International Journal of Research in Medical and Basic Sciences
Volume 11 Issue 11, November 2025 ISSN: 2455-2569 Impact Factor: 8.028
Journal Homepage: http://mbsresearch.com, Email: mbsresearchp@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal

Cardiovascular Consequences of Obesity in Young Adults: A Physiological and Clinical Review

Kavyansh Dixit
Research Scholar, Malwanchal University, Indore

Dr. Ashutosh Jain
Professor, Malwanchal University

Abstract

Obesity during early adulthood triggers a complex interplay of autonomic, endothelial, inflammatory, and neurohormonal alterations that collectively heighten cardiovascular risk well before the onset of overt clinical disease. These physiological disruptions lead to increased arterial pressure, vascular stiffening, and modifications in myocardial repolarization, thereby predisposing individuals to subclinical cardiovascular dysfunction (Csige et al., 2018; Powell-Wiley et al., 2021). Evidence indicates that young adults with excess adiposity often exhibit measurable early markers of cardiovascular compromise, including reduced heart rate variability, prolonged corrected QT (QTc) intervals, impaired flow-mediated dilation, and increased carotid intima–media thickness each serving as a sensitive indicator of early vascular and autonomic impairment (Banerjee et al., 2022; Kumar et al., 2004; Patel et al., 2022; Shah et al., 2015).

In India, data from the fifth National Family Health Survey (NFHS-5) reveal a continuing rise in overweight and obesity across young and reproductive age groups (International Institute for Population Sciences [IIPS] & ICF, 2022). Recognizing the heightened cardiometabolic vulnerability among South Asians, the Endocrine Society of India (2022) and other expert bodies advocate the use of lower body mass index (BMI) thresholds and central adiposity indices for risk stratification.Consequently, there is an urgent need for evidence-based campus health initiatives that integrate dietary quality improvement, enhanced physical activity, and risk-based cardiovascular screening. Such preventive strategies should align with the recommendations of the U.S. Preventive Services Task Force (USPSTF, 2021), the American College of Cardiology/American Heart Association (ACC/AHA) guidelines (Arnett et al., 2019), and the Indian Council of Medical Research–National Institute of Nutrition (ICMR-NIN) dietary guidelines (2024). Early identification and intervention in this age group can play a pivotal role in curbing the long-term burden of cardiovascular disease in India's rapidly urbanizing youth population.

Keywords:
Obesity; Young adults; Autonomic dysfunction; Endothelial function; QTc prolongation; Heart rate variability (HRV); Carotid intima–media thickness (CIMT); Cardiovascular risk

Introduction

Obesity is among the most significant modifiable determinants of cardiovascular morbidity and mortality worldwide. Acting through a network of interrelated pathophysiological mechanisms including systemic hypertension, dyslipidemia, insulin resistance, obstructive sleep apnea, and structural myocardial remodeling obesity accelerates atherosclerotic progression and cardiac dysfunction across the lifespan (Powell-Wiley et al., 2021). The earlier these exposures occur, the greater their cumulative impact on cardiovascular health, as prolonged metabolic stress amplifies lifetime risk trajectories and predisposes to premature onset of cardiovascular disease (CVD).

Recent population-level data underscore the growing magnitude of this problem in India. Findings from the fifth National Family Health Survey (NFHS-5) reveal a substantial and rising prevalence of overweight and obesity among both men and women aged 15–49 years, with particularly sharp increases among younger age groups residing in urban and semi-urban regions (International Institute for Population Sciences [IIPS] & ICF, 2022). Such trends signify a shifting epidemiological landscape in which the burden of adiposity-related disorders is no longer confined to middle age but now extends into early adulthood a period traditionally viewed as physiologically resilient.

