Original Article

Dental caries is correlated with knowledge of comprehensive food education in Japanese university students

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In Japan, the "Food Education Basic Law" (The Basic Law on Shokuiku, food education) was enacted in 2005. The comprehensive food education programs, namely Shokuiku, aim to improve dietary practices to reduce lifestyle-related diseases. Dental caries is one of the diseases associated with inappropriate dietary habits. Thus, food education may influence the prevalence of dental caries. However, there are no data regarding the association between public based-food education and dental caries. The aim of the present study was to investigate the relationship between knowledge about comprehensive food education (Shokuiku) and dental caries experience in Japanese university students. A total of 2,184 students (1,240 men, 944 women), aged 18-20 years, were examined. They had attended the Shokuiku program while in junior/senior high school. The numbers of teeth present, and decayed, missing and filled teeth (DMFT) (dental caries experience) were recorded. Additional information was collected via a questionnaire regarding knowledge about food education, dietary habits and oral health behavior. Of the students, 315 men (20.7%) and 345 women (52.8%) reported that they know and can explain the meaning and content of the word "Shokuiku". After adjusting for potential confounding factors, subjects who did not have knowledge about Shokuiku had higher adjusted odds ratio (OR) for dental caries experience (DMFT >0) than those who had (adjusted OR, 1.23; 95% CI, 1.02-1.48; $p<0.05$). These observations revealed that having knowledge about comprehensive food education in university students correlates with low prevalence of dental caries.

Key Words: food education, dental caries, university students, cross-sectional studies, behavioral science

INTRODUCTION

Recently, eating disorders and obesity have increased among adults and school children, and there is rising concern on development of lifestyle-related diseases in Japan. The increased obesity is possibly associated with inappropriate dietary habits such as skipping breakfast, excessive fat intake and insufficient vegetables in the diet.[1] Under these circumstances, the "Food Education Basic Law" (The Basic Law on Shokuiku, comprehensive food education) was enacted in 2005, which was the first law that regulates one's diets and dietary habits.[2] The food education programs aim to improve dietary practices so as to ensure adequate energy or nutrient intake and to reduce lifestyle-related diseases. The Shokuiku also includes efforts to support food culture, especially through school-based programs, as well as to improve food environment by providing information on appropriate diets.[1] It is reported that the proportion of children skipping breakfast has decreased, and quality of life has been improved by the Shokuiku program.[2]

Good nutrition is vital to overall health, and a poor diet is the major cause of morbidity and mortality. Nutritional factors are implicated in many oral and systemic diseases, and conditions including dental caries.[3] Dental caries is one of the diseases associated with inappropriate dietary habits and remains as an important oral problem in many communities. The prevalence of dental caries has been associated with many factors, such as low socioeconomic

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status, restricted access to dental services, sugar consumption, underuse of fluorides, and nutritional issues.[4-7] Thus, food education may influence the prevalence of dental caries as well as lifestyle-related diseases. However, there is no data regarding the association between food education and dental caries. Therefore, we hypothesized that having knowledge about food education may reduce the prevalence of dental caries.

University students are in a dynamic transition period of growth and development that bridges adolescence (high school students) and adulthood (people in the community).[8] However, they are not viewed as a priority for health-promotion efforts in Japan. At this stage, many of them live away from home for the first time in their life and they are faced with the responsibility for their personal health, lifestyle, and behavior. During this period, many rapid changes occur in the body and mind, and in social relationships.[9] With the unfamiliar lifestyle, many students develop a wide range of unhealthy habits, in particular, inadequate dietary habits.[10-14] Thus, it is important to focus on dietary habits in university students for their personal health and oral health.

The decayed, missing, and filled teeth (DMFT) is an accepted indicator for caries experience.[4-7] The aim of the present study was to investigate the relationship between knowledge about comprehensive food education (Shokuiku) and DMFT in Japanese University students. We also investigated the relationship between knowledge about Shokuiku, dietary habits and oral health behavior.

