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Cigarette smoking and duration of sun exposure as risk factor for cataract formation

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ABSTRACT Cataract¹⁰ is the most common cause of vision loss in Indonesia. It involves many risk factors, such as age, trauma, persistent intra-ocular inflammation, ultraviolet radiation, diabetes mellitus, hypoparathyroidism, prolonged corticosteroid administration, and high body mass index. However, the role of smoking and sun exposure in cataracts has received less attention despite the high number of cigarette smokers in Indonesia and this country also has strong sunshine all year round. The aim of this study was to investigate the relationship of cigarette smoking and duration of sun exposure with senile cataract in Jakarta, Indonesia. This was a cross sectional study without knowing risk factor before. A total of 100 patients participated in this study selected with consecutive sampling technique. They were divided into two groups: first was the case group consisting of 50 subjects aged more than 40 years old and diagnosed with senile cataracts and the second was the control group consisting of subjects aged more than 40 years old without cataract disease. All participants had to complete the questionnaire related to the history of smoking and duration of outdoor activity per day as it related to sun exposure. The sample was taken from the eye screening program in Puskesmas Cawang, East Jakarta. This research discovered a relationship between cigarette smoking and duration of sun exposure more than seven hours per day with the incidence of senile cataract ($p=0.001$). Statistical tests also showed an association between smoking duration more than 20 years and incidence of senile cataract (OR 7.25, 95% CI: 1.43 - 36.6; $p = 0.02$). However, the results revealed that there was no relationship between the number of cigarettes smoked per day with the incidence of senile cataract ($p = 0.915$). Overall, cigarette smoking and its duration appear to increase the risk of senile cataract formation.

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1. Introduction

The most common cause of blindness is cataracts (>80%), a degenerative eye abnormality which can be overcome by surgery. Otherwise, as a tropical country, Indonesia that has a population of around 200 million people, surprisingly has a prevalence of cataracts near 3%.¹ Indonesia capital's, Jakarta, has a rate of blindness of 1.9%. Cataract formation could be related with several predisposing factors, which can be divided into internal and external causes. Age is considered a major risk factor for cataracts. However, it should be noted there are other risk factors, including demographic, socioeconomic,

and lifestyle factors including smoking cigarette and duration of outdoor activity that could be modified to reduce the risk of cataracts.

Several prior epidemiologic studies suggest that smoking was associated with an increased risk of age related to particularly nuclear cataract (NC), but quantitative evidence to confirm this association is still lacking.^{2,3} In Sweden, smoking cessation amongst men significantly decreased the risk for cataract extraction with time.⁴ Indonesia has a higher number of cataracts compared to Sweden, and additionally, Indonesia is also included in the top five countries in terms of tobacco consumption. Another difference between Indonesia and Sweden is that Indonesia, as a tropical country, has a longer duration of sun exposure than Sweden (subtropical). With this study, the researchers expected people to be able to identify modifiable risk factors for the cataracts

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which may help to establish preventive measures and decreases the number of cataracts. The relation between smoking and cataracts itself may be related to the chemical content of p-benzoquinone (p-BQ) in cigarettes which can increase the risk of cataract. This agent is allegedly causing modification of α A-crystallin that is related to opacification of the lens.^{5,6,7} Concerning sun exposure, Khurana et al. wrote that more exposure to ultraviolet (UV) irradiation from sunlight was implicated for early onset and maturation of senile cataracts in many epidemiological studies.⁸ Other risk factors related to pathophysiology of cataracts such as dietary pattern, consumption of steroid, lack of vitamin and mineral in daily menu were not investigated in this study.

The objective of this study was to investigate the relationship of cigarette smoking and duration of sun exposure with senile cataracts in Jakarta Indonesia. The benefits of this study are the results could help in implementing cataract prevention programs and interventions to improve patients' quality of life.

2. Method

This research was a cross-sectional study. The sample was collected using consecutive sampling technique. The eye screening program was held in Cawang Primary Health Services (Puskesmas Cawang) in July 2018 and samples were chosen according to their attendance order during that program. The samples were limited to 100 people who were divided into two groups containing 50 people each.

