairment is present [6].

Although WC and BMI are strongly associated with the relative risk of morbidity and mortality, their addition to established models for estimating absolute cardiovascular risk may not meaningfully improve model discrimination or reclassification beyond traditional risk factors [12]. This observation is not unexpected for two reasons. First, established risk-prediction models derive much of their prognostic performance from nonmodifiable factors such as age and sex. Second, the associations of WC and BMI with cardiovascular risk are mediated, in part, through established cardiometabolic risk factors. As a result, once these downstream cardiometabolic risk factors are included in prediction models, WC and BMI may provide little additional predictive value. This should not be interpreted to mean that WC and BMI are unimportant. Rather, their clinical importance may lie in their role as upstream determinants of the cardiometabolic abnormalities that ultimately drive cardiovascular risk.

Waist Circumference or Waist-to-Height Ratio

Abdominal obesity determined by using WC alone or WHtR is related to cardiometabolic risk, morbidity and mortality by a similar order of magnitude [13–18]. Comparative analyses generally show that WHtR yields slightly higher discrimination than WC for certain outcomes, particularly cross-sectional identification of the metabolic syndrome, but that absolute differences in risk prediction are small, with pooled area under the curve (AUC) differences in the range of 0.01–0.04 [13]. Prospective studies for incident type 2 diabetes (T2D), cardiovascular disease, mortality, and multimorbidity demonstrate similar relative risks or hazard-ratio gradients for WHtR and WC, with substantial overlap in confidence intervals across diverse populations and age [14, 16, 17], These observations are not surprising given that WC is common to both variables and in most adults, is the only component of the WHtR that changes.

A single prospective study has directly compared longitudinal changes in WC and WHtR in relation to incident disease. In the Whitehall II cohort, repeated measurements of WC and WHtR collected over approximately 10 years were used to quantify standardized changes in both variables and relate them to subsequent risk of T2D. In fully adjusted models, a 1-SD increase in WC change per decade was associated with a threefold higher risk of T2D (hazard ratio [HR] = 3.01, 95% CI: 2.15–4.22), while a comparable association was observed for WHtR (HR = 2.67, 95% CI: 2.00–3.55) [18].

Taken together, the cross-sectional and prospective evidence suggests that WHtR provides little or no incremental information beyond that conveyed by WC alone. A more important distinction may lie in clinical interpretation. WC is typically treated as a continuous marker of abdominal obesity, with lifestyle-based intervention studies demonstrating graded associations with cardiometabolic risk factors across the distribution of WC, independent of BMI and without evidence of a clear threshold effect [2, 19]. As a result, modest reductions (~2 cm) in WC are commonly interpreted as clinically meaningful indicators of reduced abdominal adiposity. In contrast, WHtR is most often interpreted using categorical thresholds, with values < 0.50 generally considered low risk, values of approximately 0.50–0.59 indicating increased cardiometabolic risk, and values ≥ 0.60 often described as high risk, particularly in population screening frameworks [8, 9].

Importantly, the magnitude of WC reduction required to meaningfully change WHtR category is substantial. For adults of average height, a reduction in WHtR of 0.05, for example, from 0.55 to the commonly cited 0.50 threshold, requires a WC reduction of 8–9 cm, whereas a 0.10 reduction (e.g., 0.60 to 0.50) requires WC reductions of approximately 16–18 cm. A smaller WHtR change, for example, from 0.58 to 0.56 ($\Delta = 0.02$), corresponds to a WC reduction of ~3–4 cm. Although a change of this magnitude would not alter categorical WHtR risk classification, it would typically be interpreted as a clinically meaningful reduction in abdominal adiposity when WC is the exposure variable [2]. In summary, the modest but clinically meaningful WC reductions commonly observed in intervention trials translate into very small absolute changes in WHtR, and are unlikely to alter threshold-based WHtR risk category (1).

These observations indicate that while WHtR may confer modest statistical advantages in selected settings, the clinical distinction between WHtR and WC is limited, and neither measure shows clear superiority for predicting clinical endpoints. Accordingly, divergence among recent diagnostic guidelines appears to reflect differences in priorities related to simplicity, standardization, and ease of implementation, including the appeal of a single height-normalized boundary value for WHtR rather than meaningful differences in clinical relevance [8, 9]. Nevertheless, as acknowledged by international expert groups and professional societies,

the central advance from both a clinical and public-health perspective is the routine incorporation of a measure of abdominal adiposity alongside BMI in the diagnosis of obesity-related health risk.

In practical terms, because adults can readily be taught to measure their own WC, tracking this simple anthropometric measure over time offers a simple way to monitor changes in abdominal adiposity relevant to health, supporting its consideration as a "vital sign." Because adult height is stable, repeated WC measurement alone is sufficient to capture longitudinal changes in abdominal adiposity over time. These observations highlight a unique opportunity for adults and health professionals to monitor a simple, clinically relevant anthropometric measure. Accordingly, when implementation and interpretability are prioritized, WC offers practical advantages compared with WHtR, including ease of measurement for adults and practitioners, the absence of a need for repeated height assessment (stable in adults), and straightforward interpretation of small changes (increase or decrease) over time.

