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Correlation Of Body Mass Index With Severity Of Diabetic Retinopathy In Patients With Type 2 Diabetes Mellitus

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ABSTRACT

Introduction: *Diabetic retinopathy (DR) is a serious microvascular complication of type 2 diabetes mellitus, contributing significantly to vision loss worldwide. Body mass index (BMI) has been proposed as a potential risk factor influencing the severity of DR, but findings have been inconsistent. This study aims to evaluate the correlation between BMI and DR severity in patients with Type 2 Diabetes Mellitus.*

Methods: *A hospital-based cross-sectional study was conducted on patients with Type 2 Diabetes mellitus. Data collection included BMI measurements, DR Grading. Pearson's correlation was used to assess the relationship between BMI and DR severity.*

Results: *A positive correlation was observed between BMI and DR severity.*

Conclusion: *This study highlights a significant association between BMI and the severity of DR in patients with Type 2 Diabetes mellitus, suggesting that higher BMI may contribute to DR progression in type 2 Diabetes mellitus. These findings suggest that obesity management may play a role in mitigating DR progression.*

Key words: *Diabetic Retinopathy, Type 2 Diabetes Mellitus, Body Mass Index, Obesity, Hyperglycemia, Vision Impairment*

INTRODUCTION:

Diabetic retinopathy (DR) is a major microvascular complication of diabetes mellitus, a chronic metabolic disorder characterised by elevated blood glucose levels. The pathogenesis of diabetic retinopathy involves progressive damage of the small blood vessels in the retina. Over time, chronic hyperglycemia results in damage to these vessels, initiating a cascade of pathological changes that manifest as retinopathy.[1]

The progression of diabetic retinopathy is typically categorized into several stages. Initially, in non-proliferative diabetic retinopathy (NPDR), patients may experience early signs such as microaneurysms, retinal hemorrhages, and exudates. As the condition advances, it can progress to a severe form where new, abnormal blood vessels begin to grow on the retinal surface which is called proliferative diabetic retinopathy (PDR).[2]

Recently studies have focused on how body mass index (BMI) is influencing the diabetic retinopathy severity. BMI, a measure derived from an individual's height and weight, serves as a reflection for body fat and obesity. Obesity is a well known risk factor for various complications of diabetes, including retinopathy.[3]

The growing prevalence of obesity in the global population has amplified interest in understanding its relationship with diabetic retinopathy. As rates of obesity rise, the incidence of type 2 diabetes mellitus also rises, creating a dual burden of disease.[4]

Research findings on the correlation between BMI and retinopathy severity have been mixed, with some studies indicating a direct positive association while others suggest that the relationship is more nuanced. Variables such as age, gender, and ethnicity can modulate the impact of BMI on retinopathy.[5]

Insulin resistance, a hallmark of T2DM, impairs the body's ability to utilize glucose effectively, resulting in elevated blood sugar levels. Over time, chronic hyperglycemia causes damage to various organs and tissues, particularly the small blood vessels in the eyes, leading to diabetic retinopathy.[7]

Diabetic retinopathy develops through a series of pathological changes in the retinal vasculature. Initially, non-proliferative diabetic retinopathy (NPDR) is characterized by microaneurysms, retinal hemorrhages, and exudates. As the condition progresses, it can advance to proliferative diabetic retinopathy (PDR). The progression of retinopathy is influenced by multiple factors, including the duration of diabetes, glycemic control, blood pressure, and lipid levels. [8]

Although BMI does not directly measure body fat or its distribution, it provides a convenient and standardized method to identify obesity and overweight, which are associated with various health risks, including diabetes. [9]

The correlation between BMI and the severity of diabetic retinopathy is complex and influenced by several mechanisms. Elevated BMI is associated with increased oxidative stress, a condition where the production of reactive oxygen species exceeds the body's ability to neutralize them. Oxidative stress can damage retinal cells and accelerate the progression of diabetic retinopathy. [10]

