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RISK FACTORS OF CATARACT OCCURENCE AT THE SUMBERASIH PUBLIC HEALTH CENTER

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Abstract

Cataracts are still one of the causes of blindness in the world. Indonesia is known as the highest cataract prevalence in the Southeast Asia. Therefore, early detection is very important to reduce the incidence of cataracts thereby increasing quality of life, especially in elderly. We aimed to analyze risk factors of cataract occurence at the Sumberasih Public Health Center. A restropective analytical study was conducted with a total of 100 samples that devided equally into cataract group and control group. The data was analyzed using SPSS program. Most cataract subjects are women (62,00%) and pre-elderly (40,00%) with the majority working exposed to UV sun rays (60,00%), cigarettes (78,00%) and having abnormal body mass index (58,00%). We obtained that gender, UV exposure based on occupation, hypertension history, cigarette exposure and body mass index were significantly correlated to cataract occurence, 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 refression and gender was the most influential risk factor of cataract occurence, approximately 4,050 times (CI 95%: 1,427 – 11,498). Risk factors discovered as early as possible can prevent cataracts from occuring in the future. We pleased that this study can be carried out in multicenter health services in Probolinggo Regency throughout Indonesia.
***Keyword**: Cataract, risk factors, public health center*

INTRODUCTION

IPEC, denoting Integrated People-Centered Eye Care, constitutes a multifaceted array of health interventions designed to address the entire spectrum of ocular conditions in accordance with the specific needs of patients. Positioned as the foundational element of the pyramid within the IPEC framework, one of its four pivotal strategies involves the empowerment and active engagement of communities, particularly targeting underserved and marginalized populations (World Health Organization 2022).

Drawing upon data sourced from roadmap of 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 deleterious effects on both physical and mental well-being, thereby imposing a substantial burden on the healthcare system of the country (Kementerian Kesehatan RI 2017).

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 (Kementerian Kesehatan RI 2017). A descriptive study in 2022 showed that Probolinggo Regency has 1763 cataract cases from non-communicable disease surveillance (Wicitra et al 2023).

The primary objective of this research is to identify cataract cases at an early stage within one of the Probolinggo Public Health Center, 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 aimed at impeding the progression of cataracts.

RESEARCH METHODS

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

RESULTS AND DISCUSSION

In 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 constructor 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. In the amount of 78,00% patients with cataract were exposed to cigarettes by themselves or the other. The risk factors of each group were shown in Table 1.

Table 1. The relationship between risk factors and cataract occurrence

Risk Factors	Cataract Group n(%)	Control Group n(%)	*p*-value
Gender			
Males	19 (38,00)	32 (64,00)	0,009*
Females	31 (62,00)	18 (36,00)	
∫			
<45 years old	12 (24,00)	13 (26,00)	0,968
45-59 years old	20 (40,00)	19 (38,00)	
≥60 years old	18 (36,00)	18 (36,00)	
UV Exposure based on Occupation			
Yes			
No	30 (60,00)	18 (36,00)	0,016*
	20 (40,00)	32 (64,00)	
Body Mass Index			
Normal (18.5 – 25 kg/m^2)	21 (42,00)	31 (62,00)	0,045*
Abnormal	29 (58,00)	19 (38,00)	
Hypertension			
Yes	23 (46,00)	13 (26,00)	0,037*
No	27 (54,00)	37 (74,00)	
Diabetes Mellitus			
Yes	18 (36,00)	16 (32,00)	0,673
No	32 (64,00)	34 (68,00)	
Cigarette exposure			
Yes	39 (78,00)	22 (44,00)	<0,001*
No	11 (22,00)	28 (56,00)	

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

The Chi-square test results p<0,025, such as gender, UV exposure based on occupation and cigarette exposure, were followed by logistic regression to find the most influential risk factors.

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

Risk Factors	B	Wald	Sig	Exp (B)	CI 95%	
					LL	UL
Gender	1,399	6,902	0,009	4,050	1,427	11,498
Occupation related to UV exposure	-1,345	6,392	0,011	0,260	0,092	0,739
Cigarettes exposure	-1,020	4,481	0,034	0,361	0,140	0,927

Table 2 showed that gender was the most influential risk factor of cataract occurrence at Sumberasih Public Health Center approximately 4,050 times (CI 95%: 1,427 – 11,498). Statistically, there was a relationship between gender, UV exposure based on occupation, hypertension history, cigarette exposure and body mass index to cataract occurrence (p<0.05). The results of bivariate statistical analysis have been shown in Table 1.

