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RISK FACTORS ASSOCIATED WITH CATARACT AND ITS SUBTYPES AMONGST INDIAN POPULATION- AN INTERSTATE STUDY (AGED ≥21 YEARS)

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Abstract:To assess risk factors associated with cataract and its subtypes an inter-state cross-sectional study was conducted on 200 participants aged ≥21 yearsbelonging to states of Telangana, Karnataka and Bihar. The results of the multivariate analysis revealed that overall incidence of nuclear cataract (76.5%) was higher when compared to cortical cataract (17.5%) and PSC (6%). Risk increased linearly with age. Notably high incidence was observed in participants withLow BMI. About 69.2% individuals affected with cataract were exposed to sun for 7 or more hours per day. Nuclear (P = 0.02) and Cortical (P = 0.01) cataract cases increased significantly with increased consumption frequency of Rice. Use of solid fuel unimproved stove had debilitating effect on cataract incidence. The study recommends further exploration with regards to increased risk associated with low BMI and consumption frequency rice which can prove to be beneficial in alleviating the cataract incidence rate amongst Indians.

Index terms – Cataract andSubtypes, Indians, Risk factors, Diet, Sun Exposure, Age

INTRODUCTION:

Cataract is a leading cause of visual impairment in low-income settings [1]. In India the onset of cataract is reported to occur a decade earlier as compared to the Western population.India has80% of the cases related to blindness primarily due to Cataract. The reason for such high number of cases remains uncertain as incidence is attributable to multifactorial aetiology associated with the genetic, environmental, sociodemographic and behaviouralfactors such as inadequate nutrition, poor standards of living, occupational exposure to sunlight, use of biofuel mass in the form of solid fuel unimproved stove for cooking purposes, body mass index, smoking, alcohol consumption and metabolic disorders like Hypertension and Diabetes mellitus [2].

The number of studies undertaken to explore the risk factors associated with presenile cataracts are very limited, and the figure remains especially low in relevance to Indian population. With the rise in cases amongst younger generation, the study aims to explore and

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highlight the potential risk factors which are responsible for the development of different types ofcataracts; as developing countries like India are subjected to greater amount of modifiable risk factors staving off from which could benefit the overall health of the individual as well as reduce the cost incurred on medical care both on personal and government front.

The current study was undertaken to investigate the previously identified risk factors associated with cataract and its subtypes among Indian individuals. The catchment area includes the states of Telangana, Karnataka and Uttar Pradesh with participants aged ≥21 years.The study expands the scope of investigation by including a wider range of age group thereby serving as a possible medium for designing precautious health and nutrition care measures in order to lower the incidence rate.

METHODOLOGY:

A population-based cross-sectional, Inter-State cohort study was conducted amongst the participants belonging to Telangana, Karnataka and Bihar between the months of April to July 2022. A written consent was obtained from the Department of Ophthalmology at Sarojini Devi Eye hospital, Hyderabad and Gracious Eye Institute, Bangalore.

Sample Size

The sample including N= 200 participants belonging to ≥ 21years of age.About 60 Participants were selected from states of Telangana and Karnataka whilst 33 participants belonged to Bihar. The sample consisted of 38.5% participants from urban background, 39% Rural and 22.5% Tribal.

Sample Design:

Simple random sampling method was employed in the selection and sampling of the participants.

Criteria for selection of location:

Majority of the participants available at Sarojini Devi Eye hospital belonged to Bihar, Karnataka and Telangana State. Ease and maximum availability of the participants was one of the criterions for selection of study states. Besides this Education level, Socio-economic status, cooking practices and occupation varied greatly amongst the selected states, aiding in better assessment of the risk factors associated impact on cataract and its subtypes.

Enumeration:

A proper listing of the participant responses was maintained in a systematic manner to avoid omissions and duplications. Apre-tested structured questionnaire was designed to obtain primary data on the following variables- socio-demographic, Behavioural factors, Sun exposure, Metabolic Status, Frequency of consumption of carbohydrates and other food groups, cooking practices using personal interview and schedule method as per feasibility of the participants and interviewer. The data was collected from the participants ≥ 21years of age who have recently undergone detailed ophthalmic examination at the clinic and diagnosed with cataract.

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Inclusion criteria: Aged ≥ 21 years, diagnosed with Nuclear, Cortisol or Posterior Subcapsular cataract. Willing to participate in the study.

Exclusion Criteria: Aged <21 years, Patients with Atopy and allergic disorders, Ophthalmic laser treatment for cataract (more than 3 months), Pregnancy, Systemic disease associated with dry eye, Unable to participate in the study.

Assessment and Scoring of risk factors:

1. **Demographic data:**

A case was considered as any patient diagnosed with nuclear, cortical or Posterior Subcapsular Cataract (PSC) in at least one eye, based on slit lamp findings and a visual acuity of 20/50 or worse in the affected eye. A patient is qualified as a case if only both eyes have no condition other than cataract that might account for vision impairment. Patients were classified as having specific type of cataract when there was specific type of opacity present either alone or at a greater grade than other type of opacity as defined by slit lamp examination in the affected eye.[3]

Age was defined at the time of interview and was categorized into 6 groups, 21-30 years, 31-40 years, 41-50 years, 51-60 years, 61-70 years and > 70 years. Grading of Socio-economic status (SES) was based on modified Kuppuswamy scale which is commonly used to measure SES in urban and rural areas as it is composed of education status, occupation of the head of the family and income per capita per month. Lower SES was scored between 1-10, Middle SES= 11-25, High SES=26-29.[4]

2. **Lifestyle associated risk factors:**

Participants were scored for sunlight exposure in order of increasing hours as, <1 hour = 1, 2-4 hours = 2, 5-7 hours = 3 and ≥ 8 hours = 4. Sun protection gear (umbrella, hat, dupatta, sunglasses, cap, others) was scored as 0 amongst users and 1 for non-users. The behavioural risk factorsscoring was provided as Alcohol consumption =1, Smoking =2, Both alcohol consumption and smoking =3, None= 0 based on increasing risk of cataract.

