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The relationship between sucrose intake in coffee or tea, and root or coronal caries in an elderly Japanese population

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Objectives: Few studies have examined the effect of sucrose intake in coffee or tea (SCT) on dental caries, especially root caries, in elderly people. The purpose of the present study was to examine the associations between SCT and the prevalence of root or coronal caries in community-dwelling elderly Japanese. ***Methods*:** Participants were 370 elders aged 75 years from a larger cohort study of elders in Niigata City, Japan. Dietary habits during the preceding month were assessed with a validated brief self-administered diet history questionnaire (BDHQ). The caries examination was conducted using mirror and ball-pointed periodontal probes under artificial light. Poisson regression analysis was performed to analyze the prevalence–rate ratios (PRRs) between SCT and the root or coronal caries. The number of root or coronal caries was selected as the dependent variable for the analysis. Then, SCT (tertiles labeled low, medium and high) and other 4 variables were selected as independent variables. ***Results:*** The PRRs between the number of root caries lesions and SCT were significantly higher in the second (medium intake, 1.38, $p < 0.001$) and third tertiles (high intake, 2.07, $p < 0.001$). Similar tendencies were seen for the number of coronal caries lesions (PRRs in the second and third tertiles 1.74 and 2.46, respectively, both $p < 0.001$). ***Conclusion:*** A significant positive relationship was observed between sucrose in coffee and tea and the number of coronal or root caries lesions in community-dwelling elderly Japanese.

Keywords: *Coronal caries, Root caries, Elderly people, Sucrose intake*

Introduction

Dental caries is the most widespread noncommunicable disease (NCD) in the world and is an important public health problem. In addition, root surface decay has been found to be associated with tooth loss (Gregory and Hyde, 2015). Therefore, it is important to investigate prevalence and incidence of dental caries and related factors.

To develop a preventive strategy, we need to determine the relationship between nutritional intake and dental caries. According to previous reports, fruit, vegetable, vitamin, mineral and dietary fiber intake are related to the number of present teeth, with individuals wearing dentures consuming fewer of these nutritious foods (Nowjack-Raymer and Sheiham, 2003; Yoshihara *et al.*, 2005). In addition, milk and milk products seem to be associated with the prevention of dental caries. Milk contains high levels of protein and calcium (Heaney, 2000) and is often fortified with vitamins A and D, the latter of which enhances calcium absorption (Gueguen and Pointillart, 2000).

Dental caries can be prevented by avoiding dietary free sugars. Recently, the World Health Organization (WHO) issued guidelines recommending that the intake of free sugars should make up ≤10% of energy intake, and suggested further reductions to <5% to protect dental health throughout life. These recommendations were informed by a systematic review of the evidence pertaining to amount of sugars and dental caries risk (Moynihan, 2016). A systemic review failed to find an association between total starch intake and caries risk, but suggested that the intake of rapidly digestible starches may increase the risk of caries (Halvorsrud *et al.*, 2018). In addition, several studies have investigated the relationships between sweet preference or sugar consumption in tea or coffee and dental caries experience (Gudkina and Brinkmane, 2010; Gudkina *et al.*, 2016; Jamel *et al.*, 1997; Karki *et al.*, 2019; Maru and Narendran, 2012; Montero *et al.*, 2018).

However, to our knowledge, few studies have examined the effects of sugar consumption in tea or coffee on the prevalence of dental caries, especially root caries, in community-dwelling elderly people in Japan. Therefore, the objective of this study was to examine the association between the intake of sucrose, a chief ingredient of sugar, and the prevalence of root or coronal caries in community-dwelling elderly Japanese people.

Methods

Participants and selection

In 1998, a longitudinal interdisciplinary study of aging was initiated in Niigata City to evaluate the relationship between oral and general health status. Questionnaires

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were sent to all residents aged 70 years (n=4,542) in Niigata city, Japan. After categorizing the residents by gender, 600 individuals were randomly selected. All participants provided written informed consent and agreed to undergo medical and dental examinations. This study was approved by the Ethics Committee of Niigata University School of Dentistry (No. 12-R1-4-21) and was carried out in accordance with the Declaration of Helsinki.

