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Original Article

Relationship between Number of Present Teeth and Nutritional Intake in Institutionalized Elderly

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Abstract

We conducted oral examinations and dietary surveys on a total of 141 subjects with an average age of 80 years or more–specifically, seniors (S-group) living in a health service facility for the elderly and patients with mild dementia (SD-group) living in a special nursing home for the elderly. All were assumed to have a roughly uniform diet. We investigated which factors contributed to their dietary intake, and the relationship between dietary intake and number of present teeth (PT). Factors affecting total energy of the subjects and those in the S-group were body weight and number of PT. No factors were recognized as having a relationship with total energy in the SD-group. A significant difference was found in males in the S-group in that those in the "five PT or more" group had higher levels of carbohydrates and vitamin B_1 than those in the "four PT or less" group. However, significant differences were found in the SD-group in that subjects in the "five PT or more" group had higher levels of carbohydrates, calcium, iron, and vitamins A, B_1, B_2, and C than those in the "four PT or less" group. Significant differences were seen in both groups for female patients in the nursing home with regard to total energy, proteins, carbohydrates, iron, vitamin B_1, and fiber intake. No significant differences were recognized, however, for females in the SD-group. Reductions in dietary intake should be considered from the perspective of nutritional status, which is a problem that can be resolved through dental treatment. This study found that recovery of chewing ability in seniors was essential not only to maintain nutritional status, but also to fully bring out all the functions of the foods themselves.

Key words: Nutrition survey—Dementia—Elderly—Institution—Number of present teeth

Introduction

Japanese people have a long life expectancy and the number of senior citizens is increasing rapidly. In fact, the ratio of senior citizens to the entire population, which was 1:6 in 2000, is expected to reach a startling 1:3 by 2025[14]. In terms of oral health, although the average number of present teeth (PT) per person has increased noticeably over the past 20 years, a

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survey on dental diseases in 1999 revealed that the average number of PT at 80 was 8.21[15]. Tooth loss in seniors reduces their chewing function and affects nutritional intake[18,23,41,47]. The relationship between chewing function and the activities of daily living (ADL)[27], dietary intake[36], and the quality of life (QoL)[28] have also been reported. Improvements to the diets of older adults through prosthodontic treatment and preventing tooth loss have been reported[23]. However, it has been reported that tooth loss and type of prosthetic do not affect the acceptability of food[9–11,31,33,39,40], and that, although there is a relationship between oral condition and occlusal force, its effect on food selection and intake is negligible[34]. This is because much of this research has generally involved surveys where evaluations of food acceptability have been based on the participant's subjective evaluations. It is, therefore, necessary to conduct surveys that include objective evaluations of food acceptability.

It should be noted that surveys comparing seniors with dementia and healthy seniors[6,17,24,42] have reported factors such as increased incidence of caries, greater dental problems, and deterioration in oral hygiene among those with dementia, and that in some cases dental problems have caused other problems such as loss of interest in food, loss of appetite, or refusal to wear dentures[4,5]. It is extremely important for seniors with dementia to have an appropriate nutritional intake in terms of maintaining and improving their QoL, but studies incorporating objective nutritional surveys on seniors beyond the age of 80 have not yet been done.

In this research, we surveyed seniors beyond 80 years of age and divided them into two groups: an S-group who lived in a health service facility for the elderly and an SD-group, which comprised patients with mild dementia living in a special nursing home for the elderly. Both groups were assumed to have a roughly uniform diet. This was necessary so that we could investigate 1) what factors contributed to dietary intake, and 2) the relationship between dietary intake and number of PT.

Materials and Methods

1. Subjects

We fully explained the goals and content of this research to the employees of each facility beforehand, and to the subjects and their families on the day of the surveys, and received consent before conducting the study.

The ability to walk and move and the stage of dementia were determined by the chief physicians at the institutions involved. The DSM-IIIR of the American Psychiatric Association's "Diagnostic and Statistical Manual of Mental Disorders (DSM), 3rd Edition"[2], was used as the diagnostic standard. Dementia was classified according to Hasegawa's dementia scale (HDS-R)[16].

There were a total of 140 subjects in this study divided into two groups: An S-group comprising 48 people (12 men and 36 women) living in a health service facility for the elderly in Chiba Prefecture for one year or more, aged from 72 to 99 years with no dementia, and an SD-group comprising 92 people (24 men and 68 women) living in a special nursing home for the elderly in Iwate Prefecture for one year or more, aged from 70 to 98 years with mild dementia (pre-dementia) where communication was possible.

