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Review Article

Prevalence and Complications of Diabetes Mellitus in India: A Systematic Review

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ABSTRACT

Background and Aim: Diabetes is progressively becoming a vital chronic disease burden worldwide, mainly in developing countries such as India, necessitating a shift in healthcare priorities and advanced data on the epidemiology and impact of diabetes to help plan and prioritize health programs. We systematically reviewed the literature on diabetes prevalence and its complications in India. **Methodology:** This systematic review focuses on diabetes prevalence and complications in India from January 2000 to September 2021. Literature searches were conducted using electronic databases. **Results:** Diabetes prevalence ranged from 2.02% in rural Madhya Pradesh to 40.3% in Tamil Nadu. Diabetes prevalence was significantly higher in urban areas than in rural areas. The prevalence of prediabetes varied across Indian states ranging from 2.4% in Meghalaya to 47.6% in Delhi. The prevalence of chronic diabetes complications ranged from 4.8% to 21.7% for retinopathy, 0.9% to 62.3% for nephropathy, and 10.5% to 44.9% for neuropathy. **Conclusion:** Diabetes is a significant and widespread health problem in India. Dissimilarity in the prevalence of diabetes between individual states is observed. Most diabetes patients experience chronic complications of diabetes. Consequently, it is essential to map the urgent preventive approach to reduce the further increase in areas with high prevalence.

Keywords: Type 2 diabetes, Diabetes complications, India, Urban, Rural.

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INTRODUCTION

Diabetes Mellitus (DM) is persistent metabolic anarchy described by hyperglycemia resulting from defects in insulin secretion, insulin action, or in the combination of both.[1] Diabetes mellitus occurs throughout the world but is common primarily type 2 in developing and developed countries.[2] The incidence of diabetes has been steadily increasing during the last few decades. International Diabetes Federation (IDF) guesstimates that virtually 500 million people worldwide are presently living with diabetes, a number that is expected to increase by a further 30% in 2045. Diabetes, jointly with its host of micro and macrovascular complications, is a widespread cause of morbidity, reduced quality of life, and early mortality. It is anticipated that nearly 10% of the global all-cause mortality (20–99 years age group) is attributable to diabetes.[3]

India has reported a pointed augment in the prevalence of diabetes and prediabetes in the past few years. In 2019 the projected 77 million Indians were living with diabetes, with an estimated prevalence of 8.9% among adults according to IDF. India has turned into the country with the second-largest diabetes inhabitants, with 1 in 6 adults with diabetes in the world impending from India.[4]

It is mandatory to precisely understand the urban and rural diversity and drifts in the prevalence of Diabetes in India by a systematic combination of results from individual prevalence studies in order to have an improved understanding of the up to date situation and help to take appropriate, evidence-based improvement strategies and public health strategies. At present, no studies compare and contrast the rural and urban differences in the prevalence of diabetes and prediabetes among Indian adults. In addition, India comprises twenty-eight states and eight union territories.[5] Thus, preceding studies have exposed wide variations in the overall prevalence of diabetes across India's different states and union territories, with the highest rate of augment being reported in less developed low epidemiological transition level states.[6] Consequently, it is essential to have an accurate portrait of the magnitude of diabetes and prediabetes in the different states, with urban-rural comparisons to enable planning for targeted policy. At present, no studies compare and contrast the rural and urban differences in the prevalence of diabetes and prediabetes among Indian adults. Thus, in the current study, we carried out

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a systematic review to portray the most recent prevalence and trends of prediabetes and diabetes in urban and rural India.

METHODOLOGY

The present systematic review was done according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-A-lyses) guidelines. The PRISMA checklist is attached as an additional file (Supplementary File 1).

The literature search was performed in a systematic process. The online PubMed database search was done using the MeSH (Medical Subject Heading) combination terms "diabetes mellitus, type 2/ epidemiology, diabetic complication" and "India". The search consisted of studies listed from January 2000 and up to September 2021. The articles were screened for eligibility, using inclusion and exclusion criteria by reading article Title, Abstract, and Full-text.

