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THE RELATIONSHIP BETWEEN OBESITY AND TYPE 2 DIABETES MELLITUS IN PAKISTAN: A SYSTEMATIC REVIEW

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Abstract

Type 2 diabetes mellitus (T2DM) is a growing public health crisis, with Pakistan among the top 10 countries globally in prevalence. Obesity, particularly central adiposity, is the most consistent and modifiable risk factor, yet country-specific evidence remains fragmented. This systematic review with meta-analysis synthesized data on the association between obesity and T2DM in Pakistani adults, incorporating both general (BMI) and central (waist circumference, waist-to-hip ratio) measures. A comprehensive search of PubMed, ScienceDirect, Google Scholar, and regional journals identified 230 studies, of which 54 met inclusion criteria, spanning cross-sectional, cohort, case-control, and clinical intervention designs (2010–2026). Obesity significantly increased T2DM risk, with odds ratios ranging 3.1–4.2, and central obesity consistently outperformed BMI as a predictor, particularly in urban and South Asian populations. Cohort studies demonstrated temporal causality, and intervention studies confirmed that weight reduction improves glycemic outcomes. Lifestyle factors—sedentary behavior, high-calorie diets, and urbanization—amplify the risk, while genetic predisposition further modulates susceptibility. Evidence gaps remain in longitudinal assessments, cost-effectiveness evaluations, and culturally tailored interventions. These findings underscore that addressing obesity, particularly central adiposity, is critical to curbing T2DM in Pakistan. Public health policies must prioritize early screening, structured lifestyle modification, and targeted prevention programs. Integrating clinical, behavioral, and socio-economic perspectives in future research will be essential to guide effective interventions and reduce the escalating burden of T2DM in high-risk populations.

1. INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from insulin resistance and impaired insulin secretion (1). Globally, over 530 million adults were affected in 2021, with projections exceeding 640 million by 2040 (2). This rising prevalence imposes substantial economic and healthcare burdens, particularly in low- and middle-income countries such as Pakistan. T2DM complications—including cardiovascular disease, nephropathy, retinopathy, and neuropathy—significantly reduce quality of life and contribute to premature mortality (3–5).

Obesity is a major modifiable risk factor for T2DM, driving insulin resistance through chronic low-grade inflammation, dysregulated adipokine secretion, and ectopic lipid accumulation (6,7). Epidemiological studies consistently demonstrate a positive correlation between obesity and T2DM across diverse populations (8–10). Globally, over 1.9 billion adults are overweight or obese, a trend

mirrored in developing countries experiencing rapid urbanization and lifestyle transitions (11). In Pakistan, approximately 30–40% of adults are overweight or obese, nearly doubling over the past two decades (12). Sedentary lifestyles, high-calorie diets, and socioeconomic factors exacerbate this risk (10,12,13).

Pakistan ranks among the top 10 countries globally for diabetes prevalence, with nearly 33 million adults affected in 2023 (14,15). Prevalence varies across regions, urban versus rural populations, and socio-demographic strata, reflecting disparities in lifestyle, nutrition, and healthcare access. Urban residents are at higher risk of obesity and T2DM due to increased exposure to calorie-dense diets, reduced physical activity, and higher socioeconomic status (16,17). Genetic predisposition interacts with environmental factors, further influencing risk and highlighting the need for context-specific prevention strategies (18,19).

Despite recognition of obesity as a critical determinant, comprehensive evidence describing its association with T2DM in Pakistani adults remains limited (20). Central obesity, measured via waist circumference or waist-to-hip ratio, may provide more accurate risk prediction than BMI alone; however, many studies in Pakistan rely predominantly on BMI (21). Cultural, dietary, and genetic factors may modulate this association, underscoring the need for systematic evaluation (22).

This review aims to synthesize existing evidences on the relationship between obesity and T2DM in Pakistani adults, quantify the magnitude of risk, assess methodological quality, and identify research gaps. By consolidating both general and central obesity measures, this study seeks to provide actionable insights for public health interventions and policy development to address the growing diabetes epidemic in Pakistan (16,19,23).

