Physical Activity, Sedentary Behavior, and their Predictors among Nursing Home Residents – Cross-Sectional Results of the BaSAlt Study

Abstract

Little is known about physical activity (PA) and sedentary behavior (SB) among nursing home residents although PA is known as a health promoter. This study examined PA, SB, and their predictors among nursing home residents (n=63). Dependent variables were accelerometry based PA and SB. Predictor variables included in a path analysis were age, sex, body-mass-index (BMI), Barthel Index (BI), cognitive status (Mini-Mental-State Examination), physical performance (hand grip strength, habitual walking speed), and well-being (WHO-5 well-being index). PA was very low (*M* steps per day=2,433) and SB was high (*M* percentage of sedentary time=89.4%). PA was significantly predicted by age (β=-.27, p=.008), BMI (β=-.29, p=.002), BI (β=.24, p=.040) and hand grip strength (β=.30, p=.048). SB was significantly predicted by BMI (β=.27, p=.008) and BI (β=-.30, p=.012). Results might be helpful for everyday practice to identify persons at high risk for low PA and high SB.

Keywords: accelerometry, sedentariness, path model, long-term care, older adults.

Introduction

In our aging society, the number of people with care needs is rising and consequently the number of people in nursing homes is increasing (Directorate-General for Economic and Financial Affairs, 2021). Nursing home residents are a multifaceted population, characterized by multimorbidity, dependency in activities of daily living (ADLs), as well as motor and cognitive impairment (Rolland et al., 2009; Williams et al., 2005). Additionally, an increased time spent sedentary can trigger health losses. Detrimental effects of sedentary behavior (SB) in older adults include lower physical performance (Mañas et al., 2017), overweight/obesity, and increased all-cause mortality (Rezende et al., 2014). Physical activity (PA) is one opportunity to promote health among nursing home residents. A systematic review of studies with nursing home residents concluded that PA improves the ability for ADLs, motor skills, and physical performance (Crocker et al., 2013). Further, a randomized controlled trial revealed benefits of PA on health-related quality of life as well as a decrease in depression symptoms (Henskens et al., 2018).

Unfortunately, the transition from homecare to an institutionalized, restricted environment like a nursing home (Goffman, 1990; Heinzelmann, 2004; van der Bij, 2002) is related to a change of habits, including a drop in PA and an increase in time spent sedentary (Bates-Jensen et al., 2004; Duran et al., 2019; van Alphen et al., 2016; Yamada et al., 2018). Consequently, a closer look is needed at the predictors for PA and SB in this special setting. This study addresses predictors for PA and SB to contribute to the knowledge about individual factors associated with PA and SB among nursing home residents and, thus, enabling further guidance for interventions targeting a long-term change of PA and SB.

Recommended levels of physical activity among nursing home residents

Current recommendations for people with care needs, such as the ones by the International Association of Gerontology and Geriatrics- Global Aging Research Network

(IAGG-GARN) and the IAGG European Region Clinical Section, refer to the status quo maintenance of the current state of health. This is different compared to recommendations for the general older adult population, which focus on the prevention of non-communicable disease (Chodzko-Zajko et al., 2009; Nelson et al., 2007). The recommendations for people with care needs call for an increase of overall activity levels by breaking up sedentary time, activating care, and implementing group activities that consider participants' personal motivation (Barreto et al., 2016). To quantify these recommendations, 3,000 steps per day are recommended for the prevention of frailty (Watanabe et al., 2020) and for older adults with disabilities or chronic disease in addition to the activities of everyday life. This might accumulate to 4,600 steps per day, accounting for all activities (Tudor-Locke et al., 2011).

Achieved levels of physical activity among nursing home residents

Bearing these PA recommendations in mind, first research reviews found overall low levels of PA paired with high interindividual variability (385 up to 3,387 steps per day (Mc Ardle et al., 2021)), Therefore, most nursing home residents do not achieve the recommended number of steps per day (Tudor-Locke et al., 2011). The results further underline the interindividual variation of PA levels despite large heterogeneity in study methodology. Studies had very different inclusion criteria for study populations, which might explain the different findings. Some studies excluded male persons (Ikezoe et al., 2013), persons with moderate or high cognitive impairment (e. g. Ikezoe et al., 2013; Mouton et al., 2017), or persons with disorientation (Buckinx et al., 2017), while others included only persons with a diagnosis of dementia (Moyle et al., 2018). Furthermore, in the case of device-based measurement of PA, the types of accelerometer devices (e. g. ActiGraph, Pebble) and their placements (e.g., hip, shoes, wrist) differ, limiting the comparability of study results.

Sedentary behavior among nursing home residents

Alongside low amounts of PA, nursing home residents are a very sedentary population. SB includes activities with a very low energy expenditure (≤ 1.5 metabolic equivalents) during waking time (Tremblay et al., 2017). A few studies reported SB to vary between 72 % (van Alphen et al., 2016) to 79 % (Barber et al., 2015) up to a maximum 85 % (Parry et al., 2019) among nursing home residents with and without dementia. Bearing study limitations in mind – like neglecting SB as a waking behavior or measuring SB as well as activity on the wrist also in walking aid users (van Alphen et al., 2016) –heterogenous results could be a consequence of different devices and wear time.

