Exploring predictors of the five-time sit-to-stand test based on cross-sectional findings from the Swedish National Study on Aging and Care (SNAC)

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Abstract

Background As we age, staying physically active and reducing sedentary behavior becomes crucial. To understand how to achieve this, factors related to daily physical function such as five-time sit-to-stand (STS) time should be explored. This study aimed to investigate the associations between STS time, self-rated physical activity, physical function, health-related quality of life, physical and mental health in community-dwelling older adults aged ≥ 60 years.

Method Cross-sectional design with self-reported and objectively measured data from adults aged ≥ 60 years ($n = 819$), acquired from the Swedish National Study on Aging and Care. Data was analyzed through multiple linear regression.

Results The model ($R^2 = 0.268$) showed that STS time was predicted by grip strength (β' = -0.204, $p < 0.05$), age (β' = 0.202, $p < 0.05$), health-related quality of life (β' = -0.192, $p < 0.05$), having fallen within the preceding twelve months (β' = -0.127, $p < 0.05$), physical activities of perceived light to moderate intensity (β' = -0.121, $p < 0.05$), one-leg stand (β' = -0.099, $p < 0.05$), and education level (β' = -0.092, $p < 0.05$). For STS time, health-related quality of life (β = -0.354, confidence interval [CI] (-0.509)–(-0.199)), having fallen within the preceding twelve months (β = -0.222, CI (-0.365)–(-0.078)), and physical activities of perceived light to moderate intensity (β = -0.166, CI (-0.278)–(-0.053)) were the most prominent predictors.

Conclusion The model highlights the importance of grip strength and health-related quality of life in predicting STS time in older adults. Clinicians can use these insights to develop interventions that maintain physical function by regularly assessing and monitoring these factors. Future research should explore the relationship between fall history, faster STS time, and the impact of grip strength and health-related quality of life on sedentary behavior among older adults.

Keywords Aging, Balance, Physical activity, Physical function, Quality of life, Sedentary behavior, Sit-to-stand

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Background

As we age, physical function declines, making it crucial for older adults to remain as physically active as possible. Furthermore, the importance preserving lower body strength and balance becomes vital measure for older adults health and to increase quality in life [1]. The physical activity recommendations for older adults includes: 150 min of moderate-intensity exercise (brisk walking) weekly, plus strength training and balance exercises [1]. Physical inactivity, defined by WHO [1] as not meeting these recommendations, becomes more common with age. Therefore, incorporating activity into daily routines is essential for optimal health. This is especially important as sedentary behavior naturally increases with age [1, 2].

In Sweden older adults aged 65–84 shows the highest age-related prevalence of sedentary behavior in leisure activities, which increases the risk of physical inactivity [1, 3]. Inactivity raises health problems and mortality risk. However, reducing time spent sitting time can lessen these risks [1]. This emphasizes the need for research that explore underlying structures of sedentary behavior, such as physical function.

The ability to rise independently from a seated position has long been a critical measure of lower body strength and overall physical function in older adults [4]. Inability to rise not only increases the risk of prolonged sitting and inactivity [5], but also reflects a decline in key performance factors like lower limb muscle control and balance [6]. Furthermore, a history of falls, often linked to the inability to stand, is a strong predictor of reduced independence in daily life [7]. Grip strength serves as another important indicator of physical function, acting as a long-established biomarker for overall health in older adults [8].

The debate regarding prolonged sitting among older adults is ongoing, and greater understanding of underlying factors that affect physical function such as the ability to stand up from sitting, is needed [9]. Investigating underlying factors of sit-to-stand time (STS) in older adults could reveal new ways to address sedentary behavior. This, in turn, could provide insights on how to increase physical activity in their daily lives. To our knowledge, there is a lack of research focusing on older adults' STS time as a proxy measure of daily physical activity or sedentary behavior. As the five-time STS test provides a reliable measure for lower body physical function, its connection to the risk of prolonging sitting time becomes interesting. Therefore, this study sought to find predictors associated with STS time in community-dwelling older adults.

Method

Aim

To investigate the associations between STS time, self-rated physical activity, physical function, health-related quality of life, physical and mental health in community-dwelling older adults aged ≥ 60 years.

Study design

Cross-sectional, descriptive research design.