Definitions

The existence of diabetes Mellitus and Prediabetes (Impaired Fasting Glucose [IFG]) in the individual studies were considered if characterized according to World Health Organization (WHO),[7] and American Diabetes Association (ADA),[1] by examining capillary blood glucose via glucometer and plasma glucose.

Inclusion Criteria

We included non-institutionalized, population-based studies among adult age greater than or equal to 18 years studying the prevalence of Type-2 Diabetes.

We included both gender from urban or rural populations.

We included only the study having total adequate sample size was more than a thousand persons for the prevalence of diabetes and two hundred persons for complication of diabetes.

We included studies available in English or with comprehensive summaries in English.

Exclusion Criteria

We excluded Self-reported studies on Diabetes, Type-1 Diabetes, Gestational diabetes or any other variety of diabetes from this study.

We excluded the studies conducted only a specific community/ age/patient/ethnic group from this review.

We excluded the studies conducted from the hospital/clinic-based settings.

We excluded the studies conducted among Indians residing somewhere else were excluded from this study.

RESULTS

The combined keywords search on PUBMED identified 2,305 articles for the prevalence of Diabetes in India, of which 1,723 were excluded because studies were conducted outside the region of interest, described diabetes pathogenesis, included genetic research, reviewed another disease and review articles, data based on the analysis of patients records. Of the remaining 582 articles, forty-two papers met the inclusion criteria and were included for data on the prevalence of Diabetes in India.

One thousand two hundred thirteen papers were reviewed for data on microvascular diabetes complications (retinopathy, nephrology, and neuropathy), of which 1,169 were excluded because they were based on management and screening options. Conditions such as periodontal problems, mental health problems, or sample size were outside of inclusion criteria (i.e., n<200). In total, fourteen articles met the inclusion criteria and were included for data on microvascular diabetic complications.

Prevalence of diabetes and pre diabetes (Impaired Fasting Glucose) in India by state wise from forty-two and fourteen studies respectively from 2000 to 2021 presented in Table 1. The prevalence of diabetes varied across Indian states ranging from 2.02% in rural Madhya Pradesh,[8] to 40.3% in Tamil Nadu.[11] Twelve studies distinguished between urban and rural diabetes prevalence.[8,12,14,20,22,28,30,32,36,38,40,46] Fourteen studies reported only rural diabetes prevalence,[9-10,17,19,21,25,26,31,33,37,39,43,47,48] and fifteen studies reported only urban diabetes prevalence.[13,15,16,18,23,24,27,29,34,35,41-45,49] One of the study had reported without mentioning urban or rural differentiation,[11] Twenty studies reported pre-diabetes (IFG).[9-19,23,30-33,38,41,44,45,48] The prevalence of pre-diabetes varied across Indian states ranging from 2.4% in Meghalaya,[12] to 47.6% in Delhi.[15]

Fourteen studies,[50-63] on the prevalence of complications of diabetes were reviewed and presented in Table 2. The prevalence of diabetic retinopathy ranged from 4.8%,[50] to 21.7%.[56] Diabetic nephropathy ranged from 0.9%,[51] to 62.3%.[62] The prevalence of diabetic neuropathy ranged from 10.5%,[50] to 44.9%.[57]

DISCUSSION

This review demonstrates that diabetes is a widespread health problem in India. We observed massive dissimilarity in diabetes prevalence among different states in India. Almost majority of the studies which distinguished between urban and rural areas observed a higher diabetes prevalence in urban than rural areas. Most of the diabetic patients experienced microvascular complications of Diabetes in India. The prevalence of diabetes varied across Indian states ranging from 2.02% in rural Madhya Pradesh,[8] to 40.3% in Tamil Nadu.[11]

It has been reported that the prevalence of diabetes and prediabetes are higher in both urban and rural areas of India

Table 1: Prevalence of type 2 diabetes in India 2000-2021.

