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Relationship between Nutritional Intake and Dental Caries Experience of Junior High Students

Ho-Kwen Kwon[1], Il Suh[2], Young-Ok Kim[3], Han-Joong Kim[2] Chung-Mo Nam[2], Kyoung-Moo Jun[1], and Hyung-Gyoo Kim[1]

This study was designed to investigate the relationship between nutritional intake and caries experience of junior high school students. The sample consisted of 295 boys and 356 girls in Kangwha county. Dependent variables were total caries experience, occlusal surface caries experience, smooth surface caries experience and DMFS score (Decayed, Missing, Filling Tooth Surface score). Independent variables such as pit and fissure retentiveness of first molars, oral hygiene status, intraoral acidogenicity were also measured by dentists. Other independent variables such as toothbrushing habits, socioeconomic conditions, between-meal eating habits, and daily nutritional intake were determined during an interview. Univariate and multivariate analysis was performed to evaluate how nutritional intake influences caries experience. The results were as follows: 1. The most influential factor on dental caries experience was pit and fissure retentiveness. 2. Dietary fiber and potassium were the significant nutritional factors on total caries experience and occlusal caries experience, and niacin was the significant nutritional factor on smooth surface caries. 3. DMFS score was positively associated with the daily amount of carbohydrate and niacin intake, and negatively associated with total energy intake. The above results suggested that pit and fissure retentiveness was the most influential factor on caries experience. However, in this study, the intake of potassium and niacin was identified to influence the caries experience in addition to confirming the well-known relationship between fiber and carbohydrate intake.

Key Words: DMFS, dental caries, pit and fissure retentiveness, caries activity

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Department of Preventive Dentistry & Public Oral Health, College of Dentistry[1], Department of Preventive Medicine & Public Health, College of Medicine, Yonsei University[2], Department of Food & Nutrition, Dongduck Women's University[3], Seoul, Korea
This study was supported by KOSEF for 1992(NO: 92-2900-04-01-3)
Address reprint request to Dr. H.K. Kwon, Department of Preventive Dentistry & Public Oral Health, College of Dentistry, Yonsei University, C.P.O. Box 8044, Seoul 120-752, Korea

It has been reported that dental caries results from demineralization of dental hard tissues, induced by acid produced by carbohydrate metabolism of oral bacteria such as *Streptococcus mutans* or *Lactobacillus casei* (Gibbons, 1964).

Therefore, a caries lesion cannot occur without bacteria. It has been proven that no caries lesion can be developed in germ-free animals or on a non-erupted tooth, and that a caries lesion cannot occur without substrate (Newbrun, 1989). For these reasons, diet has been recognized as the major determining factor for caries, especially sugar intake, which was already investigated in previous studies

(Navia, 1970: McDonald and Stookey, 1977: Birkhed *et al.* 1981: Cleaton-Johns, 1996). Generally, in animal experiments, comparison of an experimental group given a certain nutrient or food with a control group is a common method (Klein *et al.* 1935: Edgar *et al.* 1982). Most of the epidemiologic studies have been concerned with carbohydrate intake and caries experience (Hardwick, 1960: Mansbrige, 1960). Sugar, especially, is a major source of local diet effect on caries incidence. Therefore, children with intestinal sucrose deficiency or patients with hereditary fructose intolerance (HFI), diabetic patients, and Seventh Day Adventists who restrict sugar intake artificially have attracted the attention of epidemiologic researchers (Donnelly, 1961: Marsson and Koch, 1975: Newbrun *et al.* 1980). These groups have low caries prevalence compared to normal children (Cohen, 1947).