Predictors of physical activity and sedentary behavior among nursing home residents

A low amount of PA and a very high amount of SB warrant closer looks at predictors. Knowledge about predictors can be used in a targeted manner to enable long-term change in PA and SB. Considering, that PA and SB are two different types of behavior (Dogra & Stathokostas, 2012), studies have to be evaluated separately.

Previous research provides first indications that demographic variables, cognitive status, physical performance, and psychological variables are related to PA among nursing home residents. Concerning demographic variables, studies showed that men are more active than women (Grönstedt et al., 2011), and nursing home residents with higher PA had lower care needs (Grönstedt et al., 2011; Marmeleira et al., 2017). Regarding cognitive status, a higher cognitive status was associated with a higher PA level (Grönstedt et al., 2011; Marmeleira et al., 2017). Regarding physical performance, a positive relationship was reported between steps per day and walking speed, quadriceps strength, and balance (Ikezoe et al., 2013), which are essential skills and abilities for performing ADLs (Bize et al., 2007; Buchner, 2003). Lastly, for psychological variables, self-efficacy had effects on PA among nursing home residents without cognitive impairment (Huang et al., 2020). Furthermore, higher depressive symptoms were correlated with lower PA levels (Salguero et al., 2011).

Additional knowledge about behavioral determinants can be drawn from studies with older community dwellers. For example, a higher body-mass-index (BMI) and a higher age was associated with lower PA levels (Koeneman et al., 2011; van Stralen et al., 2009).

With respect to correlates of SB, first studies also showed relations to demographic variables, cognitive status, physical performance, and psychological variables among nursing home residents.

Concerning demographic variables, SB among nursing home residents did not differ between men and women (Leung et al., 2021). No differences were examined between younger (< 85 years of age) and older nursing home residents (≥ 85 years of age) (Barber et al., 2015). Regarding cognitive status, cognitively impaired nursing home residents were more sedentary during waking time than unimpaired residents (Barber et al., 2015). Regarding physical performance, more time spent sedentary was associated with a lower physical function measured as ADLs (Barber et al., 2015; Leung et al., 2017), but not with poorer results of lower extremity functional performance (measured with the Short Physical Performance Battery) and motor testing among nursing home residents (Parry et al., 2019). Lastly, for psychological variables, correlations were found between more time spent sedentary and lower levels of self-efficacy (Leung et al., 2017).

Among older community dwellers (> 65 years of age), additional associations between SB and overweight (Chastin et al., 2015; Rezende et al., 2014) were found.

Aims of the study

The aims of this study are (1) to objectively measure and describe PA and SB among nursing home residents and (2) to analyze age, gender, BMI, cognitive status, physical performance, ADLs, and well-being as possible predictors for PA and SB among nursing home residents. Based on previous empirical findings, we assume that demographic variables, cognitive status, physical performance, and psychological variables might predict

PA and SB. Furthermore, we want to exploratively compare the role of the included predictors for PA in contrast to SB.

Methods

Study design

We collected data for this study as part of the larger BaSAlt study („Verhältnisorientierte Bewegungsförderung und individuelle Bewegungsberatung in Seniorenheimen“ [“Setting-based physical activity promotion and individual physical activity counseling in nursing homes”], BaSAlt) (Thiel, Sudeck, et al., 2021). Ethical approval for the study was granted by the Ethics Committee of the Faculty of Economics and Social Sciences at XXXXXX (no. AZ A2.5.4-096_aa).

Nursing home staff recruited residents in five nursing homes in Southwestern Germany. The staff presented and explained study information to the eligible nursing home residents. Any questions which arose were answered by the staff or the study team itself. We conducted assessments stepwise between September 2020 and April 2022. Assessments were performed when written informed consent was available (by the residents or their legal representatives) and access to nursing homes was not restricted due to the Covid-19 pandemic. First, questionnaires were completed, followed by the subjects wearing an accelerometer over multiple days (Thiel, Sudeck, et al., 2021).

Inclusion and exclusion criteria

Exclusion criteria for participants were (1) a degree of care greater than 4 (classification in German care system in degree of care 1 – 5, with 5 representing the highest care needs) and (2) the inability to walk. No other exclusion criteria were applied.