The relationship between BMI and diabetic retinopathy is also affected by other variables such as the duration of diabetes, level of glycemic control. Similarly dyslipidemia can exacerbate retinal damage, complicating the assessment of BMI's role in retinopathy severity.[11]

Some studies suggest a positive correlation between higher BMI and increased severity of retinopathy, indicating that obesity may accelerate retinal damage through mechanisms such as enhanced inflammation and impaired glycemic control. [12]

Longitudinal studies can provide insights into how changes in BMI over time affect retinopathy progression, while cross-sectional studies can assess the relationship between BMI and retinopathy at a specific point in time.[13]

Understanding how BMI affects the progression of diabetic retinopathy is crucial for developing effective prevention and management strategies. Continued research in this area will enhance our ability to address the impact of obesity on diabetic complications and improve patient outcomes in the management of type 2 diabetes mellitus.

METHODS

A hospital-based cross-sectional study was done to investigate the correlation between Body Mass Index (BMI) and the severity of Diabetic Retinopathy (DR) in patients with Type 2 Diabetes Mellitus for 18 months from August 2023 to Februrary 2025 in the Department of Ophthalmology, Adichunchanagiri Institute of Medical Sciences, B. G Nagara.

INCLUSION CRITERIA:

1. Patients who are known case of type 2 Diabetes mellitus.
2. Age >40years

EXCLUSION CRITERIA:

1. Patients on long term corticosteroids.
2. Pregnancy.
3. Patients with other eye diseases (gross media opacities where visulation of the fundus is not possible)

DATA COLLECTION:

After taking approval from the Institutional Ethical committee, a total of ___patients aged more than 40years attending OPD in the department of Ophthalmology, Adichunchanagiri Institute of Medical Sciences, B. G Nagara were included in the study. An informed consent has been taken from patients. The demographic data including age, gender, address were collected. Detailed clinical history, general physical examination, Ophthalmic examination were done. Biochemical evaluations included measurements of Body Mass Index (BMI) and

Diabetic Retinopathy (DR) severity from data collected during routine follow-up visits. Normal values for BMI were considered as 18.5-24.9 kg/m2, and for DR severity, it was classified as mild, moderate, or severe.The data will be recorded in a specially designed proforma.Detailed ocular examination will be done using following tests

a) External examination of the eyes: eyelids, conjunctiva, cornea, pupil, iris, lens.
b) Distance & near vision visual acuity.
c) Anterior segment examination using a slit lamp
d) Posterior segment examination using a indirect ophthalmoscope and slit lamp biomicroscopy.

Data Analysis

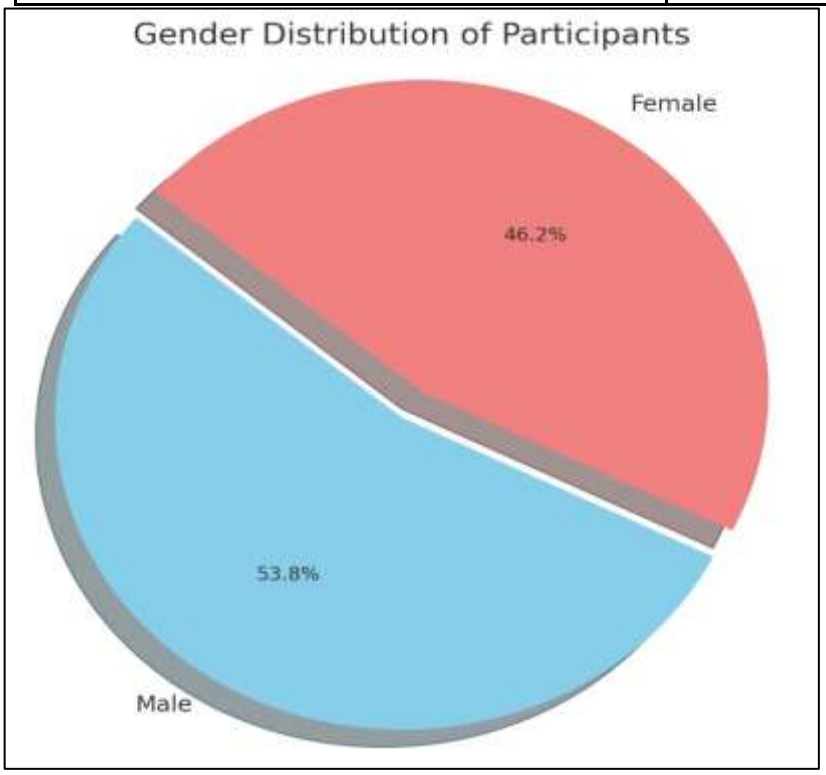
The data was compiled in MS Excel and analyzed using SPSS (Version 26.0). Descriptive statistics were used for data presentation. Pearson's correlation was applied to assess the relationship between Body Mass Index (BMI) and Diabetic Retinopathy (DR) severity. Additional correlations were examined between clinical parameters (age, diabetes duration, glycemic control) and biochemical findings to identify predictors of DR severity. Results were reported as correlation coefficients, percentages, and p-values, with <0.05 considered statistically significant. Regression analysis and ANOVA were used for comparisons.