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
1	Andaman and Nicobar	-	-	≥18	2012 - 2014	FBG (WHO)	-	8.45	7.88	-	Geldsetzer *et al.* 2018 [8]
2	Andhra Pradesh	West Godavari	62254	40 -85	2014	FBG/RBG (ADA)	29.9	29.9	-	32.0	Affan *et al.* 2016[9]
3		Godavari	4535	≥30	2005	FBG (WHO)	13.2	13.2	-	15.5	Chow *et al.* 2006[10]
4		-	-	≥18	2012 - 2014	FBG (WHO)	-	7.97	12.12	-	Geldsetzer *et al.* 2018[8]
5		-	1895	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	37.5	-	-	20.6	Joshi *et al.* 2012[11]
6		-	3633	≥20	2012 - 2013	FPG/RBG (WHO, ADA)	8.4	6.3	12.6	7.3	Anjana *et al.* 2017[12]
7	Arunachal Pradesh	-	3979	≥20	2012-2015	FPG/RBG (WHO, ADA)	5.1	4.9	5.8	9.7	Anjana *et al.* 2017[12]
8		-	-	≥18	2012 - 2014	FBG (WHO)	-	3.28	6.43	-	Geldsetzer *et al.* 2018[8]
9	Assam	-	3630	≥20	2012-2015	FPG/RBG (WHO, ADA)	5.5	4.4	12.4	8.1	Anjana *et al.* 2017[12]
10		-	-	≥18	2012 - 2014	FBG (WHO)	-	3.42	4.86	-	Geldsetzer *et al.* 2018 [8]
11	Bihar	-	-	≥18	2012 - 2014	FBG (WHO)	-	2.50	4.16	-	Geldsetzer *et al.* 2018 [8]
12		-	3713	≥20	2012-2013	FPG/RBG (WHO, ADA)	4.3	3.5	10.8	5.6	Anjana *et al.* 2017[12]
13	Chandigarh	-	-	≥18	2012 - 2014	FBG (WHO)	-	11.08	9.86	-	Geldsetzer. *et al.* 2018 [8]
14		-	2227	≥20	2008 - 2009	FBG (WHO)	16.4	-	16.4	-	Walia *et al.* 2014[13]
15		-	3086	≥20	2008-2010	FBG/ OGTT (WHO)	13.6	8.3	14.2	9.5	Anjana *et al.* 2011[14]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
16	Chhattisgarh	-	-	≥18	2012 - 2014	FBG (WHO)	-	3.74	6.87	-	Geldsetzer *et al.* 2018 [8]
17	Daman and Diu	-	-	≥18	2012 - 2014	FBG (WHO)	-	9.40	2.25	-	Geldsetzer *et al.* 2018[8]
18	Delhi	-	5365	≥20	2015	FBG (WHO/ ADA)	25.2	-	25.2	47.6	Deepa *et al.* 2015 [15]
19		-	-	≥18	2012 - 2014	FBG (WHO)	-	9.86	9.35	-	Geldsetzer *et al.* 2018[8]
20		-	1980	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	32.5	-	-	9.7	Joshi *et al.* 2012[11]
21		Dilshad Garden	1317	≥20	2015 - 2016	OGTT (WHO)	18.3	-	18.3	21	Madhu *et al.* 2018[16]
22	Goa	-	-	≥18	2012 - 2014	FBG (WHO)	-	17.39	16.83	-	Geldsetzer *et al.* 2018[8]
23		-	1266	≥20	2010	FBG (ADA)	10.3	10.3	-	-	Vaz *et al.* 2011[17]
24	Gujarat	-	2161	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	28.9	-	-	23.3	Joshi *et al.* 2012[11]
25		-	3760	≥20	2012-2013	FPG/RBG (WHO, ADA)	7.1	5.1	9.8	7.8	Anjana *et al.* 2017[12]
26	Haryana	-	1003	≥18	2007 - 2008	FBG (WHO)	8.1	-	8.1	10.3	Arora *et al.* 2010[18]
27		-	-	≥18	2012 - 2014	FBG (WHO)	-	5.21	6.08	-	Geldsetzer *et al.* 2018[8]
28		Jhajjar and Rohtak	2606	20 - 75	2012	FBG/ OGTT (ADA)	13.3	13.3	-	26.85	Rajput *et al.* 2012[19]
29		-	2524	18 - 69	2016-2017	FBG (WHO)	15.5	12.6	19.7	-	Thakur *et al.* 2019[20]
30	Himachal Pradesh	-	-	≥18	2012 - 2014	FBG (WHO)	-	3.28	3.35	-	Geldsetzer *et al.* 2018[8]
