Table 4 Prevalence of hypertension and related variables in different age groups in each subdivision in Ladakh region

	Age group (years)					
	20–39	40–59	60–74	75–	p Value	All
Leh (n=1002) (mean 51.9±15.5 years)	n=223	n=447	n=245	n=87		
Hypertension, %	19.7 (14.5–24.9)	41.6 (37.0–46.2)	58.8 (52.6–65.0)	70.1 (60.5–79.7)	<0.0001	43.4 (40.3–46.5)
(Age-standardised prevalence rate, %)						45.5 (42.4–48.6)
BMI ≥25 (%)	20.6 (15.3–25.9)	40.7 (36.1–45.3)	34.8 (28.8–40.8)	26.4 (17.1–35.7)	<0.0001	33.6 (30.7–36.5)
Leh block (n=349) (mean 55.6±16.1 years)	n=60	n=127	n=123	n=39		
Hypertension,%	6.7 (0.4–13.0)	22.0 (14.8–29.2)	48.0 (39.2–56.8)	61.5 (46.2–76.8)	<0.0001	33.0 (28.1–37.9)
(Age-standardised prevalence rate,%)						30.7 (25.9–35.5)
BMI ≥25 (%)	30.0 (18.4–41.6)	34.6 (26.3–42.9)	35.0 (26.6–43.4)	23.1 (9.9–36.3)	ns	32.7 (27.8–37.6)
Nubra (n=248) (mean 50.5±15.5 years)	n=78	n=88	n=64	n=18		
Hypertension, %	11.5 (4.4–18.6)	29.5 (20.0–39.0)	37.5 (25.6–49.4)	55.6 (32.6–78.6)	0.0001	27.8 (22.2–33.4)
(Age-standardised prevalence rate,%)						31.0 (25.2–36.8)
BMI ≥25 (%)	9.0 (2.6–15.4)	17.0 (9.2–24.8)	14.1 (5.6–22.6)	16.7 (0–33.9)	ns	13.4 (9.2–17.6)
Kargil (n=115) (mean 51.9±13.5 years)	n=25	n=46	n=42	n=2		
Hypertension, %	16.0 (1.6–30.4)	19.6 (8.1–31.1)	33.3 (19.0–47.6)	50.0 (0–100)	ns	24.3 (16.5–32.1)
(Age-standardised prevalence rate, %)						24.6 (16.7–32.5)
BMI ≥25 (%)	16.0 (1.6–30.4)	2.2 (0–6.4)	9.5 (0.6–18.4)	0	ns	7.8 (2.9–12.7)
Sham (n=451) (mean 56.2±13.8 years)	n=62	n=189	n=150	n=50		
Hypertension, %	9.7 (2.3–17.1)	31.2 (24.6–37.8)	50.7 (42.7–58.7)	72.0 (59.6–84.4)	<0.0001	39.2 (34.7–43.7)
(Age-standardised prevalence rate, %)						36.9 (32.4–41.4)
BMI ≥25 (%)	11.3 (3.4–19.2)	19.6 (13.9–25.3)	17.5 (11.4–23.6)	14.0 (4.4–23.6)	ns	17.1 (13.6–20.6)
Zanskar (n=284) (mean 59.5±12.8 years)	n=10	n=115	n=127	n=32		
Hypertension, %	20.0 (0–44.8)	25.2 (17.3–33.1)	42.5 (33.9–51.1)	56.3 (39.1–73.5)	<0.01	36.3 (30.7–41.9)
(Age-standardised prevalence rate, %)						32.1 (26.7–37.5)
BMI ≥25 (%)	30.0 (1.6–58.4)	13.9 (7.6–20.2)	13.4 (7.5–19.3)	15.6 (3.0–28.2)	ns	14.4 (10.3–18.5)
Changthang (n=351) (mean 52.9±13.6 years)	n=47	n=186	n=93	n=25		
Hypertension,%	14.9 (4.7–25.1)	22.6 (16.6–28.6)	49.5 (39.3–59.72)	60.0 (40.8–79.2)	<0.0001	31.3 (26.4–36.2)
(Age-standardised prevalence rate, %)						32.6 (27.7–37.5)
BMI ≥25 (%)	12.8 (3.2–22.4)	24.7 (18.5–30.9)	16.1 (8.6–23.6)	16.0 (1.6–30.4)	ns	20.2 (16.0–24.4)

p; χ^2 Test for the comparison of the prevalence of hypertension and BMI ≥25 (%) among the four age groups in each subdivision.
BMI, body mass index; ns, not significant.

Table 5 Prevalence of hypertension and related variables according to altitude, age and occupation in Ladakh region

	Altitude (metres above MSL)					
	2500–2999 m	3000–3499 m	3500–3999 m	4000–4499 m	4500–4999 m	p Value
All	n=417	n=428	n=1604	n=174	n=177	
Hypertension (%)	27.1 (22.8–31.4)	37.4 (32.8–42.0)	40.8 (38.4–43.2)	30.5 (23.7–37.3)	32.2 (25.3–39.1)	<0.0001
SBP	126.3±21.6	128.9±19.9	132.8±24.0	129.7±23.9	130.9±23.8	<0.0001
DBP	80.8±12.2	83.5±13.1	83.3±13.7	80.0±13.7	79.2±12.8	<0.0001
BMI	21.8±3.1	22.7±3.7	22.8±3.6	22.4±3.6	22.6±3.7	<0.0001
BMI ≥25 (%)	16.6 (13.0–20.2)	25.0	27.1	20.1	20.3	<0.0001
SpO_2	90.2±4.7	90.6±4.2	90.0±5.2	86.1±5.8	86.7±5.7	<0.0001
SpO_2 <89 (%)	26.2 (22.0–30.4)	23.6 (19.6–27.6)	28.8 (26.6–31.0)	67.1 (60.1–74.1)	68.2 (61.3–75.1)	<0.0001
20–39 years	n=119	n=128	n=211	n=30	n=17	
Hypertension (%)	10.1 (4.7–15.5)	22.7 (15.4–30.0)	13.3 (8.7–17.9)	10.0 (0–20.7)	23.5 (3.3–43.7)	<0.05
BMI ≥25 (%)	11.8 (6.0–17.6)	17.2 (10.7–23.7)	23.2 (17.5–28.9)	6.7 (0–15.6)	23.5 (3.3–43.7)	<0.05
SpO_2 <89 (%)	15.4 (8.9–21.9)	16.4 (10.0–22.8)	14.5 (9.7–19.3)	69.0 (52.4–85.6)	100.0	<0.0001
40–59 years	n=155	n=197	n=660	n=77	n=109	
Hypertension (%)	27.1 (20.1–34.1)	41.1 (34.2–48.0)	32.4 (28.8–36.0)	15.6 (7.5–23.7)	27.5 (19.1–35.9)	<0.001
BMI ≥25 (%)	20.6 (14.2–27.0)	32.5 (26.0–39.0)	30.2 (26.7–33.7)	28.6 (18.5–38.7)	22.0 (14.2–29.8)	ns
SpO_2 <89 (%)	22.6 (16.0–29.2)	24.1 (18.1–30.1)	20.5 (17.4–23.6)	55.8 (44.7–66.9)	67.9 (59.1–76.7)	<0.0001
60–74 years	n=114	n=81	n=556	n=52	n=41	
Hypertension (%)	38.6 (29.7–47.5)	44.4 (33.6–55.2)	52.3 (48.1–56.5)	55.8 (42.3–69.3)	41.5 (26.4–56.6)	<0.05
BMI ≥25 (%)	15.9 (9.2–22.6)	23.5 (14.3–32.7)	26.5 (22.8–30.2)	15.4 (5.6–25.2)	17.1 (5.6–28.6)	ns
SpO_2 <89 (%)	36.6 (27.8–45.4)	30.4 (20.4–40.4)	40.2 (36.1–44.3)	78.8 (67.7–89.9)	56.1 (40.9–71.3)	<0.0001
75 years	n=29	n=22	n=177	n=15	n=10	
Hypertension (%)	51.7 (33.5–69.9)	63.6 (43.5–83.7)	68.4 (61.6–75.2)	60.0 (35.2–84.8)	60.0 (29.6–90.4)	ns
BMI ≥25 (%)	17.2 (3.5–30.9)	9.1 (0–21.1)	22.6 (16.4–28.8)	20.0 (0–40.2)	10.0 (0–28.6)	ns
SpO_2 <89 (%)	48.3 (30.1–66.5)	36.4 (16.3–56.5)	41.5 (34.2–48.8)	80.0 (59.8–100)	70.0 (41.6–98.4)	<0.05
Farmer	n=348	n=178	n=620	n=81	n=20	
Hypertension (%)	27.6 (22.9–32.3)	33.7 (26.8–40.6)	41.3 (37.4–45.2)	40.7 (30.0–51.4)	55.0 (33.2–76.8)	<0.001
BMI ≥25 (%)	14.7 (11.0–18.4)	12.4 (7.6–17.2)	15.6 (12.7–18.5)	19.8 (11.1–28.5)	20.0 (2.5–37.5)	ns
SpO_2 <89 (%)	23.8 (19.3–28.3)	24.4 (18.1–30.7)	41.5 (37.6–45.4)	85.0 (77.2–92.8)	94.7 (84.9–100)	<0.0001
Nomad				n=67	n=145	
Hypertension (%)				22.4 (12.4–32.4)	29.0 (21.6–36.4)	ns
BMI ≥25 (%)				25.4 (15.0–35.8)	17.9 (11.7–24.1)	ns
SpO_2 <89 (%)				46.3 (34.4–58.2)	63.9 (56.1–71.7)	<0.05
Sedentary worker	n=33	n=176	n=340			
Hypertension (%)	21.2 (7.3–5.1)	40.9 (33.6–48.2)	38.8 (33.6–44.0)			ns (0.09)
BMI ≥25 (%)	21.2 (7.3–5.1)	35.2 (28.1–42.3)	36.6 (31.5–41.7)			
SpO_2 <89 (%)	42.4 (25.5–59.3)	20.2 (14.3–26.1)	15.7 (11.8–19.6)			<0.001

p; χ^2 Test for the comparison of the prevalence of hypertension, BMI ≥25 (%) and SpO_2 <89 (%) among the five altitude groups.
BMI, body mass index; DBP, diastolic blood pressure; MSL, mean sea level; SBP, systolic blood pressure; SpO_2, oxyhaemoglobin saturation measured by a pulse oximeter.

