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Risk Factor Analysis of Cataracts in Primary Health Center

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ABSTRACT

Introduction: Cataracts are still one of the causes of blindness worldwide. Indonesia is known for the highest cataract prevalence in Southeast Asia. Therefore, early detection is vital to slow the progression of visual impairment caused by cataracts, thereby increasing the quality of life, especially in the elderly. We aimed to analyze risk factors of cataract incidence at the Sumberasih Public Health Center.
Method: A retrospective analytical study was conducted with a total of 100 samples that were divided equally into a cataract group and a control group. The data was analyzed using the SPSS program.
Result: A majority of cataract subjects are women (62%), pre-elderly (40%), working exposed to UV sun rays (60%), cigarette smoke (78%), and having abnormal body mass index (58%). We found that gender, UV exposure based on occupation, hypertension history, cigarette smoke exposure, and body mass index were significantly correlated to cataract incidence, respectively, $p = 0.009$, $p = 0.016$, $p = 0.037$, $p < 0.001$, and $p = 0.045$. The Chi-square test results $p < 0.025$ were followed by logistic regression, and gender was the most influential risk factor of cataract incidence, approximately 4.050 times (CI 95%: 1.427 - 11.498).
Conclusion: Cataracts can be caused by several risk factors. Hopefully, risk factors discovered as early as possible can reduce the risk of developing cataracts.
Keywords : Cataract, risk factors, public health center

ABSTRAK

Pendahuluan: Katarak masih menjadi salah satu penyebab kebutaan di dunia. Indonesia dikenal sebagai negara dengan prevalensi katarak tertinggi di Asia Tenggara. Oleh karena itu, deteksi dini sangat penting untuk memperlambat perkembangan gangguan penglihatan akibat katarak, sehingga meningkatkan kualitas hidup khususnya pada usia lanjut. Tujuan penelitian ini adalah untuk menganalisis faktor risiko kejadian katarak di Puskesmas Sumberasih.
Metode: Penelitian analitik retrospektif dilakukan dengan total 100 sampel yang dibagi rata ke dalam kelompok katarak dan kelompok kontrol. Data dianalisis dengan menggunakan program SPSS.
Hasil: Sebagian besar penderita katarak adalah perempuan (62%), pra-lansia (40%), bekerja terpapar sinar UV matahari (60%), terpapar asap rokok (78%) dan mempunyai indeks massa tubuh tidak normal (58%). Kami mendapatkan bahwa paparan asap rokok, jenis kelamin, paparan sinar UV saat bekerja, riwayat hipertensi dan indeks massa tubuh, masing-masing $p < 0,001$, $p = 0,009$, $p = 0,016$, $p = 0,037$ dan $p = 0,045$. Hasil uji Chi-square $p < 0,025$ dilanjutkan uji regresi logistik dengan jenis kelamin merupakan faktor risiko yang paling berpengaruh terhadap kejadian katarak yaitu sekitar 4,050 kali (CI 95%: 1,427 – 11,498).
Kesimpulan: Katarak dapat disebabkan oleh beberapa faktor risiko. Harapannya, faktor risiko yang terdeteksi sedini mungkin dapat mengurangi risiko timbulnya katarak.
Kata Kunci: katarak, faktor risiko, puskesmas

INTRODUCTION

IPEC, denoting Integrated People-Centered Eye Care, constitutes a multifaceted array of health interventions designed to address the entire spectrum of ocular conditions according to the specific needs of patients, such as the prevention of visual impairment. Positioned as the foundational element of the pyramid within the IPEC framework, one of its four pivotal strategies involves community empowerment and active engagement, particularly targeting underserved and marginalized populations.[1]

Drawing upon data sourced from the roadmap of the visual impairment control program in Indonesia 2017-2030, it is revealed that the global incidence of blindness stands at 12 cases per minute, with a parallel rate of one case of blindness per minute, specifically in Indonesia. This alarming prevalence adversely impacts the quality of life, precipitating harmful effects on both physical and mental well-being, thereby imposing a substantial burden on the healthcare system of the country.[2]