The Vipeholm study (Gustafsson *et al.* 1954) and the Hopewood House study (Harris, 1963) also found that sugar intake had a very close relationship with caries incidence and food stickiness or retentiveness had a very strong influence on caries incidence. Harris reported that calcium and phosphate intake were negatively correlated with caries incidence (Niezel *et al.* 1964: Harris, 1967). Na_2HPO_4 and $(NH_4)_2HPO_4$ were confirmed as an effective cariostatic agent on animal experiment. But $Na_2P_2O_2$ and $Na_5P_3O_{10}$ were not effective under animal experiment(Reen and Ostrom, 1962). Generally, cariostatic action of phosphates could be correlated with buffering capacity, water solubility or chelating ability (Harris *et al.* 1967). But the preventive effect of phosphate has not been proved by human clinical trials (Bibby and Averill, 1964). Protein is essential for the proper formation of the enamel. It has been suggested that early malnutrition may produce defects in teeth during the developmental stage. So protein deficiency may bring about a reduction in tooth size and an increase in enamel defects (Curzon and Pollad, 1996). Protein especially affects composition and the volume of saliva, which has a major role in the maintenance of oral health (Navia, 1996). Some animal study has shown that protein deficiency is related to dental caries. But there has been little epidemiological research on protein malnutrition and dental caries. Vitamin intake has been of interest to caries researchers since the early period. Some of the experimental studies reported that vitamin D had a positive effect on calcification of the enamel. And vitamin B complex (niacin) has shown some slight laboratory evidence that it affected oral flora and hence dental caries incidence (Orland *et al.* 1950). There is a lot of controversy over the interpretation of nutrition and dental caries research results. First, dental caries is a multifactorial disease, so it is very difficult to measure a single effect of diet by controlling the other etiologic factors. Secondly, in epidemiologic study, humans are the subjects of study and it is hard to control their daily behavior technically during the observation. Thirdly, diet survey data have problems in terms of reliability and validity because of the dependence on the memory of the study subjects. Nevertheless, diet survey, with some limitations, is a very effective way to investigate the causal relationship between caries incidence and food intake patterns.

The major purpose of this study was to find out the nutrients which contribute to caries incidence after controlling other etiologic factors.

MATERIALS AND METHODS

Study subjects

This study was carried out in a girls' junior high school and a boys' junior high school in Kangwha county, located 50Km northwest of Seoul. Cluster sampling was performed. So one boys and one girls junior high school were selected. Subjects consisted of 295 males and 356 females at 12~13 years old.

Methods

Clinical examination and a questionnaire survey were conducted by two registered dentists.

Clinical Examination:

Oral health status;

Dental caries experience; Dental caries experience assessment was made using WHO criteria. The total DMFS (Decayed, Missing, Filling Surfaces) score was calculated as those of smooth surface and occlusal surface caries experience.

Gingival condition; Gingival conditions of labial

Table 1. Associations between gender and other variables influencing the caries experience

