Accelerometer-measured sedentary and physical activity time and their correlates in European older adults: The SITLESS study

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Abstract

Background: Sedentary behavior (SB) and physical activity (PA) are important determinants of health in older adults. This study aimed to describe the composition of accelerometer-measured SB and PA in older adults, to explore self-reported context-specific SB, and to assess socio-demographic and functional correlates of engaging in higher levels of SB in participants of a multi-center study including four European countries.

Methods: 1360 community-dwelling older adults from the SITLESS study (61.8% women; 75.3±6.3 years) completed a self-reported SB questionnaire and wore an ActiGraph accelerometer for seven days. Accelerometer-determined compositional descriptive statistics were calculated. A fixed effects regression analysis was conducted to assess the socio-demographic (country, age, sex, civil status, education and medications) and functional (BMI and gait speed) correlates.

Results: Older adults spent 78.8% of waking time in SB, 18.6% in light-intensity PA (LPA), and 2.6% in moderate to vigorous PA (MVPA). Accelerometry showed that women engaged in more LPA and walking and men engaged in higher amounts of MVPA. Watching television and reading accounted for 47.2% of waking time. Older age, being a man, single, taking more medications, being obese and overweight, and having a slower gait speed were statistically significant correlates of more sedentary time.

Conclusions: The high amount of SB of our participants justifies the need to develop and evaluate interventions to reduce sitting time. A clinically relevant change in gait speed can decrease almost 0.45 percentage points of sedentary time. The distribution of context-specific sedentary activities by country and sex showed minor differences, albeit worth noting.

Keywords: Compositional analysis, Sedentary behavior, Physical activity, Socio-demographic correlates.

Introduction

Physical activity (PA) and sedentary behavior (SB) (any waking activity in a sitting, reclining, or lying posture where energy expenditure is <1.5 metabolic equivalents [MET]) (1) are important determinants of health and quality of life in older adults (2,3). Diseases associated with prolonged SB cost the UK public health system £0.8 billion in the 2016-17 financial year (4). Prolonged SB throughout the day increases the risk of poor health, even in people who are moderately physically active (5,6). However, some evidence suggests the observed risks of SB may not be completely independent of total PA levels (7), as it is assumed that the reduction in PA on the one hand is accompanied by concomitant increases in SB on the other hand (8). Older adults spend most of their waking day sitting (9), placing them at increased risk for various detrimental health outcomes, among them all-cause mortality, metabolic syndrome, obesity and cognitive health (10–12).

Most of the past research has relied on self-reported assessments of the time spent in sedentary activities. Both objective and self-reported measures have strengths and limitations. Self-reported tools can be subject to response bias (e.g., recall bias) (13). For example, Harvey et al. (9) found that the self-reported SB of older adults averaged 5.3 hours per day, well below values recorded using accelerometry, which averaged 9.4 hours per day. Objective measures such as accelerometers are unable to capture how the sedentary time is spent.

Self-report instruments to assess PA have mainly focused on moderate-to-vigorous PA (MVPA) as these activities are more regimented and therefore easier to remember (14), and in line with international and national PA guidelines (15). However, evidence is accumulating that older adults spend much more of their time in lower-intensity PA. In a recent study,

objectively measured MVPA accounted for just 2% of the day in a large sample of older adults from the Netherlands. In contrast, the time spent in light-intensity PA (LPA) was 33% and time spent sedentary was 65% of their day (16). To date, efforts to increase PA in the population have also mainly focused on increasing MVPA (17). As accumulating evidence is suggesting that a higher level of LPA is associated with health benefits (18,19,20), it would appear logical that inactive adults should initially be encouraged to reduce SB and engage in any intensity of PA.

