Journal of Geriatric Physical Therapy

Can physical activity make up for the self-care disability effects of too much sitting? A moderation analysis in octogenarians residing in living care facilities

--Manuscript Draft--

Manuscript Number:	JGPT-D-21-00007R6
Article Type:	Simple Article
Keywords:	sedentary time, moderate-to-vigorous physical activity, replacement, self-care disability, nursing home
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Manuscript Region of Origin:	SPAIN
Abstract:	Objectives : Physical activity can delay the progression of self-care disability in older adults residing in living care facilities. Nonetheless, older adults residing in living care facilities, spend most of their time sedentary and do not meet the physical activity recommendation, which may result in increasing self-care disability in this population group. In this study, we aimed to determine whether the association between sedentary time and self-care disability was moderated by moderate-to-vigorous physical activity (MVPA) in older adults residing in living care facilities. Methods : Sedentary time and MVPA were both measured with accelerometers. Self-care disability was assessed with the Barthel Index. A multivariate regression model was used to ascertain the effects of the interaction between sedentary time and MVPA on the self-care disability of participants. The Johnson-Neyman technique was then used to estimate the exact MVPA threshold at which the effect of sedentary time on self-care disability became non-significant. Results : We found a significant effect of sedentary time on self-care disability (Standardized β = -1.66; 95% CI -1.77 to -1.54, P = 0.013). Results indicated that MVPA moderates the relationship between self-care disability status and sedentary time (Standardized β = 1.14; 95% CI 1.13 to 1.14, P = 0.032). The Johnson-Neyman technique determined that 51 min/day of MVPA would offset the negative effects of sedentary time on self-care disability. Conclusions : Our results suggest physical therapists should focus on reducing sedentary time alongside physical activity in order to prevent the progression to dependency in octogenarians residing in living care facilities.

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February 1, 2021

Dear Editor,

Please find attached the manuscript entitled "Can physical activity make up for the self-care disability effects of too much sitting? A moderation analysis in octogenarians residing in living care facilities for consideration in Journal of Geriatric Physical Therapy.

For the first time, we have applied the Johnson-Neyman technique and moderation analysis to determine whether or not and to what extent the association between sedentary time and self-care disability was moderated by moderate-to-vigorous physical activity in older adults 85+ living in nursing home facilities. We used data from more than 100 older people assessed with accelerometers. This represents a unique dataset. We estimated that 51 minutes per day of moderate-to-vigorous physical activity counterbalanced the negatives consequences of sedentary behaviour on self-care disability in the population under study.

Our findings are important and future-policy relevant: these results underscore the importance of engaging in physical activity while also reducing sedentary behaviour to reduce the self-care disability of older people living in long-term care facilities, particularly given that 51 min/day of MVPA is largely unfeasible.

We will also take this opportunity to state that this is an original piece of research that has never been submitted elsewhere. We hope that you consider this submission positively and look forward to hearing from you in due course.

We thank the Editor´s Review for the insightful comments and suggestions.

This manuscript has been thoroughly reviewed by a native English speaker with experience in scientific writing. We have further use the editorial comments to strengthen our manuscript. Thank you.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4*
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	6
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6

		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6
Discussion			
Key results	18	Summarise key results with reference to study objectives	6,7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Can physical activity make up for the self-care disability effects of too much sitting? A moderation analysis in octogenarians residing in living care facilities

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Can physical activity make up for the self-care disability effects of too much sitting? A moderation analysis in octogenarians residing in living care facilities

ABSTRACT:

Objectives: Physical activity can delay the progression of self-care disability in older adults residing in living care facilities. Nonetheless, older adults residing in living care facilities, spend most of their time sedentary and do not meet the physical activity recommendation, which may result in increasing self-care disability in this population group. In this study, we aimed to determine whether the association between sedentary time and self-care disability was moderated by moderate-to-vigorous physical activity (MVPA) in older adults residing in living care facilities.