Variables	Male N (%)	Female N (%)	Total N (%)	χ^2	p-value
Caries Experience					
Caries free	64 (24.0)	67 (20.6)	131 (22.1)		
Caries	203 (76.0)	258 (79.4)	461 (77.9)	0.77	.379
Total	267 (45.1)	325 (54.9)	592 (100)		
Oral Status Factor					
Gingival Condition					
Healthy Gingiva	58 (19.7)	157 (44.1)	215 (33.0)		
Incipient Gingivitis	124 (42.0)	98 (27.5)	222 (34.1)		
Moderate Gingivitis	101 (34.2)	83 (23.3)	184 (28.3)	46.28	<.001
Severe Gingivitis	12 (4.1)	18 (5.1)	30 (4.6)		
Total	295 (45.3)	356 (54.7)	651 (100)		
Pit & Fissure Retentiveness					
Low	83 (28.2)	58 (16.4)	141 (21.8)		
Moderate	164 (55.8)	197 (55.8)	361 (55.8)	20.17	<.001
Deep	47 (16.0)	98 (27.8)	145 (22.4)		
Total	294 (45.4)	353 (54.6)	647 (100)		
Caries Activity					
Low	70 (23.9)	95 (26.7)	165 (25.4)		
Moderate	119 (40.6)	107 (30.1)	226 (34.8)	8.07	<.05
High	104 (35.5)	154 (43.3)	258 (39.8)		
Total	293 (45.1)	356 (54.9)	649 (100)		
Oral Hygienic Factor					
Toothbrushing Frequency					
No	3 (1.0)	2 (0.6)	5 (0.8)		
Once a day	20 (6.8)	3 (0.8)	23 (3.5)		
Twice a day	164 (55.8)	142 (40.0)	306 (47.1)	44.07	<.001
Three times a day	105 (35.7)	195 (54.9)	300 (46.2)		
More than three times a day	2 (0.7)	13 (3.7)	15 (2.3)		
Total	294 (45.3)	355 (54.7)	649 (100)		
F mouth-rinse experience					
Yes	20 (6.8)	39 (11.0)	59 (9.1)		
No	275 (93.2)	317 (89.0)	592 (90.9)	2.92	.087
Total	295 (45.3)	356 (54.7)	651 (100)		
Regular Dental Check-up					
Yes	7 (2.4)	7 (2.0)	14 (2.2)		
No	288 (97.6)	349 (98.0)	637 (97.8)	0.07	.932
Total	295 (45.3)	356 (54.7)	651 (100)		
Between-Meal intake habit					
Between-Meal intake					
No	38 (13.1)	29 (8.2)	67 (10.4)		
Once a day	131 (45.0)	160 (45.1)	291 (45.0)		
Twice a day	82 (28.2)	125 (35.2)	207 (32.0)	6.81	.146
Three times a day	32 (11.0)	32 (9.0)	64 (9.9)		
More than three times a day	8 (2.7)	9 (2.5)	17 (2.6)		
Total	291 (45.0)	355 (55.0)	646 (100)		

*N: Number

gingival surfaces of the anterior teeth were estimated using the Gingival Index. Scoring standards read as follows; 0, healthy appearance; 1, redness and swelling over half of the papilla; 2, redness and swelling over half of the papilla and marginal gingiva; 3, redness and swelling on the papilia, marginal and attached gingiva.

Pit & fissure retentiveness; Retentiveness scoring by criteria was as follows; 1, flat and shallow pit and fissure; 2, pit and fissure of moderate depth; 3, very deep pit and fissure.

Resazurin Disk test (RD test); RD tests were performed to assess the intraoral acidogenicity of the subjects.

Questionnaire survey:

Self care habit;

Toothbrushing frequency and occasions; Oral hygiene habits were measured according to the subjects' toothbrushing frequency and timing

Regular dental check-up; This item was asked to understand the extent of the concern for dental caries prevention.

Socioeconomic status;

Parents' educational background and income levels were examined based on the students' records.

Between-meal eating habits;

Between meal eating habits were measured by frequency during a day and a dental caries index of preferred snacks was recorded (Kim, 1981: Paik, 1982).

Diet and nutritional Intake;

The diet of each subject was assessed by a food frequency method, which estimated how frequently selected foods were eaten during the last six months. A total of 211 food items were selected based on the study of the most frequently consumed foods by Koreans (Korea Food Industry Association, 1991). The questionnaire included frequency of consumption in terms of days, weeks, and months. It also suggested one portion size of each food item. After instruction, each subject completed the food frequency questionnaire. The food consumption data has been converted into nutrients by using the Korean Food Consumption Table (Korea Rural Nutrition Institute, 1991).

Data analysis

For the first stage of analysis, Chi-square test was used to identify the factors influencing caries. For