Identifying the High-risk Obesity Phenotype

Waist Circumference, BMI and Health Outcomes: Categorical Analysis

Although BMI and WC are each independently related to morbidity and mortality across age, biological sex, and race, there is considerable heterogeneity in WC for any given BMI [2]. Within each BMI category, higher WC consistently identifies individuals at increased risk compared with those with lower WC. This observation was clearly illustrated by Cerhan et al. [20], who pooled data from 650,386 adults and observed that WC was positively associated with mortality within each BMI category between 20 and 50 kg/m^2. This finding was confirmed by Kim et al. [21], who studied over 20 million Korean adult men and women and also observed that there was a linear association between WC and all-cause mortality after controlling for age, sex, smoking, alcohol, exercise and income within BMI categories between 18.5 and 30 kg/m^2. Jacobs et al. [22] examined the association between WC and mortality among 48 500 men and 56 343 women 50 years or older in the Cancer Prevention Study II Nutrition Cohort. Consistent with prior studies, WC was positively associated with mortality within all BMI categories. In men, every 10-cm increase in WC was associated with a 16% (95% CI: 9–23%), 18% (95% CI: 12–24%), and 21% (95% CI: 13–30%) increase in mortality risk within normal (18.5 to 25), overweight (25 to 30), and obesity (>30 kg/m^2) BMI categories, respectively. In women, corresponding increased risks were 25% (95% CI: 18–32%), 15% (95% CI: 8–22%), and 13% (95% CI: 6–20%).

Despite evidence of graded risk across increasing WC values, current obesity risk classification systems recommend using the same WC threshold values for all BMI categories [2]. For example, health risk in White adults with a BMI of 25–30 or 30–35 kg/m² is categorized as "very high" when these BMI categories are combined with a WC of 102 cm or higher [2, 7, 8]. The use of this single WC cut-point forces a continuous exposure into binary "high WC" vs. "low WC" categories. This reduces precision, ignores meaningful differences in risk within the "high WC" and "low WC" categories, and creates a false impression that risk changes abruptly at the WC cut-point. Furthermore, the use of the same WC cut-point in the normal weight, overweight and obese BMI categories ignores evidence that BMI-specific WC thresholds are superior at predicting risk [23]. In addition to the loss of risk resolution that accompanies the use of a single WC cut-point within all BMI categories, the categorical use of WC and BMI introduces two further limitations. First, evidence indicates that the association between WC and adverse health outcomes becomes stronger after statistical adjustment for BMI [24, 25]. Second, when WC and BMI are modelled simultaneously as continuous variables, WC emerges as a stronger predictor of health outcomes, whereas deleterious associations for BMI are attenuated, or in some cases, reversed.

Waist Circumference, BMI and Health Outcomes: Continuous Analysis

That the strength of the association between WC and adverse health outcomes is strengthened after adjustment for BMI has been reported in several investigations [22–24]. This observation is well illustrated by Bigaard and colleagues [24, 25], who studied the association between WC, BMI and mortality in 57,053 middle-aged Danish men and women. Independent of age, for both men and women, the full strength of the positive association between WC and mortality was realized after controlling for BMI (Fig. 1, Top). Conversely, after adjustment for WC, BMI was inversely related to mortality (Fig. 1, Bottom). These findings were later confirmed by Pischon et al. [26], who pooled data for 359 387 participants from nine countries in the European Prospective Investigation into Cancer and Nutrition (EPIC). A primary finding was that the positive association between WC and all-cause mortality strengthened markedly after adjustment for BMI, increasing the hazard ratio for individuals in the highest WC quintile from 1.33 (95% CI: 1.24–1.44) to 2.05 (95% CI: 1.80–2.33). The authors also observed that for a given WC quintile, the hazard ratio for mortality generally decreased with increasing BMI for men

