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Fall-Prevention Self-Efficacy in Relationship to High-Density Lipoprotein Cholesterol and Physical Strength in Elderly Residents of a Japanese Rural District : *Kosuge Cross-Sectional Study*

By

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Background : The aim of the current study was to clarify relationships between self-efficacy and high-density lipoprotein cholesterol (HDL-C) and physical strength.
Methods : Target participants were 339 elderly residents aged 65 years or older from Kosuge Village, Yamanashi Prefecture in Japan. One hundred and thirty two persons participated in the study (38.9%). Outcome measurements included the 10-m walking time, the maximal step length and 40-cm step test as moving ability, the tandem gait as balance ability, and HDL-C. Fall-prevention self-efficacy (FPSE) was evaluated using a questionnaire that examined 10 items (actions) and 4 Likert scale. A total of 40 points could be awarded. This research design was a cross-sectional study that divided the elderly into two groups by the existence of a fear of falling.
Results : Although there was no significant relationship between fall-prevention self-efficacy and HDL-C, we demonstrated that a group with poor self-efficacy had significantly deteriorated moving ability and that only one male participant with knee pain and/or lumbago exhibited poor self-efficacy.
Conclusions : We could not find significant relationships between self-efficacy and HDL-C. But this study is limited to the independent elderly people in a local area, and further studies should be conducted to detect the relationships.

Key words : elderly, fall, self-efficacy, HDL-cholesterol , moving ability

Introduction

The Annual Statistical Report of National Health Conditions 2006[1], examined the rapidly aging Japanese population. The Report states that people aged 65 years or older constituted 21.0% of the population as of October 2005 and predicted that this group will increase to 36% by 2050. With this increase in the elderly population, increasing medical expenses and nursing care insurance burdens for the benefit of the elderly are

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important issues for Japan, as well as local governments. Longevity and an extended independent life are critical concerns, to which the Japanese government responded with the policy of "*Kenkou Nippon 21*" (Healthy Japan 21)[2].

In Japan, falls resulting in bone fractures were ranked as the third (11.8%) among the causes of long-term care, and the number of deaths from falls was 6,722 in 2002[3]. The Tokyo Fire Department reported that 47,404 people required ambulance transport in 2004 because of emergency home accidents, of which falls were the most frequent, accounting for 48.8% (23,143 persons) of the total[4]. Therefore, ambulances are called most often for falls occurring as daily-life accidents of elderly people living at home.

A large number of studies have examined the correlation of falls in the elderly with a fear of falling or with a fall-prevention self-efficacy. Many elderly people who have experienced falls live with a fear of falling[5,6], restrict their daily life activities[7] and become anxious or depressed[7,8].

Recently, Deshpande, *et al.*[9] performed a prospective cohort study, and reported that fear of falling was an independent factor for disability, even after adjustment for gender, age, and BMI. In contrast, in a prospective cohort study over 3 years, Austin, *et al.* demonstrated a cause-and-effect relation between decreased balance ability, moving ability, and fear of falling in elderly female participants[10]. Other studies reported that the higher levels of high-density lipoprotein cholesterol (HDL-C) are associated with better functional performance[11,12,13]. Although there are studies that investigated relationships between fear of falling and physical activity or relationships between HDL-C and physical activity, few reports have examined relationships between fear of falling and HDL-C.

It is clear that blood profile has relationships with many diseases, for example low level of HDL-C is an important risk factor for cardiovascular disease and mortality[14]. If the relationship between fear of falling and blood profile is found, the fear of falling could be a useful parameter to predict disease, not only physical fitness.

Fear of falling can be quantitatively assessed by direct interview, but elderly people have difficulty expressing the degree of fear properly. This point is illustrated in the following response to questioning, "When I am asked if I feel fear of falling, I do so indeed. But I cannot measure it." Thus, an issue of reliability in quantification exists[15,16,17].

Sociologic learning theory has a central concept of "self-efficacy", which represents an individuals confidence in performing a necessary activity efficiently. Based on this confidence theory, fear of falling can be quantified as fear-of-falling related self-efficacy or confidence in completing an action without falling.

The aim of the current study was to clarify relationships between self-efficacy and HDL-C and physical strength.

