



Effect of obesity on tear film and ocular health among diabetic patients

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 **CONFLICT OF INTEREST**
None declared.

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ABSTRACT

Purpose: To evaluate the effect of obesity on tear film and ocular health in diabetic patients.

Methodology: This was a cross-sectional observational study conducted over six months at Alvi Hospital & Maternity Home Hospital, Lahore. A total of 120 diabetic patients aged 18 to 70 years were selected using purposive sampling. The contestants were divided into three BMI groups: normal (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), and obese (≥ 30 kg/m²). Only individuals with confirmed type 1 or type 2 diabetes and stable glycemic control (HbA1c recorded) were included. Tear film quality was examined through Schirmer's test for tear production and TBUT using fluorescein dye and slit-lamp biomicroscopy. Ocular sensitivity was measured using the OSDI questionnaire. P-value < 0.05 was considered significant.

Results: Among 120 diabetic participants, 38.33% were males, 61.67% females; 20% had type 1, 80% had type 2 diabetes. 27.5% had normal weight, 36.67% were overweight, and 35.83% were obese. The most frequently reported ocular symptoms were dry eyes (40.8% sometimes), gritty sensation (40.8% sometimes), and blurred vision (48.3% sometimes). A significant negative correlation was found between BMI and TBUT ($r = -0.992$, $p < 0.001$), BMI and Schirmer test ($r = -0.990$, $p < 0.001$), indicating reduced tear stability and production with higher BMI. Kruskal-Wallis test showed significantly lower mean ranks of TBUT and Schirmer scores in obese participants compared to normal BMI, $p < 0.001$.

Conclusion: Diabetes patients with higher BMI had considerably worse tear film characteristics, which emphasizes how crucial weight control is to maintaining the health of the ocular surface.

 **KEYWORDS** Diabetes, Obesity, Tear film



INTRODUCTION

Diabetes constitutes one of the leading causes of blindness in those aged 20 to 70. Diabetes is known to cause retinopathy and cataracts, two eye conditions. However, ocular surface problems, especially dry eye in diabetics, have recently drawn increased attention. (1) Hyperglycemia caused by deficits related to insulin action or secretion or is a hallmark of diabetes mellitus, among the group of metabolic diseases. (2) An in-depth analysis of the two main etiopathogenic subdivisions that account for the majority of diabetes cases is provided below. Complete lack of insulin secretion causes one form of diabetes. Genetic markers and serological evidence of an autoimmune pathologic process in the pancreatic islets are frequently used to identify people who are more likely to develop this type of diabetes. Type 2 diabetes, which is far more common, is caused by a combination of an insufficient compensatory insulin secretory response and immunity to the effects of insulin. (2) Type 1 diabetes manifests as unusual dryness along with a dry mouth, excessive urination, fatigue, persistent thirst, sudden weight loss, bedwetting, and blurred eyesight. Type 2 diabetes mainly affects older individuals; however, because of expanding obesity, sedentary lifestyles, and bad eating habits, it is becoming more common in younger generations. (3)

The ocular surface epithelium and the surroundings are connected by the tear film. Water, electrolytes, mucins, and a variety of proteins and lipids make up the precorneal tears' extremely complex makeup, despite its estimated 3-micron thickness. (4) Protecting the eye from the environment, lubricating the surface, keeping the conjunctiva and avascular cornea healthy, and maintaining a smooth surface for light refraction are all made possible by the tear film, which covers the ocular surface. The tear film secretes at a rate of 1 to 2 L/min, has a volume of around 3 to 10 L, and is 3 μm thick. (5) Tears have a PH of about 7.45, with seasonal and diurnal factors causing it to vary from 7.14 to 7.82. (6) The three layers of the tear film are the outer lipid layer, which lowers tears evaporation and contains cholesterol, fatty acids and phospholipids; the middle aqueous layer, which supplies lubrication, nutrients and debris removal with proteins, electrolytes and metabolites; and the inner mucin layer, which stabilizes the aqueous layer and is primarily secreted by goblet cells. Tears have been found to include over 600 distinct lipids from 17 different classes, demonstrating their complicated makeup and importance for eye health. (7) The lipid layer's primary function is to slow down the evaporation of tears from the surface of the eye. The majority of tears are made up of the aqueous/mucin layer. The lacrimal glands release a particular range of proteins, electrolytes, and water in addition to the majority of the aqueous fluid. An additional source of water and electrolytes in the tears is the conjunctival epithelium. The underlying avascular corneal tissue receives oxygen and nutrition from the aqueous phase, which also removes poisons, foreign objects, and epithelial detritus. (7)

