

The All India Ophthalmological Society - Academic and Research Committee pan-India diabetic retinopathy project "Fixing the missing link": Prevalence data from West Bengal

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Purpose: The aim of this study was to determine the prevalence of diabetic retinopathy (DR) and its risk factors among diabetic patients in rural and urban West Bengal (WB). **Methods:** Patients were screened in the physician's clinic by a team of ophthalmologist, optometrist and counsellor. Demographic details, diabetic control, compliance to eye checkup, awareness regarding diabetic blindness, and visual acuity were recorded using a questionnaire. DR was graded both by indirect ophthalmoscopy and fundus photo taken with a portable fundus camera. **Results:** A total of 1553 subjects were screened over 39 camps across 14 districts of WB over 17 months. The prevalence of DR was 21.51%, with a significant difference between rural (26.55%) and urban (13.89%) areas ($P < 0.01$). No significant difference with gender was seen ($P = 0.99$). Presence and grade of DR were related to age, loss of vision, diabetic age, diabetic control, awareness of diabetic blindness and last eye checkup. **Conclusion:** This study provides the first major prevalence data from WB, and gives valuable insight regarding modifiable risk factors for DR. It is also the first DR study in India to be conducted in the physician's clinic. The study results emphasise the need to "fix the missing link" between ophthalmologists and treating physicians to win the battle against DR.

Key words: Diabetic retinopathy, prevalence, risk factors

Diabetes mellitus (DM) has been increasing in epidemic proportions in recent times, with a forecasted jump from 463 million affected worldwide in 2019 to over 700 million by the year 2045.^[1] It is estimated that up to one-third of diabetics are living with diabetic retinopathy (DR), while at least 10% develop vision-threatening eye disease in their lifetime.^[2] The prevalence of DR among diabetics in India has been documented to be lower than in western countries. However, as India is poised to become home to the largest number of diabetic population in the world, the sheer number of people affected by DR is projected to be enormous. Most of the DR prevalence studies in India have been done in the southern Indian population, while very limited literature is available from eastern India.^[3-13]

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The Pan India Diabetic Retinopathy Project "Fixing the Missing Link" was envisioned by the Academic and Research Committee (ARC) of the All India Ophthalmological Society (AIOS) in association with the Vitreo Retina Society of India (VRSI) to gather DR prevalence data from different parts of the country, and to promote an association between treating diabetologists or physicians (TDP) and ophthalmologists.

Here, we describe the methodology of the project and present the first prevalence data from the state of West Bengal (WB).

Methods

The primary objective of the study was to determine prevalence of DR and its various risk factors among diabetic population in WB. The secondary objectives were to determine difference between rural and urban population and among males and females.

Screening camps were conducted in association with the TDP either at their own clinic or organized by them elsewhere, which is the first of its kind prevalence study conducted for DR in India.

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A total of 14 districts (Alipurduar, Bankura, Cooch Behar, Dakshin Dinajpur, Hooghly, Howrah, Kolkata, Malda, Murshidabad, Nadia, North 24 Parganas, Paschim Bardhaman, Purba Medinipur and South 24 Parganas) were purposively selected to represent different zones of WB with a rural: urban distribution of two-thirds to one-third to adequately represent the level of urbanisation in the state (31.87% as per the 2011 census).^[14] [Fig. 1] Key TDPs were identified in these areas. Approximately two weeks prior to the camp, notices regarding the free eye checkup were put up in their clinics, and the TDPs themselves informed their patients regarding the same. On the day of the camp, a team consisting of ophthalmologist, optometrist and counsellor visited the camp site to collect the data. The number of personnel on the team was variable to suit the expected camp site and size. All patients with known history of DM were included in the study. Patients with significant media opacity where fundus evaluation was not possible were excluded.

The counsellor filled in a questionnaire containing demographic details, pertinent history of DM as well as ophthalmological complaints, if any. Diabetes mellitus

age (or DM age) was recorded as the duration since the patient was first diagnosed with DM. The patient's diabetic control was assessed by reviewing their latest blood sugar report with preference being given to HbA1c, followed by postprandial blood sugar (PPBS), fasting blood sugar (FBS) and random blood sugar (RBS). For patients with no such records available in the last three months, RBS performed on the day of the camp was recorded for study purpose. For the purpose of this study, well-controlled DM was defined as HbA1c $\leq 6.5\%$, PPBS/RBS ≤ 140 mg/dl or FBS ≤ 100 mg/dl. Moderately uncontrolled DM was defined as HbA1c $> 6.5\%$ but $\leq 8\%$, PPBS/RBS > 140 mg/dl but ≤ 200 mg/dl, or FBS > 100 mg/dl but ≤ 126 mg/dl. Severely uncontrolled DM was defined as HbA1c $> 8\%$, PPBS/RBS > 200 mg/dl, or FBS > 126 mg/dl. The patient's awareness regarding DM as a possible cause of blindness was enquired. Last eye checkup was noted which must have included retinal screening. All interviews were conducted in the local languages Bengali and Hindi.