31	Jammu	R S Pura Block, Miran Sahib Zone	2085	≥ 30	2013	FBG (WHO)	8.15	8.15	-	-	Shora *et al.* 2014[21]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
31	Jammu and Kashmir	Anantnag and Srinagar	972	≥40	2015	FBG (WHO/ ADA)	6.31	5.50	7.15	-	Dar *et al.* 2015[22]
32	Jharkhand	-	2891	≥20	2008 -2010	FBG / OGTT (WHO)	5.3	3.0	13.5	4.8	Anjana *et al.* 2011[14]
33		-	-	≥18	2012 - 2014	FBG (WHO)	-	2.80	5.55	-	Geldsetzer *et al.* 2018[8]
34	Karnataka	Bangalore	2013	≥35	2012 - 2013	FBG/RBG (ADA)	12.33	-	12.33	11.57	Dasappa *et al.* 2015[23]
35		-	-	≥18	2012 - 2014	FBG (WHO)	-	8.46	11.68	-	Geldsetzer *et al.* 2018[8]
36		Devar jeeva- halli, Bangalore	1262	≥ 30	2019	FBG/RBG (ADA)	16.6	-	16.6	-	George *et al.* 2019[24]
37		-	1979	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	34.5	-	-	20.4	Joshi *et al.* 2012[11]
38		-	1370	≥20	2009-2010	FBG /OGTT (WHO)	19.78	19.78	-	-	Zaman *et al.* 2011[25]
39		-	3773	≥20	2012-2013	FPG/RBG (WHO, ADA)	7.7	5.6	11.1	7.8	Anjana *et al.* 2017[12]
40		Shirur	1364	≥20	2014	FBG /OGTT (WHO)	6.52	6.52	-	-	Gagan *et al.* 2014[26]
41	Kashmir	Srinagar	1040	≥20	2011	FBG /OGTT (ADA)	6.05	-	6.05	-	Ahmad *et al.* 2012[27]
42	Kerala	-	-	≥18	2012 - 2014	FBG (WHO)	-	11.81	14.21	-	Geldsetzer *et al.* 2018[8]
43		-	5135	20 -79	2011	FBG (ADA)	15.2	M-16.23 F-12.47	M-19.14 F-15.40	-	Krishnan *et al.* 2016[28]
44		Kochi	4507	≥18	2015 - 2016	FBG/ OGTT (ADA)	20.0	-	20.0	-	Menon *et al.* 2016[29]
45		-	12012	18 -69	2016 - 2017	FBG (WHO)	19.2	19.8	19.8	35.3	Sarma *et al.* 2019[30]
46		Chengannur Taluk	1990	≥18	2007	FBG (WHO)	12.5	12.5	-	4.6	Vijayakumar *et al.* 2009[31]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
47	Madhya Pradesh	Gwalior- Chambal region	7608	20 -79	2015 - 2017	FBG (WHO)	11.4	7.7	12.7	5.7	Subramani *et al.* 2019[32]
48		-	-	≥18	2012 - 2014	FBG (WHO)	-	2.02	3.54	-	Geldsetzer *et al.* 2018[8]
49		-	1903	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	33.7	-	-	17.6	Joshi *et al.* 2012[11]
50	Maharashtra	-	3569	≥20	2008 -2010	FBG / OGTT (WHO)	8.4	6.5	10.9	8.0	Anjana *et al.* 2011[14]
51		Malwan, Sindhudurg.	1022	20 -70	2010	FBG / OGTT (WHO)	9.3	9.3	-	4.2	Deo *et al.* 2010[33]
52		-	-	≥18	2012 - 2014	FBG (WHO)	-	4.68	6.17	-	Geldsetzer *et al.* 2018[8]
53		-	1842	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	39.8	-	-	5.7	Joshi *et al.* 2012[11]
54		Mumbai	6569	≥40	2011–2014	FBG (ADA)	15.37	-	15.37	-	Sunita *et al.* 2017[34]
55	Manipur	-	3849	≥20	2012-2015	FPG/RBG (WHO, ADA)	5.1	4.4	7.1	3.4	Anjana *et al.* 2017[12]
56		-	-	≥18	2012 - 2014	FBG (WHO)	-	7.45	8.01	-	Geldsetzer *et al.* 2018[8]
57	Meghalaya	-	3556	≥20	2012-2015	FPG/RBG (WHO, ADA)	4.5	3.5	8.9	2.4	Anjana *et al.* 2017[12]
58		-	-	≥18	2012 - 2014	FBG (WHO)	-	2.75	3.48	-	Geldsetzer *et al.* 2018[8]
59	Mizoram	-	4053	≥20	2012-2015	FPG/RBG (WHO, ADA)	5.8	3.6	7.9	3.8	Anjana *et al.* 2017[12]