Numerous tests and non-invasive tools can be employed for the evaluation of DES. The Schirmer test (TBUT) and ocular surface staining with fluorescein sodium, Lissamine green, and rose bengal are the methods for diagnosis that are most favored. Interferometry, infrared meibography, matrix metalloproteinase 9 (MM-9), lactoferrin levels, tear film osmolarity, and microassays of immunoglobulin E (IgE) are a few of the quantitative but costly diagnostic tests. Additionally, blink rate estimation is highly important. (8) One of the major warning signs for several health issues, including eye disorders, is obesity. Obesity in diabetes people makes problems with the tear film and general eye health worse. According to studies, people with diabetes mellitus frequently have decreased tear function, which can be made worse by inadequate glycaemic control. (9)

If an individual's BMI, which is determined by calculating their weight by the square of their height, is greater than or equal to 30, they qualify as obese. If your BMI falls between 25.0-29.9, you are considered overweight. Being overweight or obese is more common than being underweight around the globe, and it is linked to more fatalities than being underweight. With the rare exceptions of certain regions of Africa and sub-Saharan Asia, this natural occurrence happens all over the world. (10) The overall incidence of overweight and obesity among adolescents as well as adults is still rising. The percentage of obese adults over the age of 18 almost doubled from 7% to 16% between 1990 and 2022, while the percentage of obese children and adolescents between the ages of 5 and 19 rose from 2% to 8% worldwide. (11) Numerous variables can play a role in developing and retaining extra weight. These include nutrition, lack of activity, environmental influences, and heredity (12). Some medications, such as antidepressants, corticosteroids, and medications for seizures, might also make you gain weight. According to the latest research, those who receive fewer sleep hours are more inclined to be overweight or obese. Sleep-related hormones that control hunger and energy expenditure are partly to blame for this. (13) Someone's ability to gain weight may also be influenced by their genes. Researchers think that while genes may make a person more likely to be obese, other variables, such as a diet high in food or a lack of exercise, may also be necessary for someone to be overweight (14) Obesity raises insulin resistance, which raises the risk of type 2 diabetes and is linked to a number of major health issues. Being overweight is related to an increased risk of heart attacks, strokes, and hypertension. Excess weight puts stress on joints, causing osteoarthritis and joint degeneration. Sleep apnea can result from fat deposits around the neck that block breathing while you're asleep. A higher risk of several cancers, such as liver, colon, and breast cancer, is linked to obesity. (15) A higher incidence of





diabetic retinopathy, a consequence of diabetes mellitus, is linked to obesity. The production of inflammation-related cytokines by adipose tissue can impact ocular tissues and accelerate the course of the disease. obesity has also been associated with ocular surface disease, including DE symptoms. (16)

METHODOLOGY

This observational cross-sectional study was conducted over six months at Alvi Hospital, with purposive sampling of 120 diabetic patients aged 18 years or older, classified into normal weight, overweight, and obese groups based on BMI. Inclusion criteria included confirmed Type 1 or Type 2 Diabetes Mellitus, stable glycemic control, and no recent ocular surgeries or other ocular surface diseases. Tear film stability and production were assessed using Tear Break-Up Time (TBUT) and Schirmer's test, respectively. The ocular surface disease index (OSDI) A questionnaire and slit lamp biomicroscopy were used to evaluate ocular surface health. Demographic and clinical data, including HbA1c and BMI, were recorded. All assessments were done under standardized conditions by trained personnel. Data were analyzed using SPSS, applying non-parametric tests due to non-normal data distribution. Kruskal-Wallis and Pearson correlation were used, with a significance level set at $p < 0.05$.

