平成 27 年度学位申請論文

Risk factors for disability progression among Japanese long-term care service users –A 3-year prospective cohort study.

（要支援および要介護者の重度化リスク因子の探索に関する研究
－前向きコホート研究）

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Table of contents

Abstract

【Objectives】To explore the risk factors for disability progression among home-help service users by a 3-year prospective cohort study.

【Study 1】Cross-sectional correlational study using baseline data

〈Purpose〉 To described the prevalence of possible risk factors for disability progression among home-help service users.

〈Methods〉 Subjects were 65 years or older, certified support level 1-2 or care level 1-2 and home-help service users. Data were collected from October 2011 to November 2011 in each subjects' home. Variables included demographic characteristics (age, gender, eligibility level, usage of services, chronic conditions and family members), physical structure/function (body mass index: BMI, grip strength, calf circumference: CC), Memory impairment screen (MIS) and questionnaires (depression, functional limitations, participation, social support, nutritional status).

〈Results〉 A total of 417 subjects (109 males) were examined. There were 109 subjects (26.1%) with memory impairment. Those with care level 2 had higher prevalence of service use, higher prevalence of history of stroke, lower grip strength,

lower CC, severer functional limitation and poorer participation than care level 1 or lower. When divided by cut-off values, care level 2 was found to have higher prevalence of low grip strength, and depression.

〈Discussion〉 Grip strength, CC, functional limitations, participation and depression could be the candidates of the risk factors for disability progression. However, high prevalence of memory impairment ruined the credibility of the results of questionnaire assessments. Therefore, the objective measurements such as grip strength should be used for assessment among home-care setting.

【Study 2】Prospective cohort study

〈Purpose〉 To explore the risk factors for disability progression.

〈Methods〉 Subjects described in Study 1 were followed up until August 2014. We defined adverse outcomes as certified care level 3 or higher or institutionalized to public nursing homes. Univariate and multivariate Cox proportional hazard analysis were performed to examine the relationship between onset of adverse outcomes and independent variables.

〈Results〉 During 836 person-years of follow-up, 106 adverse outcomes occurred. In univariate analysis, older, higher eligibility level, use of visiting nurse, use of health

daycare, use of respite stay, lower MIS score and lower grip strength were significantly associated with higher hazard ratio. In multivariate analysis, memory deterioration was independently associated with higher hazard ratio. When adjusted for cancer, low grip strength tended to be associated.

〈Discussion〉 The results of this study revealed that memory deterioration could be an independent risk factor for disability progression. When considering history of cancer, low grip strength could be a risk factor, indicating that some chronic conditions might modify the risk on disability progression.

【Conclusions】Our cohort study revealed that memory impairment could be an independent risk factor for disability progression. Also, when considering history of cancer, grip strength might be a risk factor. The identification of those who are at high risk for disability progression could be demonstrated by assessing these factors.

要旨

介護度重度化のリスク因子を明らかにすることを目的として、前向きコホート研究を実施した。

【研究 1】ベースラインの横断的調査による関連研究

〈目的〉リスク因子の候補と考えられる身体・精神機能および環境因子などについて実態を明らかにすること。

〈方法〉対象は 65 歳以上、要支援～要介護 2、ホームヘルプサービスの認定を受けている者とし、2011 年 10 月から 11 月に調査を実施した。調査項目は、基本情報（年齢、性別、介護度、利用サービス、既往歴、家族構成）、身体機能（Body mass index：BMI、下腿周囲長）、記憶能力（Memory impairment screen：MIS）、質問紙（抑うつ、日常生活の困難感、社会参加、ソーシャルサポート、栄養）である。

〈結果〉調査対象は 417 名（男性 109 名）であり、109 名（26.1%）が記憶障害ありと判定された。要介護 2 の群は、要支援～要介護 1 の群と比較して、各サービスの利用者が多く、脳卒中の既往者が多く、握力および下腿周囲長が低く、日常生活の困難感が強く、社会参加の程度が低かった。

〈考察〉本研究で調査した因子のうち、介護度との関連がみられた握力、下腿周囲長、日常生活の困難感、社会参加、抑うつが介護度重度化のリスク因子の候補と考えられた。しかし、対象の 26%において記憶障害による質問紙評価の信頼性低下が考えられることより、軽度要介護者におけるリスク評価では、握力などの客観的指標が重視されるべきであると考えられた。

【研究 2】前向きコホート研究

〈目的〉介護度重度化のリスク因子を明らかにすること。

〈方法〉研究 1 でベースライン調査を実施された対象について、2014 年 8 月まで追跡調査を行った。主要アウトカムは、要介護 3 以上に認定されること、もしくは公的介護施設への入所とした。統計解析には Cox 比例ハザード解析を用い、主要アウトカム発生に関連する因子を探索した。

〈結果〉836 人・年の追跡期間において、106 名のアウトカムが発生した。単変量 Cox 比例ハザード解析において、高齢、要介護 2、訪問看護の利用、デイサービスの利用、ショートステイの利用、MIS 低値、握力低値が関連した。多変量解析では、要介護 2 と MIS 低値が関連し、癌の既往をモデルに投入すると関連が認められるとともに、握力低値が関連する傾向を示した。

〈考察〉記憶能力低値が、ベースライン時の介護度とは独立した重度化のリスク因子であることが明らかとなった。また、癌の既往を考慮した際に握力が重度化と関連することより、疾病の既往がリスク因子に対して修飾的に作用する可能性が示唆された。

