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Diabetes care in rural India – review

Abstract

Type 2 Diabetes Mellitus (T2DM) is a growing public health crisis globally, with rural India experiencing a significant increase in prevalence due to urbanization, lifestyle changes, and limited healthcare access. This review highlights the multifaceted challenges of T2DM management in rural India, including inadequate awareness, delayed diagnosis, and suboptimal treatment adherence. Factors such as genetic predisposition, socio-economic barriers, and cultural beliefs exacerbate the burden while resource constraints in rural healthcare systems hinder effective disease management. Innovations like mobile health technologies, government initiatives, and community-based education programs have shown promise in bridging healthcare gaps. This paper also emphasizes the critical role of structured diabetes education, affordable medication access, and culturally sensitive interventions in improving glycemic control and preventing complications. Strengthening primary healthcare infrastructure, fostering public-private partnerships, and integrating traditional and allopathic medicine are identified as essential strategies to address this pressing health issue. The findings call for comprehensive policies that prioritize early detection, lifestyle modifications, and equitable healthcare delivery to mitigate the rising diabetes burden in Indi's underserved areas.

Keywords: Type 2 diabetes mellitus (T2DM), rural healthcare, diabetes management, healthcare access, public health interventions

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Introduction

Diabetes is a significant global health issue, arising from persistently elevated blood glucose levels.[1] It is spreading rapidly in India, a country predominantly inhabited by a rural population. Rapid urbanization has led to a marked decline in the rural population—from 82% in 1960 to 64% in 2023—but India still remains home to a substantial rural community.[2] Rapid urbanization, the influence of mass media, reduced physical activity, and changing dietary patterns have significantly altered lifestyle patterns among India's rural population.[3] As a result, the gap in diabetes prevalence between rural and urban areas is steadily narrowing. Around 90% of diabetes cases are attributed to T2DM, which involves both insulin resistance and inadequate insulin production by the pancreatic islet β cells, leading to high blood sugar levels. Insulin resistance in T2DM is commonly associated with obesity, sedentary lifestyle, and aging.[1,4] Persistent insulin resistance in T2DM can lead to various complications, including large blood vessel problems like atherosclerosis and small blood vessel issues such as kidney disease, nerve damage, and vision problems.[5] Asia, with its large population and fast economic growth, has become a key area of focus, where individuals are developing diabetes at younger ages and with lower BMIs. Factors contributing to this include the "metabolically obese" phenotype, high levels of smoking and alcohol consumption, a diet rich in refined carbohydrates, and reduced physical activity.[6] Early malnutrition, followed by later over nutrition, also plays a role. While genetics offer some understanding, they don't fully account for ethnic differences in diabetes risk. Although lifestyle changes can help prevent the condition, addressing the growing epidemic requires significant public policy changes, particularly in promoting healthier diets and increased physical activity.[7]

Risk factors for T2DM in rural India

I. Genetic and Familial Predisposition: Individuals with a family history of diabetes are at a higher risk of developing the disease. South Asian ethnicity is associated with higher genetic susceptibility to insulin resistance.[8]

II. Changing Dietary Patterns and Poor Nutrition: Rural populations with higher intakes of refined carbohydrates and lower vegetable

consumption had a higher prevalence of diabetes.[9] Shifting away from traditional diets and micronutrient deficiencies (Vitamin D, magnesium, and iron) may also play a role in insulin resistance.[10] These deficiencies are often driven by a combination of food insecurity, low dietary diversity, and limited awareness about balanced nutrition.

III. Physical Inactivity, Sedentary Lifestyle, rising obesity, and hypertension: As urbanization and modernization continue to grow, access to facilities has improved significantly. Consequently, people living in villages now engage in less physical activity in their daily routines compared to the past. Rural populations in India are experiencing a shift from physically demanding agricultural labor to more sedentary occupations, such as factory work, small-scale businesses, and desk jobs, leading to increased obesity and insulin resistance.[9,11–13]

IV. Socioeconomic Factors and limited healthcare access: Lower-income groups often have limited access to healthcare, poor dietary choices, and higher stress levels, increasing diabetes risk. However, in rural areas, even middle- and higher-income individuals may neglect healthcare services and maintain unhealthy diets, largely due to lack of awareness and health education.[14] Many rural areas lack screening programs and specialist doctors, leading to undiagnosed and untreated diabetes.

