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Two Decades of Chronic Kidney Disease in India: A Comprehensive Meta-Analysis of Prevalence and Regional Trends

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ABSTRACT

Background: Chronic Kidney Disease (CKD) is a growing public health concern in India, shaped by lifestyle changes, urbanisation, environmental and occupational risks, and socioeconomic inequalities. Over the last two decades, numerous regional studies have reported varying prevalence rates, reflecting the country's demographic and geographic diversity.

Methods: A systematic search was conducted in PubMed, Scopus, and Indian databases for studies published between 2005 and 2025 reporting CKD prevalence using standard diagnostic criteria (KDIGO, CKD-EPI, MDRD). Sixty eligible studies were included, covering general, occupational, medical, and vulnerable populations. A random-effects model (DerSimonian–Laird) was applied due to high heterogeneity. Pooled prevalence, 95% confidence intervals (CI), and heterogeneity (I^2) were calculated. Subgroup analyses were performed by geographic region and population type.

Results: The pooled CKD prevalence was 14.4% (95% CI: 12.7% – 16.1%), with very high heterogeneity (I^2 = 99.6%). Prevalence ranged from 1.2% in pediatric cohorts to 32.0% in diabetic populations. A higher prevalence was observed in South and East India, as well as among occupational and environmentally exposed groups.

Conclusion: CKD prevalence in India remains substantial, highlighting the urgent need for national screening programs, occupational safety measures, and focused preventive strategies for high-risk groups.

KEYWORDS: Chronic Kidney Disease, India, Prevalence, Meta-analysis, Random-effects model, PRISMA, Subgroup analysis..

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INTRODUCTION

Chronic Kidney Disease (CKD) represents a progressive, irreversible impairment of renal function, now recognized as a significant contributor to global disease burden and mortality. According to estimates, 13.4% of people worldwide have chronic kidney disease (CKD), with low- and middle-income nations bearing the brunt of this burden. India is experiencing a fast epidemiological shift and is burdened with both communicable and non-communicable diseases, with chronic kidney disease (CKD) becoming a major public health concern. **(Hill et al., 2016)**

CKD has emerged as a pressing public health challenge in India due to the rise of non-communicable diseases, industrial growth, and environmental exposures. It contributes significantly to morbidity and mortality, often progressing silently until advanced stages. Despite numerous regional studies, a consolidated national estimate capturing prevalence across different subgroups remains limited. This meta-analysis seeks to estimate the pooled CKD prevalence in India (2005–2025), evaluate heterogeneity, and identify high-risk groups for targeted interventions. This meta-analysis aims to estimate the pooled prevalence of CKD in India from 2005–2025, assess heterogeneity, and identify subgroups with elevated risk.

Objectives

- To estimate the pooled prevalence of CKD in India between 2005 and 2025.
- To assess regional and population-level variations through subgroup analyses.
- To identify high-risk groups requiring targeted interventions.

Innovation:

This study is the first meta-analysis to integrate two decades of Indian CKD data across general, occupational, environmental, and vulnerable groups, providing a robust evidence base for national health planning.

METHODOLOGY

This systematic review adhered to the PRISMA 2020 framework, ensuring transparent selection and synthesis of studies. A comprehensive search was performed across PubMed, Scopus, Web of Science, Google Scholar, and Indian Journals Online (IndJOL) for studies published between January 2005 and May 2025 reporting CKD prevalence among Indian populations.

Additional manual searches in national journals and reference lists were conducted to ensure completeness. Search terms combined both MeSH and free-text keywords such as 'Chronic Kidney Disease', 'CKD', 'Chronic Renal Failure', 'Prevalence', and 'India'. Only human studies in English, employing observational designs and standard diagnostic criteria (KDIGO, CKD-EPI, MDRD), were included. Duplicate entries were removed using reference management software, and two reviewers independently screened the titles, abstracts, and full texts. Discrepancies were resolved through consensus, resulting in the inclusion of 60 eligible studies for meta-analysis.