Participants and recruitment procedure

The study population was drawn from participants in the Swedish National Study on Aging and Care (SNAC) conducted at four research centers in Sweden: Malmö, Karlskrona, Stockholm, and Nordanstig [10]. SNAC is a longitudinal study in Sweden investigating aging and care. It follows a representative group of older adults to understand the aging process and how they receive care and services. The participants of SNAC are a representative sample of the Swedish population aged 60, 66, 72, 78, 81, 84, 87, 90, 93, or 96 years at inclusion. The purpose of SNAC is to improve the Swedish care system by providing valuable data for research and policy decisions [10].

The sample included data from three baseline surveys: Cohort 1 (C1) collected in 2003, Cohort 2 (C2) collected in 2009, and Cohort 3 (C3) collected in 2015. All individuals aged 60 years and above were included from each cohort, with unique identification codes used. At the start of C1, participants were aged 60, 66, 72, 78, or 81 years and older. For C2 and C3, new participants aged 60 or 81 years were enrolled. Data from C1-C3 were combined into a single cross-sectional dataset. All participants underwent clinical examinations and physical tests measuring physical function, such as grip strength and STS time, and self-reported health [10].

The present study included a total of 819 community-dwelling older adults aged 60 years and above from the SNAC research center of Blekinge (SNAC-B) (Fig. 1). A total of 16 participants were excluded from the study due to living in a nursing home. The study adhered to the ethical principles outlined in the Declaration of Helsinki [11] and was approved by the ethics committee of Lund University (LU 128–00, LU 604–00). All participants received written information about the SNAC and provided written informed consent before entering the SNAC.

Measures

Outcome

Five-time test of sit-to-stand time (STS) The outcome was STS time as it has shown to be essential for older adults' capability to live independently and is a validated measure for lower body strength [4]. Participants completed five timed attempts to rise from a designated
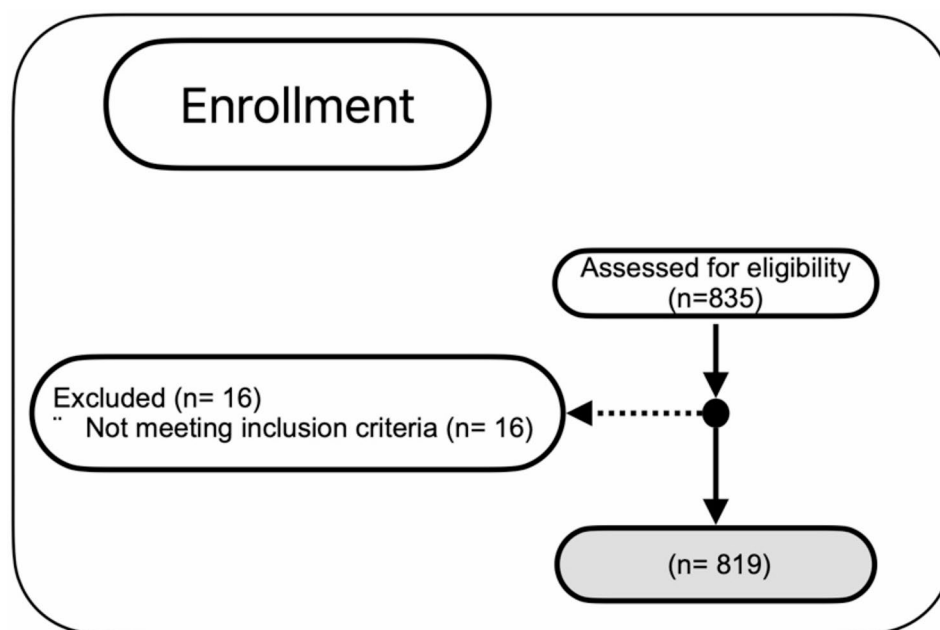
Fig. 1 Enrollment process

chair as quickly as possible, with their completion time recorded in seconds [5]. All participants utilized the same procedure, and materials.

Physical activity and physical function
Following measures were self-rated: Physical activity, Activities of daily living, Having fallen in the preceding twelve months, and Outdoor walking. Whilst GRIPPIT and one-legged stand were objectively measured.

Physical activity Frequency of performance of physical activities of perceived light to moderate intensity and vigorous intensity was categorized as less than once a week (never, once a month, two–three times a month) or at least once a week (at least once a week, every day).

