used an objective measure of disability. The LTCI certification is determined on the basis of strictly established uniform rules throughout Japan[24, 25]. The certification correlates with not only physical function but also cognitive function[24, 25].

Only two prospective studies have evaluated the relationship of PAD with loss of mobility. Mc Dermott et al. reported that during 24 months of follow-up, the subjects with PAD had a higher rate of mobility loss than those without PAD[8]. They defined mobility loss as being unable to walk a quarter mile or walk up and down one flight of stairs without assistance. However, in their first paper, they did not adjust for baseline physical function[8]. They also analyzed the association between PAD and mobility loss after 50 months of follow-up including adjustments for baseline physical function[9]. Their study indicated that the participants with PAD had greater mobility loss than those without PAD before adjustments for baseline physical function (HR = 1.63, p-value: 0.036), and that this association was attenuated significantly after the adjustments for baseline physical function (HR = 1.00-1.53, p-value: $\geqq 0.094$)[9]. From these results, they concluded that the association between PAD and mobility loss was explained by poor baseline functional performance[9].

In the present study, we investigated whether PAD was associated with incident disability independent of baseline physical function. After adjustments for baseline physical function, the risk was substantially attenuated. We considered that our findings were consistent with those of Mc Dermott *et al.* in terms of baseline physical function playing an important role in the relationship between PAD and disability. However, in our study, the HR of incident disability was still higher in the participants with PAD than in those without PAD. Additionally, the association of PAD with disability or mortality was statistically significant when we used a composite outcome of death and disability. Furthermore, compared with the group that showed high physical function without PAD, the group with higher physical function with PAD also had a higher HR of incident disability. The discrepancy between our study and that of Mc Dermott *et al.* might have been due to the difference in the endpoint, i.e. they used mobility loss and we used a comprehensive endpoint, LTCI certification. Because patients with PAD are reported to have a higher risk of incident stroke or dementia, especially, vascular dementia, not only physical function but also these pathways might contribute to the increase in risk[3-6]. However, because we did not clarify the reason for incident disability, we were unable to confirm whether the risk increase was explainable by stroke or dementia.

Our study also had some limitations. First, we used the date of LTCI-certification as the date of incident disability. Thus, the date of incident disability would be later than the true date. However, as with other diseases, it is hard to correctly estimate the date of incident disability. Therefore, we considered our approach using objective information on incident disability assessed by LTCI certification to be acceptable. The prevalence of PAD is lower in Japan than in Europe or the United States[18, 26]. Furthermore, we excluded participants already been certificated as having a disability at the baseline. Therefore, the prevalence of PAD in this study was small (about 4.5%). This low prevalence limited the statistical power of the study. Larger prospective studies in Japan will be required to corroborate our findings.

In conclusion, we have found that PAD is predictive of incident disability. The high risk of incident disability in PAD participants cannot be fully explained by baseline physical function. Therefore, we conducted that PAD is an important predictor of disability even if the level of baseline physical function is high.

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COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

The association between neighborhood social capital and self-reported dentate status in elderly Japanese – The Ohsaki Cohort 2006 Study

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Abstract – *Objectives:* Little is known about the influence of social capital on dental health. The aim of the present cross-sectional study was to determine the association between neighborhood social capital, individual social networks and social support and the number of remaining teeth in elderly Japanese. *Methods:* In December 2006, self-administered questionnaires were sent to 31 237 eligible community-dwelling individuals (response rate: 73.9%). Included in the analysis were 21 736 participants. Five neighborhood social capital variables were calculated from individual civic networks, sports and hobby networks, volunteer networks, friendship networks and social support variables. We used multilevel logistic regression models to estimate the odds ratio (OR) of having 20 or more teeth according to neighborhood social capital variables with adjustment for sex, age, individual social networks and social support, educational attainment, neighborhood educational level, dental health behavior, smoking status, history of diabetes and self-rated health. *Results:* The average age of the participants was 74.9 (standard deviation; 6.6) years, and 28.5% of them had 20 or more teeth. In the univariate multilevel model, there were statistically significant associations between neighborhood sports and hobby networks, friendship networks and self-reported dentate status. In the multivariable multilevel model, compared with participants living in lowest friendship network neighborhoods, those living in highest friendship network neighborhoods had an OR 1.17 (95% confidence interval, 1.04–1.30) times higher for having 20 or more teeth. *Conclusions:* There is a significant association between one network aspect of neighborhood social capital and individual dentate status regardless of individual social networks and social support.

Key words: dental status; multilevel analysis; remaining teeth; social capital; social epidemiology

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Increasing evidence suggests that a broad range of social determinants, not only biomedical factors, influence general health (1). Recent studies have revealed that social capital, a social determinant, has an important influence on health. Social capital has been defined as the features of social organization, such as civic participation, norms of reciprocity, and trust in others, that facilitate cooperation for mutual benefit (2). Social capital as a property of communities is distinguished from social capital as an attribute of individuals, which approximates the concepts of social support and

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social networks (3). It can be broadly defined as the density of trust, networks, or cooperation within a given community (4). In epidemiological studies, community-level social capital is often measured as an aggregated index of individual social networks or social support in each neighborhood (5), and a multilevel model is applied to distinguish the effects of individual- and community-level social capital on individual health (6).

Interest has also been focused on the importance of social determinants for oral health (7). However, only a few studies have examined the association between social capital and oral health. Previous cross-sectional studies examined the associations between social capital and oral health among 1302 students aged 14–15 years in Brazil: Empowerment as a social capital variable was investigated for its relationship with oral trauma (8) and dental caries (9). Another study examined the relationship between social capital and deciduous caries in 3301 3-year-old children: Multilevel analysis showed a beneficial contextual effect of social cohesion, one of the dimensions of social capital, on occurrence of deciduous caries (10). Association between the horizontal and vertical dimensions of social capital and the number of remaining teeth of 5560 elderly people was also examined, results showing a beneficial association between horizontal social capital and the number of remaining teeth (11).

Previous studies have suggested positive contextual effects on dental health. Both individual social networks and social support may mediate the association between neighborhood social capital and oral health. However, no study has simultaneously examined the association between neighborhood social capital, individual social networks and social support and oral health. These social determinants influence health status through subsequent life trajectories (12). The number of remaining teeth in elderly reflects the accumulative experience of dental caries, periodontal disease, dental injury, dental treatment and dental health behavior through their life-course. The aim of the present study was to determine the association between neighborhood social capital, individual social networks and social support and the number of remaining teeth in elderly Japanese.

Materials and methods

Setting and participants

This was a prospective cohort study, named The Ohsaki Cohort 2006 study, for which we analyzed cross-sectional data from the baseline survey of the study (13). The population and population density of Ohsaki city in 2005 were 138 141 and 173 person/km^2, respectively. The average age of the total resident population of the Ohsaki city was 44.2 years; 42.3 for men and 45.9 for women. Twenty-three percent of the population was 65 years or older. Among men, 19% were 65 years of age or older, while among women the rate was 27%. There were 69 208 workers; 19% in the manufacturing industry, 16% in the retail industry, 11% in the agricultural industry, 10% in the construction industry, and 8% in the medical and welfare industry. There were 15 hospitals, 85 clinics and 52 dental clinics.

There were two kinds of questionnaires in the Ohsaki cohort study: a questionnaire for persons aged 40–64 years and one for persons 65 years or older (13). Our study analyzed data obtained from those aged 65 years or older. The source population for the baseline survey comprised community-dwelling individuals aged 65 years or over, who were included in the Residential Registry for Ohsaki City. The Residential Registry identified 31 694 residents aged 65 years or older (12 750 men; 18 944 women) in Ohsaki city. The baseline survey was conducted from December 1 to December 15, 2006. A questionnaire was distributed by the heads of individual administrative districts to individual households and collected by mail. Of the 31 694 persons age 65 or over, 457 were found to be ineligible due to death, immigration, or hospitalization, yielding an eligible population of 31 237. The baseline questionnaires were collected from 23 394 persons, and valid responses were received from 23 091 (response rate: 73.9%, 9605 men and 13 486 women), who finally formed the study population of cohort participants. We excluded participants who did not respond to the items concerning administrative district (n = 252) and the number of remaining teeth (n = 1607). Consequently, the analyzed population consisted of 21 736 participants.

