

Prevalence of Diabetic Retinopathy in India

Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetics Study Report 2

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Objective: The aim of the study was to estimate the prevalence of diabetic retinopathy in an urban Indian population older than 40 years.

Design: A population-based cross-sectional study.

Participants: Five thousand nine hundred ninety-nine subjects residing in Chennai, India, were enumerated.

Methods: A multistage random sampling, based on socioeconomic criteria, was followed. Identified subjects with diabetes mellitus (based on the World Health Organization criteria) underwent detailed examination at the base hospital. The fundi of all patients were photographed using 45°, 4-field stereoscopic digital photography. The diagnosis of diabetic retinopathy was based on Klein's classification of the Early Treatment Diabetic Retinopathy Study scale.

Main Outcome Measures: These included age- and gender-adjusted prevalence of diabetes and diabetic retinopathy, and correlation of prevalence with history-based risk factors.

Results: The age- and gender-adjusted prevalence rate of diabetes in an urban Chennai population was 28.2% (95% confidence interval [CI], 27.0–29.3), and the prevalence of diabetic retinopathy in general population was 3.5% (95% CI, 3.49–3.54). The prevalence of diabetic retinopathy in the population with diabetes mellitus was 18.0% (95% CI, 16.0–20.1). History-based variables that were significantly associated with increased risk of diabetic retinopathy included gender (men at greater risk; odds ratio [OR], 1.41; 95% CI, 1.04–1.91); use of insulin (OR, 3.52; 95% CI, 2.05–6.02); longer duration of diabetes (>15 years; OR, 6.43; 95% CI, 3.18–12.90); and subjects with known diabetes mellitus (OR, 2.98; 95% CI, 1.72–5.17). Differences in the socioeconomic status did not influence the occurrence of diabetic retinopathy.

Conclusions: The prevalence of diabetic retinopathy was 18% in an urban population with diabetes mellitus in India. The duration of diabetes is the strongest predictor for diabetic retinopathy.

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Diabetic retinopathy (DR) is a major cause of blindness among the working age group.^{1–4} According to the World Health Organization, India will become one of the major hubs of diabetic population during the next 2 decades; the number of cases of adult-onset diabetes mellitus will grow to nearly 80 million in 2030 from 18 million in 1995.³

In the Indian subcontinent, only limited data are available on the prevalence of DR in the general population. The Chennai Urban Rural Epidemiology Study (CURES) reported the prevalence of DR in urban Chennai to be 17.6% in diabetic population,⁵ and the Aravind Comprehensive Eye Study reported the prevalence of DR (in self-reported subjects with diabetes) in rural South India to be 10.5%.⁶ Because diabetes and its complications are a public health problem, data on the prevalence of DR will help in formulating primary and secondary prevention programs in India.

The Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetic Study (SN-DREAMS 1), a population-based cross-sectional study, used multistage ran-

dom sampling that was stratified, based on economic criteria.⁷ The study aimed at assessing the prevalence of DR in the urban South Indian general population.

Patients and Methods

The study design and research methodology of SN-DREAMS 1 is described in detail elsewhere.⁷ The study area was the metropolis of Chennai, with a population of 4.3 million, distributed in 155 divisions of 10 zones. The estimated sample size was 5830 (the decision was to enumerate approximately 6000: approximately 600 from each of the 10 zones), assuming the prevalence of DR in the general population to be 1.3% (relative precision, 25%; dropout rate, 20%; design effect, 2).⁷ The sample was stratified, based on socioeconomic scoring: low (score, 0–14), middle (score, 15–28), and high (score, 29–42).⁸ Eligible patients older than 40 years were enumerated using the multistage random sampling method.

