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Self-assessed masticatory ability and hospitalisation costs among the elderly living independently

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SUMMARY The escalating medical costs are a social problem in many countries. Masticatory ability is thought to be related to the general health conditions. The purpose of this study was to show relationships between self-assessed masticatory ability and medical costs among the elderly living independently in community. Data on background factors and self-assessed masticatory ability were collected from 702 Japanese elderly persons by questionnaires. An intra-oral examination was performed to examine the number of remaining teeth. Self-assessed masticatory ability was classified into one of three categories: ability to chew all kinds of food (Good), ability to chew only slightly hard food (Fair) or ability to chew only soft or pureed food (Poor). Data on the annual medical excluding dental costs were obtained from the Japanese National Health Insurance system. The Kruskal–Wallis test was used to examine differences in outpatient costs and hospitalisation costs among the three groups of self-assessed masticatory ability. Univariate unconditional logistic regression models and multivariate logistic regression models were used with medical costs as the dependent variable and self-assessed masticatory ability as the principal independent variable. A significant difference ($P = 0{\cdot}039$) in hospitalisation costs but not outpatient costs was found among the three groups of self-assessed masticatory ability. The multivariate logistic regression analysis showed that severely impaired masticatory ability (Poor) was significantly related to higher costs of hospitalisation. Self-assessed impairment of masticatory ability may be a significant and independent indicator of higher costs of hospitalisation among community-dwelling elderly persons.

KEYWORDS: the elderly, medical costs, hospitalisation, masticatory ability, community

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Introduction

The prolonged life expectancy in Japan has led to an increase in the number of persons aged 65 or over. They constituted 22·7% of the total population in 2009, and their population continues to grow (1). This growth is thought to accompany a shift in medical costs towards elderly persons (2). Japan has a national health insurance system covering the health care costs of most citizens. Public medical insurers spent 34·1 trillion yen, approximately US$360·0 billion, in 2007, and 52·0% of these costs were spent on persons aged 65 or over in Japan (3, 4). The escalating medical costs for older persons are a serious social problem in many other countries as well. Therefore, it is necessary to identify the factors associated with the escalating medical costs among the elderly.

A number of studies have shown that the dental status and masticatory ability are related to the general health status (5–12). Although self-assessed masticatory ability is not objective, it is considered an approximate index that represents the total masticatory function of elderly persons with impaired dental status and is well

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suited for large-scale epidemiological studies because of its simplicity of application (8, 12). Therefore, it can be hypothesised that self-assessed masticatory ability of elderly persons is directly related to their medical costs. The purpose of this study was to show relationships between self-assessed masticatory ability and annual medical costs excluding dental costs among community-dwelling elderly persons.

Materials and methods

Eight hundred eighty-two persons aged 65 or older residing independently underwent a dental health examination sponsored by the public authority in two rural communities (Tomamae and Iwanai) in Hokkaido, the northernmost prefecture of Japan. Persons in hospital, in institutions or in need of long-term care were not included.

Interviews and examinations were performed in Tomamae, over a period of 10 days in July 2004 and in Iwanai over 15 days from August to September 2005. Full details of the study design, recruitment and procedures were discussed previously (8). Of the 882 persons, 36 died and 7 moved away during the follow-up period (1 year after the dental examination). Of living 839 persons, 702 (83·7%) persons were members of the National Health Insurance scheme during the follow-up period, and they were enrolled in this study. Ethical approval was secured from the ethical committee of Hokkaido University Graduate School of Dental Medicine, and written informed consent was obtained from each participant.

Data on age, gender, chronic medical diseases and self-assessed masticatory ability were obtained using questionnaires. Self-assessed masticatory ability was assessed by the following question: 'Can you chew all kinds of food?' The answers were divided into three categories: ability to chew all kinds of food (Good), ability to chew only slightly hard food (Fair), or ability to chew only soft or pureed food (Poor) (8). The participants were classified into one of four categories: none, one, two and three or more diseases, by the number of chronic medical diseases, including hypertension, diabetes mellitus, articular rheumatism, cardiac, cerebrovascular, respiratory, renal and hepatic diseases. However, none had any acute medical condition or were under treatment for malignancy.