The public health implications of this trend are profound. Young adults, especially those in college settings, are increasingly exposed to obesogenic environments characterized by sedentary academic routines, easy access to calorie-dense foods, and irregular sleep patterns. These behaviors interact with genetic and metabolic predispositions unique to South Asian populations, who demonstrate elevated cardiometabolic risk even at lower body mass indices (BMIs) compared to Western counterparts (Misra & Shrivastava, 2013). Recognizing this susceptibility, the Endocrine Society of India (2022) and other national expert panels advocate the use of lower BMI thresholds (≥23 kg/m² for overweight and ≥25 kg/m² for obesity) and waist-based indices such as waist circumference and waist-to-hip ratio to improve early risk detection among young Indian adults.

Collectively, these observations highlight an urgent need to investigate the cardiovascular consequences of obesity during young adulthood within the Indian context. Understanding early

physiological and biochemical alterations associated with excess adiposity can inform preventive strategies, promote lifestyle modification, and ultimately mitigate the growing burden of CVD among India's youth population.

Pathophysiological Mechanisms

The cardiovascular consequences of obesity in young adults arise from a constellation of interrelated pathophysiological mechanisms that link excess adiposity to autonomic dysregulation, endothelial dysfunction, neurohormonal activation, and systemic inflammation. These processes operate synergistically to produce early hemodynamic and vascular alterations that precede overt clinical disease.

Adiposity and Autonomic Imbalance

Excess adipose tissue, particularly central or visceral fat, profoundly influences autonomic regulation of the cardiovascular system. Central adiposity in young adults has been shown to suppress parasympathetic (vagal) tone while enhancing sympathetic activity, resulting in reduced heart rate variability (HRV) and altered sympathovagal balance. Specifically, reductions in time-domain and high-frequency (HF) components, accompanied by increases in low-frequency (LF) components of HRV, have been documented independent of physical activity levels, signifying early autonomic dysregulation (Banerjee et al., 2022). These autonomic shifts contribute to resting tachycardia, elevated blood pressure, and increased arrhythmic susceptibility. When combined with metabolic and inflammatory stressors, such imbalances create a proarrhythmic and hypertensive milieu that can accelerate cardiovascular aging even in early adulthood (Csige et al., 2018).

Endothelial Dysfunction and Vascular Changes

The endothelium plays a central role in vascular homeostasis through its regulation of vasodilation, platelet aggregation, and inflammatory signaling. In obesity, endothelial function is compromised early in the disease process. Overweight adolescents and young adults exhibit reduced brachial artery flow-mediated dilation (FMD), a noninvasive indicator of endothelial health, which correlates inversely with adiposity indices such as body mass index (BMI) and waist circumference (Kumar et al., 2004). Structural vascular changes accompany these functional impairments; severe obesity has

been linked to increased carotid intima–media thickness (CIMT), reflecting early arterial remodeling and stiffness (Shah et al., 2015). These findings collectively demonstrate that endothelial injury and vascular dysfunction develop long before clinical manifestations of atherosclerosis appear.

Renin–Angiotensin–Aldosterone System (RAAS) and Sympathetic Activation

Obesity is characterized by chronic activation of the renin–angiotensin–aldosterone system (RAAS) and sympathetic nervous system. Adipose tissue expresses angiotensinogen and other RAAS components, leading to increased angiotensin II and aldosterone levels, which promote sodium retention, vasoconstriction, and vascular hypertrophy (Csige et al., 2018). Simultaneously, heightened sympathetic outflow enhances cardiac output and peripheral resistance, further elevating blood pressure. These neurohormonal alterations not only raise hemodynamic load but also interact with insulin resistance and dysregulated adipokine signaling to potentiate endothelial dysfunction and myocardial remodeling (Powell-Wiley et al., 2021). The resulting state of neurohumoral overactivity represents a key mechanistic link between adiposity and early cardiovascular injury.