RESULTS

In this study, the normality of data was assessed through the Shapiro-Wilk test. Results indicated that data were not normally distributed ($P < 0.05$). The present study was conducted on 120 patients, of whom 46(38.33%) were males and 74(61.67%) were females, as shown in Figure 1.

Figure No. 1: Gender Distribution Among Study Participants

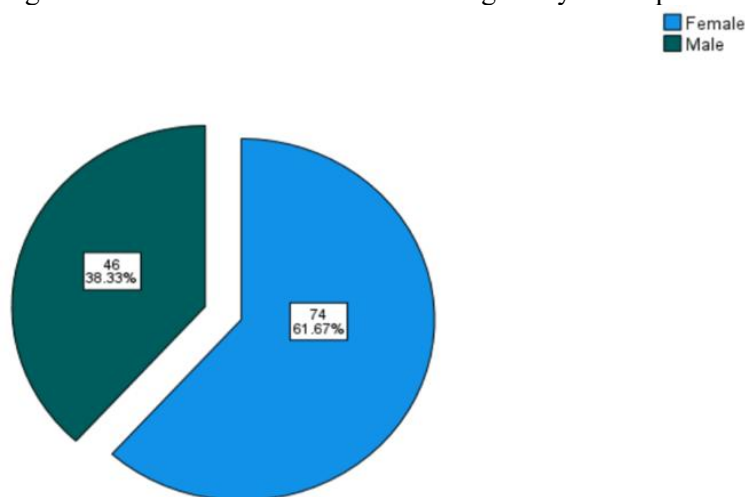
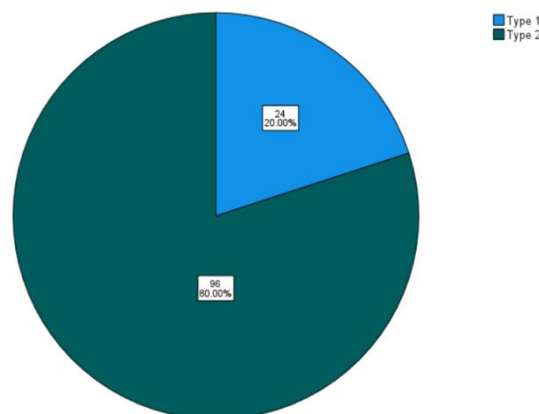


Figure No. 2: Types of Diabetes



In this study, 24 patients (20.0%) had type 1 diabetes, while 96 patients (80.0%) had type 2 diabetes. In this study, more than half of the individuals, 35.83% fell into the obese category, 36.67% classified as overweight, and only 27.50% with a normal BMI.

Figure No. 3: Distribution of BMI

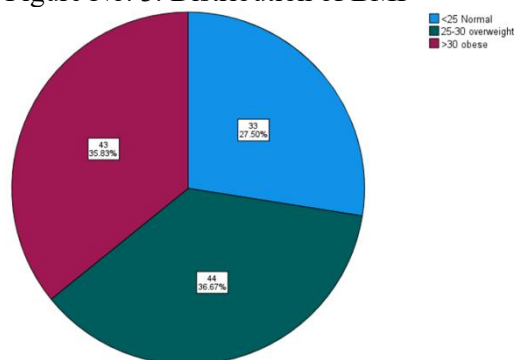




Table No. 1: Descriptive Profile of Study Participants

	N	Minimum	Maximum	Mean	Std. Deviation
Age	120	45	65	55.25	5.569
Duration of Diabetes (years)	120	1	25	11.78	7.432
HbA1c	120	6.5	9.6	7.327	.5820
BMI	120	21.60	36.50	28.5950	4.56427

In the present study, the mean age was 55.3 ± 5.6 years, ranging from 45–65 years. The average duration of diabetes among participants was 11.8 ± 7.4 years, with values spanning from 1 to 25 years, indicating a mix of recently diagnosed and long-standing cases. The average HbA1c was $7.33 \pm 0.58\%$, suggesting moderate glycemic control within the study population. Regarding body mass index (BMI), participants demonstrated an average BMI of 28.6 ± 4.6 kg/m², with values ranging from 21.6 to 36.5 kg/m², indicating that the majority were overweight or obese.