V. Other risk factors include tobacco and alcohol usage, education, caste, and gender.[15,16]

Importance of addressing diabetes in rural India

Managing chronic diseases like diabetes presents significant challenges, mainly due to the need for ongoing adherence to treatment and the prevention or management of related complications. This requires consistent engagement from healthcare systems throughout the continuum of care. Diabetes care demands coordination across all levels of healthcare, with a crucial role played by the patient's knowledge, attitudes, and commitment to treatment and adherence. Diabetes self-care refers to the actions individuals with, or at risk of, diabetes take to manage the disease independently. Effective self-care is complex and requires a comprehensive approach involving healthy eating, regular physical activity, frequent blood sugar monitoring, medication adherence, problem-solving skills, healthy coping strategies, and behaviors that reduce risk. These actions are essential for achieving optimal glycemic control and avoiding future complications.

Rising prevalence of diabetes in rural India

According to the Indian Council of Medical Research–India Diabetes (ICMR–INDIAB) study, the prevalence of diabetes in India has reached 101 million individuals (approximately 57.3 million in rural India).[9] Diabetes is no longer confined to urban populations in India. Recent studies indicate a rapid increase in diabetes prevalence in rural India, narrowing the gap with urban areas. According to the ICMR-INDIAB study (2023), the overall diabetes prevalence in India is 11.4%, with urban areas having a higher burden (17.2%), but rural areas catching up at 9.4%.[9] The Ranasinghe et al.,[17] systematic review also highlights that diabetes prevalence in rural India increased from 2.4% in 1972 to 15% in 2019 (Figure 1).[17] This sharp rise is primarily driven by urbanization, lifestyle changes, increased consumption of processed foods, and reduced physical activity.

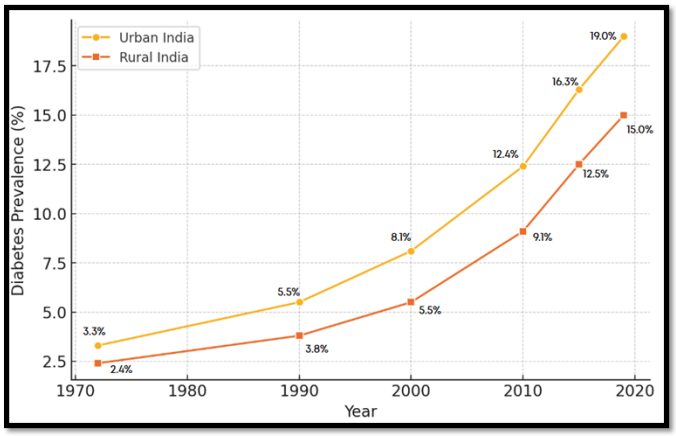

Figure 1 Trends in T2DM prevalence in India (Urban vs. Rural).

The highest diabetes prevalence is observed in the southern and northern states, while the central and northeastern regions have relatively lower prevalence rates. This regional disparity highlights the need for region-specific diabetes interventions considering economic development, healthcare infrastructure, and local dietary patterns (Table 1).[9] Recently released ICMR-INDIAB results from Jammu and Kashmir reported a prevalence of 26.5% in urban areas and 14.5% in rural areas.[18]

Table 1 Regional variations of diabetes in rural India[9]