3. **Metabolic Status:**

The data on medical history included diagnosis made by the general physician on the basis of identification, duration and biochemical parametersfor Diabetes mellitus, Hypertension, Anaemia and Thyroid. Data was extracted from the medical prescriptions of the participants. Obesity was defined based on BMI (≥30 kg/m^2). BMI was calculated based on Asian classification. Scoring of the metabolic syndromes was based on the rate of prevalence amongst the sample population, with, Hypertension =5, Diabetes = 4, Obesity = 3, Thyroid = 2, Anaemia = 1 and participants with no metabolic syndromes were scored 0.

4. **Dietary assessment:**

Data regarding the type and frequency of consumption of carbohydrates and different food groups was collected using food frequency questionnaire. The scoring was based on consumption frequency of the carbohydrates and other food groups. in carbohydrate consumption scoring was given as 3 times/day = 6, 2 times/day = 5, Once/day =4, 2-3 times

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per week= 3, Weekly once = 2, Occasionally = 1, Never taken = 0. Food groups based on consumption frequency were scored as 1-2 times/day = 6, 2-3times per week= 5, weekly once= 4, 2-3 times per month= 3, Occasionally = 2, Never taken = 1.

5. **Cooking practices:**

The type of stove and fuel used was scored in accordance with the associated risk for cataract due to particulate and toxins exposure [5], highest in case of Solid fuel unimproved stove = 3, Solid fuel improved stove = 2 and Clean fuel stove =1. Unventilated kitchens were scored 1 while Ventilated kitchens due to reduced risk were scored 0. Risk associated with cooking frequency per day was calculated based on scores in increasing order of frequency and associated linear risk for cataract, as, 3 times/day= 2, 2 times/day=1 and Once per day= 0.

Ethical Criteria:

The study was approved by the Ethical Committee of the Department of Ophthalmology at Sarojini Devi Eye Hospital, Hyderabad and Gracious Eye Institute, Bangalore. Informed consent was obtained from the participants.

Statistical analysis:

The age and gender specific incidence rates of cataract subtypes were assessed. All the analysis were carried out using Microsoft 365 Excel 2019 version. The association of demographic characteristics with cataract was evaluated using Pearson's $\chi 2$ test for the categorical variables. Association of sun exposure, lifestyle associated factors and cooking practices was assessed using single way ANOVA analysis. Multivariate regression analysis was performed with P value < 0.05 required to enter the model, to determine metabolic and diet related risk factors associated with cataract subtypes and its overall incidence.

RESULTS:

A total of 200 participants, diagnosed with one of the 3 subtypes of cataracts were selected for the study. Of the 200 study participants, 153 were diagnosed with Nuclear Cataract (NC), 35 with Cortical Cataract (CC) and 12 had Posterior Subcapsular Cataract (PSC) (Table 4.1).

Demographic Data:

Table 4.1 compares the effect of demographic characteristics on the development of cataract subtypes. The risk of developing NC increased linearly with age affecting 18% of the people belonging to the age group 51-60 years while 32% were > 70 years.Chi- square analysis done to estimate the interrelationship at P < 0.05, shows that Age (P=0.02), Gender (P=0.01), Body Mass Index (BMI) (P=0.03), Education status (P=0.03), Socio-economic status (P=0.04) and Occupation (P=0.04) are significantly associated with the risk of cataract incidence while the State (P=0.07) and Area (P=0.6) of residence were found to have no significant affect.

Table 4.1 Impact of demographic factors on subtypes of cataract

Demographic Data N= 200	**Nuclear Cataract N= 153 N (%)**	**Cortical Cataract N= 35 N (%)**	**Posterior Sub-Capsular cataract N= 12 N (%)**	**P value (<0.05)**

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Age Group, years				**0.02**
21-30	3 (1.5)	0 (0)	0 (0)	
31-40	6 (3)	3 (1.5)	0 (0)	
41-50	14 (7)	3 (1.5)	0 (0)	
51-60	36 (18)	4 (2)	6 (3)	
61-70	45 (22.5)	8 (4)	4 (2)	
>70	49 (24.5)	17 (8.5)	2 (1)	
Gender				**0.01**
Male	92 (46)	13 (6.5)	9 (4.5)	
Female	61 (30.5)	22 (11)	3 (1.5)	
BMI				**0.03**
<18.5	40 (20)	8 (4)	2(1)	
18.5-24.9	36 (18)	9 (4.5)	4 (2)	
25-29.9	52 (26)	13 (6.5)	4 (2)	
>30	25 (10.5)	4 (2.5)	2 (1)	
Education				**0.03**
Illiterate	95 (47.5)	21 (10.5)	6 (3)	
Matriculation	36 (18)	4 (2)	2 (1)	
Intermediate	6 (3)	8 (4)	3 (1.5)	
Graduate	16 (8)	2 (1)	1 (0.5)	
Socio-Economic Status (Score)				**0.04**
Lower (1-10)	116 (58)	18 (9)	8 (4)	
Middle (11-25)	21(10.5)	12 (6)	3 (1.5)	
High (26-29)	16 (8)	5 (2.5)	1 (0.5)	
State				0.07
Telangana	60 (30)	15 (7.5)	5 (2.5)	
Karnataka	60 (30)	8 (4)	2 (1)	
Bihar	33 (16.5)	12 (6)	5 (2.5)	
Area				0.6
Urban	60 (30)	12 (6)	5 (2.5)	
Rural	56 (28)	16 (8)	6 (3)	
Tribal	37 (18.5)	7 (3.5)	1 (0.5)	
Occupation				**0.04**
Full time/Part time employed/Business	15 (7.5)	2 (1)	1 (0.5)	
Unemployed/ Retired	16 (8)	4 (2)	2 (1)	
Housewife	34 (17)	5 (2.5)	2 (1)	
Industrial Worker	16 (8)	10 (5)	3 (1.5)	
Chef	14 (7)	8 (4)	2 (1)	
Farmer	58 (29)	6 (3)	2 (1)	

*Abbreviation: BMI: Body Mass Index

*P values based on χ^2Test at P<0.05

Of the 200 participants, 114 were male and females were 86. The males posed a greater risk of developing NC (46%) than females (30.5%), while women were more likely to develop CC (11%) over males (6.5%). The risk of developing PSC was relatively less amongst both the sexes compared to the other subtypes.Females were at the least risk with only 1.5% cases

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of PSC.Prevalence of NC was significantly high amongst the participants with Low BMI (<18.5) as 28.7% were affected and Overweight BMI (25-29.9) observed 39.2% affected individuals. Educational status had a significant (P=0.03) impact as 61% of affected participants were illiterate where 47.5% developed NC.

