Original Article

Sweetened Areca Nut, A Risk in Dental Caries among Adolescents in Pune, Maharashtra? A Case-Control Study

Sahana Hegde Shetiya[1], Sudhir L. Jadhav[2], Supriya Kheur[3], Ravi Shirahatti[4], Rakesh Gupta[5], Ruttika Desai[1]

Departments of [1]Public Health Dentistry, [2]Community Medicine, [3]Oral Pathology and Microbiology, Dr. D Y Patil Dental College and Hospital, Dr. D Y Patil Vidyapeeth, Pimpri, Pune, Maharashtra, [4]Department of Public Health Dentistry, SDM College of Dental Sciences and Hospital, Dharwad, Karnataka, [5]Department of Deaddiction, Santokba Durlabhji Memorial Hospital and Medical Research, Jaipur, Rajasthan, India

Abstract

Introduction: Smokeless tobacco (SLT) causes dental caries and so does chewing of areca nut (sweetened supari) due to the presence of sugar. Since conflicting views exist about whether areca nut causes dental caries or not, and since studies are undertaken in adults and data on adolescents are not available, this study was carried out. Since those were cross-sectional or longitudinal studies, this case-control study was undertaken to understand if flavored/sweetened areca nut is a risk factor for dental caries. **Material and Method:** This unmatched case-control study was conducted among the male students of 8th to 10th standard in the age group of 12–16 of four Madhyamik Vidyalaya's (MVs) in Pimpri–Chinchwad (urban area), Pune. A directed acyclic graph (DAG) was drawn to determine the independent variables to be selected for the study and minimal variables to be adjusted during data analysis. Selection of cases was based on diagnostic and eligibility criteria. The data on the use of sweetened areca nuts and the presence of caries were collected through oral examination and a semistructured questionnaire administered by the principal investigator on a one-to-one basis between August 2022 and October 2022. Data were analyzed using epiinfo™ 7.2.5.0. **Results:** This study of 146 males in the age group of 13 to 16 years had 61 students as cases and 85 as controls. No significant difference was observed between the group with (cases) and without (controls) dental caries for areca nut use (pack years) whether consumed daily or less frequently for 1 year or more. While the exposure rate to areca nut among cases was 44.26%, for the control group it was 36.47%. The odds ratio of sweetened areca nut as being the risk factor for dental caries was 1.38 at 95% CI (0.70–2.71) with $P = 0.44$. **Conclusion:** This study revealed that the adolescent users of sweetened areca nuts studying in government schools had a higher exposure odds ratio for dental caries. However, it was not significant statistically. Information bias including recall may have influenced the outcome.

Keywords: Adolescent, areca, case-control study, dental caries

Introduction

Spitting of smokeless tobacco (SLT) may be associated with the spread of tuberculosis, which is a public health problem.[1] The presence of natural and artificial sugars (as flavors) in smokeless tobacco products poses a risk as high as 35% for dental caries among their users.[2] Smokeless tobacco (SLT) products are made more tasty masking the unpleasantness through the addition of sugars such as fructose, glucose, sucrose, maltose, and isomaltose.[3] Commercially available SLT contains 0.5 to 2 g of sugar per chew of about 10 g.[4] The product is kept in the oral cavity for an average of 30 min and used repeatedly each day.[5]

A high prevalence of dental caries is a public health concern, especially in low-middle-income countries. Illiterates living in poverty and those with poor access to oral care are most affected. The consequences of chronic untreated dental caries are pain, loss of sleep, inability to chew food, infection of the head and neck, lost school days, disruption of family life, and reduced quality of life.[6]

SLT may or may not contain areca nut (a carcinogen), which causes cancer and oral submucous fibrosis.[7] Adolescent

Access this article online

Quick Response Code:

Website: www.ijcm.org.in

DOI: 10.4103/ijcm.ijcm_93_23

Address for correspondence: Dr. Sahana Hegde Shetiya, Department of Public Health Dentistry, Dr. D Y Patil Dental College and Hospital, Dr. D Y Patil Vidyapeeth, Pimpri, Pune, Maharashtra, India.
E-mail: shetiyasahana@gmail.com

How to cite this article: Shetiya SH, Jadhav SL, Kheur S, Shirahatti R, Gupta R, Desai R. Sweetened areca nut, a risk in dental caries among adolescents in Pune, Maharashtra? A case-control study. Indian J Community Med 0;0:0.