The optometrist recorded the best-corrected distance visual acuity (BCDVA) using Snellen's distance vision chart. For the study purpose, BCDVA was classified as good visual acuity (6/6-6/12), moderate vision loss (6/18-6/36), severe vision loss (6/60 - 1/60), and blindness (counting fingers, hand movement, perception of light present or absent).

Anterior segment screening examination was done using torchlight. Both eyes were dilated using tropicamide 0.8% eye drop. The on-field ophthalmologist examined the fundus with an indirect ophthalmoscope, and recorded DR grading. Simultaneously, fundus photograph was taken with the Fundus-on-phone non-mydratic camera (Remidio Innovative Solutions Pvt Ltd, Bangalore, India). The patients were educated regarding DR by the counsellor with the help of pamphlets, and the role of yearly eye checkup and control of blood sugar were emphasised. The patients were referred to ophthalmological centres if required. They were also encouraged to discuss and report to their TDP regarding their eye health regularly. The TDPs were provided with a detailed report of their patients' eye health. They were requested to regularly advise their patients to screen for eye disease, and patient health education material was provided for the same.

The fundus photographs taken by the camera were later analyzed by a retina specialist and DR grading was noted for each eye masked to the on-field ophthalmologist's grading. Images that were defocused or did not adequately represent the posterior polar area were excluded as being "ungradable". DR was graded according to the International Classification of Diabetic Retinopathy and Diabetic Macular Edema given by the International Council of Ophthalmology (ICO) as no DR, mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR or proliferative diabetic retinopathy (PDR).^[15]

Statistical analysis was done using statistical software R version 3.5.1. The results are expressed as mean \pm standard deviation for quantitative data and number (percentage) for qualitative data. Test statistics used are Pearson's Chi-squared test, t-test and Spearman's rank correlation test. A value of $P < 0.05$ was considered to be significant.

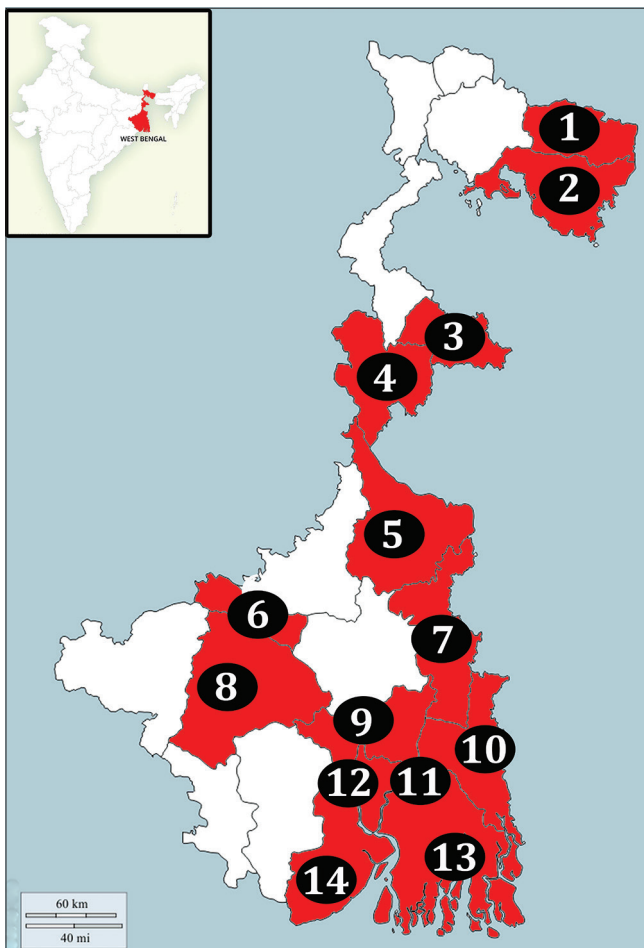


Figure 1: Map of West Bengal showing districts included for study. (1-Alipurduar, 2-Cooch Behar, 3-Dakshin Dinajpur, 4-Malda, 5-Murshidabad, 6-Paschim Bardhaman, 7-Nadia, 8-Bankura, 9-Hooghly, 10-North 24 Parganas, 11-Kolkata, 12-Howrah, 13-South 24 Parganas, 14-Purba Medinipur)