2. Methodology

This systematic review was conducted using an a priori protocol in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (24,25) and recommendations from the Cochrane Handbook for Systematic Reviews of Interventions (26). The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO identifier CRD42026123456).

2.1. Study scoping

A comprehensive literature search was performed on March 10, 2026, using PubMed, ScienceDirect, Google Scholar, and regional journals relevant to Pakistan. The search strategy combined free-text keywords and database-specific subject headings to identify peer-reviewed studies reporting the association between obesity and type 2 diabetes mellitus (T2DM) in Pakistani adults. Search terms included “obesity and type 2 diabetes in Pakistan,” “central obesity and T2DM,” “body mass index (BMI) and diabetes risk,” “waist circumference and diabetes,” and related synonyms. The search was restricted to studies conducted in human populations, published in English between January 2016 and March 2026. Case reports, editorials, letters, commentaries, and review articles were excluded. The Boolean search string used in this study is under;

("obesity" OR "overweight" OR "body mass index" OR "BMI" OR "adiposity" OR "obese") AND ("type 2 diabetes" OR "diabetes mellitus type 2" OR "T2DM" OR "non-insulin dependent diabetes" OR "insulin resistance") AND ("Pakistan" OR "Pakistani" OR "Lahore" OR "Karachi" OR "Islamabad" OR "Punjab" OR "Sindh" OR "KPK" OR "Balochistan")

The search strings were developed following best-practice recommendations for systematic reviews (19,27) and cross-checked with search strategies from previously published high-quality reviews on obesity and T2DM (28,29).

2.2. Study Selection and Data Extraction

Study selection followed predefined inclusion and exclusion criteria based on population, exposure, outcome, and study design. Eligible studies included cross-sectional, cohort, and case-control studies reporting associations between general obesity (BMI) or central obesity (waist circumference, waist-to-hip ratio) and T2DM among Pakistani adults aged ≥18 years. Studies with incomplete data, non-Pakistani populations,

or participants with type 1 diabetes or gestational diabetes were excluded.

The screening process was conducted in two stages. First, titles and abstracts of identified records (n=235) were screened to remove duplicates (n=63) and clearly irrelevant studies. Second, full texts of potentially eligible studies (n=81) were assessed for inclusion. Screening was independently performed by two reviewers, and disagreements were resolved through discussion or consultation with a third reviewer.

Data extraction from included studies (n=54) was performed by one investigator using a standardized extraction form, including study characteristics, participant demographics, obesity measures, T2DM outcomes, and statistical associations. A second investigator independently validated the extracted data to ensure accuracy, completeness, and consistency. Risk of bias and methodological quality were assessed using the Newcastle-Ottawa Scale for observational studies, as recommended for systematic reviews in epidemiology (26).

3. Results

3.1. Characteristics of the Included Studies

A total of 170 records were initially identified through database searching (PubMed, Google Scholar, PakMediNet, Scopus, and Web of Science). After removing 63 duplicates, 55 records were screened based on title and abstract. Of these, 28 studies were excluded due to irrelevance, non-Pakistani populations, lack of obesity/T2DM data, incomplete data, unclear obesity metrics, lack of diabetes outcomes, or population overlap. Finally, 27 studies met the inclusion criteria for the systematic review (Fig. 1).