Received: 16-02-23, **Accepted:** 26-06-24, **Published:** 03-10-24

students oblivious of its harmful consequences have low-risk perceptions of commercially packaged sweetened areca nuts.[8]

In the South-East Asian region with a prevalence rate of 7.5%, 14.8 million (34% globally) children between 13 and 15 years of age use tobacco.[9] In India, 8.5% of students are current tobacco users. Regardless of gender, the current use of SLT accounts for 4.1%.[10] In Maharashtra, while 5.1% of students are current users of any tobacco, 2.4% are current users of SLT.[11]

A case-control study[12] carried out in India among 20 to 60 year olds indicated that the caries experienced (61.9%) among the SLT chewers was less compared with nonchewers (90.5%). It was hypothesized that the use of snus among 20- to 70-year-old Swedish snuff users and 13- to 20-year-old middle school male SLT users in Saudi Arabia did not display a significant relationship with the risk of caries.[13-15] Among 20 to 40 year olds, SLT use lead to higher mean Decayed, Missing, Filled Teeth (DMFT)/ Decayed, Missing, Filled, Surfaces (DMFS) as compared with smokers. Around 46% of 18- to 50-year-old SLT users were in the "moderate" *Streptococcus mutans* count category, whereas the control group had lower caries experience (6%).[16,17]

Forty-one percent of the Aua islanders who chewed betel nuts regularly had a 23% prevalence of caries with DMFT of 0.364 while 59% of islanders who did not chew regularly had a 49% prevalence of caries with DMFT of 1.162.[18] Beetle nut chewing among 30- to 50-year-old Pakistani adults showed a significantly higher risk of dental caries (OR: 4.51) with significantly more cavities. However, since clinical examinations were not done all information was only on perceived oral health and not on actual oral health status.[19]

Since there is a conflicting view that SLT/sweetened areca nut, may not[12-15,18] or may[16,17,19] be associated with dental caries and since studies are undertaken in adults and since they had longitudinal[14] or cross-sectional[13,16,17] design, this study on sweetened areca nut as a risk factor for caries was planned as data on children and adolescents were not available.

High school children from municipal schools in Pimpri-Chinchwad, Pune district were seen chewing SLT/ supari products. For SLT products, more information on the toxic effects of the sugars themselves, e.g., whether they are associated with dental caries was to be further researched as there is little evidence.[20] However, during the visit to the schools' children were seen chewing *sada* (unadulterated/plain) or sweetened areca nut more often than the SLT. Since the case-control design has not been employed in earlier studies, it was considered that such a design will establish whether any statistical association exists between dental caries and the use of sweetened areca nut; and, if it does, what is the strength of its association?

Hence, the research question was, what are the odds of having sweetened areca nut as a risk factor for dental caries (decayed teeth) among adolescents?

Material and Methods

Study design: Pimpri - Chinchwad Municipal Corporation (PCMC) established in 1982 has 21 clinic dispensaries some of which have a dental diagnosis and treatment is offered to patients. Around 136 municipal schools are present, 18 of which are madhyamik vidyalays (MVs).

The unmatched case-control study was conducted solely among the male school children of 8th-10th standards of MV of PCMC, Pune district since female students did not report any consumption of areca nut. The study was approved by the scientific and ethics committee of the Vidyapeeth and written consent of each participant was obtained. The study population comprised four schools located at Kasarwadi, Wakad, Nehrunagar, and Landewadi, which are representative of a cross section of the population. A random sampling of schools using the lottery method was done after which the data were collected between August and November 2022.