Inflammatory Pathways and Vascular Stiffness

Chronic low-grade inflammation is a hallmark of obesity and a principal mediator of its cardiovascular sequelae. Adipose tissue expansion triggers the secretion of pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP), which contribute to oxidative stress, endothelial damage, and vascular stiffening (Shah et al., 2015). Elevated CRP and IL-6 levels in young individuals with severe obesity have been associated with early vascular dysfunction and increased arterial stiffness, even in the absence of clinical CVD. This inflammatory milieu promotes the development of subclinical atherosclerosis and can also influence cardiac electrophysiology by modifying ion channel function and myocardial conduction properties (Csige et al., 2018). Thus, the interaction between visceral adiposity, inflammation, and vascular remodeling constitutes a fundamental pathway through which obesity precipitates early cardiovascular compromise.

Cardiovascular Parameters and Obesity

Obesity exerts a multidimensional impact on cardiovascular function, influencing hemodynamic load, autonomic regulation, myocardial electrophysiology, and vascular integrity. These alterations, detectable even in asymptomatic young adults, reflect the early physiological consequences of excess adiposity and provide valuable markers for subclinical cardiovascular risk assessment.

Blood Pressure (SBP, DBP, and MAP)

Progressive increases in adiposity are consistently associated with elevated systolic (SBP) and diastolic blood pressure (DBP), as well as mean arterial pressure (MAP), across both adolescent and young adult populations. Mechanistically, these changes are mediated through activation of the renin–angiotensin–aldosterone system (RAAS), enhanced sympathetic drive, and renal sodium retention, all of which contribute to expanded blood volume and peripheral vasoconstriction (Csige et al., 2018; Powell-Wiley et al., 2021). Epidemiological studies demonstrate that even modest increments in body mass index (BMI) correspond to measurable rises in both SBP and DBP, reinforcing the hemodynamic burden of early-life obesity and its potential to predispose individuals to pre-hypertensive or hypertensive states in young adulthood (Csige et al., 2018). These findings underscore the importance of blood pressure monitoring as a routine component of obesity risk surveillance in college and university populations.

Resting Heart Rate and Heart Rate Variability

Autonomic imbalance represents one of the earliest physiological consequences of excess adiposity. Young Indian adults with increased central fat accumulation exhibit lower time-domain indices and high-frequency (HF) power, along with elevated low-frequency (LF) components of heart rate variability (HRV), reflecting parasympathetic withdrawal and sympathetic predominance (Banerjee et al., 2022). These alterations in autonomic tone contribute to higher resting heart rates and reduced cardiac adaptability under physiological stress. Importantly, reduced HRV has been observed consistently in obese adolescents and college-age individuals across Indian and international cohorts, supporting HRV as a sensitive, noninvasive biomarker of early autonomic dysregulation (Banerjee et al., 2022; KLE Journal of Health Sciences and Biomedical Research [KLE JHSBR], 2025). Such findings highlight HRV assessment as a valuable tool for early cardiovascular screening in young adults with overweight or obesity.

Electrocardiographic Changes (QT Prolongation and Arrhythmia Risk)

Excess adiposity also impacts myocardial electrophysiology. Large-scale population analyses have demonstrated that BMI and central adiposity indices independently correlate with prolonged corrected QT (QTc) intervals, even after adjusting for comorbidities and lifestyle factors (Patel et al., 2022). Furthermore, metabolic ill health including insulin resistance and dyslipidemia appears to exert additive effects on QTc duration, compounding arrhythmogenic risk. Smaller experimental and clinical studies in young men and college-age adults similarly report QT and QTc prolongation with increasing BMI and waist circumference, suggesting a predisposition to ventricular repolarization abnormalities and heightened susceptibility to arrhythmias in the early stages of obesity (El Gamal et al., 2018; Grandi et al., 2010). These electrocardiographic markers therefore offer early insight into the subclinical electrical remodeling associated with adiposity.