For a more detailed understanding of the relationship between PA and SB, it is necessary to know how the time spent in both behaviors is distributed across the day, and whether sex-related differences are worth exploring. The pattern of waking activity is made up of periods of SB, LPA and MVPA interspersed throughout the day (21). SB is tightly linked in a zero-sum time-use relationship with overall PA (22); standing up from a chair results in increased PA, albeit typically of a low intensity. The evidence linking SB to poor health therefore suggests that health-related benefits may be acquired displacing prolonged sitting time with LPA throughout the day. It is widely thought that a greater understanding of the role of each PA and SB component in this age group is necessary to inform appropriate strategies to modify both behaviors, and should be assessed in a holistic way (23). Compositional analysis provides a new method to deal directly with the compositional nature of movement behavior. The amount of time spent on a behavior is meaningful only in light of the time spent on other behaviors and not on its own (21). In comparison of more traditional methods, compositional analysis eliminates collinearity problems and deals with the co-dependence between time spent in different movement behaviors (21). Even if the information contained in the movement behavior composition is relative and thus scale invariant, it can be normalized to any sum (such as 100 for percentages) without loss of information.

Different types of SB occur in a variety of situations for different purposes, including leisure, household, occupation, and transportation (24). Most health-based studies in older adults have focused on total sedentary time (9,25,26). However, knowing in which context SB is accumulated (e.g. watching television, reading a book, sitting in any transport mode) as well as sex-related differences might be of use in targeting the best-suited strategies to decrease overall SB time. Also, being able to identify how SB and PA (LPA and MVPA) are interrelated and distributed across countries, age categories and other demographic and health factors is needed to identify the characteristics of older adults that could be targeted by preventive intervention efforts and ageing research, and by cross-European policies and guidelines (27–29).

Accordingly, the goals of this study were to: (a) describe the composition of accelerometer-measured SB and PA time in a cohort of community-dwelling older adults from four European countries from the SITLESS study; (b) explore the context in which self-reported SB occurs in both men and women and across countries; and (c) assess the correlates of SB according to country or residence, age, sex, civil status, education level, number of current medications, body mass index (BMI) and gait speed.

Method

The SITLESS study is a multi-center pragmatic three-armed parallel randomized controlled trial. Community-dwelling older adults aged 65 years or older, with a score on the Short Physical Performance Battery (SPPB) of four or above (30), who were insufficiently active and/or reported high levels of SB (31) were recruited in study centers in Denmark, Spain, United Kingdom (UK) and Germany according to their existing primary prevention

pathways. Spain and the UK had 85.5% and 58.6% recruitment through primary health care professionals, respectively. In Denmark, the largest recruitment pathway was through existing preventive home visits (83.2%). In Germany, participants were mostly reached through invitation letters (76.8%). The study protocol can be found elsewhere (32). The current paper uses data from the pre-intervention baseline assessments.

A total of 1360 community-dwelling older adults (61.8% women; 75.3±6.3 years old) were analyzed at baseline. The study design was approved by the Ethics and Research Committee of each intervention site: The Regional Committees on Health Research Ethics for Southern Denmark (Denmark), the Ethics and Research Committee of Ramon Llull University (Spain), the Office for Research Ethics Committees in Northern Ireland (ORECNI) (UK), and the Ethical Review Board of Ulm University (Germany). Participation was voluntary and all participants signed informed consent before the start of the study.

Outcome Measures

Personal information regarding age, sex, civil status, educational background, medical conditions and number of current medications was collected by means of a structured interview in the study centers. Weight and height were objectively measured by a trained researcher using a TANITA BC 420 and a SECA 213 portable stadiometer, respectively, to derive the participants' BMI. Gait speed was obtained from a 4-meter walk test. Participants were asked to walk at their normal pace and speed was calculated as distance in meters divided by time in seconds. Participants self-reported the number of hours spent sitting on a week day and on a weekend day in different contexts using the Sedentary Behavior Questionnaire (SBQ). Reliability and validity of the SBQ had been validated among overweight adults in a previous study (33); intraclass correlation coefficients were acceptable

for all items and the total scale, and significant associations were found with the sitting time question of the International Physical Activity Questionnaire and BMI (33). Context-specific sedentary behaviors included in the SBQ were: watching television, playing computer or video games, sitting listening to music or radio, sitting and talking on the phone, doing paperwork or computer work, sitting reading a book or magazine, playing a musical instrument, doing artwork or crafts, sitting and driving in a car, bus or train.