The Ohsaki city defined the municipal ordinance as administrative districts to improve efficiency of administration and citizens' welfare. The subjects were nested in 356 administrative districts, which we defined as neighborhoods. The analyzed population in each 356 administrative districts distributed as follows: 34 people = 25th percentile, 54 people = 50th percentile, 80 people = 75 percentile. The range of the response rates among the neighborhoods was relatively narrow. The distribution of the response rates of the whole Ohsaki cohort study including the respondents aged 40–64 among the 356 administrative districts was as follows: 60.4% = 25th percentile, 67.1% = 50th percentile, 73.0% = 75 percentile.

The study protocol was reviewed and approved by the Ethics Committee of Tohoku University Graduate School of Medicine.

Baseline survey

The baseline questionnaires consisted of the following details in sequence: (i) the frailty checklist (i.e. the Kihon Checklist in Japanese) – a tool developed to screen for frailty – (14), (ii) history of diseases, (iii) health status over the last year, (iv) smoking status, (v) alcohol drinking status, (vi) dietary habits (15), (vii) past body weight, height and educational status, (viii) health status in general, (ix) pain, (x) daily activities, (xi) sports and exercise (16, 17), (xii) psychological distress (K6) (18, 19), (xiii) social support (20), (xiv) participation in community activities and (xv) dental status.

Measurement of individual-level variables

Participation in community activities was used as a source of social network variables. Four questions composed of four kinds of networks, namely, civic networks, sports and hobby networks, volunteer networks and friendship networks, were included as follows: (i) civic networks, for example, participation in civic activities, resident and neighborhood associations and so on, (ii) sports and hobby networks, for example, participation in sports activities, culture activities, lifelong learning and so on, (iii) volunteer networks, for example, participation in volunteer activities, welfare activities, sports coaching, disaster and crime prevention, environment activities and (iv) friendship networks, for example, participation in class reunions, social gatherings and so on. Choices as to the frequency of participation in each of the four kinds of network were 'never', 'several times a year', 'once a month', 'a few times a month', 'once a week', 'a few times a week' and 'more than 4 times a week'. When we included the responses in the models, they were divided into three categories as follows: (i) lowest social network (never participated), (ii) medium social network (participated several times a year) and (iii) highest social network (participated at least once a month).

The degree of social support available to each person was assessed by asking the following five questions (20): (i) Do you have someone with whom you can consult when you are in trouble?, (ii) Do you have someone with whom you can consult when your physical condition is not good?, (iii) Do you have someone who can help you with your daily housework?, (iv) Do you have someone who can take you to a hospital when you do not feel well? and (v) Do you have someone who can take care of you when you are ill in bed? This social support questionnaire consisted of five questions, each requiring a 'yes' or 'no' answer. This questionnaire was only available in Japanese. The validity and reliability of the questionnaire were not evaluated. The percentages of the respondents who answered 'no' to each five question were low: (i) 9.5%, (ii) 6.1%, (iii) 13.5%, (iv) 6.9% and (v) 12.7%. Therefore we aggregated the five questions into one social support variable, which had three categories as follows: (i) lowest social support (responding 'yes' to less than three questions), (ii) medium social support (responding 'yes' to four questions) and (iii) highest social support (responding 'yes' to five questions).

The self-reported number of remaining teeth was used as an index of the dentate status. Retention of a minimum of 20 functional teeth at age 65 years or over was an oral health goal specified in the WHO and Federation Dentaire Internationale 'Global Goals for Oral Health in the year 2000' (21). The goal set by the Japan Dental Association was retention of a minimum of 20 functional teeth at the age of 80. Therefore, the number of remaining teeth, the outcome variable of this study, was used as a dichotomous variable: either ≥20 teeth or ≤19 teeth.

We also asked about dental health behavior: daily frequency of daily tooth brushing (free-answer question divided into three categories as follows: (i) less than 2 times, (ii) 2 times and (iii) 3 times or more), duration of tooth brushing at one time (<3 min, 3–5 min, 5 min or more), the use of dental floss or interdental brushes (yes, no), having a dental check-up at least once a year (yes, no), and frequency of intake of sweet foods (almost never, 1–2 times per month, 1–2 times per week, 3–4 times per week, almost every day and divided into three categories as follows: (i) 1–2 times per month or less, (ii) 1–4 times per week and (iii) almost every day). Smoking status (never, former, current) and history of diabetes (yes, no) were also investigated as risk factors of periodontal disease. As people in good health may tend to have good social networks, and people in poor health may tend to have much social support, the questionnaire also asked about self-rated health (excellent, good, fair, poor, and very poor and divided into three categories as follows: (i) good, (ii) fair and (iii) poor) as a covariate for social networks and social support. We also investigated the number of years of educational attainment since 6 years of age as an indicator of socioeconomic status. The number of years were divided into four categories as follows: (i) ≤9 years, (ii) 10–12 years, (iii) 13–15 years and (iv) ≥16 years.

Measurement of neighborhood-level variables

Social capital can be broken down into cognitive and structural components. We used social support and social network aspects of social capital, because perceived social support is regarded as a part of cognitive social capital (5) and social network is regarded as a part of structural social capital (5).

We created neighborhood variables by aggregating individual level data. Therefore, to determine the association between neighborhood social capital and health outcome, we adjusted for individual social network and support variables (22). All neighborhood-level variables were calculated on the basis of 356 administrative districts.

We focused on the proportion of respondents who had one or more social networks. The proportions of participants in each neighborhood who answered social network questions with answers other than 'never' were calculated for each of the four kinds of networks. The proportion of participants in each neighborhood who answered 'yes' to all five social support questions was also calculated. The neighborhoods were divided into three categories (lowest, medium or highest) based on the 33rd and 66th percentiles of each of the four social network rates and one social support rate. These five variables were used as neighborhood social capital variables.

Both individual and neighborhood socioeconomic status were considered to be associated with social capital (23). Therefore, both individual and neighborhood educational variables were included in the model. Neighborhood educational level was used as an index of neighborhood socioeconomic status. The mean number of years of education was calculated for each neighborhood. The neighborhoods were divided into three categories (lowest, medium, or highest) based on the 33rd and 66th percentiles of the average number of years of education.

Within Japan, there is no community fluoridated water supply. Therefore, we did not include water fluoridation as a variable in the multilevel models.

Analysis

In our data set, individuals (first-level) were nested in communities (second-level). We applied multilevel models (24, 25) to estimate the association of neighborhood social capital, individual social networks and social support with individual dentate status, controlling for one another, the contextual effect of neighborhood educational level and the compositional effects of individual educational attainment, health behavior and self-rated health. Multilevel logistic regression models with random intercepts and fixed slopes were estimated using the MLwiN 2.10 software package (26). The number of remaining teeth (≥20 or ≤19) was used as the outcome variable. Individual and neighborhood fixed parameters were converted to odds ratios (OR) with 95% confidence intervals (95% CI). In model 1, adjustments were made for all neighborhood social capital variables simultaneously to check the fixed and random parameters. In model 2, we included sex, age, all neighborhood social capital variables, educational level, individual social networks and social support and educational attainment variables simultaneously. In model 3, adjustments were made for sex, age, and all explanatory variables simultaneously. The univariate multilevel OR and random parameter of the intercept-only model were also estimated.

Results

The average age of the 21 736 participants (9126 male and 12 610 female) in the 356 administrative neighborhoods was 74.9 (standard deviation; 6.6) years. The prevalence of respondents having 20 or more teeth and that of those having 19 or less teeth were 28.5% (95% confidence interval; 27.9–29.1) and 71.5% (95% CI; 70.9–72.1), respectively.

