Nutritional Status and Body Composition of Independently Living Older Adults in a Snowy Region of Japan

Tomoko Shimoda, RN, PHN, MS[1],
Teppei Suzuki, RT, MHS, MBA[1], Noriko Takahashi, RN, NM, MS[1],
Kaori Tsutsumi, RT, PhD[1], Mina Samukawa, PT, PhD[1],
Shoko Yoshimachi, PH, BA[2], Teruaki Goto, PH, BA[2],
Hisashi Enomoto, BA[3], Nobuyuki Kise, BA[3],
Katsuhiko Ogasawara, RT, MBA, PhD[1],
and Sadako Yoshimura, RN, PHN, NM, PhD[1]

Abstract

Lifestyle diseases, which are associated with nutrition, account for 30% of elderly requiring long-term care. To increase health expectancy among Japan's rapidly aging population, we investigated the nutritional status and body composition of elderly adults living in a region subject to heavy snowfall, to identify pertinent health indicators. The dietary habits of 288 local residents aged ≥50 years were analyzed using body composition and a brief-type self-administered diet history questionnaire. Body mass index of all residents was normal. Basal metabolic rate (BMR) and muscle mass were reduced in the older group. Dietary habits did not differ with age among men, but older women had significantly higher dietary intake. BMR and muscle mass declined with age, even when dietary intake was sustained. Despite sufficient dietary intake, independently living older adults demonstrate less efficient use of food with age. Interventions to reduce excessive sodium and protein intake are required.

Introduction

Japan's population is rapidly aging. The 2015 national census revealed that 26% of the population (ca. 33.8 million people) is 65 years or older and 12.5% (ca. 15.7 million people) is 75 years or older (Ministry of Internal Affairs and Communications, 2015). The proportion of the population who are 65 years or older is higher in Japan than in other major industrialized nations, such as Italy (22.4%) and Germany (21.2%). Japan currently has the world's highest life expectancy (United Nations, 2015). The demographic shift has resulted from a concurrent decrease in birth and death rates, leading to an increased average life expectancy. The life expectancy averages in Japan are 80.5 and 86.8 years for men and women, respectively (Ministry of Health, Labour, and Welfare, 2015). Health expectancy ages are 71.2 years for men and 74.2 years for women. Since the World Health Organization began advocating increasing health expectancy in 2000, interest in how to increase the length of time an individual can live in good health, rather than simply increasing the length of life, has increased. Because health expectancy is defined as the length of time a person can live without being constrained by health problems, the difference between average life expectancy and health expectancy represents the "unhealthy period" during which there are constraints to daily living. In 2013, in Japan, that difference was approximately 10 years. To increase health expectancy, it is necessary to understand the

[1]Hokkaido University, Sapporo, Japan
[2]TSURUHA Holdings Inc., Sapporo, Japan
[3]City of Iwamizawa, Japan

Corresponding Author:
Tomoko Shimoda, Faculty of Health Sciences, Hokkaido University, Kita-12, Nishi-5, Kita-ku, Sapporo, Hokkaido 060-0812, Japan.
Email: tshimoda@hs.hokudai.ac.jp

health status and living habits of healthy residents in local communities.

In 2015, the principal causes of death in Japan were malignancy, cardiovascular disease, pneumonia, cerebrovascular disease, and accidents for men, and malignancy, cardiovascular disease, senility, cerebrovascular disease, and pneumonia in women (Ministry of Health, Labour, and Welfare, 2015). Prevention of lifestyle diseases, which underlie some of the principal causes of death, is important. In addition, asthenia, dementia, and falls are often the reasons for the loss of ability of later-stage elderly to live independently, and become certified as "yō-kaigo" (in need of long-term care). According to a health promotion program of the Ministry of Health, Labour, and Welfare for the 21st century, 30% of the need for long-term care in Japan arises from diseases of lifestyle, including cerebrovascular disease (Ministry of Health, Labour, and Welfare, 2010). However, 50% of this need is due to dementia, age-related asthenia, arthropathy, fractures, and falls (Ministry of Health, Labour, and Welfare, 2010). Nutrition is associated with lifestyle diseases, fractures, and falls (Curtis & Safford, 2012). Therefore, to increase health expectancy, understanding the nutritional status of individuals after middle age, in which lifestyle-related diseases develop, is important.