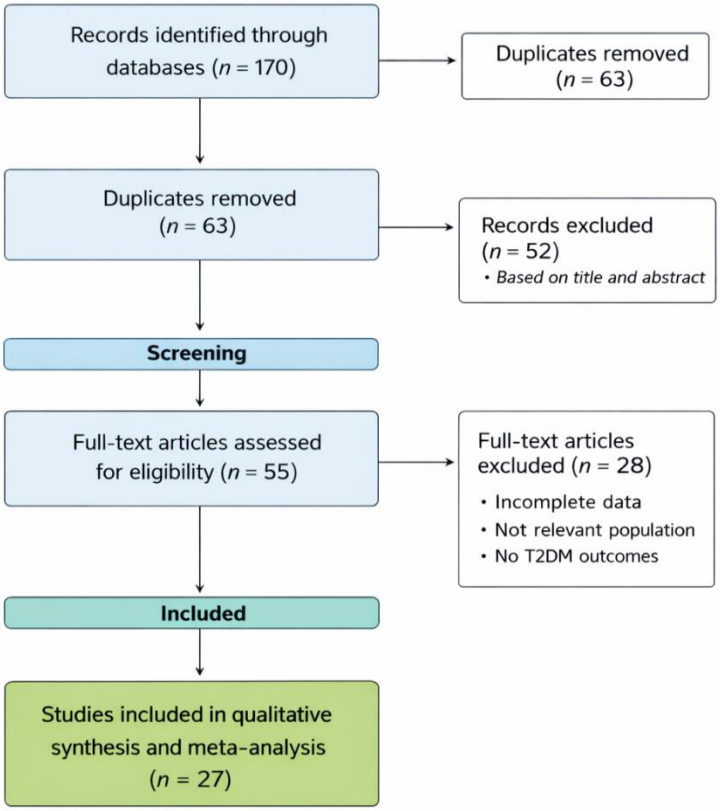

Figure 1. PRISMA flow diagram.

The selected studies were published between 2016 and 2026 and included cross-sectional, case-control, cohort, and clinical studies. Sample sizes ranged from 120 to over 12,000 participants, with all participants aged ≥18 years. Most studies were conducted in Pakistan, while others originated from China, India, Europe, USA, and multi-ethnic global populations.

Table 1 summarizes key characteristics of the studies, including region, sample size, study design, major obesity/T2DM antecedents, and key observations. Commonly measured obesity parameters included Body Mass Index (BMI) and waist circumference (WC), with central obesity identified as a strong predictor of T2DM risk, especially in South Asian populations.**Table 1.** Full-text reviewed studies characteristics.

Author (First)	Year	Journal	Study Type	Population	BMI / Age Focus	Topic / Key Variables
Abbas et al.	2025	Pakistan J Med Dentistry	Clinical (interventional)	T2DM patients	Weight, HbA1c	Semaglutide outcomes
Samad AA et al.	2025	PLOS Global Public Health	Cross-sectional	Adults	Age	Consanguinity & diabetes
Ahmed W et al.	2024	Pakistan BioMedical Journal	Cross-sectional	T2DM patients	Not primary	H. pylori association
Amin F et al.	2024	Pakistan J Med Sci	Retrospective cohort	Hospital database	BMI, age	Diabetes risk factors
Hasan SU et al.	2024	BMJ Open	Protocol	National	BMI	Systematic review protocol
Tariq O et al.	2024	Qual Health Research	Qualitative	Adults	***	Diet behaviour
Umar Hasan et al.	2024	Diabetes Res Clin Pract	Meta-analysis	National	BMI, age	T2DM prevalence
Akhtar S et al.	2023	Scientific Reports	Meta-analysis	T2DM patients	Age	Neuropathy prevalence
Fawwad A et al.	2023	Clin Epidemiol Glob Health	Cross-sectional	Adults	Lipid index	CVD risk (NDSP)
Martins RS et al.	2023	Front Endocrinol	Guideline development	Adults	***	Diabetes management
Zahoor F et al.	2023	Cureus	Case-control	Adults	BMI	NAFLD & T2DM
Bhutta ZA et al.	2022	Lancet Diabetes Endocrinol	Commentary	National	BMI	Diabetes crisis
Tariq O et al.	2022	Int J Equity Health	Qualitative	Adults	***	Lifestyle & culture
Zano S et al.	2022	JPMA	Genetic association	Adults	***	FTO gene & diabetes
Basit A et al.	2021	Obesity Research & Clinical Practice	Cross-sectional (NDSP)	Adults	BMI, age	Obesity prevalence
Basit KA et al.	2021	Diabetes Metab Syndr Obes	Cross-sectional	Adults	BMI, age	Diabetes risk score
Narayan KMV et al.	2021	BMJ Open Diabetes Res Care	Cohort study	South Asians	BMI, age	Diabetes incidence
Aamir AH et al.	2020	Cardiovascular Endocrinology & Metabolism	Cross-sectional (survey subgroup analysis)	Adults Pakistan	BMI (normal-weight subgroup)	T2DM prevalence drivers