At both the facilities targeted in this study, a dietitian was on duty at all times, managing diets, and calculating total energy, nutritional elements, and other factors with consideration to the daily dietary requirements defined for persons aged 70 and over[13,20]. The dietitian also conducted dietary management in keeping with the residents' oral status (*e.g.*, use of dentures) and personal tastes and requests of the individuals. At the SD-group facility, nutritional elements were supplemented with foods that made up for deficiencies based on food management and instructions from the facility director in order to prevent malnutrition.

2. Survey method

1) ADL assessment: ADL evaluations were done in accordance with the standards set by the Japanese Ministry of Health, Labour, and Welfare.

2) Surveys on oral states: Oral status was assessed by a single examiner. Examination items were: PT, occlusion, and the presence/type/use of dentures. We examined intact, decayed, filled, and missing teeth. We also checked whether teeth moved. We did not include PT that had severe dental caries and/or moved. We assumed a maximum of 14 occluding teeth, excluding the third molars, based on a standard of single pairs of opposing teeth. We divided the subjects into those currently with and without partial dentures; denture type was divided into upper/lower and complete/partial dentures. We then surveyed whether the dentures were actually being used during meals and when not eating. The average number of PT was 4.91 ± 7.78 in this study. We did a comparison (by gender and institution) on state of dietary intake, with subjects divided into groups according to the number of PT ("4 or less" and "5 or more") based on overall distribution.

3) Body Mass Index (BMI): BMI was calculated from height and body weight.

4) Surveys of meals: We recorded each meal (breakfast, lunch, dinner) consumed each day through digital photography[32,44,46], noting the menus and volumes, as well as the conditions before and after meals. We determined type and volume of food before and after every meal, and calculated total energy and nutritional elements in 13 categories, based on a food composition table[13]: Total energy, vitamin D, proteins, lipids, carbohydrates, calcium, iron, vitamin A, vitamin B_1, vitamin B_2, vitamin C, cholesterol, and fiber. We then compared the intake volumes of foods and their nutritional elements.

3. Statistical analysis

We used the SAS System Ver. 8.2 to analyze our data. The effects of factors such as age, body weight, height, oral state, ADL classification, and type of dementia were then derived using logistic regression analysis of total energy and other nutritional elements. We used distributed analysis to compare intake volumes between the various food groups and nutrition groups in the "4 PT or less" subjects and the "5 PT or more" subjects.

Results

The mean and standard deviations for age, BMI, and PT are listed in Table 1. The average number of PT for the S-group was 5.10 ± 4.37 and number of occlusal pairs was 1.01 ± 1.47. There were no significant differences between the groups. The average number of PT for the SD-group was 6.97 ± 5.78 and number of occlusal pairs was 1.78 ± 2.36.

We conducted logistic analysis on the variables for total energy in all subjects. Table 2 lists the odds ratios adjusted by age and gender and 95% confidence limits for these results. Factors affecting total energy were body weight and number of PT. The corresponding odds ratios for these were 1.085 and 3.869. Other factors (gender, age, height, ADL category, and presence of dementia) had no effect with regard to either energy utility or various nutritional elements (data not shown). Body weight and the number of PT were also factors affecting carbohydrates.

Table 3 lists the adjusted odds ratios for each variable relevant to total energy in the S-group, and 95% confidence limits for these results. Factors related to total energy were body weight and number of PT. The corresponding odds ratios for these were 1.146 and 8.377. Other factors (gender, age, height, ADL category) had no effect with regard to either energy utility or the various nutritional elements (data not shown). Body weight and number of PT were also factors affecting carbohydrates, proteins, iron, vitamin B_1, and vitamin C (data not shown).