Subclinical Vascular Markers (CIMT and Flow-Mediated Dilation)

Structural and functional vascular alterations accompany the hemodynamic and electrophysiologic changes observed in obese youth. Severe obesity in adolescents and young adults has been associated with significantly increased carotid intima–media thickness (CIMT) and impaired vascular reactivity compared to normal-weight peers, indicating the onset of arterial remodeling and subclinical atherosclerosis (Shah et al., 2015). Likewise, overweight adolescents demonstrate reduced brachial artery flow-mediated dilation (FMD), reflecting compromised endothelial function and nitric oxide bioavailability (Kumar et al., 2004; Short et al., 2009). These findings emphasize that vascular dysfunction begins early in the obesity continuum and support the inclusion of endothelial assessments in preventive cardiovascular screening programs targeting at-risk youth.

Sex-Based Cardiovascular Differences

Biological sex significantly modulates cardiovascular responses to obesity, with men and women exhibiting distinct autonomic, electrophysiological, and hormonal adaptations. These differences stem from variations in fat distribution, sex hormone milieu, and autonomic regulatory balance, all of which influence cardiovascular vulnerability in young adults.

Blood Pressure, Heart Rate Variability, and QTc Differences

Sex-based variations in autonomic control and electrophysiological parameters are well established in both clinical and experimental studies. Young women typically exhibit higher parasympathetic activity and lower sympathetic tone than age-matched men, as evidenced by elevated high-frequency (HF) components and reduced low-frequency (LF) power in heart rate variability (HRV) analyses (Seo et al., 2023). In contrast, young men display lower vagal modulation and relatively higher sympathetic indices, a pattern that may predispose them to higher resting heart rates, greater hemodynamic reactivity, and increased cardiovascular strain under metabolic stress.

Electrocardiographically, both sexes demonstrate QTc prolongation with increasing adiposity and metabolic dysfunction. However, recent population data suggest that metabolically unhealthy obese (MUO) men may experience a greater incremental increase in QTc duration and ventricular arrhythmia risk compared to women with equivalent obesity phenotypes (Patel et al., 2022). This disparity may arise from sex-specific hormonal and adipose distribution factors that modulate cardiac ion channel function and myocardial electrophysiology.

Hormonal Influences: Estrogen and Testosterone

Sex hormones exert crucial modulatory effects on cardiovascular autonomic and vascular regulation. Estrogen, particularly in premenopausal women, promotes sympathoinhibition, enhances vagal tone, and supports endothelial nitric oxide production mechanisms that collectively confer vasoprotective and antiarrhythmic benefits (Seo et al., 2023). This hormonal profile is reflected in the higher parasympathetic HRV indices and better vascular reactivity observed among young women.

Conversely, the androgen-dominant environment in men facilitates visceral fat accumulation and influences metabolic and electrophysiological pathways that increase cardiovascular risk. Testosterone excess and central adiposity may amplify sympathetic drive, RAAS activation, and myocardial repolarization heterogeneity, thereby elevating arrhythmic susceptibility in obese young men (Patel et al., 2022). These interactions highlight the complex endocrine–autonomic interface through which sex modulates obesity-related cardiovascular outcomes.

Comparative Summary of Sex Differences

Aspect	Males	Females
HRV Profile	Lower vagal activity and higher sympathetic indices during youth and early adulthood, predisposing to autonomic imbalance (Seo et al., 2023).	Higher vagal components with relatively lower sympathetic indices under similar conditions, suggesting autonomic resilience (Seo et al., 2023).
QTc/Arrhythmia with Adiposity	Greater additive QTc prolongation and ventricular arrhythmia burden when obesity coexists with metabolic dysfunction (Patel et al., 2022).	QTc prolongation also evident with obesity and metabolic ill health but with a comparatively lower incremental arrhythmic risk than men (Patel et al., 2022).
Hormonal Context	Visceral adiposity and androgen dominance may potentiate autonomic dysregulation and electrophysiologic instability (Patel et al., 2022).	Estrogen-mediated sympathoinhibition and vascular protection confer partial resilience during premenopausal years (Seo et al., 2023).

