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Review

Trends in prevalence of type 2 diabetes, obesity, and hypertension in urban India since 2000: a systematic review and meta-analysis

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Abstract

Rapid changes in urbanization in India have paralleled increased prevalence in noncommunicable diseases (NCDs), including type 2 diabetes (T2D), hypertension (HTN), and obesity. To examine sex-specific temporal trends in the prevalence of T2D, HTN, general obesity (GO), and abdominal obesity (AO) among urban populations in India since 2000, a systematic review and meta-analysis was conducted in accordance with a registered Prospective Register of Systematic Reviews protocol (CRD42024548962). PubMed, Global Health (via EBSCOhost), Embase, Scopus, and Web of Science were searched for studies from 2000-2025 (initial search: October 12, 2024; update: July 4, 2025). Eligible studies were cross-sectional and reported the prevalence of T2D or HTN or obesity in urban Indian populations. Screening, data extraction, and risk-of-bias assessment using the Hoy tool were performed independently by 2 reviewers, with a third resolving conflicts. Pooled prevalence was estimated via random-effects meta-analysis in R (version 4.5.3), with forest and funnel plots generated using ggplot2. Out of 3143 records screened, 57 studies were included. The pooled prevalence demonstrated upward trajectory. T2D rose from 13% in 2000-2005 to 21% in 2021-2025, and HTN from 29% to 31%. For obesity, GO increased from 24% in 2000-2005 to 36% in 2016-2020, while AO rose from 47% to 72% over the same period. Sex-stratified analyses showed greater increases among males for T2D and HTN, whereas AO increased more among females. These findings underscore increasing T2D, HTN, and obesity in urban India, highlighting the need for strengthened primary care and supportive environmental and policy measures address the urban NCD burden.

Key words type 2 diabetes, obesity, hypertension, cross-sectional studies, prevalence

Introduction

Noncommunicable diseases (NCDs) comprise a group of chronic conditions, including cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases, the leading global cause of morbidity and mortality.[1] Among these, type 2 diabetes (T2D), hypertension (HTN), and obesity are key metabolic risk factors, frequently coexist, and markedly increase the risk of cardiovascular disease, stroke, kidney failure, and premature mortality through synergistic interactions.[2,3]

Globally, the prevalence of T2D and its complications has risen rapidly. A pooled analysis of 1108 population-based studies, including over 141 million individuals showed that diabetes prevalence more than doubled between 1990 and 2022, with the fastest increases occurring in low- and middle-income countries (LMICs).[4] During 2000-2025, metabolic NCDs overtook infectious diseases as the dominant causes of morbidity and mortality LMICs, with India central to this transition.[5-8]

India is undergoing a rapid epidemiological shift driven by industrialization, globalization, and economic growth.[9,10] Alongside persistent undernutrition, urban populations have experienced rising overnutrition, physical inactivity, and cardiometabolic risk, leading to an increasing prevalence of obesity, T2D, and HTN.[5,11,12] Urban residents have a higher prevalence of these conditions than rural populations due to interactions between nonmodifiable factors,

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such as age, sex, and genetic predisposition, and modifiable lifestyle factors, including unhealthy diets, sedentary behavior, and psychosocial stress.[13-17]

Importantly, sex represents[18] a key determinant of variation in cardiometabolic risk, with evidence indicating that differences in biological susceptibility, adiposity distribution, hormonal profiles, behavioral risk exposures, health-seeking behaviors, and access to care contribute to distinct disease patterns in male and female populations. Consideration of these differences is therefore critical for accurately characterizing disease burden and informing targeted prevention strategies.

Prevalence levels of T2D, HTN, and obesity were lower before 2000 but have increased steadily since India's economic liberalization marked by market deregulation, trade openness, and increased foreign investment initiated in the late 1990s, which transformed food systems, work patterns, and lifestyles. These changes created obesogenic urban environments characterized by energy-dense diets and reduced physical activity.[16,17] National ICMR-INDIAB estimates now report ~101 million people with T2D, 315 million with HTN, 251 million with general obesity (GO), and 351 million with abdominal obesity (AO), highlighting the scale of the urban metabolic burden.[5] Together, these trends highlight India's critical contribution to the expanding global prevalence of metabolic NCDs.[5-8] Projections from the National Commission on Population indicate that nearly 600 million of India's projected population of 1.52 billion will reside in urban areas by 2036.

National surveys, such as the National Family Health Survey[6,19] and the Longitudinal Aging Study in India[20] provide valuable, nationally representative estimates of cardiometabolic risk factors using standardized sampling frameworks. However, these surveys primarily focus on defined age groups and broader population settings, limiting detailed assessment of urban-specific trends across diverse study populations. This systematic review complements these data by synthesizing evidence from urban adult populations across India, thereby providing a focused assessment of temporal trends in cardiometabolic outcomes within rapidly urbanizing settings.

Recent systematic reviews in India have examined individual conditions HTN,[21] T2D,[22] and obesity,[23,24] but are largely restricted to single outcomes or specific populations and do not assess their joint dynamics. Moreover, sex-specific and integrated long-term estimates of T2D, HTN, and obesity in urban India remain limited, and no synthesis has examined concurrent temporal trends across the past 25 years (2000-2025).[5,11] Consequently, the coevolution and potential convergence of these conditions within India's rapidly transforming urban environments remain insufficiently characterized. This systematic review and meta-analysis aim to examine temporal trends in the prevalence of T2D, HTN, GO, and AO among adults in urban India between 2000 and 2025, rather than to infer causal relationships with socioeconomic or lifestyle changes.

This review addresses these gaps by providing an integrated synthesis of T2D, HTN, and obesity (both GO and AO), focusing specifically on urban populations across India incorporating meta-regression analyses to evaluate temporal changes, alongside sex-stratified estimates and long-term trend analyses, to identify high-risk periods and population subgroups, and generate robust evidence to support targeted prevention, urban health planning, and policy responses to the growing metabolic NCD burden in India.

Methods

Protocol and registration

Review protocol was registered with the International Prospective Register of Systematic Reviews, registration number CRD42024548962.

Keywords and search strategy

The review used search terms, such as "Type 2 Diabetes," "Diabetes Mellitus," "type II diabetes," "Obesity," "Hypertension," "High Blood Pressure," "Cross-sectional studies," "Prevalence," "trends," "Urban," "Metropolitan," "Suburban," and "India."

Searches were conducted in PubMed, Global Health (via EBSCOHost), Embase, Scopus, and Web of Science. Scopus and Web of Science were used exclusively for citation searching. Combinations of keywords and medical subject headings (MeSH) related to the conditions (T2D, HTN, and obesity) and the context (urban communities, 2000 to present, adults ≥ 18 years) were applied. The search covered studies published in English between January 1, 2000, and July 2025, with the most recent search completed on July 4, 2025, aligning with the period when urbanization began to feature prominently in public health discourse in India[25-27] and when the WHO 1999 diagnostic criteria for T2D and obesity were increasingly adopted as standardized thresholds in epidemiological research.[28] To minimize temporal misclassification, studies were categorized based on data collection year rather than publication year. Studies with data collected prior to 2000 were excluded to ensure contemporary relevance. For studies reporting a range of data collection years, the midpoint was used. Where data collection year was not reported, it was approximated as 2 years prior to publication and explicitly indicated in the study tables.

The study adopted the Condition, Context, Population (CoCoPop) framework[29] rather than the traditional PICO (Population, Intervention, Comparator, Outcome) framework to define the inclusion criteria, providing a structured approach to study selection, and defining the condition (T2D, HTN, and obesity), context (urban India), and population (adults ≥ 18 years) from 2000 onwards. The search strategy planner document is provided separately (Supplementary File S1). The initial search was conducted on October 12, 2024, and the final search on July 4, 2025, to capture newly published studies. Results were deduplicated and screened in Covidence against the predefined inclusion and exclusion criteria.

Citation tracking was undertaken using Scopus and Web of Science. The number of records retrieved through citation tracking and the number included following full-text screening are reported separately in the PRISMA flow diagram (Figure 1). In line with expert librarian guidance, citation searching was restricted to Scopus and Web of Science, and no manual searches were conducted outside these platforms, as they provide comprehensive citation indexing.

Eligibility criteria

Only cross-sectional studies of urban Asian Indian adults (both sexes) aged ≥18 years reporting prevalence of T2D, HTN, or obesity published in the English language were included. Exclusions comprised migrant populations, hospital-based data, interventions, review articles (including literature, systematic reviews, and meta-analyses as they do not provide original primary prevalence data suitable for quantitative synthesis), qualitative studies, clinical trials, registries, mixed rural–urban studies without separable urban data, case reports

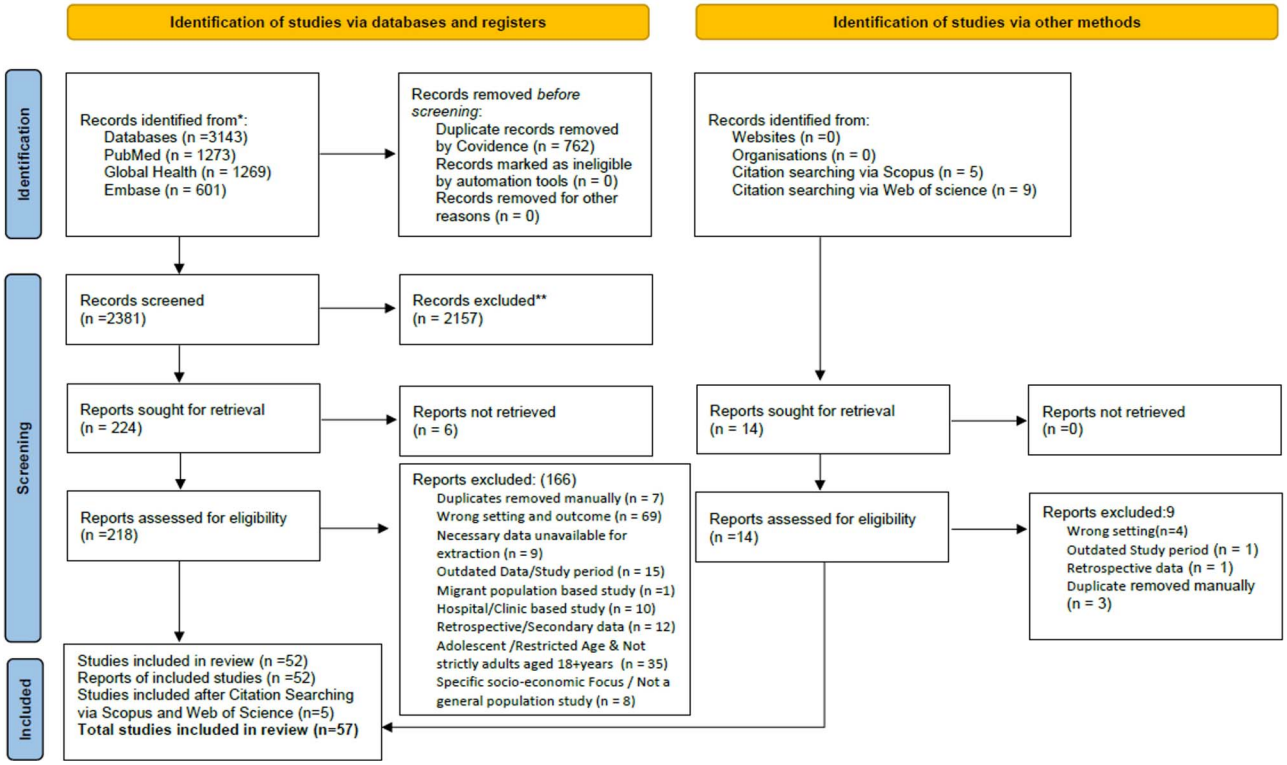


Figure 1 PRISMA flowchart depicting strategic screening stages and selection process of included studies.

or series, book chapters, editorials, letters, protocols, and conference abstracts.

Only cross-sectional studies were included, as these are most appropriate for estimating prevalence. Longitudinal studies were excluded to avoid mixing incidence and prevalence measures and to minimize bias arising from repeated observations within the same population over time. Where repeated cross-sectional datasets were identified, care was taken to avoid overlapping populations. To address concerns regarding potential overlap across studies, we carefully reviewed publications originating from the same parent studies or surveillance programs. For studies with multiple waves (eg, repeated cross-sectional surveys such as INDIAB), estimates were treated as independent only when they represented distinct sampling frames or separate time points. When multiple publications reported results from the same participant sample, only the most relevant dataset was included. Pooled results are therefore interpreted as reflecting urban India broadly, with caution regarding geographic generalizability. No geographic weighting was applied, but potential heterogeneity arising from differences across cities and regions was addressed in statistical analyses.

Definitions

For clarity, internationally recognized criteria for T2D, HTN, and obesity are presented as reference standards. However, the diagnostic thresholds varied across included studies and are detailed in the results tables

Type 2 diabetes: defined as fasting plasma glucose (FPG) or capillary blood glucose (CBG) ≥ 126 mg/dL (≥7.0 mmol/L), and/or 2-h plasma glucose or post-glucose CBG ≥ 200 mg/dL (11.1 mmol/L), physician-diagnosed diabetes, or HbA1c ≥ 6.5%.[30,31]

Hypertension: defined as systolic blood pressure (SBP) ≥ 140 mm Hg and/or diastolic blood pressure (DBP) ≥ 90 mm Hg, or current use of antihypertensive medication.[32]

Body mass index (BMI): calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Overweight: defined as BMI ≥ 23 and <25 kg/m^2.[33]

General obesity: defined as BMI ≥ 25 kg/m^2.[33]

Abdominal obesity/central obesity (CO) as waist circumference ≥ 90 cm for males and ≥80 cm for females.[34]

Urban area: In India, an urban area is defined as a settlement with a population of at least 5000, where a minimum of 75% of the workforce is engaged in nonagricultural activities, and the population density is at least 400 persons, per square kilometer.[35] Additionally, statutory towns governed by a municipal corporation, municipal council, cantonment board, or notified town area committee are classified as urban.[35]

Study selection and data collection

Two reviewers independently screened and extracted data, with disagreements resolved by the third reviewer. Extracted data included study characteristics, diagnostic criteria, and prevalence estimates, including sex-specific values when available. In cases where multiple articles referred to the same study population or represented subanalyses of a larger study, the earliest published article was prioritized to avoid duplication of data.

