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Health and Physical Function Predicting Strength and Balance Training Adoption: A Community-Based Study Among Individuals Aged 75 And Older

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Abstract

This study was conducted to determine the characteristics of health and physical function that are associated with not starting strength and balance training (SBT). The study population consisted of 339 community-dwelling individuals (75 to 98 years, 72% female). As part of a population-based intervention study they received comprehensive geriatric assessment, physical activity counseling and had the opportunity to take part in SBT at the gym once a week. Compared with the SBT-adopters, the non-adopters (n=157, 46%) were older and less physically active, had more comorbidities, lower cognitive abilities, more often sedative load of drugs or were at the risk of malnutrition, had lower grip strength, more IADL-difficulties, and weaker performance in Berg Balance Scale and Timed Up and Go. In multivariate models higher age, impaired cognition and lower grip strength were independently associated with non-adoption. In the future, more individually tailored interventions are needed to overcome the factors that prevent exercise initiation.

Keywords: muscle strength, postural balance, exercise, geriatric assessment, adherence, cognition

Health and Physical Function Predicting Strength and Balance Training Adoption: A Community-Based Study Among Individuals Aged 75 And Older

Promoting physical activity in older adults is an important public health goal. It has been shown that regular exercise can prevent, and serve as an effective therapy for, many chronic diseases and functional limitations (Nelson et al., 2007). Strength and balance training (SBT) has been demonstrated to improve physical function and prevent disability (Singh, 2002), falls (Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society, 2011) and the development and progression of frailty syndrome (Peterson et al., 2009) in older adults. Despite the recognized health benefits, relatively few older adults participate in supervised SBT. In Finland, less than 10% of the population aged ≥75 years participates in strength training (Laitalainen, Helakorpi, & Uutela, 2010) at the level recommended in health-enhancing exercise and physical activity guidelines (Nelson et al., 2007). Similarly, in Australia, 12% of persons aged >65 years participate in strength training, and 6% participate in balance training (Merom et al., 2012). Typically, less than half of those invited to take part in falls prevention activities agree to participate, and nearly half decline to attend SBT groups (Yardley et al., 2008).

The prevalence of comorbid conditions increases with age and heightens the risk for developing mobility disability (L. Fried, Ferrucci, Darer, Williamson, & Anderson, 2004). Poor health has also been described as a significantly greater barrier to general physical activity after the age of 80 years than at younger ages (Moschny, Platen, Klaassen-Mielke, Trampisch, & Hinrichs, 2011). The determinants of exercise for older adults were evaluated in a review of randomized controlled trials (RCT): better physical condition, a previous physically active lifestyle, non-smoking and higher exercise self-efficacy predicted better adherence (Martin & Sinden, 2001). However, these study populations were very limited compared with general community settings, where multiple morbidities and functional limitations are common. A recent review revealed that the evidence on the determinants of physical activity and exercise was insufficient in healthy adults aged >55 years (Koeneman, Verheijden, Chinapaw, & Hopman-Rock, 2011). Barriers to physical activity among older adults, especially for adults over 80 years of age with regard to SBT, have been studied even less frequently (Baert, Gorus, Mets, Geerts, & Bautmans, 2011). Thus, studies on the health and physical function affecting the initiation of exercise among community-dwelling older adults with a wide variety of functional limitations and comorbidities are sparse.

Information regarding the barriers to beginning a training program may improve the design and implementation of exercise programs in community settings (Glasgow, Vogt, & Boles, 1999). The purpose of the current study was to detect the factors related to health and physical function that are associated with non-adoption of supervised SBT in a community-based sample of older adults.

Methods

Participants

This study is part of the Geriatric Multidisciplinary Strategy for the Good Care of the Elderly study (GeMS). GeMS is a population-based intervention study (Lihavainen et al., 2011) that comprised a baseline assessment, a two-year intervention with annual assessments, and a one-year follow-up period. It was conducted in the city of Kuopio, Finland from 2004 to 2007. A random sample of 1,000 individuals was selected from all the inhabitants of Kuopio aged 75 years and over in November 2003 (n=5615). After excluding the subjects who died, refused to participate, or had moved out of the area, a total of 781 participants were included in the baseline assessment. The participants in the present study (n=339) were the community-dwelling individuals who were included in the intervention group at baseline (Figure 1). An additional inclusion criterion was that participant had received physical activity counseling from a physiotherapist at the beginning of the study. Written informed consent was obtained from the study participants. The study was approved by the Research Ethics Committee of Northern Savo Hospital District and Kuopio University Hospital.