Measurements

Outcome Variables

PA and SB, as the outcomes in this study, were measured with an accelerometer-based device (ActiGraph wGT3x-BT, Pensacola, FL). Activity data was assessed over seven consecutive days, including weekdays and weekends. Participants wore the device on the right ankle. Ankle position was chosen to compensate for an anticipated very low gait speed or walking disabilities, combined with the use of walking aids like a walker. In these cases, wrist and hip positioning show only a minimum of movement which would result in underestimated PA (Anderson et al., 2019; Campos et al., 2018). Participants and nursing home staff were instructed to fill out a log with daily wear time. Raw data were collected with a sample rate of 30 hz and an epoch length of 10 seconds. Following current recommendations for valid wear time, data from participants with a minimum of 10 hours wear-time between 6 a.m. and 10 p.m. and with at least three valid days were included in further analysis (Burchartz et al., 2020; Thiel et al., 2016). Non-wear time was removed (Choi et al., 2011). Outcome measures were calculated with the ActiLife 6 software (ActiGraph, Pensacola, FL). Steps per day were calculated by means over the valid days. Steps per day are recommended to be an appropriate outcome parameter for PA among nursing home residents (Mc Ardle et al., 2021) and to allow for comparisons to PA recommendations (Tudor-Locke et al., 2011; Watanabe et al., 2020). Sedentary behavior was characterized by <100 counts per minute of wear time and was calculated as means of percent from total wear time over valid days (Freedson et al., 1998; Parsons et al., 2016).

Descriptive and predictor variables

Demographic variables, including age, sex, and morbidities (categorized diseases into (1) past cardiovascular events, (2) arterial hypertension, (3) coronary heart disease, (4) cardiac insufficiency, (5) cardiac pacemaker, (6) post-stroke/cerebral hemorrhage/TIA, (7) chronic lung disease, (8) cancer, (9) diabetes mellitus II, (10) osteoarthritis of lower extremity, and (11) psychological/emotional/nervous disease of resident) were documented from patient charts, as well as *anthropometric data* in terms of the BMI. *Cognitive status* was assessed with the German Mini-Mental State Examination (MMSE), including orientation, memory, and attention as well as following verbal and written commands, and writing and copying a complex polygon (Folstein et al., 1975) with the range of 0 to 30 points. Less than 27 points indicate mild cognitive impairment (O'Bryant et al., 2008). While a high retest-reliability of r = .89 was reported (Folstein et al., 1975), validity in terms of sensitivity and specificity are dependent on the objective of investigation (Arevalo-Rodriguez et al., 2015). Nonetheless, the MMSE is a common tool for evaluating cognitive impairment, (O'Bryant et al., 2008) and recommended as a screening tool for dementia, mild cognitive impairment, or delirium (Mitchell et al., 2012).

Physical performance was measured by isometric testing of maximal hand grip strength and habitual walking speed. Hand grip strength was assessed with a dynamometer (hydraulic hand force dynamometer SH5001, Saehan, Korea) through three repetitions of each hand, selecting the achieved maximum (Roberts et al., 2011). Limited hand grip strength (men < 37 kg, women < 21 kg) is associated with increased mobility limitations (Sallinen et al., 2010). Habitual gait speed was performed with the Four-Meter Walking Test (Guralnik et al., 1994), calculated by dividing the length of the test track by the time needed to complete it. Participants were instructed to walk in their self-selected walking speed through a 2-meter zone for acceleration, and a 4-meter testing zone and a 2-meter zone for deceleration. A velocity slower than 0.8 m / s is thereby a cut-off according to the European Working Group on Sarcopenia in Older People (EWGSOP2) for detecting sarcopenia (Cruz-Jentoft et al., 2019).

ADLs were rated by the Barthel Index (BI; Mahoney & Barthel, 1965). The BI consists of 10 items that measure a person's daily functioning, particularly their ADLs and mobility. The BI score ranges from 0 to 100, whereby lower scores indicate a greater need for help. The BI is a valid and reliable tool to assess ADLs in geriatric patients (Bouwstra et al., 2019, Hopman-Rock et al., 2019).

Self-efficacy was assessed with the modified Self-Efficacy for Exercise Scale (Rodgers et al., 2008). We had to modify the scale due to participants' challenges to concentrate. We asked only one item for each of the three domains, namely task efficacy ("How confident are you that you can perform all of the required movements"), coping efficacy ("How confident are you that you exercise when you feel discomfort"), and scheduling efficacy ("How confident are you that you arrange your schedule to include regular exercise"). Items were assessed on a 10-point scale ranging from 0 = not at all confident to 10 = completely confident (Rodgers et al., 2008). Nonetheless, further analysis was deemed unnecessary, because these questions were too sophisticated for included participants with cognitive impairment. While the assessment, we noticed that most of the moderate and severe cognitively impaired participants were not able to give any response to the asked questions, especially because of the lack of a personal connection to exercise.

Well-being was assessed with the World Health Organization Well-Being Index (WHO-5 well-being index) (Bonsignore et al., 2001; Brähler et al., 2007) by interviewers, introduced in interaction with participants with cognitive impairment and dementia. The WHO-5 well-being index is a common tool for assessing well-being as an outcome parameter (range 0 – 100 points, raw score multiplied by four). An index value below 13 points (range 0 – 25 points raw score) represents a low level of well-being and furthermore indicates an advanced diagnostic for a probable depression (Brähler et al., 2007). Because of its high sensitivity of 92 % and his specificity of 74 % in nursing home residents (Allgaier et al., 2011) the WHO-5 well-being index is recommended for geriatric patient (Topp et al., 15).