Methods

Setting and participants

Target participants were 339 elderly residents aged 65 years or older from Kosuge Village, Yamanashi Prefecture in Japan. The population of the village was 920 as of June 1, 2007, therefore, the target participants comprised 36.8% of the village population. We visited 9 community centers in the village a total of 10 times on 9 weekdays from the end of June through the beginning of July, 2007. We publicized the survey's date, time, place, and content in order to recruit participants through an intra-village wired broadcast, through clubs for the aged, and by notification of district heads from the resident division of the village office. Blood study results were acquired from a database of the residents' check-up conducted in April to August 2007.

People 65 years of age or older living independently at home were included in the study, but those individuals with certification of long-term care need or who were hospitalized were excluded. Some people were excluded despite their willingness to participate because of hypertension detected immediately before the study or because of poor physical condition. We explained the reasons for declining their participation, and these individuals chose to cancel their enrollment in the study.

Research Design

This research design was a cross-sectional study that divided the community-dwelling elderly in Kosuge Village into two groups by the existence of fear of falling. The trial of procedure, analysis, and description was reported according to the STROBE (the Strengthening the Reporting of Observational Studies in Epidemiology) statement[18].

Outcome Measurements

Height, body weight, and body mass index (BMI) were measured or calculated as physical indices. Physical strength was assessed mainly by measurements of daily life activities. Moving ability was determined by a battery test of walking ability "*Kenkyakudo*"[19]. This consists of the 10-m walking time (maximal speed), measuring the maximal step length, and the 40-cm or 20-cm step test, which measures an ability to go up and down a 40-cm or 20-cm high platform. Balance ability was assessed by measuring tandem gait,[20]. Grip strength (mean of maximum values acquired on both sides) was also measured since it was regarded as an index of muscle strength and was easy to measure in the field.

Moving or balance ability was measured after a single practice. Measurements were made by well trained, skilled personnel. Examiners were blinded to the group allocation of the participants.

HDL-C was the primary outcome of the blood study. Other parameters were total cholesterol (Total-C), LDL-cholesterol (LDL-C), triglyceride (TG), hemoglobin A1c (HbA1c), AST (GOT), ALT (GPT),γ-GTP, and uric acid (UA). Blood samples were drawn in the morning, but breakfast taking depended on the participants.

We surveyed the daily life of the participants using a questionnaire that examined the existence of knee/back pains and, if present, their degree, and the number of falls during the previous year.

Fall-prevention self-efficacy (FPSE) was evaluated using a questionnaire that examined the following 10 items (actions) : 1) getting or out of a futon ; 2) standing up from or sitting down on the floor ; 3) putting on or taking off pants ; 4) housecleaning ; 5) shopping ; 6) going down stairs ; 7) walking on a crowded road ; 8) walking in dim light ; 9) walking with items in both hands ; and 10) walking on a bumpy road. The degree of confidence in carrying out these actions without falling was scaled using the following graded marks : 1 point for absolutely no confidence ; 2 points for almost no confidence ; 3 points for a little confidence ; and 4 points for great confidence. A total of 40 points could be awarded. This evaluation method was first developed by Tinetti, *et al.*,[21] and was modified by Soyano, *et al.*[17], considering Japanese living circumstances.

Written informed consent was obtained from all participants. The methodology of this study was approved by the Ethical Board of Tokyo University of Agriculture. No participants complained of pains, sickness or falling during the measurements.

Statistical Analysis

Since we set the main outcome as HDL-C, we utilized the data of people aged 65 years or older from the National Nutrition Survey in Japan 2007 in order to determine a sample size. The standard deviation of mean was approximately 15 mg/dL in both genders, so we determined the significant difference level between groups in the current study as 15 mg/dL. Statistical power was so set that the α error was 5% and the β error was 20%. The required sample size was calculated to be 16 or more persons in each group.

A two-sample t test was employed for comparisons between groups with continuous variables in the analysis. The χ^2 test and the Mann-Whitney test were performed with discrete variables. The analysis of covariance was used for age adjustment on variables. Differences within and among groups were judged significant when significance levels were 5% or less. SPSS 11.0J for Windows was used for statistical analysis.

Results

Figure 1 illustrates the process of participant recruit ment. Of the 339 target participants, 132 persons participated in the study (38.9%).