Noteworthy is the fact that over 80% of instances of blindness are preventable, with cataracts emerging as a primary causal factor in Indonesia. Intriguingly, Indonesian residents are predisposed to cataracts approximately 15 years earlier than their counterparts in neighboring tropical nations. Within Indonesia, East Java exhibits the highest incidence of cataracts, closely followed by East Nusa Tenggara and West Nusa Tenggara provinces.[2] A descriptive study in 2022 showed that Probolinggo Regency has 1763 cataract cases from non-communicable disease surveillance.[3]

The primary objective of this research is to identify cataract cases at an early stage within one of the Probolinggo Public Health Centers, representing a pivotal stride towards the realization of IPEC. This proactive approach ensures that patients necessitating surgical intervention can promptly access advanced healthcare facilities, thereby mitigating the risk of blindness. Additionally, the author undertakes a comprehensive risk factors analysis to postpone the progression of cataracts.

METHOD

This retrospective study involved 100 samples at Sumberasih Public Health Center, Probolinggo Regency, Indonesia, from January to November 2023, divided equally into a cataract group and a control group. We included patients aged more than 45 years and had been screened for non-communicable diseases. Patients with a family history of cataracts, eye trauma, eye infections, post-eye surgery, congenital cataracts, and long-term steroid treatment were excluded. Data were obtained from patient medical records, including gender, age, body mass index, and occupation related to UV exposure, cigarette smoke exposure, and non-communicable diseases like diabetes mellitus and hypertension. Data were analyzed with SPSS 23.0, using the chi-square test to determine the relationship between two variables. Logistic regression was used to find the most influential risk factors of cataract incidence.

RESULT

n the cataract group, there were 19 males (38.00%) and 31 females (62.00%). The majority were pre-elderly (45-59 years old) as well as the control group. Farmers, fishermen, and constructors constitute the majority of occupations in the cataract group, which are related to ultraviolet exposure (30 patients, 60.00%) for more than 4 hours. About 29 of 50 patients had an abnormal body mass index. A total of 23 cataract patients (46.00%) had a hypertension history, and only 18 patients (36.00%) had a diabetes mellitus history. As many as 78.00% of cataract patients were exposed to cigarette smoke by

themselves or the other. The risk factors of each group are shown in Table 1

Table 1. The relationship between risk factors and cataract incidence

Risk Factors	Cataract Group n (%)	Control Group n (%)	*p*-value
Gender			0.009*
Males	19 (38)	32 (64)	
Females	31 (62)	18 (36)	
Age			0.968
< 45 years old	12 (24)	13 (26)	
45 - 59 years old	20 (40)	19 (38)	
≥ 60 years old	18 (36)	18 (36)	
UV Exposure based on Occupation			0.016*
Yes	30 (60)	18 (36)	
No	20 (40)	32 (64)	
Body Mass Index			0.045*
Normal ((18.5 – 25 kg/m2)	21 (42)	31 (62)	
Abnormal	29 (58)	19 (38)	
Hypertension			0.037*
Yes	23 (46)	13 (26)	
No	27 (54)	37 (74)	
Diabetes Mellitus			0.673
Yes	18 (36)	16 (32)	
No	32 (64)	34 (68)	
Cigarette smoke exposure			< 0.001*
Yes	39 (78)	22 (44)	
No	11 (22)	28 (56)	

*The results of the Chi-square test between the two groups are significant.

Statistically, there was a relationship between gender, UV exposure based on occupation, hypertension history, cigarette smoke exposure, and body mass index to cataract incidence ($p<0.05$). The results of the bivariate statistical analysis are presented in Table 1.