【結論】前向きコホート研究の結果、記憶能力低下が介護度重度化の独立したリスク因子であることが明らかとなった。また、癌の既往を考慮した際に、握力がリスク因子となる可能性が示唆された。これらの指標を評価することにより重度化リスクの高い対象の抽出が可能になると考えられる。

Introduction

The number of older people in the world is expected to more than double from 2013 to 2050[1]. As a result, the healthcare expenditure for older people with disability will increase substantially. In fact, Japan has been facing the rapid increase of long-term care (LTC) costs, which increased from 30 billion dollars in 2000 to 78 billion dollars in 2013[2]. One of the strategies to control costs is prevention of disability progression among those with mild disability. Because of shortage of nursing homes, the quality enhancement of home-care become increasingly important. For cost-effective intervention, focusing on those who are at high risk for disability progression would be essential.

Previous longitudinal studies investigated unmodifiable factors such as gender, economic status, and caregivers as independent factors[3,4]. Modifiable factors such as muscle strength or mass, nutritional status, and depression have been identified as risk factors for disability, hospitalization or death in healthy community-dwelling elderly[5-14]. We hypothesized that these modifiable factors could be applied to risk factors for disability progression among home-care service users. With the

background stated above, we launched prospective cohort study to explore the risk factors for disability progression.

I. Study 1: Cross-sectional correlational study using baseline data.

Purpose

To reveal the prevalence of potential risk factors for disability progression from the cross-sectional observational study among home-help service users with using baseline assessment data of a cohort study.

Materials and Methods

Study Design

We designed a prospective cohort study. The recruit and baseline assessment of all subjects were conducted in October and November, 2011. Study 1 is cross-sectional correlational study with using the baseline assessment.

The Research Ethics Committee of the Nagoya University Graduate School of Medicine approved this cohort study (Approval No. 1274), and all of the participants provided written informed consent. All data was organized and centralized at the Yamada Laboratory at Nagoya University Graduate School of Medicine.

Study Population

We recruited community-dwelling older people who utilized home-help services which was provided by Consumers' Cooperatives (Co-op) Aichi and U Co-op (in Aichi Prefecture and in Kanagawa Prefecture in Japan, respectively). Inclusion in this study required aged 65 years or older and certified support level 1-2 or care level 1-2 in Japanese public LTC insurance system. The system has 7 eligibility levels including support level 1-2 and care level 1-5 (Table1). An applicant was certified the level based on the time required for nursing care according to his/her physical and mental health condition. For example, if the calculated required time for nursing care was 25-32 minutes per day, the applicant would be certified support level 1. Care level 2 is for those who require 50-70minutes per day, and those who are care level 3 require 70-90minutes per day. In other words, the costs for those with higher eligibility level are more expensive.

The sample size was estimated from the track record of home-help service users in U Co-op from March 2007 to March 2010. The incidence rates of disability progression, defined as certified care level 3 or higher in this study, in 3 years were 4.3% in support 1, 4.1% in support level 2, 7.2% in care level 1 and 27.7% in care level 2. Since care level 2 had a remarkably high rate, we assumed care level 1 or lower to be one group and planned to recruit the same numbers of subjects as those

from care level 2. Then, we assumed that the hazard ratio of disability progression of those who had a risk factor to those who did not was 2.0. At least 359 subjects are required for each arm to provide 80% power to detect a hazard ratio of 0.5 using a 2-sided significance level of 0.05 by chi-square test. After considering 20% for the drop-outs or unsuitable for analysis, we have expected that approximately 449 subjects are needed to be enrolled in this study.

Demographic characteristics

The information of eligibility level, chronic conditions, use of LTC services, medications and family configuration were obtained from care managers. In this study, cancer, stroke and lower limb fractures were considered as chronic conditions because they are common in the older people and the history of these diseases are well-recognized in home-care setting. Using three or more drugs were considered as a possible risk indicator[15].

Measures

Care managers or persons in charge of providing services conducted surveys and measurements in each subjects' home. Body weight was measured using a digital

weight scale (BC-301-SV; Tanita Co, Tokyo, Japan).

As an alternative indicator of height, demi-span was measured in the supine position. Demi-span was defined as the distance from the clavicular notch of the sternum to the opposite fingertip while the arm is laterally outstretched[16]. In measuring the height of the elderly, demi-span resolves problems such as the errors caused by kyphosis or difficulty in standing. A previous study measured demi-span in the seated position[16]. However, we measured demi-span in the supine position and height in the standing position on a separate group of subjects aged ≧ 50 years without kyphosis (75 males and 68 females). The estimated formula was $y=1.38x+45.3$ (cm) ($r=0.77$, $P<0.01$) for males and $y=1.28x+49.6$ (cm) ($r=0.70$, $P<0.01$) for females.

Calf circumference is an index of screening the risk for disability[9]. CC was measured at the point of greatest circumference while the subject was supine with the knee flexed at 90°. Measurements were made for both legs and the greater value (in mm) was used as the index for CC.

Handgrip strength was measured with the Jamar dynamometer set at the second handle position. The participant sat with the wrist in a neutral position and the elbow flexed at 90°[17]. The grip strength of each hand was measured twice, and

the highest value (in 0.1 kg) was used as the index of handgrip strength.