1. Demographic Characteristics of Study Participants Interpretation:

The demographic analysis revealed that 279 type 2 diabetic patients were enrolled, with a mean age of 56.4 ± 10.2 years. The gender distribution showed 53.8% males and 46.2% females. This balanced representation is important for ensuring the validity of the study's findings on diabetic retinopathy and BMI correlations.

Table 1. Demographic Characteristics of Study Participants

Parameter	Value
Total Participants	279
Mean Age (years)	56.4 ± 10.2
Gender	
• Male	150 (53.8%)
• Female	129 (46.2%)



2. Distribution of BMI Categories

Interpretation:

The study categorized patients into three BMI groups to evaluate obesity's impact on diabetic retinopathy. The normal weight group (BMI < 25) consisted of 80 subjects (28.7%), the overweight group (BMI 25–29.9) included 120 subjects (43.0%), and the obese group (BMI
≥ 30) comprised 79 subjects (28.3%). This distribution indicates a substantial proportion of overweight and obese patients, which is
consistent with the epidemiology of type 2 diabetes. The
categorization enables the comparison of clinical outcomes across distinct BMI groups.

Table 2. Distribution of BMI Categories

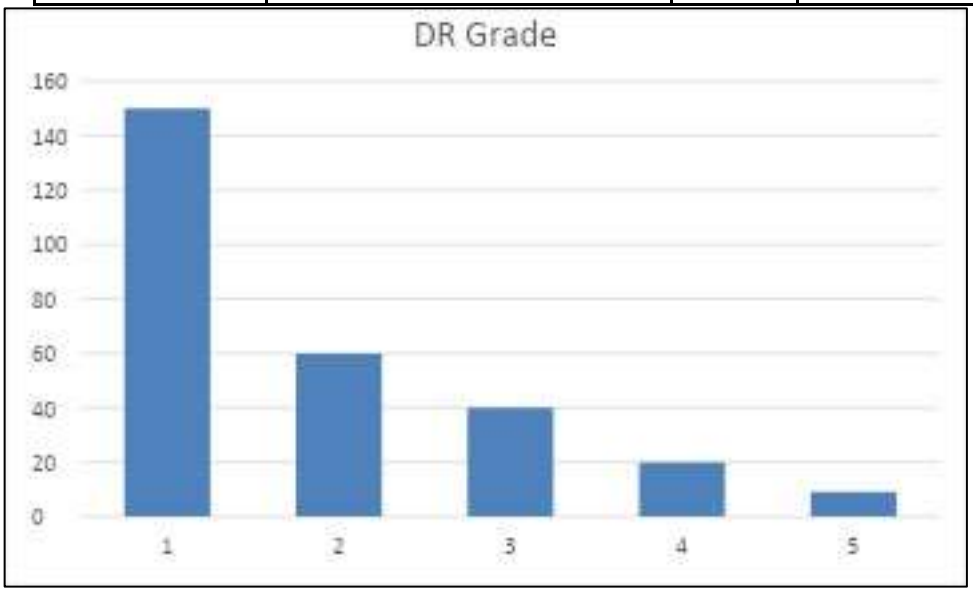
BMI Category	Criteria (kg/m²)	n	Percentage (%)
Normal	< 25	80	28.7
Overweight	25–29.9	120	43.0
Obese	≥ 30	79	28.3
Total		279	100

