JAMDA 17 (2016) 123–127

JAMDA

journal homepage: www.jamda.com

Original Study

Combined Effect of Slow Gait Speed and Depressive Symptoms on Incident Disability in Older Adults

Kota Tsutsumimoto PhD, PT[a,*], Takehiko Doi PhD, PT[a], Hiroyuki Shimada PhD, PT[a], Hyuma Makizako PhD, PT[a], Ryo Hotta PhD[a], Sho Nakakubo MSc, PT[a], Takao Suzuki PhD, MD[b]

[a] *Department of Functioning Activation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Obu, Japan*
[b] *Research Institute, National Center for Geriatrics and Gerontology, Obu, Japan*

Keywords:
Incident disability
gait speed
depression
older adults

A B S T R A C T

Objectives: To elucidate whether a combination of slow gait speed and depressive symptoms result in higher risk of incident disability in older adults than either symptom individually.
Design: Prospective cohort study.
Setting: Obu City, Aichi Prefecture, Japan.
Participants: Participants were 4038 older adults (48.7% male, mean age = 71 years) who met the study inclusion criteria.
Measurements: Longitudinal data on incident disability were collected up to 33 months [median 31 months (interquartile range 29–32 months)] after baseline. We monitored monthly incident disability, defined as Japanese long-term care insurance certification for personal support or care. Baseline measurements included covariates for incident disability, gait speed, and the Geriatric Depression Scale for assessing depressive symptoms. The associations between slow gait, depressive symptoms, or their co-occurrence, and incident disability were examined.
Results: Control participants were the reference in an adjusted Cox proportional hazard regression model. Participants with co-occurring slow gait and depressive symptoms showed a greater risk of incident disability [hazard ratio (HR) 3.08, confidence interval (CI) 95% 2.00–4.75]. Greater risk was also found for participants with slow gait speed alone (HR 2.44, CI 95% 1.71–3.47) and depressive symptoms alone (HR 1.60, CI 95% 1.01–2.53).
Conclusions: Older adults with both risk factors may require early detection and physical and psychological intervention.

Japan is the fastest aging society in the world—by 2035, 1 in 3 persons will be older than 65 years of age.[1] With this rapidly growing aging population, treating age-related health problems, such as physical and mental frailty or disability, is becoming crucial. From older adults' health promotion and health economics' perspectives, it is important for older adults without disability to maintain functional independence as long as possible. Thus, identifying incident disability risk factors is essential.

Disability onset in older adults is influenced by physiological, psychological, and social factors.[2–4] Of these, gait speed decline is one of the strongest predictors.[5] Age-related declines in gait function may reflect dysfunction of any involved systems, including the musculoskeletal, neurologic, or circulatory systems.[6,7] Thus, assessment of older adults' gait function is useful for detecting incident disability risk. Gait speed is a simple but an important clinical marker of current health and well-being. It is a powerful predictor of health problems including disability in older adults.[6,8–10]

Aside from mobility declines, mental disorders such as depressive symptoms are incident disability risk factors. Depressed individuals often engage in unhealthy lifestyle behaviors, such as smoking and lack of exercise,[11] and report somatic symptoms, such as sleep disturbances and fatigue.[12] These may exacerbate the symptoms of some medical

This work was supported by the Japanese Ministry of Health, Labor, and Welfare (Project for Optimizing Long-Term Care; grant number B-3) and the National Center for Geriatrics and Gerontology (Research Funding for Longevity Sciences; grant number 22-16).

The authors declare no conflicts of interest.

* Address correspondence to Kota Tsutsumimoto, PhD, PT, Department of Functioning Activation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, 7-430 Morioka-machi, Obu City, Aichi Prefecture, 474-8511, Japan.

E-mail address: k-tsutsu@ncgg.go.jp (K. Tsutsumimoto).

http://dx.doi.org/10.1016/j.jamda.2015.08.012
1525-8610/

conditions and ultimately lead to compromised functioning. Furthermore, several prospective studies suggest that late-life depression affects subsequent disability or impedes disability recovery.[13–16]

Slow gait speed and depressive symptoms are highly prevalent in late life and frequently co-occur. Both phenomena are associated with adverse health outcomes such as disability. In addition, there might be bidirectional longitudinal associations between physical function decline (including slow gait speed) and depressive symptoms.[17,18] As such, co-occurring slow gait speed and depressive symptoms for older adults might result in higher incident disability risk than either condition alone; however, it remains unclear whether older adults with these 2 conditions concurrently actually do have a higher risk. Thus, we investigated whether concurrent slow gait speed and depressive symptoms lead to higher incident disability risk in Japanese older adults using longitudinal cohort data.