Methods: Sedentary time and MVPA were both measured with accelerometers. Self-care disability was assessed with the Barthel Index. A multivariate regression model was used to ascertain the effects of the interaction between sedentary time and MVPA on the self-care disability of participants. The Johnson-Neyman technique was then used to estimate the exact MVPA threshold at which the effect of sedentary time on self-care disability became non-significant.

Results: We found a significant effect of sedentary time on self-care disability (Standardized β = -1.66; 95% CI -1.77 to -1.54, *P* = 0.013). Results indicated that MVPA moderates the relationship between self-care disability status and sedentary time (Standardized β = 1.14; 95% CI 1.13 to 1.14, *P* = 0.032). The Johnson-Neyman technique determined that 51 min/day of MVPA would offset the negative effects of sedentary time on self-care disability.

Conclusions: Our results suggest physical therapists should focus on reducing sedentary time alongside physical activity in order to prevent the progression to dependency in octogenarians residing in living care facilities.

Keywords: sedentary time, moderate-to-vigorous physical activity, replacement, self-care disability, nursing home

INTRODUCTION

Self-care disability is a physical dependency on others to conduct basic daily activities, such as going to the toilet, showering, eating, dressing, transfers, or ambulation.[1] Self-care disability reduces the quality of life of residents and places considerable constraints on healthcare professionals and is associated with substantial economic burden.[2] Investigating effective interventions to delay or even reverse the progression of self-care disability in this population group is critical to guide efficient clinical care and ongoing research in living care facilities.[3]

The benefits of physical activity, particularly of moderate-to-vigorous physical activity (MVPA, defined as activities that result in an energy expenditure of at least 3 METs per min) are well established. Public health guidelines recommend older adults engage in at least 150 min/week of MVPA each week.[4] Previous experimental research suggested that MVPA is beneficial for improving the physical functioning of older adults residing in living care facilities.[5] Other studies have also acknowledged the benefits of MVPA to prevent self-care disability in community-dwelling older adults.[6]

A growing body of evidence suggests that too much time spent in sedentary behaviors (defined as any waking behavior characterized by an energy expenditure ≤1.5 METs while in a sitting, reclining or lying posture) may negatively influence the wider health of individuals, independent of MVPA [7,8]. Recent evidence also suggests that time spent sedentary may compromise the ability to perform daily activities in older adults, independent of the amount of physical activity. For example, Dunlop et al.[9] reported in a nationally representative US sample assessed with accelerometers, that self-care disability was associated with time spent sedentary, independent of the time spent in MVPA. Sedentary behaviour has also associated

with an increase in self-care disability in a large sample of participants (n = 49,612) in the Women's Health Initiative.[10]

Beyond these associations, a number of studies have suggested that engaging in MVPA may offset the consequences of too much sitting for a number of outcomes including cognitive functioning,[11] frailty,[12] or even prevention of early mortality.[13,14] Whether physical activity can ameliorate or even eliminate the consequences of sedentary time for older adults who are self-care dependent and residing in living care facilities remains unknown. Given that most of the time spent in living care facilities is made up of sedentary activities, an estimation of the amount of physical activity required to overcome the negative effects of time spent in these activities could be informative for developing interventions aimed at preventing the progression to self-care disability in this population group. Therefore, this study aimed to determine whether or not, and to what extent the detrimental effects of sedentary time on self-care disability were moderated by MVPA in a sample of older adults residing in living care facilities.

METHODS

Study design and participants

This observational study considered data from 122 older adults (84 female, 68.85%) assessed between April 2016 and December 2018. Volunteers for this study came from 4 different living care facilities in Spain and Portugal. Participants were excluded if they were younger than 80 years,[15] had a pacemaker or were on hospice care. Other exclusionary criteria were medical or issues that would it difficult for participants to engage in physical activity, including total hearing loss and diagnosis of severe dementia. Totally dependent

older adults (Barthel Index <20) [16] were also excluded. Ultimately, the medical staff from the living care facilities checked the inclusion/exclusion criteria and approved the participant's enrollment in the study. The study was approved by the Ethics Committee of the University of xxxxx and xxx (ref.xxxx) and was conducted in accordance with the declaration of Helsinki. All participants signed an informed consent form prior to enrollment in the study.