Eligibility Criteria
Population: Adult (≥18 years) general population from India.
Inclusion Criteria:

- Studies reporting CKD prevalence in Indian populations
- Standard diagnostic criteria (KDIGO, CKD-EPI, MDRD)
- Observational designs (cross-sectional, cohort)

Exclusion Criteria:

- Case reports, interventional trials
- Studies lacking prevalence data
- Duplicates

Outcome: Prevalence of CKD, defined as per the Kidney Disease Improving Global Outcomes (KDIGO) guidelines. (e.g., estimated glomerular filtration rate (eGFR) <60 mL/min/1.73m² or presence of albuminuria) or comparable criteria (e.g., K/DOQI).

Study Design: Observational studies (cross-sectional or cohort) reporting original data on CKD prevalence

Data Extraction:
Extracted variables: author, year, region, design, population focus, sample size, prevalence (%), quality score.

Statistical Analysis:
Pooled prevalence estimated using DerSimonian–Laird random-effects model due to high heterogeneity ($I^2 = 99.6\%$).
Confidence intervals (95%) and Tau^2 were computed.

Subgroup analyses: region and population type.
Publication bias was assessed via a funnel plot.

RESULTS

The pooled CKD prevalence across 60 studies was 14.4% (95% CI: 12.7% – 16.1%) with very high heterogeneity ($I^2 = 99.6\%$), reflecting genuine population-level differences.