Comprehensive geriatric assessment (CGA)

Three trained nurses, two physiotherapists, and two physicians collected the GeMS data. Sociodemographic factors, health status, medication use, nutritional status, cognitive functioning, physical performance, and ability to perform activities of daily living were assessed. The data collection was supplemented by a caregiver interview if a participant had difficulty answering the questions. The balance and mobility measurements were collected by the physiotherapists. If the participant was unable to visit the outpatient clinic, the measurements and the interviews took place at the participant’s home.

Health status

Comorbidity was defined using a modified version of the 18-item functional comorbidity index (FCI), a validated scale that predicts physical function in older adults (Groll, To, Bombardier, & Wright, 2005). The FCI takes into account the number of medical conditions, with higher scores indicating greater comorbidity. This study collected data on the following 13 conditions (Tikkanen et al., 2012): 1) rheumatoid arthritis and other connective tissue diseases, 2) chronic asthma or chronic obstructive pulmonary disease (COPD), 3) Parkinson's disease or multiple sclerosis, 4) osteoporosis, 5) coronary artery disease, 6) heart failure, 7) myocardial infarction, 8) stroke, 9) diabetes, 10) depression, 11) visual impairment, 12) hearing impairment, and 13) obesity (BMI >30).

The use of medication was self-reported by the participants, and they were also asked to bring their prescription forms and drug containers to the interviews. In addition, self-reported drug use was verified against medical records. The Sedative Load Model was used to quantify the cumulative effect of taking multiple drugs with sedative properties (Linjakumpu et al., 2003; Taipale et al., 2011). Cognitive function was assessed using the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975). The scores range from 0 to 30, with higher scores indicating better performance. Depressive symptoms were assessed using the 15-item Geriatric Depression Scale (GDS-15) (Sheikh et al., 1991) with scores ≥ 5 considered to be indicative of possible depression. The short version of the Mini Nutritional Assessment (MNA-SF) was used to assess the risk of malnutrition (Rubenstein, Harker, Salva, Guigoz, & Vellas, 2001). The maximum score on the MNA-SF is 14; scores of 12-14 indicate normal nutritional status, scores of 8-11 indicate a risk of malnutrition, and scores of 0-7 indicate malnutrition. Self-rated health was assessed with the following question: "How would you rate your health at the moment?" The participants selected one of five response alternatives. In the analysis, alternatives 1 and 2 (good or very good) and 4 and 5 (poor or very poor) were combined.

Physical functioning

The Berg Balance Scale (BBS) was used to assess balance. The participant was observed performing 14 different functional balance tasks that test the ability of individuals to stand, reach, bend, and transfer (Berg, Wood-Dauphinee, Williams, & Maki, 1992). Each of the 14 items is scored from 0 to 4, and the overall scores range from 0 (severely impaired) to 56 points (excellent). The Timed Up and Go test (TUG) was used to assess balance and basic mobility skills (Podsiadlo & Richardson, 1991). The patients were instructed to stand up from a chair, walk for a distance of 3 m at maximal speed, turn around, walk back, and sit down on the chair. Time was measured with a stopwatch, and the use of a walking aid was allowed in the TUG. The participants performed the BBS barefoot and the TUG test using their regular shoes.

Grip strength was measured in kilograms using a Saehan dynamometer (Saehan Corporation, South Korea). The measurements were taken with the participant seated, elbow flexed at a 90° angle next to but slightly apart from the body. The participants were allowed to make one maximal effort for both hands, and the result from the stronger hand was used in the analyses. The grip strength analyses were conducted separately for men and women. The ability to perform instrumental activities of daily living (IADL) was assessed using the Lawton Instrumental Activities of Daily Living Scale (IADLS) (Lawton & Brody, 1969).

Self-rated mobility was assessed by asking whether the respondents could walk 400 m (yes; yes, with difficulty, but without help; not without help; or no). In the analysis, the categories “yes” and “yes, with difficulty, but without help” were combined under the single category “yes, independently”.