Table 1 shows the physical characteristics of the male and female participants. Both genders shared a

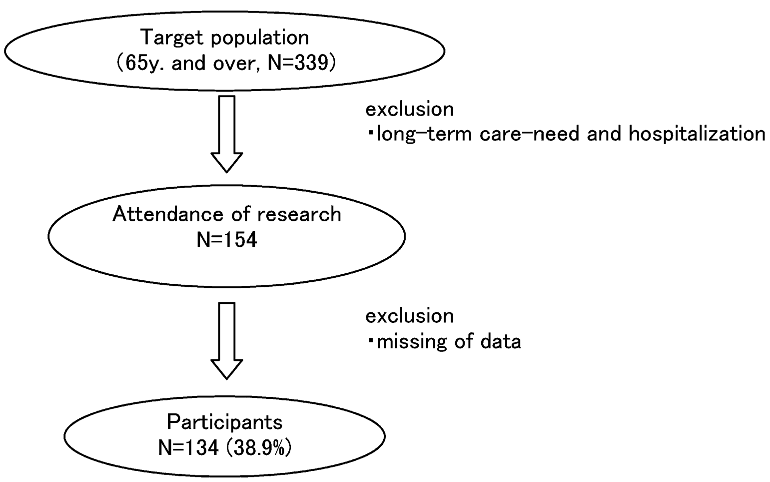

Fig. 1 Participant recruitment

Table 1 Participants' physique, blood characteristics and physical strength

Continuous variables	Male	Female
N	50	82
Age (y)	75.7 ± 7.0	74.8 ± 5.7
Height (cm)	158.1 ± 6.3	144.0 ± 6.0
Weight (kg)	60.5 ± 8.8	49.9 ± 7.6
BMI (kg/m^2)	24.1 ± 2.8	24.0 ± 2.9
Total-C (mg/dL)	181.5 ± 30.8	207.2 ± 29.6
HDL-C (mg/dL)	53.0 ± 14.1	63.8 ± 33.8
LDL-C (mg/dL)	104.1 ± 26.9	123.1 ± 23.9
TG (mg/dL)	119.3 ± 61.9	113.7 ± 58.6
GOT (IU/L)	28.8 ± 12.8	25.6 ± 10.5
GPT (IU/L)	19.7 ± 11.3	17.7 ± 11.4
γ-GTP (IU/L)	40.0 ± 67.6	20.1 ± 10.2
HbA1c (%)	5.2 ± 0.6	5.3 ± 0.5
UA (mg/dL)	5.9 ± 1.3	4.7 ± 1.1
10-m walking time (s)	6.8 ± 2.4	6.8 ± 1.8
Maximal step length (cm)	98.5 ± 19.8	83.6 ± 17.2
Grip strength (kg)	33.9 ± 7.7	20.7 ± 5.6

Discrete variables	Categories		Male N	Male %	Female N	Female %
40-cm step test	1.unable to step	low	0	0.0	0	0.0
	2.able to step 20cm using a hand	↓	2	4.0	9	11.0
	3.able to step 20cm		7	14.0	11	13.4
	4.able to step 40cm using a hand		1	2.0	14	17.1
	5.able to step 40cm	high	40	80.0	47	57.3
Tandem gait	1. No steps	low	0	0.0	1	1.2
	2. 1-3 steps	↓	7	14.0	9	11.0
	3. 4-6 steps		5	10.0	10	12.2
	4. 7-9 steps		7	14.0	11	13.4
	5. 10 steps	high	31	62.0	49	59.8
Knee pain			16	32.0	41	50.0
Lumbago			13	26.0	32	39.0
Fall experience (≧ one time during the previous year)			9	18.0	11	13.4

continuous variables: mean±SD

Table 2 Participants' fall-prevention self-efficacy

Group	Score	Male N	Male %	Female N	Female %
non-Fear	40	27	54.0	21	25.6
	39	1	2.0	5	6.1
	38	0	0.0	10	12.2
Fear	37	1	2.0	8	9.8
	36	1	2.0	5	6.1
	35	1	2.0	1	1.2
	34	1	2.0	4	4.9
	33	0	0.0	3	3.7
	32	2	4.0	2	2.4
	31	2	4.0	4	4.9
	30	3	6.0	5	6.1
	29	2	4.0	5	6.1
	28	0	0.0	2	2.4
	27	2	4.0	1	1.2
	26	2	4.0	0	0.0
	25	0	0.0	1	1.2
	24	2	4.0	0	0.0
	23	0	0.0	3	3.7
	22	0	0.0	0	0.0
	21	1	2.0	1	1.2
	20	1	2.0	0	0.0
	19	0	0.0	0	0.0
	18	0	0.0	0	0.0
	17	0	0.0	0	0.0
	16	0	0.0	0	0.0
	15	0	0.0	0	0.0
	14	0	0.0	1	1.2
	13	0	0.0	0	0.0
	12	0	0.0	0	0.0
	11	0	0.0	0	0.0
	10	1	2.0	0	0.0

Participants were separated into two groups according to the FPSE score.Those who were over 37 pts were in non-Fear Group and the others in the Fear Group.