Participants wore an ActiGraph wGT3X-BT triaxial accelerometer (ActiGraph, LLC, Pensacola, FL) on their dominant hip during waking hours for seven consecutive days, removing it only for water-based activities such as bathing or swimming and to sleep during the night. Participants recorded wear time in an activity diary. The devices were initialized to collect data at 30 Hz. To be included in the analysis, an accelerometer record needed to contain at least four valid days (including at least one weekend day), with a valid day defined as containing at least 600 minutes (10h/day) of wear time as in previous studies (34). Non-wear time was defined using a 2-window system; a 90-minute window for checking for consecutive zero counts and another 30-minute up- and down- stream window for checking for more than 2 minutes of non-zero counts (35). Due to some participants wearing the ActiGraph during night-time sleeping, a maximum daily wear time threshold was set at 19 hours using a pragmatic choice based on participants' diaries and sleep time duration recommendations for older adults (36). For participants meeting the selected threshold for maximum wear time the activity diary was used to determine if the wear-time by the software was similar to the activity diaries. For relevant participants, a log diary was used to determine daily wear-time when awake.

SB was defined as <100 counts per minute (CPM), LPA as 100-2019 CPM and MVPA as ≥2020 CPM (37) on the vertical axis. Daily step counts were also extracted. Values were normalized to the total wear time. Raw accelerometry data were analyzed using ActiLife v6.13.3 software with the normal filter and summarized into 10-second epochs, as have been recommended for estimation of sedentary behavior in clinical older adult populations (38). Values were normalized against total wear time and the proportions of daily time spent in SB, LPA and MVPA are presented.

Data Analysis

Baseline cross-sectional characteristics were presented descriptively as mean and standard deviation for continuous variables or number and percentage for categorical variables.

Analyses followed the guide to compositional data analysis for SB, PA, and sleep research published by Chastin et al. (21). Accelerometer-determined compositional descriptive statistics including compositional geometric means for central tendency and variation matrices for dispersion were calculated among the overall study sample and also for each country's sample separately. Log ratio plots with the three behaviors (SB, LPA, MVPA) were generated to show the distribution of the sample compositions using the CoDaPack software 2.02.21 (39).

The composition of daily sedentary time according to sedentary activity was obtained crossing the context-specific distribution of self-reported sedentary time using the SBQ, with

the percentage of daily sedentary time assessed with accelerometry. Descriptive results were presented for the overall sample, by country, and by sex.

To assess the covariates related to accelerometer-derived sedentary time, a linear regression analysis was conducted with co-variables: country of residence, age, sex, civil status (single vs. other − in a relationship, widowed or, separated), education (primary vs. secondary vs. post-secondary), number of medications currently taken, category of BMI (obese when BMI is ≥30 kg/m^2 vs. overweight when BMI is 25 to 29.9 kg/m^2 vs. normal weight when BMI is 18.5 to 24.9 kg/m^2), and gait speed. The fixed effects regression model included country as a cluster factor to take into account any potential correlation between participants in the same country, by setting up a diagonal covariance matrix structure for the residuals. The results were reported as unstandardized regression coefficients with 95% confidence intervals (CI).

Statistical test significance was assessed at the usual 5% significance level. For the statistical analyses, STATA V13 software was used.

Results

Of the overall SITLESS participants (n=1360), mean age was 75.3 (SD 6.3) years (range from 72.8 years in UK to 77.4 years in Denmark) and 840 (61.8%) were women **(Table 1)**. Half of the sample were married (52.6%) while 27.0% were widowed. 53.2% of the participants reported having completed secondary education, with German participants having the highest proportion at 71.6% while Spanish participants had the lowest one (30.8%). Participants from Germany and Spain reported the highest number of medical conditions (3.5 (SD 2.1) and 3.4 (SD 2.2), respectively), and current medications ranged from 0 to 19 across all participants (mean 4.5). Gait speed was the slowest in German and Danish

participants (1.0 (SD 0.2) m/s in both sites). Mean BMI was 28.9 (SD 5.2) kg/m^2. Self-reported SB did not differ between weekdays vs. weekend days among the overall sample. The self-reported average mean hours/day in SB was 7.75 (SD 2.9).