The number of remaining teeth was examined by four dentists of the Graduate School of Dental Medicine, Hokkaido University, and assessments of the dental status were calibrated for agreement prior to the survey. The dental status was classified into four categories: no teeth, 1–7 teeth, 8–19 teeth and 20 or over teeth. Height and weight were measured to calculate the body mass index (BMI; weight in kg per height in m^2). The BMI values were classified into three categories according to Takata *et al.* (13): <18·5, 18·5–24·9 and 25 kg m^{-2} or over.

Data on their annual medical costs during the follow-up period were obtained from the National Health Insurance claim history files nd divided into outpatient and hospitalisation costs, excluding dental costs. We divided the annual outpatient costs into three categories: 0–19 999 points, 20 000–39 999 points and 40 000 points or over. The annual hospitalisation costs were also divided into three categories: 0 point, 1–29 999 points and 30 000 points or over. In both classifications, one point represented 10 yen. We determined the cut-off points to divide each medical cost into three categories and used the different cut-off points between the outpatient and hospitalisation costs, in order that percentage distributions of participants were appropriate for logistic analysis we used.

The Kruskal–Wallis test was used to examine the statistical differences in the annual medical costs among the three categories of self-assessed masticatory ability (Good, Fair and Poor). Outpatient and hospitalisation costs were employed as the dependent variables in a univariate unconditional logistic regression analysis, and gender, age, number of chronic medical diseases, BMI, number of remaining teeth and self-assessed masticatory ability were employed as the independent variables. The odds ratio and 95% confidence interval (CI) were calculated for the categories of 20 000–39 999 points and 40 000 points or over compared with the 0–19 999 points category of outpatient costs and for the categories of 1–29 999 points and 30 000 points or over compared with the 0 point category of hospitalisation costs. Further, multivariate logistic regression models were constructed with each medical cost as the dependent variable and self-assessed masticatory ability as the principal independent variable to adjust for age, gender, the number of chronic medical diseases, BMI and the number of present teeth. The level of statistical significance was set at $P = 0{\cdot}05$. The statistical analyses were performed using the SPSS statistical package*.

*11.0J for Windows; SPSS Japan, Tokyo, Japan.

Table 1. Percentage distributions by demographic factors, general and oral health conditions, and medical costs (n = 702, aged 65 or over)

Variables	%
Gender	
Female	57·0
Male	43·0
Age (years)	
65–69	29·1
70–74	31·2
75–79	26·2
80 or over	13·5
No. of chronic medical diseases	
0	26·5
1	37·2
2	29·2
3 or over	7·1
BMI (kg m^{-2})	
<18·5	5·4
18·5–24·9	56·3
25·0 or over	38·3
No. of present teeth	
0	23·2
1–7	20·4
8–19	25·5
20 or over	30·9
Self-assessed masticatory ability	
Good	58·8
Fair	33·0
Poor	8·1
Outpatient medical costs (points*)	
0–19 999	44·4
20 000–39 999	30·2
40 000 or over	25·4
Hospitalisation costs (points)	
0	84·3
1–29 999	6·1
30 000 or over	9·5

BMI, body mass index.
*One point = 10 yen.

Results

Percentage distributions by the demographic factors, general health status, oral conditions and medical costs are shown in Table 1. Comparisons of the annual medical costs according to self-assessed masticatory ability are shown in Table 2. A significant difference in the hospitalisation costs, but not in the outpatient costs, was found among the three groups of self-assessed masticatory ability (P = 0·039).