Typical factors causing poor nutrition among older adults in Japan are social factors, psychological factors, aging, and illness (Kuzuya, 2012). In addition, overnutrition is directly related to living habits and leads to lifestyle diseases, such as obesity, diabetes mellitus, dyslipidemia, and hypertension (Hozawa et al., 2008). However, there is debate about whether nutrition has the same significant impact on mortality among older adults, especially the later-stage elderly, as it does among younger adults. Older adults tend to accumulate visceral fat and have a higher prevalence of metabolic syndrome. However, it has been reported that, for older adults, the effect of metabolic syndrome on cardiovascular disease–related mortality is insignificant (Hildrum, Mykletun, Dahl, & Midthjell, 2009). Furthermore, the effect of blood cholesterol levels and obesity on mortality diminishes with age (Prospective Studies Collaboration et al., 2007; Tamakoshi et al., 2010). A study conducted in the West reported that overnutrition, particularly obesity (body mass index [BMI] ≥30 kg/m^2), was associated with frailty (Blaum, Xue, Michelon, Semba, & Fried, 2005). This study showed that, of the five criteria used to diagnose frailty, a small percentage of the obese group met the criterion for weight loss; however, a high percentage met the criteria for slowness (walking speed), low physical activity, and weakness (grip strength). Whether these data apply to the Japanese population requires further empirical testing, because the number of Japanese older adults who qualify as obese is extremely small.

In Japan, in 2010, there were 2.15 doctors for every 1,000 people, which is significantly fewer than the average of 3.00 for the member countries of the Organisation for Economic Cooperation and Development. Furthermore, the distribution of doctors among communities is uneven, with few doctors in mountainous areas and remote regions (Annual Health, Labour and Welfare Report, 2012-2013). In Hokkaido, a large island in northern Japan, the life expectancy averages are 78.3 and 85.8 years and health expectancy averages are 70.0 and 73.2 years for men and women, respectively. These differences are similar to the national averages. There are more medically underserved areas in Hokkaido than anywhere else in Japan; however, this is improving. Moreover, access to medical facilities in this region can be constrained during the winter, due to snowfall.

Given the importance of exploring possible measures to maintain health in such areas, a telehealth consultation system was designed and empirically tested for the promotion and maintenance of health (Shimoda et al., 2015). It was demonstrated that health consultations can be successfully conducted using information and communication technology when patients are far from medical facilities. Moreover, the content of those consultations was shown to be diverse. However, the lives and nutritional status of people living in these kinds of regions with heavy snowfall are yet to be studied. The weather may be a barrier to physical activity, but this hypothesis has not yet been assessed objectively. The estimated magnitudes for the various effects were modest, ranging from ca. 1% to ca. 20%. Thus, for an average individual taking ca. 10,000 steps/day, weather-dependent changes in physical activity could involve 2,000 steps/day (Chan, Ryan, & Tudor-Locke, 2006). Therefore, we studied a sample of healthy older adults living in a region prone to heavy snowfall to assess their nutritional status and body composition to promote the health of local residents and to obtain pertinent indicators.

Method

Participants

The participants consisted of 409 community residents who attended health examinations at a drugstore between January and March 2016. Data from 288 residents aged ≥50 years were used for this analysis.

Measurements and Survey Items

Medical history and living habits. Participants completed a self-administered questionnaire that asked about their medical history (previous illnesses and treatment), exercise habits (frequency per week engaging in moderate exercise for ≥10 min), and bowel habits (number of stools passed per week); they were also asked to provide a self-rated health assessment ("healthy," "more or less healthy," "not very healthy," and "not healthy"). For the

analysis, these responses were grouped into two categories: "healthy" and "not healthy."

Height and body composition. Height was measured using a digital height gauge (AD-6400; A&D Medical, Tokyo, Japan). Body composition was measured using a body composition scale (Well Scan900; Canon, Osaka, Japan).

Blood pressure and grip strength. Blood pressure was measured using an automatic blood pressure monitor (HBP-T1055-N; Omron, Kyoto, Japan). Grip strength was measured twice on the right and left using the Jamar Hydraulic Crush Strength Meter (Fabrication Enterprises, Inc., White Plains, NY, USA).