The sample size calculation was done by using WinPepi PORTAL Copyright J.H.Abramson, Aug. 23, 2016. Based on the study by Sen *et al*.[17] considering DMFT >1 in 78% consuming smokeless tobacco and 32% in the control group, with a significance level at 1%, power at 95%, the ratio of sample sizes B: A as 1 with proportion in B as 0.32, the sample size arrived at was 39 in each group, having a total of 78 participants. The choice of risk and protective factors to investigate was based on the review of literature. DAG[21] was used to help choose which covariates should be included in traditional statistical approaches to minimize the magnitude of the bias in the estimate produced. [Figure 1]. We categorized these variables as (1) demographics: age, sex; past medical and dental history; and, (2) other determinants of dental caries such as oral hygiene, fluoride exposure through toothpaste, brushing habit, medical history, diet, and malocclusion.

Study cases and controls: For the unmatched case-control study, cases were selected based on the definition of a case as per World Health Organization (WHO) 2013[22] criteria by the principal investigator who is a Public Health Dentist.

1. Diagnostic criteria: Caries was considered to be present when a cavity, undermined enamel, or a softened floor or wall was present in a pit, fissure, or on a smooth tooth surface. Teeth with mixed dentition, especially deciduous teeth with caries, and deep dental caries of permanent dentition were not considered. Those who had systemic and salivary gland disease, undergone radiation therapy, differently abled (mental retardation), and students from privately run secondary schools of PCMC were excluded.
2. Eligibility criteria: All newly diagnosed cases with caries involving enamel and dentine only.

Data sources: Sources of cases and controls were a random sample of students who chewed/did not chew sweetened areca nut and who did/did not have dental caries present in the MVs in PCMC ascertained through a survey and oral examination. To ensure similarity between them about sex

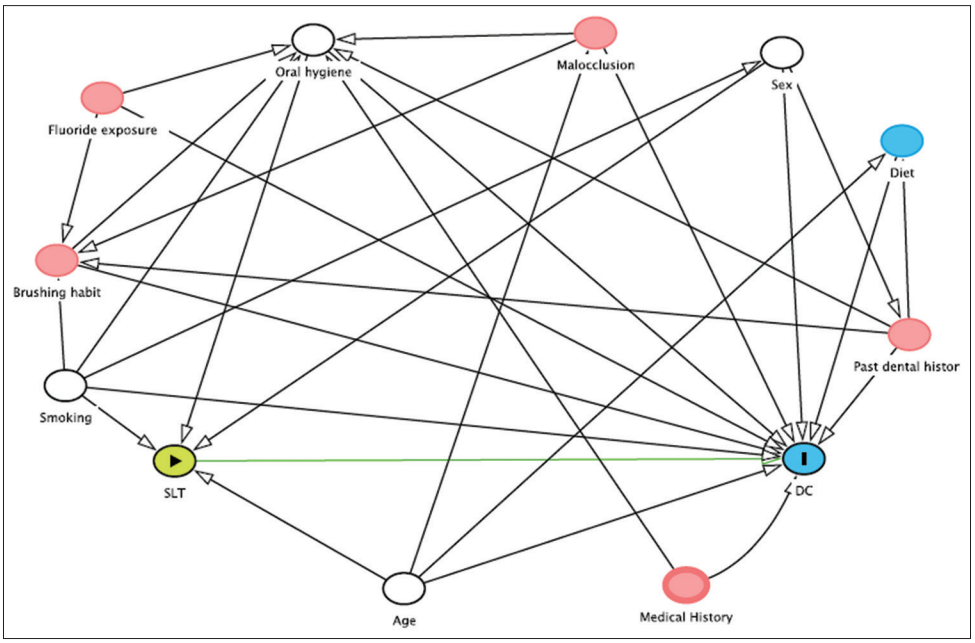

Figure 1: Theoretical model of the relationship between sweetened areca nut and dental caries in adolescents based on a Direct Acyclic Graph (DAG). Exposure (SLT/sweetened areca nut), Outcome (Dental caries), ancestor of exposure and outcome, adjusted variable, ancestor of the outcome, Black arrow- red biasing path changed to black as few variables were adjusted, Green arrow- causal path

and socioeconomic status, eligible students attending the same school were categorized as the cases and those without caries were selected as controls.