MATERIALS AND METHODS

Study population

Of 2,395 first-year students who underwent a general health examination at the Health Service Center of Okayama University in April 2011, 2,319 students volunteered to undergo oral examination and answered the questionnaire described below. We excluded 135 participants who were >20 years old (n=71) and had provided incomplete data in their questionnaires (n=64). As a result, data from 2,184 students (1,240 men, 944 women) aged 18-20 years were analyzed. The study was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences. Verbal consent was obtained from all subjects.

Questionnaire

A questionnaire was mailed before the health examination. Participants were asked about sex, age and general condition. Knowledge about comprehensive food education was reported according to one of three categories: 1) I know and can explain the meaning and content of the word "Shokuiku"; 2) I only know the word, Shokuiku; and 3) I don't know Shokuiku. We combined the latter two categories into a single category of no knowledge about Shokuiku to distinguish precisely between subjects having knowledge about Shokuiku and subjects without knowledge. For oral health behavior, information regarding regular dental check-ups during the past year, daily frequency of tooth brushing, and use of dental floss and fluoride dentifrice was obtained.[15] For the following factors, the subjects responded in a yes/no form: eating until full, an irregular diet, skip breakfast, frequently eat a fatty diet, frequently eat green vegetables, frequently eat junk food, frequently snack and/or eat at night, frequently drink soft drinks (sugar-sweetened), and take supplements.[16]

Oral examination

Four dentists (SM, DE, KI, and TA) examined the oral health status of the study subjects. The number of teeth and DMFT index (dental caries experience) in the mouth was recorded according to WHO criteria.[17] In order to check the intra- and inter- examiner agreement, counts of DMFT were recorded and repeated within a 2-week interval in 8 volunteers. Data were analyzed with the non-parametric kappa test and intra-class correlation. The kappa coefficients for intra- and inter-examiner and intra-class correlation coefficients were >0.8.

Assessment of BMI

In the general health examination, height and body weight of subjects were measured by public health nurses. BMI was computed as weight in kilograms divided by square height in meters.[16] Participants with a BMI of ≥25.0 were considered as being overweight in this analysis.[16]

Statistical analyses

At first, the parameters were compared between the participants having knowledge about the food education and subjects without knowledge. The participants were then divided into two groups (dental caries group with DMFT >0; no caries group with DMFT=0).[18,19] The Student t-test or chi-square test was used to compare parameters between the two groups. All possible associations of dental caries experience were examined in a series of logistic regression models, and the odds ratio (OR) and 95% confidence intervals (CI) were calculated. The logistic regression models were reviewed for goodness-of-fit and validated using the Hosmer-Lemeshow statistic.[16] Dental caries experience was used as the dependent variable, and knowledge about food education, dietary habits and oral health behavior were added as the independent variables. A p value of $p<0.05$ was considered to be significant. A statistical program (SPSS version 17.0; IBM, Tokyo, Japan) was used for data analyses.

RESULTS

Overall, 315 men (20.7%) and 345 women (52.8%) reported that they knew and could explain the meaning and content of the word "Shokuiku". Mean number of teeth present (±SD), DMFT and BMI were 28.4±1.4, 2.3±3.9, 20.8±2.9, respectively.

There were no significant differences in mean BMI or prevalence of overweight between the subjects who had knowledge about comprehensive food education (Shokuiku) and those without the knowledge (20.9±2.9 vs 20.8±2.9, 7.0% vs 7.7%, respectively).

Table 1 shows the results of dietary habits and knowledge about food education. Among the subjects who had knowledge about food education, there were fewer females who frequently snacked and/or ate at night compared with those without knowledge ($p<0.05$). The prevalence of females who took supplements was signifi-

cantly higher among the subjects having knowledge than those without knowledge ($p<0.05$).

The percentage of males who used dental floss was significantly higher among the subjects having knowledge than those without knowledge ($p<0.05$) (Table 2). The percentage of females subjects who used fluoride dentifrice was significantly higher in the subjects having knowledge than without knowledge ($p<0.05$) (Table 2).