Table No. 2: Ocular Symptoms Among Diabetics

Symptoms	Never n (%)	Rarely n (%)	Sometimes n (%)	Often n (%)	Always n (%)	P-value
Dry Eyes	11 (9.2)	24 (20.0)	49 (40.8)	25 (20.8)	11 (9.2)	<0.001
Gritty/Sandy Eyes	14 (11.7)	26 (21.7)	49 (40.8)	24 (20.0)	7 (5.8)	<0.001
Painful Eyes	8 (6.7)	26 (21.7)	44 (36.7)	30 (25.0)	12 (10.0)	<0.001
Blurred Vision	10 (8.3)	21 (17.5)	58 (48.3)	17 (14.2)	14 (11.7)	<0.001
Light Sensitivity	11 (9.2)	19 (15.8)	48 (40.0)	29 (24.2)	13 (10.8)	<0.001
Reading Difficulty	7 (5.8)	31 (25.8)	46 (38.3)	20 (16.7)	16 (13.3)	<0.001
Driving at Night	21 (17.5)	22 (18.3)	46 (38.3)	21 (17.5)	10 (8.3)	<0.001
Computer Use	14 (11.7)	22 (18.3)	49 (40.8)	30 (25.0)	5 (4.2)	<0.001
Watching TV	9 (7.5)	20 (16.7)	59 (49.2)	26 (21.7)	6 (5.0)	<0.001
Windy Conditions	14 (11.7)	29 (24.2)	41 (34.2)	26 (21.7)	10 (8.3)	<0.001
Low Humidity	13 (10.8)	18 (15.0)	50 (41.7)	27 (22.5)	12 (10.0)	<0.001
Air Pollution	14 (11.7)	21 (17.5)	51 (42.5)	25 (20.8)	9 (7.5)	<0.001

Out of 120 diabetic patients evaluated using the OSDI, symptoms of dry eye and related discomfort were frequently stated. The majority of participants reported experiencing dry eyes sometimes (40.8%) or often (20.8%). Similarly, gritty or sandy sensations were stated sometimes (40.8%) or often (20%). Painful eyes were experienced sometimes by 36.7% and often by 25% of participants. Blurred vision affected nearly half of the respondents sometimes (48.3%), while 14.2% experienced it often. Other symptoms, such as light sensitivity, difficulty reading, and problems with computer use, were also common, with “sometimes” responses ranging from 38–42% across these items. Environmental triggers, including wind, low humidity, and air pollution, were also distinguished, with around one-third to one-half of patients reporting symptoms sometimes or often. These findings suggest a substantial burden of ocular surface symptoms among diabetic individuals, emphasizing the need for screening and management of dry eye disease.

Table No. 3: Correlation between BMI and Clinical Tests

	TBUT	Schirmer's
Pearson Correlation	-0.992	-0.990
P-value	<0.001	<0.001
No. of cases	120	120

There was a statistically significant $p < 0.001$ and strong negative correlation between BMI and TBUT among diabetic patients, indicating that higher BMI was associated with significantly lower tear break-up time, suggesting poorer tear film stability. Moreover, there was also a strong and statistically significant $p < 0.001$ negative correlation between BMI and Schirmer test scores among diabetic patients. It was revealed that higher BMI was associated with significantly reduced tear production.





Table No. 4:

BMI Category	N	TBUT Mean Rank	Schirmer Mean Rank
<25 (Normal)	33	103.53	103.29
25–30 (Overweight)	44	65.23	64.95
>30 (Obese)	43	22.64	23.10
P-value		<0.001	<0.001

A Kruskal-Wallis test was used to compare TBUT and Schirmer test results across three BMI categories. The results revealed statistically significant differences in both TBUT ($p < 0.001$) and the Schirmer test ($p < 0.001$) among the groups. Participants in the normal BMI category had the highest mean ranks for TBUT (103.53) and Schirmer (103.29), indicating better tear film stability and production, while those in the obese category had the lowest ranks (22.64 for TBUT and 23.10 for Schirmer), suggesting greater impairment of tear function associated with obesity.

