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			
				Age- and Sex-Adjusted Model	Multivariate-Adjusted Model*			Age- and Sex-Adjusted Model	Multivariate-Adjusted Model*
NT-Pro BNP Quintile	Person-Years	n	Rate/1,000 Person-Years	HR (95% CI)		n	Rate/1,000 Person-Years	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

Effect of Age on the Association between Body Mass Index and All-Cause Mortality: The Ohsaki Cohort Study

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ABSTRACT

Background: To clarify the effect of age on the association between body mass index (BMI) and all-cause mortality.

Methods: We followed 43 972 Japanese participants aged 40 to 79 years for 12 years. Cox proportional hazards regression analysis was used to estimate hazard ratios (HRs), using the following BMI categories: <18.5 (underweight), 18.5–20.9, 21.0–22.9, 23.0–24.9 (reference), 25.0–27.4, 27.5–29.9, and ≥30.0 kg/m^2 (obese). Analyses were stratified by age group: middle-aged (40–64 years) vs elderly (65–79 years).

Results: We observed a significantly increased risk of mortality in underweight elderly men: the multivariate HR was 1.26 (0.92–1.73) in middle-aged men and 1.49 (1.26–1.76) in elderly men. In addition, we observed a significantly increased risk of mortality in obese middle-aged men: the multivariate HR was 1.71 (1.17–2.50) in middle-aged men and 1.25 (0.87–1.80) in elderly men. In women, there was an increased risk of mortality irrespective of age group in the underweight: the multivariate HR was 1.46 (0.96–2.22) in middle-aged women and 1.47 (1.19–1.82) in elderly women. There was no excess risk of mortality with age in obese women: the multivariate HR was 1.47 (0.94–2.27) in middle-aged women and 1.26 (0.95–1.68) in elderly women.

Conclusions: As compared with the reference category, obesity was associated with a high mortality risk in middle-aged men, whereas underweight, rather than obesity, was associated with a high mortality risk in elderly men. In women, obesity was associated with a high mortality risk during middle age; underweight was associated with a high mortality risk irrespective of age. The mortality risk due to underweight and obesity may be related to sex and age.

Key words: body mass index; mortality; age effect; underweight; obesity

INTRODUCTION

Epidemiological studies have indicated that the association between body mass index (BMI) and all-cause mortality is dependent upon age.[1–18] While almost all studies have agreed that the excess risk of mortality due to obesity attenuates with age,[1–14,17,18] there is long-standing disagreement regarding the effect of age on the association between underweight and all-cause mortality.[1–15] Some studies have shown that the excess risk of mortality due to underweight attenuates with age.[2,3,6–12,15] Other studies have indicated that the excess risk of mortality due to underweight increases with age[5,13] or remains high irrespective of age.[3,4,10,14] This inconsistency may be partly due to the inability to control for history of cancer and cardiovascular disease,[4,6,7,10,12] and to inadequate adjustment for several other confounders such as cigarette smoking,[14] alcohol consumption,[7–9,12,14] physical activity,[7–10,12,14] and socioeconomic status.[2,8,10,12,14,15] Additionally, several studies failed to include a category for the lowest BMI (<18.5) because of the small proportion of such underweight participants,[1,3,8,9,13–15] or neglected to recruit a study population from the general population.[2,10,12,15]

Serena et al concluded that it is necessary to develop appropriate BMI cut-off points that are country- and ethnic-specific for Asians.[19] Among 4 Asian studies of the effect of age on the association between BMI and all-cause mortality,[2,6,7,10] one was conducted in Japan.[10] In that study, however, multivariate analysis failed to adjust adequately for several confounders. Therefore, the effect of age on the

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association between underweight and all-cause mortality remains to be clarified.

To further examine the effect of age on the association between BMI and all-cause mortality, we conducted a cohort study among middle-aged and elderly Japanese who were recruited from the general population. We obtained information about their medical history, smoking status, and other possible confounders. In addition, our study overcomes problems in previous studies because we adjusted for several confounders after excluding participants with subclinical disease. We believe that by clarifying the effect of age on the association between BMI and all-cause mortality, it might be possible to improve public health measures by targeting body weight control according to life stage.

METHODS

Study cohort

The details of the Ohsaki National Health Insurance (NHI) Cohort Study have been described previously.[20–22] Briefly, we delivered a self-administered questionnaire requesting information on various lifestyle habits during the period from October through December 1994 to all NHI beneficiaries aged 40 to 79 years living in the catchment area of the Ohsaki Public Health Center, Miyagi Prefecture, in northeastern Japan. The Ohsaki Public Health Center is a local government agency that provides preventive health services to the residents of 14 municipalities in Miyagi Prefecture. Of 54 996 eligible individuals, 52 029 (95%) responded.

We excluded 776 participants who withdrew from the NHI before 1 January 1995, when we started prospective collection of data on NHI withdrawals. Thus, the study cohort comprised the remaining 51 253 participants. The study protocol was approved by the Ethics Committee of Tohoku University School of Medicine. We considered the return of the self-administered questionnaires signed by the participants to imply their consent to participate in the study.

For the current analysis, we also excluded 1767 participants with a history of cancer, 1384 participants with a history of myocardial infarction, and 997 participants with a history of stroke, because the presence of these diseases at baseline could have affected their BMI. In addition, we excluded 3133 participants who did not provide information about body weight or height. As a result, a total of 43 972 adults (21 038 men and 22 934 women) participated. After 12 years of follow-up, there were 5707 deaths (3685 men and 2022 women).

Body mass index

The self-administered questionnaire included questions on weight and height. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). We used BMI as a measure of total adiposity and divided the participants into groups according to the following BMI categories: <18.5 (underweight), 18.5–20.9, 21.0–22.9, 23.0–24.9, 25.0–27.4, 27.5–29.9, and ≥30.0 kg/m^2 (obese). These weight categories correspond to the cut-off points proposed by the World Health Organization (WHO), ie, normal BMI range (18.5–24.9 kg/m^2), grade 1 overweight (25.0–29.9 kg/m^2), grade 2 overweight (30.0–39.9 kg/m^2), and grade 3 overweight (≥40.0 kg/m^2).[23]

We previously evaluated the validity of self-reported weight and height.[22] Briefly, the weight and height of 14 883 participants, who were a subsample of the cohort, were measured during health examinations in 1995. The Pearson correlation coefficient (r) and weighted kappa (κ) for the self-reported values and measured values were $r = 0.96$ ($P < 0.01$) for weight, $r = 0.93$ ($P < 0.01$) for height, and $r = 0.88$ ($P < 0.01$) and $\kappa = 0.72$ for BMI. Thus, the self-reported heights and weights in the baseline questionnaire were considered sufficiently valid.

Follow-up

We followed the participants from 1 January 1995 through 31 December 2006 and recorded any mortality or migration by reviewing data on NHI withdrawals. When a participant withdrew from the NHI system because of death, emigration, or employment, the date of and reason for withdrawal were coded in the NHI withdrawal history files. Because we were unable to obtain subsequent information on participants who withdrew from the NHI because of emigration or employment, we discontinued follow-up of these participants.

The end point was all-cause mortality. Data on the death of participants were based on the death certificates filed at Ohsaki Public Health Center.

The person-years of follow-up were counted for each participant, until either the date of death, withdrawal from the NHI, or the end of the study period, whichever occurred first. The total number of person-years accrued was 440 175.

Statistical analysis

We used Cox proportional hazards regression analysis to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for all-cause mortality according to BMI category, and to adjust for potential confounding factors, using the SAS version 9.1 statistical software package.[24] To enable detailed examination of the association of BMI and all-cause mortality by WHO categories, the normal weight and overweight categories were divided into 3 and 2 categories, respectively. The BMI category 23.0–24.9 kg/m^2 was selected as the reference because it is the median of the 7 categories.