Prior to administering the survey of home help service users, the principal investigator provided and handled training sessions for the above-described measurements to care managers or persons in charge of providing services in the Co-op Aichi and U Co-op. One hundred and twenty-five examiners, including 56 from Co-op Aichi and 69 from U Co-op, practiced measuring CC and MAC 10 times on a single subject to master the method of measurement. Then, the examiners measured CC and MAC twice on 5 subjects on different days, and each subject was measured by more than 2 examiners. From the data, intra-class correlation coefficients (ICC) for each examiner and the averages of the CC and MAC obtained from each subject were calculated. The examiners repeated the measurements if one of the following conditions were met: the ICC was < 0.9; the value of the measurement was more than 1 cm above or below the average. The ICC of each examiner ranged from 0.90 to 1.00 for both the CC and MAC measurements. The averages of ICC were 0.97 ± 0.04 for CC and 0.96 ± 0.05 for MAC.

Memory impairment screening (MIS)[18] was used to confirm the credibility of the assessment with questionnaire. This test required subjects to recall 4 words and the score ranged from 0 to 8, with lower scores indicating poorer memory.

The 5 item geriatric depression scale (GDS5) was used to assess depressive symptoms[19]. The original version was translated into Japanese and established the reliability and validity[20]. It is scored from 0 to 5, with higher scores indicating more severe depression.

Functional limitation was assessed using the performance measure for activities of daily living 8 (PMADL-8)[21]. The PMADL-8 is composed of a list of 8 performance items potentially requiring daily physical activity in chronic heart failure patients and determines the extent to which patients currently experience difficulties in performing daily physical activity as evaluated by a four-category response scale. It is scored from 8 to 32, with higher scores indicating more severe functional limitations.

The participation scale was used to assess participation restriction[22]. The participation scale is composed of a list of 5 activity items, such as going out for a hobby or conversing/exchanging e-mails with family/friends. Response options for each question ranged from 1 to 4, and responses were determined by the frequency of the activities. It is scored from 5 to 20, with lower scores indicating more severe participation restriction.

We also assessed subjects' social support, which is received by interacting with

others. Zumit et al. designed the original social support scale[23], and Iwasa et al. modified it to create a Japanese version, which consisted of 7 items[24]. We preliminarily surveyed healthy, community-dwelling elderly using the Japanese version of the questionnaire, and pared the original list of 7 items down to the following 3 items: (1) There is a special person who is around when I am in need. (2) My family really tries to help me. (3) I have friends with whom I can share my joys and sorrows. These three items were chosen because of the strong correlations between these 3 items and the other 4 items. We also confirmed that there is a strong correlation of the total score of these 3 items with the total of the 7 item score (unpublished data). The response options for each question ranged from 1 to 7, and responses were determined by the quality of the support. It is scored from 3 to 21, with higher scores indicating better support.

The mini nutritional assessment (MNA) was used to assess nutritional status[25,26]. MNA is composed of eighteen items, such as content of meals, BMI, internal use and mid-arm circumference (MAC). It is scored from 0 to 30, with lower scores indicating poorer nutritional condition.

Statistical Analysis

The data obtained from the subjects in care level 2 were compared with those in support levels and care level 1 using chi-square analyses and independent group t tests. Correlations between variables were assessed using Spearman's Rank correlation. Risk factors were defined as follows: (1)BMI < 18.5kg/m^2, (2)grip strength ≦ 27 kg in males and ≦ 16 kg in females aged 65-74, and ≦ 20 kg in males and ≦ 12 kg in females aged 75 or older[5], (3)CC < 31 cm[9], (4) GDS5 score≧ 2[19], (5)MNA score ≦ 16[25,26].

For analysis of questionnaires, we excluded subjects with MIS scores ≦ 4, which indicated mild cognitive impairment level.

All data were analyzed using SPSS for Windows (version 16.0; SPSS, Tokyo, Japan). A P value <0.05 was regarded as statistically significant.

Results

Study population

A total of 417 subjects were surveyed (109 males and 308 females). Subject characteristics are presented in Table 2. We had planned to recruit the same numbers of subjects from care level 1 or lower and care level 2. However, that was difficult because the number of those who were difficult to communicate or refused to cooperate with the survey was more than expected in care level 2. As a result, the number of subjects in care level 1 or lower doubled that in care level 2. The average age was 83 years old in each group. There were 83 males (29.9%) in care level 1 or lower and 26 males (18.7%) in care level 2. More than half of our subjects lived alone, and the ratio was higher in care level 1 or lower. One hundred and nine subjects (26.1% of the total) had MIS scores $\leqq$ 4 and were excluded from the questionnaire analysis.

Prevalence of risk factors

The comparison of the prevalence of risk factors between care level 2 and care level 1 or lower were shown in Table 3. Care level 2 had higher prevalence of low grip

strength and depression (GDS5 score ≧ 2) than care level 1 or lower. In contrast, there were no differences in the prevalence of CC < 31cm, BMI < 18.5kg/m^2 and MNA ≦ 16 between two groups.

Correlations between factors

The correlations between factors are shown in table 4. Grip strength, CC, GDS5 and social support were correlated moderately or weakly with PMADL-8 and the participation scale, respectively. There were moderate correlations between MNA and BMI and between MNA and CC. Social support was negatively correlated with GDS5.

Discussion

The present study is the first study to compare the prevalence of possible objective risk parameters as well as questionnaires in those who were certified care level 2 or lower in Japanese LTC insurance system. The results of this study support our hypothesis that subjects in care level 2 had poorer at grip strength, CC and GDS5 values than those in care level 1 or lower.