The level of physical activity was assessed using a modified version of the Grimby scale (Frändin & Grimby, 1994; Grimby, 1986). The participants were asked “Which of the following options describes best your present physical activity?” (0) hardly any physical activity, (1) light physical exercise eg. walking 1-2 times a week, (2) light physical exercise eg. walking several times a week, (3) moderate physical exercise that causes some shortness of breath and sweating 1-2 times a week, (4) moderate physical exercise that causes some shortness of breath and sweating several times a week, (5) hard or very hard physical exercise that causes quite strong sweating and shortness of breath several times a week, and (6) competitive sports and exercise several times a week. The participants were categorized on the basis of their self-rated physical activity into the low-activity group (0-1), the moderate-activity group (2-3), or the high-activity group (4-6).

Physical activity counseling

The individually tailored annual physical activity counseling with the physiotherapist started with a semi-structured interview that charted the participants’ current and prior physical activity. During the counseling session, practical and detailed goals for future physical activity were set, and both the participant and the physiotherapist signed the plan. The session took approximately 1.5 hours. In addition to the counseling, the physical activity component of the intervention included an opportunity to participate in group-based SBT once a week. The eligibility to SBT was based on clinical examination by a doctor and training was supervised by a trained physiotherapist. The SBT was conducted in at one gym in the city center. The intervention did not include transportation to the gym, but the participants received help in finding community transportation services or arranging transportation with family members or neighbors. Training was free of charge. The inclusion criterion for training was that participant was able to move independently or with minimal help at the gym.

Adoption of training

The participation to SBT was monitored by the study physiotherapists and recorded on the training logs at the gym. The criterion for SBT adoption was taking part at least once in training at the gym during the study period. The non-adoption is here used as a synonym for not to take up, initiate or start training.

Statistical analysis

The data are presented as means with standard deviations (SD) or 95% confidence intervals (95% CI) or as counts with percentages. The normality of the variables was tested using the Shapiro-Wilk *W*-test. The statistical significance of the difference between the exercise and non-exercise groups was analyzed with a t-test for continuous variables and a chi-square test for categorized variables. Logistic regression models were used to study the factors associated with non-adoption (i.e., not initiating training). The bivariate analyses were adjusted for age and sex. In the second phase, the independent variables that were significantly related to non-adoption in the bivariate analysis were used as predictors in the multivariate analysis. To avoid multicollinearity, BBS and TUG scores were omitted from the multivariate model because they were strongly correlated with the IADLS. The participants' education level was not included because data were missing for several participants. If the 95% CI did not include 1, the result was regarded as statistically significant. The α-level was set at 0.05. SPSS version 19.0 was used to conduct the analyses.

Results

Of the 339 participants (75 to 98 years old, 72% female), 157 (46%) did not adopt SBT during the intervention. The characteristics of the participants are summarized in Table 1. The non-adopters were older (p<0.001) and had less education (p<0.001) than the adopters. With regard to health status, the non-adopters had more comorbidities (p<0.011), lower cognition (p<0.001), more often sedative load of drugs (p<0.001) or risk of malnutrition (p=0.002), and poorer self-perceived health (p<0.003) compared with the SBT adopters.

With regard to self-reported functioning, the group of non-adopters was less physically active (p<0.009) and had more difficulties with IADLs (p<0.001) and walking 400 m (p<0.001). In addition, a higher proportion of them used a walking aid (p<0.001). In terms of measured physical performance, the non-adopters had lower grip strength (women p<0.001; men p=0.025) and more balance and mobility problems according to the BBS (p<000.1) and the TUG (p<0.001) compared with the adopters. (Table 1).

In the bivariate analysis, non-adoption was associated with higher age, lower education, a greater sedative load of drugs, lower levels of cognition, the risk of malnutrition, less ability to perform IADLs, lower performance in BBS and TUG and having grip strength in the two weakest quartiles (Table 2). In the multivariate analysis, higher age, weaker cognition and lower grip strength were independently associated with non-adoption. For each point the MMSE decreased, the odds of non-adoption increased by 14%.

Discussion

To our knowledge, this is one of the first studies exploring SBT adoption in a community setting after a multidisciplinary CGA and physical activity counseling. In this study, SBT adoption was assessed based on actual participation in training, not only by self-report or willingness to take part. Almost half (46%) of the community-dwelling older adults did not participate in SBT at the gym. Compared to the results of a previous survey from the UK, in which 41% of population aged ≥54 years reported that they would definitely not attend group-based SBT for falls prevention (Yardley et al., 2008), the degree of non-participation in our study with a far older population seems moderate. Conversely, falls prevention exercise trials for older people have reported notably higher (70%) participation rates (Nyman & Victor, 2012). The participants in RCTs are recruited differently, and they often have better health and a higher level of functioning than the older adults in our community-based intervention study.