Activities of daily living (KATZ-ADL index) The KATZ-ADL index measures the ability of older adults and chronically ill patients to perform basic tasks without assistance [12]. The index assesses daily activities like hygiene, dressing, and toileting. It uses a 0–2 score (higher = more dependence) and in this study dichotomized to "dependent" (0) or "independent" [1]. This aligns with past Swedish studies on disability using KATZ-ADL index [13].

Having fallen in the preceding twelve months Having fallen in the preceding twelve months was categorized as no (never) or yes (from once to more than four times).

Outdoor walking Outdoor walking was categorized as dependent (using assistive device) or independent (not using any assistive device).

Grip strength The GRIPPIT dynamometer was used to measure grip strength (force in newtons). Both hands was tested and the average results calculated [14].

One-leg stand Participants balanced on one leg (barefoot, eyes open) for up to 60 s (three trials per leg, best time used). This common test measures static balance. This is a well-established and validated measure of static balance [15]. Normative values for people in three age groups (60–69, 70–79, 80+) was based on the findings of Springer, Marin [16].

Health-related measures
EuroQol (EQ-5D) The EQ-5D, a self-reported measure [17], assesses health across five domains and generates a utility score (-0.59 to 1.0) reflecting health-related quality of life (HRQoL). Participants in this study also rated their health on a visual analogue scale (VAS) (0–100, best health = highest score) [17]. EQ-5D analysis used time trade-off values (from UK) with VAS data for Sweden, similar to past studies [18].

Depression The Montgomery-Åsberg Depression Rating Scale (MADRS) is a subscale of the Comprehensive Psychopathological Rating Scale for the rating of depressive symptoms [19]. It includes 10 items and the total MADRS score ranges from 0 to 60, with higher values indicating

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depression. This approach to exploring depression among older adults has been used in previous research [20].

Sense of coherence Sense of coherence (SOC) was assessed with the 13-item version of the SOC questionnaire [21]. The five negatively formulated items were reversed and scored from 13 to 91 (higher = better stress response), and Swedish norm values were used for dichotomization [22].

SF-12 The 12-item short form health survey (SF-12) was used to measure physical and mental health [23]. SF-12's generic design allows it to track health in large populations. Individual item responses were weighted and then combined to create two summary scores (ranged 0-100): one for physical health and one for mental health [23].

Control factors
Age was categorized as 60–69 years, 70–79 years, or ≥ 80 years. Education level was categorized as "Up to complete primary school" (non-completed primary school up to completed primary school) and "Above primary school" (secondary school to graduate school). *Gender* was a dichotomous variable (man or woman), *Living alone* was categorized as no (all answers but living alone) or yes (living alone), *Economy* was dichotomous (not able to cover unexpected expenses of 14,000 Swedish krona (SEK) within a week or able to cover unexpected expenses of 14,000 SEK within a week).

Grip strength, HRQoL, MADRS, and EQ-5D were dichotomized as low (first quartile) or high (second–fourth quartile) in the descriptive part of the results and used in the continuous form in the multiple linear regression.

Statistical analysis
Descriptive statistics for personal characteristics, and STS time were presented as frequencies and percentages for categorical variables. The chi-squared test were used to compare data on distribution of personal characteristics and STS time between groups [24]. In the crude analysis, we examined the bivariate association between STS time and the predictors using simple linear regression.

A multiple linear regression model including all variables utilizing backward elimination procedure was conducted. STS time acted as the outcome, and grip strength, age, health-related quality of life, having fallen within the preceding twelve months, physical activities of perceived light to moderate intensity, and education as significantly associated predictors. The model's squared dependent variable resulted in normally distributed residuals, no heteroscedasticity, and low collinearity (all variance inflation factors were approximately 1). Block-wise linear regression was performed to assess the individual contribution of each predictor. The magnitude of the change in R-squared was used to assess the individual contribution of each predictor to the model, thereby providing insights into their relative importance [25]. The outcome of the regression model is presented with β, β', confidence interval (CI), p value, and R^2, as recommended for statistical interpretation [24, 25]. To emphasize both clinical and scientific impacts, unstandardized and standardized betas were analyzed. All tests were two-tailed with a significance level set at $p = 0.05$. Data were processed using IBM® SPSS® version 28.0.