Among men, the dental caries group (DMFT >0) showed significantly higher prevalence of subjects who took an irregular diet and received regular dental check-up than the no caries group (DMFT=0) ($p<0.05$) (Table 3). On the other hand, the dental caries group showed significantly lower prevalence of subjects who had knowledge about food education than the no caries group ($p<0.05$). Among women, the dental caries group showed significantly higher prevalence of subjects who frequently snacked and/or ate at night and received regular dental check-up than the no caries group ($p<0.05$).

In Table 4, men who did not have knowledge about food education had higher adjusted OR for dental caries experience than those who had (adjusted OR, 1.33; 95% CI, 1.02-1.72; $p<0.05$). In contrast, there was no significant difference for women who had knowledge about food education or not. However, after adjustment for sex, participants who did not have knowledge about food education had higher adjusted OR for dental caries experience than those who had (adjusted OR, 1.23; 95% CI, 1.02-1.48; $p<0.05$).

DISCUSSION

The comprehensive food education (Shokuiku) program, a school-based public health activity, aims to improve dietary practices so as to reduce lifestyle-related diseases.[1] The proportion of children skipping breakfast has decreased and quality of life has improved by the Shokuiku program.[2] However, there is little information about the relationship between this food education program and dental caries as a lifestyle-related disease. Thus, we focused on the effects of food education on dental caries experience expressed as DMFT index. This is the first study to assess the relationship between dental caries

Table 1. Relationship between dietary habits and knowledge about food education

Covariate	Men		Women		Total	
	Knowledge (-) (n=925)	Knowledge (+) (n=315)	Knowledge (-) (n=599)	Knowledge (+) (n=345)	Knowledge (-) (n=1,524)	Knowledge (+) (n=660)
Eating until full	31.3†	25.7	37.1	36.8	33.5	31.5
An irregular diet	28.0	24.4	20.7	21.4	25.1	22.9
Skip breakfast	15.6	12.7	5.3	7.0	11.5	9.7
Frequently eat a fatty diet	31.4	27.0	27.2	24.3	29.7	25.6
Frequently eat green vegetables	67.0	69.8	71.6	75.4	68.8	72.7
Frequently eat junk food	9.5	9.2	4.5	4.6	7.5	6.8
Frequently snack and/or eat at night	25.9	21.9	29.7†	22.6	27.4*	22.3
Frequently drink soft drinks (sugar-sweetened)	0.2	0.0)	1.0	1.4	0.5	0.8
Take supplements	9.6	11.1	10.1†	17.1	10.1†	14.2

† %
* $p<0.05$, chi-square test

Table 2. Relationship between oral health behavior and knowledge about food education

Covariate	Men		Women		Total	
	Knowledge (-) (n=925)	Knowledge (+) (n=315)	Knowledge (-) (n=599)	Knowledge (+) (n=345)	Knowledge (-) (n=1,524)	Knowledge (+) (n=660)
Regular dental check-up	41.6†	39.0	54.9	52.8	46.9	46.2
Toothbrushing (times/day)						
≥2	68.1	66.0	77.5	74.2	71.8	70.3
≤1	31.9	34.0	22.5	25.8	28.2	29.7
Dental floss (usage)	2.8*	6.0	5.5	8.7	3.9*	7.4
Fluoride dentifrice (usage)	21.9	20.6	21.2*	27.2	21.7	24.1

† %
* $p<0.05$, chi-square test

Table 3. Differences in knowledge about food education, dietary habits and oral health behavior between dental caries group (DMFT >0) and no caries group (DMFT=0)