Statistical Analysis

Descriptive data were presented as frequencies and percentages for categorical variables, and mean values and standard deviations for continuous variables, as appropriate. Differences between participants who did or did not reach valid activity data were calculated by unpaired t-test, or chi-square test.

To investigate predictors of PA and SB, a path model was analyzed. The model includes age, sex, BMI, MMSE, hand grip strength, gait speed, BI, and WHO-5 well-being index as predictors for PA as well as for SB. Significant correlations between variables were considered as covariances in the model. Model-fit is described by the chi-square divided by the degrees of freedom (χ^2/df), the Root-Mean-Square-Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR) and the Comparative Fit Index (CFI). The following thresholds were used: for the χ^2/df test, a value ≤ 3 indicates a good model fit. (Homburg & Giering, 1996). For the RMSEA, a close model fit is described for values ≤ 0.05 and a reasonable model fit for values ≤ 0.08 (Browne & Cudeck, 1993). For SRMR, a value of ≤ 0.10 (Homburg et al., 2014) describes a reasonable model fit, and for CFI a value of ≥ 0.90 (Homburg & Baumgartner, 1995).

Missing values are imputed on a model basis using the Full-Information-Maximum-Likelihood Procedure (FIML) implemented in Amos 28.0 (Amos Development Corp, Meadville, PA, USA). Calculated outliers were checked for plausibility. All of them (2 for PA and 3 for SB) were identified to be correctly measured values and were retained in the data set.

For all analyses, a two-sided p value $\leq .05$ indicated statistical significance. All analyses were performed using IBM SPSS Statistic for Windows, version 28.0 (IBM Corp., Armonk, N.Y., USA), and Amos 28.0 (Amos Development Corp, Meadville, PA, USA).

Results

Participant characteristics

Overall, 81 individuals gave consent and were included in the BaSAlt Study. Dropouts from this study before and during assessments (*n* = 11) were due to death, moving away from the nursing home, transition to palliative care, developed inability to walk or multiple combined reasons. Furthermore, seven participants did not reach valid wear time data for accelerometric assessment. Participants with valid wear time (*n* = 63) and those without valid wear time (*n* = 7) did not differ with respect to descriptive variables, predictors, and outcome measurements, except for cognitive status (supplement A).

The following results concern the 63 participants with valid wear time. The sample represents predominantly multimorbid (two or more morbidity categories: 88.9%, *n* = 54), older (*M* = 86.46 years of age, *SD* = 7.06, range: 64 – 98) participants, most with cognitive impairment (MMSE score < 27: 71.4%, *n* = 45, range: 2 – 30) and a high proportion of motor impaired participants (walking speed < 0.8 m/s: 84.1%, *n* = 53; handgrip strength women < 21 kg: 95.7%, *n* = 45; men < 37 kg: 93.8%, *n* = 15) and participants in need of care (BI < 85 points: 65.1 %, *n* = 41). Nearly half of them are overweight (BMI 25-29.9: 23.8 %, *n* = 15) or obese (BMI > 30: 19.0 %, *n* = 12; Table 1).

Amount of physical activity and sedentary behavior

Mean steps per day were 2,433 (*SD* = 2,195, *Mdn* = 2,091), with a wide range between 118 and 14,275 steps per day (Figure 1). The minimal recommended 3,000 steps per day were achieved by 17 participants (27%) including 10 participants (15.9%) who took 3,500 steps per day or more, and six participants (9.5%) who achieved 4,600 or more steps.

SB represented by mean percentage of sedentary time was 89.4% (*SD* = 6.09, *Mdn*: 90.5%), with a range between 69.1% and 98.5% (Figure 1).

Path analysis for evaluating predictors of physical activity and sedentary behavior

Figure 2 shows the results of the path analysis. Significant bivariate correlations between predictor variables and residuals of the dependent variables were considered in terms of covariances (supplement B). The global model-fit was good (χ^2 = 21.550, *df* = 21, *p* = .426; χ^2/df = 1.026; CFI = 0.997; RMSEA = 0.021, C.I. = 0.00 – 0.110, *p* = .609; SRMR = 0.078), allowing for the further analysis of the local parameters within the path model.

More steps per day were significantly predicted by younger age (β = -.27, *p* = .008), lower BMI (β = -.29, *p* = .002), higher hand grip strength (β = .30, *p* = .048), and higher BI (β = .24, *p* = .040). The remaining variables in the model (sex, MMSE, habitual gait speed, WHO-5 well-being index) were not significantly related with the PA measurement.

Mean percentage of sedentary time per day was significantly predicted by a higher BMI (β = .27, *p* = 008) and a lower BI (β = -.30*, p* = .012). Age and hand grip strength were not significantly associated with SB. Additionally, there were no significant associations between sedentary time and sex, MMSE, habitual gait speed, nor the WHO-5 well-being index (Figure 2).