Result
The participants included 451 women (median age 72 years, range 36) and 368 men (median age 72 years, range 36). As shown in Table 1, the mean time of STS time was 11.9 s (standard deviation (SD) 4.2), with males being faster (11.2 s, SD 4.0) than females (12.5 s, SD 4.4). As regards age groups, 60–69-year-olds had the fastest STS time (10.0 s, SD 3.3), 70–79-year-olds were in the middle (12.2 s, SD 3.8), and participants aged 80 years and above had the slowest STS time (14.1 s, SD 4.8) (Table 1). A high value on grip strength, health-related quality of life (EQ-5D) physical health (SF-12), or mental health (SF-12), correlated with faster STS time. Whilst a low value on depression (MADRS) correlated with faster STS time. Among the participants, 76% were engaged in weekly physical activity of perceived light to moderate intensity, 54% engaged in weekly physical activity of perceived vigorous intensity. A share of 77% was independent in KATZ ADL index, 69% reached the age-related time limit for the one-leg stand, nearly 78% were able to walk outdoors independently and for 80% of the participants no falls had occurred in the last twelve months. (Table 1). More than 92% of the participants were able to cover unexpected expenses of 14,000 SEK within a week, 68% lived with someone, 65% had completed at least secondary school and 40% reached the age-related Swedish norm value indicating SOC.

Crude analysis of predictors
In the crude analysis (Table 2), positive associations were found between STS time and age (β = 0.028), having fallen within the preceding twelve months (β = 0.027), gender (β = 0.199), living alone (β = 0.183), comprehensive psychopathological rating scale (β = 0.027), and physical health (β = 0.028). Negative associations was found between STS time and education (β = -0.216), physical activity of perceived light to moderate intensity (β = -0.276), physical activity of perceived vigorous intensity (β = -0.232), health-related quality of life (β = -0.591), one-leg stand (β = -0.008), grip strength (β = -0.002), economy (β = -0.078), outdoor walking (β = -0.560),

Table 1 Sample characteristics and distribution of the results of STS time in seconds

	N	%	STS time (s, mean)	Standard deviation	P^a
Age (years)	819	31.3	10.0	3.3	**< 0.001**
70–79	256	34.1	12.2	3.8	
≥ 80	279	34.7	14.1	4.8	
60–69	284				
Gender	819	44.9	11.2	4.0	**< 0.001**
Man	368	55.1	12.5	4.4	
Woman	451				
Can you within a week cover unexpected expenses of 14,000 SEK?	653	7.8	12.5	4.7	0.883
No	51	92.2	11.8	4.2	
Yes	602				
Living alone	653	68.3	11.5	4.2	**< 0.001**
No	446	31.7	12.7	4.0	
Yes	207				
Education	819	34.2	13.2	4.2	**< 0.001**
Primary school, left at age < 13 yrs.	258	13.2	11.4	4.0	
Secondary school, left at age 14–16 yrs.	100	30.5	11.9	4.2	
Upper secondary or vocational school, left at age 18–19 yrs.	230	22.1	10.9	4.1	
University	167				
Outdoor walking	818	21.6	15.6	4.8	**< 0.001**
Dependent	177	78.4	11.5	4.0	
Independent	641				
Having fallen within preceding twelve months	800	80.2	11.9	4.2	0.329
No.	642	19.8	12.0	4.2	
Yes.	158				
Physical activities of perceived light to moderate intensity	653	29.3	13.4	4.9	**< 0.001**
< Once a week	158	75.8	11.4	3.9	
≥ Once a week	495				
Physical activities of perceived vigorous intensity	650	46.0	12.4	4.3	**< 0.001**
< Once a week	299	54.0	10.8	3.8	
≥ Once a week	351				
KATZ ADL index	812	23.3	13.1	3.7	**< 0.001**
Dependent	189	76.7	11.7	4.3	
Independent	623				
Grip strength [b]	702	25.0	14.6	4.4	**< 0.001**
Low	176	75.0	10.9	3.6	
High	526				
One-leg stand	586	30.7	12.2	3.7	**0.007**
Not meeting age-related norm value	180	69.3	11.1	3.8	
Meeting age-related norm value	406				
Sense of coherence	638	59.7	12.0	4.2	**< 0.001**
< Swedish norm value	381	40.3	11.8	4.1	
≥ Swedish norm value	257				
Health-related quality of life (EQ-5D) [b]	650	25.0	13.4	4.7	**< 0.001**
Low	169	75.0	11.2	3.8	
High	481				
Physical health (SF-12) [b]	634	25.0	11.7	4.0	0.766
Low	158	75.0	12.0	4.3	
High	476				
Mental health (SF-12) [b]	634	25.0	13.0	4.4	**0.012**
Low	158	75.0	11.5	4.1	
High	476				
Depression (MADRS) [b]	654	25.0	10.8	3.3	**< 0.001**
Low	242	75.0	11.8	4.4	
High	520				
Tot	819[c]	100[c]	11.9	4.2	