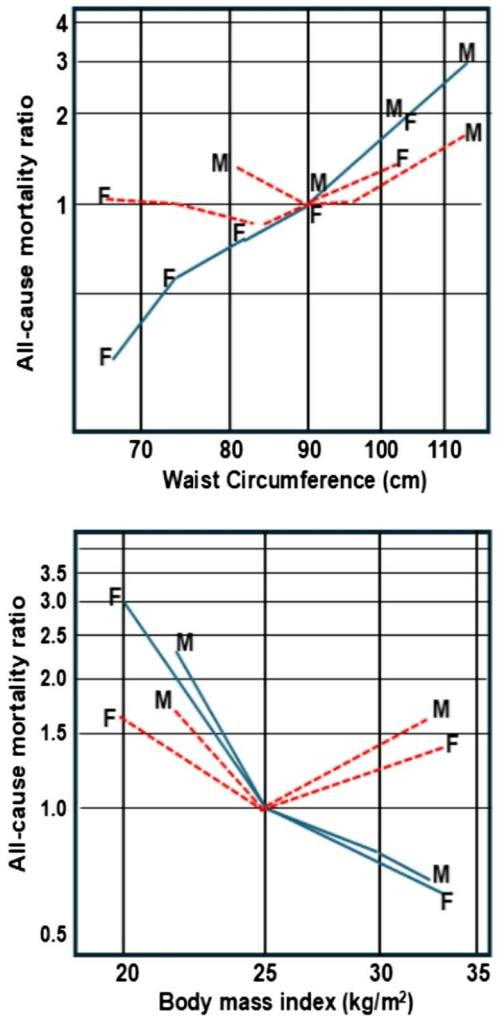

Fig. 1 Reproduced from Bigaard [21]. Associations between WC and BMI and all-cause mortality for men and women 50 to 64 years of age. Upper panel, WC and mortality (quartile breakpoints). Lower panel, BMI and mortality (breakpoints: 25 and 30 kg/m^2). Dashed red lines, unadjusted associations. Solid blue lines, mutually adjusted associations. Both y-axes are log-scales. M, male participants; F, female participants.

and women. This pattern was reinforced in a pooled analysis by Coutinho et al. [27] who combined individual-level data from five prospective studies of adults with cardiovascular disease. In multivariable models that included adjustment for BMI, WC was positively associated with all-cause mortality (HR = 1.29, 95% CI: 1.20–1.39). In contrast, BMI demonstrated an inverse association with mortality when adjusted for WC and other covariates (HR = 0.64, 95% CI: 0.59–0.69).

That a higher BMI may be protective against morbidity and mortality at a given WC is especially relevant in older adults, given that aging is characterized by progressive increases in WC coupled with declines in lower-body subcutaneous adipose tissue and skeletal muscle mass. The importance of considering BMI and WC in combination in older adults is reported in several studies [28–31]. In a meta-analysis of 29 prospective cohorts including 58 609 adults aged 65–74 years, de Hollander et al. [28] reported that WC was positively associated with all-cause mortality after accounting for BMI, whereas BMI showed an inverse association with mortality after accounting for WC. Importantly, among normal-weight adults, a large WC was associated with substantially higher mortality risk compared with a small WC (men: RR = 1.7, 95% CI: 1.2–2.2; women: RR = 1.7, 95% CI: 1.3–2.3). Conversely, within WC categories, overweight status as determined by BMI was associated with similar or lower mortality risk than normal weight (e.g., men with a small WC : RR = 0.9, 95% CI: 0.8–1.0).

Collectively, observations from studies examining the combined influence of BMI and WC on health risk underscore two important points. First, BMI and WC combined identify health risk better than either variable alone. Second, the risk prediction may change substantively depending on whether WC and BMI are considered as categorical or continuous variables in regression models (Fig. 2).

The biological basis for the protective effect of BMI on risk after accounting for WC is not firmly established. We [2] and others [32] have proposed that for a given WC, a higher BMI or thigh circumference may reflect a greater capacity to store the consumption of excess energy into peripheral (lower body) subcutaneous adipocytes and, consequently, less deposition of excess energy into ectopic depots, including visceral adipose tissue, an established marker of increased cardiometabolic risk. Alternatively, adults with a lower BMI for a given WC would have less subcutaneous adipose tissue and thus, higher amounts of visceral adipose tissue.

This notion is supported by findings from Kuk et al. [33], who observed that BMI, hip and thigh circumference were positively associated with visceral adipose tissue before adjustment for WC, but inversely associated after adjustment for WC. When WC was held constant, higher BMI was also positively associated with lower-body subcutaneous adipose tissue and skeletal muscle mass. These observations support the notion that the inverse association between BMI, hip and thigh circumference and morbidity or mortality risk observed after adjustment for WC may reflect a greater deposition of peripheral adiposity and muscle mass, a decreased accumulation of visceral adipose tissue, or both (Fig. 3).

Clinical interpretation of obesity-related health risk differs substantially depending on whether BMI and WC are treated as categorical or continuous measures. Current obesity- risk classification systems recommend using the same WC threshold values for all BMI categories. Although