Composition of accelerometer-measured SB and PA

Overall, participants spent 78.8% of daily awake time in SB, 18.6% in LPA, and 2.6% in MVPA (375 participants with less than 1%). Participants in Denmark showed the highest percentage of daily awake time in SB (81%), followed by participants from Spain (79.2%), Germany (78.4%) and the UK (76.5%). LPA ranged from 17.2% of waking time among participants from Denmark to 19.8% among participants in the UK. MVPA accounted for less than 4% of waking time across all four sites (Denmark 1.8%; Spain 2.3%; Germany 2.7%; and UK 3.7%). Accelerometry showed minimal differences by sex (data not in table), with women engaging in more LPA (19.7% (SD 5.6) vs. 16.6% (SD5.5)) and walking (5099 steps/day (SD 2436.1) vs. 4987 steps/day (SD 2839.7)) and men engaging in higher amounts of MVPA (2.8% (SD 2.6) vs. 2.5% (SD 2.1)).

Participants in the UK took the highest mean number of daily steps with 5839 (SD 2985), with participants from Denmark taking the lowest (mean 4420 (SD 2410)).

Figure 1 shows the sample composition of time spent in SB, LPA, and MVPA for the whole sample, by means of a matrix of ternary plots with the three behaviors represented at a time. Ternary plots can be understood as the scatterplots of compositions. The overlap of points towards the SB corner indicates the highest data concentration in this behavior. The dispersion structure is represented by 99% and 95% normal-based probability regions around the compositional center. These reflect that the highest variability is found in the direction of MVPA, with some variability towards the LPA.

The variability of the data is summarized in the variation matrix (**Supplemental file 1**) containing all pair-wise log-ratio variances. A value close to zero implies that the time spent in the two behaviors involved in the ratio (arranged by rows and columns) are highly proportional. For example, the variance of log(SB/LPA) ranges from 0.138 to 0.206, which reflects the highest (proportional) relationship or co-dependence (not correlation in the usual sense) between two behaviors. On the other end, it can be observed that the highest log-ratio variances all involve MVPA, which shows that time spent in MVPA is the least co-dependent on the other behaviors (is independent from LPA and SB).

Self-report context-specific sedentary behavior

Table 2 shows the descriptive statistics of the proportion of time spent in context-specific SBs by participants of the four European countries and by sex. Watching television and reading were the context-specific SBs that accounted for most of the daily time in the four countries (34.8% and 12.4% respectively (i.e. 47.2% of daily waking hours). Distribution of context-specific SBs was broadly similar across countries. The highest proportion of daily sedentary time was spent watching television, and Spain showed the highest percentage with 40.1% (SD 17.8), followed by Denmark (34.2% (SD 14.0)), Germany (33.8% (SD 15.1)), and the UK showing the lowest (31.7% (SD 12.9)). Distribution of activities by sex was similar, with some differences in activities such as doing paperwork (9.9% (SD 11.5) in men and 4.6% (SD 6.9) in women), and doing artwork or crafts (1.3% (SD 4.5) in men and 4.6% (SD 8.5) in women) (**Figure 2**).

Correlates of sedentary time

Table 3 displays correlates of sedentary time according to country of residence, age, sex, civil status, education, medication, gait speed and BMI. Most of the variables had a weak association with daily sedentary time. Participants who were male (women=reference) [β=2.78], those who declared themselves to be single (e.g., had never been married or living with a stable relationship) (not single=reference) [β=1.89], and those with upper-secondary education (education level, primary=reference) [β=1.54] were more likely to be sedentary.

Sedentary time increased with age and number of medications taken, and it was also higher in participants with slower gait speed. For each 10-year increase in age over 65 years (the minimum to be included in the study), sedentary time increased two percentage points (2.3%). A clinically relevant change in gait speed of 0.1 m/s (40) translated into a change of 0.43 percentage points of sedentary time. Compared to obese participants (obese=reference) [β=1], those with who were overweight [β=-1.98] and normal weight [β=-2.77] were less sedentary.