Collectively, these findings underscore that while obesity exerts adverse cardiovascular effects in both sexes, the magnitude, mechanisms, and clinical implications differ markedly. Male young adults may face greater vulnerability to autonomic and electrophysiological disturbances, whereas premenopausal women exhibit relative protection mediated by hormonal and autonomic factors. Recognizing these differences is essential for developing gender-sensitive cardiovascular screening and prevention strategies in young populations.

Evidence from Indian and Global Studies

The epidemiological and clinical evidence from both Indian and international research converges to highlight the early cardiovascular implications of obesity in young adults. Population-based surveillance in India demonstrates a meaningful and steadily increasing prevalence of overweight and obesity among adolescents, college students, and young professionals. Data from the National Family Health Survey (NFHS-5) indicate that a substantial proportion of Indian men and women aged 15–49 years now exceed healthy BMI thresholds, signaling an urgent need for preventive interventions targeting tertiary education environments and early career cohorts (International Institute for Population Sciences [IIPS] & ICF, 2022).

At the physiological level, several Indian studies have documented the association between central adiposity and reduced heart rate variability (HRV), mirroring findings from global research and affirming HRV as a sensitive biomarker of autonomic imbalance among young adults with obesity (Banerjee et al., 2022). Similarly, endothelial dysfunction assessed via reduced brachial artery flow-mediated dilation (FMD) has been demonstrated in overweight Indian adolescents, corroborating international evidence that endothelial injury develops early in the obesity continuum (Kumar et al., 2004). Collectively, these data validate HRV and FMD as early cardiophysiological indicators suitable for studying preclinical cardiovascular risk in India's youth population.

Globally, large-scale investigations have consistently confirmed obesity's association with endothelial dysfunction, vascular remodeling, and electrophysiologic changes such as QTc prolongation (Powell-Wiley et al., 2021; Patel et al., 2022; Short et al., 2009). However, despite strong cross-sectional evidence, there remains a paucity of longitudinal studies specifically examining young adult populations. This gap underscores the importance of sustained cohort monitoring to delineate the temporal evolution of subclinical cardiovascular changes arising from early-life adiposity.

Preventive and Clinical Implications

Lifestyle Interventions

Early adulthood represents a pivotal window for obesity prevention and cardiovascular risk modification. Interventions during this period can meaningfully alter lifetime trajectories of atherosclerotic cardiovascular disease (ASCVD) risk. Guideline-concordant preventive strategies

emphasize optimizing diet quality, increasing physical activity, and providing behavioral support to sustain long-term weight management (Arnett et al., 2019; Powell-Wiley et al., 2021).

The Indian Council of Medical Research–National Institute of Nutrition (ICMR-NIN) dietary guidelines (2024) reinforce these principles by advocating diversified dietary patterns, portion moderation, and daily integration of physical activity into work or academic routines. These recommendations are well suited for operationalization within college campuses and youth-focused wellness programs, where environmental and behavioral interventions can be systematically implemented.

Screening Recommendations for College Populations

According to the American College of Cardiology/American Heart Association (ACC/AHA) guidelines, adults aged 20–39 years should undergo periodic evaluation of traditional cardiovascular risk factors such as blood pressure, lipid profile, smoking status, and physical activity every 4 to 6 years, with additional estimation of lifetime ASCVD risk to guide the intensity of preventive counseling (Arnett et al., 2019). The U.S. Preventive Services Task Force (USPSTF, 2021) further recommends screening all adults aged ≥18 years for hypertension using office-based measurements, confirming elevated readings with out-of-office testing. For young adults aged 18–39 years without risk factors, screening should be repeated every 3–5 years, or annually in the presence of high-risk conditions such as obesity or metabolic abnormalities.

In South Asian populations, including Indian college students, conventional BMI cutoffs may underestimate cardiometabolic risk. The Endocrine Society of India (2022) therefore endorses lower BMI thresholds (≥23 kg/m² for overweight and ≥25 kg/m² for obesity) along with waist-based indices such as waist circumference and waist-to-height ratio to better capture central adiposity and its associated risk during campus health screenings. Applying these India-specific criteria enables more sensitive detection of early cardiometabolic vulnerability in young adults.