Consent was obtained from the Education Department, PCMC, and school principals along with written informed consent from the participating students. In this manner, 830 students were potentially eligible to be examined from four schools. 146 were confirmed eligible to participate having 61 cases with dental caries and 85 controls without dental caries. Both, the cases and the controls included in the study were interviewed after which a dental examination was done, which on average took 10 to 12 min.

Confounders like age and oral hygiene were collected in a schedule prepared for data collection. The examiner was trained to make consistent clinical judgments. Intraexaminer consistency was assessed by calculating the percentage of agreement between scores for dental caries after the dental examination was repeated in 15 days among 46 students in one of the MVs. The measurement of agreement as denoted by kappa was 0.82 ($P < 0.01$).

Exposure variable: Information about exposure to sweetened areca nut (*Raju Elaichi Supari, Aunty*, contents of which are *supari, elaichi, menthol, sugar, sodium saccharin, flavors,* and *Vimal Pan Masala* contents of which are *betel nut, catechu, lime, cardamom, menthol, saffron, flavors*), its use along with frequency, duration, and brand used was obtained by the interviewer using pretested semistructured questionnaire. The armamentarium used for oral examination was mouth mirror and community periodontal index probe.

Exposure measures such as (1) dietary sugar exposure through a nutrient evaluation chart[23] by scoring the sweets using dietary recall on an ordinary weekday at and between meals in the solid and sticky, liquid, and slowly dissolving forms and their frequency of intake was ascertained. The Sweet Score was classified as (a) excellent: 5 or less; (b) good: 10; and (c) watch-out zone: 15 or more. Data were also collected on (2) brushing of teeth with brush and paste, and the number of times teeth was brushed in a day; (3) visit to a dentist: once/twice in a year, never or sometimes, which was once in 5 to 6 years; (4) brand of toothpaste used (fluoridated/not fluoridated); (5) oral hygiene classified as good, fair, or poor based on simplified oral hygiene index[24] having a score in the range of 0–1.2, 1.3–3, 3.1–6; (6) crowding in the incisal segment as largest anterior maxillary/mandibular irregularity in millimeters; and (7) medical history-systemic disease, radiation therapy, or salivary gland disease [Table 1].

The adolescents were generally consuming sweetened areca nut packets of 0.8 g weight. The reasons to use areca nut were peer pressure or use by family members. Hence, overall areca nut exposure (pack years) was calculated by taking into consideration the frequency of use per year and duration of chewing (number of years) for each case and control and standardized by multiplying by 0.8.

A theoretical model was proposed to study the relationship between sweetened areca nut chewing and dental caries experience among adolescents before the start of the study. A directed acyclic graph (DAG), a graphic analytical tool was designed in DAGitty v3.0 software to determine the minimal sufficient adjustment sets containing oral hygiene, age, and

Table 1: Percentage distribution of study participants (*n*=146) according to independent variables including 2×2 table depicting unadjusted odds ratio

