## **Oral Biology**

# Activities of daily living and chewing ability in an 80-year-old population

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**OBJECTIVES:** The aim of this study was to determine whether chewing ability or number of intact teeth was related to performance of activities of daily living in 80year olds.

DESIGN: This was a cross-sectional survey including dental examinations, chewing self-assessment, and everyday function.

SUBJECTS AND METHODS: A total of 823 people (309 males, 514 females) who were 80 years of age and resident in the Fukuoka Prefecture, Japan participated in this study.

**RESULTS:** The mean number of intact teeth was 7.5 ± 8.7; of the 15 food items offered, the mean number of foods chewed was 11.2 ± 3.8. Function was independent in 713 subjects, and dependent in 93. After adjustment for gender, we found the number of foods chewed being linked to independent function by the multiple regression analysis ( $\beta = 0.223$ , P < 0.0001); the number of intact teeth was only weakly related ( $\beta = 0.077$ , P = 0.03). By logistic regression analysis, functional dependency was 7.5 times more prevalent in individuals capable of chewing four foods or fewer, and 3.3 times more prevalent in those chewing all 15 items. No significant functional difference was related to the number of intact teeth.

**CONCLUSION:** Chewing ability may be independently related with functional status in 80-year olds. Oral Diseases (2004) 10, 365–368

**Keywords:** elderly populations; activities of daily living (ADL); chewing

## Introduction

Tooth loss commonly occurs in association with aging, compromising mastication of food (Carlsson, 1984;

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Slade et al, 1996; Oosterhaven et al, 1988; Warren et al, 2002). Impaired chewing ability may adversely affect nutritional status (Osterberg and Steen, 1982; Chauncey et al, 1984; Krall et al, 1998; Papas et al, 1998; Walls et al, 2000; Avlund et al, 2001; Nordenram et al, 2001) and undermine general well-being (Walls et al, 2000; Nordenram et al, 2001; Warren et al, 2002). In a longitudinal study where subjects were followed up between the ages of 75 and 80 years, a relationship between chewing problems and general functional limitations was evident (Avlund et al, 2001). We have observed, in an 80-year-old Japanese population, a positive relationship between chewing ability and physical activity (Takata et al, 2004). Catovic et al (2003) recently found a relationship in an elderly population between problems with carrying out activities of daily living (ADL) and poor condition of fixed and removable dental prostheses. Functional dependency in older people is a particularly important factor in everyday health care (Challis et al, 2000). The present study examined the relationships of ADL status in 80-year olds to chewing ability as well as to the number of intact teeth in their dentition. The number or the types of foods that the subjects could chew was used as an indicator of chewing ability.

## Materials and methods

In 1998, 1282 80-year-old individuals residing in one of three cities (Buzen, Yukuhashi, or Munakata), four towns (Katsuyama, Tikujo, Toyotsu, or Kanda), one village (Shinyoshitomi), or one ward (Tobata of Kikakyushu City) in the Fukuoka Prefecture of Japan were invited to participate in the present study. The study areas were randomly selected from urban, preurban and rural populations taking into consideration the living environment including socio-demographic background, dietary habits, health behavior, and medical and dental treatment. Of these, 823 (64.2%) (309 male and 514 female) were included. A survey of the study subjects was approved by the Human Investigations Committee of Kyushu Dental College, and informed consent was obtained from all participants. The authors performed a dental examination of

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each subject in the manner recommended by the World Health Organization (WHO, 1997).

The ADL status was determined by public health nurses who classified subjects either as independent or as dependent, requiring day-to-day assistance. Questionnaires concerning food intake have proven valuable in epidemiologic surveys of masticatory function in the elderly (Leake, 1990; Nagai et al, 1990; Slade et al, 1996; Miura et al, 1998). Accordingly, each subject was asked about ability to chew the following 15 foods: peanuts, yellow pickled radish, hard rice cracker, French bread, beefsteak, octopus in vinegar, pickled shallots, dried scallops, dried cuttlefish, squid sashimi, konnyaku, a tubular roll of boiled fish paste, boiled rice, tuna sashimi, and grilled eel. These 15 foods were selected, and divided into four groups; three foods which are very hard to chew (hard rice cracker, peanuts, and yellow pickled radish), six foods moderately hard to chew (French bread, beefsteak, octopus in vinegar, pickled shallots, dried scallops, and dried cuttlefish), three foods slightly hard to chew (konnyaku, a tubular roll of boiled fish paste, and squid sashimi), and three easy-to-chew foods (boiled rice, tuna sashimi, and grilled eel) (Yamamoto, 1972). The number and types of these foods that a subject could chew was used as an index of chewing ability, which was assessed as a possible independent influence on ADL status by multiple and logistic regression analyses.