Quality check and risk of bias

Risk of bias was assessed using the 10-item Hoy tool, which is specifically designed for prevalence studies.[36] The tool evaluates external

Table 1 Summary table showing the increase in overall and sex-wise prevalence of type 2 diabetes (T2D), hypertension (HTN), general obesity (GO), and abdominal obesity (AO) in urban India (2000-2025).

Condition	Sex	Initial prevalence (baseline) (%)	Final prevalence (2025) (%)	%Point change (pp) (absolute change)	Relative change (%)
(a) T2D overall	Male	13	21	+8pp	+61.5
sex-wise		13	20	+7pp	+53.8
	Female	11	14	+3pp	+27.3
(b) HTN overall	Male	29	31	+2pp	+6.9
sex-wise		30	33	+3pp	+10.0
(c) GO overall (2000 → 2020)		24	36	+12pp	+50.0
Sex-wise (2000 → 2020)	Male	20	29	+9pp	+45.0
	Female	30	37	+7pp	+23.3
(d) AO overall (2000 → 2020)		47	72	+25pp	+53.2
Sex-wise (2000 → 2020)	Male	28	52	+24pp	+85.7
	Female	49	86	+37pp	+75.5

Abbreviations: AO, abdominal obesity; GO, general obesity; HTN, hypertension; T2D, type 2 diabetes.
For GO and AO has prevalence data available from 2000 → 2020, hence only nearly 20-year change.

validity (items Q1–Q4) and internal validity (items Q5–Q10). Studies were classified as low (≤33% high-risk items), moderate (34%-66%), or high risk (≥67%) (Supplementary File S2). A formal GRADE assessment was not performed; however, certainty was evaluated narratively based on risk of bias, heterogeneity, and precision. Funnel plots were used to visualize the distribution of effect sizes across 57 prevalence studies, and publication bias was further assessed through Egger's regression test.[37]

Statistical analysis and reporting

All analyses were conducted using R (version 4.5.3; RStudio). Statistical analyses were performed using the *meta* package, with data visualization carried out using *ggplot2*. An interactive interface was developed using *Shiny* to facilitate visualization and exploration of the results. Pooled prevalence estimates were calculated using a random-effects model with 95% CIs. Prediction intervals were calculated for all meta-analyses to account for between-study heterogeneity. Publication bias was assessed with funnel plots, and robustness of results was evaluated through leave-one-out sensitivity analyses.

The outcome measures of each selected study are presented in Tables 1-4, including first author and publication year, study title, study setting (city/state/country), study design and data collection year, age range, sample size, outcomes studied, diagnostic criteria, overall prevalence (%), and sex-wise prevalence. Male and female sex distribution and overall sample size were reported, with weighted or age-adjusted prevalence presented where available; otherwise, crude prevalence was recorded. Studies were organized chronologically by publication year under the headings T2D, HTN, and obesity prevalence in urban India (2000-2025). Cumulative graphs and forest plots with pooled estimates were used to illustrate variations in prevalence across studies, populations, and the period 2000-2025.

Prevalence data were transformed and expressed as weighted proportions under random-effects models,[38,39] with logit transformation applied to stabilize variance.[40] Pooled prevalence estimates were generated using a random-effects meta-analysis DerSimonian–Laird method, recognizing that true prevalence differs between studies because of variations in populations, study periods, and urban settings.

Pooled prevalence of T2D, HTN, and obesity was calculated for 5-year intervals (2000-2005, 2006-2010, 2011-2015, 2016-2020, and 2021-2025) using random-effects meta-analysis, accounting for anticipated heterogeneity. Between-study variability was assessed using the Chi-square test and I^2 statistics. Results were presented as pooled estimates with 95% CIs. This approach, widely regarded as appropriate for prevalence synthesis, accommodates the binomial distribution of prevalence data and addresses issues of variance instability and unlikely confidence limits. Finally, forest plots were used to derive pooled estimates. Overall and sex-wise prevalence trends for T2D, HTN, and obesity in urban India (2000-2025) are presented as line graphs incorporating all 57 studies (Figure 2).

To quantify temporal shifts in T2D, HTN, and obesity prevalence, changes between successive 5-year intervals were expressed using 2 complementary measures: (1) percentage-point (pp) change and (2) relative change.[41] The pp change, defined as the arithmetic difference between 2 consecutive estimates, reflects the absolute magnitude of variation, while the relative change, obtained by dividing this difference by the earlier prevalence and multiplying by 100, captures the proportional change relative to baseline. Using both measures follow established epidemiological guidance, which emphasizes that absolute change is independent of baseline prevalence, whereas relative change depends on it. This dual approach allowed for meaningful interpretation of large fluctuations in low-prevalence settings and smaller shifts in high-prevalence contexts, offering a balanced view of the scale and pace of change over 2000-2025.

Results

Identification of studies

A total of 3143 records were identified from PubMed, Global Health, and Embase databases. Following the removal of 762 duplicates through Covidence, 2381 studies were screened using the predefined inclusion and exclusion criteria. Of these, 2157 records were excluded, and 224 studies were assessed in full-text screening. A total of 57

Table 2 Characteristics studied for type 2 diabetes prevalence studies (2000-2025).

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome: overall T2D prevalence (%)
1.	Ramachandran et al. (2001)[42]	High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey	Six major cities in India (Chennai, Bangalore, Hyderabad, Kolkata, Mumbai, and New Delhi)	Cross-sectional community-based (2000)	20-59 years	11 216 (male: 5288, female: 5928) RR: 89.7%	WHO criteria (FPG ≥126 mg/dL and/or 2-h PG ≥200 mg/dL or history of diabetes)	**12.1%** (male = 12.5%, female = 11.9%)
2.	Gupta et al. (2002)[43]	Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2	Jaipur, India	Cross-sectional study Community-based (1999-2001)	≥20 years	1123 (male: 550, female: 573) RR: 62.4%	WHO criteria (history or FPG ≥126 mg/dL)	**12.2%** (male = 13.1%, female = 11.3%)
3.	Mohan et al. (2006)[44]	Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban South India—the Chennai Urban Rural Epidemiology Study (CURES-17)	Chennai, Tamil Nadu, South India.	Cross-sectional study Community-based (2003-2004)	≥20 years	2350 (male: female = NA) RR: 90.4%	WHO 2-h OGTT criteria	**15.5%** (male: female = NA)
4.	Menon et al. (2006)[45]	Prevalence of known and undetected diabetes and associated risk factors in central Kerala—ADEPS	Ernakulam District, South Central Kerala, India	Cross-sectional study Community-based (2002-2005)	18-80 years	986 (male: 389, female: 597) RR: NA	WHO 1999/2006 OGTT criteria	**9.63%** (male = 11.0%, female = 8.4%)
5.	Gupta et al. (2007)[46]	Body-mass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects	Jaipur, Rajasthan, India	Cross-sectional study Community-based (1999-2001)	≥20 years	1091 (male: 532, female: 559) RR: 60.6%	FPG ≥126 mg/dL or known diabetic	**12.3%** (male = 13.2%, female = 11.5%)
6.	Ramachandran et al. (2008)[48]	High prevalence of diabetes and cardiovascular risk factors associated with urbanization in India	Tamil Nadu, India	Cross-sectional community-based (2006)	≥20 years	2192 (male: 1053, female: 1139) RR: 82.0%	WHO criteria (FPG ≥126 mg/dL and/or 2-h PG ≥200 mg/dL or history of diabetes)	**18.6%** (male = 20.9%, female = 16.7%)
7.	Arora et al. (2010)[49]	Prevalence of diabetes in urban Haryana	Rohtak, Haryana, India (urban field practice area of Pt. B.D. Sharma PGIMS)	Cross-sectional study Community-based (October 2007–September 2008)	≥18 years	1003 (male: 460, female: 543) RR: 92%	WHO 2006 criteria Fasting plasma glucose ≥126 mg/dL (glucose oxidase enzymatic method)	**8.1%** (male = 6.1%, female = 9.8%)
8.	Gupta et al. (2010)[47]	Cardiovascular risk according to educational status in India	Jaipur, Rajasthan, India (urban areas using stratified cluster sampling from voter lists)	Cross-sectional study Community-based (1993-2003)	20-59 years	1280 (male: 619, female: 661) RR: NA	WHO 1999 criteria (FPG ≥126 mg/dL or self-reported)	**6.4%** (male: female = NA)

(Continued)

Table 2 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome: overall T2D prevalence (%)
9.	Ravikumar et al. (2011)[52]	Prevalence and risk factors of diabetes in a community-based study in North India: the Chandigarh Urban Diabetes Study (CUDS)	Chandigarh, Union Territory (Urban North India)	Cross-sectional study population-based (2008-2009)	≥20 years	2227 (male: 1068, female: 1159) RR: 94%	WHO 1999 criteria (FPG ≥126 mg/dL or 2-h PG ≥220 mg/dL)	**15.7%** (male = 15.6%, female = 15.7%)
10.	Ahmad et al. (2011)[50]	Prevalence of diabetes mellitus and its associated risk factors in age group of 20 years and above in Kashmir, India	Hazratbal, semi-urban central Kashmir, India	Cross-sectional study population-based (year of data collection not stated, ∼2009)	≥20 years	1040 (male: 500, female: 540) RR: NA	ADA 2004 criteria (FPG ≥126 mg/dL or 2-hr OGTT ≥200 mg/dL) and/or known diabetes on treatment	**6.05%** (male = 3.6%, female = 8.3%
11.	Bharati et al. (2011)[51]	Prevalence and determinants of diabetes mellitus in Puducherry, South India	Puducherry, South India	Cross-sectional study population-based (May–November 2007)	≥20 years	685 (male: 301, female: 384) RR: NA	WHO 2006 criteria (FPG ≥126 mg/dL and not on treatment)	**8.6%** (male: female = NA)
12.	Prasad et al. (2012)[53]	Prevalence and risk factors for diabetes and impaired glucose tolerance in Asian Indians: a community survey from urban eastern India	Berhampur, Orissa (urban Eastern India)	Cross-sectional study population-based (2010-2011)	20-80 years	1178 (male: 590, female: 588) RR: 98.16%	WHO/International Diabetes Federation (IDF) Consultation (2006)—FPG ≥126 mg/dL or 2-h PG ≥200 mg/dL (T2D); FPG < 126 mg/dL and 2-h PG 140-199 mg/dL (IGT)	**15.7%** (male = 17.8%, female = 13.8%)
13.	Walia et al. (2014)[54]	High prevalence of cardiovascular risk factors in Asian Indians: a community survey—Chandigarh Urban Diabetes Study (CUDS)	Chandigarh, Union Territory (North India)	Cross-sectional study Community-based (April 2008–June 2009)	20-94 years	2227 (male: 1068, female: 1159) RR: 94%	WHO 1999 criteria FPG ≥126 mg/dL or 2-h PG ≥220 mg/dL	**16.4%** (male = 15.9%, female = 14.2%)
14.	Bhadoria et al. (2014)[55]	Prevalence of hypertension and associated cardiovascular risk factors in Central India	15 Urban wards, Jabalpur District, Central India	Cross-sectional study Community-based (year of data collection not stated, ∼2012)	≥20 years	309 (male: 162, female: 147) RR: 98.1	WHO 1999 criteria FPG ≥126 mg/dL	**16.5%** (male: female = NA)
15.	Sahu et al. (2015)[56]	Coronary heart disease risk factors of in an urban locality of Eastern India	Bhubaneswar, Odisha, India	Cross-sectional study Community-based (May 2013–April 2014)	25-64 years	350 (male: 147, female: 203) RR: 100%	Fasting blood sugar (FBS) measured via Hexokinase method (cut-off not explicitly stated but implied ≥126 mg/dL)	**13.1% n (**male = 14.9%, female = 11.8%)

(Continued)