Results

A total of 39 camps were conducted over 14 districts in West Bengal from August 2018 to December 2019. A total of 1553 subjects were included for study purpose, which included 60% males and 40% females. The mean age was 55.29 ± 11.19 years (range 18-89 years). 60.14% of subjects belonged to rural areas, whereas 39.86% resided in urban areas. The rural and urban samples are age and gender matched ($P = 0.71$ and 0.46 , respectively). [Table 1]

Prevalence of DR in our study was 21.51% with mild NPDR constituting 11.2%, moderate NPDR 8.24%, severe NPDR 0.77% and PDR 1.29%. There was a significantly stark difference

between prevalence among rural (26.55%) and urban (13.89%) areas ($P < 0.01$). There was also significant difference with age ($P = 0.005$), DM age ($P < 0.01$), and duration since last checkup ($P < 0.01$). No significant difference was found with gender ($P = 0.99$). [Table 2] Stage of DR was significantly correlated with DM age ($r = 0.29$, $P < 0.01$), and loss of DM control ($r = 0.18$, $P < 0.01$).

Control of DM over last three months was variable with 33.61% having well-controlled disease, 35.22% having moderately uncontrolled disease, and 31.17% having severely uncontrolled disease. There was no significant difference in control between males and females ($P = 0.18$).

66.77% of subjects screened were aware of DM as a cause of blindness, while 33.23% had never been informed about it. There was no statistically significant difference in the level of awareness between males and females ($P = 0.57$). However, level of awareness was significantly higher among urban subjects (71.24%) compared to rural subjects (63.8%) ($P < 0.01$). Level of awareness also increased significantly with DM age ($r = 0.23$). Subjects with DM age ≤ 5 years had significantly less knowledge (59.08%) than those with DM age > 5 years (76.39%) ($P < 0.01$). Those who were aware regarding DM blindness were significantly less prone to an uncontrolled disease state ($r = -0.15$, $P < 0.01$).

54.93% of subjects did not have a comprehensive eye checkup in the last one year, of which a substantial 19.19% had never had an eye checkup since DM was diagnosed. Significant negative correlation was seen between level of awareness and duration since last checkup ($r = -0.29$, $P < 0.01$). No comprehensive eye

Table 1: Demographic characteristics of sample studied

Demographic Characteristic	No. (%)
AREA	
Rural	934 (60.14%)
Urban	619 (39.86%)
SEX	
Male	932 (60.01%)
Female	621 (39.99%)
AGE (YEARS)	
<40	111 (7.15%)
40-60	863 (55.57%)
60-80	558 (35.93%)
≥ 80	21 (1.35%)

Table 2: Prevalence of diabetic retinopathy in the subgroups studied

GROUP	SUB-GROUP	SUBJECTS (%)	SUBJECTS WITH DR (%)	P
GENDER	MALE	932 (60.01%)	201 (21.57%)	0.9943
	FEMALE	621 (39.99%)	133 (21.42%)	
AGE	<40	111 (7.15%)	9 (8.11%)	0.0049
	40-59	863 (55.57%)	179 (20.74%)	
	60-79	558 (35.93%)	138 (24.73%)	
	>80	21 (1.35%)	8 (38.10%)	
AREA	RURAL	934 (60.14%)	248 (26.55%)	<0.01
	URBAN	619 (39.86%)	86 (13.89%)	
DM AGE	<6	865 (55.77%)	101 (11.68%)	<0.01
	6-10	355 (22.89%)	96 (27.04%)	
	11-15	150 (9.67%)	63 (42.00%)	
	16-20	54 (3.48%)	19 (35.19%)	
	>20	127 (8.19%)	54 (42.52%)	
DM CONTROL	WELL CONTROLLED	522 (33.61%)	60 (11.49%)	<0.01
	MODERATELY UNCONTROLLED	547 (35.22%)	133 (24.31%)	
	SEVERELY UNCONTROLLED	484 (31.17%)	141 (29.13%)	
DM AWARENESS	YES	1037 (66.77%)	234 (22.57%)	0.1696
	NO	516 (33.23%)	100 (19.38%)	
LAST EYE CHECKUP	≤ 1 YEAR	700 (45.07%)	1 (0.14%)	<0.01
	1-2 YEARS	305 (19.64%)	141 (46.23%)	
	2-3 YEARS	138 (8.89%)	81 (58.70%)	
	>3 YEARS	112 (7.21%)	82 (73.21%)	
	NEVER	298 (19.19%)	29 (9.73%)	