Methods

Setting and Participants

We used a prospective study design, recruiting participants from the population-based cohort of the Obu Study of Health Promotion for the Elderly (OSHPE), conducted from August 2011 to February 2012 at baseline.[19] OSHPE inclusion criterion was ≥65 years old at examination. Before recruitment, we excluded 1661 people who participated in another study, were hospitalized or in residential care, or had a certified care level of greater than 3 in the Japanese long-term care insurance (LTCI) system. OSHPE recruitment was conducted by letter invitation to 14,313 individuals, of whom 5104 ultimately participated. After baseline assessment, monthly information on participants' health status, including incident disability as assessed by Japanese LTCI, death, or moving away from Obu city, was monitored. The current study included 4038 participants, excluding 1066 participants based on the following criteria: (1) a history of Parkinson disease (n = 23), Alzheimer disease (n = 9), or stroke (n = 528); (2) severe cognitive impairment [Mini-Mental State Examination (MMSE)[20] <19; n = 157]; (3) requiring support or care by the LTCI system at baseline (n = 160); or (4) missing values at baseline assessment (n = 189). The Ethics Committee of the National Center for Geriatrics and Gerontology approved the study protocol. The study's purpose, nature, and potential risks were fully explained to the participants. All gave their written informed consent before study participation.

Measure

Disability assessment

During follow-up, we monitored participants' LTCI certification [median 31 months (interquartile range 29–32 months)]. Incident disability was defined as being certified for any level of LTCI service for the first time. The Japanese Government established the nationally uniform criteria for LTCI certification objectively; certification of care need levels for older adults is determined by the results of municipal committee evaluation (ie, Certification Committee for Long-Term Care Need) using these criteria. The process of determining eligibility for LTCI system certification is as follows. An older adult or his caregiver contacts the municipal government to request official certification of the applicant's care needs. Then, a trained local government official visits the older adult's home to evaluate nursing care needs in terms of current physical and mental status. After this official completes the assessment, the results are entered into a computer to (1) calculate the applicant's standardized physical and mental status scores; (2) estimate the care time required for the older adult; and (3) assign a care-need level based on the total estimated care time. The Care Needs Certification Board reviews the data, which include the applicant's primary physician's report. Finally, the applicant was assigned a level of care need (certified support level of 1–2 or care level of 1–5). Every 6 months, the older adult's eligibility was re-evaluated. In the present study, incident disability was defined as being certified for the first time for support level 1–2 or care level 1–5.

Gait speed

Two markers were used to indicate the start and end of a 2.4-m walking path, with a 2-m section to be traversed before passing the start marker so that participants were walking at a comfortable pace by the time they reached the timed path. Participants were asked to continue walking for an additional 2 m past the end of the path to ensure a consistent walking pace while on the timed path. Those with poor mobility were identified according to a cut-off (<1.0 m/s).[19]

The 15-item Geriatric Depression Scale

The 15-item Geriatric Depression Scale (GDS) was administered by conducting an interview to assess depression symptoms.[21] The GDS is unique in that it was specifically developed for use with geriatric patients and contains fewer somatic items. The participants were

Table 1
Baseline Participant Characteristics by Risk Pattern (Control, Depressive Symptoms, Slow Gait Speed, or Co-occurring)