Table 2. The Results of Logistic Regression as a Multivariate Analysis

Risk Factors	n	B	Wald	Sig	Exp (B)	CI 95%	
						LL	UL
Gender	100	1.399	6.902	0.009	4.050	1.427	11.498
Occupation related to UV exposure	100	-1.345	6.392	0.011	0.260	0.092	0.739
Cigarette smoke exposure	100	-1.020	4.481	0.034	0.361	0.140	0.927

B: beta coefficient; Wald: wald test value; Sig: significance value; Exp (B): the exponential value of B; CI 95%: confidence interval 95%; LL: lower limit; UL: upper limit

The Chi-square test results $p < 0.025$, such as gender, UV exposure based on occupation, and cigarette smoke exposure, were followed by logistic regression to find the most influential risk factors. Table 2 showed that gender was the greatest risk factor for cataract incidence at the Sumberasih Public Health Center, approximately 4.050 times (CI 95%: 1.427 - 11.498).

DISCUSSION

Gender

Based on the table above, most cataract patients were female, specifically 31 people (62%). An analysis based on gender regarding the incidence of senile cataracts in the patient population visiting the Sumberasih Health Center's working area in Probolinggo Regency yielded results (p = 0.009) with an odds ratio (OR) of 4.050. There is a high risk of senile cataracts in the female gender, which is 4.050 times greater than in males. Building upon the previous analysis results, it is evident that gender has the greatest risk of cataract incidence at the Sumberasih Public Health Center, Probolinggo Regency, in 2023.

Several theories proposed by researchers suggest that the incidence of cataracts is higher in women due to factors such as their longer life expectancy, and hormonal changes during pregnancy, breastfeeding, and menopause. Several population-based studies indicate that females have a higher prevalence of lens opacities, particularly cortical ones.[4] According to Jiang et al. (2023), it has been hypothesized that the decrease in estrogen at menopause increases the risk of cataracts in women. This is not strictly related to the concentration of estrogen but rather to the withdrawal effect.

Estrogens are known to exert various anti-aging effects, potentially explaining the longer lifespan in women. These effects include metabolically beneficial effects, neuroprotection, preservation of telomeres, and antioxidative properties. Oxidative stress is thought to be important in cataractogenesis. Previous studies investigated the effects of estrogen on lens epithelial cells in culture or animal models. There was protection of physiological concentrations of 17β-estradiol against oxidative stress caused by H2O2 in cultured lens epithelial cells. Most studies suggest that estrogen-mediated protection in the lens occurs via non-genomic, possibly via extracellular signal-regulated kinase phosphorylation.[5]

Age

The Ministry of Health of the Republic of Indonesia divided society based on age, namely adults (15-44 years), pre-elderly (45-59 years), and elderly (≥ 60 years). We obtained that cataracts mainly were found starting from the pre-elderly (40%). It happened because the proteins in the lens began to break down and clump together. This clump makes a cloudy area in the lens.[6] The incidence of cataracts is known to increase with age, but in our study, age is not related to the incidence of cataracts (p = 0.968). Among the 100 subjects, most of them are pre-elderly people, with 20 cataract groups and 19 control groups.

Previous studies have shown that the average age of cataract incidence varies because there is no certainty about when the lens opaque started. It depends on the patient's complaints to the health facility. Age is an ongoing risk factor for cataracts, increasing by 16% with age. The main explanation is the accumulation of oxidative stress in lens proteins with increasing age.[7]

UV Exposure

In this study, the cataract group was exposed to UV as many as 30 subjects, while the control group was exposed to UV as many as 18 subjects. It showed that subjects exposed to UV based on occupation have a significant risk of cataract incidence with a value of p=0.016. Exposure to UV sun rays causes damage to the eye lens due to the absorption of aromatic amino acids by lens proteins such as tryptophan, phenyl-alanine, and tyrosine to form reactive oxygen species (ROS) and decreased activity of catalyzation enzymes. One of which is the reduction of catalase enzymes that catalyze the decomposition of hydrogen peroxide

(H2O2) into water (H2O) and oxygen (O2). The high concentration of H2O2 in the aqueous humor causes an increase in oxidants in the lens, thereby reducing the role of antioxidant activity and defense enzymes in the cataract lens.[8] Exposure to UV rays in this study had an odds ratio of 0.260, which means the subjects had a 0.260 times risk of developing cataracts. In contrast to research conducted in Balikpapan and Kendari, exposure to ultraviolet light increases the risk of cataracts by 3.217 times and 2.908 times, respectively. The duration of UV exposure from the sun influences the incidence of cataracts through the oxidation process of UV free radicals, which causes clouding of the nucleus and cortical eye lens. Several studies state that exposure to UV rays from the sun for more than 4 hours increases the incidence of cataracts.[9,10]