Discussion

This study investigated PA, SB, and their predictors among nursing home residents. Systematic evaluation of accelerometric measured PA and SB adapted for the highly vulnerable subjects in nursing home residents revealed new insights into the PA and SB of the study group. Furthermore, the applied path model, including known and unknown predictors, might help in designing PA promotion programs and reducing SB among nursing home residents.

PA among nursing home residents

The results of this study showed that most nursing home residents come short of the 4,600 steps per day goal, which is recommended for older adults with disabilities and chronic disease (Tudor-Locke et al., 2011). In the study population, only six out of the 63 participants (9.5%) reached 4,600 or more steps. Further studies reported that 3,000 or 3,500 steps per day already reduce the frailty risk (Watanabe et al., 2020) and reduce cognitive decline (Chen et al., 2020) among community-dwelling older adults. In the present study, only 17 participants (27%) realized 3,000 steps per day, and only ten participants (15.9%) took 3,500 steps per day or more.

Our findings are in line with further studies among nursing home residents or persons with a high dependency on care needs (Mc Ardle et al., 2021) and underline the need for targeted PA promotion. Nonetheless, this study showed slightly higher activity in comparison to other studies focusing on nursing home residents (Marmeleira et al., 2017). This could be a consequence of the placement of the accelerometer. In contrast to the common waist position, in this study the device was worn on the ankle. The ankle position showed more valid results than the hip position in step counts among people with walking disabilities (Anderson et al., 2019; Campos et al., 2018). These results should be verified in further studies in nursing home residents through ankle accelerometer usage over hip accelerometer usage.

Furthermore, a wide range of steps per day was measured. This wide range illustrates the enormous heterogeneity of the examined sample and confirm previous results (Grönstedt et al., 2011).

Sedentary behavior among nursing home residents

Observed SB in this study population was high (*M* percentage of sedentary time = 89.4%). Here, too, a wide range underlines the heterogeneity of SB with respect to the sample. Previous studies reported high amounts of SB (Barber et al., 2015; Parry et al., 2019; van Alphen et al., 2016), but not with these results. Different approaches to the calculation of sedentary time might be a reason for contrasting results. More studies are needed to give recommendations on the calculation of SB among nursing home residents. Furthermore, accelerometry took place during the COVID-19 pandemic. It is known that COVID-19-related restrictions and lockdowns during the pandemic affected activity promotion in nursing homes (Palacios-Ceña et al., 2021; Thiel, Altmeier, et al., 2021). But, to the best of our knowledge, there are no accelerometry data that allow a comparison between SB before and during pandemic among nursing home residents.

Reducing sedentary time in the nursing home setting seems to be a big challenge. Regular interruptions of SB could be targeted (Barreto et al., 2016), or evaluated predictors might alternatively give insights on how to deal with this challenge.

Predictors for physical activity and sedentary behavior among nursing home residents

BMI and BI as significant predictors give new insights in parameters influencing both, PA and SB, among nursing home residents. Furthermore, age and hand grip strength significantly predicted PA but not SB.

Demographic variables – age and sex

In the present study, older age significantly predicted PA, but not SB. This is in line with other investigations in nursing homes (Barber et al., 2015), but not in line with studies among community-dwelling older adults. There, older age was related to higher SB (Harvey et al., 2015). Thus, the setting of the nursing home itself might provide strong environmental influences on SB (e.g., social practices associated with sitting) (Benjamin et al., 2011), which are stronger than individual factors like age. Therefore, the setting should also be considered to further facilitate the reduction of SB on the individual level of each resident (Thiel, Sudeck, et al., 2021).

The results of this study did not reveal sex as a significant predictor of PA or SB. Previous studies found male nursing home residents to have a greater life-space mobility then women, a concept addressing mobility within the environment rather than PA (Grönstedt et al., 2011). Additionally, it is possible that there is a difference between men and women concerning the motivation for and pursued goals in being active. This specific difference is known for younger age groups (Schmid et al., 2014), but has not yet been examined for nursing home residents. Varying goals for being active could result in differences concerning life-space mobility, but not necessarily the amount of PA. Knowledge about these goals could help to develop targeted activity programs. Furthermore, men were more sedentary than women in assisted living. This difference seemingly vanishes among nursing home residents (Leung et al., 2021). Here too, it is possible that the different settings themselves influence this behavior in a considerable amount.

Anthropometric data – body-mass-index

This study showed that a higher BMI, which is a known predictor for lower PA among older community dwellers (Koeneman et al., 2011; van Stralen et al., 2009), also led to lower PA among nursing home residents. Furthermore, nursing home residents with a higher BMI are at special risk for being sedentary. Therefore, obesity among nursing home residents should be taken seriously. While it is known that additional exercise can improve weight loss among older adults (Goisser et al., 2020), studies that explore weight loss among nursing home residents are lacking. Considering that up to 57.6% of nursing home residents suffer from malnutrition (Lampersberger et al., 2022), pursuing the goal of weight loss while simultaneously attempting to reduce the risk for malnutrition seems to be a challenge. However, overweight / obese nursing home residents require special attention when developing strategies for PA promotion and interrupt SB.