Variables	All Participants n = 4038	Missing	Control n = 3033	Depressive Symptoms* n = 399	Slow Gait Speed† n = 449	Co-occurring n = 157	*P* Value
Incident disability; n (%)	220 (5.0)	0	86 (2.8)	24 (6.0)	72 (16.0)	38 (24.2)	<.001‡
Sex; n of male (%)	1968 (48.7)	0	1477 (48.7)	197 (48.6)	218 (49.4)	76 (48.4)	.944‡
Age (years); mean ± SD	71.9 ± 2.5	0	71.1 ± 4.7	72.1 ± 5.3	75.8 ± 6.6	77.0 ± 6.4	<.001§
Education (years); mean ± SD	11.4 ± 2.5	0	11.6 ± 2.5	11.0 ± 2.4	10.9 ± 2.7	10.2 ± 2.5	<.001§
Hypertension; n (%)	1851 (45.8)	9	1331 (43.9)	188 (47.1)	240 (53.5)	92 (58.6)	<.001‡
Diabetes mellitus; n (%)	530 (13.1)	15	370 (12.2)	41 (10.3)	91 (20.3)	28 (17.8)	<.001‡
Hyperlipidemia; n (%)	1663 (41.2)	6	1267 (41.8)	167 (41.9)	176 (39.2)	53 (33.8)	<.001‡
Heart disease; n (%)	667 (16.5)	7	469 (15.5)	66 (16.5)	88 (19.6)	44 (28.0)	<.001‡
Osteoarthrosis; n (%)	570 (14.1)	11	384 (12.7)	67 (16.8)	85 (18.9)	34 (21.7)	<.001‡
Medication; mean ± SD	1.9 ± 2.0	7	1.7 ± 1.9	2.3 ± 2.3	2.6 ± 2.4	2.8 ± 2.1	<.001§
Pain; n (%)	1494 (37.0)	46	1006 (33.2)	194 (48.6)	195 (43.4)	99 (63.1)	<.001‡
MMSE score; mean ± SD	26.4 ± 2.5	16	26.6 ± 2.4	26.3 ± 2.6	25.6 ± 2.6	25.1 ± 2.7	<.001§
Physical activity (min/day); mean ± SD	283.2 ± 159.3	17	293.5 ± 158.5	253.9 ± 156.1	259.3 ± 162.2	228.7 ± 147.3	<.001§
Sleeping time (min/day); mean ± SD	461.6 ± 74.2	38	457.4 ± 68.6	457.5 ± 82.4	481.2 ± 75.6	495.4 ± 121.0	<.001§

ANOVA, analysis of variance; SD, standard deviation.
Plus-minus values are means ± SD.
*15 data were missing.
†12 data were missing.
‡$\chi 2$ test.
§ANOVA. Significance set at $P < .05$.

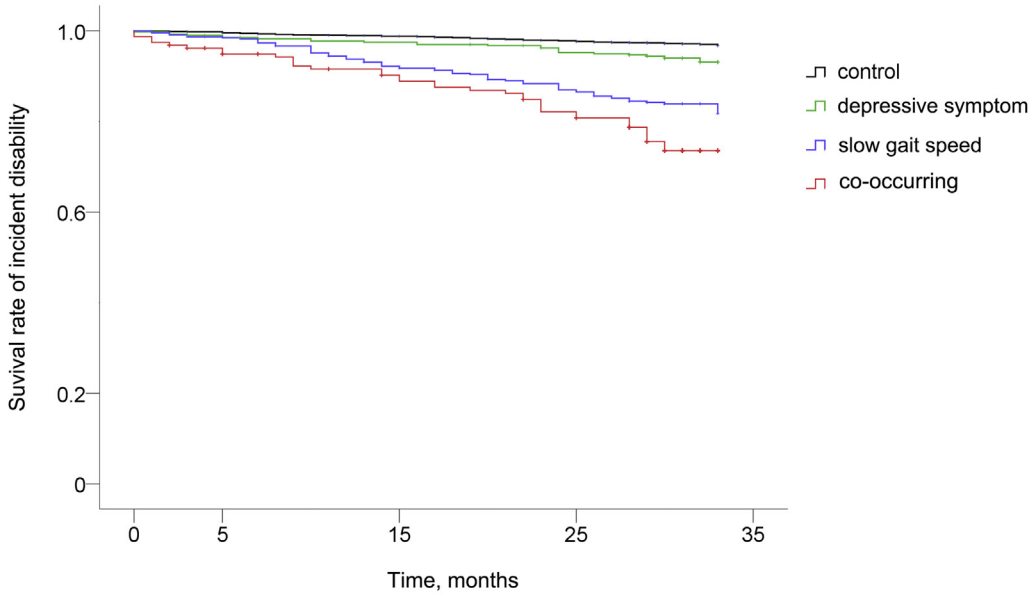

Fig. 1. Kaplan–Meier survival curves of older adults showing the relationship between incident disability and functional decline (slow gait speed, depressive symptoms, or their co-occurrence).