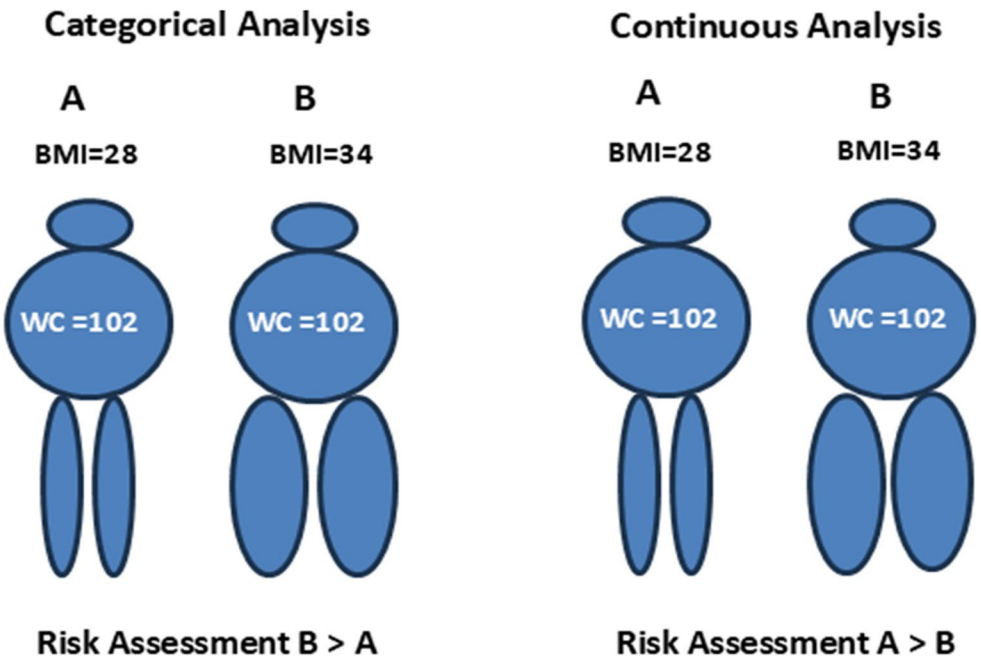

Fig. 2 Differences in risk stratification when WC and BM are used in categorical and continuous models. For the same WC and BMI values, in categorical analysis, risk assessment in subject A is greater than subject B, whereas in categorical analysis, risk assessment in subject B is greater than subject A. See related text for details

categorical classification systems offer a straightforward and accessible framework for clinical interpretation, as we have shown, this approach may fail to identify individuals with a high-risk phenotype. In contrast, although current evidence supports the use of BMI and WC as continuous measures, it would be less pragmatic for clinicians and allied health practitioners to identify high-risk phenotypes in routine practice using combinations of continuous measures. In response, we propose that a simple nomogram could be used by clinicians to identify individuals with the high-risk phenotype.

Here we present a 'proof of concept' model illustrating how continuous measures of WC and BMI, when modeled

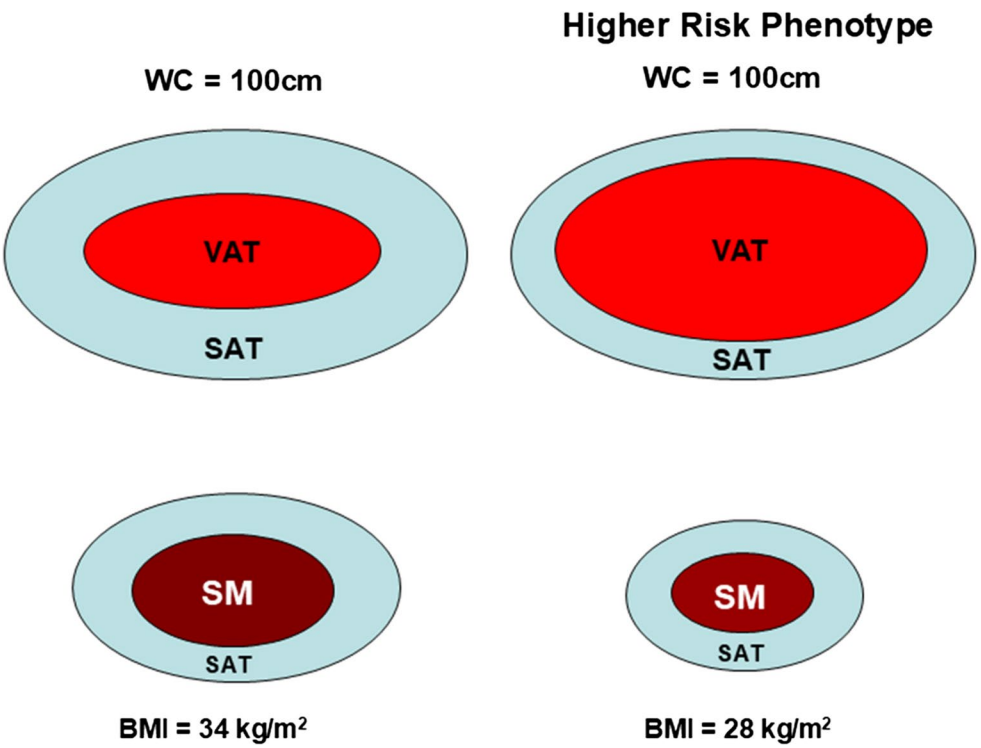

Fig. 3 The 'higher-risk phenotype' reflects the inability of subcutaneous adipose tissue (SAT) depicted in the lower body to expand through hyperplasia (generation of new fat cells) which allows the storage of excess energy intake into a properly expanding subcutaneous 'metabolic sink'. When this process becomes saturated or in situations where adipose tissue has a limited ability to expand, there is a spillover of the excess energy, which must be stored in ectopic sites including visceral adipose tissue (VAT). See reference [2] for details