Self-drawing of blood samples. Under the supervision of a pharmacist, the participants used a simple blood testing kit (Eiken Chemical Co., Tokyo, Japan) to draw a sample of their own blood. Each blood sample was collected into a specimen tube that came with the kit and was analyzed for total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, creatinine, urea nitrogen, uric acid, and hemoglobin A1c.

Nutritional status. Participants completed the brief-type self-administered diet history questionnaire (BDHQ). This is a brief version of the diet history questionnaire that retains the features of the original questionnaire, but simplifies its structure and makes the processing of the answers and data more convenient. The questionnaire can be printed on both sides of a single A3-size page of paper and takes an average of 15 min to complete. The BDHQ was developed for use in large-scale nutritional epidemiology studies and in studies in which nutrition is of secondary interest. Using a nutritional value calculation program, the dietary intake of approximately 30 types of nutrients and 50 types of foods can be calculated. The questionnaire's validity has been demonstrated (Kobayashi et al., 2012).

Statistical Analysis

The data obtained from the questionnaires were stratified into three groups according to age: 50 to 64 years (Group X), 65 to 74 years (Group Y), and 75 years or older (Group Z). Significance was tested using the chi-square test and ANOVA. Results are shown as mean ± standard deviation. JMP 12.2.0 software was used to perform statistical analyses. The level of statistical significance was 5%.

Results

Responses were obtained from 71 men and 217 women who were 50 to 89 years of age. As shown in Table 1, in the self-reported health assessment, 68.8%, 70.6%, and 52.4% of men in Groups X, Y, and Z, respectively, considered themselves healthy, as did 67.6%, 74.1%, and 44.0%, respectively, of women. There were no significant differences between the three groups in terms of self-rated health assessment. The majority (≥70%) of both men and women habitually exercised 1 to 2 days per week. There were no significant group differences in terms of bowel habits. Table 2 shows the data from the blood tests. There were no significant differences for the groups among men. However, among women, there were significant group differences in levels of creatinine, urea nitrogen, and uric acid.

The average BMI was within the normal range for men and women, although it was higher for women in Group Z (Table 3). The percentage of body fat was higher and basal metabolic rate (BMR) and muscle mass were lower for women in Group Z than for women in the other groups. There were no significant group differences in the percentage of body fat among the groups of men; however, compared with the other groups, BMR and muscle mass were significantly lower in Group Z.

There were no significant differences in mean blood pressure among the three groups of men. However, there was a significant difference among the groups of women (Figure 1). In addition, grip strength was significantly lower ($p < 0.01$) in Group Z for both men and women (Figure 2). We found a positive correlation between grip strength and muscle mass for men ($r = .55, p < .001$) and a weak positive correlation for women ($r = .26, p = .001$) (Figure 3).

In terms of dietary intake, there were no significant differences in any dietary intake category among the groups of men (Table 4). Among women, there were significant differences in all categories except carbohydrates and alcohol, with the dietary intake being highest in Group Z. No correlation was demonstrated between protein intake and muscle mass for men or women (men: $r = .076, p = .25$; women: $r = .013, p = .20$).

Discussion

Other studies (Jingu, Egami, Kinukawa, Sano, & Takei, 2003; Nakamura et al., 2002) have reported that in Japan, 20% to 40% of self-rated health assessments tend toward the negative, that is, "not very healthy," and the results of this study were similar. There is no reason to think that the participants in this study, as a group, had a bias that would affect their health assessments. Although this study's results included participants with medical histories, all participants were living independently. All laboratory blood test results were within the Japanese reference ranges, with the exception of the triglyceride levels, which were high for women in Group Y.

Regarding bowel movements, it has been reported that older adults, especially those 80 years or older, have slower colonic transit (Madsen & Graff, 2004). The risk of constipation may increase with age, given that this study's results were similar for women in Group Z.

Table 1. Characteristics of Participants Stratified by Age and Sex.