required to respond with a "yes" or a "no" to each question. Those who scored 6 or higher on the GDS had depressive symptoms.[21]

Demographic variables and covariates

Sex, age, and educational level (years) were collected as socio-demographic variables. Via face-to-face interviews, participants reported any medical diagnoses and medications. Comorbid illnesses considered as confounding variables were hypertension, diabetes mellitus, hyperlipidemia, cardiovascular disease, and osteoarthrosis. Participants were asked about whether they had chronic pain continuing for more than 2 months (yes/no). Global cognitive function was assessed using the MMSE, which is commonly used throughout the world; scores range from 0 to 30.[20] Physical activity was assessed by the total amount of time spent walking per average day. Finally, participants were asked about usual bedtimes and wake times to calculate self-reported sleep durations.

Statistics

All data entry and analyses were performed using SPSS v 19.0 (SPSS Inc, Chicago, IL). We divided the participants into groups by whether the cut-offs for mobility decline (a gait speed of less than 1.0 m/s) and depressive symptoms (GDS score $\leq$5). Thus, the groups were as follows: (1) no mobility decline and absence of depressive symptoms (control group); (2) normal gait speed with depressive symptoms (depressive symptoms group); (3) slow gait speed but no depressive symptoms (slow gait speed group); and (4) co-occurring slow gait speed and depressive symptoms (co-occurring group). Continuous data are presented as means $\pm$ standard deviations. The study participants' characteristics were compared by gait speed and depression symptom status using Student *t*-test or the Mann–Whitney U-test for continuous variables and the χ^2 test for categorical variables. We calculated the cumulative incident disability during follow-up for each of the 4 groups with Kaplan–Meier curves. Intergroup differences were estimated by the log-rank test. Univariate and multivariate Cox proportional hazard regression models were conducted to calculate the hazard ratios with 95% confidence intervals for incident disability risk. Incident disability was the objective variable and the explanatory variable was the group factor compared with the control group. Model 1 was the crude model. Model 2 added the following covariates: age, sex, and education. Model 3 added hypertension, diabetes mellitus, hyperlipidemia, heart disease, osteoarthrosis, number of medications, pain, MMSE score, physical activity, and sleeping time. Each model calculated hazard ratios and 95% confidence intervals referred to the control group.

Results

Out of the 4038 participants initially recruited, 220 (5.4%) developed incident disability during follow-up, which was a median of 31 months (interquartile range 29–32). The incident disability rates by group can be found in Table 1. Descriptive statistics for the baseline characteristics of the 4 groups are presented in Table 1; all variables, except for sex, significantly differed between groups.

Figure 1 shows the probability of being independent using Kaplan–Meier analysis. The co-occurring group showed a higher rate of incident disability than the slow gait speed and depressive symptoms groups. The log-rank test revealed significant differences in incident disability rates between the groups (Table 2).

Finally, Table 3 shows the unadjusted and adjusted probabilities of survival for groups using Cox proportional hazard risk analysis. In the crude and 2 adjusted models, the co-occurring group showed significantly highest risk of incident disability, followed by the slow gait speed and depressive symptoms groups, respectively (Table 3).

Discussion

This study showed that the incident disability rate was 5.4% for a median follow-up of 31 months in community-dwelling older adults.

Table 2
Difference in Incident Disability Rates Between Groups During Follow-Up Analyzed by Log-Rank Test

	Control		Depressive Symptom		Slow Gait Speed	
	χ^2	*P* Value	χ^2	*P* Value	χ^2	*P* Value
Depressive symptom	11.879	<.001				
Slow gait speed	165.897	<.001	20.929	<.001		
Co-occurring	211.257	<.001	41.569	<.001	6.109	.013

Significance set at P < .05.