Table 3 Cross-group difference of each variable in male

Continuous variables	non-Fear Group	Fear Group	p value
N	28	22	
Age (y)	72.9 ± 5.7	79.3 ± 7.0	0.001 ※
Height (cm)	159.0 ± 6.5	156.9 ± 5.9	0.610 †
Weight (kg)	60.9 ± 8.2	59.8 ± 9.7	0.504 †
BMI (kg/m^2)	24.1 ± 2.6	24.2 ± 3.1	0.242 †
Total-C (mg/dL)	182.9 ± 31.2	179.7 ± 31.1	0.709 †
HDL-C (mg/dL)	56.1 ± 14.6	48.6 ± 12.5	0.198 †
LDL-C (mg/dL)	100.8 ± 28.3	108.9 ± 24.7	0.444 †
TG (mg/dL)	121.8 ± 68.8	115.6 ± 51.7	0.683 †
GOT (IU/L)	31.1 ± 15.8	25.6 ± 5.5	0.267 †
GPT (IU/L)	22.3 ± 13.0	16.0 ± 7.2	0.384 †
γ-GTP (IU/L)	50.1 ± 87.1	25.5 ± 9.3	0.467 †
HbA1c (%)	5.2 ± 0.8	5.2 ± 0.3	0.953 †
UA (mg/dL)	5.9 ± 1.2	6.0 ± 1.5	0.908 †
10-m walking time (s)	5.7 ± 1.1	8.2 ± 2.9	0.003 †
Maximal step length (cm)	108.5 ± 13.9	85.8 ± 19.1	0.002 †
Grip strength (kg)	36.3 ± 7.3	31.0 ± 7.2	0.271 †

Discrete variables	Categories		N	%	N	%	p value
40-cm step test	1.unable to step	low	0	0.0	0	0.0	0.001 ♯
	2.able to step 20cm using a hand	↓	0	0.0	2	9.1	
	3.able to step 20cm		1	3.6	6	27.3	
	4.able to step 40cm using a hand		0	0.0	1	4.5	
	5.able to step 40cm	high	27	96.4	13	59.1	
Tandem gait	1. No steps	low	0	0.0	0	0.0	0.029 ♯
	2. 1-3 steps	↓	2	7.1	5	22.7	
	3. 4-6 steps		2	7.1	3	13.6	
	4. 7-9 steps		3	10.7	4	18.2	
	5. 10 steps	high	21	75.0	10	45.5	
Knee pain			4	14.3	12	54.5	0.005 ♮
Lumbago			3	10.7	10	45.5	0.009 ♮
Fall experience (≧ one time during the previous year)			4	14.3	5	22.7	0.481 ♮

※: Independent-sampled t-test
†: Analysis of covariance using age as a coveriate
♯: Mann-Whitney U-test
♮: χ^2 test

Table 4 Cross-group difference of each variable in female

Continuous variables	non-Fear Group	Fear Group	p value
N	36	46	
Age (y)	72.1 ± 4.8	76.9 ± 5.5	0.000 ※
Height (cm)	146.4 ± 5.4	142.0 ± 5.7	0.193 †
Weight (kg)	51.6 ± 8.7	48.5 ± 6.5	0.967 †
BMI (kg/m^2)	24.0 ± 3.2	24.0 ± 2.7	0.115 †
Total-C (mg/dL)	211.8 ± 30.6	203.3 ± 28.5	0.115 †
HDL-C (mg/dL)	58.7 ± 13.4	67.9 ± 43.4	0.379 †
LDL-C (mg/dL)	129.1 ± 23.4	118.0 ± 23.5	0.026 †
TG (mg/dL)	116.0 ± 58.6	111.9 ± 59.3	0.939 †
GOT (IU/L)	26.3 ± 12.6	24.9 ± 8.4	0.778 †
GPT (IU/L)	18.0 ± 12.4	17.5 ± 10.7	0.448 †
γ-GTP (IU/L)	20.1 ± 12.0	20.1 ± 8.6	0.647 †
HbA1c (%)	5.3 ± 0.4	5.3 ± 0.7	0.972 †
UA (mg/dL)	4.7 ± 1.4	4.8 ± 0.9	0.691 †
10-m walking time (s)	5.8 ± 1.3	7.6 ± 1.8	0.010 †
Maximal step length (cm)	92.1 ± 16.0	77.2 ± 15.3	0.033 †
Grip strength (kg)	22.4 ± 5.5	19.4 ± 5.4	0.426 †