Group	Men							Women						
	X		Y		Z			X		Y		Z		
	50-64		65-74		75+			50-64		65-74		75+		
Age (years)	n	%	n	%	n	%	p	n	%	n	%	n	%	p
n	16	22.5	34	47.9	21	29.6		111	51.2	81	37.3	25	11.5	
Health assessment														
Healthy	11	68.8	24	70.6	11	52.4	ns	75	67.6	60	74.1	11	44.0	ns
Not healthy	1	6.3	7	20.6	5	23.8		17	15.3	7	8.6	4	16.0	
No response	4	25.0	3	8.8	5	23.8		19	17.1	14	17.3	10	40.0	
Exercise habits														
0 days	2	12.5	0	0.0	0	0.0	ns	4	3.6	2	2.5	1	4.0	ns
1-2 days	12	75.0	31	91.2	17	81.0		93	83.8	72	88.9	19	76.0	
3+ days	0	0.0	1	2.9	1	4.8		0	0.0	1	1.2	0	0.0	
No response	2	12.5	2	5.9	3	14.3		14	12.6	6	7.4	5	20.0	
Bowel movements														
Less than 4/week	0	0.0	4	11.8	4	19.0	ns	13	11.7	9	11.1	5	20.0	ns
4+/week	13	81.3	29	85.3	15	71.4		89	80.2	66	81.5	17	68.0	
No response	3	18.8	1	2.9	2	9.5		9	8.1	6	7.4	3	12.0	
Medical history														
Malignant tumors	0	0.0	2	2.8	2	2.8	—	2	0.9	3	1.4	1	0.5	—
Stroke	0	0.0	4	5.6	0	0.0		1	0.5	0	0.0	0	0.0	
Heart attack	0	0.0	0	0.0	1	1.4		0	0.0	0	0.0	0	0.0	
Angina	0	0.0	0	0.0	4	5.6		2	0.9	1	0.5	0	0.0	
Arrhythmia	0	0.0	2	2.8	1	1.4		2	0.9	3	1.4	2	0.9	
High blood pressure	4	5.6	12	16.9	5	7.0		17	7.8	19	8.8	8	3.7	
Dyslipidemia	1	1.4	5	7.0	6	8.5		20	9.2	16	7.4	8	3.7	
Diabetes	0	0.0	3	4.2	3	4.2		4	1.8	3	1.4	1	0.5	
COPD	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	
Tuberculosis	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	
Kidney disease	0	0.0	0	0.0	1	1.4		0	0.0	0	0.0	0	0.0	
Bone fractures	3	4.2	4	5.6	1	1.4		9	4.1	7	3.2	6	2.8	
Dementia	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	

Note. COPD = chronic obstructive pulmonary disease. *p* values were derived using McNemar's test.

Despite copious intake of water and consumption of insoluble dietary fiber (Table 4), Group Z had a larger percentage of individuals with a low rate of bowel movements.

It has been reported that loss of muscle mass is associated with aging (Keys, Taylor, & Grande, 1973); our findings supported this (Table 1). The older adults living in a region prone to heavy snowfall studied here lost muscle mass with age even though they were healthy and exercised habitually. BMR also decreases with age. Longitudinal studies have reported that BMR decreases by approximately 1% to 3% over the course of 10 years and that the rate of decrease is particularly rapid for men (Henry, 2000; Pannemans & Westerterp, 1995). It is assumed that this phenomenon is a result of the decline in lean mass that accompanies aging (Poehlman et al., 1993). However, the decrease in BMR associated with aging is not necessarily a linear change. Some studies have shown that there is a significant decline in BMR in men in their 40s and in

BMR for women in their 50s (Poehlman, 1992; Volpi, Mittendorfer, Rasmussen, & Wolfe, 2000); however, the causes of these decreases have not been fully explained. In this study, the decrease in BMR stratified by age was significant for both men and women. Therefore, this study provides data obtained from healthy elderly people whose activity was restricted by snow. Activity during the winter can be a criterion for health management indices for those who cannot leave their living space because of weather conditions.

In terms of grip strength and muscle mass, grip strength for both men and women was significantly lower in Group Z ($p < 0.01$). Many studies have reported that the measurement of grip strength in older adults correlates with factors such as muscle strength and walking ability (Houston et al., 2008); the results of the present study may support those findings. Measuring grip strength is a convenient and useful way to assess the overall physical strength of healthy individuals aged above 75 years and who are living independently.