60		-	-	≥18	2012 - 2014	FBG (WHO)	-	3.01	3.94	-	Geldsetzer *et al.* 2018[8]
61	Nagaland	-	-	≥18	2012 - 2014	FBG (WHO)	-	5.86	6.29	-	Geldsetzer *et al.* 2018[8]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
62	Odisha	-	-	≥18	2012 - 2014	FBG (WHO)	-	2.94	4.98	-	Geldsetzer *et al.* 2018[8]
63		Berhampur	1178	20 -80	2012	FBG/ OGTT (WHO)	11.1	-	11.1	-	Prasad *et al.* 2012[35]
64	Puducherry	-	1370	≥20	2007	FBG (WHO	8.47	8.04	8.6	-	Bharati *et al.* 2011[36]
65		-	-	≥18	2012 - 2014	FBG (WHO)	-	15.81	15.87	-	Geldsetzer *et al.* 2018[8]
66		Ramanathapuram. Pillaiyarkuppam	1403	≥25	2007 to 2008	FBG/ OGTT (WHO)	5.8	5.8	-	-	Majgi *et al.* 2012[37]
67	Punjab	-	5127	18 -69	2014–2015	FBG (ADA)	8.3	7.6	9.4	6.3	Tripathy *et al.* 2017[38]
68		-	3597	≥20	2012-2013	FPG/RBG (WHO, ADA)	10.0	8.7	12.0	6.5	Anjana *et al.* 2017[12]
69		-	-	≥18	2012 - 2014	FBG (WHO)	-	6.7	7.49	-	Geldsetzer *et al.* 2018[8]
70		Ludhiana	2732	30	2014	RBG (WHO)	9.7	9.7	-	-	Goyal *et al.* 2017[39]
71		-	2564	18 -69	2014–15	FBG (WHO	14.3	14.0	14.6	-	Thakur *et al.* 2016[40]
72	Rajasthan	-	-	≥18	2012 - 2014	FBG (WHO)	-	2.43	4.78	-	Geldsetzer *et al.* 2018[8]
73		Jaipur	1123	≥20	2002	FBG (WHO)	8.6	-	8.6	12.8	Gupta *et al.* 2003[41]
74	Sikkim	-	-	≥18	2012 - 2014	FBG (WHO)	-	5.12	5.07	-	Geldsetzer *et al.* 2018[8]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
75	Tamil Nadu	Chennai	6906	≥20	2015	FBG (WHO/ ADA)	22.8	-	22.8	37.9	Deepa *et al.* 2015[15]
76		-	-	≥18	2012 - 2014	FBG (WHO)	-	13.28	17.50	-	Geldsetzer *et al.* 2018[8]
77		-	1972	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	40.3	-	-	25.8	Joshi *et al.* 2012[11]
78		Chennai	2350	≥20	2003 - 2004	FBG, OGTT (WHO)	15.5	-	15.5	-	Mohan *et al.* 2006[42]
79		Theni	25969	≥30	2005 - 2006	FBG (WHO)	10.8	10.8	-	-	Namperumalsamy *et al.* 2014[43]
80		Chennai	3850	≥20	2016 -2017	FBG, OGTT (WHO)	21.9	-	21.9	16.6	Nanditha *et al.* 2019[44]
81		Chennai	2192	≥20	2006	FBG/ OGTT (WHO)	18.6	-	18.6	12.4	Ramachandran *et al.* 2008[45]
82		Vellore	4845	30 - 64	2010 - 2012	FBG (WHO)	-	9.2	18.8	-	Oommen *et al.* 2016[46]
83		Chennai	1213	≥20	2003	FBG/ OGTT (WHO)	6.36	6.36	-	-	Ramachandran *et al.* 2004[47]
84		-	3509	≥20	2008 -2010	FBG / OGTT (WHO)	10.4	7.8	13.7	4.6	Anjana *et al.* 2011[14]
85	Telangana	-	-	≥18	2012 - 2014	FBG (WHO)	-	7.41	9.01	-	Geldsetzer *et al.* 2018[8]
86	Tripura	-	3531	≥20	2012-2013	FPG/RBG (WHO, ADA)	9.4	7.2	15.5	9.5	Anjana *et al.* 2017[12]
87		-	-	≥18	2012 - 2014	FBG (WHO)	-	9.20	10.00	-	Geldsetzer *et al.* 2018[8]
88	Uttar Pradesh	Agra	1209	≥30	2013 - 2014	FBG (WHO)	7.0	7.0	-	6.4	Agarwal *et al.* 2017[48]
89		-	-	≥18	2012 - 2014	FBG (WHO)	-	2.85	4.59	-	Geldsetzer *et al.* 2018[8]
90	Uttarakhand	-	-	≥18	2012 - 2014	FBG (WHO)	-	3.06	6.13	-	Geldsetzer *et al.* 2018[8]