Table 2 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome: overall T2D prevalence (%)
16.	Solanki et al. (2015)[57]	Prevalence and risk factors of Diabetes Mellitus among adults residing in field practice area of a teaching hospital in Punjab	Patiala, Punjab, India	Cross-sectional study Population-based (August 2013–March 2014)	≥20 years	475 (male: 202, female: 273) RR: 100%	WHO 2006 criteria (Fasting plasma glucose > 126 mg/dL or 2-h post-glucose > 200 mg/dL)	**12.6%** (male: female = NA)
17.	Deepa et al. (2015)[11]	High burden of prediabetes and diabetes in three large cities in South Asia: the Center for cArdio-metabolic Risk Reduction in South Asia (CARRS) Study	Chennai and Delhi, India	Cross-sectional study Population-based (2010-2011)	≥20 years	2930 Chennai = 1581 (male: 663, female: 918) RR = 90.9% Delhi = 1349 (male: 651 female: 698) RR = 98.9%	Fasting plasma glucose (FPG) 126 mg/dL (7.0 mmol/L) and/or HbA1c 6.5% (48 mmol/mol).	**24.24%** (male = 25.24%, female = 25.24%)
18.	Raghavendra et al. (2016)[61]	Prevalence of diabetes mellitus in an urbanized village of East Delhi	Gazipur, East Delhi, India)	Cross-sectional study Community-based (2015-2016)	≥20 years	451 (male: 247, female: 204) RR: NA	WHO 2006 criteria (FPG > 126 mg/dL or 2-h post-glucose > 200 mg/dL)	**15.3%** (male = 16.6%, female = 13.7%)
19.	Anjana et al. (2017)[58]	Prevalence of diabetes and prediabetes in 15 states of India: results from the ICMR-INDIAB population-based cross-sectional study	15 States-India (phases I & II and North-eastern India)	Cross-sectional study population-based (2008-2015)	≥20 years	16 909 (male: female = NA) RR: 94%	WHO and ADA criteria (fasting CBG ≥126 mg/dL or 2-h post-glucose ≥220 mg/dL)	**11.2%**
20.	Harikrishnan et al. (2018)[59]	Prevalence of metabolic syndrome and its risk factors in Kerala, South India: Analysis of a community based cross-sectional study	Urban municipal wards of three districts in Kerala (Kozhikode, Thrissur, Trivandrum)	Cross-sectional study Community-based (January–June 2011)	20-79 years	2201 (male: 946, female: 1255)	T2D: FPG ≥ 126 mg/dL or current antidiabetic therapy	**17%** (male = 19.3%, female = 15.1%)
21.	Madhu et al. (2018)[62]	High prevalence of diabetes, prediabetes and obesity among residents of East Delhi—the Delhi urban diabetes survey (DUDS)	East Delhi, Delhi, India (Urban middle-income area—Dilshad Garden)	Cross-sectional study Community-based (August 2015–July 2016)	≥20 years	1317 (male: female) NA RR: NA	WHO criteria (based on OGTT. FBG ≥126 mg/dL or 2-h PPBG ≥220 mg/dL)	**18.3%** (male: female = NA)
22.	Patil et al. (2019)[60]	Risk factors for type 2 diabetes mellitus: an urban perspective	Pune, Maharashtra, India	Cross-sectional study Community-based (2013-2014)	≥20 years	425 (male: 160, female: 265) RR: 97%	Self-reported diagnosis and/or current drug treatment	**9.88%** (male = 13.75%, female = 7.5%)
23.	Sahoo and Patnaik (2019)[63]	An epidemiological study of diabetes mellitus among adult population in an urban area of Odisha	Bhubaneswar, Odisha (urban)	Cross-sectional study Community-based (February–May 2018)	≥20 years	170 (male: 105, female: 65) RR: 100%	WHO criteria FBS ≥ 126 mg/dL or PPBS ≥200 mg/dL	**15.9%** (male = 16.2%, female = 15.4%)

(Continued)

Table 2 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome: overall T2D prevalence (%)
24.	Sivanantham et al. (2021)[64]	Profile of risk factors for non-communicable diseases (NCDs) in a highly urbanized district of India: findings from Puducherry district-wide STEPS Survey, 2019-20	Puducherry, India	Cross-sectional study Community-based (February 2019-2020)	18-69 years	2415 (male: 1086, female: 1329) Step 1 and 2 RR: 94.3% and Step 3 RR: 92.0%	FPG ≥ 126 mg/dL or currently on antidiabetic medications	**27.6%** (male = 31.6%, female = 23.2%)
25.	Lyngdoh et al. (2021)[65]	Prevalence of type 2 diabetes mellitus and adherence to antidiabetic treatment in an urban population of Manipur, India	Imphal West, Manipur, India (Urban field practice area of RIMS)	Cross-sectional study Community-based (July 2016–October 2018)	≥30 years	250 (male: 96, female: 154) RR: NA	RBS ≥200 mg/dL and/or self-reported physician diagnosis and on medication (ADA 2016)	**14.4%** (male = 19.8%%, female = 11.0%)
26.	Anjana et al. (2023)[5]	Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study (ICMR-INDIAB-17)	Pan-India: 28 states, 2 union territories, and NCT Delhi	Cross-sectional study population-based (2008-2020)	≥20 years	4272/31 560 (male: female = NA) RR: NA	T2D: WHO OGTT (FPG ≥126 mg/dL or 2-h PG ≥220 mg/dL)	**16.4%** (male = 12.1%, female = 10.7%)
27.	Rajalakshmi et al. (2023)[66]	Burden of undiagnosed and suboptimally controlled diabetes in selected regions of India: results from the SMART India population-level diabetes screening study	New Delhi, Assam, West Bengal, Orissa, MH, MP, Chhattisgarh, Tamil Nadu, Karnataka, Kerala, and Telangana	Multicenter cross-sectional population-based study (2018-2020)	≥40 years	22 150/42146 (male: female = NA) RR: 89.8%	ADA and WHO criteria Random blood glucose (RBG) ≥200 mg/dL or HbA1c ≥6.5%	**22.2%** (male = 24.6%, female = 20.0%)
28.	Himanshu et al. (2024)[67]	Assessing the prevalence of type 2 diabetes mellitus and impaired glucose tolerance in the adult urban population of Katihar, North Bihar: a cross-sectional study	Sharifganj, Katihar, Bihar, India	Cross-sectional study Community-based (2018)	≥20 years	1050 (male: 537, female: 513) RR: 100%	WHO/IDF 1999 criteria (fasting plasma glucose ≥126 mg/dL OR 2-h post-OGTT ≥200 mg/dL)	**9.24%** (male = 9.87%, female = 8.58%)
29.	Sundaresan et al.(2024)[68]	Gender differential prevalence of overweight and obesity, hypertension and diabetes in South India: A population-based cross-sectional study	Coimbatore region, Tamil Nadu (urban area: Kalapatti within Coimbatore City)	Cross-sectional study Community-based (2015-2016)	≥20 years	1081 (male: 438, female: 643) RR: 93.2%	WHO criteria RBG ≥200 mg/dL or HbA1c ≥6.5%	**23.0%** (male = 28.3%, female = 19.4%)
30.	Pal et al. (2025)[69]	Prevalence and risk factors of type 2 diabetes mellitus in urban and rural population of Kanpur	Uttar Pradesh-India (Urban Kanpur Nagar)	Cross-sectional study Community-based (2024-2025)	≥20 years	250 (male: 148, female: 102) RR: 100%	RBS ≥200 mg/dL (based on ADA/WHO screening guidelines)	**17.6%** (male = 20.3%, female = 13.7%)

Abbreviations: CUDS, Chandigarh Urban Diabetes Study; FPG, fasting plasma glucose; OGTT, oral glucose tolerance test; PG, plasma glucose; RR, response rate; T2D, type 2 diabetes. Bold Values in Table 2 represents Overall Prevalence Percentage of T2D in the selected studies.

Table 3 Characteristics studied for hypertension prevalence studies (2000-2025).

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome/overall HTN prevalence (%)
1.	Gupta et al. (2002)[43]	Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2	Jaipur, India	Community-based cross-sectional study (1999-2001)	≥20 years	1123 (male: 550, female: 573) RR: 62.4%	JNC-VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg	**36.9%** (male: female = NA)
2.	Das et al. (2005)[70]	Study of urban community survey in India: growing trend of high prevalence of hypertension in a developing country	Malda Town (English Bazaar Municipality), West Bengal, India (Urban district town in Eastern India)	Community-based cross-sectional study (2001)	≥18 years	1609 (male: 867, female: 742) RR: NA	JNC VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg)	**24.9%** (male: female = NA)
3.	Mohan et al. (2007)[71]	Prevalence, awareness and control of hypertension in Chennai—the Chennai Urban Rural Epidemiology Study (CURES-52)	Chennai, Tamil Nadu, India (Urban South Indian metropolitan population)	Community-based cross-sectional study (2003-2005)	≥20 years	2350 (male: 1096, female: 1254) RR: 90.4%	JNC VII criteria (SBP ≥140 and/or DBP ≥90 mm Hg or on treatment)	**20.0%** (male = 23.2%, female = 17.1%)
4.	Chaturvedi et al. (2007)[72]	Hypertension in Delhi: prevalence, awareness, treatment and control	Delhi, India	Population based cross-sectional study (year of data collection not stated, ~2005)	(20-59 years)	754 (male: female = NA) RR: NA	JNC VI criteria (SBP ≥140 and/or DBP ≥90 mm Hg or on antihypertensive treatment)	**30.5%** (male: female = NA)
5.	Gupta et al. (2007)[46]	Body-mass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects	Jaipur, Rajasthan, India	Community-based cross-sectional study (1999-2001)	≥20 years	1091 (male: 532, female: 559) RR: 60.6%	JNC VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg or known case)	**37.3%** (male: 37.0%, female: 37.6%)
6.	Mandal et al. (2010)[73]	Burden of hypertension and its risk factors in an urban community of India: are we aware and concerned?	Kolkata-India	Community-based cross-sectional study (2008)	≥20 years	872 (male: 444, female: 428) RR: 90%	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	**19.80%** (male = 16.7%, female = 23.1%)
7.	Gupta et al. (2010)[47]	Cardiovascular risk according to educational status in India	Jaipur, Rajasthan, India	Community-based cross-sectional study (1993-2003)	20-59 years	1280 (male: 619, female: 661) RR: NA	JNC VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg or known case)	**26.7%** (male: female = NA)
8.	Bharati et al. (2011)[51]	Prevalence and determinants of diabetes mellitus in Puducherry, South India	Puducherry, South India	Cross-sectional study population-based (May–November 2007)	≥20 years	685/1370 (male: 301, female: 385) RR: 100%	JNC VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg or known case)	**54.4%** (male: female = NA)

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Table 3 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome/overall HTN prevalence (%)
9.	Prasad et al. (2012)[76]	Prevalence and predictors of adult hypertension in an urban eastern Indian population	Berhampur City, Odisha (Eastern India)	Community-based cross-sectional study (2010-2011)	20-80 years	1178 (male: 590, female: 588) RR: 98.16%	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or on antihypertensive medication)	**36.6%** (male: female = NA)
10.	Singh et al. (2012)[77]	Effect of life style risk factors on prevalence of hypertension in a defined urban population of Rewa	Rewa City, Madhya Pradesh, India	Community-based cross-sectional study (July 2010–June 2011)	≥20 years	300 (male: 171, female: 129) RR: NA	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	**21.3%** (male: 21.6%, female, 20.9%)
11.	Bhadoria et al. (2014)[55]	Prevalence of hypertension and associated cardiovascular risk factors in Central India	15 Urban wards, Jabalpur District, Central India	Community-based cross-sectional study (year of data collection not stated, ~2012)	≥20 years	309 (male: 162, female: 147) RR: 98.1	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg, or known case)	**21.4%** (male: female = NA)
12.	Singh et al. (2014)[74]	A cross-sectional study on prevalence of hypertension and its relationship with selected demographic factors in Western Uttar Pradesh	Agra Urban ward no. 55, western Uttar Pradesh, India	Community-based cross-sectional study (March 2009–August 2010)	≥45 years	258 (male: 132, female: 126) RR:NA	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	**41.96%** (male: 40.90%, female: 42.06%)
13.	Walia et al. (2014)[54]	High prevalence of cardiovascular risk factors in Asian Indians: a community survey—Chandigarh Urban Diabetes Study (CUDS)	Chandigarh, Union Territory (North India)	Community-based cross-sectional study (April 2008–June 2009)	20–94 years	2227 (male: 1068, female: 1159) RR: 94%	JNC VII criteria (BP ≥140/90 mm Hg)	**43.6%** (male: female = NA)
14.	Bhansali et al. (2015)[75]	Prevalence of and risk factors for hypertension in urban and rural India: the ICMR-INDIAB study	Tamil Nadu, Maharashtra, Jharkhand, Chandigarh (Union Territory), India	Community-based cross-sectional study (November 2008–April 2010)	≥20 years	5112 (male: female = NA) RR: NA	JNC-VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg and/or on antihypertensive drugs)	**Overall = 30.78%** (male: female = NA)
15.	Sahu et al. (2015)[56]	Coronary heart disease risk factors of in an urban locality of Eastern India	Bhubaneswar, Odisha, India	Community-based cross-sectional study (May 2013–April 2014)	25-64 years	350 (male: 147, female: 203) RR: NA	JNC-VII criteria (SBP ≥140 nd/or DBP ≥90 mm Hg or known case)	**22.0%** (male: female = NA)
16.	Galav et al. (2015)[78]	Prevalence of hypertension among rural and urban population in southern Rajasthan	Urban Dhanmandi field practice areas of Udaipur, Rajasthan	Community-based cross-sectional study (March–August 2013)	≥18 years	300 (male: 126, female: 174) RR: NA	JNC-VII criteria (SBP ≥140 nd/or DBP ≥90 mm Hg or known case)	**32. 67%** (male = 32.5%, female = 32.7%)

