EXTENDED REPORT

Influence of tobacco use on cataract development

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Aim: To study the influence of tobacco use on cataract formation in a rural South Indian population.

Methods: 3924 subjects from the Chennai Glaucoma Study conducted in rural south India underwent a comprehensive eye examination, including Lens Opacities Classification System II grading. Information on tobacco use, type of tobacco (smoking and smokeless), duration and quantity of use was collected.

Results: 1705 (male:female (M:F) 1106:599) people used tobacco and were significantly older (mean (standard deviation (SD)) age 55.80 (10.64) years) than non-users (52.23 (10.51); $p < 0.001$). 731 (M:F 730:1) people smoked, 900 (M:F 302:598) used smokeless tobacco, and 74 (M:F, 74:0) used tobacco in both forms. The unadjusted and adjusted (age and sex) odds ratio (OR) for a positive history of tobacco use and cataract was 1.72 (95% confidence interval (CI) 1.51 to 1.96) and 1.39 (95% CI 1.15 to 1.68), respectively. The unadjusted OR for smokers and smokeless tobacco users was 1.04 (95% CI 0.88 to 1.23) and 2.74 (95% CI 2.31 to 3.26), respectively. The adjusted OR was 1.19 (95% CI 0.89 to 1.59) and 1.54 (95% CI 1.22 to 1.95), respectively. No significant association was noted between smoking and any particular type of cataract. Smokeless tobacco use was found to be significantly associated with nuclear cataract even after adjusting for age and sex (OR 1.67, $p = 0.067$, 95% CI 1.16 to 2.39).

Conclusion: Tobacco use was significantly associated with cataract. Smoking was not found to be significantly associated with cataract formation; however, smokeless tobacco use was more strongly associated with cataract.

Cataract is the leading cause of blindness and moderate visual impairment worldwide. It has been estimated that developing countries such as India have a large cataract burden, accounting for 44% of blindness.¹ Numerous risk factors have been identified for early cataract development: environmental factors such as sunlight or ultraviolet exposure, systemic diseases such as diabetes mellitus, indices of nutrition such as low body mass index, and lifestyle factors such as smoking.^{2,3} Although effective treatment options are available to restore vision, identifying risk factors helps establish preventive measures as primary intervention. Tobacco use is a major public health problem worldwide and is the leading preventable cause of disease, disability and premature death. It has been reported to be responsible for a considerable amount of morbidity and mortality among middle-aged adults.⁴ It is estimated that one third of all women and two thirds of men in India use tobacco in some form, such as smoking tobacco in the form of cigarettes, bidis and cheroots, and smokeless tobacco in the form of snuff or chewing tobacco.^{4,5} In South Asia, the use of smokeless tobacco is common. The various forms are chewed, sucked, or applied to teeth or gums. The use of unprocessed tobacco, the cheapest form, varies in different parts of India. In Tamil Nadu, smokeless tobacco is sold as packets of strands and is used alone or along with betel leaf, areca nut and lime. Tobacco is also inhaled nasally in powdered form as dry snuff.⁶ Smoking is reported to be a risk factor for eye diseases such as cataract, age-related macular degeneration and glaucoma.⁷ No epidemiological studies have been carried out so far on the effect of smokeless tobacco on the eye. This paper reports the relationship between both use of both forms of tobacco (smoking and smokeless) and cataract in a population-based sample from rural south India.

METHODS

This study was part of a population-based study that was conducted to estimate the prevalence of glaucoma in a rural south Indian population. The methods and design of the

Chennai Glaucoma Study are described in detail elsewhere.⁸ The rural study area (based on the Government of India Census 2001 definition) comprised a total population of 22 000 people residing in 27 villages spread over the Thiruvallur and Kancheepuram districts of Tamil Nadu. The 1991 census of India reported 22% of the population as being >40 years of age. On the basis of this distribution, 4840 subjects aged ≥ 40 years were expected in our study area and 4800 people were enumerated in the rural area. The study was conducted between May 2001 and June 2003.⁸ Written informed consent was obtained from all the participants and the study was carried out in accordance with the tenets of the Declaration of Helsinki. The institutional review board of the Vision Research Foundation, Chennai approved the study.

A detailed medical and ocular history was elicited for all participants enrolled in the study. As some of our participants were illiterate, the questionnaire was read to the participants and the answers were filled in by the person administering it. Details on form of tobacco use, duration and quantity of use were ascertained. On the basis of the history of tobacco use, data on the number of cigarettes or bidis or cheroots smoked per day were elicited for current smokers. For analysis, smoking was categorised as mild (up to the 33rd centile of pack years smoked (≤ 13 pack years)), moderate (33rd–67th centile (13–30 pack years)) or heavy (>67 th centile (>30 pack years)). Similarly, smokeless tobacco use was graded as mild, moderate or heavy based on the 33rd and the 67th centiles of the frequency and duration of tobacco use. All participants underwent a complete ophthalmic examination, including best-corrected visual acuity using the modified Early Treatment Diabetic Retinopathy Study (ETDRS) chart (Light House Low Vision Products, New York, New York, USA), applanation tonometry, gonioscopy, grading of lens opacities using the Lens Opacities Classification System