Table 6 Prevalence of hypertension and overweight in different altitude levels in each subdivision in Ladakh region

	Altitude (metres above MSL)					
	2500–2999 m	3000–3499 m	3500–3999 m	4000–4499 m	4500–4999 m	p Value
Leh (3300–3600 m)						
n		189	813			
Hypertension (%)		42.9 (35.8–50.0)	43.5 (40.1–46.9)			ns
BMI ≥25 (%)		32.8 (26.1–39.5)	33.7 (30.5–36.9)			ns
Leh block (3000–3700 m)						
n		49	300			
Hypertension (%)		28.6 (15.9–41.3)	33.7 (28.4–39.0)			ns
BMI ≥25 (%)		40.8 (35.8–63.8)	31.3 (26.1–36.5)			ns
Nubra (2600–3000 m)						
n	248					
Hypertension (%)	27.8 (22.2–33.4)					
BMI ≥25 (%)	13.7 (9.4–18.0)					
Kargil (2600–3100 m)						
n	52	63				
Hypertension (%)	19.2 (8.5–29.9)	28.6 (17.4–39.8)				ns
BMI ≥25 (%)	15.4 (5.6–25.2)	1.6 (0–4.7)				<0.01
Sham (2700–3900 m)						
n	117	127	207			
Hypertension (%)	29.1 (20.9–37.3)	37.0 (28.6–45.4)	46.4 (39.6–53.2)			<0.01
BMI ≥25 (%)	23.3 (15.6–31.0)	18.9 (12.1–25.7)	12.6 (8.1–17.1)			<0.05
Zanskar (3500–3900 m)						
n			284			
Hypertension (%)			36.3 (30.7–41.9)			
BMI ≥25 (%)			14.4 (10.3–18.5)			
Changthang (4000–4900 m)						
n				174	177	
Hypertension (%)				30.5 (23.7–37.3)	32.2 (25.3–39.1)	ns
BMI ≥25 (%)				20.1 (14.1–26.1)	20.3 (14.4–26.2)	ns

p; χ^2 Test for the comparison of the prevalence of Hypertension and BMI ≥25 (%) among the altitude groups.
BMI, body mass index; MSL, mean sea level; ns, not significant.

Table 7 Prevalence of hypertension and overweight in people with different occupations in each age group in Ladakh region

	20–39 years			40–59 years			60–74 years			75 years		
	n	Hypertension	BMI ≥25	n	Hypertension	BMI ≥25	n	Hypertension	BMI ≥25	n	Hypertension	BMI ≥25
		Per cent	Per cent		Per cent	Per cent		Per cent	Per cent		Per cent	Per cent
Farmer	171	12.9 (7.9–17.9)	12.3 (7.4–17.2)	476	26.3 (22.3–30.3)	16.0 (12.7–19.3)	465	47.3 (42.8–51.8)	15.9 (12.6–19.2)	135	65.9 (57.9–73.9)	14.1 (8.2–20.0)
Nomad	4	0	25.0 (0–67.4)	146	19.9 (13.4–26.4)	23.3 (16.4–30.2)	54	40.7 (27.6–53.8)	11.1 (2.7–19.5)	16	62.5 (38.8–86.2)	25.0 (3.8–46.2)
Sedentary worker	204	19.5 (14.1–24.9)	19.1 (13.7–24.5)	277	48.0 (42.1–53.9)	44.0 (38.2–49.8)	61	45.9 (33.4–58.4)	39.3 (27.0–51.6)	7	42.9 (6.2–79.6)	42.9 (6.2–79.6)
Others	126	10.3 (5.0–15.6)	23.8 (16.4–31.2)	299	30.8 (25.6–32.1)	36.5 (23.2–36.0)	264	55.7 (49.7–61.7)	36.4 (30.6–42.2)	95	66.3 (56.8–75.8)	26.3 (17.4–35.2)
Housewife	44	13.6 (3.5–23.7)	25.0 (12.2–37.8)	157	29.0 (21.9–36.1)	36.3 (28.8–43.8)	98	57.1 (47.3–66.9)	25.5 (16.9–34.1)	26	84.6 (70.7–98.5)	23.1 (12.1–31.7)
Manual labourer	1	0	0	53	11.3 (2.8–19.8)	20.8 (9.9–31.7)	9	33.3 (2.5–64.1)	11.1 (0–31.6)	0		
Monk	43	4.7 (0–11.0)	30.2 (16.5–43.9)	36	36.1 (20.4–51.8)	61.1 (45.2–77.0)	57	56.1 (43.2–69.0)	52.6 (39.6–65.6)	21	52.4 (31.0–73.8)	38.1 (17.3–58.9)
No job	37	13.5 (2.5–24.5)	16.2 (4.3–28.1)	25	36.0 (17.2–54.8)	36.0 (17.2–54.8)	44	61.4 (47.0–75.8)	38.6 (24.2–53.0)	32	62.5 (45.7–79.3)	28.1 (12.5–43.7)
Retired sedentary	1	0	0	28	35.7 (18.0–53.4)	35.7 (18.0–53.4)	56	51.8 (38.7–64.9)	41.1 (28.2–54.0)	16	62.5 (38.8–86.2)	12.5 (0–28.7)
p Value		ns (0.05)	ns (0.07)		<0.0001	<0.0001		ns (0.07)	<0.0001		ns	<0.05

p; χ^2 Test for the comparison of the prevalence of hypertension and BMI ≥25 (%) among the four occupation groups: farmer, nomad, sedentary worker and others.
BMI, body mass index.

Table 8 shows the prevalence of hypertension and overweight comparing among dwellers in rural areas and Leh town and rural-to-urban migrants. The prevalence of hypertension and overweight was highest in migrants settled in Leh (hypertension/overweight; 48.3%/40.9%) followed by dwellers in Leh town (41.1%/30.2%) compared with those in rural areas (33.5%/15.3–19.3%). The percentage of engagement in occupations was shown in each participant group.

There was a difference in the prevalence of hypertension between Tibetan and Ladakhi nomads. The lowest prevalence of hypertension in spite of a higher prevalence of overweight was shown in Tibetan nomads (n=76) (hypertension/overweight; 19.7%/39.5%) compared with Ladakhi nomads (n=144) (31.9%/10.4%) living at higher altitude (4000–4900 m).

The effects of altitude, occupation and dwelling area on hypertension were analysed in all the participants by multiple logistic regression adjusted with age, sex and overweight in models 1–3 (table 9). In model 1, the altitude ranges of 3000–3499 (OR 1.78) and 3500–3999 (OR 1.42) were significantly associated with high prevalence of hypertension compared with 2500–2999 (m) adjusted with age, sex and obesity. However, the higher range of 4000–4499 or 4500– was not associated with hypertension. In model 2 with further adjustment by occupation, the altitude ranges of 3000–3499 (OR 1.62) and 3500–3999 (OR 1.34) and the highest range of 4500– (OR 2.57) became significantly associated with hypertension. Sedentary workers had a higher association (OR 1.56) compared with farmers, while nomads had a lower association (OR 0.42). In model 3, with further adjustment by dwelling area, the altitude range of 3000–3499 (OR 1.44) and the highest altitude range of 4500– (OR 2.69) kept significant association with hypertension independent of occupation and dwelling area. People dwelling in Leh town (OR 1.92) and migrants from Changthang (OR 1.70) were significantly associated with a high prevalence of hypertension compared with those dwelling in rural areas.