Table 3
Association of Co-occurring Slow Gait Speed and Depressive Symptom With Incident Disability

Risk Pattern	At Risk	Events	Rate per 1000 Person-Years	Crude Model		Adjusted Model 1		Adjusted Model 2	
	N	N		HR (95% CI) and *P* Value					
Co-occurring	157	38	88.0	9.92 (6.77–14.54)	<.001	4.40 (2.91–6.63)	<.001	3.08 (2.00–4.75)	<.001
Slow gait speed	449	72	58.3	6.08 (4.45–8.32)	<.001	3.00 (2.12–4.23)	<.001	2.44 (1.71–3.47)	<.001
Depressive symptom	399	24	21.9	2.17 (1.38–3.41)	<.001	1.85 (1.18–2.92)	.008	1.60 (1.01–2.53)	.046
Control	3033	86	10.3	Reference		Reference		Reference	

CI, confidence interval; HR, hazard ratio.
Significance set at $P < .05$.
Adjusted model 1: adjusted for age, sex, and education.
Adjusted model 2: adjusted for model 1 covariates, hypertension, diabetes mellitus, hyperlipidemia, heart disease, osteoarthrosis, number of medications, pain, MMSE score, physical activity, and sleeping time.

In addition, slow gait speed and depressive symptoms were independent risk factors of incident disability and co-occurring slow gait speed and depressive symptoms presented the highest risk of incident disability. This association remained after adjusting for covariates.

This is the first study that examined the combined effects of depressive symptoms and slow gait speed on incident disability compared with the individual effects of these factors. Accumulating evidence suggests that depressive symptoms are a risk factor for physical dysfunction[4,22–25] and poor physical performance[26–30] among older adults, whereas deteriorating physical function increases the likelihood of depressive symptoms and depression.[31–35] One possible explanation of our results is that slow gait speed and depressive symptom form a vicious cycle whereby slow gait induces depressive symptoms; namely, difficulty walking results in decreased physical activities and a restricted living space, which subsequently result in a loss of social support and isolation and eventually leads to depressive symptoms and depression.[36] In contrast, depressive symptoms can then lead to physical dysfunction by feelings of discouragement and hopelessness, which reduce people's willingness to attempt tasks that they are otherwise capable of performing.[37] Subsequently, this decrease in physical activities and life space restriction might lead to physical function decline, eventually leading to slow gait speed. The association between slow gait speed and depressive symptoms appears to be bidirectional in older adults.[38] Based on these previous and our current findings, slow gait speed and depressive symptoms in older adults appear to have an interactive effect on incident disability.

Slow gait speed had greater impact on incident disability than depressive symptoms. Previous studies indicated that slow gait speed has a higher risk of incident disability.[8,10,39–42] In the present study, incident disability was defined as being certified for personal support and care by the LTCI system, and nearly half (47.5%) of the incident disability cases were certified support levels 1 or 2. The older adults with support levels 1 or 2 require relatively little personal care compared with those certified for care levels 1–5; however, the support levels are a transition phase to the care levels. In support levels 1 and 2, certification causes were as follows: aging-related debilitation, 20.7%; arthritic disorders, 15.4%; and fall and bone fractures, 14.6%.[43] These causes were thought to have a direct link with mobility. Thus, the LTCI system's method of classifying disability might have partially contributed to the result that slow gait speed had a high risk of incident disability.

The central strengths of the present study are as follows. First, we used a robust and objective assessment of incident disability created by the Japanese Government. In most studies of incident disability in older adults, disability is assessed by subjective methods such as questionnaires. Second, disability assessment is frequent; it is conducted monthly by the Japanese Government. Thus, changes in participants' functional status are identified quickly and in detail, although the observation period in the present study was relatively short compared with other studies of incident disability.

A major strength of this longitudinal study is the application of monthly disability follow-up in a large sample using the mandatory social LTCI in Japan. Nevertheless, several limitations should be considered. First, the 33-month follow-up might have been too short to sufficiently capture incident disability and our follow-up period was shorter than previous studies.[44–47] Furthermore, incident disability end points were too small to investigate prospective associations of slow gait speed and depressive symptoms with incident disability. Second, some variables were self-reported (eg, education history, comorbidity, physical activity). These factors and others should be examined in future studies. Future studies examining causes of incident disability and longitudinal relationships between slow gait speed, depressive symptoms, and disability using longer follow-up data would be helpful to consider preventive strategies for disability.