Table 1 shows the distribution and univariate association between explanation variables and dentate status. Univariate OR were calculated by multilevel logistic regression analyses. There were statistically significant associations between neighborhood sports and hobby networks, friendship networks, educational level and dentate status. Four individual social network variables, educational attainment, all health behavior variables,

Table 1. Distribution of characteristics of individual- and neighborhood-level variables and univariate multilevel OR for remaining teeth

Variables		No. of participants who had 20 or more teeth (%)	No. of participants who had 19 or less teeth (%)	Univariate multilevel OR (95% CI)	*P*-value
Neighborhood-level variables					
Social capital					
Civic network	Lowest	2113 (28.5)	5289 (71.5)	1.00 (referent)	
	Medium	2030 (28.5)	5090 (71.5)	1.00 (1.00–1.00)	0.964
	Highest	2054 (28.5)	5160 (71.5)	1.03 (0.93–1.14)	0.568
Sports and hobby network	Lowest	1808 (25.1)	5407 (74.9)	1.00 (referent)	
	Medium	2089 (28.8)	5160 (71.2)	1.22 (1.10–1.35)	<0.001
	Highest	2300 (31.6)	4972 (68.4)	1.37 (1.24–1.51)	<0.001
Volunteer network	Lowest	2026 (27.4)	5366 (72.6)	1.00 (referent)	
	Medium	2084 (28.9)	5134 (71.1)	1.07 (0.97–1.18)	0.181
	Highest	2087 (29.3)	5039 (70.7)	1.10 (0.99–1.22)	0.070
Friendship network	Lowest	1798 (25.0)	5394 (75.0)	1.00 (referent)	
	Medium	2074 (28.5)	5195 (71.5)	1.19 (1.08–1.31)	<0.001
	Highest	2325 (32.0)	4950 (68.0)	1.41 (1.28–1.56)	<0.001
Social support	Lowest	2079 (28.4)	5229 (71.6)	1.00 (referent)	
	Medium	2085 (28.8)	5163 (71.2)	1.04 (0.93–1.17)	0.509
	Highest	2033 (28.3)	5147 (71.7)	1.00 (1.00–1.00)	0.982
Neighborhood educational level	Lowest	1744 (24.3)	5429 (75.7)	1.00 (referent)	
	Medium	2086 (28.6)	5212 (71.4)	1.23 (1.12–1.35)	<0.001
	Highest	2367 (32.6)	4898 (67.4)	1.49 (1.36–1.64)	<0.001
Individual-level variables					
Social network					
Civic network	Lowest	2677 (25.1)	7999 (74.9)	1.00 (referent)	
	Medium	1151 (32.9)	2347 (67.1)	1.49 (1.37–1.62)	<0.001
	Highest	1717 (36.5)	2982 (63.5)	1.76 (1.63–1.90)	<0.001
Sports and hobby network	Lowest	2577 (24.0)	8154 (76.0)	1.00 (referent)	
	Medium	643 (33.6)	1270 (66.4)	1.61 (1.45–1.79)	<0.001
	Highest	2264 (38.2)	3655 (61.8)	1.93 (1.80–2.07)	<0.001
Volunteer network	Lowest	3390 (26.1)	9614 (73.9)	1.00 (referent)	
	Medium	885 (35.8)	1584 (64.2)	1.61 (1.47–1.76)	<0.001
	Highest	1057 (41.4)	1494 (58.6)	2.01 (1.84–2.20)	<0.001
Friendship network	Lowest	2383 (23.6)	7698 (76.4)	1.00 (referent)	
	Medium	2157 (36.3)	3777 (63.7)	1.84 (1.71–1.98)	<0.001
	Highest	700 (38.7)	1108 (61.3)	2.02 (1.82–2.25)	<0.001
Social support	Lowest	903 (28.3)	2290 (71.7)	1.00 (referent)	
	Medium	672 (27.3)	1792 (72.7)	0.96 (0.85–1.08)	0.493
	Highest	4558 (28.9)	11 220 (71.1)	1.04 (0.95–1.14)	0.383
Educational attainment	≤9 years	1534 (23.3)	5063 (76.7)	1.00 (referent)	
	10–12 years	2522 (30.4)	5787 (69.6)	1.41 (1.31–1.52)	<0.001
	13–15 years	1283 (34.3)	2458 (65.7)	1.69 (1.55–1.85)	<0.001
	≥16 years	474 (41.1)	680 (58.9)	2.18 (1.91–2.49)	<0.001
Age	65–69	2348 (45.3)	2834 (54.7)	1.00 (referent)	
	70–74	2088 (33.6)	4118 (66.4)	0.61 (0.57–0.66)	<0.001
	75–79	1168 (22.2)	4099 (77.8)	0.34 (0.32–0.38)	<0.001
	80–84	431 (13.8)	2687 (86.2)	0.19 (0.17–0.22)	<0.001
	≥85	162 (8.3)	1801 (91.7)	0.11 (0.09–0.13)	<0.001
Sex	Female	3309 (26.2)	9301 (73.8)	1.00 (referent)	
	Male	2888 (31.6)	6238 (68.4)	1.30 (1.22–1.38)	<0.001
Health behavior					
Daily frequency of toothbrushing	< 2 times	1986 (23.9)	6327 (76.1)	1.00 (referent)	
	2 times	2649 (34.6)	5018 (65.4)	1.65 (1.54–1.77)	<0.001
	≥3 times	1213 (31.9)	2588 (68.1)	1.45 (1.33–1.58)	<0.001
Brushing time (minutes)	<3 min	3243 (25.3)	9584 (74.7)	1.00 (referent)	
	3–5 min	2258 (37.2)	3818 (62.8)	1.74 (1.63–1.86)	<0.001
	≥5 min	599 (46.1)	700 (53.9)	2.50 (2.22–2.81)	<0.001
Use of dental floss or interdental brushes	No	4784 (25.0)	14 318 (75.0)	1.00 (referent)	
	Yes	1413 (53.6)	1221 (46.4)	3.39 (3.12–3.69)	<0.001

Table 1. Continued

Variables		No. of participants who had 20 or more teeth (%)	No. of participants who had 19 or less teeth (%)	Univariate multilevel OR (95% CI)	P-value
Dental check-up at least once a year	No	3697 (25.3)	10 937 (74.7)	1.00 (referent)	<0.001
	Yes	2292 (40.6)	3355 (59.4)	2.00 (1.87–2.14)	<0.001
Frequency of intake of sweet foods	Almost every day	813 (22.8)	2747 (77.2)	1.00 (referent)	
	1–4 times/ week	2984 (29.5)	7117 (70.5)	1.41 (1.29–1.54)	<0.001
	≤1–2 times/ month	1961 (31.7)	4225 (68.3)	1.56 (1.42–1.72)	<0.001
Smoking status	Current	592 (24.1)	1861 (75.9)	1.00 (referent)	
	Past	1408 (28.3)	3574 (71.7)	1.23 (1.10–1.38)	<0.001
	Never	3453 (30.2)	7964 (69.8)	1.38 (1.25–1.53)	<0.001
History of diabetes	Yes	671 (25.7)	1943 (74.3)	1.00 (referent)	
	No	5526 (28.9)	13 596 (71.1)	1.20 (1.09–1.32)	<0.001
Self-rated health	Poor	1006 (21.6)	3655 (78.4)	1.00 (referent)	
	Fair	2985 (29.3)	7211 (70.7)	1.51 (1.39–1.64)	<0.001
	Good	2138 (32.6)	4416 (67.4)	1.75 (1.60–1.91)	<0.001

history of diabetes and self-rated health also showed significant associations.

We compared the characteristics of participants in the lowest and highest categories of neighborhood social capital, individual social networks and support variables (Table 2). We showed the percentage of participants within one category of each variable: for example, 41.6% of male participants were included in the lowest civic network category. In contrast, 59.4% (not shown in the table) of female participants were included in the lowest civic network category. There were no marked differences between the civic network aspects of social capital and the characteristics of the participants. A higher proportion of participants residing in the highest sports and hobby network neighborhoods and highest friendship network neighborhoods had 20 or more teeth, lived in the highest educational level neighborhoods, and had better oral health behavior, except for the frequency of intake of sweet foods. A higher proportion of participants residing in the highest volunteer network neighborhoods lived in the highest educational level neighborhoods. There were no marked differences between the social support aspects of social capital and the characteristics of the participants. A higher proportion of participants in the highest category of civic networks had 20 or more teeth, had a longer period of education, had better oral health behavior except for the frequency of intake of sweet foods, and had good self-rated health. A higher proportion of participants in the highest category of sports and hobby networks, volunteer networks and friendship networks was male, had 20 or more teeth, lived in neighborhoods with a higher educational level, had a longer period of education, had better oral health behavior except for the frequency of intake of sweet foods, and had good self-rated health. A higher proportion of participants in the highest category of social support had good self-rated health.

Table 3 shows the results of multivariable multilevel logistic regression analyses. Model 1 included all neighborhood social capital variables simultaneously. There were beneficial statistically significant associations between neighborhood sports and hobby networks, friendship networks and dentate status. Model 2 included sex, age, all neighborhood social capital variables, educational level, individual social networks and social support and educational attainment variables simultaneously. After adjusting for neighborhood educational level, individual social networks, social support and education attainment, neighborhood friendship network variable still had a significant association with dentate status. Model 3 adjusted for sex, age, and all explanatory variables simultaneously. Compared with the participants living in lowest friendship network neighborhoods, those living in medium friendship network neighborhoods had an OR 1.10 times higher for having 20 or more teeth and those living in highest friendship network neighborhoods had an OR 1.17 times higher for having 20 or more teeth. Compared with the participants living in the lowest educational level neighborhoods, those living in the highest educational level neighborhoods had an OR 1.17 times higher for having 20 or more teeth.