Abbreviations: ETDRS, Early Treatment Diabetic Retinopathy Study; LOCS II, Lens Opacities Classification System II; ROS, reactive oxygen species; SOD, superoxide dismutase

II (LOCS II), fundus examination, optic disc and fundus photography, and random blood sugar estimation.⁸ Visual acuity was tested at 4 m distance using the modified ETDRS chart. The chart was illuminated from above and was maintained at 900 lux uniformly. Testing was carried out by one of two trained optometrists. LOCS II grading was carried out on all participants after dilation by one of two trained ophthalmologists. A grading of $\geq$ N II/C I/P I or a combination was considered to indicate significant cataract.

Data analysis was carried out using SPSS V.13. Significance was assessed at $p < 0.05$ for all parameters. Associations between age and sex and the presence of specific types of cataract were estimated by odds ratio (OR) and its 95% confidence interval (CI). Multivariate analysis was used to estimate the age-adjusted and sex-adjusted OR. Categorical variables between groups were compared using χ^2 test or Fisher's exact test; t test was used for continuous variables.

RESULTS

In all, 3924 people (response rate 81.95%) participated in the study. A positive history of tobacco use in any form was obtained from 1705 participants (43.45%), of whom 1106 were men (64.87%) and 599 were women (35.13%; fig 1). The mean (standard deviation (SD)) age of the tobacco users (55.80 (10.64) years) was found to be significantly higher than that of the non-tobacco users (52.23 (10.51) years, $p < 0.001$; table 1). Fischer's exact test showed a significant difference in sex between the two groups ($p < 0.001$).

Among the tobacco users, 731 participants (42.87%) used tobacco in the form of cigarettes, bidis or cheroots, 900 participants (52.79%) used tobacco in the smokeless form and 74 (4.34%) used tobacco in both forms (fig 2).

Of the smokers, 671 participants (91.79%) used tobacco in the form of bidis, 58 (7.93%) smoked cigarettes and only 2 (0.27%) smoked cheroots. The mean (SD) age of the smokers was found to be 53.07 (9.89) years, which was not significantly different from that of the non-tobacco users ($p = 0.055$). However, the smokeless tobacco users were significantly older (57.71 (10.61) years, $p < 0.001$). A significant difference in sex was found among the smokers ($p < 0.001$) and the smokeless tobacco users ($p = 0.03$; table 1). More women were found to use tobacco in the smokeless form.

The prevalence of cataract was found to be highest among smokeless tobacco users. The prevalence of cataract among smokers was found to be 52.60%. Men who used tobacco in any form were found to have a higher prevalence of cataract (67.57%). Little difference was found among men and women in the prevalence of cataract among the non-tobacco users (table 2).

Participants who used tobacco in any form had a significant unadjusted OR of 1.72 (95% CI 1.51 to 1.96 $p < 0.001$) for the development of cataract and an OR 1.39

Figure 1 Demographics of the study group.

Table 1 Demographics of tobacco users

	M:F	Mean (SD) age, years	p Value
Non-tobacco users	656:1563	52.23 (10.51)	
Smokers	730:1	53.07 (9.89)	0.06
Users of smokeless tobacco	302:598	57.71 (10.61)	<0.001
Users of both forms of tobacco	74:0	59.68 (11.90)	<0.001

F, female; M, male.

(95% CI 1.15 to 1.68) after adjustment for age and sex. Smoking was not found to be significantly associated with cataract (OR 1.04, $p = 0.67$, 95% CI 0.88 to 1.23), even after adjustment for age and sex (OR 1.19, $p = 0.24$, 95% CI 0.89 to 1.59). However, smokeless tobacco use was found to be significantly associated with cataract (OR 2.74, $p < 0.001$, 95% CI 2.31 to 3.26), and this significance remained even after adjusting for age and sex (OR 1.54, $p < 0.001$, 95% CI 1.22 to 1.95). The odds for cataract did not change significantly after adjusting for other risk factors such as diabetes and occupation. The odds for cataract development also showed an increasing trend, with increased smoking and smokeless tobacco use (table 3; fig 3).

A total of 2235 participants (56.96%) had significant cataract. This included participants who were operated for significant cataract and were bilaterally or unilaterally pseudophakic or aphakic at presentation. Only patients with bilateral phakia were included to study the association of cataract type with tobacco use. Smoking was found to have a significant positive association with pure nuclear cataract (OR 1.40, $p = 0.036$, 95% CI 1.02 to 1.91). However, it was not found to be significant after adjustment for age and sex, although the OR did not change (OR 1.40, $p = 0.153$, 95% CI 0.87 to 2.23). Use of smokeless tobacco was also found to be significantly and positively associated with pure nuclear cataract (OR 2.52, $p < 0.001$, 95% CI 1.85 to 3.43) and remained significant even after adjustment for age and sex (OR 1.67, $p < 0.001$, 95% CI 1.16 to 2.39).