Prediabetes			**Diabetes**		
Prevalence	**Rural**	**Urban**	**Prevalence**	**Rural**	**Urban**
≥ 15%	Himachal Pradesh, Delhi, Haryana, Chandigarh, Rajasthan, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, West Bengal, Sikkim, Tripura, Kerala, Puducherry, Goa	Himachal Pradesh, Delhi, Haryana, Chandigarh, Rajasthan, Madhya Pradesh, Chhattisgarh, Odisha, Bihar, Uttar Pradesh, West Bengal, Sikkim, Tripura, Kerala, Karnataka Puducherry, Goa	≥ 10%	Himachal Pradesh, Punjab, Delhi, Chandigarh, Bihar, West Bengal, Goa, Kerala, Puducherry	Himachal Pradesh, Delhi, Punjab, Haryana, Chandigarh, Uttarakhand, Rajasthan, Madhya Pradesh, Chhattisgarh, Odisha, Bihar, Jharkhand, West Bengal, Sikkim, Meghalaya, Assam, Nagaland, Mizoram, Tripura, Kerala, Karnataka Puducherry, Goa, Telangana, Andhra Pradesh, Tamil Nadu, Maharashtra, Gujarat
10-14.9%	Uttarakhand, Bihar, Arunachal Pradesh, Assam, Meghalaya, Odisha, Telangana, Karnataka, Maharashtra, Gujarat	Uttarakhand, Jharkhand, Arunachal Pradesh, Assam, Nagaland Telangana, Andhra Pradesh, Maharashtra, Tamil Nadu	7.5-9.9%	Uttarakhand, Haryana, Tripura, Odisha, Chhattisgarh, Maharashtra, Tamil Nadu	Uttar Pradesh, Manipur

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Table1 Continued.....

5.0-9.9%	Punjab, Jharkhand, Manipur, Mizoram, Nagaland, Andhra Pradesh, Tamil Nadu	Punjab, Gujarat, Meghalaya, Manipur, Mizoram	5.0-7.4%	Gujarat, Arunachal Pradesh, Assam, Andhra Pradesh, Telangana, Karnataka	Arunachal Pradesh
0-4.9%	-	-	0-4.9%	Rajasthan, Uttar Pradesh, Madhya Pradesh, Jharkhand, Bihar, Meghalaya, Manipur, Nagaland, Mizoram	-

High burden of undiagnosed diabetes and poor control

A major challenge in rural diabetes care is the high proportion of undiagnosed cases and poor glycemic control. The SMART India study (2023) found that 36.7% of rural individuals with diabetes remain undiagnosed, compared to 22.8% in urban areas.[19] The National Family Health Survey (NFHS-5) reported that only 7% of individuals with diabetes in India have their condition under control, with rural populations having even lower treatment and control rates.[14] This lack of diagnosis and control increases the risk of complications such as cardiovascular disease, kidney failure, neuropathy, and blindness, imposing a significant economic and health burden on rural families. A study by Rai et al.,[20] in Karnataka reported that individuals residing in rural areas had 2.30 times higher odds of having undiagnosed diabetes compared to those in urban areas (Adjusted Odds Ratio [AOR]: 2.30, 95% CI: 1.19–4.45). Additionally, rural participants were 2.33 times more likely to have untreated diabetes than their urban counterparts (OR: 2.33, 95% CI: 1.65–3.31).[20]

Socioeconomic barriers

Diabetes care in India is heavily influenced by socioeconomic factors, with rural populations facing greater barriers to awareness, treatment, and control of the disease. The disparities in diabetes management between rural and urban India stem from limited healthcare access, financial constraints, and lower health literacy. According to the NFHS-5 data, awareness [urban (33.7%) vs. rural (23.9%)] and treatment [(urban (27.8) vs. rural (17.7) were slightly more in urban, while control of diabetes was poor in both urban and rural India [urban (6.3) vs. rural (8.3)].[14] This indicates that a significant proportion of rural individuals with diabetes remain undiagnosed and untreated, likely due to the lack of screening programs and poor access to diagnostic facilities, a disparity further exacerbated by financial constraints, distance to healthcare centers, and the limited availability of specialized care in rural areas. Wealthier urban populations tend to have higher awareness and better diabetes management, whereas poorer rural populations face significant barriers to diagnosis and treatment. According to the ICMR-INDIAB study, states with lower human development indices have higher proportions of undiagnosed diabetes and poorer diabetes care.[9]

The cost of diabetes management, including regular glucose monitoring and medication, poses a significant financial burden for rural populations, leading to delayed or inadequate treatment (Figure 2). A systematic review by Oberoi et al.,[21] (32 studies), found that the cost of managing diabetes in India ranges between ₹8,000 and ₹46,000 per annum, posing a significant financial burden, especially for individuals in rural areas.