DISCUSSION

The present study evaluated the relationship between BMI and ocular surface parameters among diabetic individuals aged 18-70 years. Findings demonstrated a significant association between increased BMI and worsening tearfilm parameters, as evidenced by both subjective symptoms and objective clinical tests. Among the 120 diabetic patients, 61.67% were females and 38.33% were males. Type 2 diabetes was more prevalent (80.0%) compared to type 1 diabetes (20.0%). BMI distribution showed that 27.50% of participants had a normal weight, 36.67% were overweight, and 35.83% were obese. The average age was 55.3 ± 5.6 years, with a mean diabetes duration of 11.8 ± 7.4 years. Glycemic control was moderate, as reflected by a mean HbA1c of $7.33 \pm 0.58\%$.

Ocular symptoms were commonly reported. Based on the OSDI responses, 40.8% of participants reported dry eyes “sometimes,” and 20.8% often. Gritty sensations were also frequent, reported “sometimes” by 40.8% and often by 20.0%. Painful eyes were noted by 36.7% “sometimes” and 25.0% often. Other symptoms, such as blurred vision, reading difficulty, and light sensitivity, showed similar trends, indicating a high burden of ocular discomfort in this population. As the data were non-normally distributed (Shapiro-Wilk test $p < 0.05$), non-parametric tests were applied. Pearson correlation analysis revealed a strong, statistically significant negative correlation between BMI and both TBUT ($r = -0.992$, $p < 0.001$) and Schirmer’s test scores ($r = -0.990$, $p < 0.001$). These findings indicate that higher BMI is closely associated with reduced tear film stability and tear production.

Additionally, the Kruskal-Wallis test demonstrated significant differences in TBUT and Schirmer scores across BMI categories ($p < 0.001$ for both). Participants with normal BMI had the highest mean ranks (103.53 for TBUT, 103.29 for Schirmer), while obese participants had the lowest (22.64 and 23.10, respectively), supporting the conclusion that increasing BMI correlates with worsening ocular surface function. Saud A. Alanzi and associates examined the impact of body weight on men’s tear film quality in a 2019 study. Two distinct categories were evaluated: one with a high BMI (average 31.8), and the other with a normal weight (average BMI 20.5). There were 20 individuals of the same age in all of them. According to the findings, males with greater BMI had lower-quality tear films. They performed poorly on the tear Ferning test (TF) and NITBUT (a test that evaluates how rapidly tears break apart) than the normal BMI group. Though the individuals with a high BMI group displayed symptoms of dry eye (NITBUT: 8.5 seconds, TF: 2.0), the normal-weight group’s eyes were healthy (NITBUT: 14.7 seconds, TF: 0.7). (17)

In another study, 59 studies including “7234” eyes were examined in a 2022 meta-analysis review to determine the impact of diabetes on tear function. According to the findings, tear production and tear film stability were worse in persons with both type 1 and type 2 diabetes. Patients with diabetes had poorer scores on two crucial tests: the invasive TBUT and the Schirmer 1 test. This indicates that they had dry eye, as evidenced by the fact that their eyes generated fewer tears and the tear layer disintegrated more quickly. (18) In contrast to my research, higher BMI is linked to worse tear film function in diabetics. Most of the 120 participants were overweight or obese, and 61.67% were female. About 30-40% reported symptoms like dry eyes and eye pain. TBUT Schirmer’s test both showed a strong negative correlation with BMI ($p < 0.001$). The tear function was lowest in obese patients, showing the need for weight control to help manage dry eye in diabetics.

CONCLUSION

Diabetes patients with higher BMI had considerably worse tear film characteristics, which emphasizes how crucial weight control is to maintaining the health of the ocular surface



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