Stratified analyses were conducted using 2 age groups: middle-aged participants (40–64 years) and elderly participants (65–79 years). The classification of elderly participants was based on a report by the WHO.[25] All P values were 2-tailed, and a P value of <0.05 was considered statistically significant.

The following variables were selected as potential confounding factors: 5-year age group, weight change since age 20 years (loss of ≥10.0 kg, loss of 5.0–9.9 kg, change of less than 5.0 kg, gain of 5.0–9.9 kg, or gain of ≥10.0 kg), education (junior high school or less, high school, or college/university or higher), marital status (married or unmarried), cigarette smoking (never smoker, past smoker, current smoker consuming 1–19 cigarettes per day, or current smoker consuming at least 20 cigarettes per day), alcohol consumption (never drinker, past drinker, or current drinker), time spent walking per day (less than 1 hour or 1 hour or longer), sports and physical exercise time per week (less than 1 hour, 1–2 hours, 3–4 hours, or 5 hours or longer), history of kidney disease (yes or no), and history of liver disease (yes or no). We further adjusted for hypertension and diabetes mellitus in multivariate model 2. Before including the above potential confounders into the multivariate models, we examined interactions between all-cause mortality and all potential confounders through the addition of cross-product terms to the multivariate model. Based on the results of these analyses (data not shown), we included all the above variables into the multivariate models. In addition, we repeated the analyses after excluding the 739 participants who died within 2 years of baseline.

RESULTS

Baseline characteristics by BMI category

The baseline characteristics of the study participants according to the 7 BMI categories are shown for middle-aged men (Table 1), elderly men (Table 2), middle-aged women (Table 3), and elderly women (Table 4). Among middle-aged men and women, 2.3% and 2.9%, respectively, were underweight, about 50% of each had a BMI from 21.0 to 24.9 kg/m^2; 25.7% and 28.5% had a BMI from 25.0 to 29.9 kg/m^2, and 2.3% and 3.4% were obese, respectively. Among elderly men and women, 5.8% and 5.9%, respectively, were underweight, about half of each had a BMI from 21.0 to 24.9 kg/m^2; 19.2% and 27.9% had a BMI from 25.0 to 29.9 kg/m^2, and 1.4% and 4.0% were obese, respectively.

In men, mean age decreased linearly with an increase in BMI category. In women, middle-aged women with a BMI from 25.0 to 27.4 kg/m^2 and elderly women who were underweight were oldest. The proportions of men and women who had lost ≥5 kg of body weight since age 20 years decreased with increasing BMI category. Participants with the highest level of education were middle-aged men with a BMI from 25.0 to 27.4 kg/m^2, middle-aged women with a BMI from 18.5 to 20.9 kg/m^2, and underweight elderly men and women. The proportions of unmarried men and women were higher among those who were underweight and obese. The proportions of men and women who were current smokers decreased with increasing BMI. The proportions of men and women who had never drunk alcohol were highest in the underweight, with the exception of middle-aged women. Underweight and obese men and women were less likely to walk 1 hour or longer per day and to participate in <1 hour of sports or physical exercise per week. The proportions of men and women who had histories of hypertension and diabetes increased with an increase in BMI category. The proportions of middle-aged men and elderly women who had histories of kidney disease and liver disease did not significantly differ across BMI categories. The proportions of participants with histories of liver disease and kidney disease were highest among elderly obese men and underweight middle-aged women, respectively.

All-cause mortality by BMI category

Table 5 (for men) and Table 6 (for women) show person-year totals, numbers of all-cause deaths, and HRs of all-cause mortality with 95% CIs according to BMI category and age group.

In men, we observed significantly increased risks of mortality in the underweight and obese: the model 1 multivariate HRs (95% CI) were 1.42 (1.23–1.65) and 1.44 (1.11–1.87), respectively. After stratification by age group, we observed a significantly increased risk of mortality in elderly underweight men: the model 1 multivariate HRs were 1.26 (0.92–1.73) in middle-aged men and 1.49 (1.26–1.76) in elderly men. There was also a significantly increased risk of mortality in middle-aged obese men: the model 1 multivariate HRs were 1.71 (1.17–2.50) in middle-aged men and 1.25 (0.87–1.80) in elderly men.

In women, we observed significantly increased risks of mortality in the underweight and obese: the model 1 multivariate HRs were 1.49 (1.24–1.80) and 1.33 (1.05–1.69), respectively. After stratification by age group, we observed an increased risk of mortality irrespective of age group in the underweight category: the model 1 multivariate HRs were 1.46 (0.96–2.22) in middle-aged women and 1.47 (1.19–1.82) in elderly women. However, we did not observe an excess risk of mortality with age in the obese: the model 1 multivariate HRs were 1.47 (0.94–2.27) in middle-aged women and 1.26 (0.95–1.68) in elderly women.

The inclusion of covariates for histories of hypertension and diabetes (model 2) attenuated the HR in adults with a BMI ≥25.0 kg/m^2 and increased the HR in those with a BMI <23.0 kg/m^2. However, model 2 multivariate HRs were similar to model 1 HRs. After the exclusion of participants who died during the first 2 years of follow-up (model 3), multivariate HRs were similar to model 2 HRs in men and obese women. In underweight women, however, there was no excess risk of mortality with age: the model 3 multivariate HRs were 1.78 (1.13–2.81) in middle-aged adults and 1.45 (1.15–1.83) in elderly adults.

We also calculated model 1 multivariate HRs after changing the reference category to 18.5 ≤ BMI ≤ 24.9 kg/m^2 from

Table 1. Baseline characteristics by BMI[a] category in 13 764 men aged 40–64 years