Variables

***Self-care disability*.** The Barthel Index [16] was used in this study to assess self-care disability and dependency. The Barthel Index has demonstrated to be reliable[17] (ICC 0.936) and valid[18] (0.67) in people residing in living care facilities. The Barthel Index assessed different activities of daily living including going to the toilet, showering, eating, dressing, continence, transfers, and ambulation. Each dimension is scored based on whether they require physical assistance to perform the task or can complete the task independently. Items are graded according to the professional judgment of the assessors. A person scoring 0 points would be dependent in all assessed activities of daily living, whereas a score of 100 would reflect independence in these activities.

Physical activity and sedentary behavior. Physical activity and sedentary behavior were assessed during 7 consecutive days by accelerometry (ActiGraph wGT3X-BT; ActiGraph, LLC, Pensacola, FL). Accelerometry has been demonstrated to a reliable (ICC>0.80) and valid method to assess ambulatory physical activity and sedentary behaviour in older adults[19]. All participants wore the accelerometer on their hip, except while bathing or swimming. Accelerometers were set to sample in 1-minute epochs. Non-wear time was defined as 60 consecutive minutes or longer of zero-intensity counts, with no more than 2 minutes of tolerance.[20] A valid day was defined as having 600 min or more wear time. Data was only valid

if participants had at least four valid days[21–23]. Following Migueles et al[24] recommendations, the vector magnitude was used to calculate time spent in each activity intensity band. The intensity threshold for sedentary time was <200 cpm, whereas MVPA was defined as ≥2114 cpm[24]. The values were averaged over the number of valid days to derive an estimate of the mean time (in minutes) spent in sedentary time and MVPA per day.

Covariates. Age and sex were self-reported. Height was measured to the nearest centimetre using a stadiometer (SECA 711 Scales, Hamburg, Germany), and weight was measured with a SECA precision scale (SECA 711 Scales, Hamburg, Germany). Individuals removed their shoes, socks, and heavy clothes prior to being weighed. Body mass index was calculated as weight (in kilograms) divided by height (in meters) squared.

Statistical analysis

All analyses were conducted using R (version 3.5.2). The alpha level was set at 0.05, two-tailed. The explanation between sedentary time and self-care disability was ascertained with a multiple linear regression. The moderation hypothesis was tested by including an interaction term of sedentary time x MVPA as a predictor of self-care disability. We used the Johnson-Neyman technique to estimate the statistical MVPA threshold from which the relationship between sedentary time and self-care disability ceased to be significant. This approach has been successfully used in other similar studies.[12] All models adjusted for age, sex, body mass index, and accelerometer wear time. Additionally, we used the observed probability level, the number of predictors, the observed R2, and the sample size to estimate the post-hoc power of our calculations[25].

RESULTS

The characteristics of the participants are shown in Table 1. Out of the 122 volunteers who initially gave informed consent, 102 (83.60%) had valid accelerometry data, self-care disability data, and were included in the analysis (Figure 1). The mean age of participants included in the analysis was 85 years old and 69.1% (N=84 were women. The Barthel Index scores indicated that the majority of participants had mild self-care disability. On average, participants spent 917 min/day (SD, 189.86; range 474.5 to 1191.69) sedentary, and 23 min/day (SD, 26.55; range 0 to 158.51) engaged in MVPA.

The multivariate regression model revealed a statistically significant relationship between sedentary time and self-care disability in our study sample (Standardized β = -1.66; 95% CI -1.77 to -1.54 [Standard Error = 0.05], *P* = 0.013). The sedentary time × MVPA interaction term contributed uniquely to the model (Standardized β = 1.14; 95% CI 1.13 to 1.14 [Standard Error = 0.05], *P* = 0.032). The Johnson-Neyman technique revealed a significant relationship between sedentary time and self-care disability when MVPA levels fell below 51.8 min/day (7.84% in our study sample). The strength of the inverse relationship decreased as MVPA levels increased (see Figure 2). The current post-hoc power achieved in this study was 0.67.