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Table 3 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome/overall HTN prevalence (%)
17.	Adhikari et al. (2015)[79]	Prevalence of hypertension in Boloor Diabetes Study (BDS-II) and its risk factors	Boloor, Mangalore, India	Community-based cross-sectional study (year of data collection not stated, ~2013)	≥20 years	551 (male: 176, female: 375) RR: 68.8%	JNC-VII criteria (SBP ≥140 nd/or DBP ≥90 mm Hg or known case)	**41.0%** (male: 40.9% female: 41.3%)
18.	Chellamma et al. (2017)[81]	Risk factors associated with hypertension among adults residing in an urban area of Kerala: a cross-sectional study	Kollam City, Kerala, India	Community-based cross-sectional study (February–April 2017)	≥18 years	300 (male: 106, female: 194) RR: 100	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or self-reported/on medication)	**40.0%** (male: 39.6% female: 40.2%)
19.	Ingale et al. (2017)[80]	Prevalence of hypertension, awareness and health seeking among urban adults in India: results from the WHO STEPS survey	Aurangabad, Maharashtra, India	Community-based cross-sectional study (January–December 2012)	≥18 years	305 (male: 131, female: 174) RR: 100%	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or known case on antihypertensive medication)	**26.2%** (male: 16.8% female: 33.3%)
20.	Harikrishnan et al. (2018)[59]	Prevalence of metabolic syndrome and its risk factors in Kerala, South India: Analysis of a community based cross-sectional study	Urban municipal wards of 3 districts in Kerala (Kozhikode, Thrissur, Trivandrum)	Community-based cross-sectional study (January–June 2011)	20-79 years	2201 (male: 946, female: 1255)	HTN (BP ≥140/90 mm Hg or treatment)	**34%** (male: 39.0% female: 29.7%)
21.	Dakshinamurthy et al. (2020)[83]	Prevalence of hypertension and associated cardiometabolic risk factors in urban Rishikesh, Uttarakhand	Rishikesh, Uttarakhand, India (urban municipal area in Dehradun district)	Community-based cross-sectional study (2018-2019)	19-60 years	478 (male: 165, female: 313) RR: 100%	JNC VII criteria (SBP ≥140 and/or DBP ≥90 mm Hg or self-reported HTN/on medication)	**32.4%** (male: 34.5%, female: 31.3%)
22.	Mohanty et al. (2020)[82]	Trends of hypertension and neurological diseases in India: a nationwide survey reporting the distribution across geographical areas	24 states and 4 union territories of India	A nationwide cross-sectional study (2017)	≥20 years	70 031 (male: 33 668, female: 36 363) RR: NA	2017, American Heart Association (AHA) guidelines (SBP ≥130 and/or DBP ≥80 mm Hg)	**24.4%** (male: 24.7%, female: 23.5%)
23.	Lyngdoh et al. (2021)[65]	Prevalence of type 2 diabetes mellitus and adherence to antidiabetic treatment in an urban population of Manipur, India	Imphal West, Manipur, India	Community-based cross-sectional study (July 2016–October 2018)	≥30 years	250 (male: 96, female: 154) RR: NA	WHO 2003 criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	**18.0%%** (male: 30.2%, female: 10.4%)

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Table 3 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome/overall HTN prevalence (%)
24.	Nanditha et al. (2021)[84]	Secular trends in cardiovascular risk factors among urban and rural populations in Tamil Nadu, India—an ancillary analysis of the STRiDE-I study	Chennai, Tamil Nadu, India	Population-based cross-sectional study (2016)	≥20 years	3850 (male: 1784, female: 2066) RR: 86.5%	JNC-VIII criteria (≥140/90 mm Hg or on medication)	**26.3% (**male: 29.4%, female: 23.9%)
25.	Sivanantham et al. (2021)[64]	Profile of risk factors for non-communicable diseases (NCDs) in a highly urbanized district of India: findings from Puducherry district-wide STEPS Survey, 2019-20	Puducherry, India	Community-based cross-sectional study (February 2019-2020)	18-69 years	2415 (male: 1086, female: 1329) Steps 1 and 2 RR: 94.3% and Step 3 RR: 92.0%	JNC-VIII criteria (≥140/90 mm Hg or on medication)	**36.0%** (male: 37.1%, female: 30.8%)
26.	Sidenur and Shankar (2023)[86]	A cross-sectional study of hypertension among 20–40 years old residing in an urban area of Bagalkot City, North Karnataka	Bagalkot City, North Karnataka-India	Population-based cross-sectional study (2021)	20-40 years	420 (male: 47), female: 32) RR: NA	JNC-VIII criteria (≥140/90 mm Hg or on medication)	**17.9%** (male: 22.3%, female: 15.4%)
27.	Anjana et al. (2023)[5]	Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study (ICMR-INDIAB-17)	Pan-India: 28 states, 2 union territories, and NCT Delhi	Population-based cross-sectional study (2008-2020)	≥20 years	11 588/33063 (male: female) = NA RR: NA	JNC-VIII criteria (≥140/90 mm Hg or on medication)	**35.5%** (male: 38.7%, female: 32.6%)
28.	Shaikh et al. (2023)[87]	Prevalence and risk factors of hypertension in urban population: a cross-sectional study	Solapur, Maharashtra, India	Community-based cross-sectional study (year of data collection not stated, ~2021)	≥18 years	325 (male: 158, female: 167) RR: NA	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or on antihypertensive medication)	**48.9%** (male: 48.6%, female: 51.4%)
29.	Sundaresan et al. (2024)[68]	Gender differential prevalence of overweight and obesity, hypertension and diabetes in South India: a population-based cross-sectional study	Coimbatore region, Tamil Nadu (urban area: Kalapatti within Coimbatore City)	Community-based cross-sectional study (2015-2016)	≥20 years	1081 (male: 438, female: 643) RR: NA	JNC VII criteria (SBP ≥140 mm Hg and/or DBP ≥90 mm Hg)	**39.7%** (male: 45.9%, female: 35.5%)

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Table 3 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Diagnostic criteria used	Outcome/overall HTN prevalence (%)
30.	Singh et al. (2025)[85]	Prevalence and associated risk factors of hypertension in rural and urban areas of Punjab: a cross-sectional study	Ludhiana district, Punjab (3 urban wards + 3 villages)	Community-based cross-sectional study (2017-2018)	≥20 years	500 (male: 235, female: 265) RR:NA	JNC-VII criteria (SBP ≥140 mm Hg or DBP ≥90 mm Hg)	**56.0%** (male: 63.0%, female: 50.0%)

Abbreviations: CUDS, Chandigarh Urban Diabetes Study; HTN, hypertension; RR, response rate; T2D, type 2 diabetes. Bold Values in Table 3 represents Overall Prevalence Percentage of Hypertension in the selected studies.

Table 4 Characteristics studied for obesity prevalence studies (2000-2025).

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Outcome(s) studied general obesity/abdominal obesity	Diagnostic criteria used	Overall obesity prevalence (%)
1.	Gupta et al. (2002)[43]	Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2	Jaipur, India	Community-based cross-sectional study (1999-2001)	≥20 years	1123 (male: 550, female: 573) RR: 62.4%	General obesity	WHO Asia-Pacific criteria (BMI ≥ 27kg/m^2)	**General obesity**: **27.4%** (male: female) = NA
2.	Gupta et al. (2007)[46]	Body-mass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects	Jaipur, Rajasthan, India	Community-based cross-sectional study (1999-2001)	≥20 years	1091 (male: 532, female: 559 RR: 60.6%	General obesity and abdominal obesity	WHO and NCEP ATP-III Criteria BMI ≥ 30kg/m^2 WC: men: ≥90 cm, women: ≥80 cm	**General Obesity: 16.5%** (male = 12.8% female = 20.0%) **Abdominal obesity: 32.2%** (male = 21.6% female = 42.2%)
3.	Deepa et al. (2009)[88]	Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India (CURES: 47)	Chennai, Tamil Nadu, India (across 46 wards of the Chennai Corporation area)	Community-based cross-sectional study (2001-2004)	≥20 years	2350 (male: 1096, female: 1254) RR: 90.4%	General obesity and abdominal obesity	WHO Asia-Pacific guidelines (BMI ≥ 25 kg/m^2) and (WHO Expert Consultation, 2004) as GO: ≥23 kg/m^2, CO: WC ≥90 cm (men), ≥80 cm (women)	**General obesity: 26.5%** (men 22.8%, women 29.4%) **Abdominal obesity: 46.6%** (men: 35.1%, women: 56.2%)
4.	Vadera et al. (2010)[90]	Study on obesity and influence of dietary factors on the weight status of an adult population in Jamnagar city of Gujarat: a cross-sectional analytical study	Jamnagar City, Gujarat, India	Community-based cross-sectional analytical study (July–December 2008)	≥20 years	903 (male: 509, female: 394) RR: 92.1%	General obesity	WHO Criteria Overweight: BMI ≥25 Obesity: BMI ≥30	**General obesity: 27.3%** (male: 16.1% female: 29.7%)
5.	Gupta et al. (2010)[47]	Cardiovascular risk according to educational status in India	Jaipur, Rajasthan, India	Community-based cross-sectional study (1993-2003)	20-59 years	1280 (male: 619, female: 661) RR: NA	General obesity and abdominal obesity	NCEP 2001 criteria GO: BMI ≥30 kg/m^2 CO: WC ≥90 cm (men), ≥80 cm (women)	**General obesity: 17.0%** (male: female) = NA **Abdominal obesity: 61.3%** (male: female) = NA
6.	Bharati et al. (2011)[51]	Prevalence and determinants of diabetes mellitus in Puducherry, South India	Puducherry, South India	Cross-sectional study population-based (May–November 2007)	≥20 years	1370 (male: female) = NA RR: 100%	General obesity	WHO Criteria Obesity: BMI ≥30	**General obesity: 57.9%** (male: female) = NA

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Table 4 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Outcome(s) studied general obesity/abdominal obesity	Diagnostic criteria used	Overall obesity prevalence (%)
7.	Uthakalla et al. (2012)[89]	Prevalence study of overweight/obesity among adults (20-60 yrs) of urban field practice area of Osmania Medical College, Hyderabad	Harajpenta area, Hyderabad, Andhra Pradesh (now Telangana), India	Community-based cross-sectional study (March–September 2005)	20-60 years	400 (male: 176, female: 224) RR: 100%	General obesity	WHO Asia-Pacific criteria (BMI ≥25 kg/m^2)	**General obesity: 37.0%** (male: 27.27%, female: 44.64%)
8.	Prasad et al. (2013)[91]	Effect of obesity on cardiometabolic risk factors in Asian Indians	Berhampur City, Odisha (Orissa), India	Community-based cross-sectional study (year of data collection not stated, ~2011)	20-80 years	1178 (male: 590, female: 5880 RR: 98.16%	General obesity	WHO criteria: Revised Asia-Pacific criteria: BMI ≥25 kg/m^2	**General obesity: 36.82%** (male: 33.17%, female: 40.79%)
9.	Bhadoria et al. (2014)[55]	Prevalence of hypertension and associated cardiovascular risk factors in Central India	15 Urban wards, Jabalpur District, Central India	Community-based cross-sectional study (year of data collection not stated, ~2012)	≥20 years	309 (male: 162, female: 147) RR: 98.1%	Abdominal obesity	WHO Asia-Pacific criteria: WC ≥90 cm (men), ≥80 cm (women)	**Abdominal obesity: 47.9%** (male: female) = NA
10.	Walia et al. (2014)[54]	High prevalence of cardiovascular risk factors in Asian Indians: a community survey – Chandigarh Urban Diabetes Study (CUDS)	Chandigarh, Union Territory (North India)	Community-based cross-sectional study (April 2008–June 2009)	20-94 years	2227 (male: 1068, female: 1159) RR: 94%	Abdominal obesity	WHO Asia-Pacific criteria: WC ≥90 cm (men), ≥80 cm (women)	**Abdominal obesity: 62.86%** (male = 47.96% female = 50.04%)
11.	Pradeepa et al. (2015)[12]	Prevalence of generalized & abdominal obesity in urban & rural India—the ICMR-INDIAB study (Phase-I) [ICMR-INDIAB-3]	Tamil Nadu, Maharashtra, Jharkhand, and Chandigarh (Union Territory)	Community-based cross-sectional study (November 2008–April 2010)	≥20 years	4063 (male: female) = NA RR: NA	General obesity and abdominal obesity	WHO Asia-Pacific criteria General Obesity: BMI ≥25 kg/m^2 Abdominal obesity: WC ≥90 cm (men), ≥80 cm (women)	**General obesity: 32.6 %** (male: female) = NA **Abdominal obesity: 36.1%** (male: female) = NA
12.	Chandrashekar et al. (2015)[103]	A study of obesity and associated factors in a selected urban area of Mysore	Mysore, Karnataka, India	Community-based cross-sectional study (year of data collection not stated, ~2013)	20-60 years	1551 (male: 780, female: 771) RR: NA	General obesity	WHO global criteria (BMI ≥30 kg/m^2)	**General obesity: 6.5% (**male: 2.4%, female: 10.6%)