Among our subjects, the prevalence of CC < 31cm, the cut-off value for predicting disability in female, was as high as 35%. Furthermore, grip strength was similar to those who were certified LTC eligibility level in previous studies[27]. Therefore, from the view point of muscle strength or mass, the our subjects were frail and might be a representative sample of those who were certified same eligibility levels in Japanese LTC insurance system.

The prevalence of malnutrition, indicated by MNA scores $\leqq$ 16, was approximately 10%. This prevalence was 10 times as high as that in non-disabled elderly[28]. Similarly, 22.5% of the subjects in our study were underweight, with BMI values < 18.5 kg/m^2. This prevalence was two times greater than in the independent community-dwelling elderly[29]. Low MNA score alone was reported as a risk factor for disability or death[12,30,31]. In addition, malnutrition and underweight may lead to

sarcopenia, which is one of the primary causes of the onset of disability among the frail elderly population[32-34]. Thus, we confirmed that our subjects were at high risk for disability. However, there were no differences in the prevalence of MNA ≦16 and BMI < 18.5kg/m^2 between care level 2 and care level 1 or lower. This was because nutritional status was not considered for certifying eligibility level in Japanese LTC insurance system[35]. Thus, malnutrition should be given more attention to prevent increasing eligibility level because the prevalence of malnutrition was high even in low eligibility levels. In addition to MNA and BMI, progressive weight loss should be taken into account because unintentional weight loss (5% in a half year or more) is one of the initial signs used as a screening for sarcopenia[36]. The future results of this study will reveal the relationship between malnutrition, being underweight or weight loss and disability progression.

Depressive symptoms were related to eligibility level, activity limitations and participation restrictions in the present study. In previous studies, depressive symptoms predicted disability, hospitalization and death[37-39]. In contrast, social support were negatively correlated to depressive symptom, therefore, social support may be a counter-measure against the adverse impact of depressive symptoms on disability progression. This is because social support was shown to buffer the effects

of negative life events or disease on mental health[40].

The prevalence of memory impairment was as high as 26%. This result highlighted the difficulty of using questionnaires to assess those who were certified eligibility level in LTC insurance system. The questionnaires for assessing depressive symptoms, nutritional status and activity levels are useful tools to screen the risk for disability among community-dwelling elderly. However, memory impairment limits the credibility of the results obtained from these questionnaires. This result highlights the importance of objective parameters, such as grip strength, CC, or BMI, as the screening measure for increasing eligibility level in those who were certified LTC eligibility level.

We should describe potential limitations of the findings of the present study. Since this report was a cross-sectional study, it could not examine cause-effect relationships. Our ongoing prospective study will reveal risk factors for disability progression among Japanese home help service users. Another limitation was small sample of male subjects. Because of the gender differences in muscle strength or body composition, the analysis might be better to be carried out on the gender basis. Further study will need to examine the gender differences in the possible risk factors.

Summary of Study 1

The results of Study 1 clarified that those with care level 2 have lower grip strength, lower CC, higher difficulty of daily living, higher participation restriction and high prevalence of depression than those with care level 1 or lower. These factors might be risk factors for disability progression among home-help service users.

As much as a quarter of our subjects had memory impairment, therefore, the credibility of questionnaire assessments was ruined. In other words, objective parameters, such as grip strength, CC, or BMI, should be applied as screening indices among for predicting disability progression.

This article was published in Biome Research International in September 9, 2013, entitled “Predictors for increasing eligibility level among home help service users in the Japanese long-term care insurance system.”

(Biomed Res Int 2013; 2013:374130)

Table

Table 1: Eligibility levels in long-term care insurance system in Japan

Eligibility Level	Indication of need for help	Required time for nursing care
Support level 1 Support level 2	Need of efforts regarding the prevention of increasing to care level	25-32 min/day
Care level 1	Partly need help for toileting or bathing	32-50 min/day
Care level 2	Partly need help for ambulation	50-70 min/day
Care level 3	Totally need help for ambulation or clothing	70-90 min/day
Care level 4	Totally need help for clothing or eating	90-110 min/day
Care level 5	Totally need help for all of activities and difficult to communicate	≧110 min/day

Table 2. Comparison of characteristics between subjects in care level 1 or lower and those in care level 2.

	Care level 1 to less (N=278, *N=210)	Care level 2 (N=139, *N=98)	Statistic			P value
Age [yo]	82.94 ± 5.88	82.97 ± 7.26	t	=	-0.041	0.97
Female	195 (70.1%)	113 (81.3%)	χ^2	=	5.968	0.02
Living alone	177 (63.7%)	73 (52.5%)	χ^2	=	4.799	0.03
Service use						
Home bath service	0 (0%)	0 (0%)				
Visiting nurse	17 (6.1%)	28 (20.1%)	χ^2	=	18.944	0.00
Home rehabilitation	14 (5.0%)	12 (8.6%)	χ^2	=	2.051	0.20
Nursing home daycare	15 (5.4%)	23 (16.5%)	χ^2	=	13.913	<0.01
Health daycare	99 (35.6%)	64 (46.0%)	χ^2	=	4.235	0.04
Respite stay in a nursing home	3 (1.1%)	11 (7.9%)	χ^2	=	13.341	<0.01
Medical history						
Cancer	57 (20.5%)	27 (19.4%)	χ^2	=	0.067	0.90
Stroke	27 (9.7%)	32 (23.0%)	χ^2	=	11.366	<0.01
Heart disease	76 (27.3%)	37 (26.6%)	χ^2	=	0.024	0.91
Fracture of lower leg	52 (18.7%)	31 (22.3%)	χ^2	=	0.752	0.44
Compression fracture of the spine	33 (11.9%)	21 (15.1%)	χ^2	=	0.862	0.36
Rheumatoid arthritis	12 (4.3%)	7 (5.0%)	χ^2	=	0.11	0.81
BMI [kg/m^2]	22.3 ± 4.2	21.3 ± 4.1	t	=	-1.19	0.24
Grip strength [kg]	19.1 ± 6.9	15.1 ± 6.7	t	=	5.528	<0.01
CC [cm]	32.5 ± 3.4	31 ± 39	t	=	3.795	<0.01
Memory impairment (MIS score ≦4)	68 (24.5%)	41 (29.5%)	χ^2	=	1.217	0.29
PMADL-8*	24.28 ± 4.877	27.8 ± 3.675	t	=	-6.986	<0.01
Participation scale*	13.93 ± 3.715	16.62 ± 2.646	t	=	-7.261	<0.01
Social support scale*	15.78 ± 4.09	15.51 ± 4.593	t	=	0.503	0.62