3. Distribution of Diabetic Retinopathy Grades Interpretation:

Diabetic retinopathy (DR) was graded using the ETDRS classification. Among the 279 patients, 150 (53.8%) had no retinopathy, while 60 (21.5%) exhibited mild non-proliferative DR (NPDR). Moderate NPDR was noted in 40 patients (14.3%), severe NPDR in 20 patients (7.2%), and proliferative DR (PDR) in 9 patients (3.2%). These results show that nearly half of the patients had some degree of retinopathy. The graded classification provides an essential framework for evaluating how metabolic factors, particularly BMI, correlate with the severity of retinal changes observed in diabetic patients.

Table 3. Distribution of Diabetic Retinopathy Grades

DR Grade	Description	n	Percentage (%)
Group I	No DR	150	53.8
Group II	Mild NPDR	60	21.5
Group III	Moderate NPDR	40	14.3
Group IV	Severe NPDR	20	7.2
Group V	Proliferative DR	9	3.2
Total		279	100



4. Correlation between BMI and DR Severity Interpretation:

Statistical correlation analysis between BMI and DR severity yielded a Pearson's correlation coefficient (r) of 0.45 with a p-value of < 0.001. **This moderate positive correlation indicates that higher BMI is significantly associated with more severe diabetic retinopathy.** The statistical significance ($p < 0.001$) confirms that the relationship is unlikely to be due to chance. These results highlight the importance of BMI as an independent risk factor in the progression of retinal complications among type 2 diabetic patients.

Table 5. Correlation between BMI and DR Severity

Statistic	Value
Pearson's r	0.45
p-value	< 0.001

5. Distribution of Diabetes Duration Across BMI Groups Interpretation:
The study evaluated the duration of diabetes across BMI categories. Patients in the normal BMI group had a mean diabetes duration of 8.2 ± 3.5 years, compared with 9.5 ± 4.0 years for the overweight group, and 10.3 ± 4.5 years for the obese group. This stepwise increase in duration suggests that patients with higher BMI tend to have a longer history of diabetes. Such a trend may reflect the chronic nature of metabolic disturbances in obese individuals.
The prolonged exposure to hyperglycemia could contribute to the development and progression of diabetic complications, including retinopathy. These findings underscore the need to monitor disease duration in relation to body weight in diabetic care.