The following factors were considered as possible influences upon the number of intact teeth, number of foods reported to be chewable, and ADL: gender (male/ female), smoking (smoker *vs* non-smoker), regular outpatient dental or medical treatment (yes *vs* no), and self-performed oral hygiene (yes *vs* no). These categorical factors were adjusted for identifying independent risk factors for ADL.

All data are reported as mean  $\pm$  s.d. The differences in mean values between groups were assessed by the analysis of variance. Categorical variables were compared using the chi-squared test. Multiple regression analysis was carried out to evaluate which factors were related to ADL after adjustment for confounding variables. Logistic regression was also used to determine which categorical factors were independent predictors of ADL. All statistical analyses were performed using StatView 5.0 (SAS Institute, Cary, NC, USA). Results were considered statistically significant when the *P*-value < 0.05.

## Results

The mean number of intact teeth in the sample was 7.5  $\pm$  8.7; height was 149.5  $\pm$  8.9 cm; and weight was 50.9  $\pm$  9.3 kg. The mean number of foods that the subjects could chew was 11.2  $\pm$  3.8. ADL was evaluated in 806 individuals, of whom, 713 were independent in everyday life activities, while 93 were dependent. The number of foods that a subject felt capable of chewing was greater in the independent than the dependent group (11.5  $\pm$  3.6 vs 8.7  $\pm$  4.3, F = 41.4, P < 0.0001). The mean number of intact teeth was 7.8  $\pm$  8.8 in

independent subjects, and  $5.6 \pm 7.7$  in dependent subjects, being significantly greater in the independently living group than in the dependent group (F = 5.3, P = 0.02). Individuals with independence in ADL were more likely to have good oral self-care (75.3%) than those with dependent ADL (55.2%) ( $\chi^2 = 16.0$ , P < 0.0001). A gender difference was present in the number of foods chewed ( $11.8 \pm 3.5$  for men vs  $10.9 \pm 3.9$  for women, F = 12.1, P = 0.0005), and in the number of intact teeth ( $9.2 \pm 9.5$  for men vs  $6.5 \pm 8.0$  for women, F = 18.1, P < 0.0001). However, the percentage of individuals independent for ADL was similar between men and women (90.1% for men and 87.5% for women,  $\chi^2 = 1.3$ , P = 0.2).

Multiple regression analysis after adjustment for gender showed that the number of foods chewed was related to better ADL status ( $\beta = 0.223$ , P < 0.0001). The number of intact teeth was only slightly related to better ADL status after adjustment for gender ( $\beta = 0.077$ , P = 0.03). When the subjects were divided into four groups according to the number of foods chewed (0–4, 5–9, 10–14, or 15), the likelihood of poor ADL status was significantly greater in the groups capable of chewing fewer foods ( $\chi^2 = 34.0$ , P < 0.0001; Table 1). However, prevalence of dependent ADL status was not significantly different between the four groups defined by the number of intact teeth (0, 1–9, 10–19, and  $\geq 20$ ;  $\chi^2 = 6.6$ , P = 0.0859; Table 1).

After the data were adjusted for various confounding factors such as gender (men vs women), smoking (yes vs no), oral self-care (yes vs no), regular dental treatment (yes vs no), and medical treatment (yes vs no), we calculated odds ratios (OR) and 95% confidence intervals (CI) for a poor ADL status using logistic regression analysis (Table 2). Simple regression analysis showed that associations of ADL status with gender (r = 0.041, P = 0.2487), smoking (r = 0.026, P = 0.4598), or dental and medical treatment (r = 0.055, P = 0.1246) were not significant, and those performing self-oral hygiene (r = 0.163, P < 0.0001) were significant. Compared with individuals capable of chewing 15 foods, a poor ADL status was significantly more prevalent among individuals capable of chewing only 10-14 foods, 5-9, or 0-4 (Table 2). Likelihood of dependent ADL status

 Table 1 Independent vs. dependent activities of daily living (ADL)

 status in four elderly subject groups differing by number of foods

 considered chewable or by tooth number

Number of foods chewed	0–4	5–9	10–14	15
Independent in ADL Dependent in ADL Percent dependent in ADL	41 17 29.3	143 25 14.9	318 31 8.9	205 10 4.7
Number of intact teeth	0	1–9	10–19	≥20
Independent in ADL Dependent in ADL Percent dependent in ADL	248 44 15.1	214 23 9.7	146 18 11.0	105 8 7.1

Comparisons were made by  $x^2$  tests.