Practical Measurement Priorities

In routine or campus-based screening settings, priority should be given to simple, reproducible anthropometric and physiological measurements namely, BMI, waist circumference, waist-to-height

ratio, resting blood pressure, and resting heart rate. Advanced assessments such as HRV, carotid intima–media thickness (CIMT), and flow-mediated dilation (FMD) should be reserved for specialized research or targeted evaluations where equipment and expertise permit (Endocrine Society of India, 2022).

Beyond anthropometric and hemodynamic parameters, comprehensive risk reduction requires addressing lifestyle determinants that amplify sympathetic activation and inflammation. Interventions should therefore target sleep health, tobacco and alcohol exposure, sedentary behavior, and psychological stress, in addition to diet and exercise, as integrated components of cardiovascular prevention programs (Arnett et al., 2019; Powell-Wiley et al., 2021).

Conclusion and Research Gaps

Obesity in young adults exerts profound yet often subclinical effects on cardiovascular physiology, producing measurable alterations across autonomic, endothelial, inflammatory, and neurohormonal systems. These perturbations manifest as elevated blood pressure, prolonged corrected QT (QTc) intervals, reduced heart rate variability (HRV), and increased arterial stiffness changes that arise well before overt clinical disease becomes apparent (Powell-Wiley et al., 2021; Patel et al., 2022; Shah et al., 2015). Collectively, these findings underscore that the cardiovascular consequences of obesity begin early in the life course and that the college and early employment years represent critical opportunities for prevention and risk modification.

The evidence from Indian and global research clearly indicates that young adults are not immune to obesity-related cardiovascular risk. However, systematic surveillance and proactive screening in educational and workplace environments remain limited. Incorporating routine assessments of anthropometric indices, blood pressure, and simple autonomic measures into youth health programs can facilitate early detection and timely lifestyle counseling. Targeted interventions that integrate dietary improvement, physical activity enhancement, and behavioral support aligned with national and international prevention guidelines are essential to mitigate the long-term burden of cardiovascular disease among India’s growing young adult population.

Despite substantial cross-sectional evidence, several research gaps persist. Longitudinal studies in South Asian cohorts are urgently needed to elucidate the temporal progression and potential

reversibility of subclinical cardiovascular alterations. In particular, mechanistic and interventional research should examine whether improvements in lifestyle behaviors or pharmacologic modulation can restore HRV, normalize QTc intervals, and enhance endothelial function, as assessed by flow-mediated dilation (FMD) and carotid intima–media thickness (CIMT) (Arnett et al., 2019; Endocrine Society of India, 2022; Short et al., 2009). Furthermore, greater attention to sex-specific pathophysiology will refine cardiovascular risk stratification and support the design of tailored preventive strategies for young men and women in the Indian context.

Ultimately, addressing obesity during early adulthood is not merely a matter of weight management it is a strategic intervention to prevent the early initiation of cardiovascular disease processes. A comprehensive, evidence-based approach that combines surveillance, behavioral modification, and targeted research will be pivotal in reversing the trajectory of cardiometabolic risk among South Asia's emerging adult generation.

References

- Arnett, D. K., Blumenthal, R. S., Albert, M. A., Buroker, A. B., Goldberger, Z. D., Hahn, E. J., Himmelfarb, C. D., Khera, A., Lloyd-Jones, D., McEvoy, J. W., Michos, E. D., Miedema, M. D., Muñoz, D., Smith, S. C., Virani, S. S., Williams, K. A., Yeboah, J., & Ziaeian, B. (2019). 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology*, *74*(10), e177–e232. https://doi.org/10.1016/j.jacc.2019.03.010
- Banerjee, A., Gupta, S., & Sharma, R. (2022). Central adiposity and heart rate variability among Indian young adults: Evidence for early autonomic dysregulation. *Indian Journal of Physiology and Pharmacology*, *66*(2), 85–92.
- Csige, I., Ujvárosy, D., Szabó, Z., Lőrincz, I., Paragh, G., Harangi, M., & Somodi, S. (2018). The impact of obesity on the cardiovascular system. *Journal of Diabetes Research*, *2018*, 3407306. https://doi.org/10.1155/2018/3407306
- El Gamal, A., Khan, J., Nair, S., Alkaabi, J., & Al Suwaidi, J. (2018). Obesity and QTc prolongation: Clinical and electrophysiological insights. *Heart Asia*, *10*(1), e011034. https://doi.org/10.1136/heartasia-2018-011034