Relationships between the each independent variable and the annual medical costs were analyzed using univariate unconditional logistic models (Table 3) and further analyzed by using multivariate logistic regression models (Table 4). Age (80 years or over) and the number of chronic medical diseases were significantly and independently related to the outpatient costs (Table 4). In the case of hospitalisation costs, age (75–79 years) and gender (male) were significantly and independently related to the 1–29 999 points category, and self-assessed severe impairment of masticatory ability (Poor) was significantly and independently related to the 30 000 points or over category (Table 4). The OR of the 30 000 points or over category was 3·04 (95% CI = 1·32–7·00, $P < 0·01$) for the participants with Poor of self-assessed masticatory ability, compared with Good as the reference. Further, not only the number of chronic medical diseases but also the type of each chronic medical disease was adjusted by a multivariate logistic regression model in which each chronic medical disease (presence versus absence) was employed as the independent variable. In this model, the significant relationships between self-assessed impairment of masticatory ability and hospitalisation costs were again established (data not shown).

Table 2. Comparisons of the annual medical costs according to self-assessed masticatory ability (n = 702)

	n	%	Outpatient costs Means ± s.d. ($\times 10^4$ points)	Hospitalisation costs Means ± s.d. ($\times 10^4$ points)
Self-assessed masticatory ability				
Good	413	58·8	2·88 ± 3·45*	1·37 ± 5·64**
Fair	232	33·0	2·78 ± 2·62	1·56 ± 6·22
Poor	57	8·1	3·15 ± 2·76	2·25 ± 5·80

*P = 0·416, **P = 0·039 (Kruskal–Wallis test).

Discussion

The present study showed that self-assessed severe impairment of masticatory ability was significantly related to higher annual costs of hospitalisation, after adjusting for age, gender, the number of chronic medical diseases, BMI and the number of present teeth, among community-dwelling elderly persons. This study has several limitations. First, the study applied a cross-sectional design, and causal relationships were not elucidated. Second, the causal diseases responsible for hospitalisation in each case were not studied in detail. Finally, the follow-up period was limited to only 1 year.

Table 3. Results of univariate unconditional logistic analysis for the medical costs (n = 702)

	Outpatient costs (points)†		Hospitalisation costs (points)‡	
Independent variables	20 000–39 999 OR (95% CI)	40 000 or over OR (95% CI)	1–29 999 OR (95% CI)	30 000 or over OR (95% CI)
Age (years)				
65–69	1·00	1·00	1·00	1·00
70–74	1·34 (0·86–2·10)	1·35 (0·82–2·21)	1·44 (0·60–3·44)	1·66 (0·85–3·25)
75–79	1·89 (1·17–3·03)**	2·26 (1·36–3·75)**	2·64 (1·16–6·01)*	1·75 (0·87–3·52)
80 or over	1·79 (0·99–3·25)	2·75 (1·51–5·03)**	0·46 (0·10–2·17)	0·83 (0·31–2·21)
Gender				
Female	1·00	1·00	1·00	1·00
Male	0·83 (0·58–1·18)	0·76 (0·52–1·10)	1·60 (0·86–3·00)	1·19 (0·72–1·98)
No. of chronic medical diseases				
0	1·00	1·00	1·00	1·00
1	12·33 (6·70–22·67)***	9·06 (4·28–19·18)***	0·65 (0·27–1·55)	1·22 (0·61–2·42)
2	21·30 (10·95–41·43)***	39·31 (18·27–84·60)***	1·62 (0·74–3·53)	1·69 (0·85–3·39)
3 or over	29·11 (9·76–86·82)***	87·54 (29·00–264·54)***	1·43 (0·43–4·72)	1·42 (0·48–4·12)
BMI (kg m^{-2})				
<18·5	0·59 (0·24–1·44)	1·11 (0·51–2·40)	0·46 (0·06–3·53)	1·07 (0·36–3·18)
18·5–24·9	1·0	1·0	1·0	1·0
25·0 or over	1·52 (1·06–2·20)*	1·43 (0·97–2·10)	1·36 (0·73–2·55)	0·98 (0·58–1·68)
No. of present teeth				
0	0·99 (0·61–1·61)	1·42 (0·85–2·35)	1·28 (0·51–3·24)	1·65 (0·86–3·17)
1–7	1·64 (1·00–2·68)*	1·67 (0·97–2·87)	1·85 (0·78–4·41)	0·73 (0·32–1·67)
8–19	1·12 (0·70–1·78)	1·46 (0·89–2·40)	1·54 (0·63–3·58)	1·12 (0·56–2·33)
20 or over	1·0	1·0	1·0	1·0
Self-assessed masticatory ability				
Good	1·00	1·00	1·00	1·00
Fair	1·18 (0·81–1·73)	1·10 (0·74–1·65)	1·76 (0·92–3·37)	1·03 (0·58–1·82)
Poor	1·44 (0·73–2·83)	1·81 (0·92–3·54)	1·70 (0·56–5·21)	2·60 (1·23–5·48)*