Table 3: Correlation of visual acuity with demographic parameters and risk factors studied

	Good Visual Acuity	Moderate Vision Loss	Severe Vision Loss	Blindness	P
SEX					
Male (n=932)	641 (68.78%)	230 (24.68%)	51 (5.47%)	10 (1.07%)	0.173
Female (n=621)	406 (65.38%)	160 (25.76%)	41 (6.60%)	14 (2.25%)	
AREA					
Rural (n=934)	591 (63.28%)	257 (27.52%)	73 (7.82%)	13 (1.39%)	<0.01
Urban (n=619)	456 (73.67%)	133 (21.49%)	19 (3.07%)	11 (1.78%)	
AWARENESS					
Yes (n=1037)	749 (72.23%)	214 (20.64%)	58 (5.59%)	16 (1.54%)	<0.01
No (n=516)	298 (57.75%)	176 (34.11%)	34 (6.59%)	8 (1.55%)	
DM CONTROL					
Well Controlled (n=522)	391 (74.90%)	111 (21.26%)	19 (3.64%)	1 (0.19%)	<0.01
Moderately Uncontrolled (n=547)	362 (66.18%)	142 (25.96%)	33 (6.03%)	10 (1.83%)	
Severely Uncontrolled (n=484)	294 (60.74%)	137 (28.31%)	40 (8.26%)	13 (1.83%)	
DM AGE (YEARS)					
<6 (n=865)	638 (73.76%)	189 (21.85%)	33 (3.82%)	5 (0.58%)	<0.01
6-11 (n=355)	225 (63.38%)	98 (27.61%)	25 (7.04%)	7 (1.97%)	
11-16 (n=150)	96 (64.00%)	39 (26.00%)	13 (8.67%)	2 (1.33%)	
16-20 (n=54)	30 (55.56%)	16 (29.63%)	5 (9.26%)	3 (5.56%)	
≥20 (n=127)	57 (44.88%)	47 (37.01%)	16 (12.60%)	7 (5.51%)	
LAST EYE CHECKUP					
≤1 Year (n=700)	451 (64.43%)	206 (29.43%)	31 (4.43%)	12 (1.71%)	<0.01
1-2 Year (n=305)	206 (67.54%)	68 (22.30%)	26 (8.52%)	5 (1.64%)	
2-3 Year (n=138)	96 (69.57%)	32 (23.19%)	9 (6.52%)	1 (0.72%)	
>3 Year (n=112)	69 (61.61%)	30 (26.79%)	11 (9.82%)	2 (1.79%)	
Never (n=298)	225 (75.50%)	54 (18.12%)	15 (5.03%)	4 (1.34%)	

checkup since DM detection was significantly higher among subjects having no awareness of DM blindness (44.8% vs 6.46%, $P < 0.01$). The duration of last checkup did not vary significantly between males and females ($P = 0.15$).

Duration since last comprehensive eye check-up was correlated negatively with level of urbanisation ($r = -0.13$, $P < 0.01$), i.e., for rural subjects, duration since last eye checkup was significantly higher. Percentage of subjects who never had an eye checkup since DM detection was also significantly higher in rural areas (21.2%) as compared to urban areas (16.2%) ($P < 0.01$).

Compliance to yearly eye checkup went significantly up as DM age increased ($P < 0.01$). Yearly eye check-up rates were highest in those who exhibited good DM control (58.62%), followed by those who had severely uncontrolled DM (42.56%), and least in those with moderately uncontrolled DM (34.37%).

Loss of BCDVA was significantly correlated to DM age ($r = 0.18$, $P < 0.01$), age of the patient ($r = 0.26$, $P < 0.01$), and severity of DR ($r = 0.2$, $P < 0.01$). Percentage of subjects with good visual acuity (VA) was significantly higher in urban areas (73.7% vs 63.3%, $P < 0.01$) and among those having awareness of diabetic blindness (72.2% vs 57.8%, $P < 0.01$). Subjects who exhibited good control of DM had better VA (74.9%), when compared to those who had moderately uncontrolled (66.2%) or severely uncontrolled disease (60.7%) ($P < 0.01$). Again, there was no significant variation between males and females ($P = 0.17$). [Table 3]