Cognitive status – Mini-Mental State Examination

In our study, no association between cognitive status and PA or cognitive status and SB was observed. In previous studies, higher cognitive status was associated with a higher amount of PA (Grönstedt et al., 2011; Marmeleira et al., 2017) and a lower amount of SB in nursing home residents, but not in the setting of assisted living (Barber et al., 2015; Leung et al., 2021). However, our study showed a significant influence of BI on PA, and BI on SB, but lacking relationships with (partial) motor impairment and cognitive impairment. The BI might be an expression of cumulative motor and cognitive impairment. There is no additional variance explanation through the MMSE. This could explain different findings.

Physical performance – handgrip strength and gait speed

In our study, hand grip strength showed a significant relation to PA in contrast to gait speed, which is not an intuitive result. In another study, gait speed was found to be a significant predictor of PA among female nursing home residents (Ikezoe et al., 2013). These contrasting results might exist due to the differences between the populations studied. Ikezoe and colleagues (2013) investigated only female nursing home residents with a mean gait speed of 1.10 m / s and excluded those with severe cognitive impairment. In the present study, men and women, including those with severe cognitive impairment, showed a mean habitual gait speed of 0.59 m / s. Further analyses could examine whether any cut points for gait speed might result in a specific high-risk population for low amounts of PA. This very low gait speed is another indication for the vulnerability of the present population and might be a result of including severely cognitively impaired residents (Öhlin et al., 2021).

In our study, strength and gait speed are not correlated (see supplement B). This implies that basic motor abilities, represented by hand grip strength as a representative of overall muscle strength, are important predictors of PA among nursing home residents with and without walking aids. Previous studies reported that old people with dementia can train maximal strength (Hauer et al., 2012). The increase of maximal strength by physical exercises might thus be one target to increase PA among nursing home residents' programs.

Noticeably, hand grip strength did not significantly determine SB but did significantly determine PA. This highlights the discrepancy between PA and SB as two different behavioral outcomes (Dogra & Stathokostas, 2012). It seems that strength, as a basic motor ability, is needed to be active. However, strength has no influence on sedentary time. The lacking relation between physical performance (hand grip strength and walking speed) and SB contrasts with other studies among nursing home residents (Ikezoe et al., 2013). This could be a result of methodological differences (study populations only including women, different accelerometer devices, different wear time requirements) and has to be elucidated in further studies. Additionally, further studies should take a closer look at how to reduce or interrupt sedentary time with recommended activating care, group activities and breaking up sedentary time (Barreto et al., 2016).

Activities of daily living – Barthel Index

The BI as a measure of ADLs predicted both, PA and SB, among the present study population. These results are in line with previous studies, also showing higher levels of PA among persons with lower care needs (Grönstedt et al., 2011; Marmeleira et al., 2017).

The BI is a common tool in geriatrics and geriatric nursing, standardly assessed in German nursing homes. Increasing nursing home staff's awareness of the BI as a predictor of PA and SB, might help with attentiveness to the low activity levels of this sub-population, increase PA, and lower SB.

Psychological variable– WHO-5 well-being index

Well-being did not significantly influence PA or SB in this study. In previous studies, other psychological health outcomes like depressive symptoms showed associations with PA (Salguero et al., 2011). These results are not necessarily contrasting. An evaluation of depression is a common indicator for a negative psychological state, whereas well-being indicates a positive psychological state. Furthermore, in the applied model, well-being is examined as a predictor of PA and SB, while further studies might generate well-being as an outcome. Unfortunately, this calculation was not feasible with the currently available data.

Strengths and Limitations

The aim of this study was to evaluate PA and SB as well as possible predictors among nursing home residents. The present sample represents mostly multimorbid, older nursing home residents with cognitive and motor impairment – a group which is hard to reach and has not been widely studied. Including all residents who were willing to take part in the study gave detailed insights into this group. Previous studies excluded cognitively impaired nursing home residents (Ikezoe et al., 2013; Mouton et al., 2017), only included persons with dementia (Moyle et al., 2018), or excluded persons with specific diseases (Buckinx et al., 2017; Ikezoe et al., 2013). Such exclusion criteria ignore the heterogeneity of nursing home residents which nursing staff face every day. In our data, this heterogeneity is represented by a very wide range of values in several variables (e.g., steps per day, hand grip strength, WHO-5 well-being index), and underlines previous results (Grönstedt et al., 2011). Therefore, this study can help to understand PA, SB, and their predictors among nursing home residents.

Sample size of the present study was low. Nonetheless, 63 nursing home residents were assessed, which is an acceptable sample size in comparison to other studies (Mc Ardle et al., 2021). However, small to medium effect sizes are needed to have sufficient statistical power. Nonetheless, we identified first predictors for the overall amount of PA and SB. Further studies could evaluate predictors for less active persons. Recruitment and assessments took place during the COVID-19 pandemic. Throughout the study period, we ensured a close cooperation between the nursing homes and the study team. Nonetheless, we cannot exclude some measurement bias. Therefore, the generalizability of the results is limited.