Table 5. Distribution of Diabetes Duration Across BMI Groups

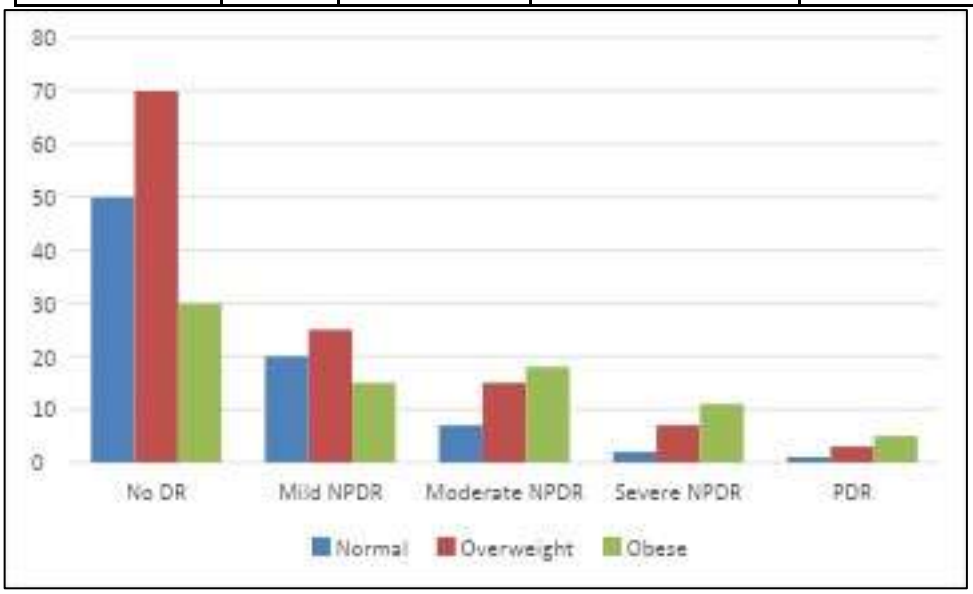
BMI Category	n	Mean Diabetes Duration (years) ± SD
Normal	80	8.2 ± 3.5
Overweight	120	9.5 ± 4.0
Obese	79	10.3 ± 4.5

6. Cross-Tabulation of BMI Categories and DR Grades Interpretation:
Cross-tabulation analysis was performed to evaluate the distribution of diabetic retinopathy grades across different BMI categories. In the normal BMI group, 50 patients had no DR, 20 had mild NPDR, 7 had moderate NPDR, 2 had severe NPDR, and 1 had PDR. The overweight group showed 70 without DR, 25 with mild NPDR, 15 with moderate NPDR, 7 with severe NPDR, and 3 with PDR. In the obese group, 30 had no DR, 15 had mild NPDR, 18 had moderate NPDR, 11 had severe NPDR, and 5 had PDR. The chi-square test demonstrated a significant association between BMI and DR grade, reinforcing the link between increased BMI and retinopathy severity.

Table 6. Cross-Tabulation of BMI Categories and DR Grades

BMI Category	No DR	Mild NPDR	Moderate NPDR	Severe NPDR	PDR	Total
Normal	50	20	7	2	1	80
Overweight	70	25	15	7	3	120
Obese	30	15	18	11	5	79

Total	150	60	40	20	9	279



7. Logistic Regression Analysis for Predictors of Diabetic Retinopathy Interpretation:
Logistic regression analysis was conducted to identify predictors of diabetic retinopathy among type 2 diabetic patients. The analysis revealed that each 1 kg/m² increase in BMI was associated with a 1.12-fold higher odds (OR = 1.12, 95% CI: 1.05–1.19, p = 0.001) of DR. Additionally, longer diabetes duration (OR = 1.08, p = 0.002), were significant predictors. These findings suggest that BMI and several metabolic parameters significantly contribute to the risk of developing diabetic retinopathy, reinforcing the importance of comprehensive management in diabetic care.