Limited healthcare access and need for strengthened infrastructure

One of the biggest hurdles in rural diabetes care is limited access to healthcare facilities and specialists. A shortage of trained endocrinologists, diabetologists, and diagnostic facilities in rural areas delays diagnosis and treatment initiation. Only 45.2% of individuals in rural areas with diabetes have access to adequate diabetes care, compared to 68.5% in urban India.[9] A study by Banerjee found that elderly residents in rural areas were seven percentage points less likely to utilize healthcare services compared to their urban counterparts.[22]

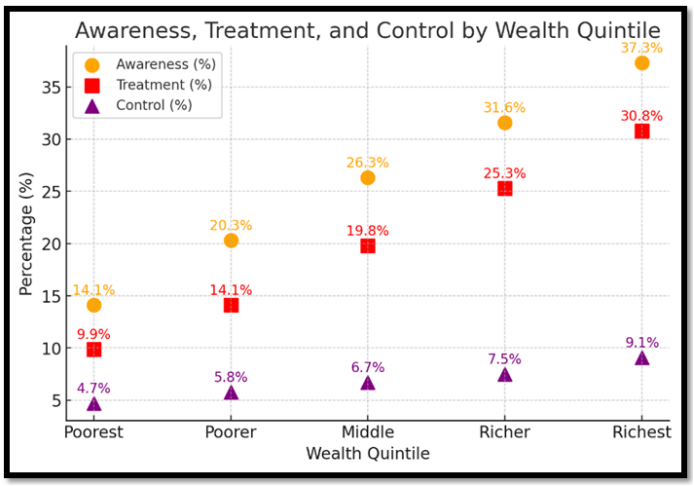

Figure 2 Socioeconomic impact on diabetes awareness, treatment, and control[14] (based on NFHS-5 data).

The Health Dynamics of India report on infrastructure and human resources, published by the Ministry of Health and Family Welfare, highlights a severe shortage of community health centers (CHCs) in rural India, with an almost 80% deficit in required facilities. Additionally, the report reveals that 31.4% (52,116) of all rural sub-centers lack proper infrastructure, as they do not have dedicated buildings.[23] As of March 2023, only 4,413 specialist doctors were available in rural CHCs, far below the required 21,964 specialists, indicating a critical gap in healthcare accessibility.[24]

In addition to limited healthcare infrastructure, several contextual barriers hinder effective diabetes care in rural India. Low levels of educational attainment reduce awareness of diabetes symptoms, complications, and the importance of long-term management, often resulting in delayed diagnosis and poor treatment adherence. The WHO SAGE study in India found that individuals with more years of education were more likely to be aware of their diabetes diagnosis and engage in effective self-management practices.[25] The absence of certified diabetes nurse educators—who play a vital role in delivering personalized diabetes self-management education—further limits patient support in these settings.[26] The National Diabetes Educator Program (NDEP) and the Association of Diabetes Educators (ADE) were established with the goal of training and certifying professionals to become qualified diabetes educators.[27] Long travel distances and poor public transport hinder routine follow-ups, especially for the

elderly, increasing both out-of-pocket costs and wage loss. To address these barriers, the Indian government launched Ayushman Bharat in late 2018 to improve primary healthcare access, provide free NCD medications, and deliver care closer to people's homes.[28,29] Moreover, extreme weather conditions, such as monsoon floods or heat waves, often disrupt access to care and medication supply chains, particularly in geographically vulnerable regions.[30,31] These factors collectively contribute to underdiagnosis, irregular treatment, and poor glycemic control, highlighting the urgent need for decentralized and context-sensitive diabetes care models in rural India.