DISCUSSION

In the current study, we found that one-third of the population is at a higher risk of hypertension. As table 3 shows, the prevalence of hypertension tends to increase with age in both genders. Average SBP and DBP in men less than 60 years of age was found to be higher than in age-matched women. This is consistent with the prevalence of adult hypertension in a US population,[22] in a south Indian Chennai urban population study[23] and in rural and urban communities of Rajasthan.[24] The cause of lower blood pressure in women below 60 years may be due to hormonal effects in women during this age, that is, premenopausal women having a lower arterial blood pressure than age-matched men.[25] This may also be due to the effect of obesity, as the prevalence of overweight in men was higher in people under 75 years

Table 8 Prevalence of hypertension and related variables in different dwelling areas in Ladakh region

		Urban: Leh town		
	Rural areas	Dwellers in Leh town	Migrants from Changthang	
n	1798	683	319	p Value
Age (years)	54.9±14.6	49.0±15.9	58.2±12.3	<0.0001
Hypertension (%)	33.5 (31.3–35.7)	41.1 (37.4–44.8)	48.3 (42.8–53.8)	<0.0001
BMI ≥25 (%)	19.3 (17.5–21.1)	30.2 (26.8–33.6)	40.9 (35.5–46.3)	<0.0001
SpO_2	88.8±5.6	90.7±4.2	92.3±3.2	<0.0001
SpO_2 <89 (%)	40.6 (38.3–42.9)	21.7 (18.6–24.8)	10.1 (6.8–13.4)	<0.0001
Altitude (m)	3543.2±534.1	3449.0±86.9	3491.9±39.6	<0.0001
Occupation (%)				
Farmer	66.8 (64.6–69.0)	6.3 (4.5–8.1)	0.9 (0–1.9)	
Nomad	12.0 (10.5–13.5)	0	1.3 (0.1–2.5)	
Sedentary	8.0 (6.7–9.3)	47.0 (43.3–50.7)	26.6 (21.8–31.4)	
Others	13.2 (11.6–14.8)	46.7 (43.0–50.4)	71.2 (66.2–76.2	
Housewife	2.6 (1.9–3.3)	27.2 (23.9–30.5)	28.8 (23.8–33.8)	
Manual labourer	0	0.9 (0.2–1.6)	17.9 (13.7–22.1)	
Monk	6.8 (5.6–8.0)	5.0 (3.4–6.6)	0.3 (0–0.9)	
No job	1.5 (0.9–2.1)	5.9 (4.1–7.7)	22.3 (17.7–26.9)	
Retired sedentary	2.3 (1.6–3.0)	7.8 (5.8–9.8)	1.9 (0.4–3.4)	

p; χ^2 Test for the comparison of the prevalence of hypertension and BMI≥25 (%) among the three groups, and ANOVA for the comparison of mean age among the three groups.
ANOVA, analysis of variance; BMI, body mass index; SpO_2, oxyhaemoglobin saturation measured by a pulse oximeter.

compared with women. The epidemiology of hypertension on the Tibetan plateau carried out by Sun and shinfu,[12] however, reports a higher prevalence of hypertension in women in all age groups. This difference in results might be influenced by there being more females in their cohort, as well as possible differences in obesity that are not shown in their report.

Though age-standardised prevalence of hypertension in Leh block (30.7%) was not high compared with other rural areas (24.6–36.8%), higher prevalence of hypertension in Leh town (45.5%) and higher prevalence of overweight in Leh block (32.7%) and Leh town (33.6%) were found compared with other rural areas (overweight; 7.8–20.2%). The high prevalence of overweight may be brought about because Leh block is somehow a more developed subdivision than the others in this study. Urbanisation can change the lifestyle of the people and their diet habits, which may result in obesity and high prevalence of hypertension. Dietary quantity intake as assessed by our nutritionist (Y.K) by a 24 h recall method showed that energy intake was higher in Leh town (2305 kcal in men and 1933 kcal in women) as compared to higher altitude at Changthang (2029 kcal in men and 1802 kcal in women). Variety of food intake as assessed by 11-item Food Diversity Score Kyoto (FDSK-11) was higher in Leh (6.7±1.8) as compared to higher altitude Changthang (6.1±1.5).[26–28] Economic conditions, traditional food culture and a harsh environment with limitation of resources affect energy intake and food diversity. In urban Leh and Leh block, the economic condition of the population is better. Bread, mutton, rice, pulses, vegetables, thukpa and eggs are the main dietary foods, with snacks of sweet tea, biscuits, and fast food. Such a diet increases their calories, resulting in high BMI, and increases their salt intake, contributing to the higher prevalence of hypertension. One of the villages in Leh block, Stok, was a study centre in the Indian component of the Intersalt study,[29] an international study to determine the relationship of blood pressure with dietary ingredients, particularly sodium and potassium. Urinary sodium (means (and SD) calculated for men aged 20–39, men aged 40–59, women aged 20–39, and women aged 40–59 and then averaged over age and sex groups) was 203.7 mmol/24 h (75.0) and urinary potassium was 47.0 (19.2) mmol/24 h with a poor potassium sodium ratio. Although the data pertain to the year 1988, there is every reason to surmise that the situation which persists as a condition of socioeconomic improvement without parallel improvement in health awareness prevails even today. There is a recent report on the effect of using a low-sodium, high-potassium salt substitute for Tibetan highlanders with hypertension.[30]

Domkhar valley in Sham subdivision situated along the Domkhar stream is about 25 km long and divided into three hamlets of different altitudinal contour and diversified environment. Paba, rice, bread, thukpa, sku, kholak and the local beverage chang are the main diets. Meat is rarely available. Fresh fruit is available in plenty in lower Domkhar and at some places in middle Domkhar, but none in upper Domkhar due to its high-altitude location (Altitude 3800 m). Prevalence of hypertension is very high here (39.1%) among the rural subdivisions. The prevalence of hypertension, especially in Sham subdivision, was as high as that in Leh town in the old age group above 60 years (Sham: 56.0% vs Leh town:

Table 9 The effect of altitude, occupation and dwelling area on hypertension adjusted with age, sex and overweight by multiple logistic regression analysis

		Model-1			Model-2			Model-3		
	n	OR	CI	p Value	OR	CI	p Value	OR	CI	p Value
Age (year)										
20–39	505	1.00			1.00			1.00		
40–59	1198	2.43	1.84 to 3.22	<0.0001	2.78	2.08 to 3.71	<0.0001	2.85	2.12 to 3.83	<0.0001
60–74	844	5.66	4.24 to 7.55	<0.0001	6.93	5.09 to 9.43	<0.0001	7.20	5.26 to 9.86	<0.0001
75–	253	11.40	7.89 to 16.46	<0.0001	14.45	9.82 to 21.26	<0.0001	14.71	9.93 to 21.79	<0.0001
Male (vs female)	1240 (1560)	1.02	0.86 to 1.21	ns	0.95	0.80 to 1.13	ns	1.00	0.84 to 1.20	ns
BMI ≥25 (vs BMI <25)	683 (2117)	2.60	2.14 to 3.13	<0.0001	2.51	2.07 to 3.05	<0.0001	2.52	2.08 to 3.06	<0.0001
Altitude (m)										
2500–2999	417	1.00			1.00			1.00		
3000–3499	428	1.78	1.30 to 2.44	<0.001	1.62	1.17 to 2.23	<0.01	1.44	1.04 to 2.01	<0.05
3500–3999	1604	1.42	1.10 to 1.83	<0.01	1.34	1.02 to 1.75	<0.05	1.16	0.88 to 1.54	ns
4000–4499	174	1.01	0.67 to 1.53	ns	1.37	0.87 to 2.15	ns	1.40	0.88 to 2.20	ns
4500–	177	1.19	0.79 to 1.79	ns	2.57	1.41 to 4.68	<0.01	2.69	1.48 to 4.90	<0.01
Occupation										
Farmer	1247				1.00			1.00		
Nomad	220				0.42	0.24 to 0.72	<0.01	0.37	0.22 to 0.64	<0.001
Sedentary worker	549				1.56	1.20 to 2.02	<0.001	1.02	0.74 to 1.40	ns
Others	784				0.99	0.80 to 1.23	ns	0.68	0.52 to 0.90	<0.01
Dwelling area										
Rural areas	1798							1.00		
Dwellers in Leh town	683							1.92	1.45 to 2.55	<0.0001
Migrants from Changthang	319							1.70	1.21 to 2.38	<0.01

Model-1: The effect of altitude on hypertension adjusted with age, sex and overweight.
Model-2: The effect of altitude and occupation on hypertension adjusted with age, sex and overweight.
Model-3: The effect of altitude, occupation and dwelling area on hypertension adjusted with age, sex and overweight.
BMI, body mass index; ns, not significant.

61.7%) and in the higher altitude level of 3500–3999 (Sham: 46.4%, Leh town: 43.5%) in spite of a much lower rate of overweight in Sham (17.1%) compared with Leh town (33.6%). Different from people in the Leh block subdivision, people in Sham had much poorer availability of foods for a long time until recently and they may have vulnerability to the recent quick change of dietary habits, especially in older people and those dwelling in remote areas at higher altitude. We showed the high prevalence of impaired glucose tolerance (35%) in old people in Domkhar compared with Tibetan people in Qinghai, China in the previous report. We also suggested that there may be a vulnerability to glucose intolerance brought on by recent changes in lifestyle in people with long-term backgrounds of economically traditional lifestyles with limited food resources.[31]

Mutton, rice, momo (mutton), thukpa (comprising of Atta, vegetable mostly dry and dry cheese), kholak (Barley flour with local tea) and paba (a mix of barley flour, wheat flour and grounded pea cooked in plain water with salt added to taste) are the main diets of the Changthang population in both Ladakhis and Tibetans. Taking snacks is not in their food culture, and nor are modern snack items available at that remote high-altitude region. A relatively lower prevalence of hypertension was observed in Changthang Tibetan natives (19.7%) and Changthang Ladakhis (31.9%) living at higher altitude (4000–4900 m).

Zanskar subdivision, located at an intermediate high altitude (3500–3900 m), has a population mainly concerned with farming and cattle rearing. Butter tea, local beverage chang, thukpa, barley flour kholak, rice and pulses are the main dietary foods; meat is rarely eaten. Fresh fruit and vegetables are usually not available in Zanskar and Changthang. The crude prevalence of hypertension in Zanskar appears to be high (36.3%) but age-standardised prevalence (32.1%) was the same as in other rural areas, as the mean age was highest in Zanskar (table 4).