Table 2. Blood Test Results of Participants Stratified by Age and Sex.

Group		Men				Women			
		X	Y	Z	*p*	X	Y	Z	*p*
Age (years)		50-64	65-74	75+		50-64	65-74	75+	
Total cholesterol (mg/dl)	M	196.67	187.33	178.11	.2849	217.58	225.32	212.60	.2034
	SD	34.71	36.46	26.48		31.95	29.59	38.90	
LDL cholesterol (mg/dl)	M	112.13	101.71	95.56	.2930	121.26	127.17	115.85	.2112
	SD	27.44	36.41	21.52		27.47	22.89	36.04	
HDL cholesterol (mg/dl)	M	58.33	51.79	56.06	.4481	71.41	67.80	66.15	.2646
	SD	13.01	18.43	15.63		16.36	17.74	14.31	
Triglycerides (mg/dl)	M	145.60	166.96	126.72	.4104	119.04	140.47	112.95	.1889
	SD	80.18	116.52	76.65		69.05	92.91	66.66	
Creatinine (mg/dl)	M	0.85	0.94	0.98	.1481	0.62	0.68	0.69	.0011
	SD	0.12	0.19	0.24		0.09	0.11	0.12	
Urea nitrogen (mg/dl)	M	19.47	20.00	20.78	.7530	17.25	19.58	19.95	.0007
	SD	4.64	4.22	6.25		4.10	3.75	4.84	
Uric acid (mg/dl)	M	6.19	5.85	6.11	.5818	4.29	4.89	4.64	.0038
	SD	0.94	1.20	0.99		1.10	1.01	1.21	
HbA1c (%)	M	5.66	5.90	5.98	.2333	5.61	5.77	5.74	.0652
	SD	0.37	0.67	0.50		0.40	0.50	0.42	

Note. HDL = high-density lipoprotein; LDL = low-density lipoprotein; HbA1c = glycated hemoglobin. *p* values were derived using ANOVA.

Table 3. Body Composition of Participants Stratified by Age and Sex.

Group		Men				Women			
		X	Y	Z	*p*	X	Y	Z	*p*
Age (years)		50-64	65-74	75+		50-64	65-74	75+	
Height (cm)	M	166.87	165.26	159.82	.0003	154.84	151.57	149.57	<.0001
	SD	6.05	5.86	5.81		5.56	4.86	4.72	
Weight (kg)	M	67.19	65.22	61.35	.0913	54.07	51.87	54.64	.1379
	SD	9.00	10.24	6.64		8.94	7.63	9.45	
Body fat (%)	M	21.96	21.88	22.11	.9896	27.47	27.98	30.99	.0471
	SD	6.70	5.99	6.06		6.41	6.63	8.35	
Body water (kg)	M	37.67	36.53	34.43	.0261	27.99	26.71	27.00	.0073
	SD	4.35	4.29	3.10		2.87	2.46	4.22	
Muscle mass (kg)	M	48.46	46.96	44.23	.0238	35.81	34.18	34.46	.0059
	SD	5.64	5.46	4.08		3.58	3.10	5.51	
BMI (m/kg²)	M	24.09	23.84	24.12	.9315	22.57	22.62	24.46	.0399
	SD	2.80	3.19	3.17		3.67	3.34	4.34	
BMR (kcal)	M	1,276.94	1,189.83	1,072.92	.0009	1,061.34	996.21	975.96	<.0001
	SD	155.17	179.38	171.85		83.49	80.80	104.58	

Note. BMI = body mass index; BMR = basal metabolic rate. *p* values were derived using ANOVA.