Table 2. Demographical distribution of lowest and highest categories of neighborhood social capital, individual social networks and social support variables

	Civic network		Sports and hobby network		Volunteer network		Friendship network		Social support	
	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest
Neighborhood social capital variables										
Number of participants	7402	7214	7215	7272	7392	7126	7192	7275	7308	7180
Age, year, mean ± SD	74.9 ± 6.6	75.1 ± 6.6	75.4 ± 6.6	74.5 ± 6.5	75.1 ± 6.6	74.7 ± 6.6	75.4 ± 6.7	74.5 ± 6.5	74.7 ± 6.5	75.2 ± 6.7
Sex, Male (%)	41.6	41.6	41.5	42.8	41.2	42.7	41.0	42.8	41.9	41.4
Number of remaining teeth, ≥20 teeth (%)	28.5	28.5	25.1	31.6	27.4	29.3	25.0	32.0	28.4	28.3
Neighborhood educational level, highest (%)	31.2	34.4	14.3	50.6	26.3	36.7	14.0	55.7	34.1	28.6
Education attainment, ≥16 years (%)	5.3	5.2	3.2	6.8	4.6	5.3	3.4	7.3	5.6	4.5
Daily frequency of toothbrushing, ≥3 times (%)	19.8	18.3	16.3	21.2	18.4	19.5	16.4	21.3	18.4	19.3
Brushing time (minutes), ≥5 minutes (%)	6.9	5.9	5.5	7.0	6.4	6.3	5.7	6.9	6.9	5.9
Use of dental floss or interdental brushes, yes (%)	13.0	11.0	9.6	14.4	11.8	11.8	10.0	14.1	12.4	11.4
Dental check-up at least once a year, yes (%)	27.9	27.5	25.5	29.6	27.6	29.2	26.0	29.8	28.5	27.0
Frequency of intake of sweet foods, 1–2 times/month	31.0	30.1	31.6	31.0	31.9	31.1	31.9	29.9	31.5	29.7
Smoking status, never, (%)	60.3	61.8	61.6	59.8	60.3	60.9	61.6	59.8	59.3	62.4
History of diabetes, no (%)	87.6	88.2	88.5	87.4	88.0	88.2	88.1	87.8	87.5	88.5
Self-rated health, good (%)	30.3	31.6	29.1	31.5	29.8	31.0	29.3	31.3	29.4	31.6
Individual social network and support variables										
Number of participants	10 676	4699	10 731	5919	13 004	2551	10 081	1808	3193	15 778
Age, year, mean ± SD	75.8 ± 7.1	73.3 ± 5.5	75.9 ± 7.1	73.1 ± 5.6	75.5 ± 6.9	72.3 ± 5	76.1 ± 7.2	73.1 ± 5.3	74.2 ± 5.9	75.1 ± 6.8
Sex, male (%)	37.8	51.4	39.0	45.2	38.2	58.6	37.3	53.3	42.8	41.4
Number of remaining teeth, ≥20 teeth (%)	25.1	36.5	24.0	38.2	26.1	41.4	23.6	38.7	28.3	28.9
Neighborhood educational level, highest (%)	33.5	33.7	31.2	39.7	33.7	37.4	31.7	41.1	34.6	33.1
Education attainment, ≥16 years (%)	4.8	7.2	3.8	9.1	4.8	10.5	3.9	11.3	5.5	5.3
Frequency of toothbrushing, ≥3 times (%)	18.2	20.2	17.0	23.9	18.0	24.4	17.0	23.2	18.3	19.4
Brushing time (minutes), ≥5 min (%)	6.2	6.5	5.7	7.9	6.1	8.2	5.7	8.0	7.7	6.2
Use of dental floss or interdental brushes, yes (%)	10.9	14.9	8.9	20.5	11.4	17.9	9.7	17.3	13.8	11.8
Dental check-up at least once a year, yes (%)	23.0	33.6	21.6	36.3	23.5	38.1	21.5	37.8	28.7	27.2
Frequency of intake of sweet foods, 1–2 times/month	32.2	28.6	32.2	28.4	31.5	28.0	32.2	25.9	38.3	29.0
Smoking status, never (%)	63.2	57.3	62.9	60.4	63.5	53.5	63.8	57.2	56.9	62.1
History of diabetes, no (%)	87.4	88.5	87.2	88.6	87.5	88.4	87.3	88.5	87.8	88.0
Self-rated health, good (%)	26.1	41.0	25.8	40.4	27.5	46.2	25.5	46.3	23.8	32.8

Table 3. Association of remaining teeth with individual- and neighborhood-level variables determined by using multivariable multilevel logistic regression models

Variables		Model 1 OR (95% CI)[a]	Model 1 *P*-value	Model 2 OR (95% CI)[b]	Model 2 *P*-value	Model 3 OR (95% CI)[c]	Model 3 *P*-value
Neighborhood-level variables							
Social capital							
Civic network	Lowest	1.00 (referent)		1.00 (referent)		1.00 (referent)	
	Medium	0.94 (0.85–1.04)	0.224	0.94 (0.85–1.03)	0.180	0.96 (0.87–1.06)	0.399
	Highest	0.87 (0.77–0.98)	0.020	0.94 (0.84–1.04)	0.236	0.99 (0.89–1.10)	0.824
Sports and hobby network	Lowest	1.00 (referent)		1.00 (referent)		1.00 (referent)	
	Medium	1.16 (1.05–1.28)	0.004	1.03 (0.94–1.14)	0.523	1.02 (0.93–1.12)	0.687
	Highest	1.29 (1.16–1.44)	$P < 0.001$	1.06 (0.95–1.18)	0.280	1.04 (0.94–1.16)	0.436
Volunteer network	Lowest	1.00 (referent)		1.00 (referent)		1.00 (referent)	
	Medium	0.95 (0.85–1.06)	0.365	0.95 (0.86–1.05)	0.350	0.96 (0.87–1.06)	0.372
	Highest	0.92 (0.81–1.05)	0.212	0.92 (0.82–1.03)	0.142	0.92 (0.82–1.03)	0.129
Friendship network	Lowest	1.00 (referent)		1.00 (referent)		1.00 (referent)	
	Medium	1.2 (1.08–1.33)	0.001	1.10 (1.00–1.22)	0.061	1.10 (1.00–1.21)	0.057
	Highest	1.37 (1.22–1.54)	$P < 0.001$	1.17 (1.04–1.31)	0.008	1.17 (1.04–1.30)	0.007
Social support	Lowest	1.00 (referent)		1.00 (referent)		1.00 (referent)	
	Medium	1.06 (0.97–1.16)	0.217	1.03 (0.94–1.12)	0.573	1.01 (0.93–1.10)	0.833
	Highest	1.01 (0.86–1.19)	0.904	1.02 (0.93–1.12)	0.657	1.01 (0.92–1.10)	0.885
Neighborhood educational level	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			1.10 (1.01–1.21)	0.039	1.07 (0.98–1.17)	0.132
	Highest			1.22 (1.10–1.35)	$P < 0.001$	1.17 (1.06–1.29)	0.002
Individual-level variables							
Social network							
Civic network	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			1.05 (0.95–1.16)	0.310	1.01 (0.91–1.12)	0.907
	Highest			1.08 (0.98–1.20)	0.123	1.07 (0.97–1.19)	0.187
Sports and hobby network	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			1.07 (0.95–1.20)	0.284	0.99 (0.87–1.12)	0.862
	Highest			1.32 (1.21–1.44)	$P < 0.001$	1.12 (1.02–1.22)	0.019
Volunteer network	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			1.00 (0.90–1.12)	0.930	0.98 (0.88–1.10)	0.788
	Highest			1.13 (1.01–1.27)	0.034	1.09 (0.97–1.23)	0.146
Friendship network	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			1.23 (1.13–1.34)	$P < 0.001$	1.14 (1.04–1.25)	0.004
	Highest			1.23 (1.09–1.40)	0.001	1.14 (0.99–1.30)	0.060
Social support	Lowest			1.00 (referent)		1.00 (referent)	
	Medium			0.93 (0.82–1.05)	0.219	0.93 (0.82–1.05)	0.256
	Highest			1.03 (0.94–1.12)	0.542	1.03 (0.94–1.13)	0.542
Educational attainment	≤9 years			1.00 (referent)		1.00 (referent)	
	10–12 years			1.06 (0.98–1.14)	0.170	0.99 (0.91–1.08)	0.840
	13–15 years			1.14 (1.03–1.26)	0.009	1.04 (0.94–1.15)	0.482
	≥16 years			1.31 (1.14–1.51)	$P < 0.001$	1.12 (0.97–1.30)	0.136
Health behavior							
Daily frequency of toothbrushing	<2 times					1.00 (referent)	
	2 times					1.23 (1.14–1.33)	$P < 0.001$
	3 times≥					0.95 (0.86–1.05)	0.289
Brushing time (minutes)	<3 min					1.00 (referent)	
	3–5 min					1.44 (1.34–1.55)	$P < 0.001$
	5 min ≥					1.81 (1.59–2.05)	$P < 0.001$
Use of dental floss or interdental brushes	No					1.00 (referent)	
	Yes					2.07 (1.88–2.27)	$P < 0.001$
Dental check-up at least once a year	No					1.00 (referent)	
	Yes					1.41 (1.31–1.52)	$P < 0.001$