Modernised sedentary workers, rural-to-urban migrants, and dwelling in urban area population (Altitude 3300–3600 m) had a higher prevalence of hypertension and increased BMI as compared to the rural population. Previous reports support our hypothesis of highlanders' vulnerability to hypertension by socio-economic globalisation.[12–14 31–34] A higher prevalence of hypertension was reported in Tibetans compared with immigrant Hans in the Tibetan plateau, with the prevalence being greater in the urban population around Lhasa than in the rural population.[12] In another report, a longitudinal survey was carried out in the prevalence of hypertension in people over 15 years in different ethnic groups in China in 1991 and 2002. The prevalence of hypertension in Tibetan people increased from 17.8% (in 1991) to 24.7% (in 2002), which was the highest compared with the other seven ethnic groups including Han (from 11.3% to 16.2%).[32] A recent report showed that the prevalence of hypertension (SBP≥140 or DBP ≥90 or treatment) in 1289 Tibetan highlanders (Lhasa and suburbs; 3700–4200 m) aged 18 and more was 39%.[13] Another report showed that the prevalence of hypertension in 692 Tibetan highlanders (rural area of Lhasa; 3700 m) aged 30–80 years was 37% (SBP≥130 or DBP ≥85 or treatment).[14] The prevalence of hypertension was close to our result of 37% and higher than that of Chinese lowlanders aged 20 years and more (27% in 2007–2008).[15] Blood pressure in 332 highlanders in Leh (13–81 years old, mean 50 years) was compared with those in U town, Hokkaido, Japan (24–79 years, mean 56.8) in 2004. Higher DBP and a larger increase in blood pressure with age were observed in people living at a high altitude, as compared with Japanese living at a low altitude.[35] Younger people, but not adults and elderly people, among Tibetan immigrants from Leh to the lowlands in India were reported to have higher blood pressure compared with those living in the highlands. Measurements of adiposity had a significant effect on BP.[33] The prevalence of hypertension was higher (72.7%) in Tibetan highlanders in Shangrila (Altitude: 3300 m) compared with lowlanders in Jing Hong (57.0%) and Tosa (59.9%). There was a significant association between living in an urban area with a higher prevalence of hypertension and obesity in younger people under 60 years compared with those living in a rural area.[34] Younger people may be more vulnerable to hypertension by a quick modernised lifestyle change. Also in our report, a higher prevalence of hypertension in Leh town (44.7%) was observed, especially in the middle-aged group of 40–59 years, compared with other areas (19.6–30.7%).

A higher OR of altitudes from 3000 to 3999 m compared with an altitude below 3000 m was observed after adjustment with age, sex and overweight. One reason may be socioeconomic factor, as this altitude level was compatible with that of the urban area of Leh town and urban dwellers had a higher rate of hypertension and obesity by lifestyle change compared with rural dwellers. Another reason may be the effect of high altitude itself, as the dwellers in Sham subdivision at the altitude of 3000–3999 m had a higher prevalence of hypertension in spite of a lower prevalence of overweight compared with those dwelling below 3000 m. The highest prevalence in older people was shown at a higher altitude over 4000 m. Moreover, the prevalence of hypertension rose closely with altitude remarkably in farmers ($p<0.001$), mildly in sedentary workers ($p=0.09$) and insignificantly in nomads (table 5). That is the reason why the higher altitude range of 3000–3999 and 4500– (OR 2.18) kept significant association with hypertension after adjustment with age, occupation or dwelling area by the multivariate analysis, which also supports the effect of high altitude itself to hypertension.

The limitation of this paper is that it did not look into the genetic factors, as environmental and genetic factors may contribute to regional and racial variations of blood pressure and prevalence of hypertension. Genetic evidence for high-altitude adaptation in Tibetan people was reported recently.[36 37] A relatively lower prevalence of hypertension in spite of a higher one of overweight in Changthang Tibetan natives (hypertension/overweight; 19.7% vs 31.9%/39.5% vs 10.4%) compared with Changthang Ladakhi living at higher altitude (4000–4900 m) was observed in our report. The association between the hypoxic adaptation gene and hypertension should be studied further. The strength of this study is that it looked into most of the environmental factors known to influence hypertension in the population of different distinct geographical subdivisions of a high-altitude region. This study showed the influence of ageing, overweight, modernised sedentary occupations and rural-to-urban migration and dwelling in urban areas to hypertension as well as the effect of high altitude on hypertension by multivariate analysis.

The conclusion reached is that like everywhere else in the world, hypertension prevalence in a high-altitude population has multifactorial aetiology. Our study shows that age, gender, socioeconomic factors, culture, race and changing lifestyle play a big role with the effect of high altitude itself on the high prevalence of hypertension.

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Prevalence of hypertension at high altitude: cross-sectional survey in Ladakh, Northern India 2007–2011

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Association between risk perception, subjective knowledge, and depression in community-dwelling elderly people in Japan

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ABSTRACT

Risk perception is one of the core factors in theories of health behavior promotion. However, the association between knowledge, risk perception, and depressed mood in depression is unknown. The aim of this study was to clarify the relationships between subjective knowledge, risk perception, and objective scores of depression in community-dwelling elderly people in Japan. A total of 747 elderly participants (mean age: 76.1, female: 59.8%) who completed the 15-item Geriatric Depression Scale (GDS-15) along with items assessing subjective knowledge and risk perception were included in the analysis. We assessed the correlation between subjective knowledge and risk perception, and then compare GDS-15 scores by level of subjective knowledge and risk perception. Subjective knowledge was weakly associated with risk perception and related to lower GDS-15 scores in a dose–response pattern, which did not change after adjusting for age, gender, basic activities of daily living (ADL), instrumental ADL, years of education and history of depression. There was no significant association between risk perception and GDS-15 scores. The relationship between knowledge, risk perception, and depressed mood in younger generations is unclear, but warrants examination.

1. Introduction

Risk perception is a core factor in most theories of health behavior promotion, such as fear appeal theory, protection motivation theory, the health belief model, and the extended parallel process model. The basic concept across theories is that perception of high personal risk increases the likelihood of taking precautions and changing behavior; however, the factors that lead to modified behavior differ across the various theories (Weinstein and Nicolich, 1993). For example, in the extended parallel process model, precautionary behavior depends on two appraisals: threat and efficacy. If perceived threat or perceived efficacy is low, precautionary behavior will not be taken. Precautionary behavior is taken only when both perceived threat and perceived efficacy are high (Witte, 1992).

Several meta-analyses have shown that risk perception influences health behavior in empirical settings, although effect sizes have varied. For example, in a review of 34 studies with 15,988 participants about vaccination, risk likelihood ($r=0.26$), susceptibility ($r=0.24$), and severity ($r=0.16$) significantly predicted vaccination behavior (Brewer et al., 2007). Another review of 15 studies with 16,293 participants about protection motivation theory reported an effect size (as expressed by Cohen's d) of threat vulnerability and severity of 0.54 (Floyd et al., 2000). Witte and Allen conducted a meta-analysis of fear appeal and reported the effect size of severity was $r=0.13$ (16 studies, $n=2528$) and susceptibility was $r=0.14$ (11 studies, $n=1797$) (Witte and Allen, 2000).

There is evidence that knowledge of depression affects attitudes and behavior. Indeed, "Blues-out," a depression awareness campaign targeting the gay/lesbian community in Switzerland, was found to significantly reduce the lifetime prevalence of suicidal ideation and suicide plans of studied participants (Wang et al., 2013). The campaign included brochure and website offering basic information on depression, a symptoms checklist, a list of gay-friendly providers and institutions for consultation, a hotline, and emergency cards. Furthermore, the "Defeat Depression Campaign" in the United Kingdom positively changed public attitudes toward depression, reported experiences of depression, attitudes toward antidepressants, and attitudes toward treatment from general practitioners, by about 5–10% (Paykel et al., 1998). In addition, 40.7% of general practitioners definitely or possibly made changes in practice as a result of the

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campaign (Rix et al., 1999). Thus, knowledge of depression may positively influence attitudes or behavior, however the relationship between knowledge and risk perception in depression remains unclear. Clarification of this relationship is important for effective health promotion regarding depression.

The relationship between knowledge, risk perception, and depressed mood in depression is another concern. Few studies have investigated the influence of risk perception on depressed mood. A study of patients with multiple sclerosis showed that a higher perception of short-term risk of wheelchair dependence was significantly related to higher levels of anxiety (regression coefficient $B=0.78$, $P<0.001$) and depression ($B=0.45$, $P<0.01$) (Janssens et al., 2004), whereas another study reported that knowledge of evidence-based patient information increased the accuracy of leukemia risk estimation without increasing concerns (Hofmann et al., 2013).

In summary, the relationship between knowledge, risk perception, and depressed mood remains unclear. Currently, no studies, to our knowledge, are examining this relationship in depression research. However, it would be important to clarify this relationship in the field of depression because if knowledge of depression increase depressed mood of people, the enlightenment campaign of depression could be good will with big side effect.

The depression in elderly population is especially important in the aging society and Japan is one of the most aged countries in the world. According to research on community-dwelling older adults, the proportion of individuals reporting depressive symptoms is 2.8–35% (Beekman et al., 1999). The natural course of laterlife depressive disorders is poor: a 6-year follow-up study showed that 76% of patients followed an unfavorable but fluctuating course or a severe chronic course of depression. A study in the United States found that the additional medical cost per one depressed older adult was USD 686 for 1 year and USD 5271 for 4 years (Unutzer et al., 1997).

Thus, the aim of this study was to clarify the relationship among subjective knowledge, risk perception, and objective scores for depression among community-dwelling elderly people in Japan.