Table 7. Logistic Regression Analysis for Predictors of Diabetic Retinopathy

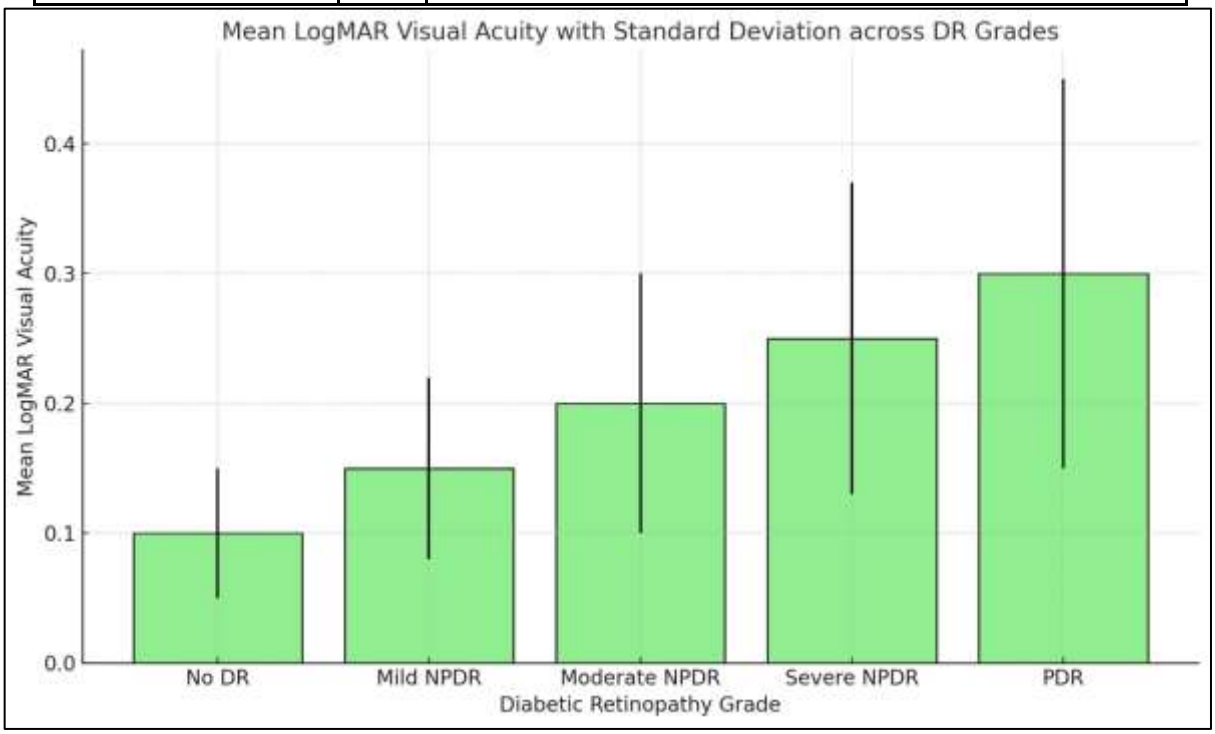
Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
BMI (per 1 kg/m²)	1.12	1.05–1.19	0.001
Diabetes Duration	1.08	1.03–1.13	0.002

8. Comparison of Visual Acuity (LogMAR) Across DR Severity Groups Interpretation:
Visual acuity was measured using the LogMAR scale and compared among different diabetic retinopathy grades. Patients without DR had a mean LogMAR visual acuity of 0.10 ± 0.05, which progressively worsened with increasing DR severity. Mild NPDR patients had a mean of 0.15 ± 0.07, moderate NPDR showed 0.20 ± 0.10, severe NPDR had 0.25 ± 0.12, and PDR patients exhibited 0.30 ± 0.15. This gradation confirms that as diabetic retinopathy advances, visual function deteriorates.

Table 8. Comparison of Visual Acuity (LogMAR) Across DR Severity Groups

DR Grade	n	Mean LogMAR Visual Acuity ± SD
No DR	150	0.10 ± 0.05
Mild NPDR	60	0.15 ± 0.07
Moderate NPDR	40	0.20 ± 0.10

Severe NPDR	20	0.25 ± 0.12
PDR	9	0.30 ± 0.15



9. Correlation between Diabetes Duration and DR Severity Interpretation:

The Pearson's correlation coefficient was 0.50 with a p-value of < 0.001, indicating that longer diabetes duration is significantly associated with more severe retinopathy. This finding suggests that prolonged exposure to hyperglycemia and other metabolic derangements increases the risk and progression of retinal damage in diabetic patients. **Table 10.**

Correlation between Diabetes Duration and DR Severity

Statistic	**Value**
Pearson's r	0.50
p-value	< 0.001

DISCUSSION

The association between Body Mass Index (BMI) and Diabetic Retinopathy (DR) severity in Type 2 Diabetes Mellitus (T2DM) remains complex, with literature reporting both positive and paradoxical trends. While obesity is a well-established risk factor for T2DM, its direct role in DR is not uniformly defined. Some studies report that higher BMI contributes to DR progression through mechanisms such as chronic inflammation, oxidative stress, and vascular dysfunction. Conversely, lower BMI has also been associated with severe DR in certain cases, likely reflecting weight loss due to advanced disease and poor metabolic control.