Table 3. Continued

Variables		Model 1		Model 2		Model 3	
		OR (95% CI)[a]	P-value	OR (95% CI)[b]	P-value	OR (95% CI)[c]	P-value
Frequency of intake of sweet foods	Almost every day					1.00 (referent)	
	1–4 times/week					1.28 (1.16–1.41)	$P < 0.001$
	≤1–2 times/month					1.45 (1.31–1.61)	$P < 0.001$
Smoking status	Current					1.00 (referent)	
	Past					1.42 (1.26–1.60)	$P < 0.001$
	Never					2.40 (2.12–2.72)	$P < 0.001$
History of diabetes	Yes					1.00 (referent)	
	No					1.16 (1.04–1.28)	0.006
Self-rated health	Poor					1.00 (referent)	
	Fair					1.16 (1.06–1.27)	0.002
	Good					1.37 (1.24–1.51)	$P < 0.001$

[a]Adjust for all neighborhood social capital variables simultaneously.
[b]Adjust for sex, age, all neighborhood social capital, educational level, individual social networks and social support and educational attainment variables simultaneously.
[c]Adjust for sex, age, and all explanatory variables simultaneously.

Individual- and community-level social support variables did not show any significant associations. The result of the intercept-only multilevel model showed significant neighborhood level variance ($\sigma^2_{\mu 0}$ (standard error) = 0.075 (0.012), $P < 0.001$). This means that dentate status significantly differed between neighborhoods. Since the neighborhood social capital variables explained the neighborhood level variance, neighborhood level variance in model 1 was decreased ($\sigma^2_{\mu 0}$ (SD) = 0.044 (0.009), $P < 0.001$). The neighborhood level variance in the model 2 was 0.023 (SD = 0.008, $P = 0.004$). The neighborhood level variance in the model 3 was 0.012 (SD = 0.007, $P = 0.093$).

Discussion

To our knowledge, this large-scale cross-sectional study is the first to have simultaneously examined the association between neighborhood social capital, individual social networks, and individual social support and oral health. After adjustment for individual- and neighborhood-level covariables, one aspect of neighborhood-level high social capital was found to be significantly associated with having 20 or more teeth. This result suggests that one aspect of neighborhood social capital has a contextual effect on the self-reported dentate status of elderly people. In addition, neither individual nor neighborhood social support variables showed any significant association. It was suggested that the network aspect of social capital has a more important effect on dentate status than the social support aspect of social capital. Only the friendship network neighborhoods had a statistically significant but small OR (1.17). However, because neighborhood social capital has an influence on all the residents in each area, this result was meaningful.

There were several plausible pathways linking social capital to health outcomes. At first, social capital may affect individual health by influencing health-related behavior through promotion of more rapid diffusion of health information and by exerting social control over deviant health-related behavior (27). For example, cigarette smoking by peers is among the best predictors of smoking in adolescents (28). Second, social capital may affect health by influencing access to local service and amenities (27). Access to service such as transportation, dental clinics and community health centers could affect dental health. Third, there are associations between social capital and psychological distress (29). Psychological distress is a risk indicator of periodontal disease (30, 31). In addition, psychological distress can lead to an increase in smoking and/or consumption of 'comfort foods' such as confectionary (12). These behaviors may increase the risk of periodontal disease and dental caries respectively. In addition, neighborhoods with higher social capital are less violent (32) with fewer dental injuries (8). In our results, only friendship-network-based social capital showed a significant beneficial association, while other kinds of network variables did not. This may suggest that access to dental clinics as well as dental health behavior and stress are influenced mainly by close friends.

A multilevel approach enables demonstration of whether social capital has an independent 'contextual' effect on individual health outcomes, regardless of individual characteristics, including individual-level social networks and social support (6). Our results emphasize the importance of community actions or governmental investment to establish amenities that promote the building of social capital, especially that based on friendship networks. In addition, our results showed a significant neighborhood level variation of dentate status. Approaches for influencing not only individual risk factors but also the underlying social determinants of oral health through upstream public health interventions, such as water fluoridation or a tobacco tax policy, are needed to reduce neighborhood level variation on dentate status by improving the dental health of the population (7).

Broadly speaking, there are two ways of measuring neighborhood variables: (i) aggregating individual level data and (ii) directly measuring the properties of groups (22). However, it is difficult to separate collective explanation about the neighborhood effect from the contextual explanation (33). Aggregating collective measurements have been generally used to estimate the neighborhood contextual effect (6). We determined the association between neighborhood level collective variables and health outcome with adjustment for individual level variables (22).

Our study had some limitations. First, although it demonstrated an association between one aspect of social capital and dentate health, a cross-sectional study showed no causal inference, and therefore prospective follow-up studies are required. Second, it could be argued that the questionnaire used in this study did not provide a full picture of social capital. There is still debate about the definition and measurement of social capital (6). Various types of social capital such as bonding, bridging and linking should be measured. Third, it could be argued that the questionnaire used in this study did not provide a full picture of the differences in quantity and quality of dental health behavior and dentate status. Because of our measure of remaining teeth was discrete variable, it could not describe the full picture of dental health status. In addition, we could not consider occlusal pairs of the teeth of respondents. Although we used many covariables pertaining to dental health behavior, more detailed variables, such as use of fluoride toothpaste, are needed. Additionally, variation of dental health behavior and dentate status were needed. Although previous studies in other countries have shown that the general population can provide accurate self-reported estimates of the number of remaining teeth (34), validation among Japanese elderly was needed. This study could not include other measurements of neighborhood and individual social capital or dental health variables. Therefore, there may be residual bias. Our study had some strength. Because dental health has an important influence on personal appearance and speaking ability, people with a poor dentate health status might have a less well developed social network. Our multilevel study showed that regardless of individual social networks, dental health behavior and self-rated health, neighborhood friendship networks were significantly associated with individual dentate status. This result was reliable because our study had a large number of participants and a sufficient response rate.

The present study has demonstrated a significant association between one aspect of neighborhood social capital and individual dentate status in the elderly population. In addition, only the network aspect of social capital, and not the social support aspect, was found to have a significant association with dentate status.

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risk of UI was 45% lower in people with vitamin D levels of 30 ng/mL or higher than in those with inadequate levels.[5] This letter reports on two adult women with UI who responded to "adequate" vitamin D supplementation (with posttreatment levels >40 ng/mL).

CASE 1

A 78-year-old woman with a long history of allergic rhinitis, well-controlled asthma, and hyperlipidemia had UI for longer than 6 months. The symptoms were consistent with urge type, and she had to wear pads for protection. She was fully functioning and still worked part time. She had had a hysterectomy 36 years before and had one full-term pregnancy (with vaginal delivery). Medications included omeprazole, inhaled corticosteroid, fexofenadine, corticosteroid nasal spray, inhaled albuterol, a statin, and multiple vitamins. She had been taking 50,000 IU of vitamin D_2 twice a month after her 25-hydroxy (OH) vitamin D (25(OH)D) level was found to be 10 ng/mL (normal 30–100 ng/mL) 1 year before. She had also been diagnosed with vitamin B_{12} deficiency 1.5 years before, and had received cobalamin injections since them.

Her weight was 75.8 kg, and her height was 1.68 m (body mass index (BMI) = 26.9 kg/m^2). Physical examination revealed congested turbinates and a surgical scar on the abdomen and nothing else remarkable. Laboratory tests including complete blood count (CBC), chemistry, thyroid function test, sedimentation rate, and urinalysis were all normal; rechecked 25(OH)D level was 21 ng/mL, despite being treated with 100,000 IU monthly for 1 year. She refused gynecological referral as she felt her condition was not "correctable."