For all those patients who were not previously diagnosed as having diabetes, fasting blood glucose estimation was evaluated

twice: once in the field using capillary blood and a second time at the base hospital using venous blood (glucose oxidase method).⁹ Patients were considered to be newly diagnosed subjects with diabetes if fasting blood glucose level was 110 mg/dl or more on 2 occasions, as described previously.¹⁰ Patients were considered to be diagnosed as having diabetes if they were using hypoglycemic drugs, either oral or insulin, or both. Both newly diagnosed individuals and subjects with known diabetes mellitus were referred to the physician for glycemic control and management of other diabetes-related complications, if present. The study was approved by the Institutional Review Board, and written informed consent was obtained from the subjects according to the Declaration of Helsinki.

A detailed interview was carried out at the base hospital by trained bilingual interviewers. All instruments were developed initially in English and later translated into Tamil (regional spoken language), ensuring that the contents and the meanings were preserved. The data collected in the medical history included family history of diabetes mellitus, the current treatment of diabetes mellitus, history of hypertension, ischemic heart disease, and smoking.⁷ Data were collected regarding nonocular complications of diabetes through history: distal neuropathy (symptoms of tingling and numbness) and nephropathy (swelling of legs and feet, facial puffiness).

Diabetic retinopathy was graded clinically using Klein's classification (Modified Early Treatment Diabetic Retinopathy Study scales).¹¹ Retinal photographs were obtained after pupillary dilatation (Carl Zeiss fundus camera; Visucamlite, Jena, Germany); all patients underwent 45°, 4-field stereoscopic digital photography (posterior pole, nasal, superior, and inferior). For those who showed evidence of any retinopathy, additional 30°, 7-field stereo digital pairs were obtained. All photographs were graded by 2 independent observers (RR and PKR) in a masked fashion; the grading agreement was high ($\kappa = 0.83$).⁷

Of the 5999 subjects enumerated, 5784 (96.42%) responded for first fasting blood sugar estimation (Fig 1). Of these 5784, 1349 (23.32%) were diagnosed previously with diabetes, and 467 (8.07%) were diagnosed provisionally as having diabetes (first blood sugar estimation, ≥ 110 mg/dl). These 1816 (previously diagnosed as having diabetes, 1349; provisionally diagnosed as having diabetes, 467) were invited to visit the base hospital for comprehensive evaluation, including a second blood sugar estimation and biochemical investigations; 1563 (85.60%) responded. Of these 1563 (previously diagnosed as having diabetes, 1175; provisionally diagnosed as having diabetes, 388) who visited the base hospital, 138 were excluded. In 2 subjects, the age criterion was not met, and in 136, second fasting blood sugar was less than 110 mg/dl. An additional 11 individuals were excluded because their digital fundus photographs were of poor quality, making them ungradable for further analysis. Thus, a total of 1414 were analyzed for DR grading.

Statistical analyses were performed using statistical software (SPSS for Windows version 13.0; SPSS Science, Chicago, IL). The results were expressed as mean $\pm$ standard deviation if the variables were continuous, and as percentage if the variables were categorical. The Student *t* test for comparing continuous variables and the chi-square test to compare proportions among groups were used. Newly diagnosed subjects with diabetes were given a value of 0 for duration of diabetes. Both univariate and multivariate logistic regression analyses were performed to study the effect of various risk factors using DR as a dependent variable. From the univariate analysis, variables with *P* values of 0.05 or less and those that already were established as risk factors were included in the multivariate logistic regression analysis to derive the parsimonious model. A *P* value of ≤ 0.05 was considered significant.

Results

The data were compared between responders ($n = 1563$ who visited the base hospital) and nonresponders ($n = 253$ who did not visit the base hospital) with regard to mean age, gender, diabetes status, and mean fasting blood sugar. No statistically significant differences were observed (Table 1).