Covariate	Men		Women		Total	
	DMFT (-) (n=521)	DMFT (+) (n=719)	DMFT (-) (n=360)	DMFT (+) (n=584)	DMFT (-) (n=881)	DMFT (+) (n=1,303)
Knowledge about food education	28.8†	22.9*	38.6	35.3	32.8*	28.5
An irregular diet	22.6**	30.3	18.3	21.4	20.9**	26.9
Frequently snack and/or eat at night	22.8	26.4	22.8*	29.8	22.8**	27.9
Frequently drink soft drinks (sugar-sweetened)	0.2	0.1	1.7	0.9	0.8	0.5
Regular dental check-up	33.2***	46.6	44.7***	59.9	37.9§	52.6
Toothbrushing (daily frequency)						
≥2 times	67.8	67.5	77.2	75.7	71.6	71.1
≤1 time	32.2	32.5	22.8	24.3	28.4	28.9
Dental floss (usage)	3.3	3.9	6.9	6.5	4.8	5.1
Fluoride dentifrice (usage)	20.5	22.4	21.9	24.3	21.1	23.3

† %
* $p<0.05$, Chi-square test
** $p<0.01$, Chi-square test
*** $p<0.001$, Chi-square test

Table 4. Odds ratios (OR), and 95% confidence interval (CI) of knowledge about food education, dietary habits and oral health behavior

	Men (n=1,240)		Woemn (n=944)		Total (n=2,184)	
Independent variables	Adjusted OR† (95%CI)	*p*	Adjusted OR† (95%CI)	*p*	Adjusted OR‡ (95%CI)	*p*
Knowledge about food education						
Yes	1		1		1	
No	1.33 (1.02-1.72)	0.034	1.12 (0.85-1.48)	0.423	1.23 (1.02-1.48)	0.034
An irregular diet						
Yes	1		1		1	
No	1.45 (1.11-1.89)	0.006	1.31 (0.94-1.84)	0.113	1.41 (1.15-1.74)	0.001
Frequently snack and/or eat at night						
Yes	1		1		1	
No	1.13 (0.87-1.49)	0.361	1.40 (1.03-1.91)	0.034	1.01 (1.02-1.62)	0.042
Regular dental check-up						
Yes	1		1		1	
No	0.57 (0.45-0.72)	<0.001	0.53 (0.41-0.70)	<0.001	0.55 (0.46-0.66)	<0.001

The logistic regression analysis with caries experience (DMFT >0) as a dependent variable
* Adjusted for knowledge about food education, an irregular diet, frequently snack and/or eat at night, regular dental check-up
† Adjusted for sex, knowledge about food education, an irregular diet, frequently snack and/or eat at night, regular dental check-up

experience and knowledge about comprehensive food education (Shokuiku) in university students. Knowledge about Shokuiku was significantly associated with dental caries experience (DMFT >0) in the Japanese students at the Okayama University after adjustment for potential confounding factors (Table 4). Poor knowledge about food education may independently lead to a higher prevalence of dental caries.

The non-biological determinants of dental caries are becoming noticeable,[20] although the concept of causation of caries has been restricted to biological processes for many years.[21] Recently, the empirical attention has shifted to the relationship between dental caries and broader ecological influences including education. However, the role of food education in the etiology of dental caries remains unclear. Possible mechanisms may underline the relationship between knowledge about food education and dental caries. In primary-school children, food education resulted in significantly lower reported intakes of snack foods that are high in sugar.[22] Sugar consumption affects dental caries experience.[23] Thus, comprehensive food education, especially knowledge about snack and sugar intakes, may lead to good dietary habits and low sugar intake, which contribute to low incidence of dental caries. In this study, all or female subjects who did not have knowledge about Shokuiku snacked and/or ate at night more frequently, and had higher adjusted odds ratios for dental caries experience than those who had. Our results support this hypothesis. However, these relationships were not clear in males. Further investigation is required to clarify the relationship in males.