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Table 4 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Outcome(s) studied general obesity/abdominal obesity	Diagnostic criteria used	Overall obesity prevalence (%)
13.	Sahu et al. (2015)[56]	Coronary heart disease risk factors of in an urban locality of Eastern India	Bhubaneswar, Odisha, India	Community-based cross-sectional study (May 2013–April 2014)	25-64 years	350 (male: 147, female: 203) RR: 100%	General obesity and abdominal obesity	NCEP-ATP III criteria GO: BMI ≥23 kg/m^2 taken as CHD risk cutoff Waist Circumference CO: Men ≥102 cm, Women ≥88 cm	**General obesity: 42.0%** (male: 43.5%, female: 40.9%) **Abdominal obesity 52.9%** (male: 43.5%, female: 59.6%)
14.	Kamboj et al. (2017)[93]	Overweight and obesity above 18 years of age in an urban population	Meerut, Uttar Pradesh, India	Community-based cross-sectional study (year of data collection not stated, ∼2015)	≥18 years	1152 (male: 590, female: 562) RR: NA	General obesity	WHO criteria Obesity: BMI: ≥30 kg/m^2	**General obesity: 36.0%** (men: 36.1%, women: 35.9%)
15.	Harikrishnan et al. (2018)[59]	Prevalence of metabolic syndrome and its risk factors in Kerala, South India: analysis of a community based cross-sectional study	Urban municipal wards of 3 districts in Kerala (Kozhikode, Thrissur, Trivandrum)	Community-based cross-sectional study (January–June 2011)	20-79 years	2201 (male: 946, female: 1255) RR: 97.9%	Abdominal obesity	WHO Asia Pacific Abdominal obesity: WC ≥90 cm (men), ≥80 cm (women)	**Abdominal obesity: 64.2%** (male: 50.5% female: 74.6%)
16.	Banerjee et al. (2019)[95]	A study on the prevalence of metabolic syndrome and its components among adults aged 18-49 years in an urban area of West Bengal	Kolkata Municipal Corporation (KMC) of West Bengal, India	Community-based observational cross-sectional study (2019)	18-49 years	388 (male: 212, female: 176) RR: NA	Abdominal obesity	WHO Asia Pacific Abdominal obesity: WC ≥90 cm (men), ≥80 cm (women)	**Abdominal obesity: 68.6%** (male: 57.1% female: 82.4%)
17.	Lyngdoh et al. (2021)[65]	Prevalence of type 2 diabetes mellitus and adherence to anti diabetic treatment in an urban population of Manipur, India	Imphal West, Manipur, India	Community-based cross-sectional study (July 2016–October 2018)	≥30 years	250 (male: 96, female: 154) RR: NA	General obesity and abdominal obesity	WHO Asia Pacific BMI ≥25 kg/m^2 WC ≥90 cm (men), ≥80 cm (women)	**General obesity: 48.8%** (male: 43.8% female: 53.2%) **Abdominal obesity: 74.8%** (male: 54.2% female: 87.7%)

(Continued)

Table 4 Continued

No.	Article first author and publication year	Study title	Study setting (city/state/nation)	Study design and data collection year	Age range	Sample size and RR	Outcome(s) studied general obesity/abdominal obesity	Diagnostic criteria used	Overall obesity prevalence (%)
18.	Sivanantham et al. (2021)[64]	Profile of risk factors for non-communicable diseases (NCDs) in a highly urbanized district of India: findings from Puducherry district-wide STEPS Survey, 2019-20	Puducherry, India	Community-based cross-sectional study (February 2019-2020)	18-69 years	2415 (male: 1086, female: 1329) Steps 1 and 2 RR: 94.3% and Step 3 RR: 92.0%	General obesity and abdominal obesity	WHO Asia Pacific BMI ≥25 kg/m^2 WC ≥90 cm (men), ≥80 cm (women)	**General obesity: 46.1% (**male: 37.5%, female: 53.1%) **Abdominal obesity: 71.9% (**male: 46.0% female: 86.5%)
19.	Sidenur et al. (2022)[94]	Prevalence of obesity and overweight and its correlates among 20–40-year-old population in an urban area in southern India	Bagalkot City, Karnataka, India	Community-based cross-sectional study (2017-2018)	20-40 years	207 (male: 99, female: 107) RR: 100%	General obesity	WHO criteria Obesity: BMI ≥30 kg/m^2	**General obesity: 11.1%** (male: 8.2%, female: 13.8%)
20.	Anjana et al. (2023)[5]	Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study (ICMR-INDIAB-17)	Pan-India: 28 states, 2 union territories, and NCT Delhi	Population-based cross-sectional study (2008-2020)	≥20 years	32 784 (GO) and 32 293 CO (male: female) = NA RR: NA	General obesity and abdominal obesity	WHO Asia-Pacific criteria (BMI ≥25 kg/m^2; WC ≥90 cm men, ≥80 cm women)	**General obesity: 39.6%** (male: female) = NA **Abdominal obesity: 51.6%** (male: female) = NA
21.	Sundaresan et al. (2024)[68]	Gender differential prevalence of overweight and obesity, hypertension and diabetes in South India: a population-based cross-sectional study	Coimbatore region, Tamil Nadu	Community-based cross-sectional study (2015-2016)	≥20 years	1081 (male: 438, female: 643) RR: NA	General obesity	WHO criteria Obesity: BMI ≥30 kg/m^2	**General obesity: 47.5%** (male: female) = NA

Abbreviations: AO = abdominal obesity; β = regression coefficient; CO, central obesity; FPG = fasting plasma glucose; GO = general obesity; HTN = hypertension; I^2 = residual heterogeneity after accounting for moderator; k = number of studies; NA = not available; NS = not statistically significant; OGTT = oral glucose tolerance test; P-value = significance level; R^2 = proportion of between-study variance explained by moderator; RR, response rate; T2D = type 2 diabetes; WC = waist circumference; WHO = World Health Organization. Additional details of the meta-regression analysis are provided in Supplementary File S4; Bold Values in Table represents Overall Prevalence Percentage of general obesity and abdominal obesity in the selected studies.

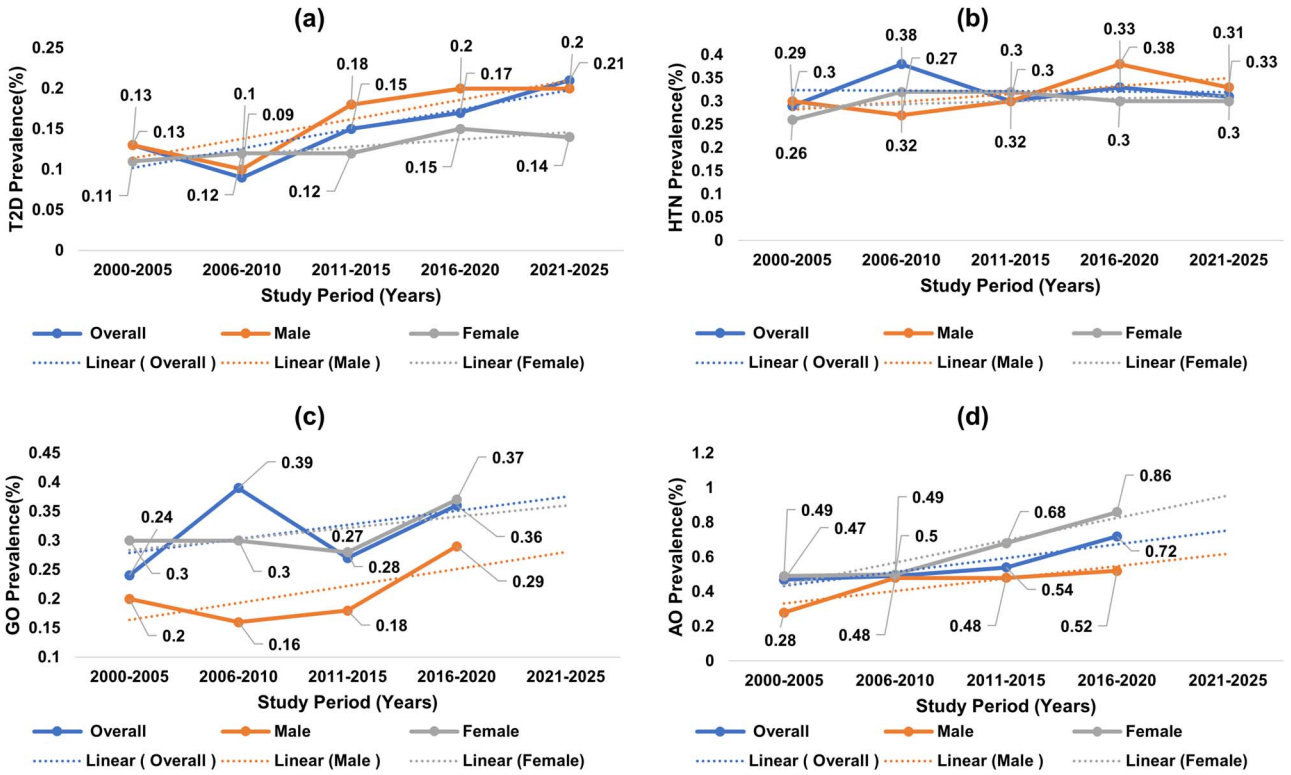


Figure 2 Trends in prevalence of type 2 diabetes (T2D) (A) Hypertension (HTN) (B) general obesity (GO) (C), and abdominal obesity (AO) (D) in urban India 2000-2025.

studies met the eligibility criteria after duplicate removal, screening, and full-text assessment. Among the included studies, 5 were identified through citation searching using Scopus and Web of Science, while the remaining 52 were retrieved from PubMed, Global Health, and Embase databases. Studies were excluded due to design, population, or setting mismatch. The PRISMA diagram (Figure 1) summarizes the screening process. Included studies consisted of 17 reporting T2D prevalence, 18 HTN, 9 GO, 1 reporting both T2D and HTN, and 12 reporting combined estimates. Table 1 presents overall and sex-wise prevalence. The study characteristics are shown in Tables 2-4.[5,11,42-87]

Across 2000-2025, all 4 outcomes T2D, HTN, GO, and AO showed clear upward trends (Figure 2). Pooled prevalence estimates rose from 13% to 21% for T2D, 29% to 31% for HTN, 24% to 36% for GO, and 47% to 72% for AO. Sex-stratified pooled prevalence estimates demonstrated a consistent upward trend over time. Among males, T2D prevalence increased from 13% to 20%, while among females, it rose from 11% to 14%. For HTN, prevalence increased from 30% to 33% in males and from 26% to 30% in females. Overall and sex-specific pooled prevalence estimates for GO and AO could be generated only for the period 2000-2020 due to the absence of data collected between 2021 and 2025. During this period, GO prevalence increased from 20% to 29% in males and from 30% to 37% in females. A more pronounced rise was observed for AO, with prevalence increasing from 28% to 52% in males and from 49% to 86% in females. Table 1 presents the overall and sex-wise absolute and relative percentage point rise. Random-effects meta-analysis yielded pooled prevalence of 14% for T2D (95% CI, 13%-16%; 95% PI: 7%-27%), 32% for HTN (95% CI, 28%-36%; 95% PI: 15%-57%), 31% for GO (95% CI, 23%-39%; 95% PI: 8%-70%), and 56% for AO (95% CI, 48%-64%; 95% PI: 26%-83%) (Figures 3-6). Egger's test indicated no publication bias for HTN, GO, or AO, but small-study effects were detected for T2D (Figure 7A).

Meta-regression analyses were conducted to explore sources of heterogeneity, showed no consistent temporal trends in prevalence for T2D (β = .014, P = .25; R^2 = 30.3%), HTN (β = .006, P = .68), GO (β = .041, P = .31), or AO (β = .023, P = .20). Residual heterogeneity remained high across outcomes (I^2: 96.0%-99.5%) (Table 5). Supplementary File S3 shows meta-regression Forest plots (Figures S1-S4), bubble plots (Figures S5-S8), and Traffic Light plots (Figure S9). Detailed results and interpretations for each outcome are provided in Supplementary File S4. The completed PRISMA 2020 checklist is provided in Supplementary File S5.

Sensitivity analyses stratified by diagnostic criteria demonstrated that pooled prevalence estimates were generally robust (Supplementary File S2 [Tables S1-S4]). For T2D, exclusion of studies using FPG/oral glucose tolerance test (OGTT) criteria increased prevalence from 0.14 to 0.18 (+0.04), whereas exclusion of other diagnostic groups resulted in minimal changes. For HTN, exclusion of JNC-VII studies reduced prevalence from 0.32 to 0.28 (−0.04). Similar patterns were observed for GO and AO, indicating that while diagnostic heterogeneity contributes to variability, it does not fully account for between-study differences (Supplementary File S2 [Tables S1-S4]).

Leave-one-out sensitivity analyses showed that no single study including large datasets exerted a disproportionate influence on pooled estimates across T2D, HTN, GO, and AO (Supplementary File S2 [Tables S5-S8]).

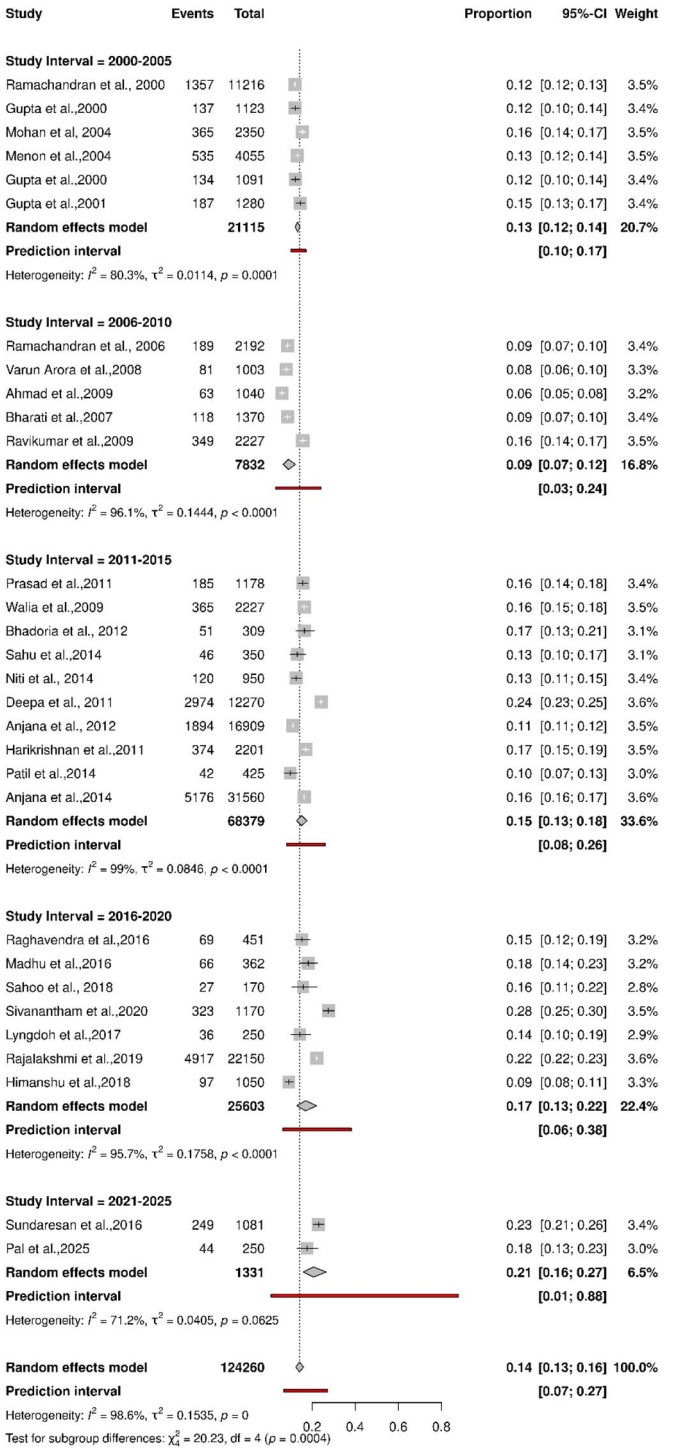


Figure 3 Forest plot of pooled prevalence of type 2 diabetes (T2D) in urban India, 2000-2025.