The age- and gender-adjusted prevalence of diabetes mellitus for the urban Chennai population was 28.2% (95% confidence interval [CI], 27.0–29.3). The prevalence of diabetes in lower, middle, and high socioeconomic group subjects was 148 (31.1%) of 475 (95% CI, 26.9–35.3), 1183 (28.3%) of 4172 (95% CI, 26.9–29.7), and 485 (42.6%) of 1137 (95% CI, 39.7–45.5), respectively ($P < 0.0001$). Of the 1166 subjects with previously diagnosed diabetes mellitus, only 377 (32.3%) had undergone an eye examination, and 13 of them had undergone laser treatment. Of those 1414 subjects with diabetes who were analyzed for DR evaluation, the mean age was 56.32 ± 10.02 years (Table 2).

The prevalence of DR among subjects with diabetes between 40 and 49 years of age was 13.4%; for those between 50 and 59 years of age, the prevalence was 20.9%; for those between 60 and 69 years of age, the prevalence was 20.5%; and for those older than 70 years, the prevalence was 14.8% (chi-square trend, 1.41; $P = 0.23$). Men had a higher prevalence of DR (21.1%; 158/750) compared with women (14.6%; 97/664; $P = 0.0018$). The prevalence of DR among the subjects with diabetes who were taking insulin was significantly higher (52.9%; 36/68) compared with that among those who were not receiving insulin treatment (16.3%; 219/1346; $P < 0.0001$). Factors that did not influence the prevalence of DR significantly included smoking status, history of systemic problems like hypertension or ischemic heart diseases, family history of diabetes, and history of other microvascular complications such as diabetic neuropathy or nephropathy.

Figure 2 depicts the prevalence of any form of DR and various stages of DR with regard to diabetes status (known or newly detected). The overall prevalence of DR in subjects with diabetes mellitus was 18.0% (95% CI, 16.0–20.1). The prevalence of DR was 20.6% (95% CI, 18.3–23.0) in the subjects with known diabetes, compared with 6.0% (95% CI, 3.4–9.8) in the newly diagnosed diabetes group; a similar trend with regard to more severe DR was observed in subjects with known diabetes. The age- and gender-adjusted prevalence of DR for the urban Chennai general population was 3.5% (95% CI, 3.49–3.54).

Figure 3 shows that the severity of DR increased proportionately with increase in the duration of diabetes (chi-square trend, 140.62; $P < 0.0001$). There was no significant difference in the prevalence of DR in subjects with diabetes belonging to various socioeconomic groups ($P = 0.682$).

The results of regression analysis are shown in the Table 3, taking DR as the dependent variable. In the univariate analysis, males had a 1.59-times higher risk and the previously diagnosed group had 4.02-times higher risk of developing DR in comparison with females and those who were newly detected, respectively. With every 5-year increase in duration of diabetes, the risk of retinopathy increased 1.79 times. Those who were taking insulin had a 5.79-times higher risk of retinopathy developing compared with those who were not. From the multivariate analysis, the adjusted odds ratio was 1.41 for DR for males in comparison with females, and the adjusted odds ratio was 2.98 for DR for the previously diagnosed group as compared with the newly diagnosed group. Those who had duration of diabetes of more than 15 years had a 6.43-times risk of developing retinopathy in comparison with those whose diabetes was newly detected ($P < 0.0001$). Those who were taking insulin had a 3.52-times higher risk of developing retinopathy compared with those who were not taking insulin