	BMI (kg/m^2)							P value[b]
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0	
No. of subjects	310	2159	3591	3852	2637	903	312	
Mean age (years) (SD[a])	54.2 (7.7)	53.0 (8.0)	53.1 (7.8)	53.2 (7.6)	52.8 (7.6)	52.1 (7.4)	52.0 (7.6)	<0.0001
Mean weight (kg) (SD)	48.9 (4.8)	54.6 (4.6)	59.4 (4.7)	64.6 (5.2)	70.3 (5.8)	77.4 (6.3)	86.9 (14.8)	<0.0001
Mean height (cm) (SD)	166.3 (7.6)	164.9 (6.6)	164.0 (6.3)	164.1 (6.2)	164.1 (6.5)	164.8 (6.5)	163.6 (19.1)	<0.0001
Mean BMI (kg/m^2) (SD)	17.6 (0.9)	20.1 (0.7)	22.1 (0.5)	24.0 (0.6)	26.1 (0.7)	28.5 (0.7)	32.4 (4.7)	<0.0001
Weight change since age 20 years (%)								
≤−10.0 kg	24.4	8.5	4.0	2.8	1.5	2.5	0.7	<0.0001
−9.9 to −5.0 kg	26.8	21.9	14.2	8.0	4.5	3.3	3.0	
−4.9 to +4.9 kg	43.5	61.2	57.2	36.1	15.5	6.6	4.3	
+5.0 to +9.9 kg	4.4	7.1	19.9	32.9	28.1	12.3	7.2	
≥+10.0 kg	1.0	1.3	4.6	20.2	50.4	75.2	84.9	
Education (%)								
Junior high school or less	57.2	56.6	55.8	55.1	52.3	54.2	55.8	NS[a]
High school	35.7	35.9	36.8	37.2	39.0	37.3	35.6	
College/university or higher	7.1	7.5	7.5	7.7	8.7	8.6	8.6	
Marital status (%)								
Married	84.3	87.0	88.8	89.7	88.6	90.4	82.4	0.0072
Unmarried	15.7	13.0	11.2	10.3	11.4	9.6	17.6	
Smoking status (%)								
Never smoker	13.1	13.1	18.2	21.5	24.9	24.9	23.6	<0.0001
Past smoker	16.8	14.1	17.2	19.4	22.9	21.2	19.5	
Current smoker, 1–19 cigarettes/day	23.4	26.6	20.9	19.0	14.7	13.3	13.8	
Current smoker, ≥20 cigarettes/day	46.7	46.3	43.7	40.2	37.5	40.7	43.1	
Alcohol drinking (%)								
Never drinker	20.7	14.7	14.3	14.5	14.7	15.2	19.7	<0.0001
Past drinker	14.4	7.3	7.3	5.9	7.0	5.8	8.9	
Current drinker	64.9	78.0	78.4	79.7	78.3	79.1	71.5	
Time spent walking (%)								
≥1 hour/day	44.3	55.9	53.8	53.0	49.1	46.1	45.3	<0.0001
<1 hour/day	55.8	44.1	46.2	47.0	50.9	53.9	54.7	
Sports and physical exercise (%)								
≥5 hours/week	2.4	5.8	5.4	5.8	4.5	4.4	5.9	0.0367
3–4 hours/week	3.8	4.1	4.7	5.2	5.0	4.8	3.0	
1–2 hours/week	11.9	12.1	14.2	14.1	14.3	15.8	12.9	
<1 hour/week	81.9	78.1	75.7	75.0	76.2	75.0	78.2	
History of hypertension (%)								
Yes	10.0	12.6	14.6	17.2	21.2	26.8	25.3	<0.0001
No	90.0	87.4	85.4	82.8	78.8	73.2	74.7	
History of diabetes (%)								
Yes	6.1	4.5	5.9	5.9	6.6	7.3	9.6	0.0015
No	93.9	95.6	94.2	94.1	93.4	92.7	90.4	
History of kidney disease (%)								
Yes	4.5	4.3	3.3	3.0	3.5	4.7	2.6	NS
No	95.5	95.7	96.7	97.0	96.6	95.4	97.4	
History of liver disease (%)								
Yes	6.1	6.4	6.2	7.0	7.4	7.6	8.0	NS
No	93.9	93.7	93.8	93.0	92.6	92.4	92.0	

[a]BMI, body mass index; SD, standard deviation; NS, not significant.
[b]P values were calculated by using the chi-square test (for categorical variables) or ANOVA (for continuous variables).

$23.0 \leq \text{BMI} \leq 24.9\,\text{kg/m}^2$ (model 4). The HRs were similar to model 1 HRs: the model 4 multivariate HRs in underweight men were 1.18 (0.88–1.60) in middle-aged men and 1.42 (1.26–1.76) in elderly men, in obese men they were 1.64 (1.13–2.38) in middle-aged men and 1.25 (0.87–1.80) in elderly men, in underweight women they were 1.38 (0.94–1.99) in middle-aged women and 1.43 (1.19–1.71) in elderly women, and in obese women they were 1.41 (0.92–2.16) in middle-aged women and 1.25 (0.95–1.64) in elderly women.

DISCUSSION

The present results indicate that the mortality risk associated with underweight and obesity might be dependent upon sex and age group. We noted significant increased risks of mortality only in middle-aged obese men and elderly underweight men. In women, there was no significant excess risk of mortality with age in the obese, and no significant increased risk of mortality, irrespective of age group, in the underweight.

Table 2. Baseline characteristics by BMI[a] category in 7274 men aged 65–79 years

	BMI (kg/m²)							*P* value[b]
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0	
No. of subjects	422	1518	2026	1805	1089	310	104	
Mean age (years) (SD[a])	71.5 (4.2)	70.4 (4.2)	70.2 (4.0)	69.9 (4.0)	69.6 (3.9)	69.5 (3.8)	69.9 (4.3)	<0.0001
Mean weight (kg) (SD)	47.1 (4.9)	52.0 (4.4)	56.5 (4.7)	61.6 (5.0)	66.7 (5.4)	72.4 (6.5)	81.0 (21.6)	<0.0001
Mean height (cm) (SD)	164.5 (8.0)	161.1 (6.4)	160.1 (6.5)	160.4 (6.3)	159.9 (6.2)	159.6 (7.2)	153.8 (13.7)	<0.0001
Mean BMI (kg/m²) (SD)	17.4 (1.0)	20.0 (0.7)	22.0 (0.6)	23.9 (0.6)	26.0 (0.7)	28.4 (0.6)	34.3 (8.1)	<0.0001
Weight change since age 20 years (%)								
≤−10.0 kg	55.0	29.9	13.5	6.9	3.1	3.1	4.0	<0.0001
−9.9 to −5.0 kg	28.9	37.1	30.5	16.6	8.4	5.9	5.0	
−4.9 to +4.9 kg	15.4	29.9	43.6	43.0	26.1	13.8	12.0	
+5.0 to +9.9 kg	0.8	2.3	9.7	22.1	29.1	19.3	8.0	
≥+10.0 kg	0.0	0.8	2.7	11.4	33.4	57.9	71.0	
Education (%)								
Junior high school or less	69.4	73.9	75.4	72.1	73.2	72.9	69.6	0.0107
High school	20.9	19.4	18.5	19.2	20.9	22.4	24.5	
College/university or higher	9.8	6.7	6.1	8.8	6.0	4.7	5.9	
Marital status (%)								
Married	89.8	90.3	90.0	89.2	91.7	91.4	89.6	NS[a]
Unmarried	10.2	9.7	10.0	10.9	8.3	8.6	10.4	
Smoking status (%)								
Never smoker	12.7	14.0	14.6	18.5	18.6	23.4	29.4	<0.0001
Past smoker	32.7	31.7	34.9	38.9	43.1	42.3	35.9	
Current smoker, 1–19 cigarettes/day	34.8	30.7	29.2	24.5	21.0	15.7	18.5	
Current smoker, ≥20 cigarettes/day	19.8	23.6	21.4	18.1	17.3	18.5	16.3	
Alcohol drinking (%)								
Never drinker	21.3	19.3	19.9	19.2	18.4	20.1	20.8	<0.0001
Past drinker	24.0	18.1	15.0	14.0	14.9	12.3	18.8	
Current drinker	54.8	62.6	65.1	66.7	66.7	67.6	60.4	
Time spent walking (%)								
≥1 hour/day	36.9	47.1	46.0	43.0	37.6	41.7	34.8	<0.0001
<1 hour/day	63.1	52.9	54.0	57.0	62.4	58.3	65.2	
Sports and physical exercise (%)								
≥5 hours/week	16.2	15.4	17.0	17.4	15.3	15.4	10.7	NS
3–4 hours/week	9.2	9.8	10.4	10.4	11.4	8.8	7.1	
1–2 hours/week	14.8	17.0	18.9	17.6	20.4	24.2	26.2	
<1 hour/week	59.9	57.9	53.7	54.5	52.9	51.7	56.0	
History of hypertension (%)								
Yes	21.6	27.8	32.8	38.2	43.3	48.4	52.9	<0.0001
No	78.4	72.2	67.2	61.8	56.7	51.6	47.1	
History of diabetes (%)								
Yes	6.2	6.7	9.2	9.7	9.7	12.9	11.5	0.0010
No	93.8	93.3	90.8	90.3	90.3	87.1	88.5	
History of kidney disease (%)								
Yes	5.0	4.0	3.4	4.5	3.5	2.9	3.9	NS
No	95.0	96.1	96.6	95.5	96.5	97.1	96.2	
History of liver disease (%)								
Yes	8.3	7.7	5.8	5.7	6.5	7.4	11.5	0.0284
No	91.7	92.3	94.2	94.4	93.5	92.6	88.5	

[a]BMI, body mass index; SD, standard deviation; NS, not significant.
[b]*P* values were calculated by using the chi-square test (for categorical variables) or ANOVA (for continuous variables).

