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## **The role of diabetes mellitus in causing posterior subcapsular cataracts in outpatients**

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### **Abstract**

The eye is an essential visual organ for humans. To reduce the rate of cataracts and blindness in Indonesia, data on the leading causes of cataracts or blindness is critical. This study aimed to determine the role of diabetes mellitus in causing cataracts, especially posterior subcapsular cataracts that occur at the Pasuruan Eye Hospital. The sample used in this study was patients who went to the Pasuruan Eye Hospital from February 2020 to February 2021, experiencing posterior subcapsular cataracts or non-posterior subcapsular cataracts and have a history of diabetes mellitus or non-diabetes mellitus. The sampling technique used in this study is a consecutive sampling technique which is classified as non-probability sampling. The data obtained were then processed and analyzed using a cross-sectional design and chi-square test using IBM SPSS 26 software to determine the proportion of data distribution and the relationship between diabetes mellitus and PSC cataracts. In this study, it is known that diabetes mellitus affects PSC cataracts by 39.1%.

**Keywords:** cataract, diabetes mellitus, PSC cataract

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### **Introduction**

The eye is an essential visual organ for humans <sup>[1]</sup>. With the eye, human beings can get a variety of visual information transmitted to the brain properly to be processed as a basis for decision-making in carrying out daily activities. Every organ in the eye has a vital function for humans because if one of the eye functions is problematic, it will affect the function of other organs.

Eyes need lenses that are clear, transparent, and flexible or elastic. If the lens in the eye loses its translucency or clarity, the vision will become foggy and even cause a person unable to see at all <sup>[2]</sup>, this is because the cloudiness that occurs in the lens makes the amount of incoming light decrease and causes a person unable to see correctly <sup>[3]</sup>. Turbidity or loss of translucency that occurs in the lens is called a cataract. Turbidity in the lens or cataracts can occur due to hydration of the lens fluid, denaturation of the lens protein, or a result of both <sup>[4]</sup>.

According to data reported by the World Health Organization <sup>[5]</sup>, it is estimated that 2.2 billion people suffer from vision problems, with 65.2 million people in the world suffering from cataracts. With a large number, cataracts are pointed out as one of the global health problems. In the Rapid Assessment of Avoidable Blindness (RAAB) survey by the Association of Indonesian Ophthalmologists (PERDAMI) and Balitbangkes in 15 Provinces, the population over 50 years old in Indonesia has a blindness rate of 3 per cent, with cataracts as the highest cause, around 81 per cent. Because as we age, the mass and thickness of the lens increase and its accommodating capacity decrease. Moreover, there will be a decrease in the concentration of glutathione and potassium in elder people while also increasing the concentration of sodium and calcium in the cytoplasm of the lens cells to help prevent cataracts.

Cataracts consist of four types: secondary cataracts, senile cataracts, complicated cataracts, and traumatic cataracts <sup>[6]</sup>. In a population over 50 years old, most people suffered from senile

cataracts consisting of nuclear cataracts, cortical cataracts, and Posterior Subcapsular Cataracts (PSC) caused by lens degeneration <sup>[7]</sup>. This research will focus on the PSC, which is located in front of the posterior lens capsule. Early in its development, PSC made patients feel dazzled by the light and then experienced decreased vision of bright light <sup>[8]</sup>.

According to <sup>[9]</sup>, several factors can make the lens cloudy quickly. These factors include increasing age, hypertension, alcohol consumption, smoking, certain drugs, and diabetes mellitus. While specifically, senile cataracts are associated with metabolic diseases, such as hypertension and diabetes mellitus <sup>[7]</sup>. People with diabetes who already have retinopathy are prone to experiencing macular edema, one of the leading causes of vision loss <sup>[10]</sup>. In fact, compared to nondiabetics, patients with diabetes mellitus, especially those with uncontrolled blood glucose levels, are at risk of the early development of PSC cataracts and are approximately twice as susceptible to cataracts <sup>[11, 12]</sup>.