BMI: body mass index; CC: calf circumference; MIS: memory impairment screen PMADL-8: performance measure for activities of daily living 8. Values are mean ± SD or n (%). Values are mean ± SD or n (%).

Table 3. Comparison of the number of those at risk for disability between care level 1 or lower and care level 2.

	Care level 1 to less (N=278, *N=210)	Care level 2 (N=139, *N=98)	$\chi 2$	P value
BMI < 18.5kg/m^2	65 (23.4%)	29 (20.9%)	0.34	0.56
Low Grip strength	56 (20.1%)	59 (42.4%)	23.1	<0.01
CC < 31cm	92 (33.1%)	62 (44.6%)	0.02	0.29
GDS5* ≧ 2	87 (42.2%)	63 (64.3%)	12.9	<0.01
MNA* ≦ 16	21 (10.0%)	11 (11.2%)	0.11	0.84

Low grip strength was defined as ≦ 27 kg in males and 16 kg in females aged 65-74, ≦ 20 kg in males and 12 kg in females aged 75 or older; BMI: body mass index; CC: calf circumference; GDS5: 5 item geriatric depression scale; MNA: mini nutritional assessment. Values are n (%).

Table 4. Spearman's Rank correlation.

	Age	BMI	Grip strength	CC	PMADL-8	Participation	Social support	MNA	GDS5
BMI	0.006								
Grip strength	-0.092	-0.017							
CC	-0.111 *	0.028	0.354 †						
PMADL-8	0.089	-0.021	-0.412 †	-0.156 †					
Participation	-0.136 *	-0.009	0.273 †	0.194 †	-0.373 †				
Social support	-0.035	-0.019	-0.046	0.044	-0.129 *	0.214 †			
MNA	-0.014	0.580 †	0.048	0.130 *	-0.013	0.037	0.060		
GDS5	0.087	-0.020	-0.160 †	-0.168 †	0.326 †	-0.400 †	-0.274 †	-0.033	
MIS	-0.283 †	-0.040	0.100 *	0.117 *	0.012	-0.069	0.053	-0.034	-0.028

* P<0.05, † P<0.01; BMI: body mass index; CC: calf circumference; MNA: mini nutritional assessment; GDS5: 5 item geriatric depression scale; MIS: memory impairment screen.

II. Study 2: A 3-year prospective cohort study.

Introduction and purpose

The results of Study 1 indicated that the risk screening of disability progression should be done except questionnaires assessment. Among community-dwelling older people, low physical or cognitive functions have been reported as risk factors for disability. Grip strength is one of the most validated indicator for disability or death[8,41]. Also, memory impairment, which is an early symptom of dementia, has been reported as a risk factor for disability or mortality[42]. However, among those who need LTC service, factors associated with disability progression remained unknown.

Chronic conditions have also been noticed as risks for the incident disability[43]. In addition, a previous study reported that the risk of functional dependency increased by number of chronic conditions[44,45]. In these studies, every chronic condition, such as stroke, cancer or arthritis, was considered to have statistically equivalent effects on disability. However, stroke patients often experience acute onset of disability with various symptoms, whereas cancer patients are gradually disabled. Therefore, each chronic condition could have different effects on the risk of

disability.

With the above background, Study 2 aimed to explore the risk factors for disability progression among home-help service users with the hypothesis that: (1) memory deterioration and low muscle strength could be risk factors; and (2) chronic conditions might modify the risk of disability progression.

Materials and Methods

Study design

Study 2 is a prospective cohort study. Eligibility criteria for baseline assessment were described in Study 1 section. Then, subjects were prospectively followed for occurrence of primary events until August 2014. We excluded those who had missing data in the baseline assessment and those who deceased during follow-up.

Outcome variables

We defined adverse outcomes as certified care level 3 or higher or admission to public nursing home. Those who certified care level 3 or higher need total assistance for daily activities such as walking indoors or clothing and, in turn, increasing home-care service cost. We did not consider admission to private residential home as an adverse outcome because the older people seldom admit there due to disability progression. Subjects who terminated utilizing home-help service were censored. The date of event onset was reported by care managers.

Independent variables

Indices to be tested the predictive ability for disability progression included age, gender, eligibility level, use of nursing care services, chronic conditions, number of drugs, living alone, BMI, MIS and grip strength. The results of questionnaires were excluded from the independent variables because high prevalence or memory impairment ruined the credibility of them. Also, CC was excluded because the measurement of it was not easy for care managers or persons in charge of providing services.