Annual follow-up surveys were subsequently conducted for all participants using the same methods employed in the baseline survey. In 2003, 370 of the 600 participants, who were 75 years of age at the time, were selected to participate in this study. During the 5-years after the baseline, 230 participants were lost from the analysis because of death (n=27), moving out of the area (n=9), no longer wanting to participate (n=149) or being in a poor state of care (n=45). An *a priori* sample size calculation was therefore not performed for this study.

The sample was homogenous in terms of race, and age was restricted to 75 years to exclude confounding. All participants were Japanese and did not require special care for daily activities.

Survey methods

Dietary intake assessment

Dietary habits during the preceding month were assessed using the brief self-administered diet history questionnaire (BDHQ) (Murakami *et al.*, 2008; Sasaki, 2004). The BDHQ is a validated fixed-portion questionnaire that asks about the consumption frequency of selected foods, but not portion size, to estimate the dietary intake of 58 food and beverage items, including sucrose in coffee or tea (SCT). The food and beverage items in the BDHQ were selected from foods commonly consumed in Japan, mainly from a food list based on the Standard Tables of Food Composition in Japan (Agency., 2005). Registered dietitians asked the participants to record all foods and beverages consumed on the recording day. All collected records were checked by trained registered dietitians. SCT was calculated using an ad hoc computer algorithm for the BDHQ. SCT was energy-adjusted by per 1000 kcal.

The questionnaires were also used to obtain information on oral health behaviors such as the use of an interdental brush or dental floss (yes/no), regular dental check-ups/cleaning and scaling (yes/no), years of schooling and smoking habits (never/ current or past experience).

Oral examination

On the same day, four trained and experienced dentists assessed participants' oral health status. A caries examination was conducted using mirror and ball-pointed periodontal probes under artificial light. Radiographs were not used. Root caries was diagnosed using the WHO (1997) criteria. Firstly, we determined whether each root surface was exposed, defined as at least 1 mm of visible root surface between the gingival crest and the cement-enamel junction or restoration margin. All exposed root surfaces were examined. Root decay was defined as the presence of a lesion on an exposed root surface that was soft or leathery on probing. For decay affecting both the crown and the root, the likely site of origin of the lesion was recorded as decayed. When it was not possible to judge the site of origin, both the crown and the root were recorded as decayed. In the case of fillings involving both the crown and the root, the most likely site of the primary carious lesion was recorded as filled. When it was not possible to judge the site of origin, both the crown and the root were recorded as filled. A multiple-surface lesion or filling was recorded if it extended more than one-third of the way across the adjacent surface. Coronal decay was defined as an unmistakable cavity, undermined enamel, or a detectable soft lesion. The number of roots with decay (soft or leathery lesions) and restoration with recurrent decay were categorized as root D, and sound restorations in roots were categorized as root F. When calculating coronal DFT, coronal and recurrent decay were categorized as coronal D, and coronal fillings and prosthetic crowns were categorized as coronal F.

The examiners were calibrated with 18 volunteer patients at the University Hospital before the study. Inter-examiner reliability for surfaces (root caries) and teeth (coronal caries) was assessed for the four examiners. Kappa values between each pair of examiners were 0.80–0.95 for coronal caries and 0.87–0.97 for exposed root caries,.

Analysis

The participants were classified into SCT tertiles (low, medium and high intake). The mean values for outcome variables were compared between the three groups using analysis of variance and Scheffe's multiple comparison analysis. For categorical variables, the ratio of each item was compared using the χ^2 test. Poisson regression analysis was performed to analyze the crude or adjusted prevalence–rate ratios (crude or adjusted PRRs) of the root or coronal caries and SCT. The number of root or coronal caries was used as the dependent variable, and SCT tertiles, gender, years of schooling, smoking habits (never/ current or previous experience) regular dental checkups/cleaning and scaling (yes/no), and usage of interdental brush or dental floss (yes/ no) were the independent variables, after converting the number of remaining teeth into an offset variable. All analyses were performed using STATA15™ software (StataCorp, College Station, TX, USA). The level of statistical significance was set at a=0.05.

