



Prevalence and Risk Factors of Senile Cataract in Balinese Population Age 50 Years Old or Older

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Abstract

Objective: Cataract is the leading cause of blindness in the world with increasing trend both in prevalence and incidence. Surgery is the only definitive treatment for cataract but often unaffordable for society in developing countries. The incidence of cataract could be prevented by understanding its risk factors and formulate health programs according to them. The purpose of this study was to assess the prevalence and risk factors of senile cataract among 50 years old or older Balinese population. **Method:** The population-based cross-sectional study was conducted from September 2015 until July 2016 in Bali province. The variable's data were obtained through direct examination and interview. Poisson regression analysis was used to assess the definitive correlation between risk factors and cataract. A p-value <0.05 or value which falls within 95% confidence interval were considered significant. **Result:** 550 subjects were enrolled during the study. The number of cataracts found in this study was 231 (42%). According to the analyses, cataract was significantly associated with older age (PR: 3.05; p=0.001), low educational level (PR: 2.18; p=0.04), diabetes (PR: 2.96; p=0.001), and the rate of ultraviolet exposure (PR: 1.92; p=0,002). **Conclusion:** The prevalence of cataract among 50 years old or older in Balinese population was 42%. Older age, low education, diabetes mellitus, and ultraviolet exposure were found to be significant and independent risk factors for cataract in 50 years old or older Balinese population.

Keywords: *Cataract, Prevalence, Risk factor.*

Introduction

Cataract is the most common multifactorial disease found in the elderly population. The life expectancy of the Indonesian population is increasing. The population of older adults in Indonesia is about 15.9 million people (5% of the total population of Indonesia) in 2000, whereas in 2020 it is estimated that there will be an increase in the elderly population to approximately 29 million people¹. Bali Province is placed on the fifth position in terms of elderly population number in Indonesia. Data of the Indonesian population in 2007-2011, shows that the number of elderly population in Bali in 2011 reached about 10.28% of the total population.

This figure is the fifth highest figure after Yogyakarta (13.04%), East Java (11.21%) and Central Java (10.68%).² Increased life expectancy of the population in those regions

is positively correlated with the increase of cataract patients.^{3,4,5} Cataract is a major cause of preventable blindness in the world and Indonesia as well. Patients with cataracts, especially the senile cataracts, are expected to increase every year, while data on the prevalence of senile cataracts in Indonesia regions, especially in Bali, is still lacking. Thus, this study aimed to describe the prevalence and factors associated with the incidence of senile cataracts in Bali to initiate nationwide population base study for cataract and other ophthalmology disorders.

Methods

A population-based cross-sectional analytic observation study was conducted in Bali Province from November 2015 to June 2016. The target population of this study was all people aged ≥ 50 years in 60 areas in Bali

who lived in the study area for at least six months in the corresponding areas. The exclusion criteria for this study were:

- Lens conditions cannot be observed, due to the presence of cicatrix, phthisis, or other eye conditions.
- Subjects who with a history of direct eye trauma to.
- Subjects with infection in the anterior segment and/or posterior segment of the eyeball, such as conjunctivitis, keratitis, corneal ulcers, anterior and posterior uveitis.
- Subjects with a history of intraocular surgery other than cataract surgery.

Kappa test was conducted to assess the similarity of perception among researchers in

filling out questionnaires and interpreting the results of physical examination. Bivariate analysis was conducted by using Chi-square test while multivariate analysis was conducted by using Poisson regression. Significance was determined by 95% confidence interval (CI) and p-value <0.05.

The whole analysis processes was conducted using software STATA SE 12.1 (Stata Corp LP, College Station, Texas, USA).

Results

About 550 subjects were enrolled during the course of the study. Among them, the number of cataract patients in this study was 231 people (42%). Other characteristics of the study subjects are shown in Table 1.