Table 4 lists the adjusted odds ratios for each variable, and 95% confidence limits for the SD-group. No factors were recognized as being related to energy utility. Other factors

Table 1 Population characteristics

S-group

		n	Age	Height (m)	Weight (kg)	BMI[a]
Male	≧5PT[b]	6	77.5 ± 6.35	1.59 ± 0.04	58.0 ± 9.59	22.9 ± 2.97
	≦4PT[c]	6	84.5 ± 3.73	1.60 ± 0.09	53.5 ± 13.0	20.7 ± 4.00
Female	≧5PT	15	84.0 ± 5.64	1.45 ± 0.05	46.8 ± 8.27	22.3 ± 4.12
	≦4PT	21	85.6 ± 6.71	1.40 ± 0.07	42.2 ± 9.33	21.4 ± 3.53
Total		48	82.9 ± 5.61	1.51 ± 0.06	50.1 ± 10.0	21.8 ± 3.66

SD-group

		n	Age	Height (m)	Weight (kg)	BMI
Male	≧5PT	12	80.5 ± 10.6	1.51 ± 0.09	51.1 ± 9.05	23.8 ± 4.47
	≦4PT	12	79.4 ± 11.4	1.58 ± 0.06	50.0 ± 9.28	20.4 ± 3.20
Female	≧5PT	19	79.4 ± 5.48	1.40 ± 0.08	43.5 ± 8.54	23.0 ± 4.66
	≦4PT	49	85.3 ± 6.23	1.37 ± 0.07	41.9 ± 8.32	22.9 ± 5.06
Total		92	81.2 ± 8.43	1.47 ± 0.08	46.6 ± 8.80	22.5 ± 4.35

[a]: Body mass index, [b]: 5 present teeth or more, [c]: 4 present teeth or less, S-group: seniors living in a nursing home, SD-group: seniors suffering from mild dementia and living in a nursing home

Table 2 Odds ratio estimates for energy (all subjects)

Parameter	Point estimate	95% Confidence intervals	p-value
Gender	0.613	0.128– 2.936	0.541
Age	1.023	0.946– 1.107	0.571
Weight	1.085	1.020– 1.153	0.009
Height	0.965	0.895– 1.041	0.360**
Present teeth	3.869	1.418–10.554	0.008
ADL classification	0.866	0.590– 1.271	0.463**
Dementia classification	0.481	0.123– 1.878	0.293

(n = 140 **: $p<0.01$)

Table 3 Odds ratio estimates for energy (S-group)

Parameter	Point estimate	95% Confidence intervals	p-value
Gender	0.834	0.039–17.802	0.908
Age	0.955	0.819– 1.113	0.554
Weight	1.146	1.014– 1.294	0.029*
Height	0.915	0.774– 1.083	0.302
Present teeth	8.377	1.405–49.950	0.020*
ADL classification	0.440	0.175– 1.107	0.081

(n = 48 *: $p<0.05$)

(gender, age, height, ADL category) had no effect on either energy utility or the various nutritional elements. No other nutritional elements were recognized as representative factors affected by the number of PT (data not shown).

Table 4 Odds ratio estimates for energy (SD-group)

Parameter	Point estimate	95% Confidence intervals	p-value
Gender	0.563	0.070– 4.519	0.589
Age	1.060	0.953– 1.179	0.282
Weight	1.069	0.979– 1.166	0.137
Height	0.971	0.890– 1.059	0.500
Present teeth	2.825	0.672–11.880	0.157
ADL classification	1.090	0.692– 1.716	0.710

(n=92)

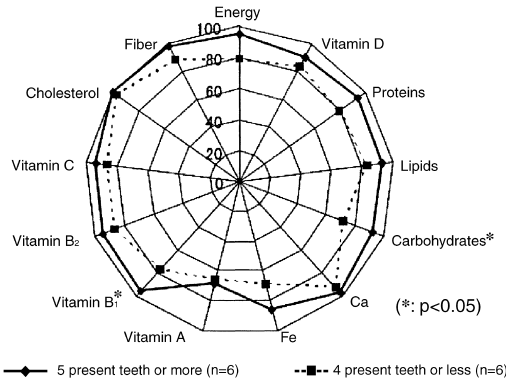

Fig. 1 Proportion of nutrients consumed by males in S-group
(Total nutrients adjusted on 100%)

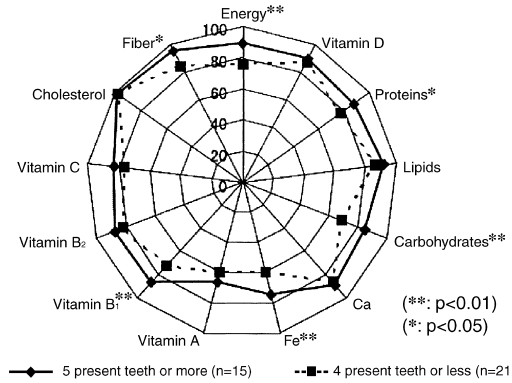

Fig. 2 Proportion of nutrients consumed by females in S-group
(Total nutrients adjusted on 100%)