[a] p for the differences between groups as calculated with the chi-squared test

[b] Linear variable with quartile range (≤ 25 and > 25)

[c] Total numbers may not be equal to 819 and 100% due to missing data for some variables

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Table 2 Crude and adjusted analysis

	Crude analysis				Adjusted analysis [a]				
	β	β′	CI 95%	p	β	β′	CI 95%	p	R^2
Variable									< 0.001
Age	0.028	0.417	0.985 – 1.679	**< 0.001**	0.014	0.202	0.007 – 0.021	**< 0.001**	0.072
Education	-0.216	-0.201	(-0.362) – (-0.161)	**< 0.001**	-0.114	-0.092	(-0.217) – (-0.011)	**0.031**	0.010
Physical activities of perceived light to moderate intensity.	-0.276	-0.195	(-0.390) – (-0.163)	**< 0.001**	-0.166	-0.121	(-0.278) – (-0.053)	**0.004**	0.013
Having fallen in preceding twelve months	0.027	0.016	(-0.100) – 0.154	0.680	-0.222	-0.127	(-0.365) – (-0.078)	**0.002**	0.011
Health-related quality of life (EQ-5D)	-0.591	-0.321	(-0.734) – (-0.448)	**< 0.001**	-0.354	-0.192	(-0.509) – (-0.199)	**< 0.001**	0.028
One-leg stand	-0.008	-0.337	(-0.009) – (-0.006)	**< 0.001**	-0.002	-0.099	(-0.010) – (-0.001)	**0.048**	0.007
Grip strength	-0.002	-0.375	(-0.003) – (-0.002)	**< 0.001**	-0.001	-0.204	(-0.002) – (-0.001)	**< 0.001**	0.120
Gender	0.199	0.170	0.111 – 0.288	**< 0.001**					
Economy	-0.078	-0.033	(-0.271) – 0.115	0.426					
Living alone	0.183	0.142	0.078 – 0.288	**< 0.001**					
Outdoor walking	-0.560	-0.278	(-0.707) – (-0.412)	**< 0.001**					
Physical activities of perceived vigorous intensity	-0.232	-0.187	(-0.332) – (-0.132)	**< 0.001**					
KATZ-ADL index	-0.223	-0.136	(-0.384) – (-0.098)	**< 0.001**					
Sense of coherence	-0.021	-0.018	(-0.120) – 0.077	0.669					
Physical health (SF-12)	0.028	0.238	0.018 – 0.037	**< 0.001**					
Mental health (SF-12)	-0.021	-0.190	(-0.030) – (-0.012)	**< 0.001**					
Depression (MADRS)	0.027	0.164	0.014 – 0.039	**< 0.001**					
Total variance explained (R^2)									0.268

[a] Only variables significantly associated with the outcome are presented. Variables are listed as selected during the backward elimination procedure in the multiple linear regression analysis

[b] The square of the dependent variable "STS" is shown

Reference values: Education (0 = below secondary school, 1 = secondary school or more), Physical activities of perceived light to moderate intensity (0 = less than weekly engagement, 1 = weekly engagement), Having fallen in preceding twelve months (0 = no, 1 = yes), Gender (0 = man, 1 = woman), Economy (0 = not able to cover unexpected expenses of 14,000 SEK within a week, 1 = able to cover unexpected expenses of 14,000 SEK within a week), Living alone (0 = no, 1 = yes), outdoor walking (0 = dependent, 1 = independent), Physical activities of perceived vigorous intensity (0 = at least weekly engagement, 1 = weekly engagement), Capacity for activities of daily living (0 = dependent, 1 = independent)

capacity for activities of daily living (β = -0.223), sense of coherence (β = -0.021), and mental health (β = -0.021).

Adjusted analysis of predictors

In the adjusted analysis (Table 2), the model explained 26.8% of the variance in STS time. Out of the seven predictors explained by β′, grip strength (β′ = -0.204; R^2 = 12.0%), age (β′ = 0.202; R^2 = 7.2%), and health-related quality of life (β′ = -0.192; R^2 = 2.8%) explained STS time to the greatest degree.