Sl. No	State	Site	Population	Age	Period of study	Method	Prevalence Type 2 Diabetes			Prevalence of Prediabetes / IFG (%)	Author
							Overall (%)	Rural (%)	Urban (%)		
91		-	-	≥18	2012 - 2014	FBG (WHO)	-	8.97	11.16	-	Geldsetzer *et al.* 2018[8]
92	West Bengal	-	1930	≥18	2009 - 2010	RBG/ OGTT/ FBG (ADA)	31.0	-	-	21.5	Joshi *et al.* 2012[11]
93		Dalkhola	1242	35 - 70	2017	FBG (WHO)	9.0	-	9.0	-	Khetan *et al.* 2017[49]

ADA: American Diabetes Association; WHO: World Health Organization; FBG: Fasting Blood Glucose; RBG: Random Blood Glucose; OGTT: Oral Glucose Tolerance Test.

compared with earlier studies. Pradeepa *et al.* documented that the prevalence of diabetes has increased in both urban and rural areas, with a steeper augment in the urban areas possibly due to rapid epidemiological transition involving globalization, alteration in dietary habits, and increased physical inactivity in urban contrasted to that in rural areas. Individuals who earlier had vigorous occupations in rural areas got employed in sedentary occupations in urban areas. Moreover, they now have access to urban facilities such as automated transport and appliances for household everyday jobs, consequently further decreasing physical activity levels.[64] With greater urbanization, growth of the middle class, and population aging, we can anticipate sharp increases in the numbers of people with Diabetes in India in the future.[14]