Table 2. Mean intake amount of nutrients by gender

Nutrient	Male		Female		Total	
	Mean	SD	Mean	SD	Mean	SD
Energy (Kcal)**	3149.03	1905.86	2719.94	1780.15	2914.38	1849.15
Protein (g)*	107.15	76.17	93.74	75.43	99.82	76.00
Fat (g)***	71.30	57.35	56.60	51.02	63.26	54.43
Carbohydrate(g)*	521.92	285.98	460.48	268.02	488.33	277.78
Fiber (g)	7.53	6.54	6.70	10.19	7.07	8.73
Calcium (mg)	849.02	578.40	773.64	579.76	807.80	579.92
Phosphorus (mg)	1315.79	1024.63	1166.94	1069.02	1234.39	1050.95
Iron (mg)	16.31	13.40	14.26	13.54	15.19	13.50
Sodium (mg)	809.08	863.06	791.24	881.28	799.32	872.45
Potassium (mg)	1914.12	1439.57	1712.48	1616.55	1803.85	1540.99
Thiamine (mg)**	1.65	1.30	1.38	1.23	1.50	1.27
Riboflavin (mg)	1.56	1.13	1.40	1.15	1.47	1.14
Niacin (mg)	26.43	20.09	24.04	21.11	25.12	20.67
Ascorbic acid(mg)	85.58	78.39	75.51	76.37	80.08	77.39
Magnesium (mg)	59.50	50.66	54.89	49.95	56.98	50.28

* : statistically significant $p < 0.05$
** : statistically significant $p < 0.01$
*** : statistically significant $p < 0.001$

Table 3. Associations between caries experience and other variables

Variables	Caries-free	Caries	Total	χ^2	p-value
Oral Status Factor					
Gingival Condition					
Healthy Gingiva	37 (6.3)	150 (25.3)	187 (31.6)		
Incipient Gingivitis	47 (4.7)	163 (27.5)	210 (35.5)		
Moderate Gingivitis	39 (6.6)	128 (21.6)	167 (28.2)	1.42	.700
Severe Gingivitis	8 (1.4)	20 (3.4)	28 (4.7)		
Total	131 (22.1)	461 (77.9)	592 (100)		
Pit & Fissure Retentiveness					
Low	60 (46.2)	70 (15.3)	130 (22.1)		
Moderate	57 (43.8)	273 (59.6)	330 (56.1)		
Deep	13 (10.0)	115 (25.1)	128 (21.8)	58.74	<.001
Total	130 (22.1)	458 (77.9)	588 (100)		
Caries Activity					
Low	33 (25.6)	115 (24.9)	148 (25.1)		
Moderate	42 (32.6)	164 (35.6)	206 (34.9)		
High	54 (41.8)	182 (39.5)	236 (40.0)	.42	.8094
Total	129 (21.9)	461 (78.1)	590 (100)		
Oral Hygienic Factor					
Toothbrushing Frequency					
No	2 (1.5)	1 (0.2)	3 (0.5)		
Once a day	6 (4.6)	13 (2.8)	19 (3.2)		
Twice a day	66 (50.8)	213 (46.3)	279 (47.3)		
Three times a day	53 (40.8)	223 (48.5)	276 (46.8)	6.21	.184
More than three times a day	3 (2.3)	10 (2.2)	13 (2.2)		
Total	130 (22.0)	460 (78.0)	590 (100)		
F mouth-rinse experience					
Yes	15 (11.5)	37 (8.0)	52 (8.8)		
No	116 (88.5)	424 (92.0)	540 (91.2)	1.09	.295
Total	131 (22.1)	461 (77.9)	592 (100)		
Regular Dental Check-up					
Yes	0 (0.0)	11 (2.4)	11 (1.9)		
No	131 (100)	450 (97.6)	581 (98.1)	3.18	.156
Total	130 (22.0)	460 (78.0)	590 (100)		
Dietary Factor					
Between-Meal intake					
No	15 (11.5)	46 (10.1)	61 (10.4)		
Once a day	72 (55.4)	195 (42.7)	267 (45.5)		
Twice a day	33 (25.4)	159 (34.8)	192 (32.7)		
Three times a day	7 (5.4)	46 (10.1)	53 (9.0)	9.01	.061
More than three times a day	3 (2.3)	11 (2.4)	14 (2.4)		
Total	130 (22.1)	457 (77.9)	587 (100)		

the second stage, logistic multiple regression analysis was used to assess the relationship between nutritional intake and caries experience by caries free group and caries experienced group. And finally, multiple regression analysis was performed with DMFS scores and all the other independent variables.