Statistical Analysis

Continuous variables are expressed as mean ± standard deviation (SD). Grip strength was ranked and divided into tertiles separately for males and females. Independent variables were compared by the chi square test, Wilcoxon rank sum test or unpaired Student's t test between those with and without adverse outcomes.

Univariate and multivariate Cox proportional hazards analyses were performed to identify independent risk factors for adverse outcomes. First, the following variables were considered in the univariate analysis: age, sex, chronic conditions, eligibility level, use of nursing care services, the number of medicine, living alone, MIS, BMI and grip strength. Second, variables with a $P < 0.2$ at univariate analysis

were entered into the multivariate analysis. Age and sex were entered as control variables. Finally, each of chronic conditions including cancer, stroke and lower limb fracture were additionally entered in the multivariate model.

Statistical analyses were performed with SPSS 22 (SPSS Japan, Tokyo, Japan) or Stata 13 (Stata Corporation, Texas, USA) and a $P < 0.05$ was considered significant; a $P < 0.1$ was considered a tendency.

Results

The occurrence rate of adverse outcomes

After excluding 31 subjects, the overall sample of 386 had an average age of 82.9 ± 6.4 years; 76.1% were female; 52.1% lived alone; and 82.4% admitted to the hospital during follow up. During 836 person-years of follow-up, 106 adverse outcomes occurred (Figure). Baseline characteristics of those with and without adverse outcomes are shown in Table1. Prevalence of those who hospitalized during follow up period was not different between two groups.

Cox proportional hazard analysis

In univariate analysis, older, higher eligibility level, use of visiting nurse, use of health daycare, use of respite stay, lower MIS score and lower grip strength were significantly associated with higher hazard ratio. Any chronic conditions were not associated with the outcomes (Table2).

In all multivariate models, higher eligibility level and lower MIS score were independently associated with higher hazard ratio (Table3). This result partly supported our hypothesis that memory deterioration is a risk factor for disability

progression, whereas grip strength is not. When adjusted for cancer, low grip strength tended to be associated (Model2), supporting the other hypothesis that chronic conditions may modify the risk on disability progression.

Discussion

The major finding of this study was that risk factors for disability progression among home-care service users were multidimensional. Higher eligibility level, memory deterioration, low grip strength, and a chronic condition were all associated with disability progression. This suggests that the assessment of both cognitive and physical functions should be added to routine assessment conducted by service providers. In addition, our results suggest that chronic conditions may be a potential key component of risk stratification. To our knowledge, this is the first study to reveal the multiple risk factors for disability progression among home-care service users.

Present study indicated that early stage of memory deterioration could be a significant sign for disability progression. MIS was associated with adverse outcomes while the average score in adverse outcome group was still above the cutoff point of memory impairment[18]. In a previous study, mild cognitive decline even in a normal range was associated with incident disability[46]. Another study demonstrated that slight cognitive decline could be a determinant of motor performance decline[47]. This means that mild cognitive deterioration could be a prodromal symptom not only of cognitive impairment but also of physical dysfunction. Unfortunately, we did not

obtain the information about direct reason of increasing care need. Future study is required to reveal the detailed information of disability progression, such as specific reason or trajectories, among those with mild memory deterioration.

In this study, grip strength was marginally associated with adverse outcomes when adjusted for cancer, suggesting that grip strength may predict disability progression under particular diseases. Grip strength have been reported to reflect whole-body muscle mass and predict disability or mortality[48,49]. Since cancer leads to progressive muscle wasting, so-called cachexia[50], maintaining muscle mass could be the most important consideration among those with cancer. This hypothesis might be applied to other cachexic diseases, such as heart failure or chronic obstructive pulmonary diseases.

We should describe potential limitations of the present study. First, we provided the data in male subjects from a small sample. Second, the observational nature of this study does not allow us to determine cause-and-effect relationship. Third, in home-care setting, it was difficult to obtain the detailed medical record, such as the type or stage of cancer, infarction area of stroke or fracture location. Fourth, the difference in the duration of home-care service use before observational period of this study was not considered. Finally, even after adjustment for age or eligibility level,

other unknown confounders might affect the outcomes. Nevertheless, our study suggests that memory capability and muscle strength among home-care service users could be considerable factors for disability progression. Further study with detailed disease information in a large sample population will yield the effect of chronic conditions on disabling process.

Summary of Study 2

The findings of Study 2 indicated that memory deterioration was a risk factor for the disability progression. Also, grip strength might be a risk factor with consideration of chronic condition.

This article is in press in Geriatrics and Gerontology International, entitled “Risk factors for disability progression among Japanese long-term care service users -A 3-year prospective cohort study.”