Socio-economic status showed a significanteffect on the rate of cataract subtypes incidence (P=0.04) with highest number of Nuclear cataract cases (58%) seen in low SES. Incidence State of Residence seemed to have no relation with the developmental risk of cataract.The area of residence also seemed to play no significant role in the developmental risk (P=0.6). Cataract subtype incidence varied vastly with the type of occupation participants vested in (P=0.04). Farmers were found to be at the highest risk for developing NC (37.9%) while CC incidencewas greater amongst Industrial workers (28.5%).

Table 4.2 depictsincidence rate of cataract subtypes is strongly influenced byLifestyle associated risk factors such as Exposure to Sunlight (P=0.0004) and Behavioural risk factors involvingconsumption of Alcohol and Cigarette smoking (P=0.01).

No significant impact of the use of Sun Protection Gear on cataract development was noted (P=0.2).

Table 4.2: Impact of Lifestyle associated risk factors on cataract subtypes

Lifestyle Factors N= 200	**Nuclear Cataract N= 153 N (%)**	**Cortical Cataract N= 35 N (%)**	**Posterior Sub-Capsular cataract N= 12 N (%)**	**P value (<0.05)**
Sunlight exposure				**0.0004**
<1 hour (N=23)	17 (8.5)	4 (2)	2 (1)	
2-4 hours (N=43)	30 (15)	10 (5)	3 (1.5)	
5-7 hours (N=63)	48 (24)	11 (5.5)	4 (2)	
>8 hours (N=71)	58 (29)	10 (5)	3 (1.5)	
Sun Protection Gear				0.2
Yes	28 (14)	6 (3)	3 (1.5)	
No	125 (62.5)	29 (14.5)	9 (4.5)	
Smoking/Alcohol				**0.01**
Alcohol	23 (11.5)	4 (2)	3 (1.5)	
Smoking	18 (9)	5 (2.5)	2 (1)	
Both	48 (24)	12 (6)	4 (2)	
None	64 (32)	14 (7)	3 (1.5)	

*P values based on ANOVA single factor analysis at P = <0.05

Individuals who were exposed to sun for >8 hours were affected with NC while 31.3% affected individuals were exposed to sun for 5-7 hours. Risk for CC (31.4%) and PSC (33.3%) also remained high amongst those exposed to sun for 5-7 hoursper day. Cataract incidence significantly increased with Smoking and Alcohol consumption(P=0.02).

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According to Table 4.2 individuals who consumed both alcohol and smoked cigarette were at a 2 times greater risk of developing CC and PSC while NC risk was increased by about 24%. 40.5% affectedneither consumed alcohol nor smoked.

Table 4.3 represents the risk of NC is significantly associated with the metabolic status of the participants (P=0.01). Whereas, no relationship was found between metabolic status and developmental risk of CC (P=0.5) and PSC (P=0.06).

Table 4.3: Impact of Metabolic status on Cataract Subtypes

Metabolic Status **N= 200**	**Score**	**Nuclear Cataract N= 153 N (%)**	**Cortical Cataract N= 35 N (%)**	**Posterior Sub-Capsular cataract N= 12 N (%)**	**R^2 value**
		[P = 0.01]	*[P=0.5]*	*[P= 0.06]*	
Hypertension	5	35 (17.5)	13 (6.5)	4 (2)	0.98
Diabetes	4	26 (13)	10 (5)	3 (1.5)	
Obesity	3	25 (12.5)	4 (2)	2 (1)	
Thyroid	2	5 (2.5)	2 (1)	1 (0.5)	
Anaemia	1	1 (0.5)	1 (0.5)	0 (0)	
None	0	61 (30.5)	5 (2.5)	2 (1)	

*Scores for metabolic symptoms established based on the prevalence rate

*P values for cataract subtypes based on the multiple linear regression analysis at P= <0.05

*R^2 value determined from the multiple linear regression analysis

It was observed that metabolic diseases or co-morbidities contributed to 60.1% of the total NC cases and a whopping 22.8%belonged to those with Hypertension. Diabetes was second highest with 16.9% of the total NC cases followed by Overweight/Obesity with 16.3%. A two-fold increase in the cases of CC and PSC was seen amongst the participants with Hypertension and Diabetes. Amongst affected individuals 34% presented no underlying co-morbidities.

Food Preference:

Table 4.4 shows that a significant association (P=0.02) is present between Food preferences and risk of developing cataract as maximum NC (48%), CC (11.5%) and PSC (4.5%) cases prevailed amongst non-vegetarians.

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Table 4.4: Impact of Food Preference on Cataract subtypes

Food Preference N= 200	**Nuclear Cataract N= 153 N (%)**	**Cortical Cataract N= 35 N (%)**	**Posterior Sub-Capsular cataract N= 12 N (%)**	**P value (<0.05)**
Vegetarian	57 (28.5)	12 (6)	3 (1.5)	**0.02**
Non- vegetarian	96 (48)	23 (11.5)	9 (4.5)	

*P value based on ANOVA single factor analysis at P= < 0.05

A two-fold increase in the risk of CC and a three-fold increase in risk in case of PSC was observedin non-vegetarian group.

Carbohydrate Intake:

Table 4.5 analyses the impact of the type and frequency of consumption of carbohydrate on cataract subtypes. Frequent intake of Rice with a majority (63.5%) consuming twice a day was significantly associated with increased risk of NC (P=0.02) and CC (P=0.01) development. Other types of carbohydrates intake showed no significant impact on developmental risk.