DISCUSSION

Population-based studies have studied several risk factors for the development of cataract, and smoking has been identified as one of them. Our study has shown tobacco use to be a risk factor for cataract development. A survey conducted by the World Health Organization in 1992 showed that only 20% of tobacco in the form of cigarettes and bidis accounted for 40% of tobacco consumption. The remainder was in the form of smokeless tobacco. It has also been estimated that 65% of men use some form of tobacco (35% smoking, 22% smokeless and 8% both) and that 3% of women smoke. The use of smokeless tobacco was found to be similar among men and

Table 2 Sex distribution of the prevalence of significant cataract

	Men (%)	Women (%)
Smoking	52.60	—
Use of smokeless tobacco	74.17	73.57
Use of both forms of tobacco	67.57	—
No habits	50.76	51.44

Figure 2 Age and sex distribution of tobacco users.

women.⁴ This finding is similar to that in our population, where 68.45% men use some form of tobacco. Social norms in India do not favour women smoking. However, the use of smokeless tobacco is culturally acceptable. In this study population too there was just one woman who smoked, whereas more than one third of them used tobacco in a smokeless form.

Several population-based studies have reported a higher prevalence of cataract among women. One of the causes proposed has been exposure to indoor smoke; toxins from biomass fuel smoke are absorbed systematically, and accumulate in the lens, resulting in cataract.⁹ The mechanisms by which tobacco use affects the lens have been studied extensively. It has been shown that smokers have higher levels of cadmium in their blood than non-smokers. The cadmium inactivates the superoxide dismutase (SOD) by replacing the bivalent metals, such as zinc, copper and manganese, thereby weakening the antioxidant defence. The accumulation of cadmium in the blood and decrease of SOD might affect the lens and be responsible for early onset of cataractogenesis among smokers.¹⁰ A similar finding has been shown among tobacco chewers too. It has been reported that there is a threefold increase in the amount of blood cadmium and a 33% reduction in the activity of SOD among tobacco chewers, making the lens susceptible to cataract.¹¹ Cataractogenesis secondary to tobacco use is also believed to be due to the constituents in smoke causing a decrease in the SOD activity. It is believed that the major pathway is due to the oxidative stress brought about by the reactive oxygen species (ROS) generated by the constituents in smoke. These constituents, when systematically absorbed, reach the lens and generate ROS through photodynamic action. The ROS

affects the activity of the SOD enzyme that acts as a defence against the ROS. This decrease in the activity of SOD is also believed to cause early cataractogenesis.⁹

This study has its own limitation as it was not designed to study the risk factors for cataract, but was part of a glaucoma prevalence study. The study was conducted on a rural population, most of whom were illiterate and farmers by occupation; hence, exact details on duration and quantity of tobacco use could not be ascertained. The use of a questionnaire for these participants might have had a potential for recall bias, which could have influenced the study results. Data on nutritional status, exposure to sunlight, exposure to indoor smoke and other confounders were not collected. This could have influenced the adjusted ORs for tobacco use on the risk of cataract.

Most men in this rural population who smoked used bidis. Each bidi weighs approximately 0.36 g and contains 0.15 g of tobacco loosely wrapped in a leaf. Each cigarette weighs approximately 0.82 g and contains 0.70 g of tobacco wrapped in paper.¹² Thus, the daily inhalation dose per cigarette is four to five times higher.¹² A bidi burns less efficiently than a cigarette, as it is wrapped in a leaf that is not easily combustible and hence extinguishes frequently and may not be used completely.¹³ As most of our population smoked bidis, this probably explains the lack of association of smoking with cataract or cataract type. Indoor smoke and exposure to sun could also be confounders in this rural population as they are known to influence cataract formation.^{14 15} We speculate that these confounders may explain the lack of association between smoking and cataract formation in this study.

Several studies have shown the association of nuclear and cortical cataract with smoking.^{2 3 12 16-18} Other population-based studies from south India have reported an association

Figure 3 Odds ratio for the development of cataract.

Table 3 Odds ratio for the development of cataract

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Use of any form of tobacco	1.72 (1.51 to 1.96)	1.39 (1.15 to 1.68)
Smoking	1.04 (0.88 to 1.23)	1.19 (0.89 to 1.59)
Use of smokeless tobacco	2.74 (2.31 to 3.26)	1.54 (1.22 to 1.95)

between cigarette smoking and cataract. The Andhra Pradesh Eye Disease Study was carried out in an urban setting and did not find a relationship between bidi smoking and cataract.¹² The Aravind Comprehensive Eye Study reported information only for the cigarette-smoking population.³

Several studies indicate that smoking is a risk factor for eye diseases such as cataract. However, the effect of smokeless tobacco on the eye has not been studied before. Awareness of the hazards of smokeless tobacco use is low in rural populations. In fact, many people believe that tobacco in smokeless form has medicinal value in curing toothache or cold. Hence an effective anti-tobacco programme educating people on the ill effects of tobacco use may help in promoting healthy behaviour, particularly among the younger generation, thereby reducing tobacco-related conditions.

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