Independent Variable		Cases (*n*=61) (%) (with caries)	Controls (*n*=85) (%) (without caries)	OR (CI), Chi-square, df, *P*
Age (mean, SD)		14.54±1.25	14.34±1.31	*t*-0.93, df=144, *P*=0.356
Decayed Teeth-DT (mean, SD)		2.67±1.97	NA	-
Brushing frequency	Brushing-Once	46 (75.41)	62 (72.94)	OR=1.14 (0.54–2.42), Chi-sq=0.02, df=1, *P*=0.89
	Twice	15 (24.59)	23 (27.06)	
Use of toothpaste	Toothpaste-Fluoridated	58 (95.08)	81 (95.29)	OR=1.04 (0.23–4.86), Fisher's exact-0.62, *P*=1
	Non-fluoridated	3 (4.92)	4 (4.71)	
Sweet score	Excellent (5 or less)	19 (31.15)	18 (21.18)	Chi-sq=2.94, df=2, *P*=0.22
	Good (10)	14 (22.95)	16 (18.82)	
	Watch out (15 or more)	28 (45.9)	51 (60.0)	
Areca nut chewing	Yes	27 (44.26)	31 (36.47)	OR=1.38 (0.71–2.71), Chi-sq (yates corrected, 2 tailed)=0.60, df=1, *P*=0.44
	No	34 (55.74)	54 (63.53)	
Frequency of areca nut chewing	Daily	6 (9.84)	9 (10.59)	Chi-sq=1.26, df=2, *P*=0.53
	Non-daily	21 (34.43)	22 (25.88)	
	Does not chew	34 (55.74)	54 (63.53)	
Duration	Upto 1 year	7 (11.48)	13 (15.29)	Chi-sq=2.58, df=2, *P*=0.28
	>1 year	20 (32.79)	18 (21.18)	
	Does not chew	34 (55.74)	54 (63.53)	
Dental visit	Sometimes	11 (18.03)	11 (12.94)	OR=0.68 (0.27–1.68)
	Never	50 (81.97)	74 (87.06)	Chi-sq=0.38, *P*=0.54
Oral hygiene	Good	55 (90.16)	76 (89.41)	Chi-sq=0, *P*=1, row 2 & 3 clustered for analysis
	Fair	6 (9.84)	8 (9.41)	
	Poor	0 (0)	1 (1.18)	
Crowded teeth	No	11 (18.03)	23 (27.06)	Chi-sq=3.04, df=2, *P*=0.22
	One anterior segment crowded	21 (34.43)	33 (38.82)	
	Two anterior segments crowded	11 (18.03)	23 (27.06)	

smoking without overadjustment. Diet was considered as the ancestor of outcome. Fluoride exposure, malocclusion, past dental history, and brushing habits were considered ancestors of exposure and outcome [Figure 1].

Statistical analysis: Descriptive statistics was depicted as numbers and percentages. The odds ratio was calculated and *P* value < 0.05 was considered significant. Bivariate analysis and unpaired *t* test were performed as a test to know the significance of the difference between the cases and controls for overall exposure to areca nut in grams. Data were analyzed using epiinfo™ 7.2.5.0 and WinPepi PORTAL. Copyright J.H.Abramson, Aug 23, 2016 Version 11.65.

Results

Independent variables with their number and percentages are depicted in Table 1. The normality test for pack years indicated normality ($P > 0.05$). Compared by unpaired *t* test, overall areca nut use (pack years) was not significantly different between cases (with caries) and controls (without dental caries) though the mean pack years of areca nut exposure was higher among cases [Table 2]. Furthermore, the subgroup analysis was done to compare overall areca nut exposure in those who (a) consumed it for 1 year or more and (b) nondaily and daily users which did not differ significantly in either category. No significant difference in different categories of oral hygiene index, crowding of teeth, and sweet scores was seen between cases and controls. Brushing frequency showed higher odds indicating that there is a risk of having caries, however, there is no significant association. No difference in exposure to fluoridated toothpaste is seen between cases and controls. The exposure rate to areca nut was 44.26% and 36.47% for cases and controls, respectively, with a marginally higher exposure odds ratio of 1.38, which was not significant ($P = 0.43$) [Table 1].

Though oral hygiene and age needed adjustment, eventually, since areca nut was found statistically unassociated with the risk of caries, these variables were not considered for adjustment.

Discussion

To our knowledge, this case-control study conducted among the students of MVs, PCMC, Pune is the maiden one nationally to assess whether sweetened areca nut is a risk factor for caries.

Sweetened areca nut use is quite rampant among school students. They consider it harmless since it does not have the statutory and the pictorial warning. In this study, 58 (39.72%) students, mostly between 13 and 16 years of age consumed

Table 2: Comparison of mean pack years of areca nut exposure between Cases (DT≥1) and Controls (DT=0) by unpaired *t* test