Unfortunately, Indonesia ranked 7th out of 10 countries with the highest number of diabetics globally in 2019. According to the International Federation <sup>[13]</sup>, people with diabetes in Indonesia reached 10.7 million in 2019. If it is not handled correctly, it will cause other issues that will make the health of the Indonesian people decrease, especially in causing cataracts and even blindness.

Diabetes mellitus is a chronic metabolic disease caused by inadequate insulin secretion, impaired insulin function (insulin resistance), or both <sup>[4]</sup>. Diabetes mellitus is reported to cause cataracts due to long-term uncontrolled hyperglycemia and significant fluctuations in blood glucose levels <sup>[14]</sup>. This condition is because most of the glucose breakdown in the lens 78% is via the anaerobic glycolysis pathway, 14% via the pentose phosphate pathway, and about 5% via the polyol pathway.

In conditions of hyperglycemia, the anaerobic glycolysis pathway saturates quickly, and glucose selects the polyol pathway. In the polyol pathway, glucose is converted to sorbitol. Sorbitol is then broken down into fructose by the Polyol Dehydrogenase enzyme. However, in diabetes mellitus, the Polyol Dehydrogenase enzyme levels are low, so sorbitol accumulates in the eye lens. A hypertonic state will draw the Aquos fluid into the eye lens, damage the lens architecture and cause lens cloudiness or what is called cataracts [1].

PSC cataract patients may not realize they have cataracts if the visual disturbance does not occur in the centre of the lens because visual disturbances in cataract patients occur slowly and are only realized when their eyesight is getting worse, even when patients experience blindness [15]. PSC cataracts and diabetes mellitus are a severe condition, which becomes an enormous health burden, especially for developing countries such as Indonesia, which do not yet have excellent and affordable cataract and diabetes management [16].

For this reason, to reduce the rate of cataracts and blindness in Indonesia, data on the leading causes of cataracts or blindness is critical. This study aimed to determine the causes of cataracts, especially PSC at Pasuruan Eye Hospital. Moreover, there has been no research on the relationship between the history of diabetes mellitus patients and PSC, especially in Pasuruan city. Therefore, it is hoped that through this research, the rate of cataracts and blindness in Indonesia, especially in the city of Pasuruan, can be suppressed from an early age by preventing the causes of PSC cataracts; prevention of diabetes mellitus and providing input regarding the management of PSC cataract patients with a history of diabetes mellitus, especially patients with diabetes who already have retinopathy.

**Data and Methods**

The sample used in this study were patients who treated by the Pasuruan Eye Hospital from February 2020 to February 2021 who suffers from cataract eye diseases. The sampling technique used in this study is a consecutive sampling technique which is classified as nonprobability sampling. Consecutive sampling is a sample selection technique by selecting all samples that meet the criteria set by the researcher. The criteria set are:

1. Cataract patients over 45 years old at the Pasuruan Eye Hospital
2. Experiencing PSC cataract or Non-PSC cataract eye disease
3. Have a history of diabetes mellitus or nondiabetes mellitus
4. Treated by Pasuruan Hospital from February 2020 to February 2021

The consecutive sampling method used in this study the overall data of cataract patients treated by the Pasuruan eyes hospital from February 2020 to February 2021. This data is a medical record containing a history of diabetes mellitus and the types of cataracts suffered by 229 patients.

The data obtained in this study were then processed and analyzed with a cross-sectional design and chi-square test using IBM SPSS 26 software to determine the proportion of data distribution and the relationship between the independent and dependent variables. In this study, the independent variable was diabetes mellitus, while the dependent variable was PSC cataract. The analysis results will then be recorded in a 2x2 table. The

hypotheses proposed in this study are as follows.

**H<sub>0</sub>:** History of diabetes mellitus does not cause PSC cataract eye disease

**H<sub>1</sub>:** History of diabetes mellitus causes PSC cataract eye disease

In addition to the cross-sectional analysis, a regression test was also conducted to determine the value of the determinant coefficient (R<sup>2</sup>), which shows the magnitude of the influence of Diabetes Mellitus disease history (independent variable) in causing PSC cataract (dependent variable). If the R<sup>2</sup> value shows a value of 0.67 or more, then the independent variable significantly influences the dependent variable. Meanwhile, if the R<sup>2</sup> value shows a value of 0.33 or 0.19, then each independent variable has a moderate or weak influence on the dependent variable [17].