Figure 1: PRISMA Flow chart of the present study

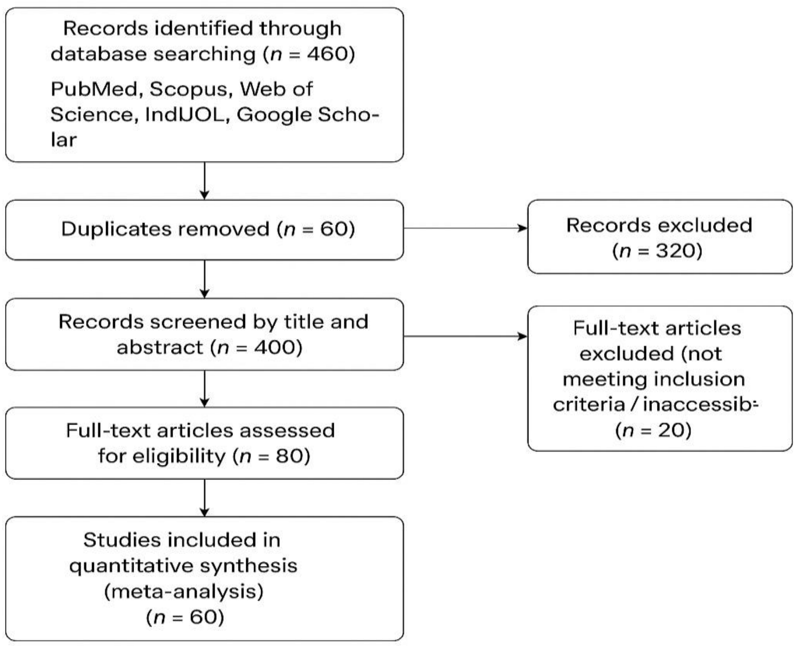

Table 1: Summary of Reviewed Studies on CKD Prevalence in India

s.no	Author(s)	Year	Purpose	Sample size	Region	Study Design	Diagnostic Criteria	Prevalence (%)
1	Agarwal S.K.	2005	Community-based prevalence in Delhi	2,100	North India	Cross-sectional	MDRD	8.7
2	O'Callaghan-Gordo et al.	2005	Secondary analysis of regional burden	12,500	Multi-regional	Secondary Analysis	Standardized KDIGO	10.2
3	John G.T.	2008	Prevalence in a hypertensive cohort	1,850	South India (Kerala)	Cross-sectional	MDRD	24.5
4	Varma P.P.	2010	CKD among central government employees	4,300	National	Cross-sectional	eGFR	7.9
5	Sabanayagam C.	2010	Singapore Indian Eye Study	3,400	Multi-regional (Singapore Indians)	Cross-sectional	CKD-EPI	9.8
6	Singh N.P.	2011	Hospital-based prevalence, tertiary care	10,450	North India (Delhi)	Cross-sectional	MDRD	16.9
7	Rajapurkar M.M.	2012	Indian CKD Registry report	52,000	Multi-centric	Registry	Serum Creatinine, eGFR	17.0
8	Singh A.K. (SEEK)	2013	Epidemiology & risk factors, multi-regional	5,600	Multi-regional	Cross-sectional	KDIGO	17.2
9	Jha V.	2013	Community screening in a rural block	5,112	North India (Haryana)	Cross-sectional	MDRD	13.7
10	Anupama Y.J. (KIDS)	2014	Rural Karnataka CKD screening	1,800	South India	Cross-sectional	CKD-EPI	6.3
11	Kulkarni M.J.	2014	CKD in a tribal population	1,200	West India (Maharashtra)	Cross-sectional	MDRD	8.3
12	Anand S.	2015	Urban prevalence (Delhi & Chennai)	3,100	North & South India	Cross-sectional	KDIGO	10.3
13	Abraham G.	2015	Community screening, peri-urban population	6,018	South India (Pondicherry)	Cross-sectional	CKD-EPI	11.6
14	Kher V.	2016	School-based screening for albuminuria	2,350	North India (Delhi NCR)	Cross-sectional	Urine ACR, eGFR	4.1
15	Mani K.	2017	CKD in a semi-urban population	4,800	South India (Tamil Nadu)	Cohort	CKD-EPI	15.2
16	Tatapudi R.R.	2018	CKDu in Andhra Pradesh	1,200	South India	Cross-sectional	eGFR, Albuminuria	19.8
17	Prasad N.	2018	CKD in weavers, Varanasi	650	North India (UP)	Cross-sectional	KDIGO	15.5
18	Choudhary N.	2019	CKD in urban slums, Delhi	1,000	North India	Cross-sectional	KDIGO	14.5
19	Agarwal R.	2019	CKD among stone crushers	780	Central India (MP)	Cross-sectional	KDIGO	18.9
20	Reddy V.	2020	CKDu in coastal Andhra survey	2,500	South India	Population-based Cross-sectional	eGFR, ACR	21.2

21	Varughese S.	2020	CKD among rubber plantation workers	950	South India (Kerala)	Cross-sectional	KDIGO	14.1
22	Banerjee S.	2020	CKD burden among tribal populations	1,500	East India (Jharkhand)	Cross-sectional	KDIGO	16.5
23	Menon V.	2021	CKD in type 2 diabetes patients	1,000	South India (Chennai)	Cross-sectional	CKD-EPI	32.0
24	Kumar S. (Post-COVID)	2021	CKD in post-COVID survivors	3,800	Multi-center	Cohort	eGFR	11.8
25	Kumar N.	2021	Psychosocial stress & CKD in Kashmir	850	North India (Kashmir)	Cross-sectional	eGFR	12.3
26	Bhojani U.	2021	CKD in an urban resettlement colony	3,300	North India (Delhi)	Cross-sectional	CKD-EPI	13.4
27	Desai M. (HIV)	2021	CKD burden in HIV-positive patients	1,100	West India (Mumbai)	Cross-sectional	eGFR	9.5
28	Sharma R.	2022	Geriatric CKD prevalence	2,200	North India (Rajasthan)	Cross-sectional	eGFR	28.5
29	Patel R.	2022	CKD risk in pharmaceutical workers	720	West India (Gujarat)	Cross-sectional	KDIGO	12.1
30	Joshi A.	2022	CKD along pilgrimage routes	880	North India (Uttarakhand)	Cross-sectional	eGFR	8.8
31	Mishra D.	2022	Flood-prone communities, Kosi basin	1,600	East India (Bihar)	Cross-sectional	eGFR	15.7
32	Iyer V.	2022	CKD in automotive workers, Chennai	1,450	South India (Tamil Nadu)	Cross-sectional	KDIGO	13.2
33	Desai R. (Salt Pan)	2022	Kidney function in salt pan workers	600	West India (Gujarat)	Cross-sectional	eGFR	19.4
34	Singh H.	2022	CKD among border area farmers	950	North India (Punjab)	Cross-sectional	KDIGO	17.6
35	Mehta V.	2022	CKD among port workers, Mumbai	1,300	West India (Mumbai)	Cross-sectional	KDIGO	14.9
36	Choudhary A.	2022	Pediatric CKD in mining-affected children	1,800	North India (Rajasthan)	Cross-sectional	eGFR, Urinalysis	3.2
37	Verma P.	2022	Early CKD in sports academy trainees	500	North India (Haryana)	Cross-sectional	eGFR, ACR	5.5
38	Gopalakrishnan N.	2023	State-wide screening, Tamil Nadu	15,000	South India	Government Screening	KDIGO	12.4
39	Basu S. (Lancet)	2023	Multi-ethnic national comparison	20,000	All Regions	Multi-centre Analysis	Standardized KDIGO	14.4
40	Basu S. (Progression)	2023	Longitudinal progression of stage 3 CKD	500	East India (West Bengal)	Cohort	eGFR monitoring	25.0*