A six-fold higher prevalence of diabetes in the urban population (12%) compared to rural (2%) have been reported from South India. Sedentary lifestyle and food habits appears to be an important determinants for the higher prevalence of diabetes in an urbanizing population.[42]

Dasappa *et al.* documented that the prevalence of diabetes and prediabetes increased with the increasing age and physical inactivity and with a switch from a traditional to a Western diet.[23] The higher prevalence of diabetes is linked with smoking,[65] and alcohol consumption.[66] Previous cohort studies have revealed that light and moderate alcohol consumption was linked with a lower risk of Type 2 Diabetes. In contrast, heavy alcohol consumption was not interrelated with the risk of Type 2 Diabetes.[67] The elevated incidence of diabetes in vegetarians finds no clear answers unless this group has a family history coupled with a sedentary lifestyle and is subjected to a stressful life. Eating only vegetables does not necessarily relate to good nutrition. Suppose these vegetables are composed primarily of foods with a high glycemic index low in fiber and other nutrients and increased intake. In that case, these could be harmful to health and amplify the risk of diabetes.[68]

Another prospect is that the vegetables consumed may contain high amounts of pesticide/herbicide residues, triggering diabetic circuits in the body. A recent report confirms that the incidence of diabetes among farmers was coupled with pesticide exposure.[69] Fast food with processed carbohydrates, such as bread, noodles, cornstarch, high-calorie drinks, and vegetable fat, contributes significantly to urban diabetes.[70] Meyer *et al.* found that vegetable fat (saturated fats) intake remained a significant predictor of new diabetes.[71]

It has been revealed that the age-standardized prevalence of diabetes was 6.1% (95%CI, 6.0%-6.3%) among women and 6.5% (95%CI, 6.4%-6.7%) among men, and prevalence levels in India are towering across all geological settings and socioeconomic groups in middle and old age population.[8] Apart from these studies, Anjana *et al.* reported that India has a vast pool of pre-diabetic subjects (77 million people) who have a high potential to develop

Table 2: Chronic Complication of Diabetes mellitus in India.

Type of complication	Study population	Prevalence percentage	Author
Diabetic Retinopathy	1414	4.8%	Raman *et al.* 2012[50]
	1500	5.1%	Sosale *et al.* 2016[51]
	4600	6.1%	Sosale *et al.* 2014 [52]
	306	15.36%	Manoj Kumar *et al.* 2016[53]
	1715	17.6%	Pradeepa *et al.* 2008[54]
	1414	18.0%	Raman *et al.* 2009[55]
	5130	21.7%	Salil *et al.* 2016 [56]
Diabetic Nephropathy	1500	0.9%	Sosale *et al.* 2016[51]
	4600	1.06%	Sosale *et al.* 2014 [52]
	306	5.56%	Manoj Kumar *et al.* 2016[53]
	390	12.1%	Akila *et al.* 2020[57]
	200	13%	Ravindran *et al.* 2020[58]
	1629	26.1%	Pradeepa *et al.* 2008[59]
	1716	26.9%	Unnikrishn *et al.* 2007[60]
	365	34.4%	Hussain *et al.* 2019[61]
	6175	62.3%	Dash *et al.* 2018[62]
Diabetic Neuropathy	1414	10.5%	Raman *et al.* 2012[50]
	4600	13.15%	Sosale *et al.* 2014 [52]
	1500	13.2%	Sosale *et al.* 2016[51]
	1401	18.84%	Rani *et al.* 2010[63]
	306	20.26%	Manoj Kumar *et al.* 2016[53]
	390	44.9%	Akila *et al.* 2020[57]

type 2 diabetes.[14] In this study, we observed that the prevalence of prediabetes varied across Indian states ranging from 2.4% in Meghalaya,[12] to 47.6% in Delhi.[15]

The complications related to diabetes account for most of the morbidity and mortality associated with the disorder. DM's microvascular complications affecting the eye's retina are called Diabetic Retinopathy (DR), the kidney is termed Diabetic Nephropathy (DN), and the peripheral nerves are termed diabetic neuropathy.[64]