Previous research has reported that physical activity decreases with aging (Cohen-Mansfield, Shmotkin, & Goldberg, 2010; Laitalainen et al., 2010), which aligns with the present finding that higher age was independently associated with SBT non-adoption. In contrast to a previous study (Chevan, 2008), female gender was not associated with participation in training in this study. For older women, group-based training may be even more motivating because of its social component (King, 2001). In addition to more advanced age, the non-adopters had more co-morbidities and poorer self-perceived health. They used more drugs with sedative properties and were more often at risk of malnutrition compared with the SBT adopters. This result indicates that the non-adopters had a greater accumulation of health problems. One clinical implication of these results is that many of these barriers, such as the risk of malnutrition and the sedative load of drugs are treatable. The sedative load of drugs may prevent participation in SBT by increasing tiredness and dizziness and impairing attention. Furthermore, the safety and effectiveness of SBT are questionable if energy or protein intake is lacking. Thus, medication and nutritional assessments and further interventions might be necessary before SBT initiation.

Of the physical functioning measures, low grip strength was a significant independent predictor of non-adoption. Grip strength is a practical measure of sarcopenia (Hairi et al., 2010), and it predicts major mobility disability (Marsh et al., 2011). The functional impairments, chronic diseases and undernutrition detected among the non-adopters are signs and symptoms of frailty and core elements in the cycle of frailty (Fried et al., 2009). Sarcopenia is a key pathophysiological feature in this cycle because it decreases muscle strength, power and walking speed and leads to disability and dependency (Fried et al., 2009).

In our study, the non-adopters also demonstrated reduced balance and mobility as assessed by the BBS and the TUG. Our objective measures of balance and mobility support the previous finding that self-rated mobility limitations prevent the initiation of weight training among older community-dwelling adults (Rasinaho et al., 2012). In our study, a higher proportion of non-adopters (39% vs. 21%) used a walking aid. The use of a walking aid or a fall during the past year has shown to limit older adults' participation in strength training or balance-challenging activities (Merom et al., 2012). These factors also make it challenging to go to the gym, especially when combined with the inability to walk 400 meters independently, a self-rated functional limitation significantly more common among the SBT non-adopters than the adopters .

One third of the non-adopters in this study had cognitive impairment (MMSE$\leq$24), and lower cognitive status independently predicted SBT non-adoption. This result is concordant with a previously reported finding that better cognitive function predicts exercise initiation in older adults (Cohen-Mansfield et al., 2010). However, the evidence suggests that SBT may have several benefits for cognitive performance among older adults (Brown, Liu-Ambrose, Tate, & Lord, 2009; Liu-Ambrose et al., 2010). In addition, patients diagnosed with dementia may be able to enhance their mobility and physical functioning (Pitkälä, Savikko, Pöysti, Strandberg, & Laakkonen, 2013) and relieve the cognitive and non-cognitive symptoms of dementia (Olazaran et al., 2010) by engaging in physical exercise. Cognitive decline leads to the inability to perform instrumental activities of daily living (Marshall et al., 2011). In our study, the inability to perform IADLs was associated with SBT non-adoption. Problems performing IADLs, such as difficulties with transportation, are most likely considerable barriers for older adults to take part in training outside the home.

Strengths and limitations

The major strength of this study was the community-based setting. There were as few exclusion criteria as possible, and this study included the oldest participants with several comorbidities to reflect real-life situations. In the GeMS study, the participants underwent a CGA, and their health conditions and medical history were carefully assessed and documented by health care professionals. Objective measures of functional status as well as valid and reliable measures of health determinants were used.

We acknowledge that this study has certain limitations. We found that the weakest participants most in need of the training did not initiate it. Therefore, forms of training other than SBT, including home-based exercises (Ashworth, Chad, Harrison, Reeder, & Marshall, 2005; Liu & Fielding, 2011) and accessible aerobic activities such as walking (Liu & Fielding, 2011), might be needed for the most frail or homebound adults. According to earlier studies, multiple interacting factors determine exercise participation, and these factors have previously been categorized as personal characteristics, program-related factors and environmental factors (King et al., 1992). The present study focused on health-related factors and aspects of physical functioning that affect SBT adoption; behavioral and psychological barriers or motivators were not addressed in this study.