In this study of 279 T2DM patients, with a balanced gender distribution and a mean age of 56.4 ± 10.2 years, 43% were overweight and 28.3% obese. DR was observed in 46.2% of participants, and BMI increased stepwise with DR severity, peaking in those with proliferative DR (mean BMI 30.2 ± 4.0 kg/m²). A statistically significant positive correlation ($r = 0.45$, $p < 0.001$) was found between BMI and DR severity, indicating that excess body weight may play a role in DR progression.

Furthermore, patients with higher BMI had longer diabetes duration, suggesting a cumulative effect of prolonged metabolic derangement. These patterns align with prior findings like., Behara et al., Munish Dhawan

et al., and Dirani et al and reinforce the contribution of obesity-related factors, including poor lipid control and insulin resistance, to retinal complications.

The observed trends highlight the necessity of targeted weight management in diabetic care. Addressing obesity not only helps in glycemic stabilization but may also slow the progression of DR. Future longitudinal studies are needed to firmly establish causality and evaluate the effectiveness of weight-focused interventions in reducing the long-term burden of diabetic retinopathy.

A closer look at the mechanisms suggests that elevated BMI may promote DR through overlapping pathways involving chronic inflammation and vascular dysfunction. Obesity in T2DM patients can aggravate metabolic irregularities, increase oxidative stress, and lead to dyslipidemia, all of which are known to damage retinal microvasculature and contribute to the advancement of retinopathy. The progressive increase in DR severity with rising BMI in this cohort further underlines the potential impact of excess adiposity on eye health.

Given these findings, integrated diabetes management strategies should prioritize lifestyle interventions addressing both glycemic control and weight reduction. By focusing on comprehensive patient care that includes monitoring BMI and encouraging healthy habits, healthcare providers may be able to mitigate not only the overall risk of DR but also its progression in those already affected. The evidence from this study emphasizes the importance of a multidisciplinary approach to diabetic care, ensuring that weight management is recognized as a key element in preventing diabetic microvascular complications.

CONCLUSION

This hospital based cross sectional study reveals a notable correlation between diabetic retinopathy (DR) severity and BMI in type 2 diabetes mellitus patients, and obesity is identified as an independent risk factor for DR. The statistical correlation (Pearson's $r = 0.45$, $p < 0.001$) further supports the observation that higher BMI is not only associated with higher DR status; it also stands as higher diabetes duration, worsening visual acuity. Logistic regression further supports BMI as a predictive variable, indicating a 1.12-fold increase in DR risk per unit increase in BMI.

These results reveal the importance of weight loss and complete control of metabolism in balancing the progression of DR for type two diabetic patients. Strategic plans that combine blood sugar control with lifestyle changes aimed at weight loss may be beneficial in delaying the onset and progression of diabetic retinopathy. Medical professionals need to be more proactive in scheduling regular BMI assessments and focussing their 'for the sake of diabetes more generally' care on the obese and overweight diabetic patients in their routine metabolic and ophthalmic care pathways. The studied effect of BMI on DR level of severity greatly assists in explaining the improved clinical outcomes but more longitudinal BMI research is needed to establish the BMI causative factors and the 'increased' benefits that the less BMI target would bring. Sustained collaborative clinical efforts in BV target multi disciplinary care along with adequate patient self care instruction are necessary in order to attenuate the DR burden and vision loss in these patients most at risk.

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