The model accounted for within-country correlation of participants in the same site, which is not negligible as shown by the significant likelihood test comparing this model against a standard regression model with no clustering (p=0.0098).

Discussion

In 1360 participants of a multi-center study including four European countries (the SITLESS-study) we show that participants spent 78.8% of daily awake time in SB, 18.6% in LPA, and 2.6% in MVPA. Accelerometry showed minimal differences by sex with women engaging in more LPA and walking and men engaging in higher amounts of MVPA. Notably, we found

that correlates of SB were broadly similar in the four included countries except for a few minor differences, an observation that enables a relative general preventative strategy applicable to older adults in similar socioeconomic living conditions, irrespective of the country.

A recent study in a cohort of Dutch older adults showed that participants spent on average 65% of total wear time sedentary, 33% performing LPA, and 2% MVPA using the same tri-axial accelerometer worn at the hip (16). The mean age in van Ballegooijen et al.'s (16) study was younger compared with our study (70.7 (SD 8) years vs. 75.3 (SD 6.3)), and this might partly explain the differences. Several studies have reported higher proportions of time spent being sedentary in older age groups using hip-worn accelerometers (41–43). However, the difference noted in daily time in SB and LPA in both studies might also be related to a lower health status reported by the SITLESS participants. In our study, women engaged in more LPA and walking and men engaged in higher amounts of MVPA, while daily SB was similar. Similarly in a recent study, combined categories of SB and PA indicated that men were more often high sedentary and high physically active, while women were more often low sedentary and low physically active (16). These differences could be partly explained by traditional gender roles, where women may be in charge of household chores and thus engaging in LPA, and men being more sedentary at home and engaging in more organized and regimented PA.

In our study, as in previous literature (21), the highest log-ratio variances all involved MVPA, which shows that time spent in MVPA is the least co-dependent with the other behaviors and might be unreliable. As shown in previous studies (44), environmental, social and individual level-determinants for sedentary time are distinct from those linked to the adoption and maintenance of MVPA. As a result, novel intervention strategies that focus on

reducing SB and increasing any intensity of PA by leveraging the surrounding environment (e.g., home) as well as individual-level cues and habits of SB should be designed and tested (45).

The percentage of daily time spent in SB in older adults is concerning. A better understanding of the distribution of movement behavior across the awake-time span will benefit and inform the development of cost-effective public health interventions. Reducing sitting could potentially improve older adults' subjectively and objectively measured health status (46,47) and wellbeing (48). Thus, focusing on ways to reduce sitting with non-sitting activities (e.g., doing some activities which are usually completed in a seated position by standing up) may be a promising first step to address sedentary time among older adults.

Since LPA appears to makeup a larger proportion of the day compared to MVPA in older adults, replacing SB with LPA seems to be the second step to designing successful strategies to enhance movement without immediately increasing MVPA, which might not be feasible for some older adults. This may eventually lead to a progression to higher-intensity activities, if this is safe and appropriate for the individual. Thus, efforts that target SB as a means to increase LPA is a new behavioral leverage-point that could help us increase overall PA and induce health benefits within the population (45). A recent study using isotemporal substitution regression modeling to assess the relationship of replacing the amount of time spent in one activity for another showed that replacing 60 min/d of SB with 10 min/d of MVPA and 50 min/d of LPA was associated with significant improvements in physical function (49). However, there is little evidence to guide SB limiting strategies or LPA promotion activities for older adults (50).