Out of the seven predictors explained by β, health-related quality of life (β = -0.354, CI (-0.509)–(-0.199)), having fallen in the preceding twelve months (β = -0.222, CI (-0.365)–(-0.078)), and physical activities of perceived light to moderate intensity (β = -0.166, CI (-0.278)–(-0.053)) were most prominent in the model (Table 2).

Discussion

With the aim to investigate the associations between STS time, self-rated physical activity, physical function, health-related quality of life, physical and mental health in community-dwelling older adults aged ≥ 60 years, we found predictors explaining 26.8% of the variance and the most impactful predictors. Our findings show that grip strength, age, and health-related quality of life were the most dominant predictors in explaining the variance in STS time. Furthermore, when considering the predictors that most strongly influenced the actual STS time, health-related quality of life, a history of falls in the preceding twelve months, and physical activity of perceived light to moderate intensity were the most distinguished.

In this study, the complex process of aging emerges as an interesting predictor of STS time. In short, as we get older, it takes a longer time to rise from sitting. This can be understood by the associations between aging and

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decline in physical function, with age-related sarcopenia being one contributing factor [8].

Grip strength has in previous research been shown to be a reliable indicator of overall physical function and health [8]. In our study, greater grip strength predicted faster STS time, which aligns with previous research regarding its relation to the physical function needed to independently stand up from a seated position [8]. Having the ability to stand on one leg is also a strong indicator of the physical function needed to independently stand up from a seated position [15]. Our study confirms that longer duration of one-leg balance predicts a faster STS time, as expected and supported by prior research on balance and physical function in older adults [15].

Health-related quality of life was used to identify how older adults' self-rated quality of life was weighted against a health-economy perspective. Overall high physical and mental health and quality of life have in previous research been found to be related to being more physically active and having greater physical function [5]. Our findings align with these studies, as a higher health-related quality of life predicted a shorter STS time.

People who reported more light to moderate physical activity had faster STS times in our study. This matches other research showing physical activity improves strength and rising ability [26].

A history of falling have been associated with slower STS time [7]. Our study found a surprising result: prior falls associated to faster STS time. This might be because we only considered those who had not fallen vs. those who had. A single fall might not trigger fear in older adults, which is important to bear in mind since fear of falling have shown association with lower levels of daily physical activity among older adults [27, 28]. In other words, physical activity could cause, and prevent falls. This paradox of physical activity as both a protective factor and a risk factor for falls is nothing new [29]. However, our finding adds important notes regarding the assumption that older adults who have fallen also tend to be more physically functional.

Strengths and limitations
Design
This investigation centers on the analysis of data procured from the SNAC. Leveraging existing data is a significant advantage in terms of efficiency. The SNAC used rigorous methodologies, resulting in high-quality and dependable data [10]. This reduces concerns about potential biases or inconsistencies that might have arisen during primary data collection [30]. Pre-existing data may not perfectly align with every research goals and might have biases. Careful data extraction, expert consultation, and critical evaluation of biases helped ensure robust analysis. Self-reported data, such as HRQoL, may be underreported,

but we addressed this limitation by repeatedly discussing possible outcomes and variations. A critical evaluation of these potential biases were conducted and was crucial to ensure the robustness of our analysis [30]. Lastly, the data might not reflect the most recent trends or developments, as they were taken from a longitudinal aging study. Therefore, the variables underwent a thorough review by the research team before being analyzed, with great emphasis put on the context of the data collection period in relation to the research question.

This study benefits from a robust population-based design, employing a large and nationally representative sample of older adults. This approach enhances the generalizability of the findings to the broader population [30].

Variables
The primary outcome was STS time, a validated objective measure for identifying obstacles in physical function based on the time it takes to stand up from sitting [4]. However, it is important to highlight that physical function is more than just this one measure, and that the gold standard for assessing physical function and physical activity in older adults is under constant development [31].

As shown in Table 1 the variables Can you within a week cover unexpected expenses of 14,000 SEK? Living alone, Physical activities of perceived light to moderate intensity, Physical activities of perceived vigorous intensity, Sense of coherence, Health-related quality of life, Physical health, Mental health, Comprehensive psychiatric scale, One-leg stand, and Grip strength all had missing values ranging between 14% and 22%. Contact was made with the database manager of SNAC-B to ensure that no erroneously processed data were used in this study.