DISCUSSION

The main finding of our study was that 51 minutes per day of MVPA could theoretically eliminate the negative association between sedentary time and self-care dependency in a sample of older adults residing in living care facilities. Given the cross-sectional nature of our study, establishing causation is not possible. Nonetheless, our findings provide a strong rationale for longitudinal and intervention studies to determine if our hypotheses are true. Should these be confirmed, our observations may suggest that physical therapists should

focus on increasing time spent in MVPA while decreasing time spent sedentary for individuals living in residential facilities.

To the best of our knowledge, this is the first study examining the association between sedentary behavior and self-care disability in older adults residing in living care facilities. Other studies in community-dwelling older adults have consistently reported increases in dependency and self-care disability with greater time spent in sedentary activities.[9,10,26] Our study supports this hypothesis in a sample of older adults residing in living care facilities. A plausible explanation of our findings is that the lack of movement accelerates the decline in cognitive and physical functioning reserves of older adults, which could translate into a reduction in the capacity of performing self-care activities.

The main contribution of this study was the (mathematical) estimation of the amount of MVPA required to eliminate the detrimental association between sedentary time and self-care disability in older adults residing in living care facilities (i.e., 51 min/day). In our sample, 7.84% of the population managed to reach 51 m/day of MVPA. Given the participants experienced equal environmental conditions, it is plausible that these participants had higher fitness levels than their counterparts hence their levels of observed MVPA.

Previous studies have reported the amount of MVPA that individuals are required to do to offset the detrimental consequences of an excessive sedentary behavior. Mañas et al. concluded that 27 min/day of MVPA could eliminate the consequences of sitting time on frailty in a group of 749 community-dwelling older adults[12]. Meeting the recommended level of physical activity was found to effectively eliminate the risk of early mortality in a sample of 149,077 Australian 45 years and above, particularly in those sitting for 8 hours or more.[13]

In a meta-analysis involving 1,005.791 individuals, Ekelund et al.[14] concluded that at least 60-75 min/day of MVPA was necessary to eliminate the (negative) association of sitting time with the risk of premature death. Remarkably, our study found the amount of MVPA needed to offset the negative consequences of sedentary time on self-care disability was more than double the recommended level in public health guidelines (i.e., 150 min/week of MVPA or 22 min/day). Given the study population and self-care disability outcome this finding was not unexpected yet has important implications. First, 51 min/day of MVPA may be challenging for many older adults residing in living care facilities. Both environmental and individual factors (e.g., low levels of fitness) may account for difficulty in reaching the 51-min/day cut-off point of MVPA in our study sample. Only 7.84% in our study sample met the 51-minute threshold. Therefore, alongside physical activity, other strategies such as breaks in sedentary time may be effective in preventing the progression of dependency in this segment of the population.[27,28]. Nonetheless, it may be that MVPA is underestimate in participants with low fitness. The opposite could also be true (i.e., MVPA levels may be overestimated in participants with higher fitness levels). Experimental studies are needed to confirm our hypothesis. Both creating environments that encourage movement and making physical therapy accessible in living care facilities may help older adults become more active while reducing the burden associated with dependency. Also, encouraging more physically demanding hobbies and volunteer work may enhance MVPA amongst this population group. In doing so, staff of long-term care facilities may play a critical role.

A key strength of this study was the use of accelerometers to measure physical activity and sedentary time. This is important given the challenges faced when undertaking research with older adults living in long-term care facilities.[29] The sample size of this study,