Our study showed that the highest proportion of daily sedentary time was spent watching television (34.8%) and reading (12.4%), with a similar percentage among men and women. Time spent watching television has been related to increased odds for multimorbidity (51), and the risk for multiple chronic conditions has been previously investigated to be higher for those spending more time watching television (52). Being physically active (i.e. spending ≥30 min/d of MVPA for at least 5 days/week) has not only been beneficial for having reduced risk of multiple morbidities, but also helped to attenuate or eliminate the negative role of watching television (51). However, mean MVPA in our older adults accounted for less than 2% of waking hours, highlighting the difficulty of acquiring such benefits in an older adult population and stressing the importance of reducing SB with LPA. Detrimental associations of SB while watching television with various health outcomes (53) may be due to the continuous nature of television viewing and its linked unhealthy behaviors such as eating snacks or smoking. Following our first step approach, breaking television time by simple means (e.g., standing up during advertisement breaks and leaving remote control on TV which would require standing up to switch program) should be a key strategy to reduce the health impact of SB among older adults, and when done with a partner one could act as a reminder to the other.

Distribution of activities by sex, in general, showed some differences such as doing paperwork being more common in men, and doing artwork or crafts being more common in women. Previous research has provided some insight into the type and context of SB and has shown that sitting activities which older adults typically engage in, include watching television, reading, eating meals, using the computer and transport (54). A recent study showed that many sedentary activities are embedded in older adults' lives as part of their daily routines, meaning that they might be difficult to change (55). A small number of

qualitative studies have begun to explore factors that influence older adults' SB. These studies suggest that older adults enjoy, and recognize the physical, social, and mental benefits of some sitting community-based activities (e.g., doing arts, crafts and puzzles) (56,57), but view excessive sitting as unhealthy. However, older adults tend to report that many community activities are not only sedentary (56), but also lack availability of information about community-based resources that lead them to sit more (57). A third-step in the approach to engaging older adults in healthier lifestyles, could be offering information about community-based activities using each country's existing primary prevention pathways (e.g., primary health care professionals in Spain and the UK or preventive home visits in Denmark), ideally thought to engage both men and women according to their preferences, and searching for alternatives to perform such activities in a non-sitting position.

It would also be interesting to know when these context-specific SB activities take place during the day. One study using time-lapse cameras suggested that older adults often sit most in the afternoon and evening (compared with the morning), and when they are alone at home (58). Following our second and third-step approach, promising strategies may be to reduce television time mainly in the afternoon by first, supporting older adults to go out more and engage in community-based activities in local facilities and other resources (e.g. community groups). Supporting older adults to remain socially active will not only support them to reduce SB, but might help enhance new social connections and reduce social isolation, which is associated with poor health (59).

In our study, being older, a man, single, taking more medications per day, and being obese and overweight were important correlates of higher levels of SB time. Recent studies showed that men, those who were older, and those with higher BMI were also found to be more

sedentary (16,28,41,42,60). A previous study among Japanese older adults revealed living alone was significantly associated with prolonged television viewing time (61). Living with a partner was associated with more activity in participants younger than 80 years and in those with BMI ≥ 27 kg/m2 in another study (28). The results from this and previous studies suggest the need for opportunities of focused intervention, highlighting the need to engage older adults in group-based community activities with those sharing a similar profile to themselves (e.g. single or overweight).

SB was also higher in participants with slower gait speed in our study, similar to that reported in another study (16). SB shows a tendency to increase with frailty-related outcomes in the current literature such as age, loneliness, and mobility restrictions (62). Slowing gait may reflect both damaged systems and a high-energy cost of walking (63–65). Gait speed, age, and sex may offer the clinician tools for assessing expected survival to contribute to tailoring goals of care in older adults (66). German and Danish participants showed the slowest gait speed and German participants reported the highest number of medical conditions, probably due to the most common recruitment pathway in Germany that used invitation letters sent from health professionals targeting participants with major health needs. Once again, our fourth-step is that these outcomes should be borne in mind when designing and prioritizing health-related interventions for older adults.

This study has several strengths but also limitations. It is the first study providing a comprehensive description of the composition of accelerometer-measured SB and PA time in a cohort of community-dwelling older adults from four European countries, combining self-reported information not available from accelerometry. However, as the accelerometer was not worn during the 24-hour period, we did not include sleep time in the compositional

analysis, so that the movement composition was assessed as a proportion of wearing time, which may vary among participants. For the current study we could only use a cross-sectional approach and therefore the temporal relationship between the investigated correlates and SB is unclear. The accelerometer presents some well-known limitations to assess posture that could be overcome using an inclinometer (e.g. time spent standing is likely to be classified as sedentary using an accelerometer). In addition, the representativeness for the different populations is difficult to estimate.