Government & private initiatives & policies

The Indian government has launched several recent initiatives specifically aimed at managing and preventing T2DM, focusing on early detection, affordable treatment, and lifestyle modification. Table 2 shows some of the initiatives.

Table 2 Key Diabetes management initiatives in India

Initiative	Description
Screening and standard care initiative (2025 Target)[25]	The Ministry of Health and Family Welfare aims to screen and provide standardized care for 75 million individuals with diabetes or hypertension by 2025. In collaboration with WHO, this initiative integrates diabetes management into primary healthcare, focusing on accessible and quality care.
Ayushman Bharat health and wellness centres (HWCs)[26]	HWCs under Ayushman Bharat focus on screening individuals over 30 years old for diabetes and other non-communicable diseases (NCDs). They provide free consultations, diagnostics, and treatment for diabetes, especially targeting rural and underserved populations. They also promote wellness activities and lifestyle changes to prevent diabetes onset. The progress of each HWC is verified against performance indicators through online portals.
National programme for prevention and control of non-communicable diseases (NP-NCD)[27]	As part of the National Health Mission (NHM), NP-NCD has expanded to include over 700 District NCD Clinics and numerous community-level facilities. The program emphasizes infrastructure strengthening, health promotion, and awareness campaigns for managing diabetes and early diagnosis.
Free medication and generic drug access[26]	Through initiatives like the Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP), the government provides affordable diabetes medications, including insulin, at subsidized rates in government-supported pharmacies.
Rural diabetes prevention and control campaign[28]	Initiated in 2021, this campaign focuses on diabetes prevention and control in rural areas, exemplified by its launch in Purana Ramnagar village, Varanasi district.
Chunampet rural diabetes prevention project (CRDPP)[29]	This project implements comprehensive diabetes screening, prevention, and treatment using a combination of telemedicine and personalized care in rural India.
Research society for the study of diabetes in India (RSSDI)[30,31]	I. Village adoption program: doctors actively collaborate with specific villages to deliver direct diabetes care. This initiative focuses on educating rural populations about diabetes prevention, healthy lifestyle practices, and disease management through structured awareness sessions. II. Actively contributes to advancing diabetes care by conducting research on T2DM, developing and updating clinical guidelines for T2DM management, III. Comprehensive screening programs to identify individuals at risk, assessing factors such as obesity, hypertension, and prediabetes. IV. RSSDI trains community healthcare workers, equipping them with the necessary skills to effectively manage diabetes cases within their villages. V. Mobile clinics and health camps, offering free diabetes screenings and treatments and ensuring access to healthcare in remote regions.

Recommendations

A well-rounded approach that includes education, early detection, strengthened healthcare infrastructure, lifestyle support, medication access, follow-up care, and supportive policies can empower rural communities to better prevent, identify, and manage T2DM. The strategies outlined below provide a roadmap for implementing these interventions in India's rural regions.

Increase awareness and education

I. Community Health Programs: Organize awareness campaigns in villages to educate people about T2DM through local events, health fairs, and radio broadcasts.

II. Local Language Resources: Develop easy-to-understand diabetes education materials in regional languages, focusing on dietary changes, physical activity, and the importance of regular checkups.

III. Training Local Health Workers: Equip ASHAs, Anganwadi workers, and community health volunteers with basic knowledge of diabetes to help villagers recognize symptoms and adopt preventive lifestyle changes.

IV. Promote Medication Adherence: Use visual aids, reminders, and educational workshops to ensure patients understand the importance of taking medications regularly.

V. Emphasize Regular Follow-Up: Community health workers should stress the importance of periodic health check-ups and support patients in maintaining routine diabetes monitoring.