although small, is comparable[30], or even greater than other studies using objective measures of physical activity in older adults residing in living care facilities[31]. However, the current post-hoc power achieved in this study (0.67) was below the accepted threshold (i.e., 0.80). Therefore, our results should be taken with caution and the significant statistical associations observed may not hold true in fully powered studies. Studies with an appropriate sample size are therefore required to confirm our observations. The analytical approach we used allowed us to explore the interactions between two behaviors traditionally analyzed independently in relation to health outcomes (i.e., physical activity and sitting time), which assisted in clarifying more concrete recommendations as to what strategy is best to prevent self-care disability in the study population. Despite the strengths of our study, there are several limitations. First, accelerometers are not well suited for distinguishing between standing and sitting, which may potentially bias the estimations in this study.[32] Moreover, the absolute accelerometry cut points used in our study to classify activity intensity may underestimate the amount of MVPA achieved by older adults with a lower fitness level. The development of relative (to fitness) accelerometry cut points to classify activity intensity in older adults residing in living care facilities is highly desirable. Generalization to other older adults residing in living care facilities is not possible (e.g., people with dementia). It is also important to highlight that the 51.8 min/day of MVPA threshold found in this study is only applicable to older adults 80 years and over. We expect this threshold to be lower in the younger population, but this assumption needs to be tested in future studies. Moreover, although lean mass is essential when studying self-care disability and dependence, this variable was not assessed. Nevertheless, we have included as a covariate in the study the body mass index of the participants, which is commonly used in order to assess the body composition in older adults.[33] Data on pain, self-reported health,

sleep quality, and frailty were not available, and are thought to influence physical activity. Future studies should account for this, and other important variables in the context of our study population. Lastly, the design used in this study prevents us from making any causal claim on the associations found. In addition, we cannot rule out the reverse causation (i.e., it is plausible that disability explains MVPA). Future studies may want to consider experimental designs to confirm or contrast our results.

CONCLUSION

Our study found that 51 min/day of MVPA may offset the negative consequences of sedentary time on self-care disability in older adults residing in living care facilities. However, participating in 51 min/day of MVPA may be challenging for this segment of the population. Therefore, alongside physical activity, reducing sedentary time and increasing light physical activity should be encouraged in order to prevent the progression to dependency in octogenarians residing in living care facilities. Our results warrant confirmation under rigorous experimental designs.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

FUNDING

The authors state that this research has not been funded or sponsored

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Figure legends

Figure 1. Flow diagram of participants in the study

Figure 2. Conditional effect of sedentary time on self-care disability as a function of moderate-to-vigorous physical activity.

The dashed blue vertical line (MVPA = 51.8) represents the point where the relationship between disability status and sedentary time transitions from statistically significant to non-significant and is determined using the Johnson-Neyman technique. The dashed red vertical line represents the amount of MVPA required to meet the WHO physical activity recommendations. The greyed area represents the confidence intervals. SED, sedentary behavior.

CLINICAL HIGHLIGHTS

Moderate-to-vigorous physical activity is a moderator in the relationship between sedentary time and self-care dependency in older adults living in long-term care facilities.

Encouraging moderate-to-vigorous physical activity for at least 51 minutes a day may help remove the negative consequences of too much sitting in older adults living in long-term care facilities.

Reducing sedentary time should be encouraged to prevent the slowdown of the progression to dependency in octogenarians living in long-term care facilities.