Discussion

West Bengal is the 13th largest and fourth most populous state in India.^[14] The prevalence of DM in WB was 1.66% in rural areas and 4.8% in urban areas in a 2005 study.^[16] DR is currently the leading cause of visual impairment and blindness among the working age population globally.^[17] Visual disability is the commonest cause of disability in the state of WB.^[18] The age standardised disability-adjusted life year (DALY) rates due to DM in WB is estimated to be 756 per 100000.^[19]

The International Diabetes Federation (IDF) Diabetes Atlas which analysed retinal photograph based studies worldwide from 2015-19 reported DR prevalence among diabetics to be 27%, with the lowest prevalence seen in south-east Asian IDF region with 12.5%.^[20] Numerous studies have been done in the past to estimate the prevalence of DR in states of southern and western India, while two major pan-India DR prevalence studies have been done.^[3-13] Prevalence rates of DR among diabetic population varies from 10.3% to 26.8% in population based studies, while in ophthalmological clinic based studies, it ranges from 21.7% to 34.1%. [Table 4]

Till now, prevalence data for DR has been insufficient from eastern India. The only data available is from the AIOS 2014 study which reported prevalence of DR in the eastern zone to be 22.59%.^[11] Prevalence of DR in our study was found to be 21.51%, which is lower than the latest national prevalence (32.3%) reported by the SPEED study in 2020.^[13] One of the main reasons for lower prevalence could be that

Table 4: Comparison of studies done on prevalence of diabetic retinopathy with present study

Study	Year	Place	Type of population	Subject set	Method of screening	Prevalence of DR
IDF Atlas ^[20]	2015-19	World South East Asia	Mixed	Meta analysis	Fundus photo	27% 12.5%
Rema <i>et al.</i> ^[3]	1996	Chennai	Urban	Eye clinic	Fundus photo + Ophthalmoscopy	34.1%
APEDS ^[4]	1999	Hyderabad	Urban	Population	Ophthalmoscopy	22.4%
PEDS ^[5]	2002	Kerala	Mixed	Population	Ophthalmoscopy	26.8%
CURES 1 ^[6]	2005	Chennai	Urban	Population	Fundus photo	17.6%
SN DREAMS 2 ^[7]	2009	Chennai	Urban	Population	Fundus photo	18%
Theni ^[8]	2009	Theni	Semirural	Population	Ophthalmoscopy	12.2%
SN Dreams III 2 ^[9]	2014	TN	Rural	Population	Fundus photo	10.3%
Chunampet ^[10]	2014	TN	Rural	Population	Fundus photo	18.2%
AIOS ^[11]	2016	India East zone	Mixed	Hospital	Ophthalmoscopy	21.7% 22.59%
AJ DRUMSS ^[12]	2017	Mumbai	Urban	Population	Fundus photo	15.37%
SPEED 1 ^[13]	2020	India	Mixed	Hospital	Fundus photo + Ophthalmoscopy	32.3%
Our study	2020	West Bengal	Rural + Urban	Treating physician's clinic	Fundus photo + Ophthalmoscopy	21.5%

our study was conducted in association with the TDP's clinic, hence reducing the selection bias of recruitment of subjects who are mostly visiting an eye clinic when an ophthalmological symptom has already set in. To the best of our knowledge, this is the first prevalence data from the state of West Bengal.

The most alarming statistic emerging from our study is the stark difference in the prevalence of DR among rural (26.55%) and urban (13.89%) population. This is in contrast to the findings of previous studies which had shown higher prevalence of DM and DR in urban areas.^[8,21-23] However, it had also been predicted by multiple epidemiological studies that the epidemic of non-communicable diseases and their sequelae is gradually shifting from higher to lower socio-economic societies and ultimately from urban to rural areas due to the process of rapid urbanisation.^[5,23] Our study points to the fact that in WB, this epidemic has already started, which may be complicated by the unmet need for specialists in these areas. The low awareness in rural areas, combined with socio-economic factors and limited infrastructure, may lead to a catastrophic increase in diabetic blindness in these areas in the coming years.^[23]

Several interesting risk factors for DR have come to the fore while interviewing these diabetic patients. Since the screening camps were conducted in association with the TDP, all recruited subjects were diagnosed cases of DM. Even so, a third of these patients (33.23%) remained unaware that uncontrolled DM can be a cause of blindness. This figure was even higher (36.2%) in the rural areas. Important to note was the fact that this awareness increased substantially as their DM age increased, possibly once the symptoms of diabetic eye disease have already started which led them to visit an ophthalmologist. Hence, the golden period in which retinal screening actually could have prevented vision loss due to DR is missed because of lack of awareness.

