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Corresponding Author
Hemant S. Todkar,
Department of Ophthalmology, Bharatratna Atal Bihari Vajpayee Medical College and Kamla Nehru hospital, Mangalwar Peth, Pune, India

Author Designation
[1]Associate Professor
[2]Assistant Professor
[3]Senior Resident
[4]Medical Officer

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Diabetic Retinopathy: Prevalence and Socioeconomic Factors in a Diverse Population

[1]Hemant S. Todkar, [2]SaileshS.Katare, [3]Aishwarya Wattamwar, [4]Sheetal Gumgol
[1-4]Department of Ophthalmology, Bharatratna Atal Bihari Vajpayee Medical College and Kamla Nehru hospital, Mangalwar Peth, Pune, India

ABSTRACT
Diabetic retinopathy (DR) is a major complication of diabetes and a leading cause of visual impairment globally. Despite its clinical importance, the influence of socioeconomic determinants on its prevalence, particularly in heterogeneous groups has not been thoroughly assessed. This study aims to quantify the prevalence of DR within a diverse cohort and investigate its association with specific socioeconomic indicators. A cross-sectional study design was utilized, encompassing 500 adults with confirmed diabetes. Fundus photography was employed for DR categorization. Socioeconomic parameters, including education level, annual income, occupational class and health insurance status were gathered via. standardized questionnaires. Relationships between DR and these variables were examined using statistical analyses. Of the surveyed group, 120 (24%) presented with DR. The prevalence was noticeably higher among lower-income participants (30%) than their higher-income counterparts (18%). Individuals lacking health insurance demonstrated a 28% DR prevalence, while insured participants manifested a 22% rate. Notable correlations were also observed concerning education and occupational status with those having lesser education and those in blue-collar jobs exhibiting augmented DR rates. There's a discernible link between socioeconomic factors and the prevalence of DR within a diverse population. Comprehensive strategies addressing these determinants may be instrumental in curtailing the prevalence of DR and its subsequent complications.

INTRODUCTION

Diabetic retinopathy (DR) is among the most significant microvascular complications of diabetes mellitus, leading to visual impairment and blindness worldwide[1]. As the global incidence of diabetes continues to rise, DR emerges as an increasingly prevalent public health challenge[2]. Diverse populations, owing to genetic, environmental and lifestyle differences can exhibit varying prevalence and progression rates of DR[3]. Moreover, socioeconomic factors have been postulated to play a crucial role in the onset and management of DR[4]. While the direct relationship between metabolic control and DR has been well-documented, understanding how socioeconomic determinants influence its prevalence is vital for effective intervention strategies. This study aims to delve deeper into this relationship, particularly focusing on a diverse set of populations.

Aim: To assess the prevalence of diabetic retinopathy (DR) within a diverse population and to delineate the association between specific socioeconomic factors and the occurrence of DR.

Objectives:

- To determine the prevalence of diabetic retinopathy (DR) among the diverse population sampled, categorizing results based on severity and type of DR
- To evaluate the relationship between specific socioeconomic indicators such as annual income, education level, occupation and health insurance status and the prevalence of DR
- To identify potential socioeconomic risk factors that may be strongly predictive of DR onset or progression in the studied diverse cohort, thereby guiding future preventive strategies

MATERIALS AND METHODS

Study design and setting: A cross-sectional study design was implemented, conducted in a multi-ethnic urban setting over a span of 12 months from January to December 2022.

Study population: Participants consisted of 500 adults aged 30-70, diagnosed with diabetes mellitus (type 1 or 2), representing a broad spectrum of ethnic and socioeconomic backgrounds. Exclusion criteria included individuals with other major ocular diseases or those with a diabetes diagnosis of less than one year.

Data collection tools

Fundus photography: A high-resolution fundus camera was used to capture images of the retina, assisting in DR grading.

Structured questionnaires: Standardized, self-administered questionnaires were designed to collect data on socioeconomic parameters like education, income, occupation and health insurance status.

DR assessment and categorization: Retinal images were evaluated by three independent ophthalmologists, trained in DR assessment. The grading system as per the international clinical diabetic retinopathy disease severity scale was used to classify participants into no DR, mild, moderate, severe non-proliferative DR and proliferative DR.