In relation to previous falls, it is normal to include fear of falling as a variable to assess physical function, but while fear of falling is a potentially significant variable, it is not currently included in the SNAC data. Furthermore, the analysis could have benefited of including information regarding the location of the fall, such as it occurred inside or outside of the house. While gait (walking speed) was considered due to its strong link to morbidity and sedentary time, it was not available as a variable in the 2013 database, it was first implemented in 2015. Thus, to include more participants, gait was excluded. To improve the analysis of the multiple regression and provide the best fit, STS time counts were squared. Furthermore, 174 older adults were excluded from the multiple regression model to increase fit [24].

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Conclusion

The model of predictors provides a new understanding of STS time among community-dwelling older adults. The association between faster STS time and grip strength offers valuable insights for clinical practitioners regarding the connectivity of lower and upper body strength. Health-related quality of life was a key factor in predicting STS time, with even small changes impacting performance. Therefore, regular assessment and monitoring of grip strength and health-related quality of life in older adults can be beneficial findings for clinical practitioners developing interventions that aim to maintain physical function among older adults. Future research should investigate the detailed association between fall history and faster STS time, and explore how grip strength and health-related quality of life impact sedentary behavior among older adults.

Abbreviations

β	Unstandardized regression coefficient
β′	Standardized regression coefficient
CI	Confidence interval
EQ-5D	EuroQol
HRQoL	Health-related quality of life
MADRS	Montgomery-Åsberg Depression Rating Scale
p	p value
R^2	Coefficient of determination for variance in linear regression model
SD	Standard deviation
SEK	Swedish Krona
SNAC	Swedish National Study on Aging and Care
SOC	Sense of coherence
STS	Sit-to-stand
VAS	Visual analogue scale

Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to European governing laws and agreements between participants and the research group regarding data management. These datasets are archived with the Department of Health at Blekinge Institute of Technology (BTH), Sweden. However, they are available from the authors upon reasonable request and with permission from the Department of Health at BTH.

Declarations

Ethics approval and consent to participate
The study adhered to the ethical principles outlined in the Declaration of Helsinki [11] and was approved by the ethics committee of Lund University (LU 128–00, LU 604–00). All participants provided written informed consent before entering the SNAC and received written information. Personal data were processed in accordance with the General Data Protection Regulation [32]. In connection with the survey, the participants received written information and gave written informed consent for participation.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

References
1. WHO. WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; 2020 2020.
2. Mo Y, Zhou Y, Chan H, Evans C, Maddocks M. The association between sedentary behaviour and sarcopenia in older adults: a systematic review and meta-analysis. BMC Geriatr. 2023;23(1).
3. Ericsson L, Wemrell M, Lindström M, Perez-Vicente R, Merlo J. Revisiting socio-economic inequalities in sedentary leisure time in Sweden: an intersectional analysis of individual heterogeneity and discriminatory accuracy (AIHDA). Scand J Public Health. 2023;51(4):570–8.
4. Van Lummel R, Evers J, Niessen M, Beek P, Van Dieën J. Older adults with weaker muscle strength stand up from a sitting position with more dynamic trunk use. Sensors. 2018;18(4):1235.
5. Da Silva GO, Santini LB, Farah BQ, Germano-Soares AH, Correia MA, Ritti-Dias RM. Effects of breaking up prolonged sitting on Cardiovascular parameters: a systematic review. Int J Sports Med. 2022;43(02):97–106.
6. Muñoz-Bermejo L, Adsuar JC, Mendoza-Muñoz M, Barrios-Fernández S, Garcia-Gordillo MA, Pérez-Gómez J, et al. Test-Retest Reliability of Five Times sit to stand test (FTSST) in adults: a systematic review and Meta-analysis. Biology. 2021;10(6):510.
7. Alosaimi RM, Almegbas NR, Almutairi GR, Alqahtani MA, Batook SG, Alfageh IA, et al. The five Times sit-to-stand test is associated with both history of falls and fear of falling among community adults aged 50 years and older. Ir J Med Sci. 2023;192(5):2533–40. (1971 -).
8. Bohannon RW. Grip strength: an indispensable biomarker for older adults. Clin Interv Aging. 2019;14:1681–91.
9. Lachman ME, Lipsitz L, Lubben J, Castaneda-Sceppa C, Jette AM. When adults don't Exercise: behavioral strategies to increase physical activity in sedentary middle-aged and older adults. Innov Aging. 2018;2(1).
10. Lagergren M, Fratiglioni L, Hallberg IR, Berglund J, Elmståhl S, Hagberg B, et al. A longitudinal study integrating population, care and social services data. The Swedish National study on aging and care (SNAC). Aging Clin Exp Res. 2004;16(2):158–68.
11. WMA. World medical association declaration of helsinki – ethical principles for medical research involving human subjects. Fortaleza, Brazil: WMA General Assembly; 2013.
12. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged: the Index of ADL: a standardized measure of biological and psychosocial function. JAMA. 1963;185(12):914–9.
13. Sjölund B-M, Wimo A, Engström M, Von Strauss E. Incidence of ADL disability in older persons, physical activities as a protective factor and the need for Informal and formal care – results from the SNAC-N Project. PLoS ONE. 2015;10(9):e0138901.
14. Hagel S, Lindqvist E, Petersson I, Nilsson J, Bremander A. Validation of outcome measurement instruments used in a multidisciplinary rehabilitation intervention for patients with chronic inflammatory arthritis: linking of the International Classification of Functioning, disability and health, construct validity a. J Rehabil Med. 2011;43(5):411–9.
15. Khanal P, Williams AG, He L, Stebbings GK, Onambele-Pearson GL, Thomis M, et al. Sarcopenia, obesity, and sarcopenic obesity: relationship with skeletal muscle phenotypes and single nucleotide polymorphisms. J Clin Med. 2021;10(21):4933.
16. Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the Unipedal stance test with eyes open and closed. J Geriatr Phys Ther. 2007;30(1).

