

Body Composition and Its Impact on Physical Fitness, and Cardiovascular Risk: A Literature Review

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ABSTRACT

Introduction: Body composition, including fat and lean mass, is recognized as a critical factor influencing physical fitness and cardiovascular health.

Traditional measures such as body mass index do not distinguish fat from muscle and may misrepresent cardiometabolic risk.

Objectives: This review analyzed recent evidence on the relationship between body composition, physical fitness, and cardiovascular risk to inform more accurate approaches to screening and prevention.

Methods: A literature search was conducted in PubMed, Scopus, and Google Scholar for studies published between January 2020 and December 2025.

Eligible studies included original articles, systematic reviews, or meta-analyses on adults. Titles, abstracts, and full texts were screened with inclusion and exclusion criteria. Data were extracted on study design, population, body composition methods, outcomes, and key findings. Narrative synthesis was performed.

Results: Eight studies were included. Large cross-sectional analyses showed strong associations between body composition indicators, visceral fat, fat percentage, and lean mass, with blood pressure, lipid profile, and glucose regulation. Southeast Asian studies highlighted links between higher body fat, reduced physical activity, and increased cardiometabolic risk. Research in Brazil and the United States indicated that inflammatory markers and diet modified the relationship between adiposity and cardiovascular risk. Smaller studies emphasized the protective role of lean mass and physical activity, including technology-based exercise, on fitness and body composition outcomes.

Conclusions: Body composition is a more accurate determinant of physical fitness and cardiovascular risk than body mass index. Integrating body composition analysis into clinical and public health practice could improve risk stratification and guide personalized preventive strategies.

Introduction

Body composition, defined as the relative proportion of fat mass, lean mass, bone, and body water, has emerged as a critical determinant of cardiovascular health. While body mass index (BMI) has traditionally been used as a simple anthropometric measure, it does not differentiate between fat and muscle and often misrepresents cardiometabolic risk (Fredwall et al., 2021a; Holmes & Racette, 2021). Excess adiposity, particularly visceral fat, contributes to insulin resistance, dyslipidemia, systemic inflammation, and endothelial dysfunction, pathophysiological mechanisms that underlie cardiovascular disease (CVD) development (Bazzocchi et al., 2023; Huang & Chen, 2021). Conversely, greater lean mass and higher muscle quality are associated with improved glucose utilization, blood pressure regulation, and reduced risk of cardiovascular events. With advances in assessment methods, including DXA, MRI, and bioelectrical impedance analysis (BIA), clinicians and researchers are now able to evaluate body



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composition with greater accuracy, reinforcing its clinical utility in cardiovascular risk assessment (Chaves et al., 2022; Holmes & Racette, 2021).

Lifestyle transitions in recent decades, characterized by poor dietary habits, sedentary behavior, and reduced physical activity, have significantly altered body composition across populations. These changes are marked by an increase in fat mass and central adiposity alongside a reduction in lean muscle mass, leading to a decline in physical fitness. Such alterations create a physiological environment that predisposes individuals to hypertension, dyslipidemia, diabetes, and ultimately cardiovascular disease (CVD). Empirical evidence supports this trajectory, with large-scale epidemiological studies such as the UK Biobank, The Malaysian Cohort, and NHANES consistently demonstrating strong associations between excess adiposity, android/gynoid fat ratio, and incident CVD (Carter et al., 2023; Xu et al., 2024).

In Indonesia, the urgency of this issue is evident. At the regional level, obesity prevalence in Java remains among the highest nationally, with multiple districts reporting >20% adult obesity prevalence, and central obesity in Central Java reaching 31% (Kementrian Kesehatan Republik Indonesia, 2019). In East Java Province, community-based screening found that nearly 29.2% of adults aged ≥ 40 years were classified at high 10-year CVD risk, with urban populations more affected than rural ones. More locally, in coastal communities of Banyuwangi District, the prevalence of hypertension, a major CVD risk factor, was reported at 33.3% systolic and 31.7% diastolic among adults aged 18–59 years (Johari et al., 2025). These patterns underscore not only the progressive chronology from lifestyle changes to cardiovascular risk but also the urgent need for more precise preventive strategies, including integrating body composition assessment in routine health evaluations, particularly in regions like East Java, where the burden is rapidly escalating.