Conclusions

This sample of older adults from four European countries on average spent 78.8% of daily awake time in SB, 18.6% in LPA, and 2.6% in MVPA. Accelerometry showed minimal differences by sex with women engaging in more LPA and walking and men engaging in higher amounts of MVPA. The highest proportion of self-reported daily sedentary time was spent watching television and reading. Notably, the distribution of context-specific sedentary activities by country and sex showed only minor differences. Being older, a man, single, taking more medications per day, being obese and overweight, and having a slower gait speed were important correlates of more sedentary time. A clinically relevant change in gait speed can decrease almost 0.45 percentage points of sedentary time. With an ever ageing European population the high amount of SB of our participants emphasizes the need to encourage older adults to reduce sitting time with non-sitting activities.

Conflict of Interest

None reported.

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Table 1. Sociodemographic and movement behavior characteristics of the study sample

	Overall (n=1360)	**Denmark** (n=338)	**Spain** (n=356)	**UK** (n=321)	**Germany** (n=345)
Age: years, mean (SD)	75.3 (6.3)	77.4 (5.7)	76.0 (6.5)	72.8 (5.7)	74.8 (6.2)
Sex: n (%) women	840 (61.8)	197 (58.3)	273 (76.7)	172 (53.6)	198 (57.4)
Civil status: n (%)					
Single	117 (8.9)	43 (13.0)	28 (8.2)	19 (6.0)	27 (8.3)
Married/Stable relationship	690 (52.6)	149 (45.2)	173 (50.9)	186 (58.5)	182 (56.0)
Widow/Widower	354 (27.0)	104 (31.5)	111 (32.6)	71 (22.3)	68 (20.9)
Divorced	147 (11.2)	34 (10.3)	28 (8.2)	42 (13.2)	43 (13.2)
Unknown	5 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.5)
Education: n (%)					
I do not know how to read or write	5 (0.4)	0 (0.0)	5 (1.5)	0 (0.0)	0 (0.0)

I know how to read and write	36 (2.7)	1 (0.3)	34 (10.0)	0 (0.0)	1 (0.3)
Primary education	279 (20.8)	97 (28.9)	151 (44.3)	20 (6.3)	11 (3.2)
Secondary Education	712 (53.2)	195 (58.0)	105 (30.8)	167 (52.2)	245 (71.6)
University	303 (22.6)	42 (12.5)	45 (13.2)	132 (41.3)	84 (24.6)
Unknown	3 (0.2)	1 (0.3)	1 (0.3)	1 (0.3)	0 (0.0)
Number of self-reported medical conditions: mean (SD)	2.9 (2.1)	2.9 (1.8)	3.4 (2.2)	1.9 (1.7)	3.5 (2.1)
Number of current medications: mean (range)	4.5 (0-19)	4.0 (0-14)	4.0 (0-17)	4.9 (0-19)	4.4 (0-16)
BMI: mean (SD)	28.9 (5.2)	27.4 (5.0)	29.8 (4.9)	29.0 (5.1)	29.3 (5.6)
BMI categories: n (%)					
Underweight and normal	301 (22.3)	111 (33.0)	54 (15.3)	68 (21.3)	68 (19.7)
Overweight	555 (41.1)	136 (40.5)	140 (39.8)	131 (41.1)	148 (42.9)
Obese	496 (36.7)	89 (26.5)	158 (44.9)	120 (37.6)	129 (37.4)