41	Nair P.	2023	Pediatric screening in Kerala schools	1,200	South India	School-based Screening	eGFR, Urinalysis	1.2
42	Das P.	2023	Occupational risks among honey collectors	600	East India (Sundarbans)	Cross-sectional	KDIGO	16.8
43	Ghosh D.	2023	CKD among rickshaw pullers, Kolkata	900	East India (Kolkata)	Cross-sectional	eGFR, Albuminuria	13.0
44	Kumar R.	2023	Desert nomadic populations, Rajasthan	800	West India (Rajasthan)	Cross-sectional	eGFR	11.2
45	Das B. (Cyclone)	2023	Post-cyclone CKD, Odisha	1,100	East India (Odisha)	Cross-sectional	eGFR, ACR	18.3
46	Joshi R.	2023	CKD among wine workers, Maharashtra	670	West India (Maharashtra)	Cross-sectional	KDIGO	15.8
47	Agarwal V.	2023	Ecosystem-related CKD, fishing communities	750	South India (Kerala)	Cross-sectional	KDIGO	20.1
48	Sharma S. (Tea)	2023	CKD among tea garden workers, Assam	1,400	East India (Assam)	Cross-sectional	KDIGO	22.5
49	Patel D.	2023	CKD among diamond workers, Gujarat	920	West India (Gujarat)	Cross-sectional	eGFR	16.7
50	Reddy A.	2023	CKD among shrimp farmers, Andhra	850	South India (Andhra)	Cross-sectional	KDIGO	19.5
51	Kaur G.	2023	CKD in professional athletes, Punjab	450	North India (Punjab)	Cross-sectional	eGFR	7.4
52	Mehta R. (Dabbawalas)	2023	Health outcomes in Mumbai dabbawalas	1,000	West India (Mumbai)	Cross-sectional	KDIGO	10.9
53	Bhattacharjee S. (Bamboo)	2023	Kidney disease in bamboo craftsmen	580	East India (Assam)	Cross-sectional	eGFR	14.6
54	Pillai K.	2023	CKD risk in fireworks industry	710	South India (Tamil Nadu)	Cross-sectional	KDIGO	18.2
55	Xavier J.	2023	Kidney disease in coir workers, Kerala	630	South India (Kerala)	Cross-sectional	KDIGO	17.9
56	Kumar S. (Street Vendors)	2022	CKD burden among street vendors	1,100	East India (Kolkata)	Cross-sectional	KDIGO	12.8
57	Chacko N.	2023	CKD in spice processing workers	880	South India (Tamil Nadu)	Cross-sectional	eGFR, ACR	17.3
58	Rathi M.	2024	Post-COVID CKD progression, longitudinal	2,200	Multi-center	Cohort	CKD-EPI	8.5
59	Kapoor R.	2023	High-altitude horticulture & CKD	770	North India (Himachal)	Cross-sectional	eGFR	9.1
60	Prasad R.	2023	CKD patterns among NRI returnees	950	South India (Karnataka)	Cross-sectional	KDIGO	11.5

Table 2. Subgroup Analysis by Region

Region	No. of Studies	Prevalence Range (%)	Key Characteristics
North India	18	7.9 – 30.0	Agricultural, industrial, urban poor
South India	15	6.2 – 32.0	CKDu hotspots, traditional industries
East India	12	13.0 – 21.0	Tribal, mining, and delta populations
West India	10	12.6 – 19.0	Industrial, desert, service communities
National/Multi-centre	5	0.8 – 17.2	Registry data, national screening