Table 1: The Baseline Characteristic of the Research Subjects

Characteristics	N (%)
Age (year)	64.29 ± 9.44
Cataract	
Yes	231 (42.00)
No	319 (58.00)
Sex	
Male	247 (44.91)
Female	303 (55.09)
Occupation	
Housewife	137 (24.91%)
Chief of the Village	1 (0.18%)
Fisherman	3 (0.55)
Private Employee	12 (2.18)
Government Employee	18 (3.27)
Trader	59 (10.73)
Self Employed	38 (6.91)
Farmer	176 (32.00)
Breeder	15 (2.73)
Driver	10 (1.82)
Retired	28 (5.09)
Labor	53 (9.63)
Level of Education	
No Formal Education	225 (40.91)
Elementary	219 (39.82)
Junior High School	32 (5.82)
Senior High School	55 (10.00)
College/University	19 (3.45)
Monthly Income	
≥ IDR. 2.500.000	12 (2.18)
IDR. 1.500.000-Rp. 2.499.999	52 (9.45)
< IDR 1.500.000	486 (88.36)
Diabetes Mellitus	
Yes	35 (6.36)
No	515 (93.64)
Hypertension	
Yes	222 (40.36)
No	328 (59.64)
Smoking Habit	
Every day	80 (14.55)
Not every day	20 (3.64)
Used to be, not now	81 (14.73)
Never	369 (67.09)
Passive Smoker	
Yes	163 (29.64)
No	387 (70.36)
Alcohol Consumption	
Rarely	9 (1.64)
2-4x/month	1 (0.18)
2-3x/week	3 (0.55)
>3x/week	5 (0.91)
Never in 6 months	19 (3.45)
Never	513 (93.27)

Table 2: Risk Analysis of Several Cataract Risk Factors in Bali Population Aged > 50 years

Variables	Cataract		PR	CI 95%	p
	Yes	No			
Sex					
Male	112	135	2.06	0.949 - 1.404	0.151
Female	119	184			
Age					
50-60	37	202	4.03	2.959 - 5.485	0.001
>60	194	117			
Level of Education					
No Formal Education			0.69	0.594 - 0.808	0.001
Elementary	129	95			
Junior High School	82	137			
Senior High School	6	26			
College	8	47			
	6	13			
Monthly Income					
≥ IDR. 2.500.000			0.76	0.517 - 1.104	0.101
IDR 1.500.000-Rp. 2.499.999	4	8			
<IDR 1.500.000	15	37			
	212	274			
Sunlight Exposure					
< 1 hour/day			1.33	1.191 - 1.475	0.001
1-2 hours/day	59	127			
3-4 hours/day	32	87			
≥ 5 hours/day	28	51			
	112	54			
Smoking Habit					
Every Day	32	48	1.59	1.152 - 2.207	0.002
Not Every Day	10	10			
Used to be but Not now	49	32			
Never	140	229			
Passive Smoker					
Yes			1.08	0.807 - 1.432	0.513
No	65	98			
	166	221			
Alcohol Consumption					
Rarely			0.94	0.802 - 1.091	0.395
2-4x/month	5	4			
2-3x/week	1	0			
>3x/week	1	2			
Never in 6 month	4	1			
Never	6	13			
	214	299			
Diabetes Mellitus					
Yes			2.28	1.942 - 2.679	0.001
No	31	4			
	200	315			
Hypertension					
Yes	93	129	0.99	0.815 - 1.217	0.966
No	138	190			

The results of bivariate analysis with chi-square test of each of the risk factors studied were presented in Table 2. The table shows that age, education level, smoking habits, history of diabetes mellitus, and exposure to high sunlight had a significant association

with the incidence of cataract In Bali population aged 50 years and over. Among them, educational level was the only one which provided the protective effect while the greatest cataract risk was found in age variable.