The first group of subjects was the case group. Subjects in this group had fulfilled the inclusion criteria which were: aged above 40 years and diagnosed with senile cataract at the time of examination by an ophthalmologist. The exclusion criteria were: subjects that had Congenital Eye Diseases, retinal damage due to macular degeneration, and glaucoma. The control group consisted of subjects aged above 40 years old without opacity in their lenses during the examination. In both groups, previous risk factors were unknown. All the subjects had to complete the questionnaire including history of smoking, number of cigarettes consumed per day and history of daily outdoor activity. The duration of smoking cigarette was divided into long duration (more than 20 years)

and short duration (less than 20 years). Sun exposure were related to duration of the outdoor activity in a day whereas divided into less than 7 hours per day and more than 7 hours per day. For the case group, further eye examinations were performed by trained ophthalmologists in the Eye clinic at RSU UKI Jakarta for further management. All examinations and data collection were conducted from July to December 2018, data analysis was done using SPSS. Bivariate analysis to determine odds ratio (OR) used Chi-squared and Fisher exact tests.

3. Result

Of the 50 subjects in the case group, there were more than half of the subjects found with senile cataracts who had a history of cigarette smoking and 85% of subjects in the case group smoked more than 20 years. Related to sun exposure per day, 46% of the subjects in the case group had outdoor activity more than 7 hours per day. The baseline characteristics of the subjects are presented in Table 1.

Data about smoking history were collected from a questionnaire, indicating 34 of 50 patients were active smokers while in the control group there are 9 active smokers. A 2x2 table were used to calculate OR by Chi-squared analysis and it was found that smoking had over 9-fold increased risk of the occurrence of senile cataracts (OR 9.681, 95% CI: 3.802-24.650).

Regarding the duration of smoking, we categorized it into long and short duration, with long term smoking if the respondents became an active smoker more than 20 years and short term if below it. Data were represented in Table 2. This study chose 20-years as a border, according to the survey in Indonesia that the average age of first smokers is between 15-19 years old (53.9%). From the case group, it was found that 85% of patients had smoked for more than 20 years. Smoking cigarette for more than 20 years was statistically associated with senile cataract incidence ($p=0.02$).

On the other hand, the mean of the total amount of cigarette smoking among cataract patients was 11-20 per day, whereas it had no significant relationship with increased risk of cataracts. ($p=0.915$). Association between the number of cigarettes consumed per day

Table 1. Baseline characteristics

Demographic variable	Cases (n= 50) n(%)	Controls (n = 50) n(%)	P
Age (mean ± SD)	69 ± 4.82	67 ± 5.34	
Gender			0.001
Men	33(66)	16(32)	
Women	17(34)	34(68)	
Education Level			>0.05
Primary	26 (52)	25 (50)	
Secondary	10(20)	9 (18)	
Tertiary	12(24)	16 (32)	
Postgraduate	2 (4)	0 (0)	
History of cigarette smoking			
Yes	34 (68)	9(18)	
No	16 (32)	41(82)	
Duration of sun exposure per day			
< 7hours	27(54)	45(90)	
≥ 7 hours	23 (46)	5 (10)	

with risk of cataracts is presented in Table 3.

Statistical calculation using Fisher exact tests showed a significant association between cigarette smoking over 20 years increased the risk of cataracts by 7.25 times (95% CI: 1.43 -36.6). The sun exposure itself increased the risk of senile cataracts by 7 fold (20) duration of exposure more than 7 hours per day ($p < 0.05$).

4. Discussion

In this study cataract patients were mostly in the age range between 61 – 70 years old whereas mean age of case group was 69 ± 4.82 years old. The data resembled the results from the Rapid Assessment of Avoidable Blindness (RAAB) survey that showed age of cataracts in Jakarta is between 60-69 years old. Based on our study results (Table 4), bivariate analysis by Chi-squared test found that cigarette smoking increased the risk of senile cataracts 9 times greater compared with no history of cigarette smoking ($p = 0.00$). The meta-analysis study by Ye et al. revealed that from 20 studies consisting of 12 cohort studies, there was a significant relationship between smoking and cataracts in which respondents who smoked had a 1.41 times greater risk of cataracts than non-smokers (OR 1.41, 95% CI: 1.23-1.62, $p = 0.000$) and 8 case studies showed a significant relationship between smoking and cataracts (OR 1.55, 95% CI: 1.11-2.15, $p = 0.003$).⁹ In terms of smoking duration, significant relationship was found for smokers who

smoked more than or equal to 20 years. The duration of a person's smoking will affect the duration of exposure to toxic substances in the body.^{9,10} The longer the duration that a person smokes, the longer the body is exposed to harmful materials contained in the cigarettes that can lead to oxidative stress which triggers protein changes and tissue damage to the lens.^{3,4,8,10}