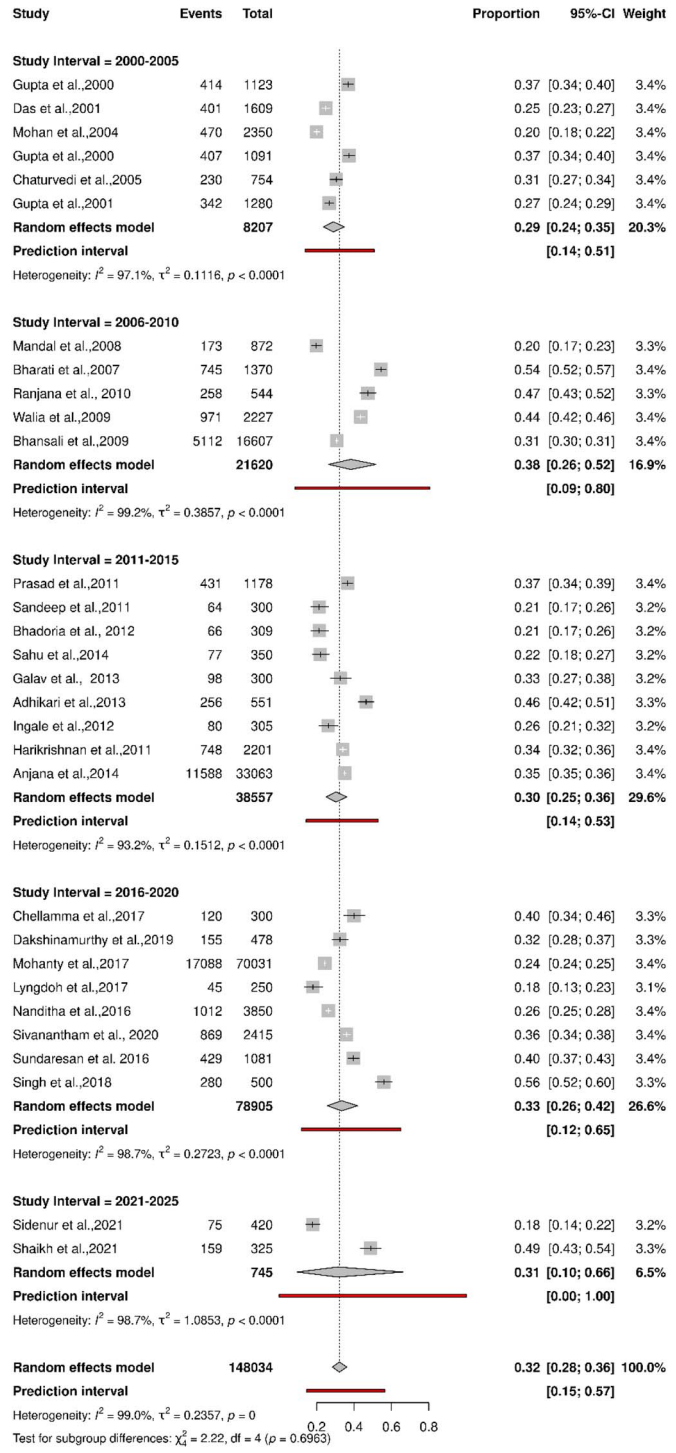


Figure 4 Forest plot of pooled prevalence of hypertension (HTN) in urban India, 2000-2025.

Trends in T2D prevalence: urban India (2000-2025)

As shown in Table 2,[5,11,42-69] the prevalence of T2D in urban India increased steadily from 2000 to 2025. T2D pooled prevalence declined from 13% in 2000-2005 to 9% in 2006-2010 (−4 pp, −30.8% relative change),[42-52] followed by a marked increase to 15% in 2011-2015 (+6 pp, ~66.7% relative rise).[5,11,53-60] This upward trend continued with a rise to 17% in 2016-2020 (+2 pp, ~13.3% relative rise),[61-67] and further to 21% in 2021-2025 (+4 pp, ~23.5% relative rise),[68,69] with higher values observed in several regions. Overall, prevalence increased by +8 pp (~61.5% relative rise) over 25 years.[5,11,42-69] The overall pooled prevalence of T2D was 14% (95% CI, 13%-16%; 95% PI: 7%-27%).

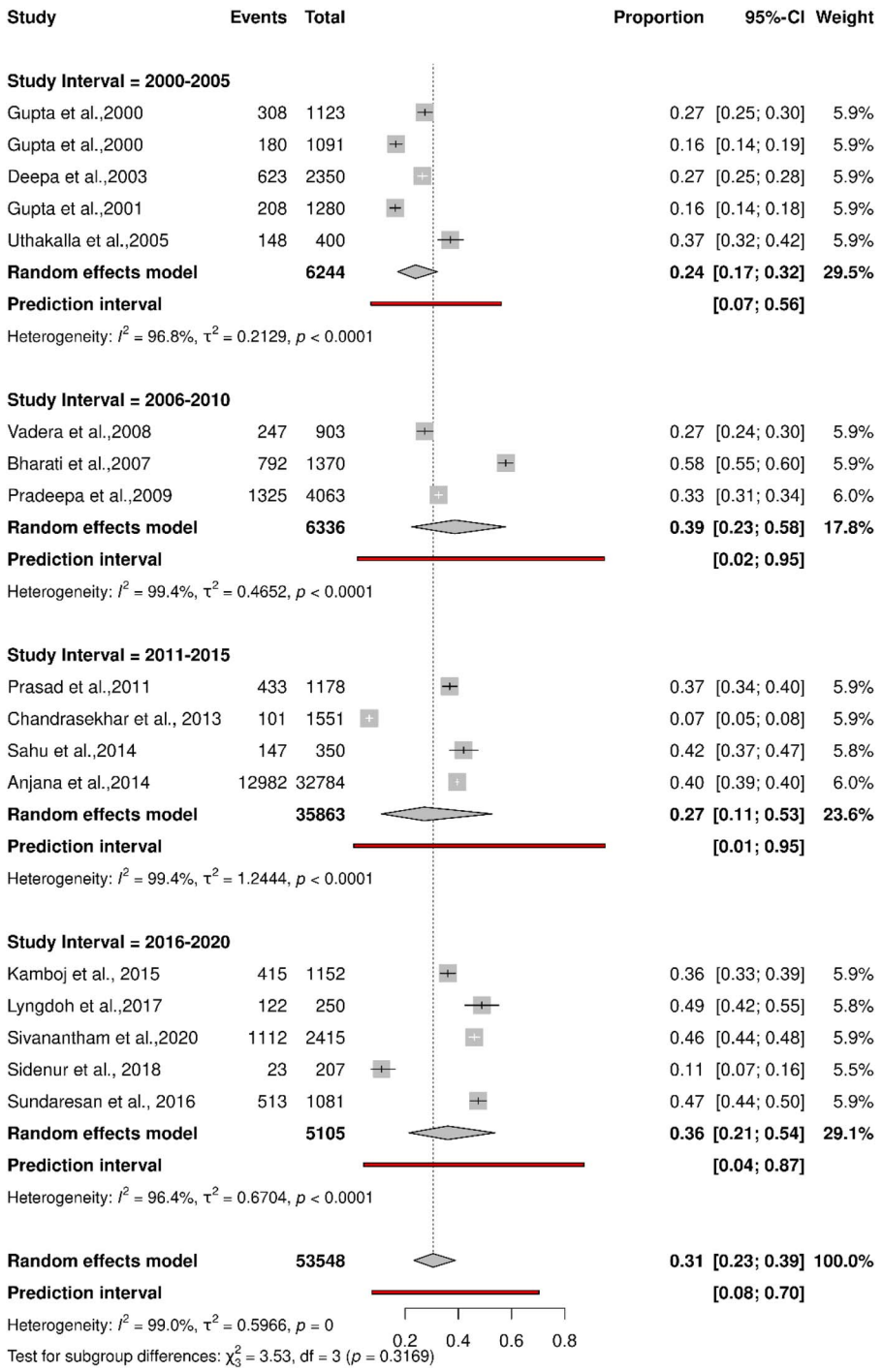


Figure 5 Forest plot of pooled prevalence of general obesity (GO) in urban India, 2000-2025.

Trends in HTN prevalence: urban India (2000-2025)

As depicted in Table 3,[5,43,46,47,51,54-56,59,64,65,68,70-87] HTN prevalence in urban India showed fluctuations over 25 years. The pooled prevalence was 29% in 2000-2005,[43,46,47,70-72] rose to 38% (+9 pp, ~31.0% relative increase) in 2006-2010,[51,54,73-75] dropped to 30% (−8 pp, −21.1%) in 2011-2015,[5,55,56,59,76-80] increased again to 33% (+3 pp, ~10.0%) in 2016-2020,[64,65,68,81-85] and slightly fell to 31% (−2 pp, −6.1%) in 2021-2025.[86,87] Overall, prevalence rose modestly by +2 pp (~6.9%) across the 25-year span.[5,43,46,47,51,54-56,59,64,65,68,70-87] The overall pooled prevalence of HTN was 32% (95% CI, 28%-36%; 95% PI: 15%-57%).

Trends in obesity prevalence: urban India (2000-2025)

As shown in Table 4,[5,12,43,46,47,51,54-56,59,64,65,68,88-95] both GO and AO prevalence increased over the study period, with some fluctuations for GO and steady rises for AO. GO prevalence was 24% in 2000-2005,[43,46,47,88,89] rose to 39% (+15 pp, ~62.5% relative increase) in 2006-2010,[12,51,90] declined to 27% (−12 pp, −30.8%) in

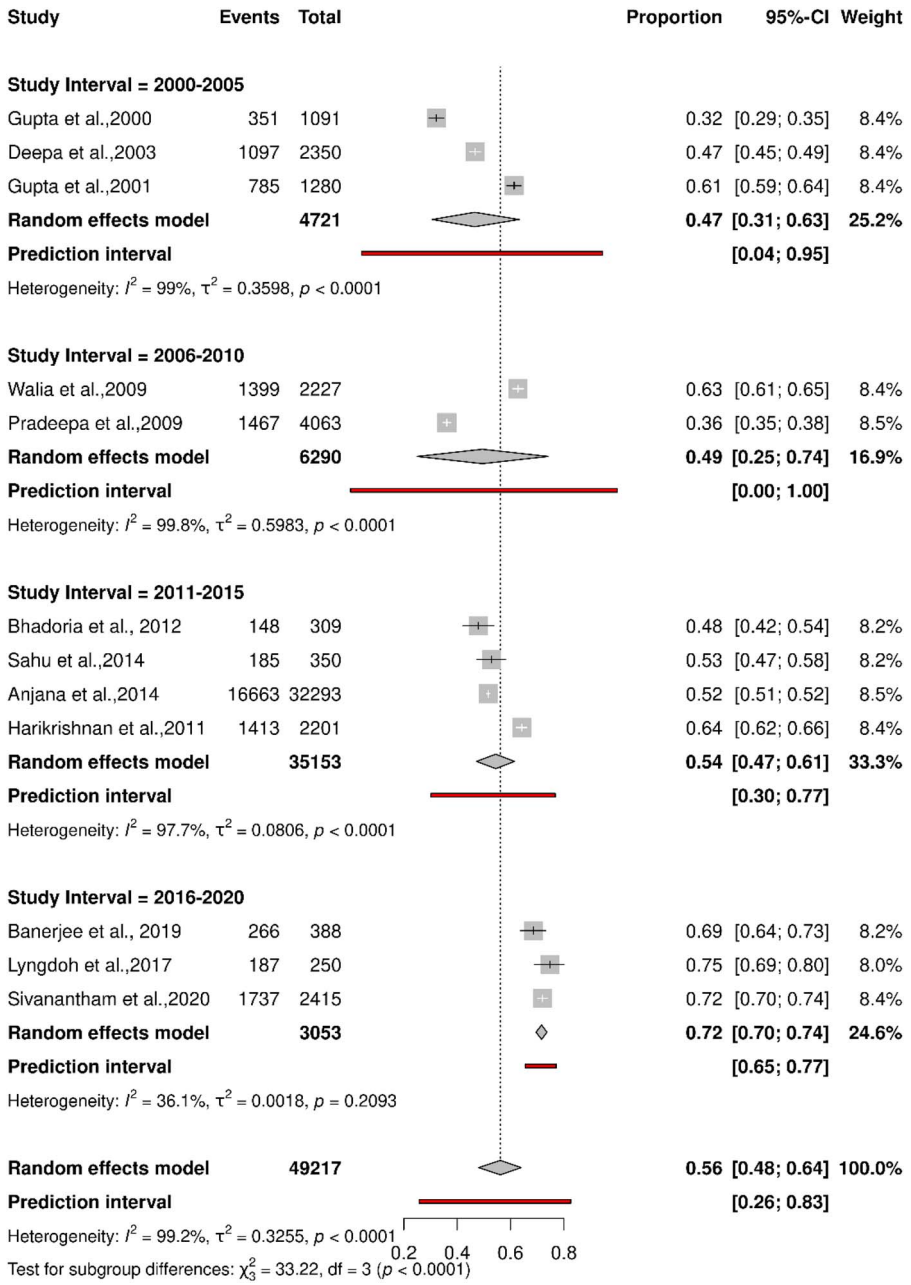


Figure 6 Forest plot of pooled prevalence of abdominal obesity (AO) in urban India, 2000-2025.