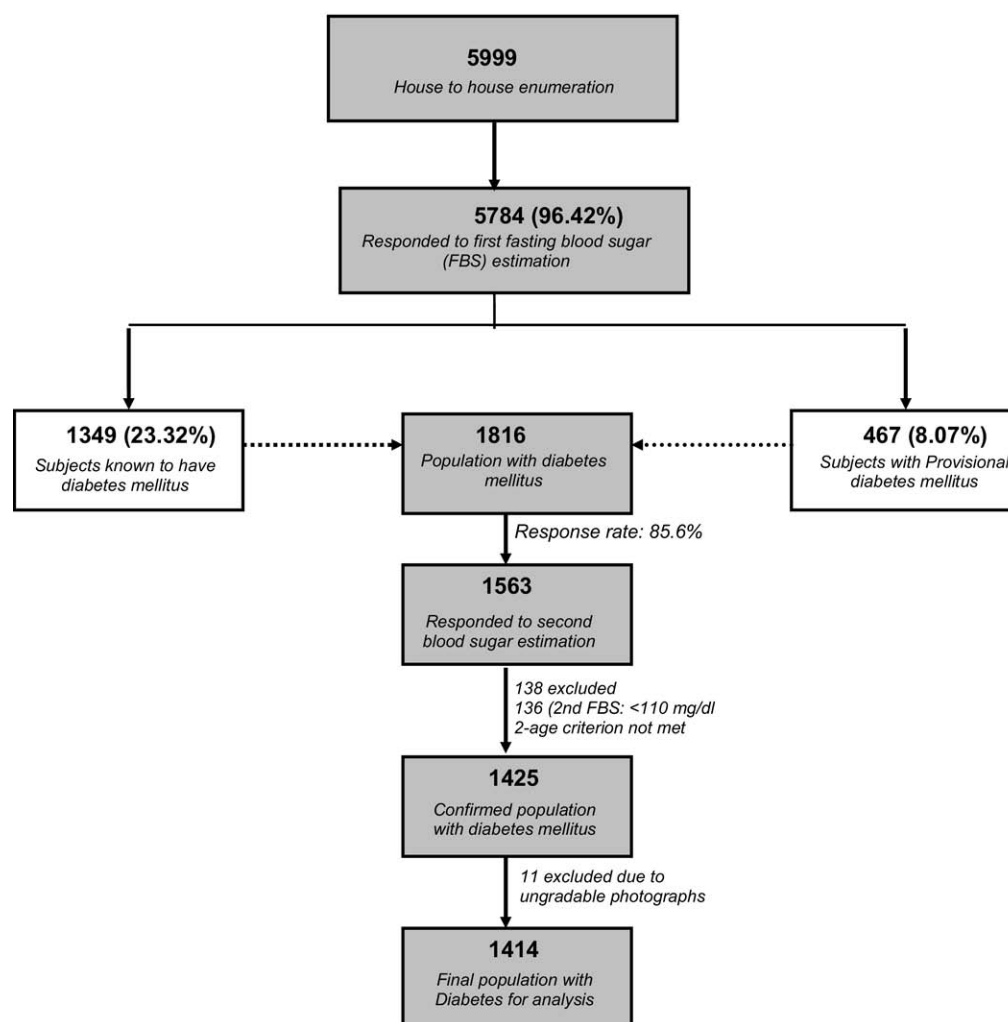


Figure 1. Flow chart showing patient enumeration. FSB = fasting blood sugar.

($P < 0.0001$). Family history of diabetes mellitus, socioeconomic status, smoking, history of systemic diseases, and history of other associated diabetes related complications were not related to the development of DR.

Discussion

This study (2003–2006) shows that the age- and gender-adjusted prevalence of diabetes mellitus in a population older than 40 years was 28.2%. Table 4 shows various studies on the prevalence of diabetes mellitus from India.^{12–16}

There were 2 reports wherein the definition of diabetes mellitus was similar to that in the present study; the data showed that the prevalence of diabetes mellitus is rising gradually in India.^{12,13} Other reports that used an oral glucose tolerance test in addition to fasting blood sugar analysis also corroborated that the prevalence of diabetes mellitus is on the rise.^{14–16} The National Urban Diabetes Study (2000)¹⁵ showed the prevalence of diabetes in a population older than 40 years to be 23.8% in 6 cities in India including

Chennai, and more recently, the Chennai Urban Rural Epidemiology Study (2003–2004)¹⁶ estimated the prevalence in those older than 40 years to be 30.1%. On extrapolating the data on the South Indian population of Tamil Nadu based on the population projections of Census of Government of India¹⁷ and considering the temporal trend between