Table 4. Results of logistic regression analysis with total caries experience and the dependent variable

Independent variables	Beta	S.E.	Odds ratio	p-value
Gender	−.0749	.2372	.9278	.7522
Fissure (Moderate)$^{\$}$ *	1.5263	.2467	4.6011	.0000
Fissure (Deep)$^{\$}$ **	2.2216	.3665	9.2222	.0000
RD test (Moderate)$^{+}$	.3271	.2925	1.3869	.2634
RD test (High)$^{+}$	.0536	.2794	1.0551	.8478
Energy (Kcal)	.0036	.0037	1.0036	.3282
Protein (g)	−.0131	.0210	.9870	.5322
Fat (g)	−.0214	.0353	.9789	.5449
Fiber (g)*	−.1254	.0574	.8822	.0289
Carbohydrate (g)	−.0173	.0149	.9829	.2461
Calcium (g)	−.0009	.0014	.9991	.5223
Phosphorus (g)	−.0011	.0013	.9989	.4245
Iron (mg)	.0465	.0644	1.0476	.4699
Sodium (mg)	−.0000	.0002	.9999	.6675
Potassium (mg)*	.0012	.0005	1.0012	.0129
Thiamine (mg)	−.6563	.5003	.5187	.1896
Riboflavin (mg)	.4379	.6457	1.5494	.4977
Niacin (mg)	.0151	.0312	1.0153	.6275
Ascorbic acid (mg)	−.0091	.0048	.9909	.0569
Magnesium (mg)	.0010	.0041	1.0010	.8098
$(Ca/P)^2$	.0899	1.1596	1.0940	.9382
Constant	−.3040	.9375		.7458

$^{\$}$: reference category : low pit & fissure retentiveness
$^{+}$: reference category : low caries activity
*: statistically significant $p < 0.05$
**: statistically significant $p < 0.01$

RESULTS

Caries experience, oral health status, oral hygiene behavior, and dietary behavior

The results, as presented in Table 1, demonstrated that the percentage of subjects with no experience of dental caries was 22.1%. And regarding oral health status, the percentage of those having gingivitis was 67%. Gingivitis was higher in females than in males. In both the cases of caries activity (high categories), pits & fissure retentiveness (deep categories) and toothbrushing frequency showed statistically significant differences between the genders. Nutrient consumption of the subjects is shown in Table 2. Average daily energy intake of the subjects was 2914 Kcal. There was a gender difference in nutrient consumption in the case of protein, fat, carbohydrate and thiamin. Energy consumption of boys (3149 Kcal) was higher than that of girls (2719 Kcal).

Identification of influencing factor on dental caries experience

Table 3 shows the Chi-square test results between caries experience and various factors such as oral health status, oral hygiene behavior and dietary behavior. Among the factors, pit and fissure retentiveness showed the most statistically significant difference ($p<0.001$). But other factors did not show any statistically significant difference (Table 3). Also, multivariate analysis was the same. Total caries experience of the moderate retentiveness group was 4.6 times higher than that of the low retentiveness group. And total caries experience of the high retentiveness group was 9.2 times higher than that of the low retentiveness group (Odds ratio of Table 4).

Table 5. Results of logistic regression analysis with smooth surface caries experience and the dependent variable

Independent variables	Beta	S.E.	Odds ratio	p-value
Gender	.1270	.1938	1.1354	.5123
Fissure (Moderate)$ **	1.0572	.2430	2.8783	.0000
Fissure (Deep)$ **	2.2735	.3054	9.7132	.0000
RD test (Moderate)+	−.0362	.2408	.9645	.8805
RD test (High)+	−.1792	.2346	.8359	.4450
Energy (Kcal)	−.0023	.0030	.9977	.4417
Protein (g)	−.0118	.0178	.9883	.5070
Fat (g)	.0192	.0287	1.0194	.5037
Fiber (g)	−.0560	.0488	.9455	.2506
Carbohydrate (g)	.0097	.0121	1.0098	.4204
Calcium (g)	−.0017	.0013	.9983	.1652
Phosphorus (g)	.0022	.0012	1.0022	.0525
Iron (mg)	−.0687	.0528	.9336	.1934
Sodium (mg)	−.0000	.0002	1.0000	.8840
Potassium (mg)	.0005	.0004	1.0005	.1703
Thiamine (mg)	.4438	.4073	1.5586	.2759
Riboflavin (mg)	.4205	.5402	1.5227	.4363
Niacin (mg)*	.0576	.0263	1.0593	.0288
Ascorbic acid (mg)	−.0017	.0041	.9983	.6710
Magnesium (mg)	.0033	.0033	1.0033	.3227
$(Ca/P)^2$	−3.3131	3.3007	.0364	.3155
Constant	−3.3706	2.3192		.1461