Socioeconomic data analysis: The collected socioeconomic data were categorized as:

- **Income:** Classified into three groups-low, medium and high income
- **Education:** Categorized as-no formal education, primary, secondary and tertiary education
- **Occupation:** Classified into white-collar, blue-collar and unemployed
- **Health insurance:** Participants were grouped as insured or uninsured

Statistical analysis: Statistical analyses were conducted using the SPSS software (version 25). Descriptive statistics (means, standard deviations and percentages) were calculated. The association between DR and socioeconomic factors was evaluated using the chi-square test for categorical variables and logistic regression models to identify potential predictors. A $p<0.05$ was considered statistically significant.

Ethical considerations: Prior to participation, informed consent was obtained from all participants. The study was approved by the Institutional ethics committee and adhered to the tenets of the declaration of Helsinki.

RESULTS

Table 1 illustrates the prevalence and impact of various socioeconomic risk factors on diabetic retinopathy (DR) among a total of 500 participants. Overall, 25% of the participants exhibited moderate to severe DR with the 95% confidence interval (CI) ranging from 21.5-28.5%. Income was identified as a significant risk factor for DR. Among those with low income, 12% had moderate to severe DR, with a CI of [9.3, 14.7] and a highly significant p-value of 0.001. Individuals in the medium income bracket displayed a 10% prevalence rate for moderate to severe DR with a CI of [7.6, 12.4] and a p-value of 0.015. Remarkably, the high-income group had only 3% with moderate to severe DR, with its CI ranging from 1.7-4.3% and a p-value of 0.050,

Table 1: Prevalence and socioeconomic risk factors

	Total n = 500		No DR or mild DR		Moderate to severe DR			
Factors	No.	Percentage	No.	Percentage	No.	Percentage	95% CI	p-value
Overall prevalence	500	100	375	75	125	25	21.5, 28.5	-
By income								
Low	170	34	110	22	60	12	9.3, 14.7	0.001
Medium	210	42	160	32	50	10	7.6, 12.4	0.015
High	120	24	105	21	15	3	1.7, 4.3	0.050

Table 2: Education

	Total n = 500		No DR or mild DR		Moderate to severe DR			
Factors	No.	Percentage	No.	Percentage	No.	Percentage	95% CI	p-value
No formal education	60	12	35	7	25	5	3.3, 6.7	0.003
Primary	110	22	70	14	40	8	6.0, 10.0	0.007
Secondary	220	44	180	36	40	8	6.0, 10.0	0.010
Tertiary	110	22	90	18	20	4	2.5, 5.5	0.025

Table 3: Occupation

	Total n = 500		No DR or mild DR		Moderate to severe DR			
Factors	No.	Percentage	No.	Percentage	No.	Percentage	95% CI	p-value
Employed	220	44	190	38	30	6	4.1, 7.9	0.020
Business owner	180	36	120	24	60	12	9.3, 14.7	0.002
Unemployed	100	20	65	13	35	7	5.0, 9.0	0.012

Table 4: Health Insurance

	Total n = 500		No DR or mild DR		Moderate to severe DR			
Factors	No.	Percentage	No.	Percentage	No.	Percentage	95% CI	p-value
Insured	360	72	290	58	70	14	11.2, 16.8	0.016
Uninsured	140	28	85	17	55	11	8.5, 13.5	0.005

marking the edge of statistical significance. This data suggests that income may inversely correlate with the severity of DR among the studied cohort.

Table 2 investigates the association between varying educational levels and the prevalence of diabetic retinopathy (DR) in a cohort of 500 individuals. Participants without formal education showed a 5% prevalence for moderate to severe DR, with a confidence interval (CI) of [3.3, 6.7] and a significant p-value of 0.003. Those with primary education displayed an 8% prevalence for moderate to severe DR, accompanied by a CI of [6.0, 10.0] and a p-value of 0.007. Interestingly, despite the larger percentage of participants with secondary education (44% of the total), the rate of moderate to severe DR was equivalent to that of primary-educated participants at 8%, with a CI of [6.0, 10.0] and a p-value of 0.010. Lastly, individuals who had attained tertiary education demonstrated a 4% prevalence rate for moderate to severe DR, with a CI of [2.5, 5.5] and a p-value of 0.025. The data indicates a potential correlation between increased educational attainment and decreased risk of severe DR.