2. Methods

2.1. Subjects

The study population consisted of 747 community-dwelling elderly people aged 65 years or older living in T town in Japan who completed a depression scale, a subjective knowledge item, and a risk perception item. T town is situated in the midpoint of Shikoku, Japan, and was studied in 2012. Its main industries are agriculture and forestry. The town had a population of 4245, and 1734 (40.8%) residents were aged 65 years or older. The local government distributed self-rating questionnaires to all the elderly people aged 65 years or older except for those who stayed in hospitals or elderly nursing home, and participants mailed their answers to the local government. The total of 1615 questionnaires were distributed, 982 people responded (60.8%). Among them, 747 questionnaires had no missing data.

2.2. Outcome measures

15-Item Geriatric Depression Scale (GDS-15)

The GDS-15 is a validated self-reported depression scale consisting of 15 items with dichotomous answers (yes or no). This scale was developed to exclude the effects of non-specific somatic symptoms such as anorexia and insomnia, which are frequently observed among elderly populations, (Yesavage et al., 1983). The highest possible score is 15, indicating severe depression. Using a cutoff point of 6, the GDS-15 has a sensitivity of 92% and a specificity of 81% to detect major depression as ascertained by the structured clinical interview for the diagnostic and statistical manual of mental disorders, third edition, revised (Lyness et al., 1997). We used the Japanese version of the GDS-15 (Niino et al., 1991). Its sensitivity and specificity using the cut-off point of 6 or more were reported to be 97.3% and 95.9%, respectively (Shreiner et al., 2003). The Cronbach's alpha of GDS-15 in the present study was 0.81.

Risk perception and subjective knowledge

Risk perception about depression was evaluated with the question "How do you feel about depression?" Answers were made on a 4-point scale: 4 (very afraid of), 3 (somewhat afraid of), 2 (rarely afraid of), or 1 (not afraid of at all). Subjective knowledge was evaluated with the question "How much do you know about depression?" This answer was also chosen from a 4-point scale: 4 (a lot), 3 (a little), 2 (hardly anything), or 1 (nothing at all).

Other variables

Other variables included gender, years of education, basic activities of daily living (BADL), instrumental activities of daily living (IADL), and history of major depression.

BADL was measured with seven aspects of daily functioning: walking, ascending and descending stairs, feeding, dressing, going to the toilet, bathing, and grooming. Each BADL item was evaluated using a 4-point rating scale from 0 (completely dependent) to 3 (completely independent). Scores on the seven BADL items were summed to obtain a total score ranging from 0 to 21. A score of 21 on the BADL indicated complete independence (Matsubayashi et al., 1996; Pace, 1989).

IADL was assessed using the instrumental ADL subscale of the Tokyo Metropolitan Institute of Gerontology Index of Competence rating scale (Koyano et al., 1991). It was composed of five items: the ability to use public transport, buy daily necessities, prepare a meal, pay bills, and handle banking matters. Each item is rated as "yes" or "no." The range of scores is from 0 to 5, with higher scores indicating better IADL.

2.3. Analysis

Statistical analysis was performed using SPSS Statistics ver. 20.0 (IBM Inc., Armonk, NY). The correlation coefficient between risk perception and subjective knowledge was calculated using Spearman's rank correlations. Differences between variables among categories were examined using ANOVA (with Bonferroni post-hoc analysis when population variance was same and with Games–Howell post-hoc analysis when population variance was different) for continuous variables and chi-square tests for categorical variables. We used multivariate linear regression modeling to determine the adjusted association of GDS-15 scores with the level of subjective knowledge and risk perception, as well as age, gender, history of depression, BADL, and IADL. Predictors were included using the stepwise method in the multivariate regression model. Significance was set at 0.05 for all analyses.

Table 1
Basic characteristics of participants according to level of subjective knowledge and risk perception.

	Total	Risk perception				p	Subjective knowledge				p
		Very much	Somewhat	Rarely	Not at all		Very much	A little	Hardly	Not at all	
	($n=747$)	($n=384$)	($n=211$)	($n=102$)	($n=50$)		($n=292$)	($n=349$)	($n=85$)	($n=21$)	
Age	76.1 (7.3)	76.2 (6.9)	75.7 (7.7)	76.1 (7.4)	76.4 (8.1)	n.s.	75.0 (6.5)	75.8 (7.5)	79.9 (7.0)	79.0 (8.5)	< 0.001
Female, %	59.8	63.5	60.2	53.9	42.0	0.02	41.2	46.8	50.6	52.4	0.045
GDS-15	5.1 (3.4)	5.3 (3.4)	5.2 (3.4)	5.2 (3.4)	4.7 (3.3)	n.s.	4.3 (3.1)	5.4 (3.4)	6.0 (3.7)	8.3 (3.9)	< 0.001
History of major depression, %	4.8	2.9	6.3	7.8	4.8	n.s.	4.3	5.9	2.5	0	n.s.
Years of education	9.8 (2.3)	9.6 (2.2)	10.0 (2.3)	10.3 (2.3)	9.8 (2.2)	n.s.	10.0 (2.3)	9.9 (2.3)	9.1 (1.6)	8.7 (1.9)	< 0.001
Basic ADL (0–21)	20.1 (2.3)	20.1 (2.2)	20.1 (2.4)	20.3 (2.3)	20.1 (3.0)	n.s.	20.6 (1.4)	20.1 (2.4)	19.1 (3.3)	18.8 (4.5)	< 0.001
Instrumental ADL (0–5)	4.4 (1.3)	4.4 (1.3)	4.5 (1.2)	4.5 (1.3)	4.4 (1.2)	n.s.	4.7 (0.9)	4.4 (1.3)	3.8 (1.8)	3.5 (2.0)	< 0.001

Note: Data are presented as mean (S.D.) unless otherwise noted. Chi-square test and ANOVA were used for categorical and continuous variables, respectively. ADL=activities of daily living.

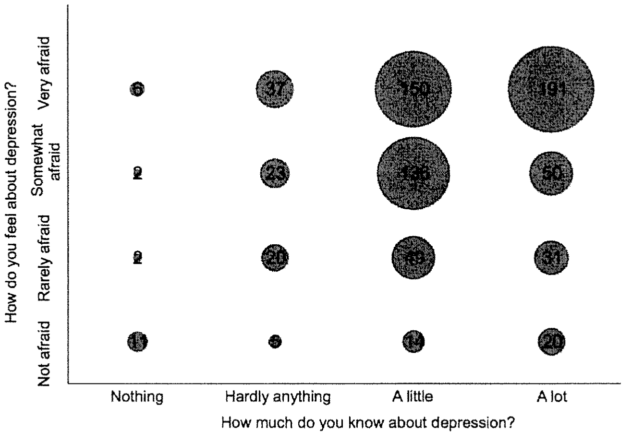

Fig. 1. Relationship between risk perception and subjective knowledge of depression. The size of the bubble corresponds to the number of each category shown inside the bubble. Spearman's $r=0.20$, $p<0.001$.

2.4. Ethical approval

The study was approved by the Institutional Ethical Review Board of the Graduate School of Medicine, Kyoto University (E-18). All the participants provided written informed consent.

3. Results

Table 1 shows the basic characteristics of participants by level of subjective knowledge and risk perception. One-way independent ANOVAs were conducted to compare the differences in subjective knowledge and risk perception by each continuous variable. There was a significant effect of subjective knowledge on age, BADL score, and IADL score. Post-hoc test revealed that there are significant differences between "hardly anything" and "a little" ($p<0.001$), "hardly anything" and "a lot" ($p<0.001$) in age; "hardly anything" and "a lot" ($p<0.005$), and "a little" and "a lot" ($p<0.005$) in BADL; "hardly anything" and "a little" ($p<0.05$), "hardly anything" and "a lot" ($p<0.001$), and "hardly anything" and "a lot" ($p<0.05$) in IADL. Both subjective knowledge and risk perception differed significantly by gender; however, there was no significant difference by a history of depression. There were no significant differences in level of risk perception by age, years of education, BADL score, and IADL score.

The correlation between risk perception and subjective knowledge was weak but significant ($r=0.20$, $p<0.001$) (Fig. 1). This indicates that the more participants felt they had knowledge of depression, the more they were afraid of depression.

Mean (SD) GDS-15 scores by level of risk perception were 4.7 (3.6) ($n=50$) for "not at all," 4.4 (3.3) ($n=102$) for "rarely," 5.2 (3.4) ($n=211$) for "somewhat" and 5.3 (3.4) ($n=384$) for "very much." There was no significant effect of risk perception on GDS-15 scores (F (3, 743)=2.06, p=n.s.) (Table 1). However, there was a significant effect of subjective knowledge on GDS-15 scores, $F(3, 743)=15.4$, $p<0.001$, $\omega=0.23$ (Table 1). Mean GDS-15 scores by the level of subjective knowledge were 8.3 (3.9) ($n=21$) in "not at all", 6.0 (3.7) ($n=85$) in "hardly", 5.4 (3.4) ($n=349$) in "a little" and 4.3 (3.1) ($n=292$) in "a lot". The post-hoc analysis revealed that there were significant differences in GDS-15 scores between the groups of "not at all" and "hardly" ($p=0.02$), "a little" ($p=0.001$) and "a lot" ($p<0.001$), "hardly" and "a lot" ($p<0.001$), and "a little" and "a lot" ($p<0.001$).