Overall areca nut exposure (pack years)	Cases (Decay present *n*=61)	Controls (No Decay *n*=85)	Unpaired *t* test	
			T, *P* and significance	Mean difference (95% CI)
Mean	150.26	106.00	T = -0.77, *P*=0.44	44.26 (–157.24,68.70)
Standard deviation	335	344.57	Not significant	

sweetened areca nut. The duration of use varied from 2 to 3 months to about 5 years and the frequency of use varied from one sachet to a few sachets per day/week/month [Table 1]. However, in an observational study in Mumbai, 355 (18.8%) male and female students attending low-income schools were areca nut users with the mean age of users as 13.75 years.[25] These students of 7th to 10th grade from five schools belonging to low-income communities in Mumbai when assessed for risk of areca nut use through focused group discussion stated that they perceived commercially packaged sweetened areca nut as low risk.[26]

Upon examining 982 villagers who had a common habit of betel chewing in the Eastern part of Java, Indonesia, the mean DMFS was 13.09 ± 9.52 among 20- to 24-year-old nonchewers and 3.86 ± 2.80 among chewers; and, on the island of Bali, it was 9.54 ± 6.23 among nonchewers and 0.00 ± 0.00 among chewers, respectively.[27] Similarly, the Aua islanders off the coast of Papua New Guinea consisting of Roman Catholic betelnut chewers had a 23% prevalence of dental caries and DMFT of 0.364, whereas, for Seventh Day Adventist's nonchewers, the prevalence was 49% with DMFT of 1.162[18] These studies clearly indicate that chewing betel nut has a protective effect. Moller[27] explains that betel chewing offers physical protection of the teeth, and has caries inhibiting effect through mechanical cleansing by frequent chewing of the fibrous and abrasive nut, which increases salivary flow and buffer capacity. Nanda and Kapoor[28] have stressed the point that beetle chewing could constitute a significant additional source of fluoride and many of the substances identified have potential antimicrobial properties.[27]

While the exposure rates to areca nut for the study and the control groups were 44.26% and 36.47%, respectively, the overall exposure to areca nut in both groups did not differ significantly, though the mean pack years of areca nut exposure was higher among cases [Table 2]. When the odds ratio was calculated, exposure odds of 1.38 with 38% higher risk were obtained which however did not yield significant results [Table 1]. This indicates that it may be considered that sweetened areca nut is a risk factor for dental caries with known and unknown confounding factors playing a role. Moreover, dental caries is a multifactorial disease with host, agent, environment, and time factor playing an important role in causing the disease.[29]

In the preceding studies conducted in 70s and 80s, among the villagers[27] and islanders,[18] they were areca nut chewers while in the present study, the adolescents chewed sweetened (flavored) areca nuts and this probably explains the difference between the two studies.

The strength of the study were as follows: (1) Its design which has a strong theoretical framework to investigate risk factors based on literature review and DAGS; (2) Elimination of the selection bias by keeping participants unaware about their belonging to either study or control group; and (3) Participants' similarity in characteristics overall; (4) Its generalizability as the adolescents from these four government schools represent the other school children from 19 schools who are from the similar socioeconomic status; and (5) Investigator's blindfolding on who the cases/controls were as oral exam was done after the interview.

The limitations of this study have been: Information bias which may have influenced the outcome; (1) the inability of the participants in both study and control groups to recall the duration for which the areca nut was used and how the habit changed over time; however, this bias existed in both, study group as well as controls. (2) suppression of the details shared by the participants on usage of SLT/smoking with or without areca nut leading to social desirability bias; and (3) inability to blind the examiner for details on consumption or duration of areca nut use since the same examiner conducted the oral exam immediately after the interview (interviewer's bias).

Conclusion

This study concludes that the sweetened areca nut (supari) has shown a marginally higher exposure odds ratio for dental caries among the students in the age group of 12 to 16 years studying in Madhyamik Vidyalays (Municipal schools) in PCMC, Pune District of Maharashtra. Further studies to confirm or refute initial observations are needed. Students/parents should be concerned about its use as it can cause precancerous condition, oral submucous fibrosis.

Registration - CTRI REF/2022/01/050526

Acknowledgment

Obliged to the students and staff members of Madhyamik Vidyalay for cooperating with the oral checkup and interview. Indebted to Dr. Rizwan SA, Adjunct Faculty, Dept. of Public Health Dentistry, Dr. D Y Patil Dental College and Hospital, Pune for clearing the doubts during the preparation of the theoretical model using DAG.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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