Table 1. Comparison of Responders and Nonresponders in the Study Population

Variable	Responders (n = 1563)	Nonresponders (n = 253)	P Value
Mean age (yrs)	56.09 ± 10.06	55.97 ± 10.41	0.861
Male, n (%)	819 (52.4)	132 (52.17)	0.947
Female, n (%)	744 (47.6)	121 (47.82)	
PDD, n (%)	1175 (75.2)	179 (70.75)	0.134
NDD, n (%)	388 (24.82)	74 (29.24)	
Mean FBS (mg%)	146.41 ± 59.60	139.12 ± 51.89	0.060

FBS = fasting blood sugar; NDD = newly diagnosed as diabetes; PDD = previously diagnosed as diabetes.

Table 2. Prevalence of Diabetic Retinopathy in Study Population

Variables	Total Population (N = 1414)	Prevalence of Diabetic Retinopathy (n = 255), n (%)	P Value
Age (yrs)			
40–49	394	53 (13.4)	0.012
50–59	498	104 (20.9)	
60–69	360	74 (20.5)	
70+	162	24 (14.8)	
Mean age $\pm$ SD	56.32 $\pm$ 10.02	57.26 $\pm$ 8.96	0.162
Gender			
Female	664	97 (14.6)	0.002
Male	750	158 (21.1)	
Treatment methods			
Exercise and diet control	403	26 (6.4)	<0.0001
Only OHA	943	193 (20.5)	
Insulin $\pm$ OHA	68	36 (52.9)	
Smoking status			
Nonsmoker	1137	202 (17.7)	0.8584
Current smoker	149	29 (19.5)	
Former smoker	128	24 (18.7)	
History of hypertension			
Yes	488	94 (19.3)	0.383
No	926	161 (17.4)	
History of IHD			
Yes	165	28 (16.9)	0.705
No	1249	227 (18.2)	
Family history of diabetes			
Yes	845	166 (19.6)	0.0571
No	569	89 (15.6)	
History of neuropathy			
Yes	198	43 (21.7)	0.1460
No	1216	212 (17.4)	
History of nephropathy			
Yes	257	53 (20.6)	0.2328
No	1157	202 (17.4)	

IHD = ischemic heart disease; OHA = oral hypoglycemic agents; SD = standard deviation.

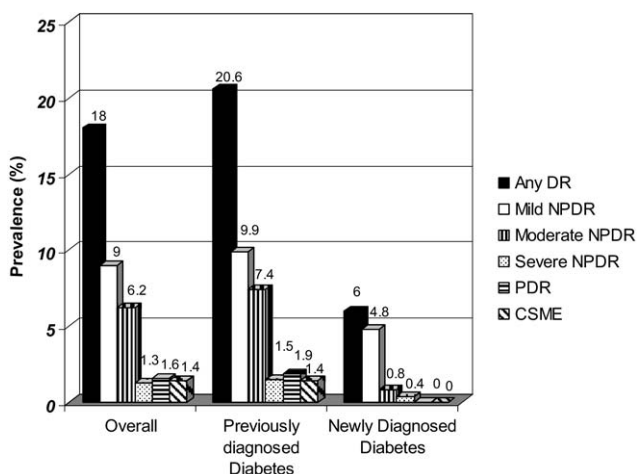


Figure 2. Bar graph showing the prevalence of diabetic retinopathy (DR) in previously diagnosed and newly diagnosed patients with diabetes mellitus. CSME = clinically significant macular edema; NPDR = nonproliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy.