We considered several important confounding factors: cigarette smoking, alcohol consumption, and physical activity are major confounding factors associated with both BMI and mortality.[1–15,17,18] We also considered education level and marital status as potential confounding factors, as in past studies.[1,3,4,6,7,9,11,17] Furthermore, the presence of subclinical disease or a history of illness could induce weight loss and increase the risk of death.[1–4,8,9,11,14,15,17,18] To eliminate any effect of medical history, we excluded participants with a history of cancer, myocardial infarction, or stroke, and adjusted for weight change since age 20 years, history of kidney disease, and history of liver disease, in multivariate analysis.

Multivariate adjustment attenuated the HR estimates associated with a BMI of 27.5–29.9 or ≥30.0 kg/m² in women, but not in men. No single covariate resulted in significant attenuation, although an increase in body weight of 5 kg or more since age 20 years, current drinking, and ≥1 hour physical activity per week attenuated hazard ratios. In contrast, a decrease in body weight of 5 kg or less since age 20 years, past drinking, being unmarried, <1 hour spent

Table 3. Baseline characteristics by BMI[a] category in 14457 women aged 40–64 years

	BMI (kg/m²)							P value[b]
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0	
No. of subjects	425	2135	3521	3770	2890	1227	489	
Mean age (years) (SD[a])	54.1 (7.7)	53.5 (7.7)	53.9 (7.5)	54.4 (7.2)	55.6 (6.9)	55.4 (6.8)	54.9 (7.0)	<0.0001
Mean weight (kg) (SD)	42.1 (4.1)	47.3 (3.7)	51.4 (3.7)	55.9 (4.0)	60.4 (4.4)	65.6 (4.9)	73.0 (11.0)	<0.0001
Mean height (cm) (SD)	154.8 (7.7)	153.6 (5.4)	152.7 (5.2)	152.6 (5.2)	152.0 (5.2)	151.5 (5.5)	149.6 (8.6)	<0.0001
Mean BMI (kg/m²) (SD)	17.5 (0.9)	20.0 (0.7)	22.0 (0.6)	24.0 (0.6)	26.1 (0.7)	28.5 (0.7)	32.6 (4.6)	<0.0001
Weight change since age 20 years (%)								
≤−10.0 kg	19.1	8.2	3.2	1.2	0.4	0.9	0.9	<0.0001
−9.9 to −5.0 kg	31.4	22.5	14.0	5.6	2.6	1.3	1.5	
−4.9 to +4.9 kg	46.8	58.6	52.7	35.6	15.0	7.1	4.3	
+5.0 to +9.9 kg	2.2	9.5	24.3	36.9	33.7	17.4	6.1	
≥+10.0 kg	0.5	1.3	5.8	20.8	48.3	73.4	87.2	
Education (%)								
Junior high school or less	49.4	42.8	45.7	49.2	55.1	58.8	63.9	<0.0001
High school	40.2	45.0	43.3	41.6	37.8	34.1	31.1	
College/university or higher	10.4	12.2	11.0	9.3	7.0	7.1	5.0	
Marital status (%)								
Married	74.4	81.7	83.6	84.8	84.1	84.1	81.1	<0.0001
Unmarried	25.6	18.3	16.4	15.2	15.9	15.9	18.9	
Smoking status (%)								
Never smoker	79.4	82.8	88.8	90.1	89.1	88.0	87.9	<0.0001
Past smoker	2.3	2.5	1.8	2.0	2.3	2.4	2.1	
Current smoker, 1–19 cigarettes/day	12.4	9.6	6.4	5.3	6.2	5.7	5.1	
Current smoker, ≥20 cigarettes/day	5.9	5.1	3.0	2.6	2.5	3.8	4.9	
Alcohol drinking (%)								
Never drinker	66.9	64.7	68.4	68.0	68.2	69.2	64.8	0.0002
Past drinker	6.4	5.1	3.4	3.6	4.4	5.6	8.5	
Current drinker	26.7	30.2	28.3	28.3	27.4	25.2	26.7	
Time spent walking (%)								
≥1 hour/day	41.0	47.5	46.8	47.9	45.2	39.9	39.4	<0.0001
<1 hour/day	59.0	52.5	53.2	52.1	54.8	60.1	60.6	
Sports and physical exercise (%)								
≥5 hours/week	3.6	3.5	4.4	3.7	3.9	3.0	3.6	NS[a]
3–4 hours/week	4.1	4.3	4.9	5.1	5.1	4.5	3.4	
1–2 hours/week	14.0	14.6	14.1	14.7	16.4	14.7	11.7	
<1 hour/week	78.4	77.6	76.6	76.5	74.6	77.8	81.4	
History of hypertension (%)								
Yes	10.6	11.0	15.2	20.7	28.8	35.6	41.3	<0.0001
No	89.4	89.0	84.8	79.3	71.2	64.4	58.7	
History of diabetes (%)								
Yes	3.3	3.4	3.2	3.5	4.5	4.5	6.1	0.0043
No	96.7	96.6	96.9	96.6	95.5	95.5	93.9	
History of kidney disease (%)								
Yes	6.4	5.3	3.9	3.2	2.7	3.9	4.9	<0.0001
No	93.7	94.7	96.1	96.8	97.3	96.1	95.1	
History of liver disease (%)								
Yes	5.2	3.2	3.6	3.9	3.7	4.5	5.7	NS
No	94.8	96.8	96.4	96.1	96.3	95.5	94.3	

[a]BMI, body mass index; SD, standard deviation; NS, not significant.
[b]*P* values were calculated by using the chi-square test (for categorical variables) or ANOVA (for continuous variables).

walking per day, and histories of kidney disease and liver disease significantly increased HRs in men.

Almost all previous studies agree that the excess risk of mortality due to obesity decreases with age,[1–14,17,18] and our results accord with this. In underweight adults, the results of past studies have been inconsistent.[1–15] Our results are in agreement with 2 of 14 studies of men,[5,13] and 4 of 13 studies of women.[3,4,10,14]

In Japan, Matsuo et al reported the effect of age on the association between BMI and all-cause mortality.[10] Their findings agree with ours, except for underweight men. They adjusted only for age, alcohol intake, and smoking status in multivariate analysis; however, physical activity and socioeconomic status have also been identified as confounding factors for the risk of all-cause mortality.[1–15,17,18] Although their result differ from ours for underweight men, our study was more careful in adjusting for physical activity, socioeconomic status, weight change since age 20 years, marital status, and histories of kidney disease and liver disease.