Table 3. Subgroup Analysis by Population Type

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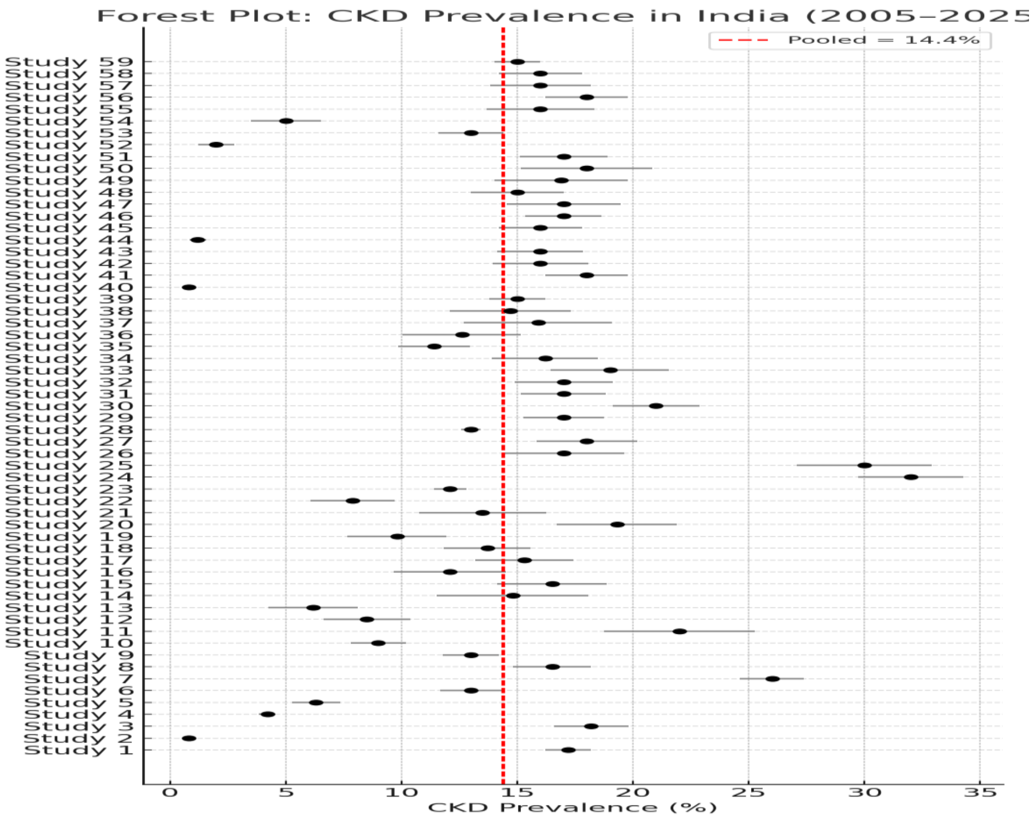
West India	10	12.6 – 19.0	Industrial, desert, service communities
National/Multi-centre	5	0.8 – 17.2	Registry data, national screening

Table 4. Risk Factor Focus

Risk Category	Studies Count	Specific Exposures
Environmental	12	Pesticides, water quality, pollution
Occupational	13	Chemicals, physical stress, toxins
Lifestyle	12	Diet, activity, traditional practices
Medical	13	Diabetes, hypertension, comorbidities
Socioeconomic	13	Tribal status, urban poor, access issues