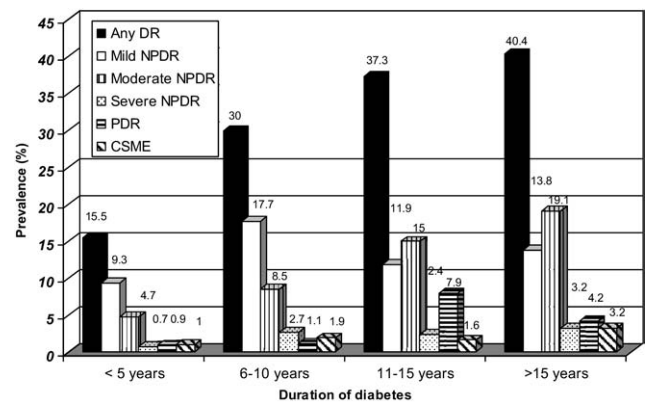


Figure 3. Bar graph showing the severity of diabetic retinopathy (DR) in relation to duration of diabetes. CSME = clinically significant macular edema; NPDR = nonproliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy.

this study (2006) and the NUDS (2000), the estimated population of diabetes in urban Tamil Nadu among those older than 40 years increases by 256.5% (from 2.9 million in 2006 to 10.4 million in 2026).

Table 5 shows the prevalence of DR in various populations with diabetes mellitus across the world.^{18–30} The diagnosis of DR was made either clinically, using indirect ophthalmoscopy, or was made using fundus photographs. Regardless of the method used to detect DR, the prevalence of DR in India, inclusive of the present study, was 12% to 22.4%.^{5,22,23} In one study, however, the prevalence was high (26.2%), because the estimation was performed in a population with self-reported diabetes.²⁴ Even the neighboring Asian countries showed a similar trend (approximately 15%),^{18,20,21} except for Japan¹⁹ (38%, with a self-reported population with diabetes). In other countries such as the United States, the United Kingdom, Australia, and the West Indies, the prevalence of DR was estimated to range from 28.5% to 50.3%^{27–30}; in countries that are somewhat closer to India such as Singapore or Mauritius, it was 21.8% and 30%, respectively.^{25,26} Although the exact reasons for these ethnic differences are not known, the likely reasons may be interaction of genetic susceptibility and protective factors in the population^{31–33} or lesser duration of diabetes, in reported series, in the Indian population. The mean duration of diabetes in the Wisconsin study²⁷ was 11.8 years, as compared with 6.7 years in the present study.

In this study, the DR was more common among men. This observation of male preponderance is in agreement with the findings of other population-based studies such as the CURES, the Andhra Pradesh Eye Disease Study, and United Kingdom Prospective Diabetes Study; however, the exact reason for male predominance has not been determined.^{5,22,28} The prevalence of DR among subjects with diabetes was higher in those receiving insulin treatment in this study, which is probably because of more severe diabetes with poor glycemic control. Similar findings were reported in the CURES, in a study of Pima Indians, and in the Beaver Dam study.^{5,34,35} The prevalence of DR in the newly diagnosed subjects with diabetes was 6%. The au-

Table 3. Regression Analysis to Study the Effect of Various Risk Factors on Diabetic Retinopathy

Risk Factor	Univariate Analysis			Multivariate Analysis		
	Odds Ratio	95% Confidence Interval	P Value	Odds Ratio	95% Confidence Interval	P Value
Gender						
Female	1			1		
Male	1.59	1.18–2.05	<0.0001	1.41	1.04–1.91	0.023
Diabetes status						
Newly diagnosed	1			1		
Previously diagnosed	4.02	2.34–6.91	<0.0001	2.98	1.72–5.17	<0.0001
Insulin treatment						
No	1			1		
Yes	5.79	3.52–9.52	<0.0001	3.52	2.05–6.02	<0.0001
Duration of diabetes mellitus						
Newly detected	1			1		
<1 yr	0.44	0.12–1.55	0.20	0.42	0.11–1.47	0.176
1–5 yrs	2.29	1.28–4.07	0.01	2.02	1.13–3.61	0.017
6–10 yrs	6.66	3.71–11.90	<0.0001	5.39	2.97–9.79	<0.0001
11–15 yrs	9.24	4.90–17.40	<0.0001	6.51	3.39–12.50	<0.0001
>15 yrs	10.54	5.42–20.50	<0.0001	6.43	3.18–12.90	<0.0001
Family history of diabetes						
No	1			1		
Yes	1.32	0.99–1.75	0.055	1.42	0.83–1.55	0.398
Socioeconomic status						
Lower	1			1		
Middle	1.44	0.89–2.33	0.13	1.11	0.65–1.85	0.664
Upper	1.25	0.72–2.18	0.43	0.81	0.45–1.47	0.502
Smoking						
No	1			1		
Yes	1.1	0.78–1.53	0.60	1.03	0.70–1.53	0.863
History of systemic diseases						
No	1			1		
Yes	1.07	0.82–1.41	0.60	1.06	0.78–1.43	0.696
History of associated diabetes complications						
No	1			1		
Yes	1.3	0.96–1.74	0.084	0.69	0.44–1.10	0.123