In the present study, path analysis was made because of the longitudinal characteristic of assessments. First, questionnaires were applied, followed by accelerometry. Nonetheless, the data do not allow conclusions to be drawn about causality. Still, first insights into established and new predictors for nursing home residents are given.

While the BI as a proxy-measurement is relatively robust against cognitive impairment (Hartigan & O'Mahony, 2011), this is not reported for the WHO-5 well-being index so far. There is still the possibility of underreporting of negative psychological status or not correctly responding to all questions as it is known from other self-report measurements in severely cognitive impaired participants (Towsley et al., 2012). Not all of the applied assessments were feasible (SEES), and therefore no path analysis for self-efficacy was made. Overall, assessments were executed by trained assessors. The applied questionnaire must be revised to give a detailed insight into PA related to self-efficacy among nursing home residents. It was a conscious decision not to evaluate fall related self-efficacy, as we wanted to elucidate positively connotated self-efficacy in this study. The applied questionnaire gathered self-efficacy for exercise, and therefore does not precisely match with the PA assessment, where a separate observation of exercise is not feasible. Therefore, modifications and validation of a revised version of the questionnaire could lead to a specific self-efficacy for exercise tool in this context.

Conclusion

The results of the present study demonstrated the need to promote PA and reduce SB among nursing home residents and to consequently increase health benefits through PA and reduce health risks through high SB. The relationship between hand grip strength and age and SB requires further study. Furthermore, BMI and BI are significant predictors for low levels of PA and high levels of SB and are therefore starting points for designing interventional studies. Further studies might explain the role of the nursing home setting itself on residents' amount of PA and SB.

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Table 1

Participant characteristics

Parameter	[a]*M* ± *SD* / [b]*n; %*
Age, [years] [a]	86.46 ± 7.06
Sex, [n, female][b]	47; 74.6
BMI, [kg/m²] [a]	26.09 ± 5.44
Barthel Index, [score] [a]	69.29 ± 21.08
Mini-Mental State Examination, [score][a]	20.61 ± 7.01
Morbidities, [number of categories][a]	3.31 ± 1.72
Degree of care 2 [n] [b]	18; 28.6
Degree of care 3 [n] [b]	34; 54.0
Degree of care 4 [n] [b]	11; 17.5
Hand grip strength, [kg][a]	17.32 ± 7.01
Gait speed, habitual, [m/s] [a]	0.60 ± 0.17
WHO-5 well-being index, [score][a]	56.42 ± 24.02

Note. n = 63.

Figure Captions

Figure 1

Boxplots of number of steps per day and of percentage of time spent sedentary per day among nursing home residents (both n = 63)

[insert figure 1 here]

Figure 2

Path model including standardized path coefficients for predictors of physical activity (steps per day) and sedentary behavior (% / valid wear time)

[insert figure 2 here]

Note. Physical activity (steps per day) and sedentary behavior (time spend sedentary in %) are predicted by demographic data (years of age, sex), anthropometric data (BMI), physical performance (hand grip strength, gait speed), activities of daily living (Barthel Index), cognitive status (MMSE: Mini-Mental-State Examination), and psychological status (WHO-5 well-being index). Significant correlations between variables were considered as covariances in the model. For reasons of simplicity, covariances are not shown in this model. Standardized parameter estimates are reported. Significant estimates ($p < .05$) are drawn in black and marked with *.

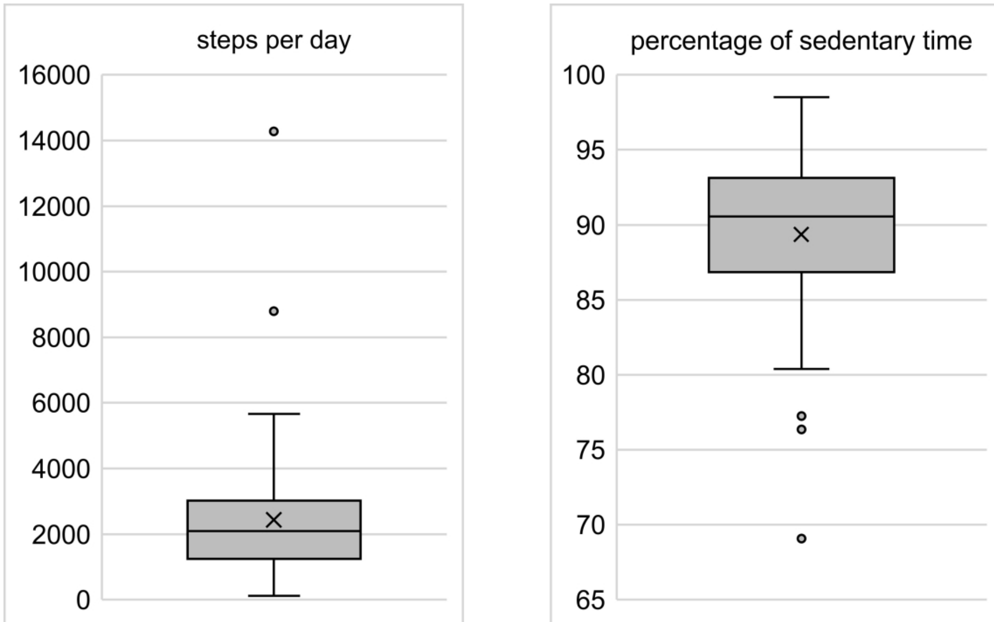

Figure 1 Boxplots of number of steps per day and of percentage of time spent sedentary per day among nursing home residents (both n = 63)