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17. Bowling A. Measuring health: a review of subjective health, well-being and quality of life measurement scales. London: McGraw-Hill Education/Open Univiversity; 2017.
18. Christiansen L, Sanmartin Berglund J, Lindberg C, Anderberg P, Skär L. Health-related quality of life and related factors among a sample of older people with cognitive impairment. Nurs Open. 2019;6(3):849–59.
19. Montgomery SA, Åsberg M. A New Depression Scale designed to be sensitive to change. Br J Psychiatry. 1979;134(4):382–9.
20. Sjöberg L, Karlsson B, Atti A-R, Skoog I, Fratiglioni L, Wang H-X. Prevalence of depression: comparisons of different depression definitions in population-based samples of older adults. J Affect Disord. 2017;221:123–31.
21. Antonovsky A. The structure and properties of the sense of coherence scale. Soc Sci Med. 1993;36(6):725–33.
22. Langius A, Björvell H. Coping ability and functional status in a Swedish population sample. Scand J Caring Sci. 1993;7(1):3–10.
23. Ware JE, Kosinski M, Keller SD. A 12-Item short-form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care. 1996;34(3):220–33.
24. Field AP. Discovering statistics using IBM SPSS statistics. London: Sage; 2018.
25. Alexopoulos EC. Introduction to multivariate regression analysis. Hippokratia. 2010;14(Suppl 1):23–8.
26. Ramsey KA, Rojer AGM, D'Andrea L, Otten RHJ, Heymans MW, Trappenburg MC, et al. The association of objectively measured physical activity and sedentary behavior with skeletal muscle strength and muscle power in older adults: a systematic review and meta-analysis. Ageing Res Rev. 2021;67:101266.
27. Niklasson J, Fagerström C, Backåberg S, Lindberg T, Bergman P. Daily activity patterns in older adults receiving initial support: the association between daily steps and sitting in bouts of at least 60 min. BMC Geriatr. 2024;24(1).
28. Liu M, Hou T, Li Y, Sun X, Szanton SL, Clemson L et al. Fear of falling is as important as multiple previous falls in terms of limiting daily activities: a longitudinal study. BMC Geriatr. 2021;21(1).
29. Van Gameren M, Hoogendijk EO, Van Schoor NM, Bossen D, Visser B, Bosmans JE et al. Physical activity as a risk or protective factor for falls and fall-related fractures in non-frail and frail older adults: a longitudinal study. BMC Geriatr. 2022;22(1).
30. Polit DF, Beck CT. Generalization in quantitative and qualitative research: myths and strategies. Int J Nurs Stud. 2010;47(11):1451–8.
31. Lincke A, Fagerström C, Ekstedt M, Löwe W, Backåberg S. Skeleton avatar technology as a way to measure physical activity in healthy older adults. Inf Med Unlocked. 2021;24:100609.
32. Regulation. Regulation (EU) 2016/679 of the European parliment and of the council. Official J Eur Union. 2016;L 119(1):88.

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