**Result**

In this study, 229 patients' data were used; it is known that there were 79 patients with a history of diabetes mellitus (34.5%) and history of nondiabetes Mellitus as many as 150 patients (65.5%), as can be seen in Table 1.

**Table 1:** Number of Cataract Patients

History of Disease	Frequency	Percentage
Diabetes Mellitus	79	34.5 %
Non-Diabetes Mellitus	150	65.5 %
Total	229	100 %

As for 229 patients who suffer from cataract eye disorders or diseases in this study, it was found that 44 patients or 19.2%, had PSC type cataracts, and 185 patients, or 80.8%, had nonPSC type cataracts, as can be seen in Table 2.

**Table 2:** Number of Diabetes Patient

Types of Cataract	Frequency	Percentage
PSC	44	19.2%
Non-PSC	185	80.8%
Total	229	100.0%

Therefore, to determine the relationship between diabetes mellitus and cataracts, a crosssection analysis was performed, as presented in Table 3.

**Table 3:** Cross-Section Test Results

History of Disease	Types of Cataract				Total	
	PSC		Non-PSC		n	%
	n	%	N	%		
Diabetes Mellitus	42	18.3	37	16.2	79	34.5
Non Diabetes Mellitus	2	0.8	148	64.6	150	65.6
Total	44	19,1	185	80,8	229	100

From the cross-section analysis results, it is known that as many as 42 patients or 18.3% had a history of diabetes mellitus and had PSC cataracts, while two patients or 0.8%, did not have a history of diabetes mellitus but had PSC cataracts. In addition, the results of the analysis also showed that there were 37 patients, or 16.2% had a history of diabetes mellitus and had non-PSC cataracts, while 148 patients or 64.6%, did not have a history of diabetes mellitus experiencing non-PSC cataracts. Overall, there were 79 patients, or 34.5% had a history of diabetes mellitus and had

cataracts, and there were 150 patients or 65.6% who did not have a history of diabetes mellitus but had cataracts. Thus, it can be concluded that diabetes mellitus has a relationship with cataracts, especially PSC cataracts. This condition is proven by more patients with PSC cataracts who have a history of diabetes mellitus than patients who suffer from PSC cataracts but do not have a history of diabetes.

As for testing whether diabetes mellitus can cause PSC cataract eye disease, a chi-square test was performed as presented in Table 4.

**Table 4:** The Result of Chi-Square Test

	Value	df	Asymptotic Significance (2sided)
<b>Pearson Chi Square</b>	89.560	1.000	0.000

In this study, a confidence interval of 95% or a 0.05 was used. Thus, to accept hypothesis H<sub>1</sub>, the Pearson Chi-Square value on the resulting Chi-Square test must be less than the cut-off value of 0.05. Table 4 shows that the resulting Pearson Chi-Square value is 0.000 less than the cut-off value of 0.05. Thus, hypothesis H<sub>1</sub> is accepted, which means that the history of diabetes mellitus causes PSC cataract eye disease.

Furthermore, to determine the measurement of the influence of Diabetes Mellitus disease history in causing PSC cataract, a regression test was carried out to determine the R<sup>2</sup> value, which results are presented in Table 5. From this table, it can be seen that PSC cataract is influenced by a history of diabetes mellitus by 39.1% (R<sup>2</sup>: 0.391), while 60.9% is influenced by other factors which were not examined in this study. The value of 0.391 indicates that the history of diabetes mellitus has a moderate effect in causing PSC cataracts.