Results

Table 1 compares selected characteristics by SCT. No variables were significantly associated with SCT.

The crude and adjusted PRRs between the number of teeth with root caries and SCT were significantly greater for the second (1.71 for crude PRRs, $p < 0.001$, 1.38 for adjusted PRRs, $p < 0.001$) and third tertiles (2.46 for crude PRRs, $p < 0.001$, 2.07 for adjusted PRRs, $p < 0.001$) compared to the first (Table 2). Similar relationships were present for the number teeth with coronal caries. The crude or adjusted PRRs were significantly for the second (2.08 for crude PRRs, $p < 0.001$, 1.74 for adjusted PRRs, $p < 0.001$) and third tertiles (3.00 for crude PRRs, $p < 0.001$, 2.46 for adjusted PRRs, $p < 0.001$. Table 3). Furthermore, years of schooling and regular dental check-ups/Cleaning & scaling were negatively associated with both the number of teeth with

Table 1. Dental Health and demographic characteristics in relation to sucrose intake in coffee or tea

	Sucrose intake in coffee or tea * *(g/1000kcal)* ** *Median (25%/75%)*			*p value*			
	Low (L) n=124 1.2 (0.4/1.7)	*Medium (M)* n=123 4.5 (3.5/5.7)	*High (H)* n=123 10.4 (8.6/13.1)	*All groups*	*L v M*	*L v H*	*M v H*
No. teeth with root caries or restorations (DF) Median (25%/75%)	2 (1/7)	2 (0/6)	2 (0/5)	0.229	0.370	0.990	0.300
No. teeth with coronal caries or restorations (DF) Median (25%/75%)	9 (4/14)	9 (5/14)	9 (4/14)	0.977	0.994	0.995	0.977
Number of teeth	17.4±9.2	16.0±9.6	15.9±9.7	0.373	0.501	0.457	0.997
Gender Male (%)	52 (41.9)	60 (49.6)	65 (52.8)	0.212	0.229	0.086	0.611
Years of schooling	9.9±2.6	10.0±2.7	10.2±2.5	0.727	0.964	0.734	0.877
Current or previous smoker (%)	62 (50.4)	58 (47.5)	55 (45.1)	0.842	0.609	0.613	0.997
BMI	23.0±3.0	23.1±3.2	22.7±3.0	0.469	0.985	0.625	0.521
Oral health behavior							
Cleaning and scaling yes (%)	52 (59.8)	55 (68.8)	49 (57.6)	0.300	0.227	0.777	0.140
Usage of inter dental brush or dental floss yes (%)	54 (43.5)	54 (43.9)	60 (48.8)	0.654	0.955	0.410	0.443

* Intakes were calculated based on BDHQ.
** Energy-adjustment was performed according to the density method.

Table 2. Presence of root caries in relation to sucrose in tea or coffee and demographic or behavioural variables

Independent variables		*Dependent variable Number of root caries*					
		PRRcrude	*95% CI crude*	*p*	*PRRadj*	*95% CI adj*	*p*
Sucrose intake in coffee or tea (g/1000kcal)	Low		reference			reference	
	Medium	1.71	1.50-1.95	<0.001	1.38	1.17- 1.62	<0.001
	High	2.46	2.15-2.80	<0.001	2.07	1.74-2.46	<0.001
Gender		2.83	2.55-3.15	<0.001	0.33	0.26-0.41	<0.001
Years of schooling		0.82	0.80-0.83	<0.001	0.71	0.69-0.73	<0.001
Current or previous smoker		1.84	1.66-2.05	<0.001	3.79	3.02-4.75	<0.001
Cleaning and scaling		0.64	0.56-0.74	<0.001	0.62	0.52-0.74	<0.001
Usage of interdental brush or dental floss		1.01	0.91-1.12	0.892	1.19	1.03-1.38	0.019
Number of teeth present		1 (offset)			1 (offset)		

root or coronal caries (Tables 2 and 3). Smoking was positively associated with the number of teeth with root and coronal caries (Tables 2 and 3).