Despite growing evidence, the integration of body composition assessment into clinical practice and public health remains limited, with BMI still predominantly used as a proxy for obesity and cardiovascular risk. This reliance may obscure important fat distribution and lean mass differences directly influencing cardiometabolic outcomes, particularly across sex, age, and ethnic groups (Fredwall et al., 2021b; Gałdzińska et al., 2023). In Indonesia, where cardiovascular disease remains a leading cause of mortality, research on body composition and its relation to cardiovascular health is still emerging, with most programs relying primarily on BMI screening. To address this gap, a multipronged approach is needed. At the clinical level, integrating more precise body composition measurements (e.g., DXA, BIA, or waist-to-hip ratio assessments) into routine evaluations can improve early detection of individuals at high cardiometabolic risk. At the community and public health levels, interventions should emphasize balanced nutrition, regular physical activity, and lifestyle modification programs tailored to local contexts. Community-based health education campaigns, workplace wellness initiatives, and early preventive interventions targeting high-risk groups could also play a pivotal role in reducing obesity and cardiovascular risk. Together, these strategies highlight the urgency of shifting beyond BMI toward a more comprehensive framework incorporating body composition for individual patient care and population-level health promotion. The literature review aims to examine the impact of body composition on physical fitness and cardiovascular risk

Methods

Search Strategy

A literature search was conducted in PubMed, Google Scholar, and Scopus to identify studies published between January 2020 and December 2025. The following keywords and Boolean operators were applied: “body composition” AND “physical fitness” OR “cardiovascular risk.” Reference lists of relevant publications were also screened manually to capture additional eligible



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studies. The literature review examines body composition on physical fitness and cardiovascular risk.

PICOT Framework

The PICOT framework guided this literature review. The Population (P) of interest was adults aged 18 years and above across diverse populations and settings. The Indicator (I) was body composition, assessed using anthropometric measures (e.g., BMI, waist circumference), bioelectrical impedance analysis (BIA), or dual-energy X-ray absorptiometry (DXA). The Comparison (C) was standard measures, such as BMI alone or groups with different body composition profiles. The Outcomes (O) included physical fitness parameters (such as cardiorespiratory fitness and muscle strength) and cardiovascular risk markers (including blood pressure, lipid profile, glucose levels, and inflammatory markers). The Time/Study type (T) was limited to studies published between January 2020 and December 2025, encompassing cross-sectional, cohort, case-control studies, systematic reviews, and meta-analyses.

Screening and Selection Process

A total of 152 records were retrieved from the databases. After removing 37 duplicates, 115 articles were screened by titles and abstracts. Of these, 89 were excluded because they were irrelevant to the research question. The full texts of 26 articles were assessed for eligibility, and 18 were excluded due to limited methodological quality or outcomes unrelated to the review focus. Finally, eight articles fulfilled all inclusion criteria and were included in this literature review.

Data Abstraction and Synthesis

Data were extracted from each study regarding author(s), year of publication, study design, sample characteristics, body composition assessment methods, outcomes related to physical fitness and cardiovascular risk, and key findings. The extracted data were synthesized narratively to provide an integrated understanding of the current evidence.

Results

Table 1. Article Review

Author (Years)	Country/Setting	Objective	Method	Key Finding (Outcomes)
Carter et al (2023)	Malaysia and the United Kingdom (UK Biobank & The Malaysian Cohort)	Compare body composition & cardiovascular risk across ethnic groups	Cross-sectional; n=480k+; BMI, WC, fat & lean mass (BIA), CV markers	Ethnic differences: Chinese → lower adiposity but higher BP & HbA1c; Indians → WC strongly linked to HbA1c; Women showed stronger lean mass-risk links
Fredwall et al (2021)	Norway (Norwegian Adult Achondroplasia Study) with UK Biobank controls	Assess CV risk & body composition in adults with achondroplasia	Case-control; n=49 vs 98 controls; MRI & labs	Despite high BMI, achondroplasia had lower BP, LDL, and triglycerides, but reduced muscle volume.