OR, odds ratio; CI, confidence interval; BMI, body mass index.
†OR and 95% CI were calculated compared with the 0–19999 points category of outpatient costs, ‡and the zero points category of hospitalisation costs.
*P < 0·05, **P < 0·01, ***P < 0·001.

However, to our limited knowledge, the findings are the first report about the relationships between subjective assessment of masticatory ability and hospitalisation costs among community-dwelling elderly persons.

The significant and strong relationship between the number of chronic medical diseases and the outpatient costs in this study is easily understandable, because outpatient costs include mainly the costs of medical examination, blood tests, diagnostic imaging and prescription for each chronic disease. Such a relationship was not established in the case of hospitalisation costs. It is necessary to consider other factors responsible for higher costs of hospitalisation, including an acute change in chronic medical conditions, occurrence of an acute disease and adverse outcomes following hospitalisation (i.e., prolonged hospital stay).

The main reasons for emergency admissions of the elderly are reportedly cardiopulmonary diseases, neuropsychiatric disorders, falls, general non-specific symptoms and the risk factors associated with an acute episode of chronic diseases, living alone and prior hospitalisation within 6 months (14). The length of hospital stay is influenced not only by the physical status, including functional status, illness severity, nutritional status, hospitalisation related-complications such as nosocomial infection, but also by the mental status such as cognitive function and social issues such as lack of an identified caregiver (15, 16). Frailty, a common problem among the elderly is a state of high vulnerability for adverse health outcomes, including disability, dependency, falls, need for long-term care and mortality (17, 18). These conditions are considered

Table 4. Results of multivariate logistic regression analysis for the medical costs (n = 702)