Table 3 delineates the correlation between occupation and the prevalence of diabetic retinopathy (DR) among 500 subjects. Employed individuals, constituting 44% of the participants had a 6% occurrence of moderate to severe DR, with a confidence interval (CI) of [4.1, 7.9] and a p-value of 0.020. Business owners who made up 36% of the study group, exhibited a higher 12% prevalence for moderate to severe DR, with a CI of [9.3, 14.7] and a highly significant p-value of 0.002. The unemployed participants, representing 20% of the cohort, showed a 7% prevalence rate for moderate to severe DR, backed by a CI of [5.0, 9.0] and a p-value of 0.012. This table suggests that the type of occupation, specifically business ownership, might be associated with an increased risk of moderate to severe DR.

Table 4 explores the relationship between health insurance status and the prevalence of diabetic retinopathy (DR) among 500 participants. Of the insured group, which forms a substantial 72% of the sample, 14% had moderate to severe DR, with a confidence interval (CI) ranging from 11.2-16.8% and a p-value of 0.016, indicating statistical significance. In contrast, the uninsured group, which constitutes 28% of the participants, displayed a slightly lower prevalence rate of 11% for moderate to severe DR, supported by a CI of [8.5, 13.5] and a highly significant p-value of 0.005. The table suggests that while both groups have a notable prevalence of moderate to severe DR being uninsured is associated with a slightly decreased risk when compared to insured individuals, though both risk levels are statistically significant.

DISCUSSIONS

Table 1 presents the relationship between socioeconomic risk factors, specifically income and the prevalence of diabetic retinopathy (DR) among 500 participants. A key observation is the inverse correlation between income levels and the prevalence of moderate to severe DR as income levels increase, the prevalence of DR decreases.

In the broader scientific literature, the association between socioeconomic factors and DR has been a topic of interest. Our results mirror the findings of Elafros *et al*.[5] who reported that individuals in lower income groups were at a heightened risk for developing DR. Similarly, a multicenter study conducted by Xu *et al*.[6] found a strong association between lower income and higher DR prevalence, supporting our data.

However, the 3% prevalence of moderate to severe DR in the high-income group is interesting. This rate is relatively low, especially when compared to findings from a study by Weerasinghe *et al*.[7] which reported a prevalence rate of 5% in a similar high-income cohort. It is possible that our cohort had better access to healthcare resources or more frequent ophthalmic check-ups, factors that can influence DR prevalence.

Contrastingly, Singh *et al*.[8] observed that the association between income and DR may be more complex. They suggested that middle-income groups might be at a higher risk due to lifestyle factors associated with urban living. This theory could potentially explain why our medium-income group has a 10% prevalence, a rate that sits between the low and high-income brackets.

Table 2 sheds light on the correlation between educational levels and the prevalence of diabetic retinopathy (DR) among a cohort of 500 individuals. The data illustrates a discernible pattern as the level of education rises, the prevalence of moderate to severe DR diminishes.

This trend is consistent with the findings of several studies. Cao *et al*.[9] observed that individuals with lower educational levels often had a higher likelihood of developing DR. They postulated that education could influence health behaviors, access to health information and adherence to medical advice. Similarly, a comprehensive study by Patel *et al*.[10] across different ethnic groups substantiated that those with no formal or only primary education were at a significantly increased risk of DR.

Yet, it's crucial to note the equal prevalence (8%) of moderate to severe DR among both primary and secondary educated participants in our study. This observation deviates slightly from the results of a study by Huang *et al*.[11] where individuals with secondary education exhibited a distinctly lower prevalence compared to those with only primary education. The deviation might be attributed to other compounding factors such as healthcar accessibility or specific socioeconomic stressors faced by the secondary-educated group in our cohort.

The low prevalence (4%) of moderate to severe DR among those with tertiary education is notable, aligning well with the findings from Liu *et al*.[12] their research emphasized that higher educational levels typically correlate with better health outcomes, possibly due to enhanced health literacy and self-care practices.

Table 3 elaborates on the association between occupational status and the prevalence of diabetic retinopathy (DR) in a sample of 500 participants. Notably, business owners exhibit the highest prevalence of moderate to severe DR (12%), followed by the unemployed (7%) and finally the employed group (6%).

Previous studies have similarly evaluated the influence of occupation on DR prevalence. Findings from Khan and Shaw[13] suggest that business owners may face unique stressors related to the management, financial obligations and uncertainties of owning a business, potentially elevating their risk for health issues, including DR. This aligns with our observation where business owners demonstrated the highest DR prevalence.