**Table 5:** The Result of R<sup>2</sup> Test

Construct	R <sup>2</sup>
Diabetes Mellitus -> PSC Cataract	0.391

**Discussion**

From the results of research conducted at Pasuruan Eye Hospital from February 2020 to February 2021 through a cross-sectional test, it is known that of the 229 patients who had cataract eye disease, 42 patients had a history of diabetes mellitus and had PSC cataracts, while two patients did not have a history of diabetes mellitus but have PSC cataracts. In addition, in this study, it was also found that there were 37 patients or 16.2% had a history of diabetes mellitus and had non-PSC cataracts, while 148 patients or 64.6% did not have a history of diabetes mellitus experiencing non-PSC cataracts. From these results, it can be seen that diabetes mellitus has a relationship with the occurrence of PSC cataracts. This situation is in line with research conducted by [18] and [19], which states that anterior and subcapsular posterior are structural characteristics of cataracts in diabetic patients.

In testing the hypothesis in this study, the chisquare test was carried out. As known in the previous analysis, the resulting Pearson chisquare value is 0.000 less than the cut-off value of 0.05. Thus, hypothesis H<sub>1</sub> is accepted, which means that a history of diabetes mellitus can cause PSC cataract eye disease. Then, in the R<sup>2</sup> test, it was found that the PSC cataract eye disease was influenced by a history of diabetes mellitus by 39.1% (R<sup>2</sup>: 0.391); this means that the history of diabetes mellitus has a

moderate effect in causing PSC cataracts, and as much as 60.9% is influenced by other factors that were not examined in this study. This finding supports other studies that say that the cause of PSC cataracts is multifactorial with other factors, not only by one thing, such as diabetes mellitus [8].

The results of this study also support several studies that have shown that diabetes mellitus can cause cataracts to occur more frequently than non-diabetics. Framingham and other eye studies showing a three to fourfold increase in cataract prevalence in patients with diabetes under 65 years old and a two-fold increase in patients over 65 years old [20]. These findings also support the Beaver Dam Eye Study, which explains the relationship between diabetes mellitus and cataract formation in a population of 3,684 people over the age of 43, showing an increased incidence and development of posterior and cortical subcapsular cataracts for diabetes mellitus patients [21]. Then, the study conducted by Blue Mountains Eye Study with a cross-sectional method on 3,654 cataract patients shows the known harmful effect of diabetes on the lens as evidenced by posterior subcapsular cataract (PSC), which is statistically significant with diabetes mellitus [20].

The results of hypothesis testing in this study also in line with The Visual Impairment Project, which evaluates risk factors for cataract development in Australia. The study showed that diabetes mellitus is an independent risk factor for posterior subcapsular cataract if it occurs for more than five years [20]. In addition, eight studies in Europe, America, Africa, and Australia on 20,837 cataract patients using a meta-analysis method showed that type 2 diabetes mellitus has an increased risk of developing posterior subcapsular cataracts (OR=1.55,95% CI:1.27-1.90, P<0.001) [11].

Medicare analysis from 1997 to 2001 revealed that the diagnosis rate of postoperative pseudophakic cystoid macular edema (PCME) was higher in diabetic patients than in nondiabetic patients [20]. So that PCME prophylaxis should be done immediately depending on the stage of diabetic retinopathy. However, if diabetic retinopathy is found, patients with PSC cataracts should delay surgery or cataract extraction [22]. The Royal College of Ophthalmology recommends using topical non-steroidal anti-inflammatory drugs (NSAIDs) in patients with elevated PCME, e.g. patients with diabetes, previous cystoid macular edema (CME), and previous retinal vein occlusion [23].

**Conclusions**

From the study results at the Pasuruan Eye Hospital from February 2020 to February 2021, it can be concluded that diabetes mellitus can cause PSC cataracts by 39.1%. These results support previous studies which say that PSC cataracts can be caused by diabetes mellitus. In addition, the effect of diabetes mellitus on cataracts which is only 39.1%, also supports other studies which say that the cause of PSC cataracts is multifactorial with other factors that are not discussed in this study.

On that account, it is hoped that the government, through medical personnel, can increase public awareness about the risks of PSC cataracts, which can cause blindness and prevent diabetes mellitus, which can lead to PSC cataracts through educational programs. Then, PSC cataract patients with diabetic retinopathy or elevated PCME recommend using topical non-steroidal anti-inflammatory drugs (NSAIDs).

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