Impact of Diabetes on Pregnancy-Related Cataract Formation: A Cross-Sectional Study

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ABSTRACT

Background: Diabetes mellitus is highly prevalent among Pakistani women of reproductive age. Pregnancy-related metabolic changes may accelerate osmotic stress on the lens, leading to early cataract formation. Limited data exist on the burden of lens opacities specifically in diabetic pregnancies.

Objective: To determine the frequency, severity, and predictors of cataract formation among pregnant diabetic women in Pakistan and correlate these findings with physiological glucose parameters.

Methods: A cross-sectional study included 100 pregnant diabetic women (both GDM and pre-existing diabetes) from a tertiary care hospital in Rawalpindi. Each participant underwent Fasting blood glucose (FBG), HbA1c testing, Obstetric evaluation, Slit-lamp ophthalmic examination. Cataracts were graded using the LOCS III system. Data were analyzed using chi-square and Pearson correlation.

Results: The prevalence of cataracts among the 100 participants was 32%.Nuclear cataract was seen in 18% cases, followed by cortical cataract in 9% and then posterior subcapsular cataract (PSC) in 5%. Women with poor glycemic control (HbA1c > 7%) had a significantly higher cataract rate (46%) compared to controlled diabetics (18%) ($p = 0.004$).   A   positive correlation was found between HbA1c and cataract score ($r = 0.62$).

Conclusion: Cataract formation is common in diabetic pregnancies in Pakistan, especially in women with poor glycemic control. Early ophthalmologic screening should be integrated into antenatal care for diabetic pregnancies..

1. INTRODUCTION

Diabetes in pregnancy is a growing public health challenge in Pakistan, with gestational diabetes mellitus (GDM) affecting an estimated 10–17% of pregnancies overall and reaching even higher levels in some urban cohorts [1,2]. In meta-analytic data, the pooled national prevalence of GDM is 16.7%, with particularly high burdens reported from urban and Balochistan-based studies [1]. Hospital-based work from South Punjab likewise shows close to 10% prevalence at delivery and confirms that urban residence, higher education, previous GDM, macrosomic birth and excess gestational weight gain cluster strongly with risk [2]. In this context, Pakistan's rapid urbanisation, rising maternal age and obesity trends create a large cohort of pregnant women exposed to hyperglycaemia at a relatively young age.

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Hyperglycaemia accelerates lens damage through both osmotic and oxidative mechanisms. In the diabetic lens, excess glucose is shunted into the polyol pathway via aldose reductase, producing sorbitol and then fructose [4,5]. Sorbitol's poor membrane permeability leads to intracellular osmotic stress, lens fibre swelling and cortical opacities, while NADPH consumption and excess NADH generation impair glutathione regeneration and promote reactive oxygen species (ROS)–mediated oxidative injury [3–5]. Clinical data now show that adults with diabetes develop cataracts earlier and up to several-fold more frequently than non-diabetic peers, underscoring the lens's particular vulnerability to chronic hyperglycaemia [3].

Pregnancy itself is a pro-oxidant, insulin-resistant state. Contemporary reviews demonstrate that GDM is characterised by increased oxidative stress and low-grade inflammation across maternal blood, placenta, adipose tissue and skeletal muscle [6]. Environmental and dietary factors—air pollution, high-fat diets, micronutrient deficiencies, further amplify ROS generation and worsen glycaemic control in pregnant women [7]. Ophthalmic literature has mainly focused on diabetic retinopathy in pregnancy, highlighting pregnancy as an independent risk factor for microvascular progression [8]. However, pregnancy-related metabolic and oxidative changes may also accelerate lens osmotic and oxidative damage, potentially precipitating "early" diabetic cataract in women who would otherwise present much later in life. Emerging molecular work, such as SMP30-mediated protection of lens epithelial cells via the Keap1/Nrf2/NQO1 antioxidant pathway, reinforces the central role of oxidative stress in diabetic cataractogenesis and points to new therapeutic targets [9].