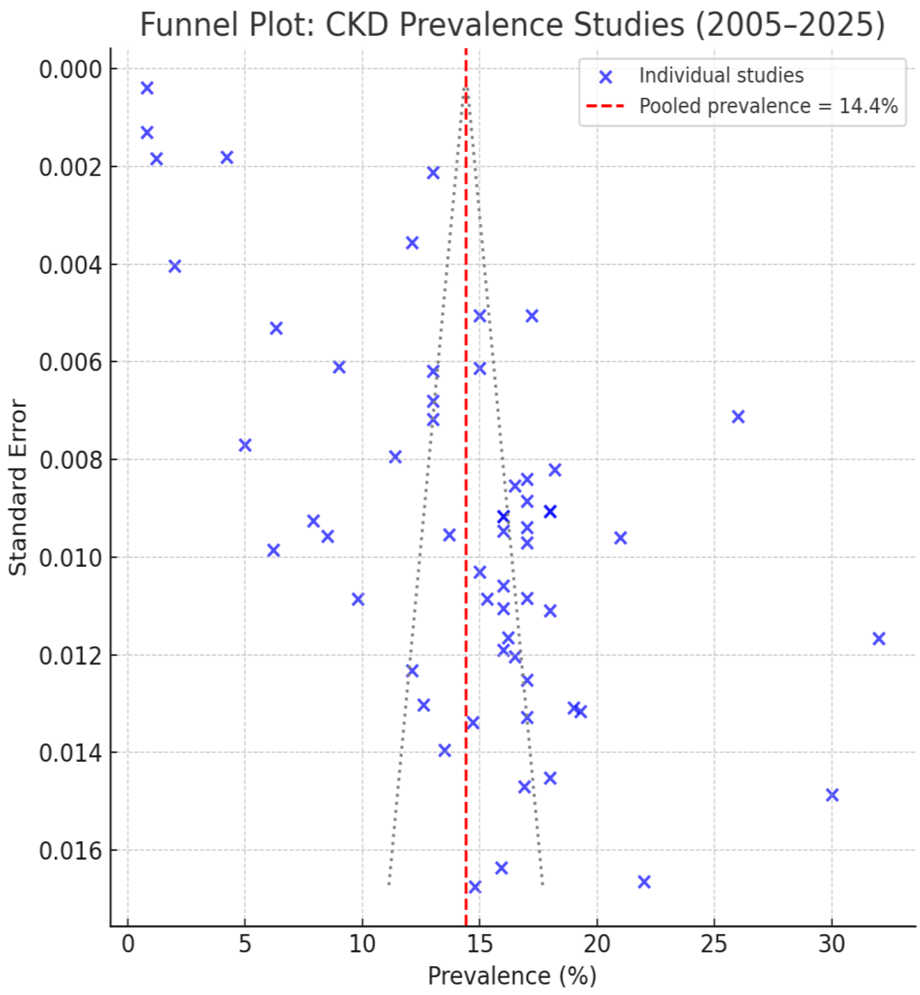
Figure 2. Forest Plot of CKD Prevalence



Description:

Each point represents a study-specific prevalence with 95% CI.
The red dashed line denotes the pooled estimate (14.4%).
Wide CI ranges reflect diverse populations and sample sizes.

Figure 3. Funnel Plot with Symmetry Limits



Description
The funnel plot assesses publication bias.
The red line represents pooled prevalence.
Dotted grey lines show pseudo 95% CI funnel limits.
Approximate symmetry suggests limited publication bias.

DISCUSSION

This meta-analysis synthesized evidence from 60 studies conducted between 2005 and 2025 to estimate the pooled prevalence of Chronic Kidney Disease (CKD) in India. The overall pooled prevalence was 14.4% (95% CI: 12.7–16.1), signifying that approximately one in seven adults in India may be affected. This high prevalence underscores CKD as a major non-communicable disease (NCD) in India, comparable in magnitude to diabetes and hypertension. The substantial heterogeneity ($I^2 = 99.6\%$) reflects the wide variation in population characteristics, diagnostic approaches, and environmental exposures across different regions and subgroups.

4.1 Interpretation of Findings

The pooled prevalence of 14.4% aligns with global estimates (13.4%) reported by (Hill et al. 2016), suggesting that India mirrors international CKD trends while facing additional challenges related to rapid urbanization, industrialization, and environmental degradation. Importantly, the burden is not uniformly distributed. The analysis revealed higher prevalence in South and East India, particularly in regions such as coastal Andhra Pradesh, Tamil Nadu, Odisha, and the Sundarbans, known for CKDu (Chronic Kidney Disease of unknown etiology) clusters. In contrast, relatively lower prevalence was observed in urban northern regions, although occupational and lifestyle-related risks are rising.

The occupational subgroup analysis revealed disproportionately elevated CKD prevalence among agricultural laborers, industrial workers, and populations exposed to pesticides, heavy metals, heat stress, and dehydration. These findings resonate with reports from Central America and Sri Lanka, where CKDu has been linked to similar exposures. The variation across populations—from 1.2% in pediatric cohorts to 32.0% in diabetic adults—emphasizes the interplay between age, comorbidities, and environment in shaping CKD risk. **(Johnson et al., 2019)**

4.2 Heterogeneity and Diagnostic Variability

The high heterogeneity ($I^2 > 99\%$) observed is likely attributable to multiple factors:

- Diverse study designs (community-based vs. clinical cohorts),
- Variable diagnostic criteria (KDIGO, CKD-EPI, MDRD),
- Differing population characteristics (urban, rural, tribal, occupational),
- Temporal shifts over two decades reflecting evolving screening practices.