Body Mass Index

Our retrospective study showed that body mass index is correlated to cataract incidence (p = 0.045). This is supported by a meta-analysis of 11 cohort studies revealing that body mass index was significantly associated with age-related cataracts, especially overweight and obesity. There are possible pathophysiological pathways through body mass index that might promote cloudy eye lens formation. Patients with obesity have elevated plasma leptin, which might increase reactive oxygen species, thereby creating opacity in lenses. Obese individuals also have more intense systemic inflammation, which promotes the development of cataracts.[11]

In contrast, a previous study showed that the prevalence of cataracts was highest in the underweight group (89.95%). Lower body mass index significantly causes nuclear cataracts. This study also carried out lifestyle and nutritional intake observations. It was found that antioxidants from nutritional intakes, such as vitamin A and vitamin B2 in the overweight group were high to use as a protection against lens damage. The antioxidant effect is very influential in the low prevalence of cataracts in the overweight group. Low energy intake in individuals with underweight, malnutrition, and inadequate nutritional intake over a long period can affect proteolysis in the lens, resulting in an opaque lens and cataracts.[12]

Hypertension

Hypertension is blood pressure above normal with systolic pressure ≥140 mmHg and diastolic pressure ≥90 mmHg. Hypertension has an additive effect on cataract etiopathology.[13] Based on our result study, hypertension also correlates significantly with cataract incidence (p = 0.037). Based on research conducted at the Makassar Eye Health Center with a sample of 150 people, the results showed that there was a relationship between hypertension and the incidence of cataracts. A study at the Makassar Eye Health Center showed that patients with hypertension are 5 times more likely to develop cataracts compared to people with no hypertension.[14]

Several theories showed pathophysiological pathways of cataract development induced by hypertension. The elevation of IL-6, TNF-a, and C-reactive protein in the plasma of hypertensive patients is closely related to intense systemic inflammation, which promotes the development of cataracts. Hypertension causes conformational changes in the lens of the eye, resulting in disruption of potassium ion transport in the lens epithelial cells. Hypertension also causes an increase in nitrogen monoxide and changes in protein structure, which can trigger cataracts.[15]

Diabetes Mellitus

In the diabetic population, cataracts not only have a 3–5 times higher incidence

than in the healthy population but also affect people at a younger age. In patients with type 1 diabetes, cataracts occur on average 20 years earlier than in the non-diabetic population. In addition, the risk of developing cataracts increases with the duration of diabetes and poor metabolic control.[16] The association between diabetes and cataracts has been extensively studied. Zhang et al. (2022) conducted a Mendelian randomization study in East Asian populations and found a strong genetic correlation (rg = 0.58; p-value = 5.60x10-6) between type 2 diabetes and cataracts.[17]

Numerous studies have suggested an association between refractive errors and glycemic control in individuals with diabetes. Glucose ingress into the lens occurs through both direct simple diffusion and indirect facilitated diffusion from the aqueous humor. Hexokinase phosphorylates most of the entering glucose, converting it into glucose-6-phosphate (G6P). Subsequently, G6P undergoes further processing, with approximately 80% entering anaerobic glycolysis. The remaining glucose, not phosphorylated to G6P, enters the sorbitol cycle, where it undergoes conversion to sorbitol. Typically, around 4% of the total glucose concentration in the lens follows this pathway under normal conditions. As blood glucose concentrations rise, so does the glucose concentration in the aqueous humor, consequently elevating it in the lens. A feedback mechanism inhibits hexokinase by glycolysis products, directing the sorbitol cycle to become the predominant pathway in glucose metabolism. Aldose reductase (AR), a pivotal enzyme in this cycle, reduces glucose to sorbitol. Subsequently, sorbitol dehydrogenase catalyzes the conversion of sorbitol to fructose. Unfortunately, due to the low affinity of the latter enzyme, a substantial proportion of sorbitol accumulates in the lens before further transformation. This, coupled with the lens's poor permeability for sorbitol, leads to its deposition within the lens. The sorbitol pathway, recognized as the polyol pathway, emerges as the primary pathway implicated in the formation of diabetic cataracts.[17]