Table 4.5: Impact of Carbohydrate type and its frequency of consumption on cataract subtypes

Carbohydrate Intake N=200 (Score)	**3 times/ day (6)**	**2 times/ day (5)**	**1 time/ day (4)**	**2-3 times/ week (3)**	**Weekly once (2)**	**Occasionally (1)**	**Never Taken (0)**	**P value (<0.05)**
Polished Rice								
Nuclear Cataract N=153	6	100	43	4	0	0	0	**0.02**
Cortical Cataract N=35	4	20	9	2	0	0	0	**0.01**
Posterior Subcapsular Cataract N=12	1	7	2	2	0	0	0	0.5
Wheat flour								
Nuclear Cataract N=153	6	26	64	52	5	0	0	0.4
Cortical Cataract N=35	3	4	14	10	4	0	0	0.3
Posterior Subcapsular Cataract N=12	0	1	5	5	1	0	0	0.1
Bajra								

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Nuclear Cataract N=153	0	2	6	3	0	53	89	0.1
Cortical Cataract N=35	0	1	2	2	3	8	19	0.5
Posterior Subcapsular Cataract N=12	0	0	0	1	1	4	6	0.1
Jowar								
Nuclear Cataract N=153	4	9	26	6	3	82	23	0.9
Cortical Cataract N=35	1	0	3	1	2	18	10	0.9
Posterior Subcapsular Cataract N=12	0	0	1	0	2	4	5	0.3

*P values based on multiple linear regression analysis at P= <0.05

*Scores established based on consumption frequency

Frequency of Consumption of different Food groups:

Table 4.6 estimates the impact of consumption frequency of different food groups by analysing the scores obtained from Food Frequency Questionnaire. Multiple regression analysis results were insignificant except for Milk. Lower consumption of milk was positively associated with enhanced risk forCC (P=0.05).

Table 4.6: Impact of consumption frequency of different food groups on Cataract Subtypes

Food Group N=200	**1-2 times/day (6)**	**2-3 times/week (5)**	**Weekly once (4)**	**2-3 times/month (3)**	**Occasionally (2)**	**Never Taken (1)**	**P value <0.05**
Milk							
Nuclear Cataract N=153	0	0	9	7	63	74	0.07
Cortical Cataract N=35	0	0	3	2	13	17	**0.05**
Posterior Subcapsular Cataract N=12	1	0	2	0	2	7	0.07
Combined Cataract risk	1	0	14	9	78	98	**0.01**
Green Leafy Vegetables (GLV)							
Nuclear Cataract N=153	13	38	70	24	8	0	0.9
Cortical Cataract N=35	3	13	14	4	1	0	0.5

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Posterior Subcapsular Cataract N=12	0	3	4	2	3	0	0.5
Combined Cataract Risk N=200	22	59	92	33	14	1	0.3
Meat/Chicken/Egg							
Nuclear Cataract N=153	4	13	35	28	16	57	0.1
Cortical Cataract N=35	2	4	9	5	3	12	0.1
Posterior Subcapsular Cataract N=12	0	1	4	2	2	3	0.6
Combined Cataract Risk N=200	6	18	48	35	21	72	0.09
Fish							
Nuclear Cataract N=153	0	0	20	32	34	67	0.2
Cortical Cataract N=35	0	0	4	5	12	14	0.7
Posterior Subcapsular Cataract N=12	0	0	1	2	6	3	0.3
Combined Cataract Risk N=200	0	0	25	39	52	84	**0.0009**
Liver							
Nuclear Cataract N=153	0	0	5	20	55	73	0.2
Cortical Cataract N=35	0	0	2	6	12	15	0.1
Posterior Subcapsular Cataract N=12	0	0	1	2	3	6	0.5
Combined Cataract Risk N=200	0	0	8	28	70	94	**0.005**
Fruits							
Nuclear Cataract N=153	9	31	42	56	15	0	0.3
Cortical Cataract N=35	2	3	8	16	6	0	0.4

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Posterior Subcapsular Cataract N=12	1	1	2	6	2	0	0.5
Combined Cataract Risk N=200	8	10	80	76	26	0	0.9
Vitamin E Rich foods							
Nuclear Cataract N=153	15	31	66	41	0	0	0.8
Cortical Cataract N=35	8	9	15	3	0	0	0.2
Posterior Subcapsular Cataract N=12	1	3	5	3	0	0	0.9
Combined Cataract Risk N=200	24	43	86	47	0	0	0.3

*P value based on Multiple regression analysis at P= <0.05

*Scoring based on frequency of consumption

A strong positive significance was observed between less frequent intake of Milk (P=0.01), Fish (P=0.0009) and Liver (P=0.005) and overall risk for cataract development.

Cooking Practices:

Table 4.7 shows the impact of various cooking practices on developmental risk of cataract. Amongst the 200 study participants, 109 were eligible for this evaluation as they were involved in cooking whilst the rest of the participants were excluded.

Within the 109 eligible participants, 92 were diagnosed with NC, 12 were suffering with CC and only 5 had PSC.

Table 4.7: Impact of cooking practices on development of Cataract Subtypes

Cooking Practices (N= 109)	**Score**	**Nuclear Cataract (N= 92)** **N (%)**	**Cortical Cataract (N= 12)** **N (%)**	**Posterior Sub-Capsular cataract (N= 5)** **N (%)**	**P value (<0.05)**
Type of Fuelused[a]					**0.03**
Clean Fuel stove (LPG, Kerosene,	1	25 (22.9%)	5 (4.5%)	1 (0.9%)	

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Biogas, Electric)					
Solid fuel Improved stove (coal, wood, cow dung with chimney)	2	11 (10%)	1(0.9%)	1 (0.9%)	
Solid fuel unimproved stove (coal, wood, cow dung without chimney)	3	56 (51.3%)	6 (5.5%)	3 (2.7%)	
Ventilation in Kitchen[b]					0.07
Fully ventilated	0	37 (33.9%)	3 (2.7%)	1 (0.9%)	
Unventilated	1	55 (50.4%)	9 (8.2%)	4 (3.6%)	
Cooking done per day[c]					**0.04**
Once	0	21 (19.2%)	3 (2.7%)	2 (1.8%)	
Twice	1	49 (44.9%)	5 (4.5%)	2 (1.8%)	
≥3 times	2	22 (20.1%)	4 (3.6%)	1 (0.9%)	

*a: scores basedtype of stove used [56]:

Stoves that used non-solid fuels—kerosene, liquefied petroleum gas (LPG), biogas, or electricity—were designated as clean-fuel stoves' (CFS)- score {1}

solid-fuel-burning stoves, with flues were designated as ‘solid-fuel-improved stoves’ (SFIS)- score {2}

Solid-fuel-burning stoves without flues were designated as ‘solid-fuel-unimproved stoves’ (SFUS) – score {3}

*b: scoring based on presence/ absence of ventilation in the kitchen:{1}Fully ventilated{0} Unventilated

*c: scoring based on frequency of cooking per day: {0} Once per day {1} Twice per day {2}≥3 times per day

The type of stove used had a significant impact on the overall incidence of cataract (P=0.03) with higher NC cases amongst SFUS (51.3%) users followed by 22.9% cases in CFS users. This could be potentially attributable to frequency of cooking which also showed a significant impact on the rate of cataract incidence (P= 0.04) with NCcases being highest (44.9%) amongst those who cooked twice per day whilst 20.1% cases belonged to those who cooked thrice/day. This discrepancy in the cooking frequency and rate of cataract incidence could be because of the poor socio-economic background of the participants which reflected on the type and consumption frequency of the food along with the cooking frequency.