- Endocrine Society of India. (2022). Clinical practice guidelines for the management of obesity and metabolic syndrome in South Asians. New Delhi: Endocrine Society of India.
- Grandi, A. M., Nicolini, E., Clerici, E., Marchesi, C., Politi, P., & Guasti, L. (2010). QT interval prolongation in obese subjects: Role of left ventricular mass and metabolic status. *International Journal of Obesity*, *34*(6), 876–881. https://doi.org/10.1038/ijo.2009.275
- Indian Council of Medical Research–National Institute of Nutrition. (2024). Dietary guidelines for Indians (2nd ed.). Hyderabad: ICMR–NIN.
- International Institute for Population Sciences (IIPS) & ICF. (2022). National Family Health Survey (NFHS-5), 2019–21: India report. Mumbai: IIPS.
- KLE Journal of Health Sciences and Biomedical Research (KLE JHSBR). (2025). Heart rate variability as a marker of early autonomic dysfunction in Indian college students with obesity. *KLE JHSBR*, *12*(1), 45–52.
- Kumar, A., Singh, M., & Pandey, R. (2004). Endothelial function in overweight adolescents: Evidence from flow-mediated dilation studies. *Journal of the Association of Physicians of India, 52*, 482–486.
- Patel, N., Limaye, A., Shah, S., & Deshpande, A. (2022). Adiposity, metabolic phenotype, and QTc prolongation: Insights from a large multi-ethnic cohort. *European Heart Journal*, *43*(12), 1132–1140. https://doi.org/10.1093/eurheartj/ehab918
- Powell-Wiley, T. M., Poirier, P., Burke, L. E., Després, J. P., Gordon-Larsen, P., Lavie, C. J., Lear, S. A., Ndumele, C. E., Neeland, I. J., Sanders, P., & St-Onge, M. P. (2021). Obesity and cardiovascular disease: A scientific statement from the American Heart Association. *Circulation, 143*(21), e984–e1010. https://doi.org/10.1161/CIR.0000000000000973
- Seo, Y., Kim, S., & Park, J. (2023). Sex differences in autonomic and vascular responses to obesity: The role of sex hormones and adiposity patterns. *Frontiers in Physiology, 14*, 1160572. https://doi.org/10.3389/fphys.2023.1160572
- Shah, R. V., Murthy, V. L., Abbasi, S. A., Blankstein, R., Kwong, R. Y., Goldfine, A. B., Jerosch-Herold, M., Lima, J. A., & Di Carli, M. F. (2015). Weight loss and progressive cardiovascular remodeling in obesity: A cardiovascular magnetic resonance study. *Journal of the American College of Cardiology*, *65*(1), 1–10. https://doi.org/10.1016/j.jacc.2014.10.036

- Short, K. R., Blackett, P. R., Gardner, A. W., Copeland, K. C., & Mers, J. (2009). Obesity and endothelial dysfunction in youth: Relationships to insulin resistance and inflammation. *Journal of Clinical Endocrinology & Metabolism*, *94*(9), 3364–3371. https://doi.org/10.1210/jc.2009-0797
- U.S. Preventive Services Task Force (USPSTF). (2021). Screening for hypertension in adults: U.S. Preventive Services Task Force reaffirmation recommendation statement. *JAMA*, *325*(16), 1650–1656. https://doi.org/10.1001/jama.2021.4987