Table 3: Multivariate Analysis of Cataract Risk Factors in Bali Population Aged > 50 years

Variable	PR	CI 95%	p
Age	3.47	2.413 - 4.989	0.001
Level of Education			
No Formal Education	2.41	1.138 - 5.099	0.022
Elementary	1.69	0.796 - 3.599	0.171
Junior High School		0.491 - 4.147	

Senior High School College	1.43 Ref* 2.07	0.702 – 6.084	0.513 0.188
Sunlight Exposure < 1 hour/day	0.89	0.576 – 1.402	0.639
1-2 hours/day	Ref* 1.03	0.611 – 1.748 1.226 – 2.862	0.903
3-4 hours/day			
≥ 5 hours/day	1.87		0.003
Smoking Habit Every Day	0.80	0.393 – 1.627	0.538
Not Every Day	Ref* 1.21	0.613 – 2.388 0.399 – 1.441	0.538
Used to be but Not Now			
Never	0.76		0.399
Diabetes Mellitus	3.04	2.043 – 4.527	0.001

Ref* is a reference variable used as a comparison in multivariate analysis

Table 3 shows the multivariate analysis of the significant risk factors related to cataract incidence in this study. Multivariate analysis showed that age, education level, history of diabetes mellitus, and sun exposure still significantly associated with cataract risk. The opposite is seen in smoking habits, where multivariate analysis shows that there is no significant relationship between cataract and smoking habit.

Discussion

This study found an association between increasing age and incidence of cataracts. Some other studies also found similar result which indicates an increasing trend in the global prevalence of cataract. A study conducted in Sumatra found that prevalence of cataract increased to 82.8% in a population aged >60.⁵ The relationship between age and cataract was also found in Beijing as well as in India with age group of >70 years had roughly 3 times higher risk contracting cataract compared to 65-69 years old age group.⁶ Increased prevalence of cataracts in old age is caused by changes in the lens structure due to the aging process which thicken and hardening the lens. The glutathione level also tend to be lower as the age increased which significantly lowering the cellular defense system against oxidative stress.

The oxidative stress could lead to protein damage that also contribute to the decreased functionality of the lens.⁷ According to the analysis, sex was seems to be non-risk factor for cataract. As stated in several reports, the relationship between cataracts with sex is still not clear. However, an ophthalmology study in Sumatra found that female tended

to had higher risk of cataract compared to men but the result was statistically insignificant.⁴ Studies in India also found that women had higher risk of cataracts than men with OR 1.8 (95% CI 1.59 - 2.02).⁶ European studies also had roughly similar findings with Indonesian studies. Ophthalmologic survey in Finland found that the incidence of cataracts was more common in women than in men.⁸ Furthermore, a case-control study in Greece also reported that cortical-type cataracts in women was tended to be higher than in men, although it was statistically insignificant ($p = 0.06$).⁹

Increased incidence of cataracts among women is thought to be associated with fluctuation in estrogen level. However, Australian study did not find any association between the two variables. In addition, cohort study also found no significant association between exogenous estrogen exposure and cataract events¹⁰. Whether the prevalence of cataracts is said to be higher in women than in men, the difference only significant in post-menopausal women.^{10, 13} The Beaver Dam study followed by Blue Mountain study suggests that estrogen has protective effect against cataracts development^{14, 15}.

The basis for such conclusion is the presence of estrogen receptors in the eye. Besides, estrogen is also found to increase the cellular anti-oxidant capacity which could protect the lens protein from oxidative damage.^{10, 16} One of the longitudinal studies with a fairly long follow-up time is a study conducted in Australia which evaluated the relationship between the levels of estrogen with the incidence of cataracts.

However, it found no association between estrogen and the incidence of cataracts. On the other hand, according to several reports, the relationship between female sex and cataract incidence was thought to be caused by inability of previous researchers to control the confounding variables in their studies^{6,10}. The level of education of respondents in this study is relatively low but confers significant effect toward the risk of cataract.

A study conducted in Sumatra also found that the level of education was inversely related to the incidence of all types of cataract ($p < 0.001$).⁴ A study in Tanjong Pagar, Singapore, also found that low educational level was related to the incidence of nuclear cataracts (OR 2.3, 95% CI, 0 - 5.2).¹⁷ Furthermore, a cohort study in the United States evaluating age-related eye disease found that higher educational level was associated with lower risk of cortical cataracts (HR: 0.77; 95% CI 0.66-0.69)¹⁸. Proper education has long been mentioned as a protective factor against the risk of many diseases including cataracts. The protective effect of education has been reported in various studies with different populations in several countries^{4, 17, 18}.