$: reference category : low pit & fissure retentiveness
+: reference category : low caries activity
*: statistically significant $p < 0.05$
**: statistically significant $p < 0.01$

Identification of the influences of the nutrient factors on the dental caries experience

Influence of nutrient factors on dental caries was measured by logistic regression analysis with control of other variables. The results showed that potassium and fiber had a statistically significant difference on total caries experience. It showed that total caries experience was negatively correlated with the daily intake amount of dietary fiber and positively correlated with the amount of potassium (Table 4). Niacin had a statistically significant difference on smooth surface caries experience. Smooth surface caries experience was positively correlated with the daily intake amount of niacin (Table 5). Fiber and potassium showed statistical significance at occlusal caries experience. Occlusal caries experience was negatively correlated with the daily intake amount of dietary fiber and positively correlated with the amount of potassium (Table 6)

Identification of the influence of the nutrients and other factors on DMFS representing the severity of the dental experience

Gender, fissure retentiveness, energy intake, carbohydrate intake, and niacin intake showed statistical significance in multiple regression analysis. Multiple regression analysis showed that DMFS scores were positively associated with the daily intake amount of carbohydrate and niacin, and negatively associated with total energy intake (Table 7).

DISCUSSION

It has been observed in this study that occlusal fissure retentiveness is the most influential factor on dental caries. So fissure sealing is a very effective preventive measure for this age group. Boys had more protein, fat and carbohydrate intake than girls,

Table 6. Results of logistic regression analysis with occlusal caries experience and the dependent variable

Independent variable	Beta	S.E.	Odds ratio	p-value
Gender	−.0776	.2356	.9253	.7418
Fissure (Moderate)$^{\$}$ **	1.5684	.2460	4.7988	.0000
Fissure (Deep)$^{\$}$ **	2.2313	.3601	9.3117	.0000
RD test (Moderate)$^{+}$	.3892	.2907	1.4758	.1805
RD test (High)$^{+}$	.0614	.2771	1.0633	.8248
Energy (Kcal)	.0028	.0037	1.0028	.4552
Protein (g)	−.0114	.0210	.9887	.5872
Fat (g)	−.0139	.0356	.9862	.6959
Fiber (g)*	−.1191	.0565	.8877	.0350
Carbohydrate (g)	−.0140	.0151	.9861	.3527
Calcium (g)	−.0023	.0015	.9977	.4068
Phosphorus (g)	.0002	.0014	1.0002	.1284
Iron (mg)	.0028	.0626	.0028	.8965
Sodium (mg)	−.0000	.0002	.9999	.8840
Potassium (mg)*	.0010	.0005	1.0010	.0327
Thiamine (mg)	−.6351	.5087	.5299	.2119
Riboflavin (mg)	.5202	.6495	1.6824	.4233
Niacin (mg)	.0171	.0311	1.0173	.5821
Ascorbic acid (mg)	−.0079	.0048	.9922	.1021
Magnesium (mg)	.0014	.0040	1.0014	.7256
$(Ca/P)^2$	−5.5126	3.6339	.0040	.1293
Constant	−4.1307	2.6573		.1201