Figure

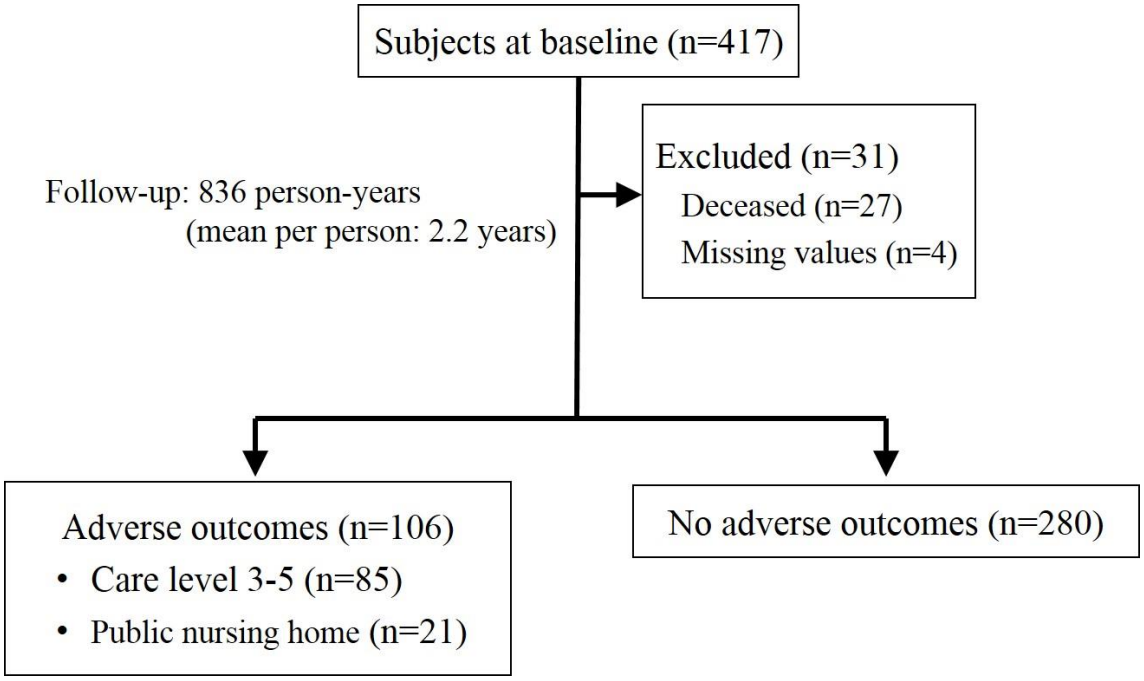

Figure: Participants flow of the study sample.

Table

Table 1: Comparison of characteristics between those with and without adverse outcomes

	Adverse outcomes n = 106	No adverse outcomes n = 280	P
Age, years	84.4 ± 6.3	82.3 ± 6.4	0.002
Male, n (%)	25 (23.6)	66 (23.6)	1.000
Eligibility level, n (%)			<0.001
Support level 1	7 (6.6)	49 (17.5)	
Support level 2	17 (16.0)	98 (35.0)	
Care level1	19 (17.9)	66 (23.6)	
Care level2	63 (59.4)	67 (23.9)	
Hospitalizatin during follow up, n (%)	93 (87.7)	249 (88.9)	0.319
Use of nursing care service, n (%)			
Visiting nurse	16 (15.1)	25 (8.9)	0.079
Home rehabilitation	8 (7.5)	16 (5.7)	0.506
Nursing home daycare	11 (10.4)	23 (8.2)	0.530
Health daycare	54 (50.9)	99 (35.4)	0.005
Respite stay in a nursing home	8 (7.5)	6 (2.1)	0.011
Chronic conditions, n (%)			
Cancer	26 (24.5)	53 (18.9)	0.224
Stroke	17 (16.0)	36 (12.9)	0.418
Lower limb fracture	19 (17.9)	43 (15.4)	0.540
Number of drugs > 3, n (%)	87 (82.1)	220 (78.6)	0.446
Living alone, n (%)	54 (50.9)	147 (52.5)	0.785
BMI, kg/m^2	22.0 ± 4.4	22.2 ± 4.2	0.860
MIS	5.2 ± 2.4	6.3 ± 2.0	<0.001
Grip strength, kg			
Men	22.6 ± 6.7	25.7 ± 6.4	0.051
Women	14.0 ± 5.5	15.9 ± 4.8	0.004

The data are the number of participants (%), mean ± standard deviations in other variables.

Abbreviations: BMI, body mass index; MIS, memory impairment screen.

Table 2: Results of univariate Cox proportional hazards analysis

	Univariate analysis	
	HR (95% CI)	P
Age (per 1year increment)	1.049 (1.02 - 1.08)	0.003*
Male	1.121 (0.72 - 1.76)	0.617
Eligibility level		
Support level 1	1.000 (ref.)	
Support level 2	1.069 (0.44 - 2.58)	0.882
Care level 1	1.825 (0.77 - 4.34)	0.174
Care level 2	4.607 (2.11 - 10.07)	<0.001*
Use of nursing care service		
Visiting nurse	1.711 (1.00 - 2.92)	0.048*
Home rehabilitation	1.246 (0.61 - 2.56)	0.550
Nursing home daycare	1.228 (0.64 - 2.36)	0.537
Health daycare	1.768 (1.21 - 2.59)	0.004*
Respite stay in a nursing home	2.886 (1.40 - 5.94)	0.004*
Chronic conditions		
Cancer	1.352 (0.86 - 2.12)	0.188
Stroke	1.226 (0.73 - 2.06)	0.441
Lower limb fracture	1.214 (0.74 - 1.99)	0.445
Number of drugs > 3	1.248 (0.76 - 2.05)	0.382
Living alone	0.795 (0.54 - 1.17)	0.240
MIS (per 1point increment)	0.818 (0.76 - 0.88)	<0.001*
BMI (per 1kg/m^2 increment)	0.991 (0.95 - 1.04)	0.704
Grip strength		
3rd tertile (≧27.7 in men, ≧17.7 in women)	1.000 (ref.)	
2nd tertile (22.0-27.6 in men, 13.5-17.6 in women)	0.778 (0.45 - 1.35)	0.372
1st tertile (≦21.9 in men, ≦13.4 in women)	2.440 (1.54 - 3.86)	<0.001*

Abbreviations: BMI, body mass index; MIS, memory impairment screen.