Table 4. Baseline characteristics by BMI[a] category in 8477 women aged 65–79 years

	BMI (kg/m^2)							*P* value[b]
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0	
No. of subjects	503	1383	1977	1906	1666	702	340	
Mean age (years) (SD[a])	72.0 (4.3)	70.9 (4.3)	70.4 (4.2)	70.0 (4.0)	70.0 (4.0)	70.0 (4.1)	70.0 (4.0)	<0.0001
Mean weight (kg) (SD)	39.6 (4.5)	44.6 (3.7)	48.8 (3.7)	53.6 (4.0)	58.1 (4.7)	62.5 (5.2)	68.7 (12.0)	<0.0001
Mean height (cm) (SD)	151.9 (8.8)	149.5 (5.8)	148.8 (5.3)	149.3 (5.3)	149.0 (5.6)	147.8 (5.9)	144.6 (10.3)	<0.0001
Mean BMI (kg/m^2) (SD)	17.2 (1.2)	19.9 (0.7)	22.0 (0.6)	24.0 (0.6)	26.1 (0.7)	28.6 (0.7)	33.0 (5.6)	<0.0001
Weight change since age 20 years (%)								
≤−10.0 kg	41.9	22.7	12.0	4.5	3.3	1.5	1.3	<0.0001
−9.9 to −5.0 kg	33.3	35.1	25.4	16.1	8.7	4.5	2.6	
−4.9 to +4.9 kg	22.7	36.9	46.3	39.0	21.6	15.3	6.2	
+5.0 to +9.9 kg	1.8	4.9	12.7	26.6	29.9	22.7	13.1	
≥+10.0 kg	0.2	0.3	3.6	13.8	36.5	56.0	76.8	
Education (%)								
Junior high school or less	65.7	68.8	68.4	67.1	72.6	75.2	82.1	<0.0001
High school	28.6	26.4	25.0	26.2	22.1	19.2	14.7	
College/university or higher	5.7	4.8	6.6	6.7	5.2	5.6	3.3	
Marital status (%)								
Married	59.8	61.7	62.9	62.8	63.9	65.5	62.0	NS[a]
Unmarried	40.2	38.4	37.1	37.2	36.1	34.5	38.0	
Smoking status (%)								
Never smoker	84.1	90.0	90.0	91.1	92.3	91.4	89.8	0.0016
Past smoker	4.1	2.6	3.0	3.6	2.9	3.0	5.1	
Current smoker, 1–19 cigarettes/day	10.5	6.3	6.1	4.8	3.9	4.7	3.9	
Current smoker, ≥20 cigarettes/day	1.3	1.1	1.0	0.5	0.8	1.0	1.2	
Alcohol drinking (%)								
Never drinker	82.0	81.1	81.8	81.4	82.0	78.3	80.4	NS
Past drinker	4.6	4.5	4.9	4.4	3.4	4.8	5.8	
Current drinker	13.5	14.4	13.3	14.2	14.6	16.9	13.8	
Time spent walking (%)								
≥1 hour/day	34.3	40.4	39.8	38.7	35.5	34.7	28.5	0.0002
<1 hour/day	65.7	59.6	60.2	61.3	64.5	65.3	71.5	
Sports and physical exercise (%)								
≥5 hours/week	4.6	8.4	6.9	9.2	8.5	7.2	9.7	0.0003
3–4 hours/week	6.7	7.6	8.5	8.1	8.1	7.8	6.6	
1–2 hours/week	12.7	14.9	19.3	19.4	18.2	18.1	13.1	
<1 hour/week	76.0	69.0	65.3	63.3	65.2	66.9	70.7	
History of hypertension (%)								
Yes	24.7	29.9	35.0	39.8	45.8	50.7	54.7	<0.0001
No	75.4	70.1	65.0	60.2	54.2	49.3	45.3	
History of diabetes (%)								
Yes	5.8	6.1	8.7	7.5	8.2	9.0	12.9	0.0004
No	94.2	93.9	91.4	92.6	91.8	91.0	87.1	
History of kidney disease (%)								
Yes	4.4	4.3	4.5	4.0	5.0	4.4	2.1	NS
No	95.6	95.7	95.5	96.0	95.0	95.6	97.9	
History of liver disease (%)								
Yes	4.0	4.8	5.5	5.0	3.8	4.6	6.2	NS
No	96.0	95.2	94.5	95.0	96.2	95.4	93.8	

[a]BMI, body mass index; SD, standard deviation; NS, not significant.
[b]*P* values were calculated by using the chi-square test (for categorical variables) or ANOVA (for continuous variables).

Development of measures to address underweight has been slower than for obesity. However, Grabowski et al and Sergi et al showed that a low BMI in elderly adults was a predictor of mortality.[26,27] Okoro et al found that underweight was associated with subsequent disability in elderly adults.[28] Our study also found that underweight is associated with a high mortality risk in elderly men and women, irrespective of age group.

A major strength of the present study was that the participants were recruited from the general Japanese population. According to the Global Database on Body Mass Index of the WHO, the prevalence of underweight participants is higher in Japan (10%–20%) than in Western populations (0%–5%). Therefore, the Japanese population is one of the best in which to examine the excess risk of mortality due to underweight.

Several limitations of our study should be considered. First, although BMI has been accepted as satisfactory index of underweight and obesity, it cannot be used to identify distributions of fat and muscle tissue. Second, we used self-

Table 5. HRs[a] and 95% CIs[a] of all-cause mortality in 21 038 men by BMI[a] category, stratified by age group

	BMI						
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0
Total							
No.	732	3677	5617	5657	3726	1213	416
Person-years	6282	35 339	55 681	57 157	37 954	12 484	4162
No. of deaths	270	805	1004	861	513	165	67
Mortality rate[b]	43.0	22.8	18.0	15.1	13.5	13.2	16.1
Age-smoking-adjusted HRs	2.78 (2.42–3.18)	1.49 (1.35–1.64)	1.19 (1.09–1.22)	1.00 (reference)	0.90 (0.81–1.00)	0.90 (0.76–1.06)	1.11 (0.87–1.43)
Multivariate HRs1[c]	1.42 (1.23–1.65)	1.10 (0.99–1.22)	1.04 (0.95–1.14)	1.00 (reference)	1.01 (0.90–1.13)	1.10 (0.92–1.31)	1.44 (1.11–1.87)
Multivariate HRs2[d]	1.52 (1.31–1.76)	1.14 (1.03–1.26)	1.06 (0.96–1.16)	1.00 (reference)	1.00 (0.89–1.12)	1.06 (0.89–1.26)	1.39 (1.07–1.81)
Multivariate HRs3[e]	1.35 (1.15–1.59)	1.06 (0.95–1.19)	1.01 (0.92–1.12)	1.00 (reference)	0.99 (0.88–1.12)	1.05 (0.87–1.26)	1.42 (1.07–1.88)
40–64 y							
No.	310	2159	3591	3852	2637	903	312
Person-years	3053	21 992	36 885	40 026	27 421	9425	3221
No. of deaths	47	224	340	305	211	75	33
Mortality rate[b]	15.4	10.2	9.2	7.6	7.7	8.0	10.2
Age-smoking-adjusted HRs	1.76 (1.29–2.39)	1.25 (1.05–1.49)	1.17 (1.01–1.37)	1.00 (reference)	1.07 (0.90–1.28)	1.17 (0.91–1.51)	1.54 (1.08–2.21)
Multivariate HRs1[c]	1.26 (0.92–1.73)	1.07 (0.89–1.28)	1.11 (0.95–1.30)	1.00 (reference)	1.14 (0.95–1.37)	1.27 (0.97–1.66)	1.71 (1.17–2.50)
Multivariate HRs2[d]	1.32 (0.96–1.82)	1.09 (0.91–1.31)	1.12 (0.96–1.32)	1.00 (reference)	1.12 (0.93–1.35)	1.22 (0.93–1.60)	1.64 (1.12–2.40)
Multivariate HRs3[e]	1.24 (0.87–1.78)	1.11 (0.92–1.35)	1.13 (0.95–1.34)	1.00 (reference)	1.16 (0.96–1.41)	1.20 (0.90–1.61)	1.62 (1.07–2.45)
65–79 y							
No.	422	1518	2026	1805	1089	310	104
Person-years	3229	13 347	18 796	17 131	10 533	3059	941
No. of deaths	223	581	664	556	302	90	34
Mortality rate[b]	69.1	43.5	35.3	32.5	28.7	29.4	36.1
Age-smoking-adjusted HRs	1.88 (1.61–2.20)	1.26 (1.12–1.41)	1.06 (0.94–1.18)	1.00 (reference)	0.91 (0.79–1.05)	0.96 (0.77–1.19)	1.21 (0.86–1.71)
Multivariate HRs1[c]	1.49 (1.26–1.76)	1.11 (0.98–1.26)	1.01 (0.90–1.14)	1.00 (reference)	0.94 (0.81–1.09)	1.01 (0.80–1.27)	1.25 (0.87–1.80)
Multivariate HRs2[d]	1.59 (1.35–1.89)	1.16 (1.03–1.32)	1.03 (0.92–1.16)	1.00 (reference)	0.93 (0.80–1.07)	0.97 (0.77–1.23)	1.23 (0.86–1.76)
Multivariate HRs3[e]	1.48 (1.23–1.78)	1.09 (0.96–1.25)	0.98 (0.87–1.11)	1.00 (reference)	0.88 (0.76–1.03)	0.91 (0.71–1.17)	1.22 (0.83–1.79)