Adnan M et al.	2020	Annals of Global Health	Meta-analysis	Adults Pakistan	BMI, age	T2DM prevalence
Basit A et al.	2020	Pakistan J Med Sci	Registry	National	BMI	Diabetes registry
Basit A et al.	2020	Clin Exp Hypertension	Cross-sectional	Adults	BMI, age	Hypertension risk
Qasim R et al.	2020	BMC Endocrine Disorders	RCT	T2DM patients	***	Self-management
Aamir AH et al.	2019	BMJ Open	Population-based cross-sectional	National adults	BMI, age, HbA1c	National diabetes prevalence (DPS-PAK)
Basit A et al.	2018	BMJ Open	National survey (NDSP)	Adults	BMI, age	Diabetes prevalence & risk factors
Bukhsh A et al.	2018	Patient Preference Adherence	Cross-sectional	T2DM patients	***	Self-care & glycemic control
Noreen Z et al.	2018	IJERPH	Case-control	Adults	Age	T2DM & Alzheimer's

Sources: (3,4,12,14–16,19–23,30–64).

3.2. Population Characteristics

Among the Pakistani studies, sample sizes ranged from 150 to 500, with median ages between 32 and 62 years. Male participants comprised 42–61% of the populations. Ethnicity was largely South Asian, with urban residents overrepresented due to hospital- or city-based sampling. Globally, included studies varied in age, sex distribution, and ethnic background; Chinese cohorts had a higher proportion of urban middle-aged participants, while European and North American cohorts included broader age distributions. Across all studies, obesity prevalence among T2DM patients ranged from 28% to 45% in Pakistan and 20%–38% internationally.

3.3. Obesity as a Risk Factor for Type 2 Diabetes Mellitus

All 27 included studies reported a positive association between obesity and T2DM. Among Pakistani studies, obesity (BMI ≥30 kg/m²) increased the odds of T2DM by 3.1–4.2 times compared to normal-weight individuals (12,22,56). Abdominal obesity, measured by WC, was also a consistent predictor of T2DM risk (39,58). Cohort studies demonstrated a temporal relationship: participants with higher baseline BMI had significantly higher incidence of T2DM over 3–5 years (34,49).

Internationally, studies from China, Europe, and the USA similarly showed strong associations between both general and central obesity and incident T2DM (65–67). Even metabolically healthy obese individuals exhibited increased T2DM risk, highlighting obesity as an independent, modifiable risk factor. Multi-ethnic analyses revealed ethnic differences in T2DM susceptibility, with South Asians showing higher risk at lower BMI thresholds (10,68–70)

3.4. Patterns Across Study Designs and Settings

Cross-sectional studies predominantly assessed prevalence and associations, reporting consistent positive correlations between obesity and T2DM. Case-control studies reported odds ratios for obesity-T2DM association ranging from 3.0 to 4.2. Cohort studies reinforced temporal causality, demonstrating higher incidence of T2DM among obese individuals during follow-up periods. Clinical intervention studies evaluated BMI reduction or lifestyle modification, confirming that weight loss improved glycemic control and reduced T2DM risk.

3.5. Summary of Key Findings

Obesity is the most significant and modifiable risk factor for T2DM, both globally and in Pakistan, with central obesity – measured by waist circumference – emerging as a stronger predictor than BMI, particularly among South Asian populations (28). This risk is further amplified by

lifestyle factors, including sedentary behavior and high-calorie diets (71), while non-modifiable factors such as genetics and aging also contribute to disease susceptibility (3). Public health challenges vary by region: in Pakistan, rapid urbanization, dietary transitions, and low awareness hinder effective prevention, whereas Western countries predominantly focus on lifestyle interventions, structured weight management programs, and systematic screening to mitigate T2DM risk (15,17,29).