Figure 1

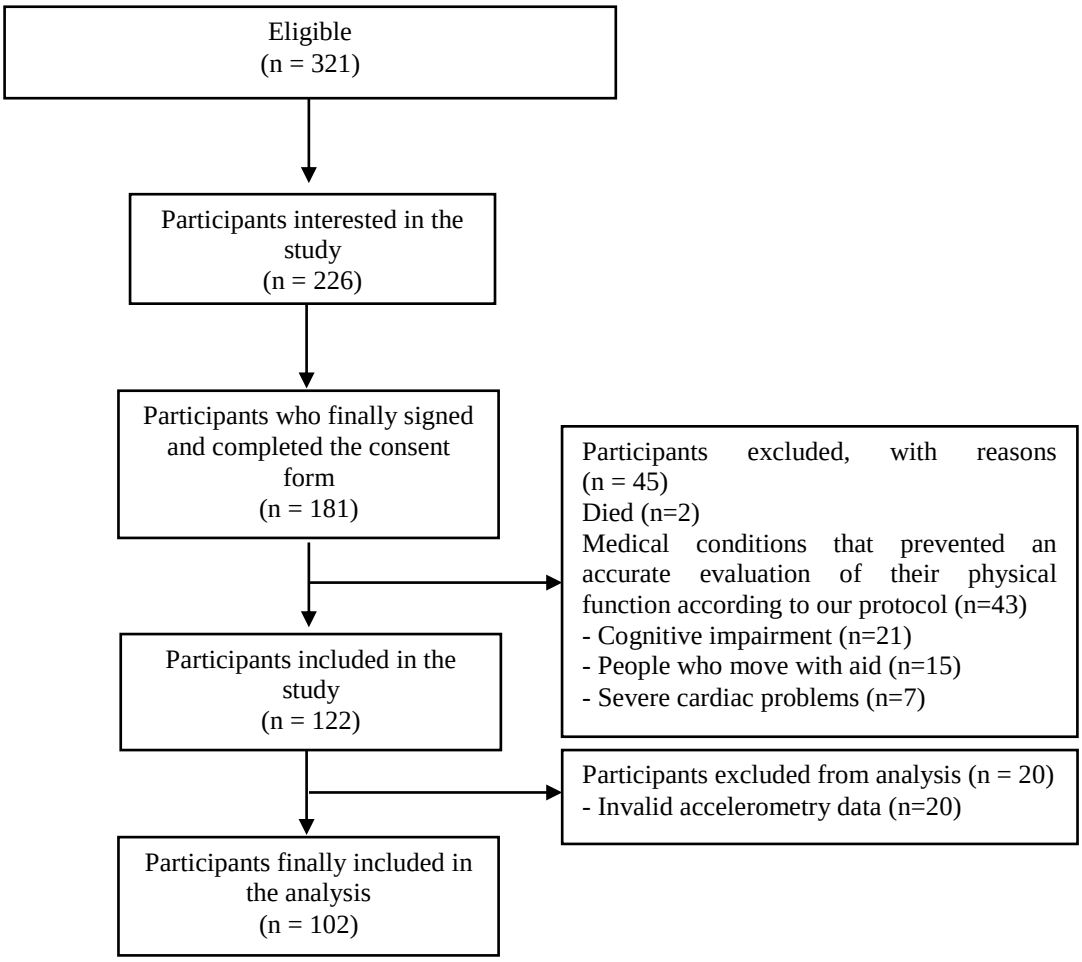
Eligible
(n = 321)
Participants interested in the study
(n = 226)
Participants who finally signed and completed the consent form
(n = 181)
Participants excluded, with reasons (n = 45)
Died (n=2)
Medical conditions that prevented an accurate evaluation of their physical function according to our protocol (n=43)
- Cognitive impairment (n=21)
- People who move with aid (n=15)
- Severe cardiac problems (n=7)
Participants included in the study
(n = 122)
Participants excluded from analysis (n = 20)
- Invalid accelerometry data (n=20)
Participants finally included in the analysis
(n = 102)