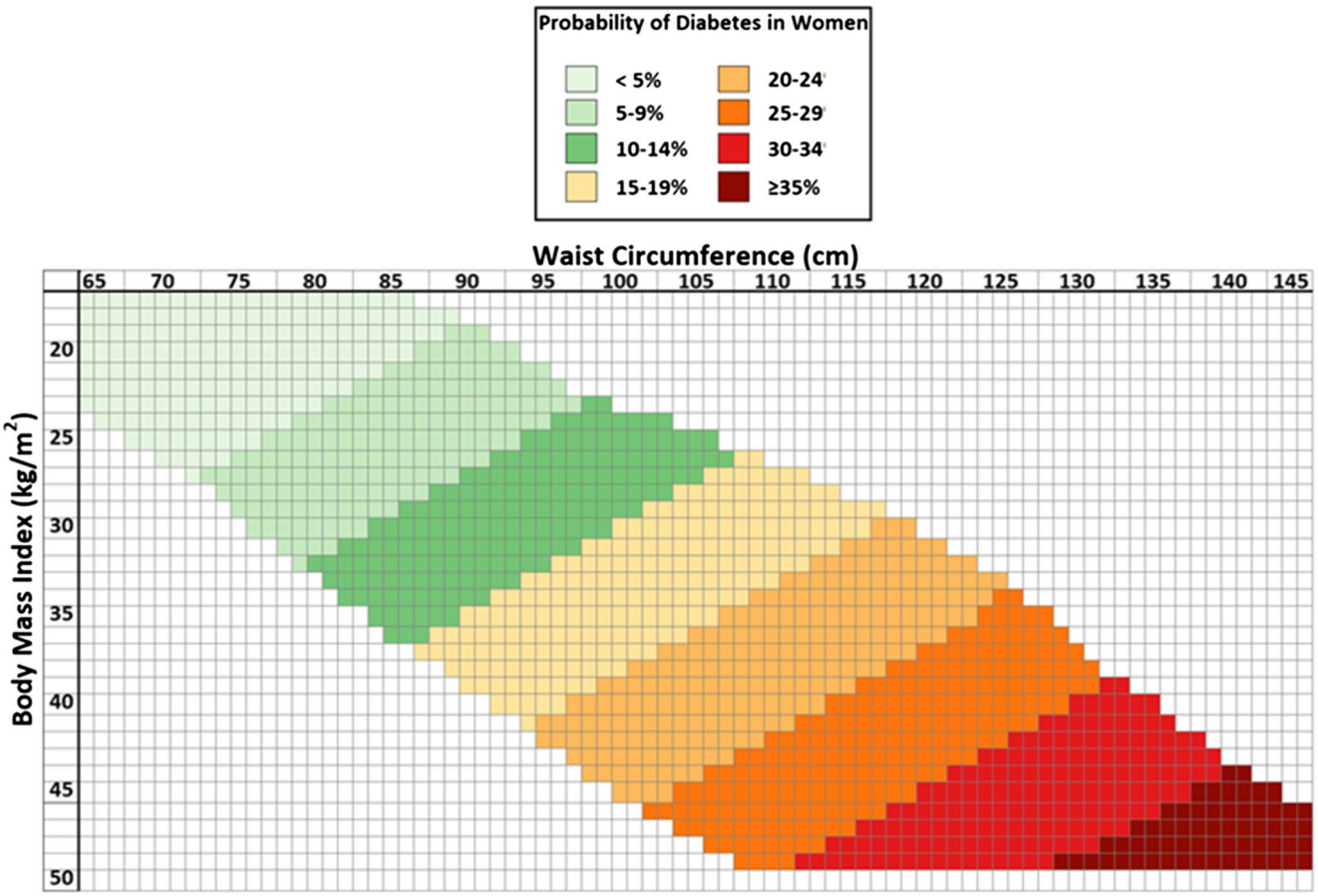

Fig. 4 Estimated probability of diabetes in women according to continuous combinations of body mass index (BMI) and waist circumference (WC). Predicted probabilities were derived from a logistic regression model including continuous BMI and WC, adjusted for age, race/ethnicity, socioeconomic status, smoking, and alcohol use. Each cell represents the model-estimated probability of diabetes for a specific BMI and WC combination. Cell colors indicate probability categories. Blank (white) cells represent unobserved BMI–WC combinations in the source population.

jointly, can be used to generate a nomogram for identifying gradations in obesity-related health risk. Using data from the 1999–2004 U.S. National Health and Nutrition Examination Survey, we fit logistic regression models to predict the probability of diabetes among women based on continuous measures of BMI and WC, adjusting for age, race, socioeconomic status, smoking, and alcohol consumption. Model estimates were then used to calculate predicted probabilities of diabetes across combinations of BMI and WC observed within the typical range of the sample, holding covariates at their average values. Figure 4 visualizes these results in a nomogram, demonstrating how joint modeling of continuous BMI and WC can reveal clinically meaningful gradients in diabetes risk. Although based on cross-sectional data and a single outcome, this nomogram illustrates a promising strategy for translating combinations of continuous WC and BMI measures into a simple tool for identifying obesity-related health risk. However, the nomogram presented here is intended as a proof of concept and requires validation in independent populations before it can be applied for clinical risk assessment. Future research is needed to evaluate its performance across diverse populations and outcomes, and to refine its application for clinical use.