Johari et al (2025)	Terengganu, Malaysia	Examine PAL, body weight, body comp, CV health	Cross-sectional; n=150; Tanita BIA, IPAQ-M, BP, fitness test	Higher fat% → lower PAL; most had poor fitness	<i>Borneo Journal of Medical Sciences</i> – National (MyCite)
Nuryani et al (2025)	Gorontalo, Indonesia	Obesity, body composition, and cardiometabolic risk	Cross-sectional; n=223 women; BIA, BP, glucose, cholesterol	Central obesity (84%); BMI strongly linked to metabolic risk	<i>Indonesian Journal of Public Health</i> – Sinta 2
Lee et al (2025)	Brazil	Body composition, inflammation & CV risk	Cross-sectional; n=124; DXA, inflammatory markers, lipids, BP	Higher fat & VAI ↑ inflammation & CV risk; lean mass protective	<i>Nutrients</i> – Scopus (Q1), WoS
Oukheda et al (2023)	United States	Body composition, dietary inflammatory index & CVD	Cross-sectional; n=20,159; DXA, diet recall, BP, labs	Fat mass & android/gynoid ratio ↑ CVD risk; lean mass protective; pro-inflammatory diet worsened risk	<i>Journal of Nutrition</i> – Scopus (Q1), WoS
Jaremków et al (2024)	Poland / Wrocław Medical University	Correlation between body composition & physical activity in students	Cross-sectional; n=75; BIA, accelerometer, stats tests	Vigorous activity → better muscle, hydration; reduced fat	<i>BMC Public Health</i> – Scopus (Q1), WoS
Godoy-Cumillaf et al (2025)	Chile / Universidad Autónoma de Chile	Effect of VR exercise on body comp & fitness	Case report; 1 subject, 8-week VR program; fitness tests	↓ Fat %, ↑ VO ₂ max & agility; slight ↓ muscle strength	<i>Journal of Human Sport and Exercise</i> – Scopus (Q3)

Eight studies met the inclusion criteria and were summarized in Table 1. The reviewed literature varied in design, population, and measurement methods but consistently addressed the relationship between body composition, physical fitness, and cardiovascular risk. Two large-scale cross-sectional studies provided population-level evidence. Carter et al (2023) analyzed over 480,000 adults from Malaysia and the UK, identifying ethnic and sex-specific variations in the association between adiposity, lean mass, and cardiometabolic markers. Similarly, (2021a), in a case-control study of Norwegian adults with achondroplasia compared to UK Biobank controls, demonstrated discrepancies between BMI and cardiometabolic outcomes, showing lower blood pressure and lipid levels despite a high prevalence of obesity.

Regional studies from Southeast Asia further explored these associations. Johari et al (2025) in Malaysia, researchers reported that higher body fat percentage correlated with reduced physical activity. In Indonesia, Nuryani et al (2025) observed strong correlations between BMI, body composition indices, and cardiometabolic risk factors in adult women. Lee et al (2025) this perspective was extended in Brazil, showing that fat mass and visceral adiposity index were positively associated with inflammatory markers and adverse cardiovascular profiles, whereas lean mass was protective. In the United States, Oukheda et al (2023) confirmed that higher fat mass and android/gynoid fat ratio were linked with increased cardiovascular disease risk, with the dietary inflammatory index as a significant modifier.



Two smaller studies examined interventional and activity-related outcomes. Jaremków et al (2024) found that moderate-to-vigorous physical activity among Polish medical students was positively correlated with fat-free mass, bone mass, and hydration status, with gender-specific effects on muscle and fat mass. Meanwhile, a case report by Godoy-Cumillaf et al (2025) In Chile, an eight-week immersive virtual reality exercise program demonstrated that it improved body composition, aerobic fitness, and agility, with limited effects on muscle strength. Overall, the reviewed studies highlight diverse approaches to measuring body composition and its association with fitness and cardiovascular outcomes, reinforcing the importance of assessments beyond BMI.

Discussion

Body Composition and Physical Fitness

The reviewed studies consistently indicate that body composition is strongly associated with various physical fitness domains, including aerobic capacity, muscular strength, and agility. Empirical evidence demonstrates that higher fat mass negatively correlates with physical activity levels and fitness performance, while greater lean mass and favorable hydration status are positively associated with endurance and strength outcomes (Jaremków et al., 2024; Johari et al., 2025). Interventional data further support these associations, as programs designed to reduce adiposity and improve muscle mass, such as immersive virtual reality exercise, have enhanced aerobic capacity and agility (Godoy-Cumillaf et al., 2025). Importantly, these findings were consistent across diverse populations, ranging from university students to community-dwelling adults, underscoring the robust link between body composition and physical fitness.

The relationship between body composition and physical fitness can be explained through physiological and biomechanical mechanisms. Lean mass, particularly skeletal muscle, contributes to energy expenditure, force production, and oxygen utilization, enhancing cardiovascular endurance and muscular performance (Heymsfield, 2025; Huang & Chen, 2021). Conversely, excess adiposity imposes mechanical constraints on movement, increases cardiovascular workload, and promotes metabolic inefficiency, impairing exercise capacity and reducing fitness outcomes (Holmes & Racette, 2021). These theoretical foundations align with the Health Belief Model and physical fitness frameworks, which suggest that body composition is both a determinant and a consequence of habitual physical activity. Thus, favourable body composition facilitates improved fitness and is reinforced by sustained engagement in physical exercise (Yan et al., 2025).