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DISCUSSION:

The current study examines theincidence, prevalenceand risk associated with demographic factors, lifestyle associated factors, metabolic status, type and consumption frequency of carbohydrate and various other food groups and cooking practices on the development of cataract and itssubtypes.

Overall incidence of NC (76.5%) was higher compared to CC (17.5%) and PSC (6%). This finding is consistent with Global cataract prevalence meta-analysis study by Hashemi et al., stating that NC is the most common type, followed by Cortical and PSC in Indian region.[6]

Increasing age significantly increased cataract risk (P=0.02). A linear rise was observed in NCcases with participants aged > 70 years being at highest risk. Nirmalan et al., showed similar results as the prevalence of definite age-related cataracts significantly (P<0.001) increased from 15.7% in case of 40-49 years to 79.4% amongst those aged ≥70years [7].

Males were found to be at a statistically significant (P=0.01) greater risk for the cataract development when compared to females as showed in Table 4.1. The incidence of NC was higher amongst males (46%) as opposed to the females (30.5%). This is comparable to the results of Aarthi R et al., where the prevalence of cataract was found to be higher amongst males (66.9%) than females (60.4%) [8]. Although our results show a disagreement with the findings of Na KS et al., as they found no significant association of gender in the prevalence of cataract [9].

Low BMI (<18.5) increased the overall risk of cataract by 20% and that of NC by 22%. 26% greater risk of developing NC was seen amongst overweight individuals while the overall risk of cataract was 38% in this group. While no studies are available till date to explain the association of Low BMI with increased risk for cataract development, one possible explanation could be low SES and lack of access to proper diet leading to the increased cataract incidence in this group. The results for association with overweight is in accordance with the meta-analysis conducted on 11 prospective cohort studies by Juan Ye et al., which addressed a significant categorical relationship between BMI and Age-related cataract, where overweight and obesity increased the risk of cataract especially PSC [10]. However, our study found overweight to increase the risk of nuclear cataract as opposed to PSC. This can be attributed to the error due to small sample size.

Highest prevalence of cataract was observed amongst the illiterates (61%) as opposed to the Graduates with only 9.5% cataract incidence. This observation showed consistency with Das et al., study where a significant association was seen between illiteracy and cataract [11]. Avachat et al., also reported a significant association between education status and cataract development [12].

Participants belonging to lower socio-economic status (SES) posed 75.8% greater risk of developing NCwhile the overall developmental risk increased by 71% in this group. Cases of CC (51.4%) and PSC (66.6%) were also significantly (P=0.04) higher amongst low SES individuals. This is similar to the findings of Ava et al., where low SES was associated with increased incidence of CC, particularly in Malays [13]. Low SES was associated with lowered participation in healthcare screening and poor health besides they were more likely

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to ignore minor symptoms and were found to have higher threshold for symptoms before seeking medical attention and had lowest incident cataract surgery rates. Gupta et al., mentioned that cataract extraction was 1.6 times more common among males and associated with low literacy and SES [14].

The overall incidence of cataract in Urban population was 38.5%, Rural 39% and Tribal 22.5% although no significant association was found. These findings were in accordance to Singh et al., who noticed 44.6% increased prevalence of cataract in rural population as opposed to 43.6% amongst urban population [15]. The incidence rate of nuclear cataract was higher in all three regions, with 39.2% affected Urbans, 36.6% Rurals and 24.1% Tribals. Our study is one of its kind to estimate the overall and individual risk of incidence of cataract subtypes based on Urban, Rural as well as Tribal population. Hence, there is not enough evidence to support the findings of this study criteria.

Occupation was found to be statistically significant with the risk of cataract development (P=0.04). Farmers posed the highest risk NC (37.9%) while Industrial workers showed greater incidence of CC (14.2%) and PSC (25%). Individuals with Full time/Part time/Business as employment were at the lowest risk for overall cataract development (9%). Housewives posed second highest risk for NC (22.2%). These observations can be attributed to low SES, long duration of exposure to sunlight, illiteracy and poor-quality diet and nutrition especially in the case of farmers and industrial workers who pose increased risk for nuclear and cortical subtypes of cataract development respectively. In case of housewives, increased cataract incidence can be related to the frequency of cooking per day and excess exposure to particulate matter and toxins in smoke especially from that of the solid fuel unimproved stove and unventilated or inadequately ventilated kitchens [16].

Amongst the Lifestyle associated risk factors, duration of exposure to sunlight serves as an important and statistically strong, significant risk factor for cataract incidence (P=0.0004). A linear increase in the incidence of NC was observed with increasing duration of exposure. About 29% participants affected with NC were exposed to sun for more than 8 hours and 24% cases were exposed for 5-7 hours per day, as most of our study participants were Farmers and Industrial workers. 31.4% of the total CC cases occurred amongst the group exposed to sun for 5-7 hours/day, whereas, 28.5% cases were found in those exposed for more than 8 hours. PSC cases were least influenced by the sunlight exposure. Our findings are in agreement with Vashist et al., whose cross sectional study covered three diverse geographical regions in India to assess the risk associated with sun exposure on cataract [17]. They observed a strong dose response relationship wherein the increase in levels of sun exposure was associated with higher odds of cataract and especially nuclear and CC. PSC did not show any significant association with sun exposure.

The use of sun protection gear had no significant impact in altering the incidence of cataract (P=0.2). This is in disagreement to existing literature that reported the positive effect of the use of different types of headgear and sunglasses in providing varying degrees of protection from UV and sunlight exposure [18]. Continuous exposure of ocular lens to light and ambient oxygen increases the risk of photooxidative damage resulting in cataract [19]. Further studies are suggested to gain in-depth information on the influence of sun protection gear in altering the incidental cataractogenesis due to long duration of sunlight exposure.