Obesity Phenotypes Response to Lifestyle Change

The effects of increases in energy expenditure (exercise) and decreases in energy intake (caloric restriction) on body weight and WC have been extensively studied, and the reader is referred to several reviews for detailed discussion [34, 35]. Of particular relevance to this review is whether reductions in WC can be achieved in the absence of weight loss, a distinction with important clinical implications.

Evidence from systematic reviews indicates that reductions in WC can occur in response to exercise with little or no weight loss. In a meta-analysis of exercise-only

interventions, Wewege et al. [36] pooled data from 13 studies involving 424 adults with overweight or obesity and reported a mean reduction in WC of approximately 3 cm in the absence of a significant change in body weight. This observation is consistent with an earlier systematic review by Ross et al. [37], which concluded that exercise training is associated with significant reductions in WC and/or visceral adiposity despite either no change in body weight or a weight change of less than 3%, irrespective of sex or age. Collectively, these findings do not challenge the benefits of lifestyle-induced weight loss for reducing WC; rather, they indicate that WC is highly responsive to negative energy balance and may be decreased even in the absence of weight loss.

Change in Waist Circumference, Morbidity and Mortality

Prospective observational studies consistently indicate that increases in WC over time are associated with a higher risk of morbidity and mortality, including T2D, CVD, and all-cause mortality [18, 38, 39]. In contrast, evidence linking changes in WC to morbidity or mortality is more heterogeneous. In a prospective study with repeated WC measurements, category-based analyses showed that both WC gain and WC loss were associated with higher all-cause mortality compared with stable WC [39]. Accordingly, reductions in WC do not uniformly confer lower mortality risk. This observation was reinforced by Yuan et al. [40], who pooled data from two longitudinal cohort studies comprising 58 132 adults aged 40 years and older. When changes in weight and WC were examined separately, U-shaped associations were observed: both weight loss (pooled HR = 1.33, 95% CI: 1.23–1.43) and weight gain (HR = 1.10, 95% CI: 1.02–1.19), as well as WC loss (HR = 1.14, 95% CI: 1.05–1.24) and WC gain (HR =1.11, 95% CI: 1.03–1.21), were associated with higher mortality risk compared with stable weight or WC, respectively. Importantly, when changes in weight and WC were assessed jointly, participants who lost weight but concurrently gained WC experienced the highest risk of all-cause mortality compared with those with stable weight and WC (HR = 1.69, 95% CI: 1.46–1.96). Together, these findings underscore the importance of assessing both BMI (or body weight) and WC, not only for stratifying health risk, but also for interpreting the health implications of long-term changes in obesity phenotype.

Authors most commonly attribute these counterintuitive findings to illness-related unintentional WC loss, reverse causation, residual confounding, and concurrent changes in body weight or smoking. These limitations are supported empirically by a large prospective cohort study that explicitly distinguished intentional from unintentional reductions in WC among 58,961 women [41]. In that analysis, Hendryx et al. reported intentional weight loss accompanied by measured WC reduction was associated with lower all-cause mortality (HR 0.91; 95% CI 0.86–0.95), lower cancer mortality (HR = 0.85, 95% CI: 0.76–0.95), and lower cardiovascular mortality (HR = 0.79,95% CI: 0.72–0.87). In contrast, unintentional WC reduction was associated with higher mortality risk across outcomes, a pattern consistent with reverse causation and other sources of bias in observational studies.

Further, direct evidence linking intentional treatment-induced reduction in WC to cardiovascular outcomes is provided by a post-hoc analysis of a large randomized, placebo-controlled cardiovascular-outcomes trial of semaglutide [42]. In this analysis, the magnitude of early weight loss (week 20) was not linearly associated with subsequent risk of major adverse cardiovascular events (MACE). By contrast, greater reduction in WC at week 20 was associated with lower subsequent risk of MACE, and WC reduction by week 104 was associated with lower in-trial MACE risk. Mediation analyses indicated that approximately 33% of the cardiovascular benefit of semaglutide was explained by reduction in WC, with attenuation of the treatment effect after adjustment for time-varying WC (HR = 0.86, 95% CI: 0.77–0.97). Collectively, these findings suggest that harmful associations with WC loss in observational studies may be explained by unintentional loss, whereas intentional or treatment-induced reductions in WC are associated with lower health risk.