$^{\$}$: reference category : low pit & fissure retentiveness
$^{+}$: reference category : low caries activity
*: statistically significant $p < 0.05$
**: statistically significant $p < 0.01$

but girls had more caries than boys in this study. Generally, girls show a consistently higher caries experience than boys of the same chronological age, at least into the early teens. Girls exhibit, in particular, a greater number of filled teeth. This is attributable largely to the fact that the teeth of girls erupt at an earlier age than do boys. So earlier eruption of permanent teeth in girls can lead to a longer exposure of such teeth to the caries environment. Therefore, girls teeth are at risk relative to dental caries at an earlier age (Menaker, 1980). If there are real differences between men and women in their lifetime experience of dental caries, it will require more precise studies which are attributable to cultural and behavioral differences rather than to inherent differences. It was reported that women visited a dental clinic more frequently than men. So it was tended to increase the dentist induced demand which mean the unnecessary treatment or tooth filling. This was supposed to be one of the reasons increasing filling component of DMFS score of women (Park, 1996). There was no statistically significant difference in the amount of nutritional intake between the caries free group and the caries prevalent group by the t-test. Among minerals, potassium intake showed a statistical significance between the caries free group and the caries prevalent group by logistic regression analysis after controlling other factors. Generally, fibrous foods have less retentiveness and thus cause less caries incidence. The intake amount of fiber had a negative correlation with occlusal caries experience. However fiber was a significant nutrient in this study. Concerning potassium, there is no reference in earlier studies, therefore more investigation is needed.

Among vitamins, niacin showed a statistical significance on DMFS as a result of multiple regression analysis. Orland had reported that niacin activates the growth of the cariogenic oral bacteria in animal studies (Orland *et al.* 1950). And Kristoffersson had

Table 7. Results of multiple regression analysis with DMFS and the dependent variable

Independent variables	Beta	S.E.	p-value
Gender*	1.125949	.527361	.0333
Fissure (Moderate)$ *	1.700537	.710632	.0171
Fissure (Deep)$ **	3.969082	.817115	.0000
RD test (Moderate)+	−.350016	.637506	.5833
RD test (High)+	−.421805	.650516	.5171
Energy (Kcal)*	−.016828	.008064	.0375
Protein (g)	.024257	.045519	.5944
Fat (g)	.148338	.078136	.0583
Fiber (g)	.122029	.130242	.3493
Carbohydrate (g)*	.072507	.032595	.0266
Calcium (g)	.000251	.003237	.9384
Phosphorus (g)	.001252	.002865	.6624
Iron (mg)	−.247416	.135765	.0691
Sodium (mg)	.00005	.000044	.9755
Potassium (g)	.000764	.000928	.4099
Thiamine (mg)	1.713399	1.018645	.0933
Riboflavin (mg)	1.611522	1.349890	.2332
Niacin (mg)**	.177456	.065665	.0072
Ascorbic acid (g)	.001704	.011788	.8851
Magnesium (mg)	.011405	.009030	.2073
$(Ca/P)^2$	11.814439	9.775150	.2275
(Constant)	12.567609	6.66668	.0601
R squqre	.13362		

$: reference category : low pit & fissure retentiveness
+: reference category : low caries activity
*: statistically significant $p < 0.05$
**: statistically significant $p < 0.01$

reported that smooth surface caries are related to the number of *Streptococcus mutans* (Kristoffersson *et al.* 1985). So there is some possibility that niacin may have some local effect on smooth surface caries incidence. At this point, niacin is an interesting nutrient with regard to cariology. Ca/P intake ratio has been debated in the nutritional aspect. FAO and WHO have reported that the ratio is not important (FAO/WHO Expert Group, 1962), but Vermeulen recommended that Ca/P = 1 is optimal from animal studies (Vermeulen, 1959). At the Ca/P intake research of the dental aspect, Stanton reported that caries prevalence was very low when the intake ratio is 0.55 (Stanton, 1969). However, this study did not show a statistical significance between phosphate intake and caries prevalence as a result of logistic regression analysis or multiple regression analysis. This study, which is a cross-sectional, has fundamental limitations in investigating the casual relationship of caries incidence and nutritional intake. Nevertheless, this investigation has some significance in providing the basic data for a follow-up study. And also it will be useful in forming hypotheses for future study.

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