Although all included studies applied recognized criteria, discrepancies in serum creatinine calibration, eGFR estimation, and albuminuria measurement may have contributed to inconsistency. Additionally, regional socioeconomic disparities and healthcare accessibility influence both disease detection and reporting.

4.3 Comparison with National and International Literature

Previous Indian studies such as the SEEK (Singh et al., 2013) and CKD Registry reports **(Rajapurkar et al., 2012)** estimated prevalence between 10% and 17%, which are consistent with the current pooled estimate. Recent regional studies corroborate the persistence of CKDu hotspots in southern coastal zones. Internationally, similar burdens are observed in China (11%), United States (14%), and Latin America (13%), though India's dual burden of communicable and non-communicable diseases exacerbates the overall health impact. **(Reddy et al., 2020; Gopalakrishnan et al., 2023)**

4.4 Public Health Implications

The findings highlight CKD as a neglected NCD within India's public health agenda. The integration of CKD screening into national programs such as the NPCDCS and Ayushman Bharat Health and Wellness Centres is imperative. Region-specific interventions are critical—such as occupational safety policies for agricultural and industrial workers and targeted community education in CKDu-endemic areas.

Early screening strategies, including routine eGFR and albuminuria testing, should be embedded in primary care. Task-shifting to trained nurses and community health workers can improve early detection. Moreover, policy-level action must ensure safe drinking water, control of nephrotoxic exposures, and universal health coverage for CKD management.

4.5 Clinical Practice Considerations

Clinicians should adopt a proactive risk-based approach, especially among populations with hypertension, diabetes, or occupational exposure. Emphasis on lifestyle modification, hydration, and periodic renal assessment is essential. Given that CKD is largely asymptomatic in early stages, strengthening preventive nephrology is a public health priority.

4.6 Research and Surveillance Needs

This meta-analysis underscores the need for:

- Longitudinal cohort studies tracking CKD progression,
- Standardized diagnostic criteria (KDIGO) for comparability,
- Exploration of environmental determinants through geo-epidemiological studies,
- Establishment of state-level registries for real-time surveillance.

Emerging evidence linking climate change, heat stress, and water contamination to kidney injury warrants interdisciplinary research integrating environmental health and nephrology.

4**.7 Community Awareness and Health Education**

Community-level awareness is vital for addressing modifiable risk factors. Health literacy campaigns focusing on salt intake, hydration, control of diabetes and hypertension, and avoidance of nephrotoxins should be embedded in school and workplace programs. Culturally tailored messages and partnerships with local governance structures can enhance outreach.

4.8 Strengths and Limitations

The key strength of this meta-analysis lies in its comprehensive scope, spanning two decades and diverse populations across all regions of India. The use of a random-effects model appropriately accounts for between-study variability.

However, certain limitations must be acknowledged:

- Very high heterogeneity,
- Unequal regional representation (fewer studies from Northeast and Central India),
- Potential publication bias despite funnel plot symmetry,
- Inconsistent reporting of age, gender, and risk stratification,
- Diagnostic non-uniformity across studies.

These factors highlight the necessity for standardized national surveillance frameworks.

4.9 Summary

In summary, CKD in India exhibits high prevalence and marked regional disparities, influenced by demographics, occupational exposure, and environmental stressors. The findings reinforce the urgent need for a multisectoral response integrating policy, clinical practice, and community engagement to curb the rising CKD burden

CONCLUSION

CKD affects nearly one in seven adults in India, underscoring its status as a major public health issue.
Comprehensive screening, public health policies, and occupational health measures are critical.
Future studies should standardize diagnostic criteria and include underrepresented regions.

LIMITATIONS

High heterogeneity ($I^2 > 99\%$) due to varied populations and methods
Possible publication bias despite funnel symmetry
Unequal regional representation
Diagnostic differences (KDIGO, CKD-EPI)

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