The results of body composition measurements showed a decline in muscle mass. It has been reported that in older adults, there is a decline in the responsiveness of skeletal muscles to synthesize protein when stimulated by the intake of dietary protein (Volpi et al., 2000). In a 3-year observational study of older community-dwelling Americans in their 70s, the 3-year decline in lean mass was 40% less for the group with the highest baseline dietary protein intake per total energy intake (average 91.0 g/day, 1.2 g/kg weight/day) than for the group with the lowest dietary protein intake per total energy intake (average 56.0 g/day, 0.8 g/kg weight/day), even after adjusting for confounding factors (Houston et al., 2008). Low dietary intake of protein has also been related to a 3-year decline in muscle strength (Bartali et al., 2012). Furthermore, for older women, it has been confirmed that a low intake of dietary protein increases the risk of incident frailty after 3 years (Beasley et al., 2010). In addition, cross-sectional research of elderly Japanese women has shown that there is a relationship
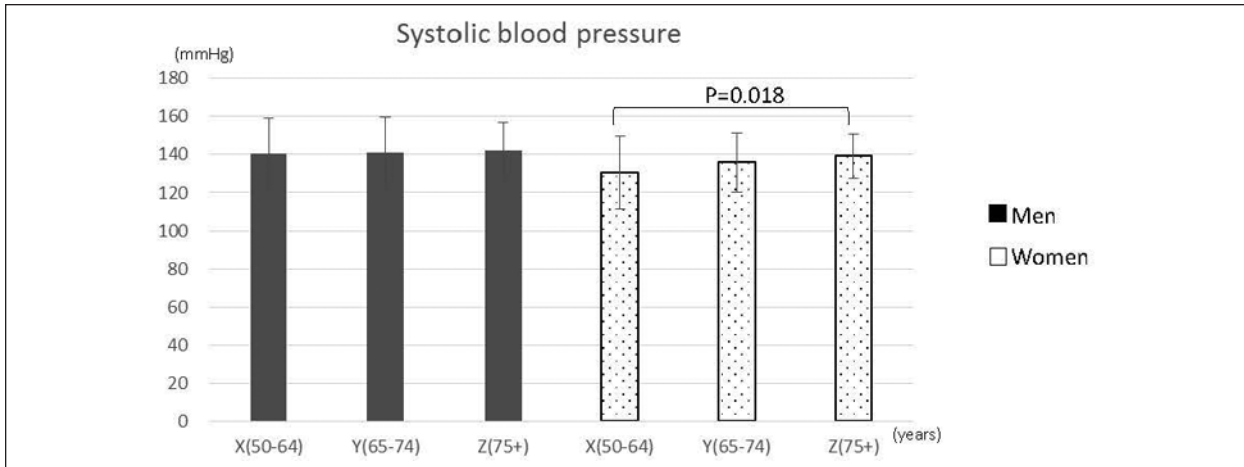
Figure 1. Mean systolic blood pressure of participants stratified by age and sex (men, *n* = 79; women, *n* = 217).
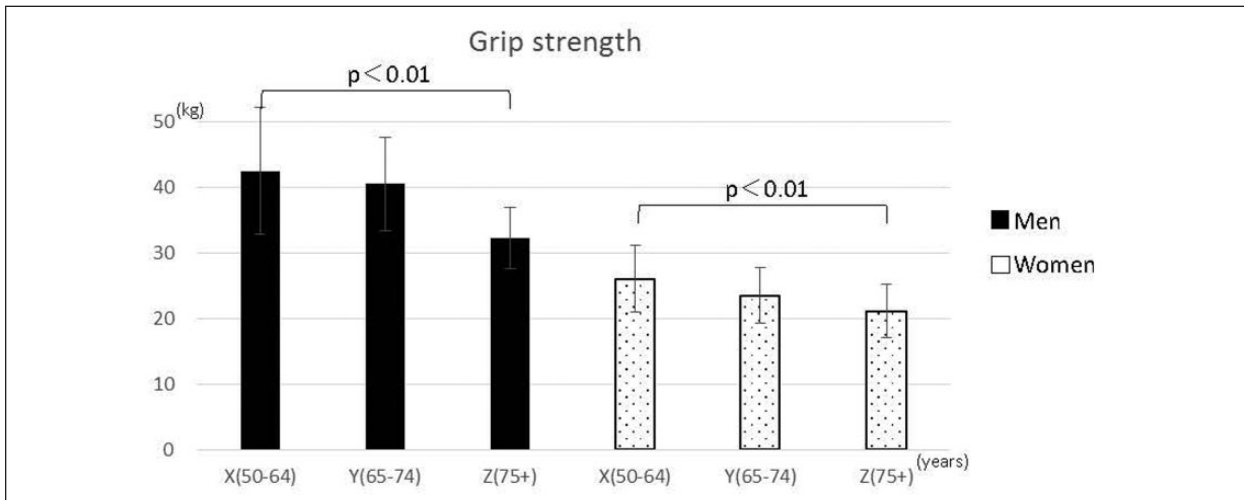