In multivariate analysis, the factors adjusted were gender, diabetes status, duration of diabetes, age of onset of diabetes, family history of diabetes, insulin treatment, socioeconomic status, smoking, history of systemic disease, and associated diabetic complications.

thors reported earlier the prevalence of DR in newly diagnosed subjects with diabetes in targeted screening versus newly diagnosed subjects with diabetes in general practice to be 6.35% and 11.71%, respectively.³⁶ These population-based findings were somewhat similar to those reported from other Western studies (7%–11%).^{37–41}

The prevalence of DR did not show any linear trend with age. Although it did show an increased prevalence in sixth decade compared with the fifth decade of life, in the seventh decade, it leveled off, and later it dropped. Similar trends also were observed by the Eye Diseases Prevalence Research Group's report on the prevalence of DR in the United States, the Barbados Eye Study, the Beaver Dam Study, and the Wisconsin Epidemiologic Study of Diabetic Retinopathy.^{2,30,35,42} This pattern may be because many subjects with severe diabetes and secondary complications may not survive beyond the age of 70.^{43,44}

The strength of the present study compared with the CURES was the stratification of subjects based on socioeconomic scoring at the initial sampling stage.^{5,7} In this study, the socioeconomic status influenced the prevalence

of diabetes mellitus, but had no effect on presence and severity of DR. Diabetes mellitus was more likely to develop in people with high socioeconomic status. However, after an individual becomes a diabetic, several other factors such as duration of diabetes influences the occurrence of DR. Furthermore, it is speculated that affluent subjects may be receiving some kind of aggressive treatment or monitoring their glucose level more stringently. Ramachandran et al²³ carried out a comparative study of a low-income group (family income, <Rs. 30 000/year; approximately £432) and high-income group (family income, >Rs. 60 000/year; approximately £864) in subjects older than 40 years in Chennai for diabetes and its complications. They found that the low-income group subjects showed a lower prevalence of diabetes and DR. Similar results also were seen with regard to DR in the Andhra Pradesh Eye Disease Study, although they were not statistically significant.²² In both studies, a single index—annual income—was used to define socioeconomic status. However, socioeconomic status of a family means the ranking of the family in the milieu to which the family belongs, with respect to defined variables

Table 4. Prevalence Studies of Diabetes Mellitus from India

Authors	Year	No.	Location	Age Criterion (yrs)	Criteria for Diagnosis	Prevalence of Diabetes Mellitus in Those Older than 40 Years
Studies based on FBS						
Raman Kutty et al ¹²	1999	233	Urban Kerala	>20	FBS	18.75%*
Gupta et al ¹³	2003	1123	Urban Rajasthan	>20	FBS	20.56%
Present study	2006	5999	Urban Chennai	>40	FBS	28.18%
Studies based on FBS & OGTT						
Zargar et al ¹⁴	2000	6091	Kashmir	>40	FBS & OGTT	14.23%
NUDS ¹⁵	2001	11216	Urban India (Chennai)	>20	FBS & OGTT	23.80%
CURES ¹⁶	2005	26001	Urban Chennai	>20	FBS & OGTT	30.10%

CURES = Chennai Urban Rural Epidemiology Study; FBS = fasting blood sugar; NUDS = National Urban Diabetes Survey; OGTT = oral glucose tolerance test.