Figure 2

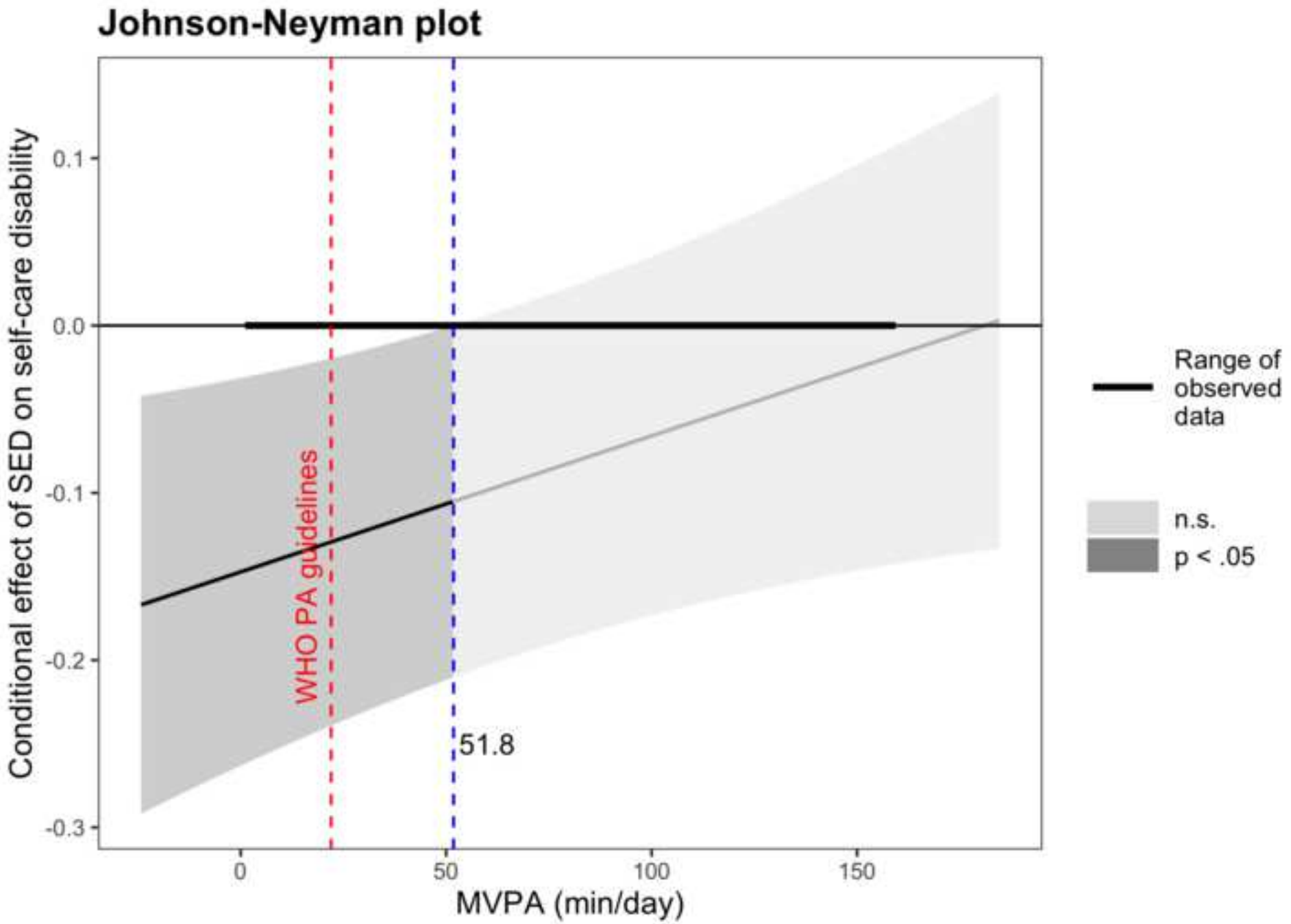

Table 1. Characteristics of the participants in the study (n =102)

Measures	**Mean (SD) or n (%)**	**Min-Max**
Age (years)	85.02 (7.24)	62-101
Gender, women, n (%)	84 (69.1)	NA
Weight (kg)	64.62 (11.23)	39.7-94.1
Height (m)	152.4 (8.1)	137-175
Body mass index (kg/m^2)	27.43 (5.37)	20.89-44.2
Waist circumference (cm)	100. 8 (10.9)	81-130
Self-care disability (Barthel Index)		
Total dependency (score < 20), n (%)	0 (0)	NA
Severe dependency (score 20-35), n (%)	2 (1.96)	NA
Moderate dependency (score 40-55), n (%)	5 (4.90)	NA
Mild dependency (score. ≥ 60), n (%)	78 (76.47)	NA
Independent (score 100), n (%)	17 (16.6)	NA
Physical activity		
Sedentary time (min/day)	917.76 (189.86)	474.5-1191.69
Moderate –to-vigorous physical activity (min/day)	23.69 (26.55)	0-158.51

Values are mean (SD) unless otherwise stated. NA, Not applicable