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Smoking (15%) and Alcohol (12.5%) contributed to a statistically significant increase in the overall cataract incidence (P=0.01). The rates of NC (31.3%) as well as cortical (34.2%) were higher among those who consumed both alcohol and smoked cigarette, particularly affected gender was male. However, it cannot be ignored that a vast majority affected by NC (41.8%) and cortical (40%) belonged to the group which neither smoked nor consumed alcohol which majorly included women, this is attributable to presence of other metabolic or environmental risk factors. Vashist et al., found significant association between smoking and cataract, particularly NC [20]. A meta-analysis studyfinds no association between smoking and CC. Their results suggestthat cumulative oxidative damage to any dissipation of the Na+ gradient in the lens core leads to reduction in the antioxidants and nutrients uptake in the lens, leading to cataract formation. This phenomenon explains why cigarette smoking affects NC and PSC over CC [21]. This is in accordance with our study where totalNC cases werehigher(44.5%)includingalcoholics, smokers and those who consumed both. A study by Gong Y et al., reported that observed association between alcohol consumption and ARC may be confounded by smoking status [22]. Heavy alcohol consumption however increased the risk of ARC, whereas moderate alcohol consumption was found to be protective in this ocular condition.

Metabolic status of the individuals significantly impacted the incidence rate of cataractand especially NC (P=0.01). NC incidence rate enhanced by 46% in those with comorbidities. Participants with Hypertension had highest NC (17.5%) incidence followed by those with Diabetes (13%) and Obesity (12.5%). High R^2 (0.98) value indicates a strong relationship that exists in our model between the metabolic status and incidence rate of cataract subtypes. A retrospective study in Kerala by Dhanya et al., reviewed that the incidence risk for PSC greatly increased amongst those with Diabetes Mellitus and Hypertension [23]. This finding happens to be in accordance with our study as only minor insignificance was observed in case of PSC and metabolic status which could be possibly due to our small sample size. Singapore Malay Eye Study by Ava et al., reported hypertension as an important risk factor PSC [13]. It has been stated that hypertension causes lens capsule structural changes which affects the electrolyte homeostasis and membrane transport. They also found diabetes to be associated with nuclear cataract progression, this finding suggested harmful impact of hyperglycaemia on the nuclear region of the lens. Prevalence of cataract amongst obese individuals is supported by Pan et al., who found the risk of NC to increase by 12%, CC by 34% and PSC by 52% amongst the obese participants [24]. This was explained as the enhanced systemic inflammation due to elevated C-reactive protein and proinflammatory cytokines amongst the obese which could promote the cataract development as it causes inflammation in the eye.

Non-Vegetarians in the study had higher incidence rate for all three types of cataracts as 62.7% were affected by nuclear type, 65.7% had CC and 81.8% had PSC. This rate was significantly lower amongst the vegetarians (P=0.02). Our study was consistent with previous findings by Tina et al., who reported that cooking meat in high temperature generates heterocyclic amines, which increases oxidative stress, an important risk factor for cataract and particularly NC [25]. The study also found that vegetarian and vegan diet is protective rather than harmful as it outweighs the risk related to homocysteine.

A significant incidental risk was associated with nuclear (P=0.02) and CC (P=0.01) amongst the participants who consumed polished rice. Whereas, with the consumption impact related to wheat flour, bajra and jowar was highly insignificant. This could be because consumption

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frequency of the rice was higher than the rest of the carbohydrate sources in the diet. A study suggestedsignificant positive trend in the developmental riskand total carbohydrate intake with the prevalence of CC. The possible explanation could be that higher carbohydrate intake may play a role in accelerating the pathophysiologic process of cataract formation, by inducing hyperglycaemia, hyperinsulinemia thereby increasing the inflammatory biomarker, C-reactive protein concentration. Here not only the quantity of the carbohydrate was found to be related to ARC but also the quality. Our study is in line with the findings of the aforementioned study as we were able to narrow down the responsible carbohydrate source for increasing the nuclear and cortical cataract incidence rates. Although not enough evidence exists to support the negative impact of increased frequency of consumption of rice on cataract formation as it may or may not be influenced by the cumulative effect of other dietary sources of carbohydrates that are consumed along with it on daily basis though not in same quantity or as frequently, further research based on the study results would help better establish our claims.

Consumption frequency of different food groups did not significantly influence the individual cataract subtypes developmental risk with only exception for milk consumption whoseless frequent consumption significantly (P= 0.05) increased the incidence of CC. However, a significant association was observed between low frequency of dietary milk (P=0.01), Fish (P=0.0009) and Liver (P=0.005) intake and consequential rise in incidence rateupon risk assessment for overall cataract. No significant association was seen between dietary frequency of consumption of GLV, Meat/Chicken/Egg, Fruits and Vitamin E rich foods. Our study is supported by the results of Lu et al., which found that increasing dietary intake of animal protein showed an in inverse association with the developmental risk of NC and PSC. Protein is required to maintain osmotic fluid balance of the body as it is responsible for albumin production and hence is associated with osmotic stress of the lens responsible for cataract formation. There was no significant relation of dietary vegetable protein consumption on any type of cataract [26]. Another study by Gritz et al., demonstrates that there was no effect of antioxidants Beta carotene, Vitamin E and C on cataract progression [27]. Study reports by Lim et al., suggests that though a diet rich in fruits and vegetables, coupled with healthy lifestyle can help reduce the risk of cataract, it's been estimated that over 2 billion people do not have regular access to safe, nutritious and sufficient food [28]. These findings are concurrent to our study as majority of the participants were illiterates belonging to low SES which hindered their ability to procure food items such as milk, fish, fruits, vegetables in adequate quantities which rendered their diet insufficient in several important food groups that has affected our result statistics.