Figure 2. Mean grip strength of participants stratified by age and sex (men, *n* = 79; women, *n* = 217).
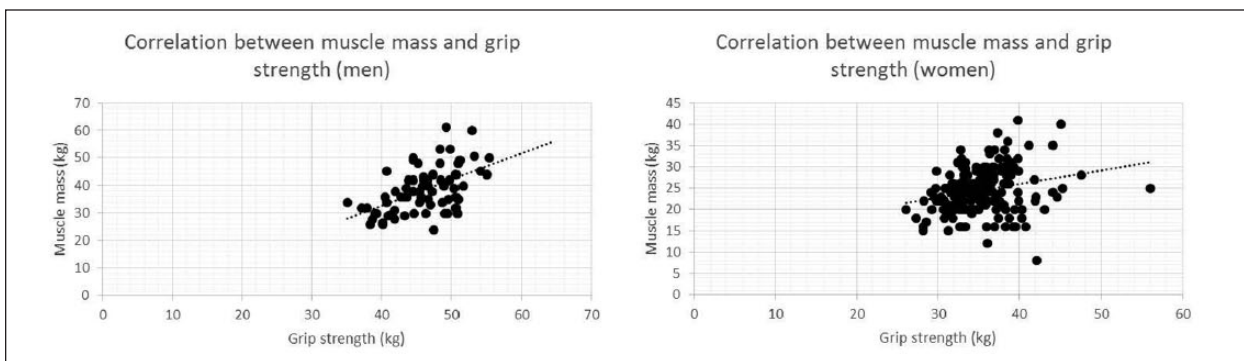

Figure 3. Correlations between grip strength and muscle mass for men (top chart) and women (bottom chart).

between the incidence of frailty and dietary protein intake (Kobayashi, Asakura, Suga, Sasaki, & Three-Generation Study of Women on Diets Health Study Group, 2013). In this study, both men and women had a dietary protein intake of ≥60 g/day. Even though intake was adequate, both men and women in Group Z lost

muscle mass (Table 3); however, intake was not correlated with the loss of muscle mass. This suggests that older adults may develop anabolic resistance; therefore, even when amino acids are supplied to muscles, protein anabolism is weaker in older individuals than it is in younger adults (Paddon-Jones & Rasmussen, 2009). In

Table 4. Dietary intake of participants derived from the BDHQ.

Group		Men X	Men Y	Men Z		Women X	Women Y	Women Z	
Age (years)		50-64	65-74	75+	*p*	50-64	65-74	75+	*p*
Energy (kcal)	M	1,835.35	1,935.84	1,910.59	.0845	1,579.20	1,645.70	2,041.72	.0004
	SD	624.57	520.27	541.31		543.10	532.71	551.52	
Water (g)	M	2,150.75	1,934.77	2,030.32	.3690	1,647.32	1,736.17	2,080.96	.0014
	SD	631.11	461.96	523.31		572.25	514.32	581.29	
Protein (g)	M	67.76	78.68	77.23	.3779	65.64	72.67	101.57	<.0001
	SD	23.11	28.69	27.14		24.13	28.62	31.13	
Fat (g)	M	50.31	51.33	48.15	.7518	47.67	49.26	66.50	<.0001
	SD	15.50	16.05	16.27		18.51	20.36	23.15	
Carbohydrates (g)	M	236.51	261.20	256.74	.5875	212.46	219.11	250.42	.0785
	SD	82.19	83.12	80.75		81.25	73.92	80.38	
Saturated fatty acids (g)	M	12.44	13.43	12.52	.6624	13.21	13.30	16.71	.0159
	SD	4.59	4.52	4.57		5.84	5.69	6.08	
Cholesterol (g)	M	389.70	381.37	417.60	.7652	331.82	389.82	550.77	<.0001
	SD	212.12	166.76	206.43		150.25	207.22	211.66	
Soluble dietary fiber (g)	M	3.15	3.54	3.89	.2239	3.18	3.46	4.42	.0003
	SD	1.08	1.41	1.42		1.44	1.47	1.24	
Insoluble dietary fiber (g)	M	8.30	9.77	10.76	.0562	8.66	9.60	12.01	<.0001
	SD	2.82	3.09	3.49		3.67	3.64	3.27	
Total dietary fiber (g)	M	11.90	13.81	15.24	.0515	12.30	13.48	17.34	<.0001
	SD	3.82	4.65	5.09		5.30	5.26	4.71	
Salt equivalent (g)	M	10.37	12.05	12.57	.1773	9.78	10.66	14.46	<.0001
	SD	2.73	4.10	3.95		3.19	3.56	3.54	
Alcohol (g)	M	20.35	12.91	17.88	.5917	3.42	3.11	2.61	.9052
	SD	22.77	20.45	35.77		8.30	9.58	8.50	
Omega-3 fatty acids (mg)	M	2.56	3.02	2.78	.4622	2.43	2.76	4.37	<.0001
	SD	0.92	1.46	1.22		1.09	1.40	1.79	
Omega-6 fatty acids (mg)	M	10.41	10.10	9.49	.6228	8.93	9.13	12.28	<.0001
	SD	3.03	3.18	3.25		3.31	3.54	3.77	