[a]HR, hazard ratio; CI, confidence interval; BMI, body mass index.
[b]Mortality rate was defined as number of deaths per 1000 person-years.
[c]Multivariate HRs1 were adjusted for age in 5-year categories; weight change since age 20 years (loss of 10.0 kg or more, loss of 5.0–9.9 kg, change of less than ±5.0 kg, gain of 5.0–9.9 kg, or gain of 10.0 kg or more); education (junior high school or less, high school, or college/university or higher); marital status (married or unmarried); cigarette smoking (never smoker, past smoker, current smoker consuming 1–19 cigarettes per day, or current smoker consuming at least 20 cigarettes per day); alcohol drinking (never drinker, past drinker, or current drinker); time spent walking per day (less than 1 hour, or 1 hour or longer); sports and physical exercise time per week (less than 1 hour, 1–2 hours, 3–4 hours, or 5 hours or longer); history of kidney disease (yes or no); history of liver disease (yes or no).
[d]Multivariate HRs2 were further adjusted for history of hypertension (yes or no) and history of diabetes (yes or no).
[e]Multivariate HRs3 excluded from multivariate HRs2 the 473 men who died within the 2 years after baseline.

reported BMI at baseline. Niedhammer et al showed that there is a systematic bias in self-reported weight and height.[29] However, we previously evaluated the validity of self-reported BMI, and demonstrated a high correlation and appropriate agreement between self-reported BMI and measured BMI in a subsample of 14 883 participants ($r = 0.88$, $\kappa = 0.72$). We consider this bias to be a nondifferential misclassification that is not dependent upon all-cause death. This misclassification weakens the true association toward the null. Third, as a result of stratification by age group, there was a possibility of beta error because of inadequate numbers of participants and events. Finally, there is a possibility of residual confounding by physical activity.

In summary, obesity increases mortality risk in middle-aged men, whereas underweight, rather than obesity, is associated with high mortality risk in elderly men. In women, obesity increases mortality risk in middle age, and underweight increases mortality risk irrespective of age. Although there

Table 6. HRs[a] and 95% CIs[a] of all-cause mortality in 22934 women by BMI[a] category, stratified by age group

	BMI						
	<18.5	18.5–20.9	21.0–22.9	23.0–24.9	25.0–27.4	27.5–29.9	≥30.0
Total							
No.	928	3518	5498	5676	4556	1929	829
Person-years	9011	34782	55716	57537	46281	19477	8313
No. of deaths	174	371	451	415	357	159	95
Mortality rate[b]	19.3	10.7	8.1	7.2	7.7	8.2	11.4
Age-smoking-adjusted HRs	2.66 (2.23–3.18)	1.48 (1.28–1.70)	1.12 (0.98–1.28)	1.00 (reference)	1.07 (0.93–1.23)	1.13 (0.94–1.36)	1.59 (1.27–1.99)
Multivariate HRs1[c]	1.49 (1.24–1.80)	1.15 (0.99–1.33)	0.99 (0.87–1.14)	1.00 (reference)	1.03 (0.89–1.19)	1.07 (0.89–1.30)	1.33 (1.05–1.69)
Multivariate HRs2[d]	1.58 (1.31–1.91)	1.19 (1.03–1.38)	1.01 (0.88–1.15)	1.00 (reference)	1.00 (0.87–1.16)	1.04 (0.85–1.26)	1.24 (0.97–1.57)
Multivariate HRs3[e]	1.44 (1.17–1.78)	1.18 (1.01–1.38)	1.02 (0.88–1.18)	1.00 (reference)	1.06 (0.91–1.24)	1.09 (0.88–1.34)	1.37 (1.07–1.77)
40–64 y							
No.	425	2135	3521	3770	2890	1227	489
Person-years	4416	21274	35734	38262	29435	12484	4999
No. of deaths	32	92	137	128	104	49	28
Mortality rate[b]	7.2	4.3	3.8	3.3	3.5	3.9	5.6
Age-smoking-adjusted HRs	2.10 (1.43–3.10)	1.30 (0.99–1.70)	1.16 (0.91–1.48)	1.00 (reference)	0.99 (0.76–1.28)	1.11 (0.80–1.54)	1.59 (1.06–2.39)
Multivariate HRs1[c]	1.46 (0.96–2.22)	1.10 (0.82–1.47)	1.09 (0.85–1.40)	1.00 (reference)	1.00 (0.77–1.31)	1.06 (0.75–1.51)	1.47 (0.94–2.27)
Multivariate HRs2[d]	1.55 (1.02–2.36)	1.14 (0.85–1.52)	1.10 (0.86–1.41)	1.00 (reference)	0.98 (0.75–1.28)	1.01 (0.71–1.43)	1.38 (0.89–2.14)
Multivariate HRs3[e]	1.78 (1.13–2.81)	1.36 (1.00–1.86)	1.21 (0.92–1.59)	1.00 (reference)	1.02 (0.76–1.36)	0.99 (0.68–1.45)	1.32 (0.82–2.15)
65–79 y							
No.	503	1383	1977	1906	1666	702	340
Person-years	4595	13508	19982	19275	16845	6994	3314
No. of deaths	142	279	314	287	253	110	67
Mortality rate[b]	30.9	20.7	15.7	14.9	15.0	15.7	20.2
Age-smoking-adjusted HRs	1.67 (1.37–2.05)	1.26 (1.07–1.48)	1.00 (0.85–1.17)	1.00 (reference)	1.02 (0.86–1.21)	1.07 (0.86–1.34)	1.33 (1.02–1.73)
Multivariate HRs1[c]	1.47 (1.19–1.82)	1.14 (0.96–1.36)	0.95 (0.81–1.12)	1.00 (reference)	1.04 (0.87–1.24)	1.07 (0.85–1.35)	1.26 (0.95–1.68)
Multivariate HRs2[d]	1.56 (1.26–1.93)	1.19 (1.00–1.41)	0.96 (0.82–1.13)	1.00 (reference)	1.01 (0.85–1.21)	1.04 (0.83–1.31)	1.17 (0.88–1.55)
Multivariate HRs3[e]	1.45 (1.15–1.83)	1.17 (0.97–1.40)	0.96 (0.81–1.15)	1.00 (reference)	1.04 (0.86–1.25)	1.07 (0.83–1.37)	1.24 (0.92–1.68)

[a]HR, hazard ratio; CI, confidence interval; BMI, body mass index.
[b]Mortality rate was defined as number of deaths per 1000 person-years.
[c]Multivariate HRs1 were adjusted for age in 5-year categories; weight change since age 20 years (loss of 10.0 kg or more, loss of 5.0–9.9 kg, change of less than ±5.0 kg, gain of 5.0–9.9 kg, or gain of 10.0 kg or more); education (junior high school or less, high school, or college/university or higher); marital status (married or unmarried); cigarette smoking (never smoker, past smoker, current smoker consuming 1–19 cigarettes per day, or current smoker consuming at least 20 cigarettes per day); alcohol drinking (never drinker, past drinker, or current drinker); time spent walking per day (less than 1 hour, or 1 hour or longer); sports and physical exercise time per week (less than 1 hour, 1–2 hours, 3–4 hours, or 5 hours or longer); history of kidney disease (yes or no); history of liver disease (yes or no).
[d]Multivariate HRs2 were further adjusted for history of hypertension (yes or no) and history of diabetes (yes or no).
[e]Multivariate HRs3 excluded from multivariate HRs2 the 266 women who died within the 2 years after baseline.

was no significant interaction by age group or sex, the mortality risks associated with underweight and obesity may nevertheless be dependent on sex and age group.