*Prevalence in those older than 30 years.

such as physical assets, economic status, education, and occupation. Because the socioeconomic status used in SN-DREAMS 1 was based on multiple indices, its influence on diabetes and DR was presumed to be better elucidated.

The strength of this study is that it used photography and standard grading techniques. Furthermore, the study is representative of a large population, and results can be extrapolated to the whole of urban India. The present study highlights the prevalence of diabetes and DR and history-related risk factors for DR. The possibility of potential bias in ascertaining history-related variables, however, was kept

in mind; this was true particularly with regard to diabetic neuropathy and diabetic nephropathy. In subjects with known diabetes mellitus, a second estimation of blood glucose was not performed; the authors were relying on the diagnostic accuracy of the treating diabetologists.

The prevalence of DR in the general population is expected to increase substantially by 2020, driven by an increasing prevalence of diabetes mellitus over time with the aging of the Indian population. In the present study, most subjects with previously diagnosed diabetes were already receiving treatment, and those receiving treatment had more

Table 5. Global Prevalence of Diabetic Retinopathy

Country	Diagnosis of Diabetes	No.	Mean Duration of Diabetes (yrs)	Age Distribution (yrs) or Mean Age	Prevalence of Diabetic Retinopathy
Diagnosis by clinical examination					
Asian countries					
China, 1986 ¹⁸	OGTT	423	ND	35–74	15.4
Japan, 1994 ¹⁹	Self-reported	2000	—	—	38
Sri Lanka, 1998 ²⁰	FBS	597	ND	42.3±6.2	15%
Pakistan, 2006 ²¹	RBS >140 mg/dl	912	—	>30	15.7
India					
Andhra Pradesh Eye Disease Study, 1999 ²²	RBS >120 mg/dl	2522	<10 in 75%	31–86	22.4% [‡]
Ramachandran et al, 2001 ²³	OGTT	1748	—	50	12%
Narendran et al, 2002 ²⁴	Self-reported	5212	<10 in 77%	62	26.20%
Diagnosis by photography					
Other countries					
Singapore, 1995 ²⁵	Self-reported	2911	—	—	21.8
Mauritius, 1998 ²⁶	OGTT	6553	6.7	53.2	30%
United States, 1982 ²⁷	FBS >140 mg/dl	1370	11.8	66.6	50.30%
United Kingdom, 1991 ²⁸	FBS >108 mg/dl*	3315	ND	25–65	39% [†]
Australia, 1994 ²⁹	FBS >126 mg/dl*	4433	<10 in 63%	67.9±1	29.30%
West Indies, 1999 ³⁰	Self-report/HbA1c	4631	5	40–84	28.5%
India					
CURES, 2004 ⁵	OGTT	1715	5.9±5.3	52±11	17.6
Present study, 2006	FBS >126 mg/dl*	1414	6.7±6.3	56.3±10	18%

— = data not available; CURES = Chennai Urban Rural Epidemiology Study; FBS = fasting blood sugar; HbA1c = glycosylated hemoglobin; ND = newly diagnosed diabetes; OGTT = oral glucose tolerance test; RBS = random blood sugar.

*On 2 separate occasions.

[†]In men.

[‡]In those older than 30 years.

severe disease than newly diagnosed cases. This means that the Indian healthcare system (at least in urban Chennai) has been successful in identifying the most severely affected cases of diabetes.

These data stress the need for regular diabetic screening programs in countries like India. In this regard, the authors have been involved in several awareness programs in rural and urban areas on diabetes and DR.^{44,45} Furthermore, DR screening camps, involving retinal specialists using indirect ophthalmoscope or telediabetic screening models using satellite connectivity, have been used by the authors in India.^{46,47} The goal is to use the data from such epidemiologic studies to improve patient care.

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