Table 2 shows the results of the multivariate linear regression analysis for variables predicting GDS-15 scores. Model 1 is a univariate linear regression with only subjective knowledge or risk perception. Then, we adjusted for gender and age (Model 2), and then gender, age, history of depression, BADL score, and IADL score (Model 3). Univariate analysis revealed that both age and gender significantly predicted GDS-15 scores (age: $\beta=0.20$, $p<0.001$; female: $\beta=0.09$, $p=0.02$). Level of risk perception did not significantly predict GDS-15 scores in the univariate analysis or in the multivariate analysis adjusted for gender and age. In terms of subjective knowledge, there were significant associations between subjective knowledge and GDS-15 scores after adjusting for gender, age, history of depression, BADL score, IADL score, and years of education.

4. Discussion

Results of this study indicate that people with subjective knowledge of depression are more afraid of depression and less depressed, however that risk perception was not significantly related to depressed mood. A negative dose–response relationship was observed between subjective knowledge and depressed mood, and the results did not change after adjustment for age, gender, history of depression, BADL score, IADL score and years of education, which are known influencing factor on depressive mood (Djernes, 2006). These results are especially important for community assessment and prevention programs such as the enlightenment campaign. Although the present study could not explain cause and effect relationships as it was cross-sectional study, the preset result show one possibility that increasing knowledge may prevent people from becoming depressed even if risk perception is increased.

Additionally, the present results reinforced the theories of health promotion behavior that message, namely knowledge, is the premise of risk perception. Because the present result showed that those who answered that they knew nothing about depression tend to feel less fear.

There are few studies on risk perception, knowledge, and anxious or depressed mood; those that have been conducted included subjects such as multiple sclerosis patients and staff reporting blood exposure incidents (Cockcroft et al., 1994; Hofmann et al., 2013; Janssens et al., 2004). The present study is the first to investigate these topics in relation to depression among community-dwelling elderly in the general population.

Thus far, three studies on the relationship among risk perception, knowledge, and depressed mood or anxiety have been conducted, and their results varied. One of the three studies concluded that knowledge increases risk estimation without increasing concerns (Hofmann et al., 2013), whereas the other two studies concluded that initial knowledge is not related to anxiety, but that increased risk perception is related to anxiety or depression (Cockcroft et al., 1994; Janssens et al., 2004). The present study supports the former result.

Although the full comparison of the results is difficult because the previous studies are about high risk subjects and the present study is about low risk community-dwelling subjects, possible explanations for the contradictory results are as follows. First, age may be related to the difference in results. The mean age of participants in the studies demonstrating increased anxiety with higher risk perception was relatively low (mean age=37.5, S.D.=9.5 (Janssens et al., 2004); median age: 27, range: 19–59 (Cockcroft et al., 1994), respectively); in contrast, the mean ages (S.D.) of participants in studies not demonstrating this relationship are 50.3 (9.8) (Hofmann et al., 2013) and 77.0 (7.2), respectively. A meta-analysis of age differences in risk taking suggests that elderly people take more risks than do younger people on a task where participants are unsure of the probability of risk and need to learn not to take a specific action (Mata et al., 2011). It is suggested that learning related to risk avoidance may become impaired with aging (Mata et al., 2011). This may be related to the results of previous studies and the present study that elderly people are less anxious thus less depressed in situations where the probability of a risk is unclear

Table 2
The results of multivariate linear regression analysis for variables predicting GDS-15 scores.

		B	SE B	β			B	SE B	β
Step 1					Step 1				
Risk perception	Not at all	Reference			Subjective knowledge	Not at all	Reference		
	Rarely	−0.32	0.59	−0.03		Hardly anything	−2.37	0.81	−0.22*
	Somewhat	0.52	0.54	0.07		A little	−2.94	0.74	−0.43**
	Very much	0.55	0.51	0.08		A lot	−4.06	0.75	−0.58**
Step 2					Step 2				
Age		0.09	0.17	0.19**	Age		0.08	0.02	0.16**
Female		0.45	0.26	0.06	Female		0.62	0.25	0.09***
Risk perception	Not at all	Reference			Subjective knowledge	Not at all	Reference		
	Rarely	−0.35	0.60	−0.04		Hardly anything	−2.40	0.80	−0.22*
	Somewhat	0.64	0.56	0.08		A little	−2.77	0.74	−0.41**
	Very much	0.5	0.53	0.07		A lot	−3.85	0.74	−0.55**
Step 3					Step 3				
Age		0.08	0.02	0.02	Age		0.02	0.02	0.03
Female		0.39	0.25	0.06	Female		0.47	0.24	0.07
Risk perception	Not at all	Reference			Subjective knowledge	Not at all	Reference		
	Rarely	−0.32	0.57	−0.03		Hardly anything	−2.72	0.94	−0.26*
	Somewhat	0.68	0.53	0.09		A little	−2.41	0.90	−0.35*
	Very much	0.61	0.51	0.09		A lot	−3.12	0.90	−0.45*
No history of depression		−4.14	0.56	−0.27	No history of depression		−4.03	0.55	−0.26**
BADL		−0.19	0.07	−0.14*	BADL		−0.18	0.07	−0.13*
IADL		−0.73	0.13	−0.28**	IADL		−0.70	0.13	−0.27**
Years of education		−0.16	0.06	−0.10*	Years of education		−0.16	0.06	−0.10*

Note: Adjusted R^2: 0.004 in Step 1, 0.05 in step 2, and 0.28 in step 3 in the analysis including risk perception; 0.06 in Step 1, 0.08 in step 2, and 0.30 in Step 3 in the analysis including subjective knowledge.
BADL = basic activities of daily living; IADL = instrumental activities of daily living; GDS-15 = 15-item Geriatric Depression Scale.

* $p < 0.01$.
** $p < 0.001$.
*** $p < 0.05$.

and there is no specific choice of action to prevent the event. Studies focusing on elderly populations are becoming much more important as the aging population grows.

Second, studies evaluated different aspects of risk. Two of the studies evaluated the probability of risk (Cockcroft et al., 1994; Hofmann et al., 2013) and the other study evaluated probability and seriousness of risk (Janssens et al., 2004). A meta-analysis of the relationship between risk perception and vaccination behavior showed the effect size of prediction for vaccination behavior was different between risk likelihood ($r = 0.26$) and severity ($r = 0.16$) (Brewer et al., 2007). Based on this finding, probability and seriousness of risk may have different influences on mood and behavior, which leads to the different results among previous studies and the present study.

Third, the targeted diseases or disorders differ. Hepatitis B virus is acute infection, whereas multiple sclerosis and depression are chronic diseases. In a previous study, increased anxiety and depression was observed when participants perceived that events would happen in the short-term (2 years), while anxiety was not observed when they perceived that events would happen in the long-term (10 years) or lifetime (Janssens et al., 2004). These results imply that if an event is perceived to happen in the short-term (e.g., an acute infection), people seem to feel more anxiety or depression about the event.

The method of diagnosis also differed. The diagnosis of physical diseases such as HIV, hepatitis B virus and multiple sclerosis is more objective and can be visualized. However, the diagnosis of major depression is heavily dependent on symptoms and history, and there are no established diagnostic laboratory examinations. These differences in criteria for diseases or disorders is related to uncertainty, which can affect anxiety (Grupe and Nitschke, 2013).

This study has several limitations. First, we used a subjective knowledge scale, and subjective knowledge is not equal to actual knowledge. Nevertheless, the present study shows that subjective feelings that one knows about depression are important. Furthermore, subjective knowledge may reflect self-efficacy, which should be investigated in future studies. Additionally, the risk scale in the present study only measured the perceived seriousness of depression. The perceived possibility of the risk may influence depression in a different way, as mentioned above. Finally, the population of this study was elderly people over 65 years old. Focusing on this population is important in an aging society like Japan; however, the relationship between perception of risk and depressed mood may be different among different age groups.

In conclusion, risk perception is related to subjective knowledge and subjective knowledge is associated with lower depressed mood in community-dwelling elderly people. Although the present study could not explain cause and effect relationships as it was cross-sectional study, there is possibility that increasing knowledge may prevent people from becoming depressed even if risk perception is increased. Information should be provided for elderly people to improve their confidence in their knowledge of depression. The relationship between knowledge, risk perception, and depressed mood in younger generations is unclear, but warrants examination.

Contributors

H.I. and K.M. made substantial contribution to the conception and design of the study, were involved in drafting the manuscript and are responsible for the administration and direction of the study as well as the analysis and interpretation of data. K.O. and E.F. assisted with the negotiation with the local government and were responsible for the preparation of the study materials as well as the analysis and interpretation of data. Y.I., Y.K., W.C. and M.T. were responsible for data collection. T.W., R.S. and M.F. contributed to the conceptualization of the study and were responsible for data analysis and interpretation. All authors read and approved the final manuscript.

Conflict of interest

The authors declare no conflict interests.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Predictors of difficulty in carrying out basic activities of daily living among the old-old: A 2-year community-based cohort study

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Aim: To present practical predictors for the difficulty of carrying out basic activities of daily living (ADL) among the old-old during a 2-year period.

Methods: Assessment was carried out using data obtained from the Tosa Longitudinal Aging Study, a community-based cohort survey on geriatric functions in the elderly. Predictor variables measured at baseline included age; sex; height; weight; blood pressure; oxygen saturation; neurobehavioral functions, such as Mini-Mental State Examination, Kohs Block Design test, Timed Up and Go test, button score, functional reach test, geriatric depression scale, cardio-ankle vascular index, ankle brachial pressure index; and blood chemical results, such as hemoglobin, fasting blood sugar, hemoglobin A1c, serum lipids, serum albumin and serum creatinine. The outcome variable was the presence of difficulties while carrying out basic ADL after 2 years.