Despite this, there is virtually no Pakistani data specifically examining cataract prevalence, type and predictors among pregnant women with GDM or pre-existing diabetes. Existing national GDM studies prioritise obstetric and neonatal outcomes, leaving ocular endpoints unreported [1,2]. Our study aims to quantify the cataract prevalence in pregnant diabetic women and identify physiological predictors (e.g. HbA1c, duration of diabetes, treatment modality, blood pressure and proxies of oxidative stress). By focusing on this neglected intersection, we aim to generate context-specific evidence that can inform screening protocols, interdisciplinary antenatal care and early ophthalmic referral pathways for high-risk pregnant women in Pakistan.

2. METHODS

Study Design & Setting

This was a cross-sectional study conducted in the Gynecology/Obstetrics and Ophthalmology Departments of Benazir Bhutto Hospital, a tertiary care teaching hospital located in Rawalpindi, Pakistan. The study was carried out over a period of one year, from January to December 2024. A total of 100 diabetic pregnant women were enrolled in the study using a convenience sampling technique.

Inclusion Criteria

Pregnant women aged 18–40 years

Diagnosed GDM or pre-gestational diabetes

Any trimester

Exclusion Criteria

Pre-existing diagnosed cataract before pregnancy

Hypertension-induced retinopathy

Chronic steroid use

Renal failure

Biochmeical and physiological parameters assessed in the study included fasting blood glucose (FBG), HbA1c, and the duration of diabetes. Obstetric parameters considered were the trimester of pregnancy and the presence of complications such as polyhydramnios, hypertension, and other relevant conditions. Ophthalmologic assessment was performed using slit-lamp examination, with cataracts graded according to the LOClS III system and classified into nuclear, cortical, and posterior subcapsular (PSC) types. Statistical analysis was conducted using SPSS version 26, with descriptive statistics reported as frequencies and mean ± standard deviation. Associations between variables were evaluated using the chi-square test, and Pearson correlation was employed to examine the relationship between HbA1c and cataract severity scores. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

In this study of 100 pregnant women with diabetes, the mean age was 29.4 ± 4.1 years and the mean gestational age was 23.6 ± 6.8 weeks. Overall, 68% had gestational diabetes mellitus, while 32% had pre-gestational diabetes. Mean fasting blood glucose was 132 ± 28 mg/dL, with a mean HbA1c of 7.4 ± 1.2%, and among those with pre-gestational diabetes, the mean duration of disease was 3.6 ± 2.1 years. Cataracts were documented in 32% of participants, comprising 18 nuclear, 9 cortical and 5 posterior subcapsular (PSC) cases. When stratified by glycemic control, cataracts were present in 18% of women with

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HbA1c $\leq$ 7% and in 46% of those with HbA1c > 7% (p = 0.004). There was a positive correlation between HbA1c and cataract severity score (r = 0.62, p < 0.001), and between duration of diabetes and cataract severity (r = 0.49, p = 0.02).

Demographics

Variable	Mean ± SD / n (%)
Age	29.4 ± 4.1 years
Gestational age	23.6 ± 6.8 weeks
GDM	68%
Pre-gestational diabetes	32%

Physiological Parameters

Parameter	Mean ± SD
Fasting Blood Glucose	132 ± 28 mg/dL
HbA1c	7.4 ± 1.2%
Duration of diabetes (pre-gestational)	3.6 ± 2.1 years

Cataract Prevalence (n = 100)

Total cataracts: 32 (32%)