* $P < 0.05$.

Table 3: Results of multivariate Cox proportional hazards analysis

	Model 1			Model 2			Model 3			Model 4		
	HR (95% CI)		P	HR (95% CI)		P	HR (95% CI)		P	HR (95% CI)		P
Age (per 1year increment)	1.024	(0.99-1.06)	0.160	1.023	(0.99-1.06)	0.173	1.024	(0.99-1.06)	0.162	1.023	(0.99-1.06)	0.181
Male	1.214	(0.76-1.93)	0.415	1.150	(0.72-1.84)	0.557	1.212	(0.76-1.94)	0.423	1.253	(0.78-2.01)	0.350
Eligibility level												
Support level 1		(ref.)			(ref.)			(ref.)			(ref.)	
Support level 2	1.031	(0.43-2.49)	0.947	1.042	(0.43-2.52)	0.927	1.030	(0.43-2.49)	0.947	1.030	(0.43-2.49)	0.948
Care level 1	1.260	(0.52-3.04)	0.608	1.247	(0.52-3.01)	0.623	1.258	(0.52-3.06)	0.613	1.251	(0.52-3.02)	0.620
Care level 2	3.076	(1.38-6.88)	0.006*	2.949	(1.32-6.6)	0.009*	3.070	(1.36-6.94)	0.007*	3.054	(1.36-6.83)	0.007*
Use of nursing care service												
Visiting nurse	1.242	(0.71-2.17)	0.448	1.268	(0.72-2.22)	0.406	1.241	(0.71-2.17)	0.450	1.229	(0.7-2.15)	0.471
Health daycare	1.354	(0.91-2.02)	0.139	1.366	(0.91-2.04)	0.128	1.353	(0.9-2.02)	0.141	1.351	(0.9-2.02)	0.142
Respite stay in a nursing home	1.498	(0.68-3.3)	0.316	1.565	(0.71-3.46)	0.269	1.501	(0.67-3.34)	0.320	1.467	(0.66-3.24)	0.344
Chronic conditions												
Cancer				1.663	(1.05-2.64)	0.032*						
Stroke							1.008	(0.58-1.75)	0.977			
Lower limb fracture										1.230	(0.73-2.06)	0.433
MIS (per 1point increment)	0.861	(0.79-0.94)	0.001*	0.851	(0.78-0.93)	<0.001*	0.861	(0.79-0.94)	0.001*	0.857	(0.79-0.93)	<0.001*
Grip strength												
3rd tertile		(ref.)			(ref.)			(ref.)			(ref.)	
2nd tertile	0.625	(0.36-1.1)	0.101	0.630	(0.36-1.1)	0.106	0.625	(0.36-1.1)	0.101	0.625	(0.36-1.1)	0.102
1st tertile	1.502	(0.92-2.45)	0.102	1.587	(0.97-2.59)	0.064#	1.502	(0.92-2.45)	0.102	1.497	(0.92-2.44)	0.106

None of chronic conditions was entered into Model 1. Cancer, stroke and lower limb fracture were entered into Model 2, 3 and 4, respectively.

Abbreviations: MIS, memory impairment screen

# $P < 0.1$, * $P < 0.05$.

III. General discussion

In these studies, we identified risk factors for disability progression among home-help service users. The findings could contribute to identify those who are at high risk of disability progression, and then, to construct cost-effective intervention.

During 3 year follow-up, more than a quarter of our subjects experienced disability progression. To note, more than half of our subjects lived alone. This warrants that care service providers should notice the early signs of functional decline with the regular assessment. Once those who are at high risk are identified, multidimensional services should be provided to prevent disability progression. Multidimensional approach might include nutritional care, exercise training program, arranging environment for their daily activities, or therapies to improve cognitive function. Inter-professional work for preventing disability progression would be the next challenge.

IV. Conclusion

In this thesis, we performed a prospective cohort study to explore risk factors for disability progression among home-help service users. The cross-sectional correlational study (Study 1) revealed the high prevalence of memory impairment, indicating that the risk screening should be done by indices which were not affected by memory impairment.

The results of the cohort study (Study 2) showed that memory impairment could be an independent risk factor for disability progression. In addition, grip strength might be a risk factor when considering history of cancer, indicating that some chronic conditions might modify the effect of risk indicators on disability progression.

Cause-effects relationship of those functions and disability progression would be a future challenging issue.

V. Acknowledgement

This research was conducted as a part of “A prospective cohort study evaluating risk factors for advancing care need in community dwelling elderly who utilize home-help services”, supervised by Prof. Sumio Yamada. This work was supported by the Japan Consumers Co-operative Union over the research period and by health promotion project for the elderly of Ministry of Health, Labour and Welfare in 2014.

I would like to appreciate all home-care service users, care managers and persons in charge of home care services of Co-op Aichi and U Co-op (Mr. Kenji Sasou, the manager of welfare department of Co-op Aichi; Mr. Makoto Fujita and Mr. Tadashi Suzuki, the manager of welfare department of U Co-op; Mr. Atsushi Yamagiwa and Mr. Tadashi Ichimiya, the manager and the stuff of welfare department of Japan Consumers Co-operative Union). Also, we would like to thank to the members of Yamada laboratory for their assistance for measurement training sessions and advice for data analysis.

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