	Dependent in ADL [OR (95% CI)]	P-value
Number of chewable foods		
15	1	
10-14	1.879 (0.863-4.092)	0.1123
5–9	3.333 (1.469–7.561)	0.0040
0–4	7.532 (2.977–19.058)	< 0.0001
Number of intact teeth	× ,	
≥20	1	
10-19	1.513 (0.583-3.931)	0.3950
1–9	1.353 (0.551-3.323)	0.5093
0	1.810 (0.766–4.275)	0.1760

OR, odds ratio; CI, confidence interval.

increased as the number of foods chewed decreased. Prevalence of impaired ADL in individuals capable of chewing 0-4 foods was 7.5 times higher than those chewing 15 foods, and impaired ADL in subjects capable of chewing 5-9 foods was 3.3 times more likely than in those chewing 15. When denture status was added as an independent variable in the logistic regression analysis, impaired ADL status in individuals able to chew 0-4 foods still was 6.9 (95% CI: 2.7-17.5, P < 0.0001) times more prevalent, and prevalence of impaired ADL in those capable of chewing 5-9 foods was 3.2 times (95% CI: 1.4–7.3, P = 0.0055) higher than in those chewing 15 foods. Multiple regression analysis showed that number of chewable foods in each of four different food types was negatively related to dependent ADL status after adjustment for gender, smoking, self oral care, and regular dental and medical treatments (very hard foods to chew;  $\beta = -0.148$ , P < 0.0001: moderately hard to chew;  $\beta = -0.176$ , P < 0.0001: slightly hard to chew;  $\beta = -0.170$ , P < 0.0001: easy to chew;  $\beta = -0.138$ , P = 0.0002). No significant difference in prevalence of poor ADL status could be found between four groups defined by the number of remaining intact teeth, using logistic regression analysis with adjustment for the various confounding factors mentioned above (Table 2). Oral self-care was also related negatively to dependency in ADL after adjusting for confounding factors including chewing ability; dependency was 2.3 times more prevalent in individuals not performing oral self-care than in those performing oral self-care (OR: 2.3; 95% CI: 1.4–3.9, P = 0.0013).

## Discussion

A relationship between poor chewing ability and dependent ADL status in 80-year olds was confirmed by multiple and logistic regression analysis with adjustment for various confounding factors. However, no significant relationship was found between the number of intact teeth and ADL status. These findings suggest that chewing ability but not the number of intact teeth, may contribute to dependent ADL status in elderly individuals. Our findings also suggest that number of chewable foods, but not the different types of foods may be related to ADL status. ST (ST segment on resting 12-lead electrocardiography) depression indicative of myocardial ischemia was linked with poor dentition status in elderly subjects (Takata, 2001). We also recently found an association between chewing ability and physical ability in an 80-year-old population (Takata et al, 2004). Locker et al (2002) found a negative impact of oral disorders upon well-being and life satisfaction in elderly people with a mean age of 83 years. In a study of nursing home residents, subjects capable of chewing also showed better cognitive and functional capacity (Nordenram and Ljunggren, 2002). ADL status appears likely to improve in elderly patients by enhancing chewing ability using appropriate dentures. Our findings are in agreement with those of Catovic et al (2003) who also found, in a group of institutionalized elderly subjects, that ADL correlated with poor condition of fixed and removable dental prostheses.

Morishita *et al* (2001) mailed questionnaires to homebound elderly subjects, finding oral health care to be poorer in subjects with poor ADL performance than in independent elderly individuals. In the present survey, oral self-care also was independently related to favorable ADL status, suggesting that oral care itself may improve ADL in elderly patients.

An '80/20 movement' was recently declared as a goal in Japan, referring to retention of 20 or more teeth at age 80 (Shinsho, 2001). This 80/20 movement includes surveys concerning relationships between general and oral conditions in 80-year-old subjects; the present study was performed as part of this movement. Precision of analysis presumably was enhanced in our survey by limiting subject age to 80 years, as an influence of age could be completely excluded in statistical analysis.

In conclusion, chewing ability but not number of intact teeth, may contribute to independence in ADL among very elderly Japanese individuals.

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