Discrete variables	Categories		N	%	N	%	p value
40-cm step test	1.unable to step	low	0	0.0	0	0.0	0.000 ♯
	2.able to step 20cm using a hand	↓	0	0.0	9	19.6	
	3.able to step 20cm		0	0.0	11	23.9	
	4.able to step 40cm using a hand		6	16.7	8	17.4	
	5.able to step 40cm	high	29	80.6	18	39.1	
Tandem gait	1. No steps	low	0	0.0	1	2.2	0.004 ♯
	2. 1-3 steps	↓	2	5.6	7	15.2	
	3. 4-6 steps		3	8.3	7	15.2	
	4. 7-9 steps		2	5.6	9	19.6	
	5. 10 steps	high	28	77.8	21	45.7	
Knee pain			15	41.7	26	56.5	0.226 ♮
Lumbago			11	30.6	21	45.7	0.180 ♮
Fall experience (≧ one time during the previous year)			2	5.6	9	19.6	0.102 ♮

※: Independent-sampled t-test
†: Analysis of covariance using age as a coveriate
♯: Mann-Whitney U-test
♮: χ^2 test

mean age of 75 years. Knee pain and lumbago were observed in 32% and 26% of male participants, respectively, and in 50% and 39% of female participants, respectively. Falls were experienced over the previous year by 18% and 13.4% of male and female participants, respectively. The FPSE distribution is shown in Table 2. In both genders, the mode was 40 points, which represented full marks. The minimum score was 10 points in males and 14 points in females. A clear cutoff point cannot be fixed in this case due to the frequency distribution. In order to examine the relationship between many variables and fear of falling, we separated the participants into two groups by the median of the distribution (sum of male and female) : the Fear-Group, which scored 37 points or less, and the Non-Fear-Group, which scored 38 points or higher.

Table 3 compares the male groups. Continuous variables were adjusted for age. The 10-m walking time was significantly slower ($p < 0.01$) and the maximal step length was significantly shorter ($p < 0.01$) in the Fear-Group as compared to the Non-Fear-Group. The Fear-Group included a significantly larger portion of lower scorers in the 40-cm step test, as well as in the tandem gait. There was no significant difference between the groups regarding the serum biochemical parameters. The prevalence of knee pain and/or lumbago was significantly greater in the Fear-Group ($p < 0.01$). No significant difference was found between the groups as to fall history during the previous year.

Results of comparisons between the female groups are shown in Table 4. The HDL-C level was significantly lower in the Fear-Group even after adjustment for age. This group showed significantly worse values in the 10-m walking time and the maximal step length ($p < 0.05$). The rate of low scorers in the 40-cm step test and in the tandem gait was significantly higher in the Fear-Group ($p < 0.01$). There was no significant difference in other serum biochemical parameters, in the prevalence of knee pain/lumbago, or in the experience of falls during the previous year between the groups.

Discssion

The participants of the current study were residents of an extremely underpopulated, aged farming and mountain village located in a headwaters area. The ratio of the participants was relatively high at 38.9% in consideration of a survey involving actual measurement of moving ability, as well as fall-related indices in the elderly.

Perfect scores of FPSE were achieved by 54% and 25% of males and females, respectively. The scores decreased as age increased in both genders in agree ment with previous studies.[9,10] Pain of the locomotorium was correlated with FPSE only in males, while no such correlation was found in females, a greater proportion of whom had actually complained of pains in structures of locomotion before entry. This observation may be explained by an assumption that the FPSE scores were affected more strongly by moving ability in females than by pains, in contrast to males.

On the other hand, in males, we can assume causation decreasing locomotiveness by this influence because sharp pain and relevance of the FPSE are strong. Because an agriculturalist is regarded as the specialty of many agricultural areas, such sex differences need further research.