She was treated with vitamin D_2 50,000 IU weekly. At her 6-month follow-up visit, she reported that her UI had resolved and that she had not had worn a protection pad for a month. Her rechecked 25(OH) vitamin D level was 54 ng/mL. No other events or interventions occurred during the 6-month period.

CASE 2

A 59-year-old woman with a long history of allergic rhinitis on her first visit complained of chronic multiple joint pains and UI, which mainly occurred when she stood up or sneezed, for several months. She denied symptoms suggestive of cystitis. She had no history of hysterectomy or bladder surgery. Medications included corticosteroid nasal spray, acetaminophen, desloratadine, and sertraline. She occasionally took ibuprofen for pain. On review of systems, she denied symptoms suggestive of polymalgia rheumatica or rheumatoid arthritis.

Her weight was 67 kg, and her height was 1.60 m (BMI 26.2 kg/m^2). Physical examination revealed nasal drainage and congested turbinates; results of other examinations, including the musculoskeletal system, were unremarkable.

Laboratory tests, including CBC, chemistry, thyroid function test, and urinalysis were all normal, except 25(OH)D level (13 ng/mL) and sedimentation rate (113 mm; normal 0–30 mm).

She was referred to a gynecologist who gave a diagnosis of "loss of external sphincter control." Pelvic floor muscle exercise was recommended, and she refused further exercise after she experienced muscle pain and ache in the pelvic and hip areas in 2 weeks.

After aggressive vitamin D_2 supplementation (50,000 IU weekly for 12 weeks), her 25(OH)D level rose to 43 ng/mL, and her sedimentation rate was 10 at a 6-week follow-up blood test. She reported that her UI had resolved, and her joint pain had significantly improved at a 3-month follow-up visit. She continued to take vitamin D_2 50,000 IU three times a month, and her most recent blood level was 70 ng/mL. No events occurred between these two visits.

DISCUSSION

These two cases suggest that vitamin D deficiency is the underlying condition associated with UI. Significant improvement in UI after "adequate" vitamin D blood levels have been achieved with aggressive treatment supports this. Side effects resulting from the use of medications such as corticosteroids or antihistamines that may have contributed to UI are unlikely because there were no changes in these medication uses in either of these cases. There is debate as to what blood levels are considered "adequate" for vitamin D supplementation and on what indication treated for—because cancer prevention may require a higher blood level.[6] Future studies such as a clinical trial will further illustrate the relationship between vitamin D deficiency and UI.

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RELATIONSHIPS BETWEEN N-TERMINAL PRO B-TYPE NATRIURETIC PEPTIDE AND INCIDENT DISABILITY AND MORTALITY IN OLDER COMMUNITY-DWELLING ADULTS: THE TSURUGAYA STUDY

To the Editor: B-type natriuretic peptide (BNP) and N-terminal pro BNP (NT-pro BNP) are used to diagnose and stratify risk for patients with heart failure and to determine the prognosis of patients with heart failure or acute coronary syndrome.[1] BNP and NT-pro BNP can also be used to predict coronary heart disease or stroke even in the general population.[1] Thus, monitoring of BNP and NT-pro BNP levels might have the potential to predict incident disability, but the relationship between BNP or NT-pro BNP and risk of disability has not been documented to the best of our knowledge. Whether plasma NT-pro BNP levels could predict incident disability in the Japanese general population aged 70 and older was therefore investigated.

The Tsurugaya Project was a comprehensive geriatric assessment (CGA) of medical status and physical and cognitive function in 2002 and 2003.[2–6] The present study is based on data from 2002 because of the availability of stored blood samples. Of 2,730 individuals aged 70 and older living in the Tsurugaya area of Sendai, 1,177 provided written informed consent to participate in the present study. Because agreement to review information about long-term care insurance (LTCI) was not obtained in 2002, agreement was requested from participants who underwent CGA in 2003. Of the 1,177 participants who underwent CGA in 2002, 671 underwent another CGA in 2003, and 657 agreed to a review of their LTCI information. Of these 657 participants, those who had already been certified as having a disability as determined according to LTCI certification by 2003 (n = 55), those who did not agree to measuring or storing their blood samples (n = 6), those who did not have sufficiently large plasma sample to measure NT-pro BNP (n = 47), and those who did not measure their blood pressure (BP) at home (n = 37) were excluded. Thus, the present study analyzed 512 participants. The ethics committee of Tohoku University Graduate School of Medicine approved the study protocol.

Levels of NT-pro BNP were measured using electrochemiluminescence immunoassay kits (MODULAR ANALYTICS E10, Roche Diagnostics, Mannheim, Germany) at a single clinical testing laboratory (SRL, Tokyo, Japan).

Information about smoking status, history of diseases, and physical activity was surveyed using a questionnaire, and an experienced pharmacist confirmed drug information. Symptoms of depression were assessed based on the Japanese version of the 30-item Geriatric Depression Scale (GDS).[3,5] Functional reach was measured as a parameter of physical function.[4] Home BP was measured using an automated device (HEM747IC, Omron Life Science Co. Ltd., Tokyo, Japan).[2] Serum creatinine, albumin, and cholesterol levels were also measured. Incident disability was defined as assessed according to the LTCI certification system that was launched as the national insurance scheme during April 2000;[7–10] those with certified incident disability were followed for 6 years.[6]

Participants were classified into five groups (Q1–Q5) based on cutoffs of NT-pro BNP of 47, 77, 133, and 241 pg/mL (25%, 50%, 75%, and 90%). The age- and sex-adjusted hazard ratio (HR) and 95% confidence interval (95% CI) or multivariate adjusted HR and 95% CI for the relationship between NT-pro BNP and the composite outcome of incident disability or mortality was calculated using Cox proportional hazards models. The median NT-pro BNP value in each NT-pro BNP category was used as the representative value in the category to calculate *P*-values for linear trends.

The level of statistical significance was set at $P<.05$. All data were statistically analyzed using SAS software, version 9.1 (SAS Institute, Inc., Cary, NC).

Table 1. Relationship Between N-Terminal Pro B-Type Natriuretic Peptide (NT-Pro BNP) Level and Incident Disability or Death: The Tsurugaya Project 2003–2009

		Disability or Death				Disability			
NT-Pro BNP Quintile	Person-Years	n	Rate/1,000 Person-Years	Age- and Sex-Adjusted Model HR (95% CI)	Multivariate-Adjusted Model* HR (95% CI)	n	Rate/1,000 Person-Years	Age- and Sex-Adjusted Model HR (95% CI)	Multivariate-Adjusted Model* HR (95% CI)
1 (reference)	686	26	37.9	1	1	20	29.1	1	1
2	658	42	63.8	1.53 (0.93–2.50)	1.40 (0.84–2.33)	39	59.3	1.77 (1.03–3.05)	1.58 (0.90–2.77)
3	629	45	72.5	1.52 (0.93–2.49)	1.34 (0.81–2.22)	38	61.2	1.55 (0.90–2.70)	1.31 (0.75–2.32)
4	369	34	92.2	1.48 (0.86–2.54)	1.32 (0.76–2.31)	30	81.3	1.49 (0.82–2.72)	1.31 (0.71–2.41)
5	225	26	115.8	2.35 (1.35–4.09)	1.90 (1.06–3.39)	22	98.0	2.45 (1.32–4.54)	2.04 (1.07–3.86)
P-value for trend				.008	.06			.02	.08

NT-pro BNP cutoff values were 47 (25%), 77 (50%), 133 (75%), and 241 pg/mL (90%).

*Adjusted for age, sex, home blood pressure (BP) category (hypertensive: systolic BP ≥ 135 mmHg, diastolic BP ≥ 85 mmHg, or user of antihypertensive medication; normotensive: systolic BP < 125 mmHg and diastolic BP < 80 mmHg without antihypertensive medication, borderline hypertensive: intermediate of hypertensive and normotensive), smoking status (current, former, never), serum creatinine, low serum albumin (≤ 3.8 g/dL), low serum total cholesterol (≤ 160 mg/dL), low body mass index (< 18.5 kg/m^2), depressive symptoms, sex-specific quartile of functional reach, and history of cardiovascular disease.

HR = hazard ratio; CI = confidence interval.