Implementation Gaps Inserting BMI and WC as Routine Measures in Primary Care

The prevalence of obesity, and particularly abdominal obesity, continues to increase unabated worldwide. Current projections suggest that 51% of the global population will be living with overweight or obesity within the next 12 years unless prevention, treatment, and support improve. According to the World Obesity Atlas 2023, the economic impact of overweight and obesity is projected to exceed US$4 trillion in lost potential income by 2035, equivalent to nearly 3% of the current global gross domestic product [43]. If comparable data were available for abdominal obesity, both prevalence estimates and associated economic costs would almost certainly be higher.

These observations underscore the importance of prioritizing obesity prevention and management within health-care systems. Primary health care, typically the first point of contact for individuals seeking health services, represents a particularly suitable setting for implementing strategies to prevent, identify, and manage obesity. However, analyses of electronic

health records and surveys of physician practice consistently indicate that obesity, whether characterized by BMI and/or WC, is infrequently assessed or discussed in routine care.

Given the global burden of obesity and obesity-related chronic disease, the combined use of BMI and WC may be particularly relevant in low- and middle-income countries and other resource-constrained settings, where access to advanced diagnostic tools and laboratory testing may be limited. Both measures are inexpensive, widely accessible, and feasible to implement in primary care and community settings with minimal equipment or training. In this context, routine assessment of BMI and WC aligns closely with the World Health Organization Package of Essential Noncommunicable Disease Interventions (WHO PEN), which emphasizes pragmatic, low-cost approaches for identifying individuals at elevated health risk within primary care, particularly in low-resource settings. Although combined BMI and WC assessment is not specifically identified within WHO PEN risk-assessment approaches, these anthropometric measures represent a feasible strategy to strengthen identification of obesity-related health risk in settings with limited health-system resources [44].

In Canada, analyses of primary-care electronic medical records indicate that although approximately 50–60% of adults have a BMI recorded, only 10–15% have a documented WC measurement, even among individuals undergoing cardiometabolic risk assessment [45]. Similar patterns have been reported in US primary care, where diffusion studies conclude that WC has "not entered routine practice," with BMI continuing to dominate anthropometric assessment despite longstanding guideline recommendations [46, 47]. In the UK, body weight is recorded for approximately one-third of patients attending primary care each year and is repeated, on average, every two years among those individuals [48]. In Germany, a study evaluating BMI documentation in general-practice electronic records reported that BMI was recorded for only 10.8% of 989 955 patients [49].

The evidence-to-practice gap reflects implementation failure rather than evidence uncertainty. Cited barriers to obesity assessment in clinical settings include time constraints, workflow disruption, lack of appropriate training, uncertainty regarding standardized technique, fear of measurement error, lack of reimbursement, inconsistent documentation systems, and discomfort with weight-related discussions, including the influence of weight stigma, as deterrents to routine WC assessment [2, 50–52].

The strategies summarized in Box 1 outline a pragmatic approach that may help to overcome some of these barriers. Together, they emphasize standardization, electronic medical records infrastructure and upstream education as mutually reinforcing options for change. Importantly, these recommendations may shift BMI and WC from discretionary assessments to vital signs routinely embedded within healthcare.

Box 1. Recommendations to overcome the implementation gap in routine BMI and WC measurement

Inclusion of obesity assessment competencies in routine medical education

Mandatory structured WC fields within electronic medical records.

Standardized measurement protocols with brief team training.

Delegation of WC measurement to nursing or allied health staff during vital-sign intake.

Use of non-stigmatizing communication scripts framing obesity (BMI and WC) as routine risk markers.

Direct linkage of BMI and WC values to therapeutic action through referral.

Reconsidering Obesity Prevention and Management in Modern Health Systems

Despite being the first point of contact for individuals seeking health services, expecting primary care clinicians to routinely assess and counsel patients regarding obesity-related health risk may be unrealistic. Competing demands on clinicians' time, coupled with the need to address a wide range of patient-driven concerns, suggest that more effective strategies may involve streamlined risk identification followed by referral to appropriate expertise. This approach is further supported by evidence indicating that obesity-related education is minimally represented in medical school curricula. Recent evidence indicates that training in obesity assessment and management is limited, which may contribute to graduates being inadequately prepared to manage patients with obesity [53, 54].

Given the competing demands in primary care and the limited training in obesity assessment and management, it is reasonable to suggest that effective prevention and management of obesity, a chronic, lifestyle-based condition, requires a team-based model of care. In such a model, the

physician's primary role would be to identify and diagnose obesity-related risk and to initiate referral, rather than deliver ongoing intervention. Comprehensive management is more appropriately provided by interprofessional teams that may include dietitians, exercise professionals, and behavioral therapists, who are trained to deliver sustained, individualized support. Operationally, this model can be implemented by incorporating standardized measurement protocols with brief team training, embedding structured WC fields within electronic medical records, and delegating measurement to nursing or allied health staff during routine vital-sign intake (see Box 1). Although this approach requires dedicated health-system resources and infrastructure, it reflects the rethinking of healthcare necessary to address chronic disease prevention and management, in contrast to care models that historically are optimized for acute care.