Expand screening and early detection initiatives

I. Mobile Screening Camps: Deploy mobile clinics in remote areas to provide free blood glucose testing and identify undiagnosed cases.

II. Point-of-Care Diagnostics: Utilize portable glucometers and HbA1c testing kits, operated by trained rural healthcare providers, to enhance early detection.

III. Household Screening Programs: Implement door-to-door diabetes screening, particularly in high-risk rural communities.

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IV. Diabetes prevalence and risk factors vary by region, making it necessary to customize interventions based on local needs

Strengthen primary healthcare infrastructure

I. Equip primary healthcare centers with Essential Resources: Ensure rural Primary Health Centers (PHCs) and CHCs are well-stocked with diagnostic tools, medications, and trained staff for effective diabetes management.

II. Establish Telemedicine Facilities: Integrate telemedicine services into rural health centers, allowing patients to consult endocrinologists and diabetes specialists remotely.

Promote lifestyle interventions and dietary changes

I. Culturally Tailored Diet Counseling: Promote affordable, locally available diabetes-friendly foods, discouraging the consumption of refined sugars and processed carbohydrates. Recommend shifting the focus back to traditional healthy diets.

II. Physical Activity Programs: Organize village-based group activities, such as morning walking clubs, yoga sessions, and traditional exercises, to encourage regular physical activity.

III. Engage Local Influencers: Collaborate with village leaders, teachers, and religious figures to promote healthy lifestyle changes.

Improve accessibility and affordability of medications

Affordable Medication and regular Medication Supply Chains: Expand government schemes and public-private partnerships to subsidize diabetes medications and insulin, making them accessible to low-income rural populations.

Enhance monitoring and follow-up

I. Mobile Health (mHealth) Solutions: Implement SMS-based reminders and mobile applications for medication adherence, lifestyle tips, and appointment scheduling.

II. Telemedicine: can significantly improve diabetes management by providing regular checkups and follow-ups. Virtual consultations with endocrinologists and diabetes specialists allow for timely monitoring.

III. Peer Support Groups: Establish local diabetes support groups where patients can share their experiences, exchange knowledge, and motivate one another to maintain healthy habits.

Leverage policy support and public health programs

I. Integrate Diabetes Care with National Health Programs: Expand diabetes screening and treatment coverage under existing initiatives such as Ayushman Bharat and NPCDCS to improve rural healthcare access.

II. Incentivize Healthcare Workers: Offer financial and career incentives to rural healthcare workers who successfully conduct diabetes screenings and follow up with patients.

III. Data-Driven Approach: Develop a national diabetes registry for rural India to monitor disease trends, evaluate the effectiveness of interventions, and inform future policies.

While universal diabetes screening and telemedicine initiatives are highly promising, their implementation in rural India faces challenges. Universal screening requires a substantial scale-up of workforce training, logistics, and community engagement, particularly in remote and underserved regions. Telemedicine, though cost-effective in the long term, depends on stable internet connectivity, digital literacy among patients and providers, and sustained infrastructure investments. Policy translation should therefore be phased and context-specific, beginning with high-risk populations and supported by pilot programs, public–private partnerships, and capacity-building efforts.[32–38]

Conclusion

Diabetes care in rural India remains a significant public health challenge, requiring long-term, sustainable interventions tailored to the unique needs of rural populations. The increasing prevalence of T2DM in these regions highlights the urgent need for improved screening, early detection, and accessible treatment options. Addressing challenges requires region-specific strategies, including community-based screening programs, dietary education, and mobile healthcare units. By adopting a patient-centered, technology-driven, and policy-supported approach, rural India can move towards better diabetes control and prevention. Encouraging healthier lifestyle habits, improving medication adherence, and expanding government-backed initiatives will help mitigate the growing burden of diabetes in these underserved regions. The future of diabetes care in rural India depends on sustained efforts, innovative healthcare delivery models, and collective action from both the public and private sectors, ensuring that no community is left behind in the fight against diabetes.

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Conflict of interest

The authors declare no competing interests.

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