Of 173 persons who developed incident disability during the 6 years of follow-up, 44 died (20 with LTCI certification and 24 without). The combined rate of incident disability or death was lower in the categories with low NT-pro BNP and higher in the categories with high NT-pro BNP (Q1, 37.9/1,000 person-years; Q5, 115.8/1,000 person-years; Table 1). This relationship was also evident in the age- and sex-adjusted model. After adjustment for possible confounding factors, the HR of incident disability or death was significantly higher in Q5 (NT-pro BNP $\geq$ 241 pg/mL) than in Q1. These results persisted when systolic BP values and antihypertensive medication instead of BP categories were included as confounding factors. When incident disability was used only as an endpoint, the risk was statistically significantly greater in group Q5 than in Q1.

Thus, the present study confirms that plasma NT-pro BNP is positively associated with incident disability and death. This relationship was independent of physical function and other possible confounders.

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THYROID HORMONES PRECIPITATE SUBCLINICAL HYPOPITUITARISM RESULTED IN ADRENAL CRISIS

To the Editor: The vague clinical presentations of adrenal insufficiency (AI) in elderly patients could be considered to be due to the aging process, which would then be overlooked and become life threatening.[1] It may be that the coexistence of AI and thyroid insufficiency, which may result from pituitary failure, is greater than previously suspected.[2] An older man with hypothyroid secondary to subclinical hypopituitarism, in whom thyroid hormone replacement eventually resulted in adrenal crisis, is reported.

CASE REPORT

A 79-year-old man was referred to the Department of Geriatric Gastroenterology PLA General Hospital, Beijing, China, in February 2010 because of intermittent diarrhea and constipation for 7 months. He had lost 5 kg of weight over this period. In 1979, he had received a 45-Gy dose of local irradiation to the pituitary area because of pituitary

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Original Article

Risk factors for overactive bladder in the elderly population: A community-based study with face-to-face interview

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Objectives: The aim of this study was to measure the prevalence of and risk factors for overactive bladder (OAB) in the elderly.

Methods: A cross-sectional study of elderly subjects was conducted by analyzing data from a community-based Comprehensive Geriatric Assessment on people aged 70 years or older. Trained interviewers performed face-to-face interviews for the assessment of urological symptoms. OAB definition was based on urgency and eight or more episodes of urination per day. The subjects completed a self-administered questionnaire including lifestyle evaluation, Geriatric Depression Scale, Mini-Mental Status Examination and medical history. Brachial-ankle pulse wave velocity was recorded to assess atherosclerotic disease. The analysis included 833 subjects, after the exclusion of 115 subjects who provided insufficient information.

Results: Based on the definition of OAB, 153 subjects (18.4%) were identified as having OAB. Univariate analysis showed a significant association between OAB and depressive symptoms. Multivariate analysis showed that the risk of having OAB was significantly higher in subjects with depressive symptoms, current drinkers, and overweight subjects with odds ratios of 2.37 (1.60–3.52, 95% confidence interval), 1.65 (1.04–2.62), and 1.51 (1.02–2.24), respectively.

Conclusions: This is the first report to show an association between OAB and depressive symptoms and alcohol intake in an epidemiological study of elderly people. The reasons for these correlations remain unclear, but should be the foci of future OAB studies.

Key words: depression, elderly, face-to-face interview, overactive bladder, risk factors.

Introduction

In 2002, overactive bladder (OAB) was defined by the International Continence Society (ICS) as the symptom of urgency, which is an indispensable condition, with or without urge incontinence, usually with increased frequency and nocturia.[1] Many epidemiological and clinical studies of these symptoms have been reported.[2–5] OAB occurs in a wide range of patients from the comparatively young to the elderly. By contrast, the number of OAB patients increases in proportion to the subjects' age. The reason for this association is not clear. Thus, it might be possible to elucidate the origin of OAB by investigating the risk factors for OAB in elderly people through epidemiological studies.

We conducted a cross-sectional study on subjects aged 70 years or older in an urban community to measure the prevalence of overactive bladder (OAB) in the elderly, and assessed the risk factors of the condition.

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Methods

Study participants

In July and August 2003, a community-based comprehensive geriatric assessment in elderly people was performed in the Tsurugaya district of Sendai City, one of the largest cities in northern Japan.[6–10] At this time, 2925 people aged ≥70 years lived in Tsurugaya. We invited all of them to participate in the assessment of their medical status, physical function, cognitive function and dental status. Of those invited, 948 (32.4%) of them particiapated, after providing informed consent for analysis of the data. All assessments were carried out in a non-clinical public facility. The protocol of this study was approved by the institutional review board of the Tohoku University Graduate School of Medicine.

We excluded subjects who did not respond to the questions related to our analysis ($n = 107$). We further excluded

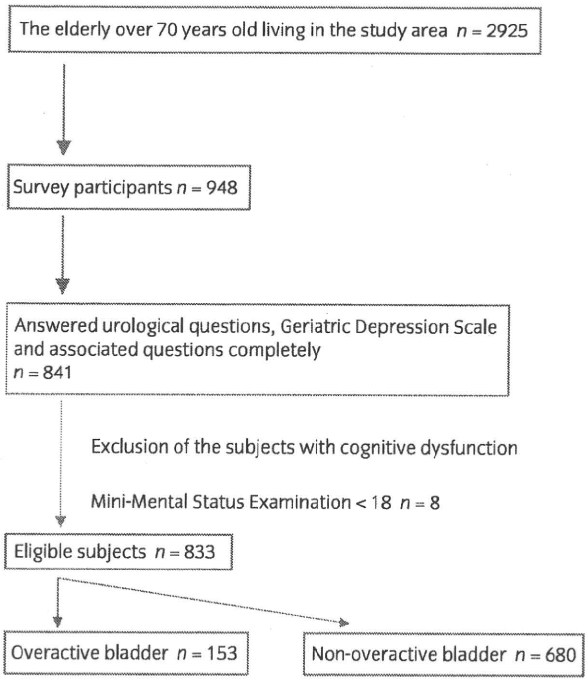

Fig. 1 The study flow.

participants who had scores of less than 18 points in the Mini-Mental Status Examination (MMSE), based on the possibility of incorrect answers due to dysgnosia ($n = 8$).[11] Therefore, a total of 833 subjects were included in the final analysis (Fig. 1).

Urological measurement

In the current study, we performed a survey of the symptoms of the lower urinary tract, including determination of the frequency of urination per day and the International Prostate Symptom Score (IPSS).[10,12] All urological interviews were performed by interviewers who were trained to identify that the urgency is the complaint of a sudden compelling desire to pass urine. OAB has been defined as urgency with urination eight times or more per day. Based on the survey results, the subjects were divided into OAB and non-OAB groups.

Anthropometric measures, lifestyle and medical history

Anthropometric measures (height, bodyweight) were recorded using a standardized protocol. The subjects completed a self-administered questionnaire that included their lifestyle and medical history.

Geriatric Depression Scale

The Geriatric Depression Scale (GDS) was used to evaluate depressive symptoms in the elderly people. Depressive symptoms were measured based on the Japanese version of the 30-item Geriatric Depression Scale (GDS 30), with a cut-off of 11.[8,9,13] We selected the cut-off of 11 because Schreiner *et al.* reported that the GDS cut-off score identified among Japanese participants was the same as that reported for Western participants using the 15-item GDS short form.[14] Each item was assessed by a yes/no question in one sentence. If the answering style tended to be depressive, we scored one point each, and summed up the 30 items. The maximum score was 30 points. The participants were further tested for cognitive ability based on the MMSE. Higher scores indicated higher cognitive function, and the maximum score was 30 points. The cognitive tests were conducted by trained personnel.

Pulse Wave Velocity measurement

Bilateral brachial-ankle pulse wave velocity (baPWV) was measured in all subjects, as an indicator of atherosclerosis, using the ankle-brachial pressure index (ABI)/pulse wave velocity (PWV) Form (Nihon Colin, Komaki, Japan), which incorporates an automatic oscillometer.[15] The ABI/PWV Form is a device with four cuffs that can simultaneously measure BP levels and pulse waves in both arms and both legs, and automatically calculates the ABI and baPWV. This device is useful for mass medical examinations and population-based studies because it enables measurement of PWV in a short time, and, more importantly, the measurement is non-invasive and is not affected by the operator's technique.[15] The validity, reproducibility and clinical significance of baPWV measurements have been reported previously.[16]

Statistical analyses

Based on the interview data, analyses of the distribution of OAB and the association of OAB with other factors were performed. The subjects were categorized into groups based on 26 factors, and significant differences in OAB prevalence were examined for each factor using logistic regression analysis; these factors included age, sex, depressive symptoms (GDS: 11 points or higher), history of comorbidities (stroke, hypertension, myocardial infarction, diabetes, cancer, kidney disease), smoking status, alcohol intake, body mass index (BMI), and baPWV. Regarding smoking, the subjects were divided into three groups: the never-smoking group (no history of smoking), the ex-smoking group and the current smoking group. In the same manner, they were also divided into three alcohol intake categories of never-drinker, ex-drinker and current drinker. For BMI, the subjects were divided into four groups: lean, <18.5; normal weight, ≥18.5 and <25; overweight, ≥25 and <30; and obese ≥30.