Results: Age of ≥85 years, Timed Up and Go test of ≥15 s, button score of >17 s and presence of knee pain were independent predictors of difficulty in carrying out basic ADL after 2 years. Elderly individuals who have had at least two positive findings out of these four variables were likely to have impaired basic ADL during a 2-year period with a positive predictive value of 52.0%, negative predictive value of 90.2%, sensitivity of 70.3% and specificity of 80.8%.

Conclusions: Assessment of age, Timed Up and Go test, manual dexterity, and presence of knee pain is a useful and relevant way to identify patients who should be informed about their likelihood of developing difficulties in carrying out basic ADL. **Geriatr Gerontol Int 2015; ••: ••–••.**

Keywords: basic activities of daily living, comprehensive geriatric assessment, knee pain, manual dexterity, predictor.

Introduction

Difficulty in carrying out activities of daily living (ADL) affects quality of life (QOL) in the elderly. Although death and senescence are unavoidable phenomena, ADL might be improved or sustained through appropriate interventions, even among old-old individuals. Identification of elderly individuals with a high risk for developing difficulties in carrying out basic ADL is important so that appropriate management can be determined before QOL is impaired. Many risk factors have been reported to be associated with difficulties in carrying out basic ADL, including dementia, depressive symptoms, visual difficulty, arthritis, incontinence, hypertension, obesity, diabetes, parkinsonism, lower physical activity, slower walking speed, lower grip strength, lower knee extensor strength, shorter stride length, shorter forward reach, lower manual dexterity, a history of hospitalization, diminished peak expiratory flow and older age.[1–14] Accordingly, many tests are available for identifying problems, and most old-old individuals might have some risk factors. In clinical settings, knowing the relative importance of the various factors

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can help to predict difficulties in carrying out basic ADL in the near future. The present study assessed the utility of several geriatric parameters as a way of identifying community-dwelling old-old who were at risk for developing difficulties in carrying out basic ADL after 2 years. The present study aimed to present algorithms for use in clinical practice as well as in field-settings to detect old-old individuals who should take precautions against disability within a few years.

Methods

Tosa Longitudinal Aging Study

Data were obtained from the Tosa Longitudinal Aging Study (TLAS), a community-based cohort study on comprehensive geriatric functions in the elderly, annually carried out in Tosa, a rural town in Kochi prefecture, Japan. The TLAS enrolled the entire unselected community-dwelling elderly population (aged ≥65 years) recorded in the town registry office. After obtaining written informed consent, we carried out comprehensive geriatric examinations that assessed ADL, depression, QOL, physical functions, neurobehavioral function tests and blood chemical analysis.[15,16]

Participants

The present study population consisted of elderly individuals who were eligible for inclusion in this study if: (i) they were aged ≥75 years when they participated in the community-based health check-ups in Tosa in 2004; and (ii) they had a full score in basic ADL at the time of the check-up in 2004.

To assess basic ADL, each participant was interviewed to rate his/her independence in seven items (walking, ascending and descending stairs, feeding, dressing, toileting, bathing, and grooming), specifically with regard to how much help was required. These were rated from 3 to 0 (3 = completely independent, 2 = requires some help, 1 = requires much help and 0 = completely dependent). Possible scores ranged from 0 to 21, with low scores indicating disability.[17] A total of 188 individuals satisfied the inclusion criteria.

This study was approved by the Ethics Committees of Kyoto University (E-18) and the Research Institute for Humanity and Nature Research.

Outcome and predictors

Predictor variables measured at baseline included age, sex, height, weight, blood pressure, heart rate, oxygen saturation and neurobehavioral function tests, such as the Mini-Mental State Examination, Kohs Block Design test, Timed Up and Go (TUG) test, button score and the functional reach test.[18–22]

The TUG test timed the number of seconds it took the participant to stand up from an armchair, walk a distance of 3 m, turn around, walk back to the chair and sit back down.[20] Button scores evaluated manual dexterity using a panel with combinations of 10 hooks, 10 big buttons and five small buttons. Three discrete time measurements were made for each participant (10 hook-ons, 10 big button-on-and-offs, and 5 small button-on-and-offs). Total manual dexterity time in seconds, defined as the button score, was calculated by adding the mean time required to complete one hook-on and one big or small button-on-and-off.[21] The functional reach test assessed balance. Specifically, a participant stood with his/her fist extended alongside a wall, then leaned forward as far as possible, moving the fist along the wall without stepping out with the feet or losing stability. The distance the fist moved was measured.[22]

We also assessed cardio-ankle vascular index, ankle brachial pressure index, fasting blood sugar, hemoglobin A1c, hemoglobin concentration, serum lipids, serum albumin, serum total protein, blood urea nitrogen and serum creatinine. Blood pressure was measured twice in a sitting position with an autosphygmomanometer (HEM 757; Omron, Kyoto, Japan).[23,24] Hypertension was defined as a systolic pressure ≥140 mmHg and/or a diastolic pressure ≥90 mmHg, or if the participant was taking antihypertensive medication.

As a screening test for depressive symptoms, the 15-item version of the Geriatric Depression Scale was used.[25] To assess an advanced range of activities, each participant was rated on his/her independence in the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC), a standardized multidimensional 13-item index of competence.[26]

Statistical analysis

Logistic regression models were used to calculate the probability of difficulty in carrying out basic ADL on the basis of algorithms of predictor variables. Difficulty in carrying out basic ADL was defined as having a basic ADL-score of less than 21. All predictor variables were used in a logistic regression model for which difficulty in carrying out basic ADL was set as the dependent variable. Each variable was used separately in the analysis with adjustments for age and sex. For multivariable analyses, the model was simplified in a stepwise fashion by removing variables that were either negatively associated with the outcome or those with a P-value >0.05.

To assess the algorithms, multiple regression analysis identified variables that served as independent predictors of the difficulty of carrying out basic ADL (dependent variable) after 2 years. Sensitivity represented the percentage of those with positive results in each item among those with difficulties carrying out basic ADL after 2 years. Specificity represents the percentage with negative results for each item among those who showed independence in carrying out basic ADL after 2 years. As no single variable was likely to predict the difficulty with high sensitivity, combinations of variables that corresponded to high or low risks of the difficulty were investigated.

Data analysis was carried out with SPSS 17.0 for Windows (IBM, Armonk, NY, USA). Baseline data are presented as either mean ± standard deviation or percentages.

Results

Table 1 shows baseline results by sex from the examination carried out in 2004. Two people died during the 2-year period and 14 people did not participate in the follow-up examination in 2006. A total of 172 individuals (91.5%) underwent the follow-up examination in 2006 and formed the participant population. Any difficulty in carrying out basic ADL was noted.

A total of 38 participants (22.1%) had difficulty in carrying out basic ADL after 2 years (Table 2). Analyses of each basic ADL item showed that 36 (20.9%) had difficulty with ascending and descending stairs, 25 (14.5%) with walking, 11 (6.4%) with bathing, nine (5.2%) with dressing, nine (5.2%) with grooming, five (2.9%) with eating and five (2.9%) with toileting (Fig. 1).

Those who had difficulty in carrying out basic ADL in 2006 had significantly shorter distances for the functional reach test, longer times for the TUG test and button score, and lower scores for Kohs Block Design test and TMIG-IC, as well as lower levels of serum creatinine in 2004, compared with those without difficulty in carrying out basic ADL after 2 years (Table 2). Univariate analysis showed that age ≥85 years, presence of knee pain, low serum creatinine (men ≤0.6 mg/dL, women ≤0.5 mg/dL), TUG test times of ≥15 s, button score of >17 s, MMSE of ≤25, Kohs Block Design test of ≤16 and TMIG-IC of ≤12 were significant predictors of developing difficulty in carrying out basic ADL after 2 years, after adjusting for age and sex (Table 3). Multivariate analyses showed that an age of ≥85 years (odds ratio [OR] 3.98, 95% confidence interval [95% CI] 1.22–13.01), presence of knee pain (OR 4.51, 95% CI 1.65–12.28), TUG test of ≥15 s (OR 2.84, 95% CI 1.19–6.79) and button score of >17 s (OR 4.60, 95% CI 1.64–12.91) were independent predictors of the likelihood of developing difficulty in carrying out basic ADL after 2 years (Table 3).

An age of ≥85 years, presence of knee pain, low serum creatinine (men ≤0.6 mg/dL, women ≤0.5 mg/dL), TUG test time of ≥15 s, button score of >17 s, MMSE of ≤25, Kohs Block Design score of ≤16 and TMIG-IC of ≤12 were significant predictors of developing difficulty in carrying out basic ADL after 2 years, after adjusting for age and sex (Table 3).

Variables deemed significant by univariate analyses included age ≥85 years (OR 4.59, 95% CI 1.35–15.63), presence of knee pain (OR 4.67, 95% CI 1.71–12.77), TUG test time of ≥15 s (OR 2.74, 95% CI 1.14–15.63) and button score of >17 s (OR 4.56, 95% CI 1.62–12.86) and were identified as significant independent predictors of difficulty in carrying out basic ADL after 2 years by multivariate analyses (Table 3).

In multivariate analyses of predictors in each ADL item, age ≥85 years (OR 5.54, 95% CI 1.75–17.59), button score of >17 s (OR 5.04, 95% CI 1.74–14.59) and presence of knee pain (OR 6.36, 95% CI 1.87–21.56) independently predicted difficulties with walking after 2 years. Difficulty with ascending and descending stairs after 2 years was independently predicted by age ≥85 years (OR 4.83, 95% CI 1.54–15.16), TUG test time of ≥15 s (OR 3.00, 95% CI 1.24–7.23), button score of >17 s (OR 4.09, 95% CI 1.48–11.31) and presence of knee pain (OR 3.68; 95% CI 1.38–9.80).