160x100mm (600 x 600 DPI)

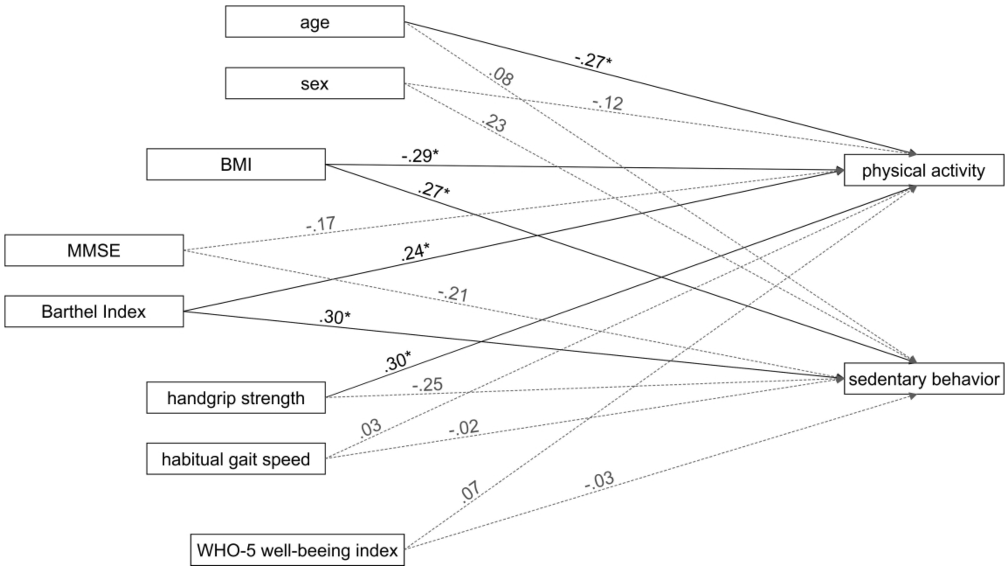

Figure 2 Path model including standardized path coefficients for predictors of physical activity (steps per day) and sedentary behavior (% / valid wear time)

160x89mm (600 x 600 DPI)

Supplement A

Results for t-test analysis comparing participants with valid wear time (n = 63) and without valid wear time of accelerometry (n = 7)

Variable	Participants with valid wear time		Participants without valid wear time		*t*	*p*
	M	*SD*	*M*	*SD*		
Age	86.46	7.06	90.00	5.03	1.29	.202
Sex[a]	—	—	—	—	.42	.515
Morbidities[b]	3.31	1.72	3.29	1.11	-0.03	.975
Body-mass-index	26.03	5.44	26.13	3.48	0.05	.963
MMSE[c]	20.67	7.19	10.75	7.59	-2.66	.010
Barthel Index	69.29	21.08	61.43	22.49	-.93	.356
Hand grip strength	17.20	6.97	11.71	7.46	-1.96	.054
Gait speed	0.60	0.18	0.61	0.19	0.10	.923
WHO-5[d]	56.55	24.93	47.00	33.84	-.73	.471

Note. [a]instead of t-test the Pearson's Chi-squared test was used due to scaling of the data. [b]Morbidities in terms of number of categories; [c]Mini-Mental State Examination; [d]WHO 5 well-being index.

Supplement B

Correlations for study variables

Variable	1	2	3	4	5	6	7	8	9	10
1.Age	—									
2.Sex[a]	-.34**	—								
3.Body-mass index	-.14	.16	—							
4.MMSE[b]	.14	.10	.06	—						
5.Barthel Index	-.03	-.07	.01	.42**	—					
6.Handgrip strength	-.35**	.71**	.08	.26*	.27*	—				
7.Gait speed	-.21	-.02	.03	-.19	.07	-.04	—			
8.WHO-5[c]	-.15	-.00	.12	.07	.32**	.16	.22	—		
9.Physical activity	-.30*	.14	-.23	.29*	.43**	.41**	.07	.23	—	
10.Sedentary behavior	.04	.07	.25*	-.35**	-.49**	-.23	-.01	-.17	-.85**	—

Note. Results demonstrate correlations calculated with Pearsons's product-moment correlation. [a]Biserial correlation was used, coded as 1 = female and 2 = male; [b]Mini-Mental State Examination, [c]WHO-5 well-being index; *p < .05 **p < .01.