Table 1 General characteristics of the 833 subjects interviewed

Characteristics, *n* (%)	Men (*n* = 414)	Women (*n* = 419)	Total (*n* = 833)
OAB	73 (17.6)	80 (19.1)	153 (18.4)
Age (years)			
70–79	352 (42.3)	330 (39.6)	682 (81.9)
80–	62 (7.4)	89 (10.7)	151 (18.1)
GDS			
<11	338 (40.6)	282 (33.8)	620 (74.4)
≥11	76 (9.1)	137 (16.5)	213 (25.6)
Alcohol intake			
Never	71 (8.5)	292 (35.1)	363 (43.6)
Ex-drinker	62 (7.4)	37 (4.4)	99 (11.9)
Current drinker	281 (33.7)	90 (10.8)	371 (44.5)
Smoking status			
Never	85 (10.2)	382 (45.9)	467 (56.1)
Ex-smoker	252 (30.2)	27 (3.2)	279 (33.5)
Current smoker	77 (9.2)	10 (1.2)	87 (10.4)
BMI			
<18.5	22 (2.6)	24 (2.9)	46 (5.5)
≥18.5 and <25	244 (29.3)	227 (27.3)	517 (56.6)
≥25 and <30	134 (16.1)	145 (17.4)	279 (33.5)
>30	14 (1.7)	23 (2.8)	37 (4.4)
ABI			
≤0.9	29 (3.5)	19 (1.4)	41 (4.9)
>0.9	385 (46.2)	407 (48.8)	792 (95.1)
baPWV (m/s)			
<1.7	98 (11.8)	81 (9.7)	179 (21.5)
≥1.7 and <1.9	93 (11.1)	89 (10.7)	182 (21.8)
≥1.9 and <2.2	118 (14.2)	106 (12.7)	224 (26.9)
≥2.2	105 (12.6)	143 (17.2)	248 (29.8)
History/comorbidities			
Stroke	27 (3.2)	8 (1.0)	35 (4.2)
Hypertension	183 (22.0)	168 (20.2)	351 (42.1)
Myocardial infarction	58 (7.0)	33 (4.0)	91 (10.1)
Diabetes	72 (8.6)	51 (6.1)	123 (14.8)
Cancer	51 (6.1)	36 (4.3)	87 (10.4)
Kidney disease	23 (2.8)	33 (4.0)	56 (6.7)

ABI, ankle-brachial pressure index; baPWV, brachial-ankle pulse wave velocity; BMI, body mass index; GDS, Geriatric Depression Scale; OAB, overactive bladder.

The potential correlations between each of these factors and OAB were examined using univariate and multivariate logistic regression analysis. SAS software (version 9.0) was used for all statistical analyses.

Results

The baseline characteristics are shown in Table 1. Of the 833 subjects in the analysis, 414 (49.7%) were male. The mean age was 75.4 ± 4.5 years. A total of 153 people (18.4%) were diagnosed with OAB, including 73 men (17.6%) and 80 women (19.1%). Subjects with a GDS score of 11 or higher were included in the group with depressive symptoms; this group comprised 213 subjects (25.6%), including 76 men (18.4%) and 137 women (32.7%).

Univariate analysis showed that the prevalence of OAB was higher in participants with depressive symptoms than in those without, but no apparent correlations were observed between other factors and OAB (Table 2). Multiple adjusted logistic regression analysis was performed to examine the association between OAB and individual factors. The multiple adjusted odds ratio (OR) for having OAB was higher in

Table 2 Factors associated with OAB and non-OAB

	OAB, *n* (%)	Non-OAB, *n* (%)	Univariate analysis OR (95%CI)	*P*-value	Multivariate analysis OR (95%CI)	*P*-value
Sex				0.59		0.91
Male	73 (17.6)	341 (82.4)	1.10 (0.78–1.57)		1.03 (0.60–1.78)	
Female	80 (19.1)	339 (80.9)	1		1	
Age (years)				0.77		0.94
70–79	124 (18.2)	558 (81.8)	1		1	
80≤	29 (19.2)	122 (80.8)	1.08 (0.68–1.68)		1.02 (0.63–1.70)	
GDS				0.0001		<0.0001
<11	95 (15.3)	525 (84.7)	1		1	
≥11	58 (27.2)	155 (72.8)	2.07 (1.43–3.00)		2.37 (1.60–3.52)	
Alcohol intake				0.34		0.064
Never	62 (17.1)	301 (82.9)	1		1	
Ex-drinker	15 (15.2)	84 (84.8)	0.87 (0.45–1.60)		0.98 (0.50–1.91)	
Current drinker	76 (20.5)	295 (79.5)	1.25 (0.86–1.81)		1.65 (1.04–2.62)	
Smoking status				0.12		0.1
Never	90 (19.3)	377 (80.7)	1		1	
Ex-smoker	42 (15.1)	237 (84.9)	0.74 (0.50–1.11)		0.68 (0.39–1.19)	
Current smoker	21 (24.1)	66 (75.9)	1.33 (0.78–2.29)		1.27 (0.65–2.48)	
BMI				0.39		0.17
<18.5	9 (19.6)	37 (80.4)	1.25 (0.58–2.68)		1.23 (0.55–2.74)	
≥18.5 and <25	77 (16.3)	394 (83.7)	1		1	
≥25 and <30	59 (21.1)	220 (78.9)	1.37 (0.94–2.00)		1.51 (1.02–2.24)	
>30	8 (21.7)	29 (78.3)	1.41 (0.62–3.21)		1.74 (0.74–4.13)	
ABI				0.54		0.5
≤0.9	9 (22.0)	32 (78.0)	1.27 (0.59–2.71)		1.32 (0.59–2.99)	
>0.9	144 (18.2)	648 (81.8)	1		1	
baPWV (m/s)				0.77		0.7
<1.7	35 (19.6)	144 (80.4)	1		1	
≥1.7 and <1.9	34 (18.7)	148 (81.3)	0.95 (0.56–1.60)		0.91 (0.53–1.56)	
≥1.9 and <2.2	36 (16.1)	188 (83.9)	0.79 (0.47–1.32)		0.73 (0.43–1.26)	
≥2.2	48 (19.4)	200 (80.6)	0.99 (0.61–1.60)		0.92 (0.55–1.56)	
History/comorbidities						
Stroke				0.29		0.23
Yes	4 (11.4)	31 (88.6)	0.56 (0.20–1.62)		0.51 (0.17–1.55)	
No	149 (18.7)	649 (81.3)	1		1	
Hypertension				0.78		0.9
Yes	66 (18.8)	285 (81.2)	1.05 (0.74–1.50)		0.98 (0.66–1.44)	
No	87 (18.0)	395 (82.0)	1		1	
Myocardial infarction				0.13		0.16
Yes	22 (24.2)	69 (75.8)	1.49 (0.89–2.49)		1.48 (0.86–2.54)	
No	131 (17.7)	611 (82.3)	1		1	
Diabetes				0.54		0.61
Yes	25 (20.3)	98 (79.7)	1.16 (0.72–1.87)		1.14 (0.69–1.89)	
No	128 (18.0)	582 (82.0)	1		1	
Cancer				0.38		0.39
Yes	13 (14.9)	74 (85.1)	0.76 (0.41–1.41)		0.76 (0.40–1.43)	
No	140 (18.8)	606 (81.2)	1		1	
Kidney disease				0.8		0.92
Yes	11 (19.6)	45 (80.4)	1.09 (0.55–2.17)		1.04 (0.51–2.10)	
No	142 (18.3)	635 (81.7)	1		1	

ABI, ankle-brachial pressure index; baPWV, brachial-ankle pulse wave velocity; BMI, body mass index; CI, confidence interval; GDS, Geriatric Depression Scale; OAB, overactive bladder; OR, odds ratio.