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1年間の要介護認定発生に対する基本チェックリストの予測妥当性の検証
大崎コホート2006研究

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目的　介護保険制度の二次予防事業の対象者把握には，25項目の基本チェックリストを用いている。しかし，基本チェックリストによる要介護認定の発生予測能を実地に検証した報告は少ない。本研究の目的は，基本チェックリストの各項目や各基準について，要介護認定の新規発生に対する関連の程度とスクリーニングの精度を検証することである。

方法　2006年12月に宮城県大崎市の65歳以上の全市民を対象に，基本チェックリストを含む自記式質問紙を配布した。有効回答者のうち要介護認定の情報提供に同意し，基本チェックリストの回答項目数が2項目以上で，ベースライン時に要介護認定を受けていない者を1年間追跡し，死亡・転出した者を除外した14,636人を解析対象とした。解析には性・年齢の影響を補正するために多重ロジスティック回帰分析を用い，基本チェックリストの各項目と二次予防事業の対象者の選定に用いられる各分野の該当基準に該当した場合のそれぞれで，1年間の新規要介護認定発生のオッズ比と95%信頼区間（95%CI）を推定した。また各分野に関して，感度と特異度を算出し，Receiver operating characteristic（ROC）分析を行った。

結果　二次予防事業の対象者の選定基準に該当する者は5,560人（38.0%），1年間の要介護認定発生者は483人（3.3%）であった。基本チェックリストの全項目が，要介護認定発生と有意に関連した（オッズ比の範囲：1.45～4.67）。全ての分野の該当基準も，要介護認定発生と有意に関連した（オッズ比の範囲：1.93～6.54）。そして「二次予防事業の対象者」の基準のオッズ比（95%CI）は3.80（3.02–4.78）であった。各分野のうち，ROC曲線下面積が最も高かったのは「うつ予防・支援の5項目を除く20項目」であり，7項目以上を該当基準にすると，「二次予防事業の対象者」の基準を用いた場合に比べ，感度は変わらないが（7項目以上を該当基準にした場合77.0%，「二次予防事業の対象者」の基準を用いた場合78.1%），特異度は高かった（それぞれ75.6%，63.4%）。

結論　基本チェックリストの各項目や各基準は，その後1年間の要介護認定の新規発生の予測に有用であった。しかし，項目や分野によって関連の強さや予測精度は異なり，基準値には改善の余地があった。

Key words：基本チェックリスト，介護予防，要介護認定，予測妥当性，二次予防事業

I　緒　　言

2006年4月,「介護予防」を重視した介護保険制度の改正が行われた。その一つとして，要介護認定非該当者のうち要介護状態になるおそれの高い者（旧：特定高齢者）を対象にした地域支援事業特定高齢者施策（現在の二次予防事業）が導入された[1]。

地域の中で要介護状態になるおそれの高い者を把握するために，二次予防事業の対象者把握事業では25項目の質問からなる「基本チェックリスト[2]」を用いている（『資料』上段）。基本チェックリストは，第一に「二次予防事業の対象者」の選定に用いられており，そのための基準が提示されている（『資料』下段）。第二に，二次予防事業の対象者に選定された者が「閉じこもり予防・支援」,「認知症予防・支援」,「うつ予防・支援」のプログラムに併せて参加することを考慮する際にも活用されており，これら

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3つの分野の基準が提示されている（『資料』中段）。

基本チェックリストには要介護認定（要支援・要介護）の発生に対する予測妥当性が求められている。予測妥当性の検証には，基本チェックリストの各項目や各分野の基準，包括的な基準である「二次予防事業の対象者の選定基準」のそれぞれについて，要介護認定発生のリスク因子としての関連の有無と強さの評価，あるいは感度，特異度の算出やROC（Receiver Operating Characteristic）分析といったスクリーニングツールとしての精度評価が必要となる。しかし，これらに関する情報は限られている。

鈴木は，基本チェックリストの要介護認定の新規発生に対するスクリーニングの精度を評価するため，「特定高齢者候補者の選定基準（現：二次予防事業の対象者の選定基準）」を区分値として感度，特異度，陽性反応適中度，陰性反応適中度を算出し，感度73.5%，特異度57.8%で比較的良好と報告している[3]。また，川越は，松江市版の基本チェックリスト（特有の項目を5項目含む）の30項目を同時投入した多重ロジスティック回帰分析により，要介護認定の発生との関連を検討している[4]。その結果，厚生労働省の基本チェックリスト25項目中で有意な項目として抽出されたのは7項目であったと報告している。以上の二つの報告から基本チェックリストの各項目や各分野の基準の予測妥当性が十分に明確になっているとは言い難い。

本研究の目的は，第一に要介護認定発生のリスク因子としての基本チェックリストの各項目や各基準の関連の有無と強さを検証すること，第二に要介護認定の発生に対する基本チェックリストの各分野のスクリーニングの精度を検証することである。そのため，宮城県大崎市の65歳以上の住民を対象に基本チェックリストに回答してもらい，その後1年間の要介護認定の発生を追跡した。

Ⅱ 研究方法

1. ベースライン時の基本チェックリストの調査

宮城県大崎市の40歳以上の住民全員（77,235人）を調査対象に，生活習慣等に関する記名自記式質問紙調査である「大崎市市民健康調査」を2006年12月1日～15日に実施した[5]。そのうち65歳以上の市民に対し，厚生労働省の基本チェックリストを用いた調査を実施した（詳細は表1を参照）[2]。

基本チェックリストの「No. 12) Body Mass Index (BMI) < 18.5 (kg/m^2)」以外の質問項目では，「はい」または「いいえ」による回答を得ており，よりネガティブな回答を「該当あり」とした。「No. 12) BMI < 18.5」では，質問紙に記入された身長，体重の値から体重［kg］/身長［m］^{2}の式によってBMIを算出し，区分した。なお，本研究では，鈴木の先行研究と同様に，行政上の業務手順に従い，欠損データは「該当あり」とみなした[3,6]。

また現行の二次予防事業の対象者の選定（「閉じこもり予防・支援」，「認知症予防・支援」，「うつ予防・支援」への参加の判定を含む）に関わる7分野の基準と二次予防事業の対象者の選定基準についても検討した[2,7]。具体的には，① No. 1からNo. 20の「うつ予防・支援の5項目を除く20項目」のうち10項目以上，② No. 6からNo. 10の「運動器の機能向上」の項目のうち3項目以上，③ No. 11とNo. 12の「栄養改善」の項目のうち2項目，④ No. 13からNo. 15の「口腔機能の向上」の項目のうち2項目以上，⑤ No. 16とNo. 17の「閉じこもり予防・支援」の項目のうちNo. 16，⑥ No. 18からNo. 20の「認知症予防・支援」の項目のうち1項目以上，⑦ No. 21からNo. 25の「うつ予防・支援」の項目のうち2項目以上に，該当した場合について，それぞれ「該当あり」とした。また，「二次予防事業の対象者」は，①～④のいずれかが該当した場合を「該当あり」とした。