In our research, 18 out of 50 individuals in the cataract cohort exhibited a diabetes history. In contrast, 16 out of the 50 participants in the cataract group lacked such a medical history, all sourced from the non-communicable disease polyvisit population. As explained by several mechanisms mentioned earlier, effective regulation of blood glucose levels in diabetes can diminish the likelihood of cataract incidence. The meticulous maintenance of optimal blood sugar levels, achieved through judicious management and pharmaceutical interventions, mitigates the risk of sorbitol accumulation and consequent cataract formation. In synthesis, adept control of diabetes through judicious management practices encompassing pharmaceutical intervention, dietary adjustments, and lifestyle modifications positively influence diverse pathways implicated in cataract development. This underscores the pivotal significance of comprehensive diabetes management not only in averting cataracts but also in preventing other diabetes-associated complications.[17]

Cigarette Smoke Exposure

Comparable to various other variables, the smoking variable reveals a statistically significant association, indicating that individuals who use cigarettes exhibit cataract symptoms at a rate three times higher ($p < 0.001$). This finding aligns with the outcomes of a systematic review conducted by Karimi et al. (2023), which underscored the direct influence of smoking on ocular health, particularly the manifestation of cataracts.[18]

A dose-response correlation is evident between cumulative smoking exposure and the susceptibility to nuclear cataract development, with a notably heightened risk observed among heavy smokers. Various study designs, including case-controlled, cross-sectional, and prospective investigations, have extensively explored the epidemiological nexus between smoking and cataracts. Nevertheless, the impact of smoking on non-nuclear opacity remains a topic of ongoing deliberation. Notably, individuals who consume 20 or more cigarettes daily, as revealed by a comprehensive 30-year research study conducted during their inaugural ocular examination, exhibit a significantly elevated likelihood of acquiring nuclear opacity compared to non-smokers. Furthermore, a substantial escalation in risk is discerned in those who smoke more than 20 cigarettes daily compared to their counterparts consuming fewer than 20 cigarettes.[18]

The harmful effects of smoking on the lens may be indirect, involving the augmentation of oxidative stress through the reduction of nutrient intake, particularly ascorbic acid and nicotinamide, both possessing antioxidant properties. Additionally, the presence of chemicals such as cadmium or isocyanate, constituents of cigarette smoke or its metabolites, may inflict structural and direct damage on the lens. The condensation products of wood smoke, observed to accumulate in organ-grown rat lens tissue, contribute to morphological aberrations, including hyperplasia, hypertrophy, and epithelial cell multilayering. Correspondingly, histological abnormalities and elevated calcium levels were identified in lenses extracted from rats exposed to cigarette smoke for two hours daily over 60 days. These empirical findings provide compelling evidence that in vivo exposure to cigarette smoke can induce detrimental effects on the lens.[18]

This study presents data on new patients visiting the non-communicable disease clinic at the Sumberasih Public Health Center with and without vision problems due to cataracts. The diagnosis of cataracts is obtained from anamnesis, visual acuity examination, and anterior segment examination with a flashlight. Our research has two limitations. First, the type of cataracts that could contribute to the risk factor relationship was not shown in the ICD-X code of electronic medical records. Second, the retrospective study allows for information bias, so future research is expected to use prospective methods to determine cause and effect relationships accurately.

CONCLUSION

Based on the study conducted, it can be concluded that gender, predominantly female, was the greatest risk factor for cataract incidence, compared to UV exposure based on occupation, hypertension history, cigarette smoke exposure, and body mass index. We expect this study to be expanded from multicenter.

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