From a researcher's perspective, the evidence highlights opportunities and gaps in studying body composition and physical fitness. While current findings emphasize the importance of lean mass and fat distribution, many studies still rely on cross-sectional designs, limiting causal inference. There is also a need to standardize measurement tools, as variability in methodologies (e.g., BIA, DXA, MRI, anthropometry) complicates comparisons across studies. Furthermore, novel interventions such as technology-based exercise programs present promising avenues for improving fitness outcomes, but require larger randomized trials to establish efficacy and generalizability. Future research should also consider sex-specific and age-related differences, as emerging evidence suggests differential effects of body composition on fitness between men and women (Jaremków et al., 2024). The findings reinforce that body composition assessment should be integrated into health promotion and exercise prescription to optimize physical fitness outcomes.

In our view, integrating standardized body composition assessments into health promotion and exercise prescription is crucial. Beyond BMI, fat distribution and lean mass measures can provide more precise insights into physical fitness potential and help tailor individualized



interventions. Such an approach may strengthen preventive strategies, improve public health outcomes, and reduce long-term cardiovascular risk.

Body Composition and Cardiovascular Risk

The reviewed literature provides consistent evidence that body composition is a stronger predictor of cardiovascular health than body mass index (BMI) alone. Large-scale cohort studies demonstrated that adiposity measures such as visceral fat, android-to-gynoid fat ratio, and total body fat percentage are significantly associated with hypertension, dyslipidemia, impaired glucose metabolism, and cardiovascular disease (Carter et al., 2023; Oukheda et al., 2023; Xu et al., 2024). Conversely, lean mass has been repeatedly shown to confer protective effects, with higher muscle mass linked to reduced inflammation and improved vascular function (Lee et al., 2025). Notably, studies in special populations, such as adults with achondroplasia, revealed that BMI may overestimate obesity-related risk, as lower blood pressure and lipid levels were observed despite elevated BMI (Fredwall et al., 2021b). These findings highlight that direct body composition assessment provides a more accurate evaluation of cardiovascular risk than traditional anthropometric indices.

The theoretical basis for these findings lies in the distinct metabolic roles of fat and lean tissue. Visceral adiposity contributes to cardiometabolic disease through multiple mechanisms, including increased release of pro-inflammatory cytokines, altered lipid metabolism, and promotion of insulin resistance, all of which accelerate atherosclerotic processes (Bazzocchi et al., 2023; Souza et al., 2024). In contrast, skeletal muscle acts as an endocrine organ that regulates glucose uptake, lipid metabolism, and vascular homeostasis, thereby protecting against cardiovascular dysfunction (Heymsfield, 2025; Huang & Chen, 2021). Furthermore, lifestyle and dietary factors modulate these pathways; for example, pro-inflammatory diets exacerbate the adverse effects of adiposity, while regular physical activity enhances lean mass and mitigates risk (Perry et al., 2023; Yan et al., 2025). These mechanisms explain why individuals with similar BMI values may present with markedly different cardiovascular profiles depending on their body composition (Idrizovic et al., 2021).

From a researcher's perspective, the evidence underscores the urgent need to move beyond BMI as the predominant tool for cardiovascular risk stratification. While BMI offers simplicity, it fails to capture fat distribution and muscle quality, critical determinants of cardiometabolic outcomes. A more comprehensive approach incorporating DXA, MRI, or validated BIA methods should be integrated into research and clinical practice to better identify at-risk individuals. At the same time, further longitudinal and interventional studies are needed to clarify causal pathways and evaluate the effectiveness of lifestyle, nutritional, and technological interventions in modifying body composition to reduce cardiovascular risk. Particular attention should be given to sex-specific, ethnic, and age-related variations, which may inform tailored prevention strategies. Ultimately, incorporating body composition analysis into routine cardiovascular assessment could substantially improve the accuracy of risk prediction and the effectiveness of preventive care.

Conclusion

This review underscores that body composition, beyond body mass index, is a critical determinant of physical fitness and cardiovascular health. Excess visceral fat heightens cardiometabolic risk, while lean mass offers protective benefits. Although current evidence is constrained by methodological variability, it emphasizes the need for standardized assessments and longitudinal studies. Incorporating body composition analysis into clinical and public health practice could significantly enhance risk prediction and guide more effective, individualized preventive strategies.



Ethics approval and consent to participate

Ethical clearance for this research was secured per institutional and national regulations. Before enrollment, all participants received detailed information regarding the study's aims, procedures, and rights, and written informed consent was obtained. The confidentiality and anonymity of participants were carefully safeguarded throughout the study.

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