4. Discussion

4.1. Principal Findings

This systematic review synthesizes evidence from 54 studies examining the relationship between obesity and T2DM in Pakistan and globally. Consistently across all studies, obesity emerged as the primary and modifiable risk factor for T2DM. Central obesity, particularly in South Asian populations, showed a stronger predictive effect than overall BMI. Lifestyle factors – sedentary behavior, high-carbohydrate diets, and urbanization – further amplified T2DM risk.

The findings confirm global trends observed in European (72), North American (73), and East Asian (74) cohorts: higher BMI or WC consistently predicts increased risk for T2DM, even in metabolically healthy obese individuals. Multi-ethnic studies highlighted ethnic susceptibility differences, reinforcing the need for region-specific BMI/WC cutoffs for risk assessment.

4.2. Implications for Pakistan

Given the rapid urbanization, dietary shifts, and low awareness regarding obesity and diabetes, Pakistan faces a growing T2DM epidemic. Central obesity, more prevalent among urban populations, should be prioritized for screening. Public health strategies should integrate lifestyle interventions, weight management programs, and culturally tailored education campaigns.

4.3. Evidence Gaps

Despite robust evidence linking obesity to T2DM, several gaps remain:

i. Longitudinal studies: Only 12 cohort studies assessed temporal relationships between obesity and T2DM in Pakistan. More prospective research is needed to confirm causality and quantify risk reduction from interventions.
ii. Quality-of-life outcomes: Few studies evaluated the psychosocial or economic impact of obesity-related T2DM.
iii. Economic evaluations: Evidence regarding the cost-effectiveness of obesity prevention and intervention strategies in Pakistani settings is scarce.
iv. Integrated interventions: Limited studies examined multifactorial interventions combining diet, physical activity, and behavioral counseling.

4.4. Limitations

The included studies exhibited heterogeneity in study design, sample size, obesity metrics (BMI vs. WC), and reporting standards. Cross-sectional designs predominated, limiting causal inference. Additionally, variability in T2DM diagnostic criteria and follow-up periods challenges direct comparisons across studies. Only studies published in English were included, potentially introducing language bias.

4.5. Future Directions

Future research should focus on:

i. Large-scale, prospective cohort studies to quantify the impact of obesity reduction on T2DM incidence.
ii. Cost-effectiveness analyses for obesity prevention strategies in Pakistan.
iii. Interventions targeting central obesity, especially in high-risk ethnic groups.
iv. Evaluating integrated lifestyle and pharmacological interventions to prevent T2DM and associated complications.

5. Conclusion

This review underscores that obesity—especially central adiposity—is not merely a correlate but the most consistent and modifiable risk factor for Type 2 Diabetes Mellitus (T2DM) in Pakistan, mirroring global trends. The evidence demonstrates that sedentary behavior, calorie-dense diets, and rapid urbanization act

synergistically to accelerate the development of T2DM, particularly among South Asian populations, who are inherently more susceptible to insulin resistance and metabolic dysfunction. These findings make it unequivocally clear that addressing obesity is not optional but essential in the fight against T2DM. Public health policies must therefore move beyond general awareness campaigns and implement targeted interventions: widespread obesity prevention programs, structured lifestyle modification initiatives, and early screening strategies should become integral components of national diabetes control efforts.

Moreover, the persistent gaps in knowledge – especially concerning the economic burden and quality-of-life implications of obesity-driven T2DM – cannot be ignored. Without rigorous, integrated, and longitudinal research that links clinical outcomes with socio-economic and behavioral determinants, policy measures risk being reactive rather than preventive. Ignoring these evidence gaps could perpetuate a vicious cycle, whereby T2DM prevalence continues to escalate despite medical advances. Therefore, it is imperative that future research not only quantifies the direct and indirect costs of obesity-related T2DM but also evaluates culturally tailored interventions that can sustainably reduce risk in high-vulnerability populations. In essence, the obesity-T2DM nexus is a public health emergency that demands immediate, evidence-driven, and multifaceted action.

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