Discussion

In this study of community-dwelling elderly people in Japan, greater sugar in coffee and tea was associated with increasing prevalence of root and coronal caries (Table 2 and 3). The data suggest that more SCT might increase the risk of both root and coronal caries. Gingival recession and root caries are more prevalent in older people, and root caries has been associated with tooth loss (Locker *et al.*, 1996; Slade *et al.*, 1997). This study shows that SCT was strongly associated with dental caries. Older people should reduce use of sugar in their coffee and tea to prevent caries.

Sugars were defined as sucrose and total, free, added, or non-milk extrinsic sugars, and expressed as g, kg/day, kg/year, and percentage E. However, whether the

Table 3. Presence of coronal caries in relation to sucrose in tea or coffee and demographic or behavioural variables

Independent variables		*Dependent variable Number of coronal caries*					
		PRRcrude	*95% CI crude*	*p*	*PRRadj*	*95% CI adj*	*p*
Sucrose intake in coffee or tea (g/1000kcal)	Low		reference			reference	
	Medium	2.08	1.92-2.26	<0.001	1.74	1.58-1.93	<0.001
	High	3.00	2.76-3.25	<0.001	2.46	2.21-2.74	<0.001
Gender		4.31	4.05-4.60	<0.001	0.71	0.62-0.82	<0.001
Years of schooling		0.82	0.81-0.83	<0.001	0.76	0.74-0.77	<0.001
Current or previous smoker		2.60	2.44-2.77	<0.001	3.29	2.84-3.81	<0.001
Cleaning and scaling	0: no 1: yes	0.50	0.46-0.54	<0.001	0.56	0.51-0.62	<0.001
Usage of interdental brush or dental floss	0: no 1: yes	0.98	0.91-1.04	0.457	1.06	0.96-1.16	0.231
Number of present teeth		1 (offset)			1 (offset)		

distinctions between total, added, or free sugars are relevant in regard to caries risk remains unclear because all sugars (and starches) are potentially cariogenic (Mela and Woolner, 2018). On the basis of a review of cohort studies, there was a significant association between total sugars intake and dental caries but the authors did not draw conclusions on any specific dietary sources, other than the general category of sugar-sweetened beverages (TSO, 2015).

The focus of that systemic review and a previous meta-analysis (Moynihan and Kelly, 2014) underpinning the WHO (2015) guidelines was on free sugars. Both the amount and frequency of sugar consumption are risk factors for the development of dental caries. A systematic review of several previous human epidemiologic studies found that the frequency of sugar intake is an important causal factor for dental caries (Moynihan and Kelly, 2014). Steele et al. (2001) reported that nine or more intakes of sugar per day more than doubled the odds of developing root caries (odds ratio: 2.2–2.4), suggesting that frequent oral exposure to sugar is a risk factor for the development of root caries. In addition, the WHO (2015) found that both the amount and frequency of sugar consumption are important, and that reducing the frequency of sugar consumption alone will not reduce the risk of developing NCDs related to excess sugar intake. Thus, guidance on limiting the frequency of free sugar intake is an important part of dental health education at the individual level. These findings are supported by those from an in vitro study in which a milk-based drinks showed higher acidogenicity than either whole or skimmed milk. Milk-based drinks containing sugar used as dietary supplements for older adults may therefore be highly cariogenic and could represent a potential risk factor for root caries (Castro *et al.*, 2018).

There is one report in which sugar intake was not related to root caries (Christensen *et al.*, 2015). Although no association was found, the authors could not eliminate the possibility of an outcome reporting bias.

This study did have some limitations. A semi-quantitative food frequency questionnaire was used to determine participants' food intake; however, some researchers have suggested that nutritional epidemiology, such as 24-h dietary recall and food intake records, may not provide a complete picture of what an individual consumes routinely (Cade *et al.*, 2002; 2004). In addition, nutritional intake, including supplements, was not included in the analysis because no detailed information on supplements was collected.

In conclusion, these data suggest that a positive relationship exists between SCT and the presence of root or coronal caries in community-dwelling elderly people in Japan. Additional prospective studies and clinical trials will be necessary to explore this relationship further.

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Disclosure statement

The authors declare no conflict of interest.

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