Acknowledgments

We thank the staff of the Obu City office for their help with participant recruitment.

References

1. Aare M, von Holst H. Injuries from motorcycle- and moped crashes in Sweden from 1987 to 1999. Inj Control Saf Promot 2003;10:131–138.
2. Carrière I, Colvez A, Favier F, et al. Hierarchical components of physical frailty predicted incidence of dependency in a cohort of elderly women. J Clin Epidemiol 2005;58:1180–1187.
3. Ishizaki T, Watanabe S, Suzuki T, et al. Predictors for functional decline among nondisabled older Japanese living in a community during a 3-year follow-up. J Am Geriatr Soc 2000;48:1424–1429.
4. Stuck AE, Walthert JM, Nikolaus T, et al. Risk factors for functional status decline in community-living elderly people: A systematic literature review. Soc Sci Med 1999;48:445–469.
5. Donoghue OA, Savva GM, Cronin H, et al. Using timed up and go and usual gait speed to predict incident disability in daily activities among community-dwelling adults aged 65 and older. Arch Phys Med Rehabil 2014;95:1954–1961.
6. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. JAMA 2011;305:50–58.
7. Abellan van Kan G, Rolland Y, Andrieu S, et al. Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people an International Academy on Nutrition and Aging (IANA) Task Force. J Nutr Health Aging 2009;13:881–889.
8. Cesari M, Kritchevsky SB, Penninx BW, et al. Prognostic value of usual gait speed in well-functioning older people—Results from the Health, Aging and Body Composition Study. J Am Geriatr Soc 2005;53:1675–1680.
9. Ayis S, Ebrahim S, Williams S, et al. Determinants of reduced walking speed in people with musculoskeletal pain. J Rheumatol 2007;34:1905–1912.
10. Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: Consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. J Gerontol A Biol Sci Med Sci 2000;55:M221–M231.
11. Bonnet F, Irving K, Terra JL, et al. Anxiety and depression are associated with unhealthy lifestyle in patients at risk of cardiovascular disease. Atherosclerosis 2005;178:339–344.
12. Kapfhammer HP. Somatic symptoms in depression. Dialogues Clin Neurosci 2006;8:227–239.
13. Armenian HK, Pratt LA, Gallo J, Eaton WW. Psychopathology as a predictor of disability: A population-based follow-up study in Baltimore, Maryland. Am J Epidemiol 1998;148:269–275.