Types of Cataract Among Affected Eyes (n=32)
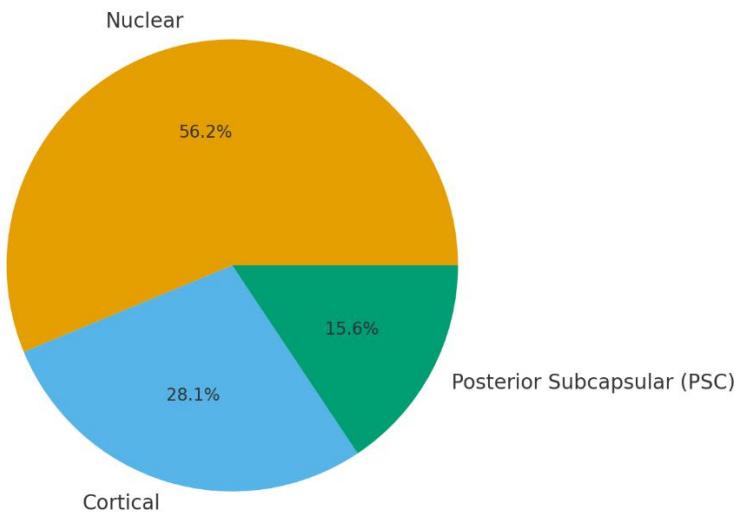
Cataracts vs Glycemic Control

HbA1c Category	Cataract Present	Cataract Absent	p-value
≤ 7%	18%	82%	0.004
> 7%	46%	54%	>0.05

4. DISCUSSION
The present study demonstrates a notable prevalence of cataract in pregnant women with diabetes, a figure that approaches

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or exceeds rates reported in much older adult diabetic cohorts from Northwest Ethiopia, Libya, and the West Bank, where cataract prevalence among clinic-attending diabetics typically ranges high [10–12]. Within our cohort, nuclear opacities predominated, followed by cortical and posterior subcapsular (PSC) types, which is broadly consistent with regional clinic-based series describing nuclear and PSC cataracts as the commonest diabetic phenotypes, though some Middle Eastern and North African cohorts report a higher proportion of cortical change [12–14]. Pakistani cataract-surgery and diabetic eye-clinic data likewise document a substantial co-burden of diabetes and cataract in older adults, with high frequencies of systemic hypertension and other vascular risk factors among cataract patients [15,16]. Against this background, the observation of women exhibiting lens opacities during the second trimester underscores an accelerated trajectory of lens ageing in diabetic pregnancy.

The strong gradient we observed across glycaemic strata—higher cataract prevalence with poorer glycaemic control, with a positive correlation between HbA1c and cataract severity—parallels large cohort data in which higher HbA1c and longer diabetes duration emerge as the dominant modifiable risk factors for diabetic cataract [17,18]. The additional association with duration of pre-gestational diabetes is also concordant with these studies, which show stepwise increases in cataract incidence with longer disease duration [17]. Notably, PSC opacities in our cohort clustered among women with poorer metabolic control, echoing reports that inadequate glycaemic control is particularly linked to PSC and mixed cataract morphologies in diabetics [12,18].

Our physiological interpretation—that higher ambient glucose drives greater sorbitol accumulation and osmotic stress in the lens, superimposed on pregnancy-related oxidative load—is consistent with recent mechanistic reviews highlighting polyol-pathway activation, redox imbalance, and antioxidant depletion as central pathways in diabetic cataractogenesis [19–21]. The slightly higher cataract frequency among women with polyhydramnios in this series further supports the notion that more severe hyperglycaemia, reflected both biochemically (HbA1c) and obstetrically, aggregates with early lens opacification, in line with emerging data that gestational and pre-gestational diabetes confer heightened vulnerability to a spectrum of ocular complications during pregnancy [22]. Taken together, these findings situate diabetic pregnancy as a period of pronounced lens susceptibility, reinforcing the need to integrate formal lens evaluation and tight glycaemic optimisation into multidisciplinary antenatal diabetes care pathways.

5. CONCLUSION

Cataract formation is significantly prevalent among pregnant diabetic women in Pakistan, with glycemic control being the strongest predictor. These results support integrating ophthalmological screening into routine antenatal care.

Disclaimer: Nil

Conflict of Interest: Nil

Funding Disclosure: Nil

Concept & Design of Study: Areesha Kamran, Irsa Zulfiqar, Abdul Rahman Abid, Sufian Ali Khan

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Critical Review: Areesha Kamran, Irsa Zulfiqar, Zehra Niazi, Farzana Rahim Memon

Final Approval of Version: All authors approved the final version.

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