HDL-C levels, the primary outcome, had no significant relationship with FPSE scores. HDL-C levels were reported by Volpato *et al.*[13], to correlate with walking speed or with knee extension torque, while Landi *et al.*[12], reported that HDL-C had a relation with physical function.

From the results of the current study showing a clear relationship between moving ability and FPSE, we predicted a relationship with HDL-C levels. However, our results were not consistent with the results of previous comparable studies. In order to explain cause-and-effect relationships among HDL-C, self-efficacy, and moving ability, future cohort studies and randomized controlled trials are needed.

Many investigators[22,23,24,25] have emphasized physical activity aimed at the prolongation of an independent life span in the elderly. Christmas *et al.*[22], reported that physical activity and exercise improved health status, muscle strength, aerobic exercise ability, and reduced the risks of bone fracture in the elderly. According to Rejeski *et al.*[23], physical activity improves the quality of life in elderly people. Frail nursing home residents improved their health status for a short period by repetitive practice of daily life activities, as reported by Peri *et al.*,[24].

The American College of Sports Medicine (ACSM) and American Heart Association (AHA) proposed regular physical activity and exercise that suited elderly people[25]. In agricultural and mountain villages, it is considered necessary to educate elderly people in recommended physical activity and exercise aimed at maintaining moving ability and to recover and maintain confidence in walking outside. Our results offer suggestions for this education and indicate that the specific environment should be considered.

In a recent report by Goldman *et al.*[26], it was found that poor sleep leads to a worse physical function. This may be an important confounding factor of FPSE. However, we did not refer to the issue because of the lack of survey of sleep time in the current study.

Scheffer *et al.*[27], reported that risk factor knowledge about fear of falling may be useful in developing multidimensional strategies to decrease fear and improve quality of life. Future studies to define risk factors, as well as residence features in a nation or in a local district will benefit planning concrete preventive measures to deal with limiting activities in the elderly.

There are several limitations to the current study. A causal relation between self-efficacy and each variable was not established because of cross-sectional design. We utilized FPSE as suggested by previous studies, but many participants earned full marks. Therefore, FPSE may be less appropriate because of environmental differences between urban areas and rural districts. Concerning FPSE, a systematic review[28] suggests several scoring methods developed to measure fall-related self-efficacy. In the future, we need to select approaches most appropriate for farming and mountain villages and, in some cases, need to develop our own approach.

In females, LDL-C level, even if adjusted for age, was higher in the high-FPSE group. However, we can not explain this result because of the lack of survey of diet.

The number of participants who experienced falls during the previous year was too small to indicate a relation with FPSE. The survey completion rate in the current study was 38%, but there was no data on elderly people in need of long-term care or those hospitalized. Our interpretation is limited to independent elderly people.

Furthermore, it is known that HDL-C level has a connection with factors such as medicine and a meal, and drinking. In the design of this study it was not possible to adjust such potential confounding factors.

We could not find significant relationships between self-efficacy and HDL-C, while showing the relationships between self-efficacy and physical strength. The outcome shows that it is difficult to predict diseases from the self-efficacy report. But, this study is limited to independent elderly people in a local area, and further studies should be conducted to detect the relationships.

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地域在住高齢者における転倒予防自己効力感と HDL コレステロール及び身体能力との関連：小菅村横断研究

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背景：本研究の目的は，転倒予防自己効力感と HDL コレステロール及び身体能力との関連性を調べることであった。
方法：対象者は山梨県小菅村に在住する 65 歳以上の高齢者 339 名で，本調査には 132 名（38.9％）が参加した。移動能力として 10 m 全力歩行，最大一歩幅，40 cm 踏台昇降を，バランス能力としてつぎ足歩行を測定した。血液性状の中で，主要なアウトカムとして，HDL コレステロールを用いた。転倒予防自己効力感は，10 項目，4 リッカートスケールからなる質問紙で評価した。研究デザインは，転倒恐怖の有無による 2 群間比較の横断研究である。
結果：転倒予防自己効力感と HDL コレステロールの間に有意な関連はなかったが，転倒予防自己効力感が低い群では有意に移動能力が低かった。また，膝痛や腰痛を伴う男性では，転倒予防自己効力感が低かった。
結論：自己効力感と HDL コレステロールとの関連は認められなかったが，本研究は地域在住で独立生活を営む高齢者に限定されているため，今後，良くデザインされた大規模な観察研究が必要だと考えられた。

キーワード：高齢者，転倒，自己効力感，HDL コレステロール，移動能力

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