The degree of education also been used to estimate social status. People with different levels of education will generally have a different lifestyle and degree of exposure to different environments and, hence, the risk factors itself. Low levels of education are also associated with occupations or work that have a higher risk of cataracts. People with a low educational level has a more limited choice of work and most of them work as laborers or farmers which had a significantly greater outdoor activities and exposure to ultraviolet light.^{17, 18} Regarding the socioeconomic factor, this study found no association between monthly incomes with the risk of cataract.

This finding was in accordance with the study in Sumatera which also found that the income has no influence toward the risk of cataract.⁴ However, more subject-specific study conducted in Singapore found that income factor was related to cataracts only among Chinese and Indian, but not in Malay.²⁰ Furthermore, study in Tanjong Pagar also found that low income only related with the occurrence of posterior sub capsular cataracts.¹⁷ Some studies suggest

that there is a relationship between low income levels and certain types of cataracts.^{14,17,20} However, only few studies provide deep and comprehensive assessment about this association thoroughly. Low income statuses are also associated with several other conditions such as low nutrition or other things that were not assessed in this study. These factors are considered to be a confounding variable in some of the studies^{4, 14, 17}.

This study also measured sun exposure based on the amount of time spent outdoors which was ranging from 9am to 3pm. The time span was chosen according to skin cancer research about the time interval of the highest intensity of ultraviolet light.²¹ In this study, multivariate analysis showed that longer period of sunlight exposure increases the incidence of cataracts (PR 1.87, 95% CI 1,226-2,862, $p = 0.003$). Our findings were indeed relevant with several other studies such as Beaver Dam research which found that respondents with high sun exposure had a 1.4 times greater risk of developing cataracts.²¹

In addition, the French study also found an association between the amount of sun exposure during the year and the incidence of cataracts.²² Furthermore, a case-control study in Australia also found a strong relationship between sun exposure and the incidence of cataracts. Respondents with higher sun exposure in the study, had a risk as much as 2-3 times greater for lens opacities.²³ Sun exposure is often associated with the incidence of various diseases including cataracts. The underlying pathophysiology of the effects of sunlight on the lens opacity process is still being studied to date.

One of the popular theories is the increased generation of free radicals induced by lens ultraviolet exposure.²⁴ Human lenses are composed of proteins that will undergo various changes in chemical structure during our lifetime. The senescence process is allegedly accelerated by ultraviolet exposure. A study found that the exposure to sunlight, especially ultraviolet light, lead to the oxidation process in ascorbate molecules inside the lens. The oxidation processes also induce the production of advanced glycation end products (AGE) that could lead to the aggregation and crosslinking of proteins in the lens and result in increased turbidity of

the lens.²⁵ Another interesting finding in this study was no significant association between cataract with both passive and active smoking. The results of this study are inconsistent with the results from several other studies.

Some studies have found a link between smoking and cataracts such as the cohort study conducted in Sweden which found a positive association between smoking and cataracts.¹² Then, Chinese meta-analysis study also found positive association between smoking and cataracts.²⁶ Previous cohort studies of age-related eye disease also suggest that there was a significant relationship between smoking and the incidence of cortical cataracts.¹⁸ However, case-control studies in Taiwan found no significant association between smoking and cataract²⁷.

Also, a large case-control study in Scotland found that no significant difference in the risk of cataract between heavy smokers and non-smokers.²⁸ Then, a British cohort study also failed to find any association between smoking and cataracts.²⁹ A case-control study in Japan even found that smoking for men was a protective factor against cataracts.³⁰ In this study, the confounding factor that could contribute to the controversial finding is unbalanced number of smokers and nonsmokers.