2. 追跡調査

基本チェックリストによるスクリーニングが健康診査などを通して1年ごとに行われていることを想定し，本研究ではベースライン調査の基準日（2006年12月16日）から1年以内に新規に要介護認定（要支援・要介護）を受けた場合を，「要介護認定発生」と定義した。上記のエンドポイントについては，大崎市と東北大学大学院医学系研究科社会医学講座公衆衛生学分野との調査実施協定に基づき，文書による同意が得られた者を対象として，要介護認定の区分および認定年月日に関する情報が本分野に提供された。

死亡または転出の情報は，住民基本台帳の除票により確認した。

3. 解析

対象者選定の流れを示す（図1）。調査対象である住民基本台帳に登録された宮城県大崎市の65歳以上の全住民31,694人のうち，調査実施基準日（2006年12月1日）で死亡・転出・入院・長期不在等で配布できなかった者を除いた31,237人（対象の98.6%）に記名自記式質問紙を配布し，23,422人（対象の73.9%）より回答を得た。このうち23,091人（対象の72.9%）から有効回答が得られ，このうち要介護認定の情報提供に同意したのは16,758人（有効回答の72.6%）であった。これら同意者のうち，基本チ

表1　基本チェックリストの各項目における新規要介護認定の発生状況

基本チェックリスト25項目	該当なし 回答 人数	%[i]	うち要介護認定発生 発生数	%[ii]	該当あり 回答 人数	%[i]	うち要介護認定発生 発生数	%[ii]	個別投入[iii] OR (95%CI)[v]	P	同時投入[iv] OR (95%CI)[v]	P
1) バスや電車で1人で外出していますか	10,441	71.3	168	1.6	4,195	28.7	315	7.5	3.41 (2.79–4.17)	<.0001	1.25 (0.96–1.63)	0.0927
2) 日用品の買物をしていますか	12,471	85.2	215	1.7	2,165	14.8	268	12.4	4.67 (3.82–5.71)	<.0001	2.05 (1.55–2.69)	<.0001
3) 預貯金の出し入れをしていますか	12,022	82.1	247	2.1	2,614	17.9	236	9.0	3.20 (2.64–3.90)	<.0001	1.16 (0.90–1.49)	0.2504
4) 友人の家を訪ねていますか	12,242	83.6	245	2.0	2,394	16.4	238	9.9	3.57 (2.93–4.35)	<.0001	1.42 (1.11–1.82)	0.0059
5) 家族や友人の相談にのっていますか	12,820	87.6	289	2.3	1,816	12.4	194	10.7	3.17 (2.58–3.88)	<.0001	1.22 (0.96–1.55)	0.1053
6) 階段を手すりや壁をつたわらずに昇っていますか	9,457	64.6	144	1.5	5,179	35.4	339	6.6	2.58 (2.09–3.19)	<.0001	1.25 (0.97–1.61)	0.0842
7) 椅子に座った状態から何もつかまらずに立ち上がっていますか	11,720	80.1	211	1.8	2,916	19.9	272	9.3	3.25 (2.66–3.98)	<.0001	1.43 (1.12–1.83)	0.0046
8) 15分位続けて歩いていますか	12,049	82.3	277	2.3	2,587	17.7	206	8.0	2.38 (1.95–2.90)	<.0001	0.98 (0.77–1.24)	0.8353
9) この1年間に転んだことがありますか	10,710	73.2	262	2.5	3,926	26.8	221	5.6	1.97 (1.63–2.38)	<.0001	1.31 (1.06–1.62)	0.0110
10) 転倒に対する不安は大きいですか	6,964	47.6	118	1.7	7,672	52.4	365	4.8	1.88 (1.50–2.34)	<.0001	1.05 (0.82–1.34)	0.7283
11) 6カ月間で2～3 kg以上の体重減少がありましたか	11,897	81.3	334	2.8	2,739	18.7	149	5.4	1.77 (1.45–2.18)	<.0001	1.20 (0.96–1.51)	0.1180
12) BMI $(kg/m^2)<18.5$	11,988	81.9	310	2.6	2,648	18.1	173	6.5	1.78 (1.45–2.17)	<.0001	1.41 (1.14–1.74)	0.0018
13) 半年前に比べて固いものが食べにくくなりましたか	9,076	62.0	196	2.2	5,560	38.0	287	5.2	1.77 (1.46–2.15)	<.0001	1.01 (0.81–1.25)	0.9469
14) お茶や汁物等でむせることがありますか	12,057	82.4	327	2.7	2,579	17.6	156	6.1	1.74 (1.42–2.13)	<.0001	0.97 (0.76–1.22)	0.7630
15) 口の渇きが気になりますか	11,103	75.9	301	2.7	3,533	24.1	182	5.2	1.45 (1.19–1.77)	0.0002	0.86 (0.69–1.08)	0.1847
16) 週に1回以上は外出していますか	12,303	84.1	291	2.4	2,333	15.9	192	8.2	2.20 (1.80–2.70)	<.0001	0.80 (0.63–1.03)	0.0774
17) 昨年と比べて外出の回数が減っていますか	10,083	68.9	164	1.6	4,553	31.1	319	7.0	2.89 (2.37–3.54)	<.0001	1.54 (1.22–1.94)	0.0003
18) 周りの人から「いつも同じ事を聞く」などの物忘れがあると言われますか	11,521	78.7	250	2.2	3,115	21.3	233	7.5	2.56 (2.12–3.10)	<.0001	1.29 (1.03–1.61)	0.0243
19) 自分で電話番号を調べて，電話をかけることをしていますか	13,305	90.9	324	2.4	1,331	9.1	159	12.0	3.46 (2.79–4.30)	<.0001	1.55 (1.20–1.99)	0.0007
20) 今日が何月何日かわからない時がありますか	10,982	75.0	231	2.1	3,654	25.0	252	6.9	2.53 (2.09–3.06)	<.0001	1.41 (1.13–1.75)	0.0020
21) (ここ2週間) 毎日の生活に充実感がない	11,991	81.9	274	2.3	2,645	18.1	209	7.9	2.83 (2.34–3.44)	<.0001	1.27 (0.99–1.64)	0.0584
22) (ここ2週間) これまで楽しんでやれていたことが楽しめなくなった	12,679	86.6	300	2.4	1,957	13.4	183	9.4	2.90 (2.38–3.55)	<.0001	1.10 (0.84–1.43)	0.4916
23) (ここ2週間) 以前は楽にできていたことが今ではおっくうに感じられる	9,811	67.0	170	1.7	4,825	33.0	313	6.5	2.62 (2.15–3.19)	<.0001	1.09 (0.84–1.40)	0.5174
24) (ここ2週間) 自分が役に立つ人間だと思えない	11,411	78.0	270	2.4	3,225	22.0	213	6.6	2.15 (1.77–2.60)	<.0001	1.05 (0.83–1.31)	0.6934
25) (ここ2週間) わけもなく疲れたような感じがする	10,653	72.8	219	2.1	3,983	27.2	264	6.6	2.41 (1.99–2.91)	<.0001	1.16 (0.91–1.47)	0.2417

i：全解析対象者（14,636名）に対する割合（%）
ii：回答人数に対する割合（%）
iii：性，年齢とともに上記の各項目（1項目ずつ）について投入したモデル（多重ロジスティック回帰分析。該当なしが基準）
iv：性，年齢とともに上記の全項目（25項目）を同時に投入したモデル（多重ロジスティック回帰分析。該当なしが基準）
v：オッズ比（95%信頼区間）

ェックリストの回答項目数が1項目以下の67人と，ベースライン調査時に要介護認定を受けていた1,814人を除外した14,877人を1年間追跡した。そして，追跡期間内に新規の要介護認定を受けずに死亡・転出した241人（死亡212人，転出29人）を除外し，14,636人を解析対象とした。