The mechanistic actions of smoking on cataracts are not fully understood, but several possible biologic mechanisms have been suggested.^{8,9} Firstly, oxidative damage appears to have a major role in cataract formation. Smoking causes an additional oxidative challenge through increased free radical activity, and promoting oxidation and lipid peroxidation. On the other hand, smoking may impose the oxidative stress indirectly on the lens through depletion of endogenous antioxidant pools, such as vitamin C, vitamin E, and beta-carotene.⁸ Secondly, by-products of tobacco contain heavy metals, such as cadmium, lead and copper, which accumulate in the lens and cause direct toxicity.^{9,10,11} The chemical that is related to pathogenesis of cigarette smoke-induced cataracts is p-benzoquinone (p-BQ). This is a causative agent involved in the modification of α A-crystallin and can cause the opacity of lens. Thirdly, cyanide and aldehyde levels rise in the blood of smokers, and also aldehydes and isocyanate, which are formed from cyanide, and can modify lens proteins, causing lens opacification in vitro.^{8,11,12}

Table 2. Duration of Smoking with risk of senile cataract

Duration of Smoking	Cataract		P Value
	No	Yes	
<20 Years	41	16	0.02
>20 Years	9	34	

Table 3. Association of cigarette amount with risk of senile cataract

Cigarette amount (per day)	Cataract		P Value
	No	Yes	
<10 Sticks	4	18	0.915
11-20 Sticks	4	16	
>20 Sticks	1	10	

This study found that the number of cigarettes consumed in a day did not increase the risk of cataract. This finding is in contrast to a study conducted by Tana which states there is a relationship between the number of cigarettes consumed per day with the incidence of senile cataracts where smokers with cigarette consumption of more than 20 cigarettes a day will increase the risk of cataracts almost 2-fold higher than smokers with cigarette consumption less than 20 cigarettes a day.⁶ Satyanarayana found men who smoke more than a pack a day statistically increase their risk for cataracts by 200%.¹³

The association between sunlight exposure and senile cataract is difficult to explain solely on the basis of direct absorption, since the damage would be expected to appear in the cortical area first.¹⁴ A few epidemiological studies have been conducted in European populations. One study in northern Italy found increasing risk of cortical cataracts with a 4-level scale of the estimated time spent outdoors, while in Spain, it was found that early occupational exposure to sunlight, from 25 to 45 years of age, increased the risk of nuclear cataracts later in life.¹⁵ Another study in Japan, found that lifetime Ultraviolet B (UVB) exposure was related to the type of lens opacities. Cumulative UVB exposure after the teenage years correlated with the presence of nuclear opacities later in life in females.¹⁷ In our study, we found that exposure of sunlight more than 7 hours per day significantly increased the risk of cataracts (OR 7.66, 95% CI: 2.61 – 22.54; *p*: 0.00).

Since the study design was a retrospective cross sectional research without knowing the risk factors before, the results of this study did not include several confounding factors such as, dietary habits, history of steroid consumption before, and body mass index.

Related to the results of our research, one limitation of the study is the design of the questionnaire whereas obtaining accurate measurements of personal past sunlight exposure and number of cigarette smoking is not a trivial task because recall was particularly difficult for those who did not have a type of work defined by a fixed schedule, for example housewives or part-time workers. Related to the huge number of cataract patients in Indonesia, our sampling could not represent the population because it was done at the primary health care level. Further study should involve wider community sampling with more subjects.

5. Conclusion

History of cigarette smoking more than 20 years and sun exposure more than 7 hours per day appear to increase the risk of senile cataract formation. There was no statistical relationship between the number of cigarettes smoked per day with the incidence of senile cataracts. Strategies to prevent smoking and promote smoking cessation are important, as related to reducing of cataract back log in Indonesia.

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Conflict of interests

There is no conflict of interests, such as any financial, professional, or personal relationships that are relevant to the submitted work.

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