Figures 1 and 2 show a comparison of the nutritional element intake volumes for the "number of PT" (also separated by gender) in the S-group. Male subjects in the "5 PT or more" group consumed significantly higher levels of carbohydrates and vitamin B_1 than those in the "4 PT or less" group ($p<0.05$). Female subjects had significant differences in that those in the "5 PT or more" group took in higher levels of energy ($p<0.01$), and consumed more proteins ($p<0.05$), carbohydrates ($p<0.01$), iron ($p<0.01$), vitamin B_1 ($p<0.01$), and fiber ($p<0.05$) than those in the "4 PT or less" group.

Figures 3 and 4 show a comparison of the nutritional element intake volumes for the "number of PT" (also separated by gender) in the SD-group. Male subjects in the "5 PT or more" group consumed significantly less calcium, iron, vitamin A, vitamin B_2, and vitamin C than those in the "4 PT or less" group ($p<0.05$). Female subjects showed no significant differences in nutritional elements between the two groups.

Discussion

Joshipura *et al.*[18] conducted a nutritional survey, dividing subjects aged 70 and over into groups by the number of PT (0, 1–10, 11–16, 17–24, and 25–32), and reported that tooth loss negatively affected dietary intake. Papas *et al.*[36] did a study on the dietary intake of "seniors with teeth", defined as those with at least six teeth, and divided the subjects into groups according to number of PT (17 or less, 18–24, and 25 or more). They found reduced nutritional element intake due to fewer PT. Morita[30] carried out a study on subjects aged

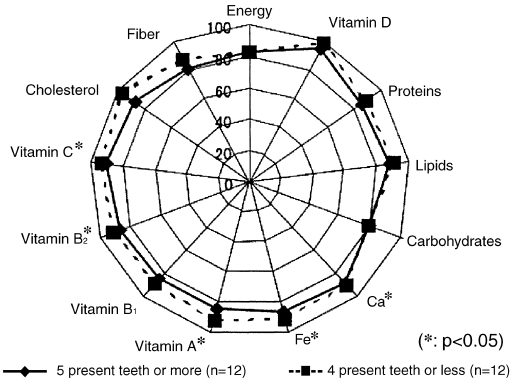

Fig. 3 Proportion of nutrients consumed by males in SD-group
(Total nutrients adjusted on 100%)

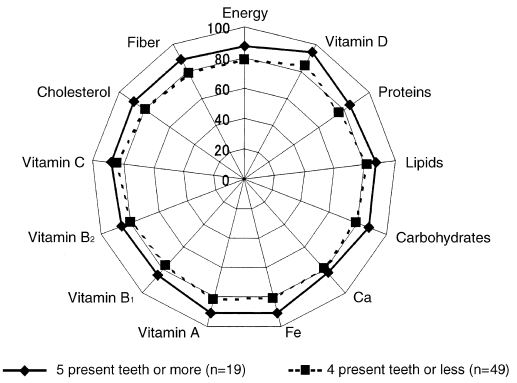

Fig. 4 Proportion of nutrients consumed by females in SD-group
(Total nutrients adjusted on 100%)

80 and over, dividing the subjects into two groups according to number of PT ("19 or less" and "20 or more"), and found that total energy was significantly lower in subjects with 19 or fewer PT. Takekoshi *et al.*[45] did a study on subjects suffering from dementia, with an average age of 80, and determined the percentiles for general diet and serration foods, dividing the subjects into two groups by number of PT ("7 or less" and "8 or more"). A comparison indicated that general diet intake was more difficult for the "7 or less" group than for the "8 or more" group.

In all subjects in this study, the factors related to total energy were body weight and number of PT; the others (gender, age, height, ADL level, and presence of dementia) were not seen as factors. We obtained the same results with regard to total energy in the S-group. We also found that, of all nutritional elements, the only factor affecting intake volumes for iron, vitamin B_1, and vitamin C_1 was the number of PT. However, in the SD-group, there was no indication of any relationship between dietary intake volumes and any of the above factors.