The type of fuel used seemed to have a significant association with the cataract incidence (P=0.03). Use of Solid fuel unimproved stove was responsible for 60.8% of the total NC cases while it increased the risk for CC by 50%. Presence of ventilated or unventilated kitchens had no significant impact on the rate of incidence of cataract (P=0.07), while the frequency of cooking done per day was found to significantly impact cataract rates in the population (P=0.04). NCincidence was higher among those who cooked twice a day (53.2%) while 41.6% CC cases were found amongst this group. As fewer individuals were involved in cooking thrice a day the rates of incidence are found to be relatively less among them. Studies by Das et al., suggest that participants with 2 hours or more than 2 hours of exposure to fuel had preponderance for cataract formation with higher prevalence observed amongst

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the women [29]. This finding is in line with our study as majority of the affected participants were housewives while few cases involved chefs. Another study by Vashist et al., also found higher prevalence of cataract especially amongst women who use solid fuel in indoor stoves for cooking [20]. Using indoor kitchen was found to be significantly associated with the occurrence of especially NC, which disagrees with our finding as we found no significant impact of ventilation upon cataract incidence. The socio-economic status greatly influenced the cooking frequency and the type of fuel used for cooking amongst the sample population as majority belonged to below poverty line, sufficient rations were unavailable and they preferred to use solid fuel unimproved stove in inadequately ventilated kitchens. Therefore, true impact of the cooking frequency, fuel type and kitchen ventilation upon cataract incidence cannot be evaluated. For this reason, the results of this study cannot be held true for a larger population without conducting further research with an economically more diverse population and a larger sample size.

The main strength of this study is extensive nature of the work done, over a geographically diverse population belonging to three different states and areas of India involving Urban, Rural and Tribal population which highlights the peculiarity of the study in the field of Cataract. Also, the information collected on age, anthropometric measurements and presence of metabolic disorders (Hypertension, Diabetes, Thyroid and Anaemia) was from the medical prescriptions of the participants while many of the previous studies based this information on self-reporting. For minimisation of misclassification of cataract diagnosis, recognized Eye institutes with trained examiners using advanced slit lamp grading technique of cataracts were approached. This study reports the parameters which have not been reported by prior studies on the impact of BMI, consumption frequency of specific carbohydrate, consumption frequency of specific food groups/items and cooking practices on incidence rate of overall cataract and its subtypes.

This study had few limitations. The sample size was small and majorly included people from low SES and literacy rate so further studies on a larger and more diverse sample are necessary for the data to be considered as a representative of concerned population. This being a cross-sectional study with a huge chunk of participants being illiterate, the data is prone to recall bias especially with regards to dietary risk factors as information is based on self-reporting. False positive significance could be expected in case of sunlight exposure as majority of the participants were farmers and industrial workers. The information used on smoking history and alcohol consumption can be biased due to non-cooperation by the cases. The results based on dietary consumption frequency and cooking practices were majorly influenced by the education status and low SES.

The most important and unique association of cataract has been found with respect to Low BMI. Low BMI or Underweight has posed to be an equally significant risk for the overall cataract incidence with higher weightage towards the NC and was found to be linear with the risk associated with overweight and obesity as was seen in our study and reported by earlier findings. No prior studies have reported the significance between underweight and cataract incidence.

Another unique finding of this study was strong positive significance of frequent polished rice intake with the increased risk of Nuclear (P= 0.02) and Cortical cataract (P= 0.01). Previously no studies had narrowed down the risk associated with specific carbohydrate

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intake. This is an important finding as the diet in South India is predominately rice-based and this could be a possible major underlying risk factor for increasing incidence of cataract rates amongst both young adults and senescent group.

Further studies on larger sample size involving considerable diversity in Education level, Socio-economic status and Occupation can strengthen the study results providing more concrete estimate to the present findings of our study.

CONCLUSION:

It demonstrates a clear influence of non-modifiable risk factors such as age, gender and modifiable risk factors in altering the likelihood of cataract. The information on significant risk associated with low BMI and high frequency of consumption of rice is pertinent and strategies to improve the prevalent malnourished status amongst Indians alongsideresearch based on dose-response relationship between polished rice intake and cataract formation by elimination of the compounding factors can help establish the findings of our studyand influence interventional strategies for designing policies in order to alleviate the long-term risk and prevent the incident rate of cataract.

BIBLIOGRAPHY

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3146699/#bib4
2. Praveen, M., Shah, G., Vasavada, A. et al. A study to explore the risk factors for the early onset of cataract in India. Eye 24, 686–694 (2010). https://doi.org/10.1038/eye.2009.137
3. Theodoropoulou, S., Samoli, E., Theodossiadis, P.G. et al.(2014). Diet and cataract: a case–control study. Int Ophthalmol 34, 59–68 https://doi.org/10.1007/s10792-013-9795-6
4. Chinta, Srivatava, Eshwar, Jain, K, & Swamy(2016). Overview of socio economic status scales in india. International journal of innovative research in dental sciences, 1(2), 6.
5. Rupak Mukhopadhyay, Sankar Sambandam, Ajay Pillarisetti, Darby Jack, Krishnendu Mukhopadhyay, Kalpana Balakrishnan, Mayur Vaswani, Michael N. Bates, PatrickL. Kinney, Narendra Arora & KirkR. Smith (2012) Cooking practices, air quality, and the acceptability of advanced cookstoves in Haryana, India: an exploratory study to inform large-scale interventions, Global Health Action, 5:1, DOI: 10.3402/gha.v5i0.19016
6. Hashemi, H., Pakzad, R., Yekta, A., Aghamirsalim, M., Pakbin, M., Ramin, S., &Khabazkhoob, M. (2020). Global and regional prevalence of age-related cataract: a comprehensive systematic review and meta-analysis. Eye (London, England), 34(8), 1357–1370. https://doi.org/10.1038/s41433-020-0806-3
7. Nirmalan, P. K., Robin, A. L., Katz, J., Tielsch, J. M., Thulasiraj, R. D., Krishnadas, R., & Ramakrishnan, R. (2004). Risk factors for age related cataract in a rural

ISSN PRINT 2319 1775 Online 2320 7876
 Volume 12, Iss 4, 2023

population of southern India: the Aravind Comprehensive Eye Study. The British journal of ophthalmology, 88(8), 989–994. https://doi.org/10.1136/bjo.2003.038380