Among the four variables, no single variable was found to be a significant independent predictor of experiencing difficulty with eating after 2 years. A button score of >17 s (OR 6.91, 95% CI 1.10–43.31) was an independent predictor of experiencing difficulty with toileting after 2 years.

A button score of >17 s (OR 4.80, 95% CI 1.11–20.82) was an independent predictor of experiencing difficulty with bathing after 2 years. A button score of >17 s (OR 12.90, 95% CI 2.33–71.43) was an independent predictor of experiencing difficulty with dressing after 2 years. A button score of >17 s (OR 6.47, 95% CI 1.34–31.16) was an independent predictor of experiencing difficulty with grooming activities after 2 years.

Our algorithm assessment determined that as single variables, age ≥85 years (sensitivity 26.3%, specificity 92.5%) and a button score of >17 s (sensitivity 39.5%, specificity 87.1%) predicted difficulties in carrying out basic ADL, with low sensitivity and rather high specificity. Presence of knee pain (sensitivity 81.1%, specificity 51.2%) predicted difficulties in carrying out basic ADL, with high sensitivity and rather low specificity. TUG test time of ≥15 s predicted difficulties in carrying out basic ADL, with a sensitivity of 60.5% and specificity of 74.6% (Table 4).

In the algorithm assessment to predict difficulties in carrying out basic ADL after 2 years, we used the four variables of age ≥85 years, TUG test time ≥15 s, button score >17 s and presence of knee pain, based on the multiple regression analysis results. Each of the four combinations chose one of the four variables. For each combination, one pattern of cut-off of one or more positive finding was considered each. Six combinations were made by choosing two of the four variables. For

Table 1 Results of baseline examination

		Men (n = 65)	Women (n = 123)	P-value
Demographic information	Age (years)	80.3 ± 4.0	80.1 ± 3.8	0.703
	Living alone (%)	11.5	34.5	0.001
	Current smoker (%)	14.5	1.8	0.002
	Daily drinker (%)	29.7	2.5	<0.001
	Non-drinker (%)	43.8	77.1	<0.001
	Habitual physical exercise (%)	73.4	68.9	0.611
Past history	Stroke (%)	10.3	6.7	0.391
	Heart diseases (%)	11.7	9.8	0.795
	Cancer (%)	13.6	5.3	0.077
	Fracture (%)	20.7	19.8	1.000
Symptoms	Knee pain (%)	41.3	64.7	0.003
	Dizziness (%)	28.6	31.0	0.865
	Visual difficulty (%)	11.1	7.6	0.425
	Hearing difficulty (%)	26.6	8.6	0.002
	Incontinence (%)	14.3	14.5	1.000
Anthropometrics	Height (cm)	157.0 ± 5.9	144.9 ± 5.8	<0.001
	Weight (kg)	56.9 ± 8.1	48.1 ± 7.4	<0.001
	Body mass index	23.1 ± 2.7	23.0 ± 3.3	0.840
	Systolic blood pressure (mmHg)	149.4 ± 17.5	157.5 ± 21.4	0.009
	Diastolic blood pressure (mmHg)	86.0 ± 7.5	87.2 ± 10.4	0.381
	Hypertension (%)	81.5	86.2	0.404
Laboratories	Oxygen saturation (%)	96.9 ± 1.0	96.8 ± 1.1	0.483
	Fasting blood sugar (mg/dL)	113.1 ± 32.7	113.6 ± 29.2	0.931
	Hemoglobin A1c (%)	5.6 ± 1.4	5.4 ± 0.5	0.466
	Hemoglobin (g/dL)	13.2 ± 1.5	12.5 ± 1.2	0.001
	High-density lipoprotein cholesterol (mg/dL)	52.0 ± 12.7	54.0 ± 14.9	0.357
	Low-density lipoprotein cholesterol (mg/dL)	105.5 ± 27.7	115.2 ± 27.0	0.022
	Albumin (g/dL)	4.2 ± 0.3	4.3 ± 0.2	0.001
	Total protein (g/dL)	7.2 ± 0.4	7.4 ± 0.4	<0.001
	Blood urea nitrogen (mg/dL)	17.0 ± 7.6	15.7 ± 3.3	0.194
	Creatinine (mg/dL)	0.9 ± 0.2	0.7 ± 0.1	<0.001
Geriatric functions	Functional reach (cm)	28.9 ± 7.5	26.2 ± 7.9	0.020
	Timed Up and Go test (s)	14.4 ± 3.8	14.7 ± 4.7	0.681
	Button score (sec)	17.5 ± 7.9	13.4 ± 4.3	<0.001
	Geriatric Depression Scale	4.5 ± 3.7	4.6 ± 3.5	0.821
	Mini-Mental State Examination	25.6 ± 4.1	26.4 ± 3.4	0.148
	Kohs Block Design test	18.0 ± 11.4	16.9 ± 10.3	0.499
	TMIG-IC	10.7 ± 2.7	11.3 ± 2.3	0.099
Arterial stiffness	Cardio-Ankle Vascular Index	9.7 ± 1.6	10.4 ± 2.1	0.030
	Ankle Brachial Pressure Index	1.14 ± 0.13	1.10 ± 0.86	0.026

TMIG-IC, Tokyo Metropolitan Institute of Gerontology Index of Competence.

these combinations, two patterns of cut-offs of one or more and two or more positive findings were considered. Four combinations were made by choosing three of the four variables. For these combinations, three patterns of cut-offs of one or more, two or more and three or more positive findings were considered. One combination was made by choosing all four variables. For this combination, four patterns of cut-offs of one or more, two or more, three or more and four or more positive findings were considered. A total of 32 algorithm patterns were considered.

Choosing a cut-off of one or more positive findings out of the four variables increased the negative predictive value and sensitivity, resulting in decreased positive

Table 2 Comparison of baseline results between the impaired and the maintained people in basic activities of daily living after 2 years

		Basic activities of daily living after 2 years With difficulty (n = 38)	Without difficulty (n = 134)	P-value
Demographic information	Sex (male/female)	11/27	49/85	0.444
	Age (years)	81.0 ± 4.6	79.8 ± 3.6	0.161
	Living alone (%)	25.0	25.8	1.000
	Current smoker (%)	6.1	6.3	1.000
	Daily drinker (%)	7.9	13.8	0.414
	Non-drinker (%)	65.8	63.1	0.849
	Habitual physical exercise (%)	55.3	75.9	0.024
Past history	Stroke (%)	13.9	7.1	0.309
	Heart diseases (%)	11.8	10.4	0.762
	Cancer (%)	14.3	7.3	0.193
	Fracture (%)	24.3	19.7	0.644
Symptoms	Knee pain (%)	81.1	48.8	0.001
	Dizziness (%)	33.3	26.6	0.529
	Visual difficulty (%)	10.8	6.9	0.486
	Hearing difficulty (%)	16.7	11.5	0.405
	Incontinence (%)	21.6	10.0	0.088
Anthropometrics	Height (cm)	146.5 ± 9.4	150.1 ± 7.5	0.016
	Weight (kg)	50.0 ± 7.1	52.0 ± 9.0	0.205
	Body mass index	23.2 ± 2.4	23.1 ± 3.3	0.836
	Systolic blood pressure (mmHg)	156.7 ± 21.5	154.7 ± 20.2	0.612
	Diastolic blood pressure (mmHg)	87.2 ± 9.6	86.4 ± 9.7	0.659
	Hypertension (%)	92.1	83.6	0.296
Laboratories	Oxygen saturation (%)	96.8 ± 1.1	96.9 ± 1.0	0.737
	Fasting blood sugar (mg/dL)	125.9 ± 77.5	113.8 ± 33.0	0.158
	Hemoglobin A1c (%)	5.7 ± 1.6	5.4 ± 0.6	0.115
	Hemoglobin A1c ≥6.1% (%)	10.5	12.0	1.000
	Hemoglobin (g/dL)	12.6 ± 1.1	12.9 ± 1.3	0.215
	High-density lipoprotein cholesterol (mg/dL)	56.3 ± 12.4	53.3 ± 14.7	0.251
	Low-density lipoprotein cholesterol (mg/dL)	118.3 ± 24.5	111.5 ± 27.9	0.179
	Albumin (g/dL)	4.3 ± 0.3	4.3 ± 0.2	0.110
	Total protein (g/dL)	7.4 ± 0.5	7.4 ± 0.4	0.672
	Blood urea nitrogen (mg/dL)	16.1 ± 3.0	15.9 ± 3.8	0.715
	Creatinine (mg/dL)	0.7 ± 0.1	0.8 ± 0.2	0.012
Geriatric functions	Functional reach (cm)	25.1 ± 9.0	28.3 ± 7.1	0.023
	Timed Up and Go test (s)	16.4 ± 4.3	13.6 ± 3.4	<0.001
	Button score (s)	16.9 ± 6.1	13.4 ± 4.3	0.002
	Geriatric Depression Scale	4.9 ± 3.3	4.4 ± 3.5	0.416
	Mini-Mental State Examination	25.4 ± 4.0	26.6 ± 3.2	0.088
	Kohs Block Design test	14.6 ± 9.7	19.1 ± 10.7	0.020
	TMIG-IC	10.6 ± 2.7	11.5 ± 2.3	0.038
Arterial stiffness	Cardio-Ankle Vascular Index	10.5 ± 2.1	10.1 ± 2.0	0.383
	Ankle Brachial Pressure Index	1.10 ± 0.11	1.13 ± 0.10	0.203

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