Note. BDHQ = Brief-Type Self-Administered Diet History Questionnaire. *p* values were derived using ANOVA.

general, protein anabolism in the muscle cells of older adults can be adequately activated by increasing the supply of amino acids. Therefore, to stimulate protein synthesis in the skeletal muscles, the concentration of amino acids in the blood needs to be higher for older adults than for younger adults, which requires sufficient intake of protein or administration of amino acids (Drummond et al., 2008; Pennings et al., 2011; Symons et al., 2007). The results of the present study demonstrated age-related changes in the sample, thereby supporting the finding that, unless the intake of high-quality protein at every meal is at least approximately 25 to 30 g, effective protein synthesis in skeletal muscles may not be maintained throughout the day (Pennings et al., 2011).

Although protein intake is important, some studies have reported misgivings about the safety of high-protein diets for older adults with renal insufficiency (Knight, Stampfer, Hankinson, Spiegelman, & Curhan, 2003; Walrand et al., 2008). For example, an increased risk of renal insufficiency in healthy older adults has been reported with high protein intake (2.0 g/kg weight/day). An 11-year observational study reported that, for older women with mild renal insufficiency (estimated glomerular filtration rate: 55-88 ml/min/1.73 m^2), high protein intake (>1.3 g/kg weight/day) during the 11-year observation period caused a decline in renal function (Knight et al., 2003). In our study, although the results of renal function tests for women were in the normal range, we observed a decline. Further study is needed to verify the nature of the relationship between renal function and diet.

According to many epidemiological studies, if a person's salt intake can be reduced by 1 g per day, a reduction in systolic blood pressure of 1 to 2 mmHg can be expected. According to the 2013 National Health and Nutrition Examination Survey, the average salt intake for men is 11.1 g and that for women is 9.4 g. Our study verified that there was a significant age group difference in salt intake for women; this difference was highest in the oldest group. However, we were not able to confirm any relationship between salt intake and blood pressure. In Japan, although salt intake is one of the causes of hypertension, understanding that relationship in independently living older adults would require a multifaceted study,

including not only salt intake but also factors such as smoking and psychological stress, which will require further investigation in future.

Conclusion

In this study, we were able to assess body composition and living habits in a sample of independently living older adults in a region of Japan subject to heavy snowfall. We found that the BMI values of these older adults, who had good health expectancy, were within the normal range, but BMR and muscle mass declined with age. In addition, although these older adults had sufficient caloric intake and ate a variety of foods, changes in body composition across age groups suggested that, with advancing physical age, food is used less effectively.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of Ethics Committee for the Graduate School of Health Sciences at Hokkaido University (15-96) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Statement of Informed Consent

The authors explained that anonymity of data would be maintained strictly, and obtained written consent regarding study participation.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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