2011-2015,[5,56,91,92] and increased again to 36% (+9 pp, ~33.3%) in 2016-2020.[64,65,68,93,94]

Abdominal obesity prevalence rose steadily from 47% in 2000-2005[46,47,88] to 49% (+2 pp, ~4.3%) in 2006-2010,[12,54] 54% (+5 pp, ~10.2%) in 2011-2015,[5,55,56,59] and 72% (+18 pp, ~33.3%) in 2016-2020.[64,65,95] Over 25 years, the overall pooled prevalence of GO was 31% (95% CI, 21%-54%; 95% PI: 8%-70%) and that of AO was 56% (95% CI, 48%-64%; 95% PI: 26%-83%).[5,12,43,46,47,51,54-56,59,64,65,68,88-95]

Regional heterogeneity was evident in the pooled prevalence estimates across urban India. GO prevalence exceeded 45% in selected southern and northeastern urban centers, including Coimbatore and Imphal West, while AO surpassed 60% in several northern cities. In contrast, lower pooled prevalence estimates were observed in eastern and central urban regions (Table 4).

Sex-specific trends

Sex-stratified analyses revealed distinct patterns across the study period. For T2D, prevalence in males increased from 13% in 2000-2005 to 20% in 2021-2025 (+7 pp; +53.8% relative rise), whereas in female, prevalence increased from 11% to 14%[42,43,45,47-56,59-61,63-65,67,68] (+3 pp; +27.3% relative rise). Over the study period, pooled prevalence estimates among males showed a consistent upward trend with a relatively larger absolute and proportional increase compared to females, with higher point estimates observed in later periods and minimal overlap of confidence intervals with earlier estimates, indicating a sustained rise in T2D prevalence over time. In contrast, pooled estimates among females increased more modestly, with smaller gains across successive periods. Sex-stratified

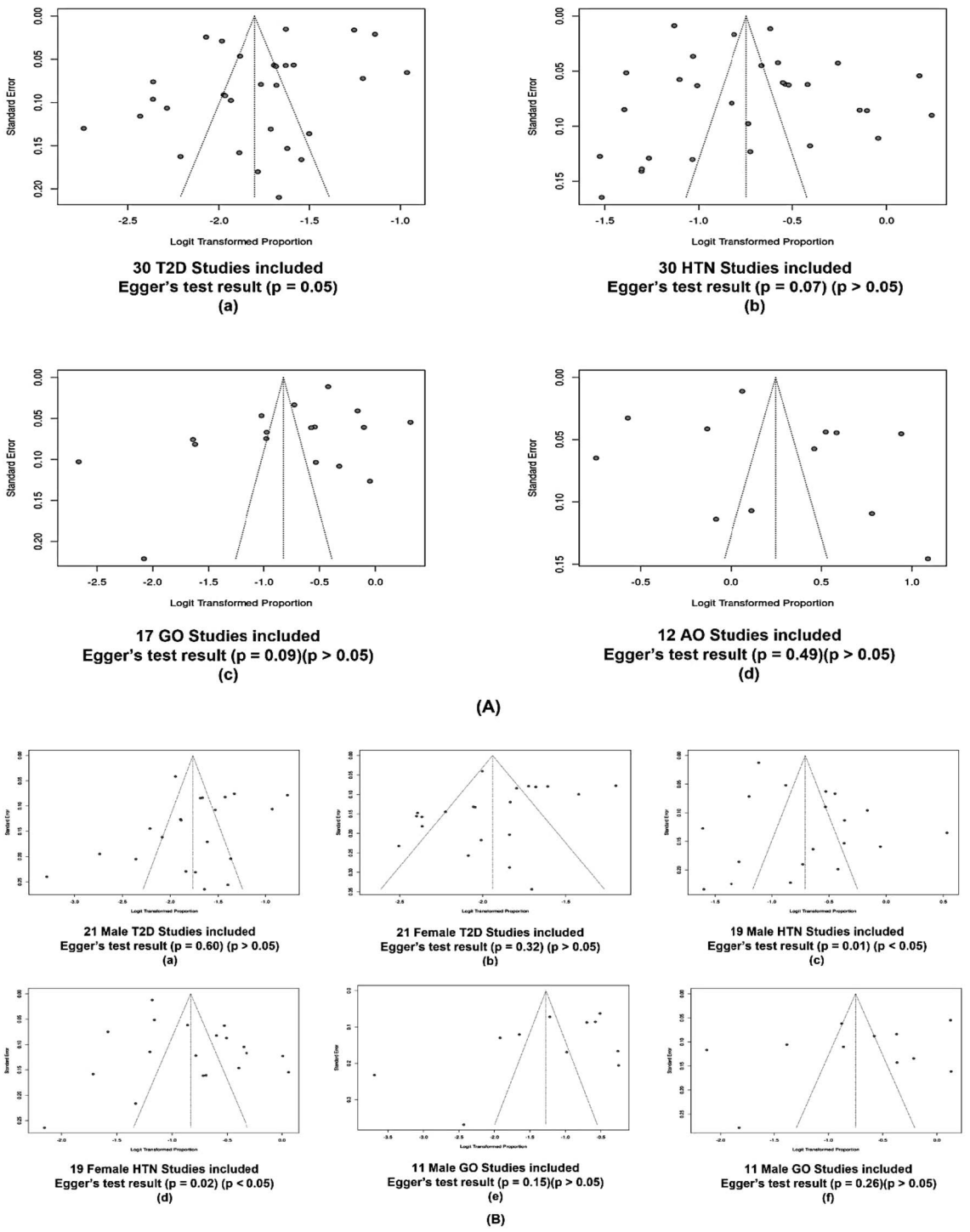


Figure 7 Funnel plots depicting the distribution of effect sizes. (A) Overall prevalence studies type 2 diabetes (T2D) (a), hypertension (HTN) (b), general obesity (GO) (c), and abdominal obesity (AO) (d). (B) Sex-specific prevalence studies male T2D (a), female T2D.

analyses showed a larger increase in T2D prevalence in urban India between 2000 and 2020 (Supplementary File S3 [Figures S10 and S11]).

A similar sex specific pattern was observed for HTN: male prevalence increased from 30% to 33% (+3 pp; +10% relative rise), while female prevalence rose from 26% to 30% (+4 pp; +15.4% relative rise).[46,59,64,65,68,71,73,74,77-87] Over time, male-specific pooled estimates demonstrated a gradual increase with modest absolute change, with progressively higher point estimates in later periods and limited overlap of confidence intervals with earlier estimates. Female-specific pooled estimates also showed a comparable but slightly greater increase in absolute and relative terms. Overall, the sex-stratified forest plots indicate persistently higher HTN prevalence among males, with only a modest change in the male–female gap over time in urban HTN prevalence between 2000 and 2025 (Supplementary File S3 [Figures S12 and S13]).

Table 5 Meta-regression results across outcomes.

Outcome	*k*	Moderator	β (SE)	*P*-value	R^2 (%)	I^2 (%)	Key interpretation
T2D	30	Year	.014 (0.012)	.25	30.3	96.8	No temporal trend
		Age ≥ 40 years	.478 (0.294)	.10	NA	NA	Higher (NS)
		FPG/OGTT	–.719 (0.340)	.034[a]	NA	NA	Lower prevalence
		Self-reported	–1.096 (0.524)	.036[a]	NA	NA	Lower prevalence
HTN	30	Year	.006 (0.016)	.68	0.0	99.4	No association
		Age groups	NA	NS	NA	NA	No association
GO	17	Year	.041 (0.040)	.31	2.1	99.5	No association
		Age restricted	–.889 (0.490)	.07	NA	NA	Borderline lower
AO	12	Year	.023 (0.017)	.20	85.2	96.0	No temporal trend
		Older/high-risk	1.144 (0.311)	<.001[a]	NA	NA	Higher prevalence
		WHO WC criteria	.618 (0.267)	.021[a]	NA	NA	Higher prevalence

Abbreviations: AO = abdominal obesity; β = regression coefficient; FPG = fasting plasma glucose; GO = general obesity; HTN = hypertension; I^2 = residual heterogeneity after accounting for moderator; *k* = number of studies; NA = not available; NS = not statistically significant; OGTT = oral glucose tolerance test; *P*-value = significance level; R^2 = proportion of between-study variance explained by moderator; T2D = type 2 diabetes; WC = waist circumference; WHO = World Health Organization. [a]Significance level: $P < .05$.

Sex-specific obesity estimates were available for 2000-2020. GO increased from 20% to 29% among males (+9 pp; +45% relative rise) and from 30% to 37% among females[46,56,64,65,88-94] (+7 pp; +23.3% relative rise). When early and later periods were compared, both male- and female-specific pooled estimates for GO demonstrated a clear upward shift, with a relatively greater proportional increase among males despite consistently higher prevalence in females. Although GO prevalence remained higher among females throughout, the magnitude of increase was slightly more pronounced in males in relative terms. The sex-stratified forest plots show limited overlap of confidence intervals between earlier and later periods, supporting a sustained rise in GO prevalence in urban populations (Supplementary File S3 [Figures S14 and S15]).

Abdominal obesity showed the steepest escalation among both sexes. Male prevalence increased from 28% in 2000-2005 to 52% in 2016-2020 (+24 pp; +85.7% relative rise), while female prevalence rose from 49% to 86% over the same period[46,54,56,59,65,88,95,96] (+37 pp; +75.5% relative rise). Across the study duration, pooled estimates for AO showed a steep and sustained increase in both sexes, with a larger absolute rise among females but a slightly higher relative increase among males and substantially higher point estimates in later periods and minimal overlap of confidence intervals with earlier estimates. Female-specific estimates consistently exceeded male estimates at all time points, and the overall burden remained markedly higher among females despite comparable relative escalation. Collectively, the sex-stratified forest plots indicate a substantially higher burden and more rapid escalation of AO among urban females between 2000 and 2020 (Supplementary File S3 [Figures S16 and S17]).

Caution regarding pooled female AO prevalence: the very high pooled prevalence observed in 2016-2020 (86%) is derived from only 3 studies with low heterogeneity (I^2 = 21%). Accordingly, this estimate should be interpreted with caution, as it may not reflect all urban settings in India. Prediction intervals were calculated to provide a plausible range of prevalence across different urban populations. AO estimates showed temporal sensitivity, with higher recent-period influence and substantial between-study variability. These results highlight the need for further sex-stratified prevalence studies in diverse urban settings to strengthen the precision of future estimates.

Publication bias

Funnel plots were constructed to evaluate the distribution of effect sizes across the included studies, and potential publication bias was assessed using Egger's regression test[37] (Figure 7A). The test yielded *P*-values of .05 for T2D (30 studies), .07 for HTN (30 studies), .09 for GO (17 studies), and .49 for AO (12 studies). These results indicate no statistically significant evidence of publication bias or small-study effects in the HTN, GO, and AO analyses. In contrast, the T2D analysis (P = .05) suggests borderline evidence of publication bias or small-study effects (Figure 7A). Accordingly, pooled T2D prevalence estimates should be interpreted with caution, as smaller studies with higher prevalence estimates may be overrepresented. However, the relatively large number of included studies and the consistency of findings across sensitivity analyses reduce the likelihood of substantial distortion of the overall estimates. For the sex-stratified analyses, Egger's test indicated no evidence of publication bias for T2D (male P = .60; female P = .32; 21 studies each). In contrast, significant small-study effects were detected for HTN in both males (P = .01) and females (P = .02) across 19 studies, while no such evidence was observed for GO (male P = .15; female P = .26; 11 studies each) (Figure 7B). Sex-specific assessment infeasible for AO due to an insufficient number of eligible prevalence studies. This limitation relates solely to the statistical assessment of publication bias and does not influence the observed prevalence estimates or the documented temporal increase in AO, which reflects underlying epidemiological trends rather than methodological artifact.

Risk of bias within studies

Assessment using the Hoy Risk of Bias Tool indicated that most studies were at low risk of bias across key domains, including objectives, sample representativeness, population definition, measurement methods, and statistical analyses. Overall, the evidence was considered robust, with only a few studies exhibiting moderate risk in select domains (Figure 8). A detailed, item-wise appraisal for all studies is provided in Supplementary File S2 (Tables S9 and S10).