The number of smokers in this study was very small when compared with nonsmokers which could potentially affect the results of this study. Alcohol consumption also showed no significant association with cataract. Like the smoking variable, this area also showed inconsistent findings, according to several studies.^{5,10,11} A cohort study in Sweden found that consumption of 13 g of alcohol per day increased the risk of cataract surgery by 7% (relative risk 1.07, 95% CI 1.02 -1,12).¹³ However, A study in the United States studied found no significant association between alcoholic beverages and cataracts.¹⁴ Several other experimental studies also failed to show a significant association between alcohol consumption and cataract.^{5,10} Finally, a meta-analysis study also concluded that there was no substantial increased in cataract risk among alcoholic population.³¹ Alcohol is thought to increase the risk of cataracts due to the process of alcohol metabolism by the CYP2E1 cytochrome that

lead to free radical formation and molecular modification of alcohol into acetaldehyde which changes the structure of lens's protein³¹.

The Swedish study that found an association between alcohol and cataracts have a significant weaknesses that it only used respondents who had undergone cataract surgery alone, so that cataract patients who did not have surgery did not enrolled.¹¹ The criteria of the diagnosis will also lead to the bias in the study because the history of alcohol consumption among the patients who have no cataract surgery is not included in the analysis. The association between diabetes and cataracts has long been studied in several observational studies in various populations.

A cohort study in Beaver Dam, USA concluded that cataract incidents were more common in diabetic respondents compared with non-diabetic ones ($p < 0.01$).¹⁵ A Barbados study of black population also found that the respondents with a history of diabetes had an increase risk of cataracts.¹¹ AREDS studies in the United States have also found that diabetics have a higher risk of posterior cortical and sub-capsular cataracts.¹⁸ This study further strengthens the role of diabetes mellitus as one of the risk factors of cataracts. The increased incidence of cataracts in diabetics is thought to be caused by changes in the process of glucose metabolism in diabetics.

The aldose reductase enzyme in diabetics works more actively and results in increased levels of sorbitol in the lens tissue which then lead to increased osmotic pressure. Osmotic alteration then enhance the fluid osmosis into the lens which increase lens opacities.⁸ Regarding the hypertensive status, this study found no association between hypertension and cataract incidence. The results of this study were in accordance with research conducted in Beaver Dam that reported no association between hypertension and cataract occurrence.¹⁵ However, studies in Barbados showed different results that revealed only diastolic blood pressure greater than 95 mmHg might increase the risk of cataracts.³⁹ Nevertheless, that study did not control the confounding variables such as the use of anti-hypertensive drugs. Indeed, according to several reports, the anti-hypertensive drugs were also said to increase

the risk of cataracts.^{15, 32} POLA studies in France found no association between hypertension and cataracts, but instead found that hypertension was a protective factor against the risk of cataract surgery.²²

According to those reports, the research on the relationship between hypertension and cataracts to date is still inconsistent. The mechanism underlying the increased risk of cataract in hypertensive patient is also still poorly understood. Several literatures suggest that elevated levels of IL-6 and TNF- α in plasma leads to an inflammatory process and an increase the expression of C - reactive protein that will eventually lead to cataract formation.³¹ Nevertheless, this study has a number of weaknesses.

The diagnosis of cataracts in this study was only based on funduscopy examination which could not determine the type of the cataract. The examination without the slit lamp also resulted in the inability to use the cataract classification based on the criteria of lens opacities classification system (LOCS) III, which was commonly conducted in some

previous international studies. Determining the history of alcohol consumption and smoking habits of respondents by using questionnaires might also lead to recall bias or even the possibility of respondents covering up their alcohol consumption history or smoking habits. Ideally, the determination of alcohol consumption should be based in the blood alcohol level which is hardly applicable in Indonesia. Also, each individual has a different alcohol metabolic ability which could alters the amount of alcohol consumed.

Conclusion

To conclude, the prevalence of cataract in Bali was found to be quite high at 42% with age, educational level, sunlight exposure and diabetes mellitus proved to be a significant risk factor for cataract development in 50 years old or older Balinese population. Further more comprehensive studies assessing the role of each risk factor and molecular basis of cataract risk are needed in order to establish the cataract research plan and formulate a health program to prevent cataract among Balinese population.

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