Gender

Based on the table above, the majority of cataract patients were female, namely 31 people (62,00%). In the control group, most of them were male, comprising 32 people (64,00%). 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 influences the incidence of cataracts in the population of new visitors to 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, hormonal changes during pregnancy, breastfeeding, and menopause. Several population-based studies indicate that females have a higher prevalence of lens opacities, particularly cortical ones (Nuzzi et al 2022). 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.

Since oxidative stress is considered important in cataractogenesis, studies have investigated the effects of estrogens on lens epithelial cells in culture or in animal models. Several investigators have found protection by physiological concentrations of 17β-estradiol against oxidative stress induced by H2O2 in cultured lens epithelial cells. Although both main types of estrogen receptors, ERα and ERβ, have been demonstrated in the lens epithelium, most studies so far indicate that estrogen-mediated protection in the lens occurs through non-genomic, i.e., receptor-independent mechanisms, possibly through the phosphorylation of extracellular signal-regulated kinase (ERK1/ERK2), a member of the mitogen-activated protein kinase (MAPK)-signaling pathway (Jiang et al 2023).

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 were mostly found starting from the pre-elderly (40%). It happened because the proteins in the lens start to break down and clump together. This clump makes a cloudy area in the lens (Sarkar et al 2023). The occurrence of cataracts is known to increase with age, but, in our study, age is not related to the occurrence of cataracts (p=0,968). Among 100 subjects, most of them are pre-elderly people, respectively 20 cataract group and 19 control group.

The previous studies shown that average age of cataract occurrance vary because there is no certainty about when the lens opaque started. It depends on the patient's complaints to the health facility. Age is a continous risk factor of cataract, which increases 16% by increasing age. Accumulation of oxidative stress in lens proteins with increasing age is the main explaination (Hugosson et al 2020).

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 cataracts occurrence 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-alamine and tyrosine to form reactive oxygen species (ROS) and decreased activity of catalyzation enzymes. One of which is reduction of catalase enzymes that catalyzes 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 (Mahendra et al 2022).

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 (Sari et al 2018); (Wati et al 2023).

Body Mass Index

Our retrospective study showed that body mass index is correlated to cataract incidence (*p*=0,045). This is supported in a meta-analysis of 11 cohort studies that revealed body mass index was significantly associated with age-related cataract, 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 becoming opacity in lenses. Obese individuals also have more intense systemic inflammation which promotes the development of cataract (Tan et al 2019).

In contrast to previous study showed that the prevalence of cataract was highest in the underweight group (89,95%). Lower body mass index significantly causes nuclear cataract. This study also carried out lifestyle and nutritional intake observations. It was found that antioxidants from nutritional intake 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 cataract 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 opaque lens and cataract (Zhang et al 2021).

Hypertension

Hypertension is known as blood pressure above normal within systolic pressure ≥140 mmHg and diastolic pressure ≥90 mmHg. Hypertension has an additive effect on cataract etiopathology (Mylona et al 2019). Based on our result study, hypertension also has a correlation significant to cataract occurrence (*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. Patients with hypertension are 5 times more likely to develop cataracts compared to people with no hypertension (Harun et al 2020).

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 cataract. 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 cataract (Xu et al 2014).

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 (Mrugacz et al 2023). The association between diabetes and cataract has been extensively studied. Zhang et al (2021) 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 cataract.

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 the majority 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, under normal conditions, around 4% of the total glucose concentration in the lens follows this pathway. 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 (Zhang et al 2021).

In our research, 18 out of 50 individuals in the cataract cohort exhibited a diabetes history, while 16 out of the 50 participants in the cataract cohort lacked such a medical history, all sourced from the non-communicable disease poly visit population. As elucidated by several aforementioned mechanisms, effective regulation of blood glucose levels in diabetes can diminish the likelihood of cataract occurrence. 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 exerts a favorable influence on 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 (Zhang et al 2021).

Cigarretes 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 in relation to the manifestation of cataracts.

A dose-response correlation is evident between the 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 (Karimi et al 2023).

The deleterious 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 a 60-day period. These empirical findings provide compelling evidence that in vivo exposure to cigarette smoke can induce detrimental effects on the lens (Karimi et al 2023).

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the research results, it was found that risk factors related to cataract occurrence in the Sumberasih area were gender, UV exposure, body mass index, hypertension and cigarettes exposure. Gender was the most influential risk factors in this study by increasing cataract occurrence 4,050 times.

Suggestions

The authors wish that the future research can be carried out using the interview method to detail the risk factor variables of cataract. In addition, this research can be expanded to multicenter health facilities in Probolinggo Regency throughout Indonesia. We hope this research can assist to reduce the prevalence of cataract Indonesia by early detection and prevention in individuals with cataract risk factors.

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