14. Kouzis AC, Eaton WW. Psychopathology and the development of disability. Soc Psychiatry Psychiatr Epidemiol 1997;32:379–386.
15. Morris PL, Raphael B, Robinson RG. Clinical depression is associated with impaired recovery from stroke. Med J Aust 1992;157:239–242.
16. Mossey JM, Knott K, Craik R. The effects of persistent depressive symptoms on hip fracture recovery. J Gerontol 1990;45:M163–M168.
17. Gayman MD, Turner RJ, Cui M. Physical limitations and depressive symptoms: Exploring the nature of the association. J Gerontol B Psychol Sci Soc Sci 2008; 63:S219–S228.
18. Sanders JB, Bremmer MA, Deeg DJ, Beekman AT. Do depressive symptoms and gait speed impairment predict each other's incidence? A 16-year prospective study in the community. J Am Geriatr Soc 2012;60:1673–1680.
19. Shimada H, Makizako H, Doi T, et al. Combined prevalence of frailty and mild cognitive impairment in a population of elderly Japanese people. J Am Med Dir Assoc 2013;14:518–524.
20. Folstein MF, Robins LN, Helzer JE. The Mini-mental state examination. Arch Gen Psychiatry 1983;40:812.
21. Yesavage JA. Geriatric depression scale. Psychopharmacol Bull 1988;24: 709–711.
22. Lenze EJ, Rogers JC, Martire LM, et al. The association of late-life depression and anxiety with physical disability: A review of the literature and prospectus for future research. Am J Geriatr Psychiatry 2001;9:113–135.
23. Bruce ML. Depression and disability in late life: Directions for future research. Am J Geriatr Psychiatry 2001;9:102–112.
24. Schillerstrom JE, Royall DR, Palmer RF. Depression, disability and intermediate pathways: A review of longitudinal studies in elders. J Geriatr Psychiatry Neurol 2008;21:183–197.
25. Bromberger JT, di Scalea TL. Longitudinal associations between depression and functioning in midlife women. Maturitas 2009;64:145–159.
26. Penninx BW, Deeg DJ, van Eijk JT, et al. Changes in depression and physical decline in older adults: A longitudinal perspective. J Affect Disord 2000;61: 1–12.
27. Lenze EJ, Schulz R, Martire LM, et al. The course of functional decline in older people with persistently elevated depressive symptoms: Longitudinal findings from the Cardiovascular Health Study. J Am Geriatr Soc 2005;53: 569–575.
28. Dalle Carbonare L, Maggi S, Noale M, et al. Physical disability and depressive symptomatology in an elderly population: A complex relationship. The Italian Longitudinal Study on Aging (ILSA). Am J Geriatr Psychiatry 2009;17: 144–154.
29. Everson-Rose SA, Skarupski KA, Bienias JL, et al. Do depressive symptoms predict declines in physical performance in an elderly, biracial population? Psychosom Med 2005;67:609–615.
30. den Ouden ME, Schuurmans MJ, Arts IE, van der Schouw YT. Physical performance characteristics related to disability in older persons: A systematic review. Maturitas 2011;69:208–219.
31. Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. Am J Psychiatry 2003;160: 1147–1156.
32. Taylor MG, Lynch SM. Trajectories of impairment, social support, and depressive symptoms in later life. J Gerontol B Psychol Sci Soc Sci 2004;59: S238–S246.
33. Schnittker J. Chronic illness and depressive symptoms in late life. Soc Sci Med 2005;60:13–23.
34. Schieman S, Plickert G. Functional limitations and changes in levels of depression among older adults: A multiple-hierarchy stratification perspective. J Gerontol B Psychol Sci Soc Sci 2007;62:S36–S42.
35. Yang Y, George LK. Functional disability, disability transitions, and depressive symptoms in late life. J Aging Health 2005;17:263–292.
36. Stegenga BT, Nazareth I, Torres-Gonzalez F, et al. Depression, anxiety and physical function: Exploring the strength of causality. J Epidemiol Community Health 2012;66:e25.
37. Cronin-Stubbs D, de Leon CF, Beckett LA, et al. Six-year effect of depressive symptoms on the course of physical disability in community-living older adults. Arch Intern Med 2000;160:3074–3080.
38. Demakakos P, Cooper R, Hamer M, et al. The bidirectional association between depressive symptoms and gait speed: Evidence from the English Longitudinal Study of Ageing (ELSA). PLoS One 2013;8:e68632.
39. Shinkai S, Watanabe S, Kumagai S, et al. Walking speed as a good predictor for the onset of functional dependence in a Japanese rural community population. Age Ageing 2000;29:441–446.
40. Cesari M, Kritchevsky SB, Newman AB, et al. Added value of physical performance measures in predicting adverse health-related events: Results from the Health, Aging and Body Composition Study. J Am Geriatr Soc 2009;57:251–259.
41. Onder G, Penninx BW, Ferrucci L, et al. Measures of physical performance and risk for progressive and catastrophic disability: Results from the Women's Health and Aging Study. J Gerontol A Biol Sci Med Sci 2005;60:74–79.
42. Studenski S, Perera S, Wallace D, et al. Physical performance measures in the clinical setting. J Am Geriatr Soc 2003;51:314–322.
43. Aaron LA, Turner JA, Mancl L, et al. Electronic diary assessment of pain-related variables: Is reactivity a problem? J Pain 2005;6:107–115.
44. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: Evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001;56:M146–M156.
45. Santos-Eggimann B, Karmaniola A, Seematter-Bagnoud L, et al. The Lausanne cohort Lc65+: A population-based prospective study of the manifestations, determinants and outcomes of frailty. BMC Geriatr 2008;8:20.
46. Ensrud KE, Ewing SK, Taylor BC, et al. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. Arch Intern Med 2008;168:382–389.
47. Song X, Mitnitski A, Rockwood K. Prevalence and 10-year outcomes of frailty in older adults in relation to deficit accumulation. J Am Geriatr Soc 2010;58: 681–687.