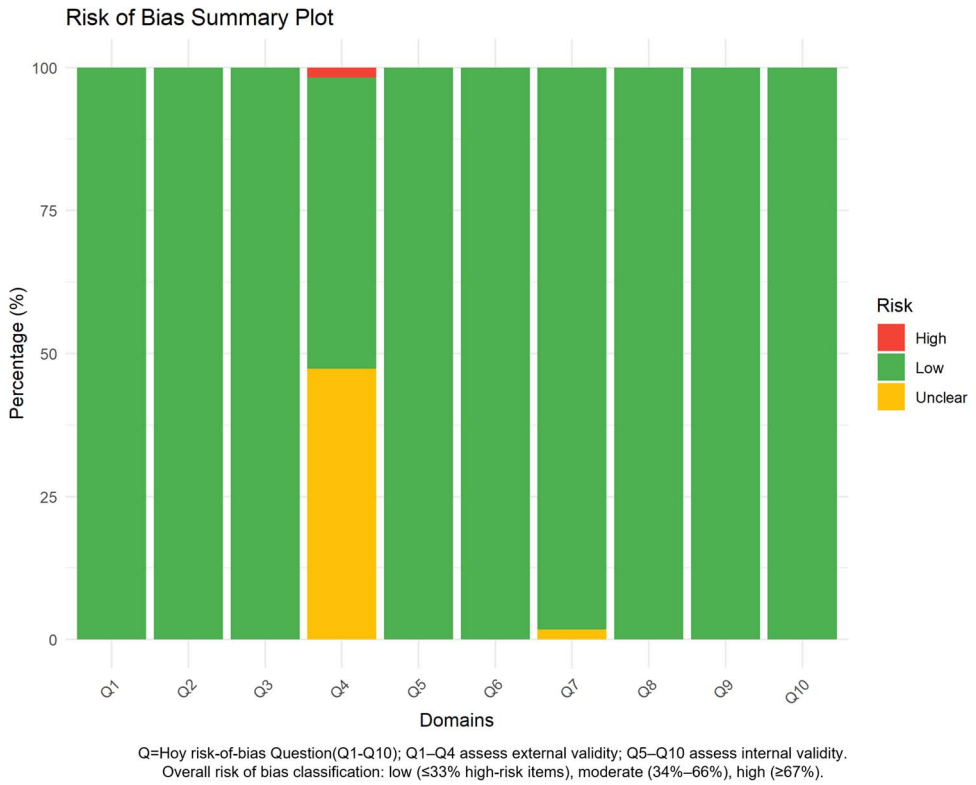


Figure 8 Hoy risk-of-bias assessment summary plot.

Discussion

This systematic review and meta-analysis demonstrated a marked and sustained rise in T2D, HTN, GO, and AO in India over the past 25 years. Synthesizing evidence from 57 studies (2000-2025), T2D increased by roughly 1.6-fold, while HTN showed only a modest rise of ∼1.1-fold. In contrast, obesity measures increased more substantially, with GO and AO rising by ∼1.5-fold overall. Notably, sex-stratified analyses revealed steeper relative increases in AO among both males (∼1.9-fold) and females (∼1.8-fold), representing the most pronounced escalation across all outcomes. This widening contrast points to a disproportionate expansion of central adiposity in urban Indian populations and highlights AO as an increasingly prominent cardiometabolic risk phenotype within rapidly urbanizing environments.

Importantly, this review provides new evidence by providing the first long-term synthesis of both GO and AO trends in Indian cities. Prior reviews have examined obesity more broadly[97-100] but did not present pooled AO estimates or document the temporal changes observed over 25 years. Our findings indicate that AO is the greatest escalating component of India's urban metabolic burden. Sex-stratified analyses revealed divergent patterns: males showed greater increases in T2D and HTN, whereas obesity, particularly AO, rose more rapidly among females, highlighting widening sex disparities. The particularly steep rise in female AO highlights a growing sex disparity in urban India. The pronounced influence of the 2016-2020 period suggests a substantial recent increase in AO, potentially reflecting rapid lifestyle and nutritional transitions. The lower contribution of earlier periods further supports a temporal shift in AO, highlighting that current burden may be considerably higher than historical estimates. Consequently, the observed trend should be interpreted with caution, highlighting the need for additional large-scale, sex-disaggregated research across diverse urban populations to strengthen confidence in these findings.

The pronounced rise after 2010 aligns with India's nutrition and lifestyle transition following economic liberalization.[13-17,98-101] Increased consumption of refined cereals and processed foods, reduced physical activity, and occupational sedentariness have contributed to rising metabolic risk, patterns also observed in other LMICs[5,12,21,43,46,47,54,56,65,68,75,88-91,93,94,98-100,102-106]; however, the pace and scale appear particularly pronounced in India's urban centers. Importantly, these behavioral shifts are embedded within urban environments characterized by limited access to affordable nutritious foods, poor walkability, and high occupational sedentariness, rendering individual-level behavior change alone insufficient.[101] Consequently, population-level policy responses, including clear front-of-package labeling, economic measures targeting ultra-processed foods, and the promotion of protein- and fiber-rich dietary staples, are increasingly necessary.[101] Recent evidence from Anjana et al., demonstrating a 14%-30% higher risk of T2D and obesity associated with cereal-heavy, low-protein diets, further reinforces these findings.[101]

Parallel technological and occupational changes likely explain the concurrent increases in T2D and HTN,[11,19,48,107-110] while rising HTN reflects aging, stress, and genetic susceptibility among South Asians.[103,111] Sex-specific differences mirror earlier findings of Jayawardena et al., from South Asia,[112] supporting the need for targeted screening and prevention, especially for women experiencing rapid increases in AO,[12,54,56,91,93,102] together with the much steeper trajectory of female AO documented in this review, highlights the importance of sex-specific strategies, such as workplace wellness programs, community-based physical activity initiatives,

and targeted screening. Strengthening urban primary care systems capable of delivering early detection, longitudinal monitoring, and integrated chronic disease care will be critical for these high-risk groups.

Environmental conditions may also shape regional differences. Cities, such as Delhi, Haryana, and Ludhiana, where HTN peaked after 2015, experience severe air pollution. Aarthi et al.[113] reported that long-term exposure to NO_2, SO_2, $PM_{2.5}$, and PM_{10} is associated with elevated T2D risk. The faster rise in northern urban clusters, compared with southern regions, suggests that environmental stressors may compound metabolic vulnerability. Efforts to improve air quality, expand green spaces, and enhance walkability represent important components of metabolic disease prevention.

This review also advances the literature methodologically. The CoCoPop framework, provides a more epidemiologically coherent synthesis of prevalence studies. We acknowledge that many included studies represent specific cities or states and may not fully capture the diversity of urban populations across India. Consequently, pooled prevalence estimates are interpreted as reflecting available urban studies rather than nationally representative estimates. Geographic heterogeneity across studies contributes to variability in pooled results, which we have highlighted in our discussion of regional trends and differences. Most included studies were classified as low risk of bias, with a small number categorized as moderate risk (Supplementary File S2 [Tables S9 and S10]). However, the high between-study heterogeneity observed suggests that variability is likely driven by clinical and methodological differences not fully captured by risk of bias assessments. No geographic weighting was applied in the meta-analysis; however, potential heterogeneity arising from differences across cities and regions was explicitly addressed through random-effects modeling, subgroup analyses, and the estimation of prediction intervals. Pooled estimates reflect methodological heterogeneity across studies, limiting direct comparability with standardized national trend analyses. Wide prediction intervals observed across outcomes reflect substantial between-study heterogeneity and suggest that prevalence may vary considerably across different urban settings.

Restricting inclusion to community-based urban populations from Tier 1 and Tier 2 cities characterized by higher levels of urbanization and socioeconomic development enhances representativeness and reduces heterogeneity, distinguishing this review from prior Indian and South Asian analyses by Anjana et al., Saeedi et al., and Nair et al., respectively[58,114,115] Additionally, this is the first review to structure findings across 5 standardized assessment periods (2000-2005, 2006-2010, 2011-2015, 2016-2020, and 2021-2025), enabling clearer temporal interpretation of cardiometabolic transitions.

While improvements in diagnostic practices including wider use of OGTT, standardized blood pressure measurement, and more representative urban sampling may have contributed to increased case detection in recent years.[52,54,56,58,61,116,117] Funnel plots and Egger's tests showed no significant publication bias and supports the interpretation that the observed increases primarily reflect genuine population level changes rather than methodological artifacts. Evidence from the ICMR-INDIAB study further indicates higher awareness of diabetes among urban residents, which may have facilitated earlier recognition and diagnosis.[118] Improved health-promoting behavior, combined with large-scale government initiatives, such as population-based NCD screening and the expansion of ∼1.5 lakh Health and Wellness Centers under the Ayushman Bharat program, has strengthened access to primary care and detection,[119-121] but has not halted rising T2D, HTN, and obesity prevalence, underscoring the need for upstream, multisectoral interventions.

Although India's overall trajectory mirrors global trends,[21,105,106,111] our findings reveal marked geographic heterogeneity within urban India, with substantially higher burdens of GO and AO concentrated in selected northern, southern, and northeastern urban centers between 2016 and 2020. These regional and sex-specific disparities shaped by dietary patterns, socioeconomic conditions, and environmental exposures highlight the need for tailored strategies within national programs.[5,11,12,103,104,122] High risk urban clusters will require intensified screening, behavior change programs, and integrated chronic disease services, supported by national efforts to strengthen urban health systems and regulate food and built environments.

Overall, the convergence of T2D, HTN, and obesity has become a defining feature of India's urban health landscape. This review adds new evidence by presenting the most detailed 25-year urban trend analysis to date including sex-stratified, region-specific, and AO trajectories demonstrating the urgency of coordinated, multisectoral interventions across food systems, urban design, environmental regulation, and primary care to control the growing metabolic disease burden and reduce widening health inequities.

Meta-regression of study-level factors year, age group, and diagnostic criteria found no consistent predictors of T2D, HTN, GO, or AO prevalence, with substantial residual heterogeneity persisting (Table 5). This suggests that unmeasured contextual and methodological factors, including geographic, socioeconomic, urbanization, and lifestyle differences, drive variability. Findings are limited by the ecological nature of meta-regression, potential residual confounding, and limited covariate variability. These results highlight the complexity of prevalence patterns and the need for individual-level data to clarify sources of heterogeneity.

Strengths

This review adds several important contributions to the existing literature. First, to our knowledge, it is the only review to systematically track 25-year trends (2000-2025) in the prevalence of T2D, HTN, and obesity in urban India using sex- and region-stratified analyses with the CoCoPop framework, providing a more epidemiologically coherent synthesis than traditional PICO approaches. Second, by integrating 57 studies with consistent methodological frameworks, it captures combined and overlapping burdens, highlighting sex-specific patterns and geographic heterogeneity across northern, southern, and northeastern urban centers, an approach not reported in earlier reviews.[123,124] Third, extensive sensitivity analyses and meta-regression using year of data collection as a continuous predictor strengthen the robustness of findings and explore sources of heterogeneity. Finally, evaluation of small study effects via Egger's regression across pooled and sex-stratified analyses further reinforces reliability and addresses a common limitation of earlier national trend studies. These elements collectively position this review as a comprehensive methodologically rigorous, and updated sex- and region-sensitive synthesis of urban NCD transitions in India.

Limitations

This review is based mainly on cross-sectional studies from urban areas. These data help show the extent to which prevalence has

changed over time, but they cannot explain causes or new case occurrence. Other limitations include considerable between-study heterogeneity, variability in diagnostic criteria, and limited availability of sex-stratified data for some outcomes. Long-term studies that use consistent diagnostic standards and offer more detailed stratification are needed to address these gaps.

Implications

The findings of this review highlight an urgent need for coordinated policy action to address the rapidly growing burden of T2D, HTN, and obesity in urban India. While strengthening routine screening and early detection is essential, lasting progress will require structural changes that directly reshape the environments driving cardiometabolic risk. Policies that improve the affordability and availability of healthy foods, promote active and safer urban design, and enforce air quality regulation particularly in northern cities, are central to reversing current trends.[52,56,58,61] Behavior focused approaches alone have limited impact when food systems, built environments, and pollution exposures continue to reinforce unhealthy lifestyles. A comprehensive, multisectoral response linking health, urban planning, environmental regulation, and the food system will be necessary to slow the convergence of T2D, HTN, and obesity across India's urban centers and to prevent further widening of cardiometabolic disparities.

Conclusion

This systematic review shows that over the past 25-years, the burden of T2D, HTN, and obesity has risen steadily across urban India, with increases seen in both males and females. The combined progression of these conditions highlights a wider shift in the urban health profile, shaped by rapid lifestyle and environmental changes. The consistency of these upward trends across multiple study periods, together with notable regional and sex-specific differences, points to a growing concentration of cardiometabolic risk in India's cities. Addressing this challenge will require stronger primary care systems, improvements in food and built environments, and policies that respond to the broader social and environmental factors driving these conditions. Without such coordinated efforts, urban areas are likely to remain the focal point of India's expanding NCD burden.

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Supplementary material

Supplementary material is available at the *American Journal of Epidemiologic Reviews* online.

Conflicts of interest

No conflict of interest.

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Author contributions

Authorship was determined in accordance with the International Committee of Medical Journal Editors guidelines, based on substantive intellectual and methodological contributions. P.S. conceived the review, developed the study protocol, conducted the literature searches, performed study screening, data extraction, data synthesis, and statistical analysis, and drafted the manuscript. T.A.P. contributed to study screening and data extraction. U.V. contributed to the statistical analysis and data synthesis. W.H. served as an independent conflict resolver during study screening and selection and provided methodological guidance. V.M., R.M.A., and R.P. contributed subject-matter expertise, interpretation of findings, and critical intellectual input. R.M.A., R.P., R.M., and D.W.D. provided senior supervision, methodological oversight, and critical revision of the study protocol and manuscript. All authors critically reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

Data availability

The data underlying this systematic review and meta-analysis were obtained from previously published studies. No new individual-level data were generated during this study. The extracted study-level data and search strategies are provided in the Supplementary Data accompanying this article. Additional information is available from the corresponding author upon reasonable request.

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