	Outpatient costs (points)†		Hospitalisation costs (points)‡	
Independent variables	20 000–39 999 OR (95% CI)	40 000 or over OR (95% CI)	1–29 999 OR (95% CI)	30 000 or over OR (95% CI)
Age (years)				
65–69	1·00	1·00	1·00	1·00
70–74	1·30 (0·77–2·19)	1·25 (0·69–2·26)	1·37 (0·56–3·36)	1·55 (0·78–3·10)
75–79	1·50 (0·86–2·66)	1·68 (0·90–3·13)	2·66 (1·09–6·54)*	1·64 (0·78–3·46)
80 or over	2·16 (1·03–4·51)*	2·79 (1·27–6·13)*	0·37 (0·07–1·89)	0·57 (0·20–1·64)
Gender				
Female	1·00	1·00	1·00	1·00
Male	0·84 (0·56–1·26)	0·81 (0·52–1·27)	2·05 (1·07–3·92)*	1·34 (0·79–2·27)
No. of chronic medical diseases				
0	1·00	1·00	1·00	1·00
1	12·39 (6·65–23·07)***	9·56 (4·44–20·56)***	0·46 (0·18–1·14)	1·12 (0·55–2·29)
2	21·01 (10·64–41·49)***	39·95 (18·22–87·56)***	1·26 (0·55–2·87)	1·62 (0·79–3·33)
3 or over	27·59 (9·15–83·23)***	89·02 (28·93–273·92)***	1·06 (0·30–3·73)	1·25 (0·41–3·85)
BMI (kg m^{-2})				
<18·5	0·57 (0·21–1·55)	1·03 (0·40–2·63)	0·39 (0·05–3·11)	1·05 (0·35–3·19)
18·5–24·9	1·0	1·0	1·0	1·0
25·0 or over	1·22 (0·80–1·85)	1·10 (0·69–1·75)	1·64 (0·84–3·20)	1·07 (0·62–1·87)
No. of present teeth				
0	0·61 (0·32–1·14)	0·76 (0·38–1·51)	1·14 (0·40–3·29)	1·48 (0·69–3·16)
1–7	1·04 (0·55–1·96)	1·12 (0·55–2·27)	1·54 (0·55–4·28)	0·60 (0·24–1·51)
8–19	1·07 (0·60–1·90)	1·46 (0·78–2·73)	1·27 (0·50–3·26)	0·98 (0·47–2·05)
20 or over	1·0	1·0	1·0	1·0
Self-assessed masticatory ability				
Good	1·00	1·00	1·00	1·00
Fair	0·94 (0·59–1·51)	0·77 (0·46–1·30)	1·57 (0·76–3·27)	1·05 (0·56–1·98)
Poor	1·38 (0·62–3·09)	1·40 (0·60–3·26)	2·17 (0·63–7·48)	3·04 (1·32–7·00)**

OR, odds ratio; CI, confidence interval; BMI, body mass index.
†OR and 95% CI were calculated compared with the 0–19999 points category of outpatient costs, ‡and the zero points category of hospitalisation costs.
*P < 0·05, **P < 0·01, ***P < 0·001.

contributing factors to poor outcomes of hospitalisation among the elderly (16, 19). Therefore, hospitalisation costs may be influenced by multiple, interrelated factors including physical, sociodemographic and psychological factors as well as the health conscious behaviour of the elderly. The present findings suggest that masticatory ability may be associated with these factors, consequently influencing the hospitalisation costs for each individual.

Several community-based epidemiological surveys have shown that self-assessed masticatory ability is significantly related to sociodemographic factors, physical and medical conditions, psychological status and dental health conscious behaviour and dental status among elderly persons (20, 21). Poor general health conditions may influence the dental health behaviour and dental status, contributing to self-assessed impairment of masticatory ability, or self-assessed masticatory ability may be incidental to poor general health conditions. Österberg *et al.* (20) have suggested that there exist a group of elderly persons who reported several functional and health problems including impaired masticatory ability. Therefore, it can be hypothesised that elderly persons with worse masticatory ability have higher costs of hospitalisation because of their poor general health conditions and poor psychosocial status.

A number of studies have shown that the dentition status and masticatory ability are significantly related to the nutrient intake and nutritional status of the elderly (5–7).

Subjective assessment of masticatory ability is also significantly related to physical performance and high-

er-level functional capacity (8–11). Furthermore, subjective assessment of masticatory ability has been shown to be an independent risk factor for cardiovascular mortality and 9-year mortality among community-dwelling elderly persons (12, 22). Although the detailed mechanisms of these relationships were not elucidated, the masticatory ability was considered a candidate factor influencing the general health conditions in those studies. According to a systematic literature review of the outcomes of older hospitalised patients, poor nutrition and functional status are significant predictors of prolonged hospitalisation (16). Consequently, the findings of the present study may be explained by the possibility that severely impaired masticatory ability influences the general health conditions and then contributes to instability of chronic medical conditions, occurrence of an acute severe disease and adverse outcomes following hospitalisation, all responsible for higher costs of hospitalisation.

The medical costs for elderly persons continue to escalate annually; they are mostly responsible for the increased national medical expenditure and may be influenced by hospitalisation costs. The findings of this study suggest that severely impaired masticatory ability may be a candidate factor associated with the rising medical costs for the community-dwelling elderly.

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