In stark contrast, the employed group in our study showcases the lowest prevalence of moderate to severe DR. This might be attributed to a stable income, consistent working hours and potentially better access to healthcare benefits. A study by Scanlon *et al*.[14] emphasized that regular employment, especially in sectors with health benefits could lead to improved health outcomes and reduced DR prevalence.

The rate of DR in the unemployed group warrants attention. While their prevalence (7%) is higher than that of the employed, it's still lower than business owners. Yin *et al*.[15] highlighted that unemployment can contribute to psychological stress, reduced self-worth and inaccessibility to timely healthcare-factors that might enhance DR risk. Nonetheless, the lower prevalence in comparison to business owners suggests the need to further investigate the unique challenges faced by each group.

Table 4 illuminates the correlation between health insurance status and the prevalence of diabetic retinopathy (DR) among 500 individuals. A striking observation is that despite the larger proportion of insured individuals, their prevalence of moderate to severe DR (14%) is only marginally higher than the uninsured group (11%).

The protective benefits of health insurance in managing chronic conditions have been well-documented. In a landmark study by Syriga *et al*.[16] individuals with health insurance were more likely to regularly access primary care, adhere to medication and benefit from early disease detection and intervention, all factors that reduce the complications of diabetes, including DR.

However, our findings slightly deviate from these established patterns. One potential explanation could be gleaned from the study by Zheng *et al*.[17] which indicated that merely possessing insurance doesn't guarantee the quality of care or eliminate barriers such

as high deductibles, co-payments or lack of access to specialists, factors which could still lead to suboptimal diabetes management.

Conversely, the somewhat elevated prevalence of DR in the uninsured group echoes findings from Harjutsalo *et al*.[18]. Their research underscored that uninsured individuals often delay or skip necessary care due to cost concerns, resulting in late-stage disease diagnoses and complications. The 11% prevalence in our uninsured group might reflect such barriers.

CONCLUSION

The study underscores the multifaceted nature of DR's occurrence in relation to socioeconomic determinants. With a quarter of the sampled population displaying moderate to severe DR, it's evident that this remains a significant public health concern. Socioeconomic disparities, manifested in income, educational attainment, occupational status and health insurance access, significantly influence the prevalence of DR. Particularly, business owners, those with low income and individuals lacking formal education are at heightened risk. Despite the protective presumption of health insurance, it is evident that simply having coverage does not unequivocally equate to reduced DR prevalence. This study accentuates the need for tailored interventions that not only focus on medical treatment but also address socioeconomic barriers. Addressing these disparities can play a pivotal role in curbing the incidence of DR and ensuring equitable health outcomes for all. Future strategies must be holistic, targeting healthcare access, quality and socioeconomic upliftment to effectively combat the menace of DR in diverse populations.

LIMITATIONS OF STUDY

Cross-sectional design: Given that our study was cross-sectional, we could only infer associations and not causations between socioeconomic factors and the prevalence of diabetic retinopathy.

Self-reported data: Some of the information, especially related to income and education, relied on self-reported data. This method is prone to recall bias or misreporting, which could affect the accuracy of our findings.

Sample representativeness: Though the study encompassed a diverse population, it may not be wholly representative of the broader population. Regional variances or specific ethnic groups might be underrepresented.

Unmeasured confounders: While we evaluated several socioeconomic determinants, there could be other unmeasured or unconsidered factors that influence the prevalence of diabetic retinopathy. For instance, genetic predisposition or comorbid health conditions might play a role.

Measurement tools: The tools and scales used for determining the severity of diabetic retinopathy or assessing socioeconomic factors might have intrinsic limitations or biases.

Temporal variability: The study's findings represent a snapshot in time. Socioeconomic conditions, healthcare accessibility or public health initiatives might change over time, affecting the prevalence rates of DR.

Lack of qualitative insights: While quantitative data provides a broad understanding, qualitative insights that could offer deeper contextual understanding of individual experiences and challenges related to DR were not captured.

Potential for selection bias: The individuals who chose to participate in the study might inherently be different from those who did not potentially skewing the findings.

Generalizability: The findings, while relevant for the studied population, might not be directly generalizable to populations from different geographical locations or cultural backgrounds.

Data collection method: Depending on the mode of data collection (e.g., online surveys, face-to-face interviews), there could be biases introduced. For example, certain demographic groups might be more or less likely to respond to online surveys.

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