The Shokuiku program in Japan as well as food education in other countries has improved dietary habits.[2] Therefore, it is important to increase the number of subjects who have good knowledge on food education and appropriate dietary habits. Enhancing knowledge about food education as a public health activity may also be a useful approach to prevent dental caries. However, we should consider which Shokuiku program is effective. Evaluating the patients' knowledge about food education might be required for effective prevention of dental caries. In Japan, health examination is performed on a regular basis according to the school health law. Therefore, evaluating the knowledge about food education during regular health examination might be useful, especially for university students, who might develop dietary habits in the transition period of growth and development.[8]

The percentage of students who used dental floss was significantly higher among the students having knowledge than those without knowledge in this study. The previous study shows that having knowledge about oral health can increase frequency of dental flossing.[15] If subjects who have knowledge about oral health also have knowledge about Shokuiku, the relationship between knowledge about food education and use of dental floss might be explained. However, further investigation is required.

In this study, dental caries experience was not related to usage of fluoride dentifrice and frequency of consumption of soft drinks. These findings were inconsistent with other studies.[24-27] The reasons may be the very low usage rate of fluoride dentifrice (22.4%) in this study, which is remarkably lower than the recent market share of fluoridated dentifrices in Japan (about 90%). It is possible that that many students do not know whether they use fluoride dentifrice or not[18]. Similarly, the very low frequency of consumption of soft drinks in this study compared to the previous study (0.6% vs. 24.7%)[27] might have skewed the result.

There was no relationship between knowledge about the food education and obesity. Originally, the "Food Education Basic Law" was enacted in 2005 to prevent obesity.[2] The reason for poor effects of food education on obesity may be linked to the low prevalence of obesity in this study population (7.4%). Thus, there may be little influence of food education on such a young population.

Our study has some limitations. We did not consider the possible association of factors, such as bacterial factors,[21] salivary factors,[21] socioeconomic status[20] and social capital,[28] in this study. Several studies reported a relationship between socioeconomic status and dental caries.[29,30] Future studies are needed to reveal the effects of the abovementioned factors. Second, since this study was cross-sectional, it is still uncertain as to whether having knowledge about food education is the cause of no dental caries. Prospective cohort studies may provide information beyond what we present here. Finally, all subjects were recruited from among students at Okayama University, which may limit the ability to extrapolate these findings to the general population of young people.

In conclusion, this study revealed that having knowledge about comprehensive food education provided as a school-based public health activity correlates with the low prevalence of dental caries in Japanese university students.

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AUTHOR DISCLOSURES

The authors have no conflicts of interest to declare. This work was supported by Grants-in-Aid for Scientific Research (23593089) from the Ministry of Education, Culture, Sports, Science and Technology, Tokyo, Japan and by the grant from the 8020 Promotion Foundation, Tokyo, Japan.

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日本大学生龋齿患病率与对综合食育的了解呈现相关性

日本于 2005 年制定颁布了 “食育基本法”(关于饮食教育的基本法律)。该项关于饮食教育的综合計劃，名为“食育”，旨在改善人们的饮食生活，进而减少与生活习惯相关的疾病发生。龋齿病是由不恰当的饮食习惯引起的疾病之一。因此，食育或将影响龋病的发生率。然而，关于龋病的发生與基于大众的饮食教育之间的关联性，目前尚无具体数据。本研究的目的是调查日本大学生的龋齿患病情况与该群体对食育的综合了解间的关联。共计调查了 2,184 名学生(其中男性 1,240 名，女性 944 名)，年龄在 18 至 20 岁之间。调查对象均在初/高中的就学期间参加过“食育”的課程。记录他们现在的存留齿、龋齿、失及补齿数(DMFT)。此外，通过问卷调查，收集了该群体对食育认识、饮食习惯及口腔健康行为等資訊。在该学生群体中，有 315 名男生(20.7%)和 345 名女生(52.8%)的自答為知道并可以解释“食育”一词的意义及内容。在调整了潜在的混淆因素后，对“食育”不了解的受试者之龋失补齿指数(DMFT>0)，相对于了解该词的受试者，有更高的调整后比值比(调整后比值比 1.23；95%可信区间 1.02-1.48；p<0.05)。观察结果表明，在大学生中，了解综合食育與較低的龋齿患病率相关联。

关键词：饮食教育、龋齿病、大学生、横断面研究、行为科学