Conclusions

This study has clarified the role of health-related barriers to SBT adoption in community settings. Several health-related factors and aspects of physical functioning may affect SBT adoption. Age, cognitive status and grip strength were independent predictors of participation. In the future, more individually tailored interventions and alternative methods of training will be necessary to overcome these barriers.

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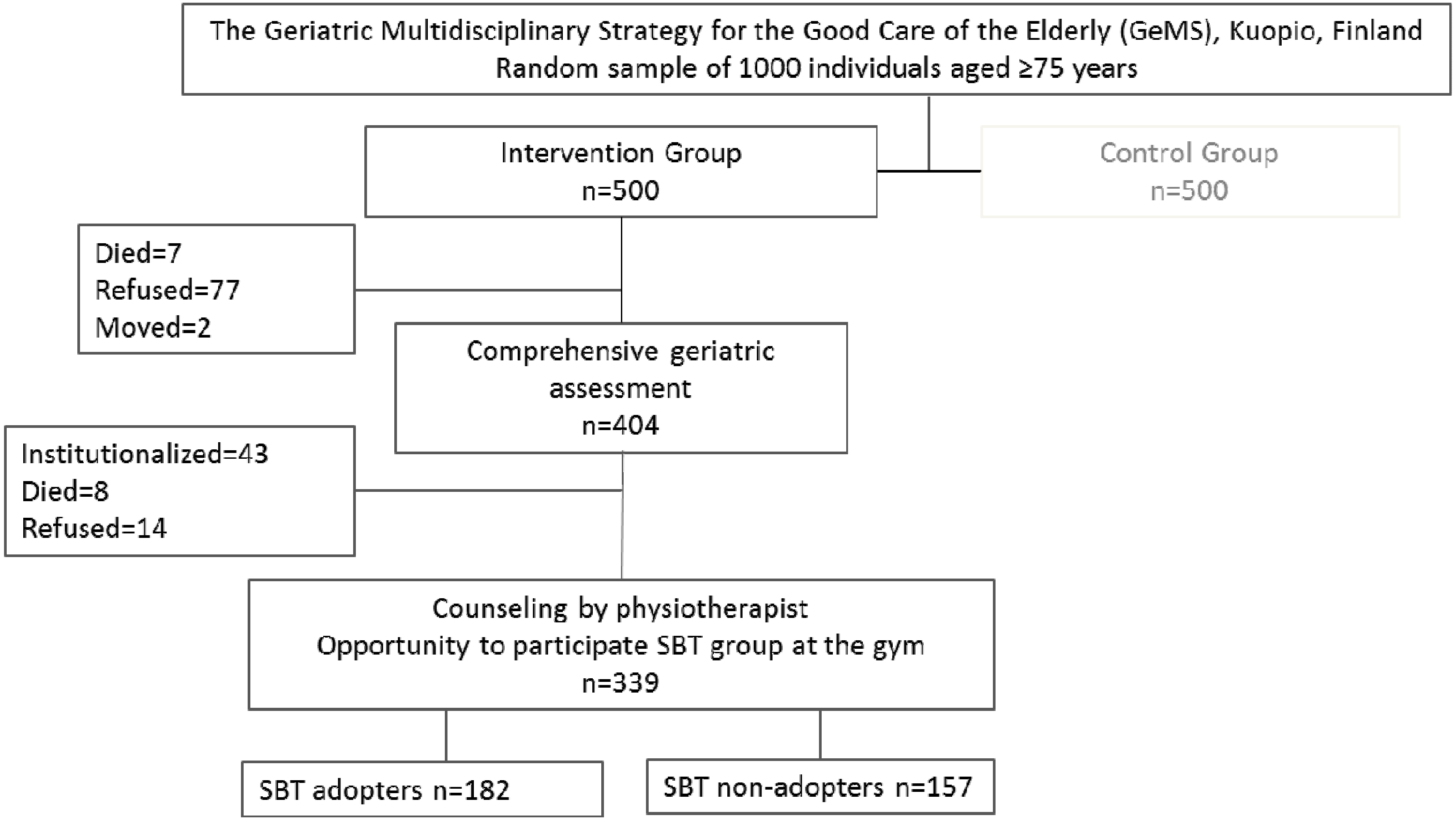

Figure1. Flow chart of the study.