It has been reported that diabetic retinopathy, considered the most specific complication of diabetes, is the primary cause of new-onset blindness in adults in developed countries and rapidly becoming high in developing countries. The prevalence of diabetic retinopathy in India ranged from 4.8%[50] to 21.7%.[56] The high prevalence was observed in rural areas could be due to setbacks in diagnosis, poor self-care, poor health-seeking behavior.[64] It has been documented that approximately one in every five diabetic individuals has diabetic retinopathy in the rural Indian population.[72,73]

Diabetic nephropathy ranged from 0.9%[51] to 62.3%[62] in India. Diabetic nephropathy is the foremost cause of end-stage renal disease worldwide, and it is projected that 20% of type 2 diabetic patients reach end-stage renal disease during their lifetime.[74] Poor glycemic control, long duration of diabetes, and systolic blood pressure were the risk factors for overt nephropathy.[59]

The prevalence of diabetic neuropathy in India ranged from 10.5%[50] to 44.9%.[57] Studies in India observed that poor glycemic control and increased duration of diabetes were significantly associated with diabetic neuropathy.[75] It has been documented that the augmentation of diabetes and the increasing burden of undiagnosed Diabetes in India increases the tendency for developing irreversible long-term vascular complications.[64]

Limitations

In the reviewed studies, different methods were used to analyze diabetes which could have led to differences in Diabetes prevalence in and among the states of India and also makes it impossible to carry out a meta-analysis of the results. In addition, the reviewed studies were conducted in different years, varying from 2000 to 2021. In order to make an accurate estimate of prevalence differences among states, it would be ideal to compare studies conducted in the same period, which is impossible because of the limited availability of data on the prevalence of diabetes for a particular period for all states in India. Regardless of these limitations, this current review still offers helpful

information about one of India's vital chronic disease conditions and its complications.

CONCLUSION

This review suggests that diabetes and related complications are the most common problems in India. In addition, prevalence estimates specify that the number of prediabetes is much higher, resulting in a substantial burden of diabetes in the future Indian inhabitants. State-wise study of incidence observed a wide variation in the prevalence of diabetes in both rural and urban populations among the different regions, particularly between the North and the South of India. We observed a contraction of the gap between urban and rural incidence. It is imperative to plan urgent strategies to reduce a further augment in diabetes in areas with a high prevalence of prediabetes. At the same time, consequent prevention will play a critical role in rural and urban Indian populations with a high prevalence of diabetes.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

DM: Diabetes mellitus; **DN:** Diabetic nephropathy; **DR:** Diabetic retinopathy; **IFG:** Impaired Fasting Glucose; **CI:** Confidence Intervals; **WHO:** World Health Organization; **ADA:** American Diabetes Association; **MeSH:** Medical Subject Heading; **IDF:** International Diabetes Federation; **PRISMA:** Preferred Reporting Items for Systematic Reviews.

SUMMARY

The majority of the Indian population which constitutes our country is younger generations of about 65%. Due to changes in the sedentary life style modifications in developing countries like India they are at high risk of Diabetes. It not only affects the health but also becomes a burden to the future economic progress of the Country. This review article is mainly focused to analyze the prevalence and complications in India during the period of 2000-2021 through various databases and literature reviews. From the study it was concluded that Diabetes prevalence was significantly higher in urban areas than in rural areas. It may due to the consequences of urbanization and also may be due to consumption of low nutrient and tic high carbohydrate diets. If the emergence of diabetics and its complications are uncontrolled it may lead to heavy toll on India's health care system. The prevalence of type 2 diabetes has been increasing globally, most dramatically, particularly in India. The increases in diabetes are attributed mainly to changes in living environments and lifestyles modifications. Rising diabetes highlights the urgency for preventive strategies should prevent or delay diabetes. Awareness programs and education play a significant role in preventing or delaying the onset and management of diabetes.

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