If prevention and management of obesity in primary care are to be addressed effectively, it must be acknowledged that existing healthcare delivery models are not well-suited to primary prevention and long-term behavior change. Meaningful progress will require coordinated discussion and action across clinical, educational, and policy domains to consider the redesign of systems capable of supporting chronic disease prevention. Without such change, the prevalence of obesity, regardless of how it is diagnosed, is likely to continue to rise unabated.

Conclusion

Evidence underscores the importance of WC and BMI combined to stratify obesity-related health risk. However, how these anthropometric variables are applied has important implications for risk assessment. Categorical approaches which are used in current clinical and surveillance practice, differ substantively from continuous analyses and can mask clinically meaningful gradients of risk, particularly when BMI and WC are modeled together. Despite the strength and consistency of the evidence supporting their combined use, obesity as defined by BMI and WC, is infrequently assessed, documented, or discussed in health care settings. Although leading health authorities have identified the importance of BMI and WC measurement in clinical practice, meaningful implementation remains unlikely within the constraints of current health-care delivery models. Change to health-care delivery models will not be easy. Coordinated discussion across clinical, educational, and policy domains is needed, recognizing that meaningful progress will be gradual and challenging, yet necessary to improve chronic disease prevention and management, in particular, obesity.

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  Consensus statement defines the criteria for diagnosis of pre-clinical and clinical obesity and the importance of combining WC and BMI to stratify obesity-related health risk.

- Ross R, Neeland IJ, Yamashita S, Shai I, Seidell J, Magni P, Santos RD, Arsenault B, Cuevas A, Hu FB, Griffin BA, Zambon A, Barter P, Fruchart JC, Eckel RH, Matsuzawa Y, Després JP. Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity. Nat Rev Endocrinol. 2020 Mar;16(3):177-189. doi: 10.1038/s41574-019-0310-7.

  Consensus Statement proposes that WC be routinely measured in clinical practice, as BMI alone is insufficient to adequately assess and manage health risk associated with excess adiposity. Emphasizes that WC is an important treatment target, with clinically meaningful reductions achievable through moderate-intensity exercise and/or dietary interventions, supporting its consideration as a clinical "vital sign."

- de Hollander EL, Bemelmans WJ, Boshuizen HC, Friedrich N, Wallaschofski H, Guallar-Castillón P, Walter S, Zillikens MC, Rosengren A, Lissner L, Bassett JK, Giles GG, Orsini N, Heim N, Visser M, de Groot LC; WC elderly collaborators. The association between waist circumference and risk of mortality considering body mass index in 65- to 74-year-olds: a meta-analysis of

29 cohorts involving more than 58 000 elderly persons. Int J Epidemiol. 2012 Jun;41(3):805-17. doi: 10.1093/ije/dys008.

Meta-analysis demonstrating that WC was positively associated with all-cause mortality after accounting for BMI, whereas BMI showed an inverse association with mortality after adjustment for WC. Among adults with normal BMI, a larger WC was associated with substantially higher mortality risk compared with a smaller WC. Conversely, within waist circumference categories, individuals classified as overweight by BMI had similar or lower mortality risk than those with normal BMI.

- Yuan Y, Liu K, Zheng M, Chen S, Wang H, Jiang Q, Xiao Y, Zhou L, Liu X, Yu Y, Wu J, Ding X, Yang H, Li X, Min X, Zhang C, Zhang X, He M, Zheng Y, Sun D, Qi L, Hemler EC, Wu S, Wu T, Pan A. Analysis of Changes in Weight, Waist Circumference, or Both, and All-Cause Mortality in Chinese Adults. JAMA Netw Open. 2022 Aug 1;5(8):e2225876. doi: 10.1001/jamanetworkopen.2022.25876.

  Using data from two cohort studies including 58,132 Chinese adults, individuals who lost weight but gained WC had the highest risk of all-cause mortality, underscoring the importance of evaluating changes in both body weight and WC when assessing associations with mortality.

- van den Hout WJ, van Peet P, Numans ME, Boone SCC, Raas L, Le Cessie S, Rosendaal FR, Mook-Kanamori DO, de Mutsert R. The value of measuring waist circumference in primary care: a mixed-methods study. Br J Gen Pract. 2026 Jan 27:BJGP.2025.0395. doi: 10.3399/BJGP.2025.0395.

  Examined the value of measuring waist circumference in primary care by assessing current recording practices among family physicians, identifying barriers and facilitators to its use, and evaluating its contribution as a screening tool for identifying patients at increased cardiovascular risk.

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Author contributions R.R. conceived the review, developed the conceptual framework, and drafted the initial manuscript. All authors contributed to the interpretation of the evidence, critically revised the manuscript for important intellectual content, and approved the final version. All authors agree to be accountable for all aspects of the work.

Data Availability The datasets generated and/or analyzed during the current study (see Figure 4) are available from https://wwwn.cdc.gov/nchs/nhanes/.

Declarations

Competing interests The authors declare no competing interests.

Conflict of interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human subjects performed by any of the authors.

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