Table 1. Characteristics of the participants by SBT adoption, n=339

Variable	SBT adopters (n=182)		Non-adopters (n=157)		*p*
Demographics					
Female, n (%)	130	(71)	114	(73)	0.810
Age, years, mean (SD)	79.7	(3.9)	82.3	(4.8)	<0.001
Years of education, mean (SD)	7.6	(3.6)	6.5	(2.9)	0.001
Living alone, n (%)	93	(51)	90	(58)	0.250
Health status					
FCI, mean (SD)	2.1	(1.5)	2.6	(1.8)	0.011
Asthma or COPD, n (%)	14	(8)	13	(8)	0.840
Coronary artery disease, n (%)	71	(39)	72	(46)	0.230
Myocardial infarction, n (%)	32	(18)	32	(20)	0.510
Heart failure, n (%)	23	(13)	38	(24)	0.006
Parkinson’s disease, n (%)	4	(2)	5	(3)	0.570
Stroke, n (%)	18	(10)	17	(11)	0.800
Diabetes, n (%)	20	(11)	24	(15)	0.240
GDS-15 ≥5, n (%)	10	(5.6)	10	(6.4)	0.740
BMI, mean (SD)	27.3	(4.0)	26.7	(4.7)	0.220
Sedative load ≥1, n (%)	38	(21)	64	(41)	<0.001
MMSE ≤24, n (%)	18	(10)	55	(35)	<0.001
MNA-SF ≤11, n (%)	13	(7)	28	(18)	0.002
Self-perceived health, n (%)					0.003
Good or very good	79	(43)	72	(46)	
Average	88	(48)	54	(34)	
Poor or very poor	15	(8)	30	(19)	
Physical functioning					
IADLS, mean (SD)	7.2	(1.4)	6.1	(2.1)	<0.001
TUG (s), mean (SD)	11.5	(5.7)	16.0	(11.2)	<0.001
BBS, mean (SD)	50	(6.9)	46	(10.2)	<0.001
Grip strength (kg), mean (SD)					
Women	21	(5.3)	16	(7.4)	<0.001
Men	35	(9.9)	31	(6.9)	0.025
Unable to walk 400 m independently	4	(2)	21	(13)	<0.001
Use of walking aid, n (%)	39	(21)	62	(39)	<0.001
Grimby physical activity score, n (%)					0.009
Low	51	(28)	67	(43)	
Moderate	93	(51)	69	(44)	
High	38	(21)	20	(13)	

Note: FCI=Functional Comorbidity Index; MMSE=Mini Mental Scale Examination; MNS-SF=Mini Nutritional Assessment; IADLS=Instrumental Activities of Daily Living Scale; TUG=Timed Up and Go, BBS=Berg Balance Scale

Table 2. Factors associated with non-adoption of SBT, n=339

	Bivariate*	Multivariate
Characteristic	Odds Ratio (95% Confidence Interval)	
Female	0.95 (0.58-1.57)	0.93 (0.53-1.61)
Age	1.15 (1.09-1.22)	1.08 (1.02-1.15)
Years of education	0.92 (0.85-0.99)	
Functional Comorbidity Index	1.15 (1.00-1.32)	
Sedative load ≥1	2.16 (1.31-3.57)	1.66 (0.96-2.88)
MMSE	0.82 (0.76-0.89)	0.86 (0.79-0.94)
Self-perceived health		
Good or very good	1	
Average	0.71 (0.44-3.98)	
Poor or very poor	1.94 (0.94-3.98)	
MNA-SF ≤11	2.84 (1.42-5.71)	2.09 (0.97-2.88)
IADLS	0.74 (0.64-0.85)	0.90 (0.76-1.07)
Use of a walking aid	1.67 (0.99-2.81)	
BBS	0.96 (0.93-0.99)	
TUG	1.06 (1.02-1.10)	
Grimby physical activity score		
High (4-6)	1	
Moderate (2-3)	1.10 (0.58-2.11)	
Low (0-1)	1.79 (0.90-3.55)	
Grip strength quartile		
4	1	1
3	1.90 (0.98-3.66)	1.59 (0.76-3.32)
2	2.79 (1.42-5.46)	2.48 (1.05-4.50)
1	4.63 (2.30-9.34)	3.28 (1.16-5.74)

*age- and sex-adjusted bivariate odds ratios

Note:
On the MMSE, IADLS and BBS, a higher score represents better performance; FCI=Functional Comorbidity Index; MMSE=Mini Mental Scale Examination; MNS-SF=Mini Nutritional Assessment; IADLS=Instrumental Activities of Daily Living Scale; BBS=Berg Balance Scale; TUG=Timed Up and Go.