It has been reported that as people get older, their selection of foods tends to become narrower, and that this may result in the deterioration of their nutritional status[12,19,37]. It has also been reported that reduced chewing efficiency accompanying tooth loss is a factor related to aging, and that this may be the main reason seniors inappropriately select certain kinds of food[1,48,50]. Many seniors with noticeable tooth loss prefer to consume soft foods that are easy to chew, but these types of foods have a low concentration of nutritional elements[7,26,49]. Sustained chewing ability is therefore important in enabling seniors to consume a diverse range of foods to improve their nutritional status[47].

Although a dietitian managed their dietary requirements and took care of seniors at both facilities, our results indicated that for both males and females in the S-group, the dietary intake-status of persons with more PT tended to be superior. Therefore, the existence of PT was important to the nutritional status of seniors in the S-group with no dementia. However, in the SD-group with dementia, dietary intake was not influenced by factors such as oral state. The main reason was nutritional supplements making up for deficiencies in foods, which was based on food management and instructions from the facility director to prevent malnutrition.

There was a tendency for persons with dentures to consume fewer salads and raw vegetables[50], which are an important source of many essential vitamins and minerals. Specifically, loss of chewing ability is related to a reduction in the frequency at which raw carrots[8], fresh fruits, and vegetables[35] are

consumed. Nevertheless, there have been almost no reports on the relationship between dental condition and the intakes of various nutritional elements. Papas *et al.*[35] reported that people with complete dentures took in fewer calories and several specific nutritional elements than those with partial dentures and those with natural teeth. Greksa *et al.*[9] concluded that persons with complete dentures consumed significantly less of vitamins A and C than those with natural teeth. Joshipura *et al.*[18] did a multivariate analysis regarding the effect tooth maintenance had on dietary intake volumes, and determined that the average intake volumes of dietary fibers and carotene, and unit consumption volumes of fruit and vegetables, decreased in relation to reductions in number of PT. It has been found that average calorie and cholesterol intake increases with reduced number of PT, and it has also been reported that the dietary intake of seniors improved through preventing tooth loss and use of prosthetics to replace missing teeth[23].

In our analysis of the two groups categorized by number of PT ("4 or less" and "5 or more"), we found significant differences in their total energy, and considerable accompanying differences in the volumes of proteins and carbohydrates consumed. We also found significant differences in vitamin B_1 intake due to reduced rice consumption as a staple food, in iron (a mineral) intake due to insufficient consumption of meat, fish, and fiber, and in fiber intake due to insufficient consumption of vegetables. These reduced intake volumes of nutritional elements should be considered from the perspective of nutritional science as well. In fact, of the people with "4 PT or less" in the S-group, 16.7% of men and 31.3% of women were not using prosthetics, and we believe that dental treatment is an important means of resolving these problems.

Males in the SD-group with fewer PT had a higher dietary intake throughout several categories than males in the group with more PT, but there were no such differences in the females. There have been many reports that suggest there is no difference between people with dementia and those without in terms of the dietary intake of calories, proteins, and other elements[38,43]. We obtained the same results with regard to women, but conflicting results for men. We believe that the status of dietary intake was not influenced by factors such as oral state, because nutritional elements were supplemented to make up for deficiencies in foods.

Kikutani *et al.*[22] have reported that seniors with dementia also tended to experience bouts of depression which made them unresponsive to instruction on nutritional and eating-related matters, something further exacerbated by the hypo function of volition and swallowing that also accompanied their condition. The subjects in the SD-group had a slight cognitive hypo function of swallowing. Moreover, 80% of the subjects in the S-group responded "yes" to the question "Is a meal is pleasure?" in the questionnaire meals. However, only 65% of the subjects in the SD-group responded "yes" to the same question. Depression with meals was also seen.

This study found that number of PT was important and that it affected the dietary status of seniors in the S-group, but dietary intake in the SD-group was not influenced by factors such as oral condition. Although the elderly receive adequate nutrition as a function of food products, organic adaptation functions and other component sensory functions derived through chewing have yet to be achieved. Foods can be categorized into three main functions: 1) Dietary functions required to sustain life (primary functions), 2) sensory functions that emphasize sensations of the food's texture and composition (secondary functions), and 3) organic adaptation functions of foods such as those for bio-defense and recovery from illness (tertiary functions). Sensory and adaptation functions are both gained through chewing with the teeth[3,21,25,29].

It is conceivable that lack of sensory and adaptation functions may result in a lower level of satisfaction with regard to food. Our results indicated that it is essential for seniors to regain their chewing ability to improve their QoL.

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