ICO recommends eye checkup with retinal screening for all diabetic patients at least once in 1-2 years.^[15] In our study, more

than half (54.93%) the patients had not had an eye checkup within the last year. Once again this figure was higher among rural patients (59.31%) compared to urban patients (48.3%). In fact, more than one-fifth of the rural population (21.2%) had never had an eye checkup since the detection of DM.

Prevalence of DR, awareness regarding diabetic eye disease and duration since last eye checkup were all found to be similar among both the sexes in our study in rural as well as urban areas. This is similar to the global META-EYE analysis.^[2] However, a majority of other studies have demonstrated a higher prevalence among males, without citing any physiological reason for the same.^[4,6,7,11-13,21,24,25] It is possible that socio-economic factors may have a bigger role to play than male gender itself as a risk factor for DR.

A sequence of etio-pathological factors is evident from our results, whereby patients who had awareness that uncontrolled DM could cause diabetic blindness were more regular with their eye checkups and exhibited better control of their diabetic status. As a result, these patients showed lower prevalence and grades of DR and better visual acuity. The increasing prevalence of various grades of DR with duration and deterioration in control of DM has been reported in earlier studies.^[2,5,6,8,9,11,12,25,26] This brings us to the most important question: Can this chain of events be broken at the beginning by increasing the awareness among diabetic population?

It was dismaying to note that even among patients who were well aware about their diabetic disease, and under regular treatment from their TDP, the awareness regarding diabetic blindness and the importance of regular eye screening for the same remains low. This is leading to patients reporting to ophthalmologists with more advanced eye disease, where the goal often becomes vision salvage instead of prevention of diabetic blindness. The awareness and compliance to eye checkup becomes better as the age of the patient and their DM age goes up, possibly after an intervention by an ophthalmologist, which then becomes a case of too little and

too late. This has been reported in previous studies which showed that most patients first become aware of diabetic eye disease only after symptoms have developed.^[27,28] Studies have also reported low uptake of DR screening among young diabetics aged 20-39 years, which epidemiologists now feel is the group which must be targeted and educated in order to reduce diabetic blindness in the working age group.^[29,30] This is specially pertinent in case of our country since the Asian phenotype is known to be predisposed to developing DM at an earlier age.^[31,32]

The key we propose, therefore, is to “fix the missing link” between ophthalmologists and TDPs in our country, since the TDP can reach and educate the young diabetic population before eye symptoms have developed. Previous studies have shown that patients with DR who were compliant to regular screening had improved visual outcomes.^[33,34] Further, screening compliance rates have been shown to improve with TDP recommendation and guidance.^[35-37] However, it has also been shown that isolated eye screening without management of underlying disease and patient education is bound to fail.^[38,39] All these together lead us to the conclusion that the battle against diabetic blindness can be won only if the ophthalmologist and the TDP join hands and a strong system of referral is created which patients can conveniently utilise.

Limitations of our study include not classifying patients into type 1 and type 2 DM and not being able to assess inter-observer variability between the various on-field ophthalmologists. The study included only those subjects who were aware of their diabetic status, hence it may not be a true representation of the general population.

Strengths of our study included collection of data from all representative zones of WB. This is the first study giving a direct comparison between rural and urban population from the same state. This is the first DR prevalence study to be conducted in association with the TDP, thus examining a newer subject set. DR grading for every patient was done by on-field indirect ophthalmoscopy as well as correlated with fundus photographs, thus reducing the chances of missing subtle DR changes. The data collection and patient education was carried out simultaneously, thus paving a stone to fix “the missing link”.

Conclusion

The prevalence of DR among known diabetics in WB was found to be similar to data available from the rest of India. However, there is a stark difference between rural and urban areas, predicting an upcoming epidemic of diabetic eye disease in rural areas in the near future. The study also highlights the low awareness, compliance to eye checkup among young diabetic population. These findings are likely to be applicable to the rest of India as well which suffers from a similar handicap of lack of awareness, limited accessibility and a similar genetic stock. Based on the above findings, we propose it is imperative to shift the onus of management from tertiary to primary prevention by “fixing the missing link” between the TDP and an ophthalmologist. Robust referral pathways and convenient communication systems need to be established which will ensure timely screening and referral for all diabetic patients.

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Conflicts of interest

There are no conflicts of interest.

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