8. Aarthi R, Roy G, Kar SS, Srinivasan R (2015). Prevalence of cataract among adults above 50 years in a rural community of Villupuram, Tamil Nadu. Int J Adv Med Health. https://www.ijamhrjournal.org/text.asp?2015/2/1/50/159170
9. Na KS, Park YG, Han K, Mok JW, Joo CK (2014) Prevalence of and Risk Factors for Age-Related and Anterior Polar Cataracts in a Korean Population. PLOS ONE 9(6): e96461. https://doi.org/10.1371/journal.pone.0096461
10. Juan, Y., Li-Xia,L., Jin-Jing, H., Yu-Feng, X. (2014). Body Mass Index and Risk of Age-Related Cataract: A Meta-Analysis of Prospective Cohort Studies. https://doi.org/10.1371/journal.pone.0089923
11. Das, G. K., Boriwal, K., Chhabra, P., Sahu, P. K., Kumar, S., & Kumar, N. (2019). Presenile cataract and its risk factors: A case control study. Journal of family medicine and primary care, 8(6), 2120–2123. https://doi.org/10.4103/jfm
12. Avachat, S. S., Phalke, V., & Kambale, S. (2014). Epidemiological correlates of cataract cases in tertiary health care center in rural area of maharashtra. Journal of family medicine and primary care, 3(1), 45–47. https://doi.org/10.4103/2249-4863.130273
13. Ava G. T., Yih, C. T., Miao, L. C., Paul, M., Robert G. C.,Charumathi,S.,Tien, Y. W., Jie, W.,Ching-Yu, C. (2020). Incidence, progression and risk factors of age-related cataract in Malays: The Singapore Malay Eye Study. Clin Experiment Ophthalmol.;48:580-592. DOI: 10.1111/ceo.13757
14. Gupta, M. C., & Mahajan, B. K. (2021). Textbook of preventive and social medicine. Jaypee Brothers. P: 378
15. Singh, S., Pardhan, S., Kulothungan, V., Swaminathan, G., Ravichandran, J. S., Ganesan, S., Sharma, T., & Raman, R. (2019). The prevalence and risk factors for cataract in rural and urban India. Indian journal of ophthalmology, 67(4), 477–483. https://doi.org/10.4103/ijo.IJO_1127_17
16. Ravilla, T. D., Gupta, S., Ravindran, R. D., Vashist, P., Krishnan, T., Maraini, G., Chakravarthy, U., & Fletcher, A. E. (2016). Use of Cooking Fuels and Cataract in a Population-Based Study: The India Eye Disease Study. Environmental health perspectives, 124(12), 1857–1862. https://doi.org/10.1289/EHP193
17. Vashist P, Tandon R, Murthy GVS, Barua CK, Deka D, et al. (2020) Association of cataract and sun exposure in geographically diverse populations of India: The CASE study. First Report of the ICMR-EYE SEE Study Group. PLOS ONE 15(1): e0227868. https://doi.org/10.1371/journal.pone.0227868
18. Backes, C., Religi, A., Moccozet, L. et al. (2014). Sun exposure to the eyes: predicted UV protection effectiveness of various sunglasses. J Expo Sci Environ Epidemiol 29, 753–764. https://doi.org/10.1038/s41370-018-0087-0
19. Kaur, J., Kukreja, S., Kaur, A., Malhotra, N., & Kaur, R. (2012). The oxidative stress in cataract patients. Journal of clinical and diagnostic research : JCDR, 6(10), 1629–1632. https://doi.org/10.7860/JCDR/2012/4856.2626
20. Vashist, P., Talwar, B., Gogoi, M., Maraini, G., Camparini, M., Ravindran, R. D.,Murthy, G. V., Fitzpatrick, K. E., John, N., Chakravarthy, U., Ravilla, T. D., &Fletcher, A. E. (2011). Prevalence of cataract in an older population in India: theIndia study of age-related eye disease. Ophthalmology, 118(2), 272–8.e82.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **Volume 12, Iss 4, 2023**

21. Juan, Y., He, J., Wang, C., Wu, H., Shi, X., Zhang, H., Xie, J.,Yeul, S., L. (2012) Smoking and Risk of Age-Related Cataract: A Meta-Analysis. Invest. Ophthalmol. Vis. Sci;53(7):3885-3895. doi: https://doi.org/10.1167/iovs.12-9820.
22. Gong Y, Feng K, Yan N, Xu Y, Pan CW. (2015). Different amounts of alcohol consumption and cataract: a meta-analysis. Optom Vis Sci; 92:471–479. doi: 10.1097/OPX.0000000000000558
23. Dhanya, V. S., Abraham, M., MG, D. (2021). Risk Factors and Types of Presenile Cataract inPatients Attending a Tertiary Care Hospital inKerala- A Retrospective Study. International Journal of Research and Review. Vol.8; Issue: 2.
24. Pan, Chen-Wei; Lin, Y. (2014). Overweight. Obesity, and Age-Related Cataract. Optometry and Vision Science- Volume 91 - Issue 5 - p 478-483 doi: 10.1097/OPX.0000000000000243
25. Tina H.T.Chiu, Chia-ChenChang, Chin-LonLin, Ming-NanLin. (2021). A Vegetarian Diet Is Associated with a Lower Risk of Cataract, Particularly Among Individuals with Overweight: A Prospective Study. Journal of the Academy of Nutrition and Dietetics. Volume 121, Issue 4, April 2021, Pages 669-677.
26. Lu, Z. Q., Yan, J., Sun, W. H., Jiang, T. X., Zhai, S. N., Li, Y., & Gao, G. D. (2013). Relationship between dietary macronutrient intake and the risk of age-related cataract in middle-aged and elderly patients in northeast China. International journal of ophthalmology, 6(6), 805–810. https://doi.org/10.3980/j.issn.2222-3959.2013.06.12
27. D C Gritz, M Srinivasan, S D Smith, U Kim, T M Lietman, J H Wilkins, B Priyadharshini, R K John, S Aravind, N V Prajna, R DuraisamiThulasiraj, J P Whitcher. (2006). The Antioxidants in Prevention of Cataracts Study: effects of antioxidant supplements on cataract progression in South India. Br J Ophthalmol;90:847–851. doi: 10.1136/bjo.2005.088104
28. Lim, J. C., Caballero Arredondo, M., Braakhuis, A. J., & Donaldson, P. J. (2020). Vitamin C and the Lens: New Insights into Delaying the Onset of Cataract. Nutrients, 12(10), 3142. https://doi.org/10.3390/nu12103142
29. Das, R., Sengupta, B., Debnath, A., &Bhattacharjya, H. (2021). Cataract and Associated Factors Among OPD Attendees in a Teaching Institute of North East India: A Baseline Observation. Journal of family medicine and primary care, 10(9), 3223–3227. https://doi.org/10.4103/jfmpc.jfmpc_2493_20