Gait speed: mean (SD)	1.1 (0.3)	1.0 (0.2)	1.1 (0.3)	1.2 (0.2)	1.0 (0.2)
Self-report SB: hours/day, mean (SD)					
7-days	7.75 (2.9)	7.93 (2.7)	7.46 (3.3)	7.86 (2.8)	7.72 (2.5)
Weekday	7.82 (3.0)	7.85 (2.8)	7.59 (3.6)	8.08 (3.1)	7.78 (2.6)
Weekend day	7.54 (3.0)	8.13 (2.9)	7.05 (3.2)	7.30 (2.8)	7.62 (2.7)
Accelerometry[a]**:**	n=1266	n=326	n=313	n=310	n=317
% daily sedentary time	78.8 (7.0)	81.0 (6.6)	79.2 (6.6)	76.5 (6.5)	78.4 (7.4)
% daily LPA time	18.6 (5.8)	17.2 (5.6)	18.5 (5.9)	19.8 (5.2)	18.9 (6.1)
% daily MVPA time	2.6 (2.3)	1.8 (1.8)	2.3 (1.9)	3.7 (2.6)	2.7 (2.2)
Number daily steps, mean (SD)	5056.0 (2596.9)	4420.1 (2409.7)	5225.7 (2302.8)	5838.5 (2985,3)	4777.1 (2439.5)
MVPA daily counts, mean (SD)	2945.3 (386.8)	2915.3 (352.4)	2844.7 (335.8)	3062.3 (388.0)	2961.1 (433.6)
Daily wear time, hours,	14.4 (1.1)	14.5 (1.1)	14.3 (1.2)	14.3 (1.1)	14.3 (1.2)

mean (SD)

a n of participants with valid accelerometry data.

Table 2. Compositional descriptive statistics of the percentage of daily time spent in context-specific sedentary behaviors by country

	Overall[a] (n=1230)	Denmark (n=325)	Spain (n=284)	UK (n=309)	Germany (n=312)	Overall men (n=474)	Overall women (n=756)
Daily %							
Watching television	34.8 (15.3)	34.2 (14.0)	40.1 (17.8)	31.7 (12.9)	33.8 (15.1)	34.6 (15.4)	35.0 (15.2)
Playing computer games	3.6 (7.2)	3.6 (7.4)	3.6 (7.3)	2.7 (5.8)	4.4 (7.8)	2.9 (6.6)	4.1 (7.5)
Sitting listening to music / radio	5.7 (7.9)	6.2 (8.5)	6.8 (9.3)	5.3 (6.8)	4.6 (6.6)	6.3 (8.0)	5.4 (7.8)
Sitting and talking on the phone	4.2 (4.1)	3.7 (3.2)	4.6 (5.3)	4.2 (3.6)	4.3 (4.0)	3.4 (3.3)	4.7 (4.4)
Doing paperwork	6.6 (9.3)	7.5 (8.8)	3.7 (7.4)	7.4 (9.4)	7.4 (10.7)	9.9 (11.5)	4.6 (6.9)
Sitting reading	12.4 (9.2)	14.0 (9.8)	9.9 (8.8)	10.3 (7.6)	15.1 (9.3)	12.6 (9.6)	12.3 (9.0)

Playing a musical instrument	0.4 (2.0)	0.5 (2.6)	0.2 (1.7)	0.5 (2.0)	0.4 (1.6)	0.6 (2.4)	0.3 (1.8)
Doing artwork or crafts	3.4 (7.4)	2.8 (7.1)	5.0 (8.5)	3.5 (8.0)	2.2 (5.5)	1.3 (4.5)	4.6 (8.5)
Sitting and driving in a car	7.7 (6.5)	8.3 (6.4)	5.5 (5.2)	10.6 (7.4)	6.2 (5.3)	8.9 (7.3)	6.9 (5.7)

[a] n of participants with valid accelerometry and Sedentary Behavior Questionnaire data.

Table 3. Mixed linear regression analysis of correlates of sedentary time[a] per country

	SITLESS overall sample (n=1360)		
	β	95% CI	p-value
Constant	89.85	(86.39, 93.32)	<0.001
Site (Denmark = reference)			
Spain	-0.22	(-1.25, -0.81)	0.671
UK	-3.14	(-4.18, -2.10)	<0.001
Germany	-2.95	(-3.97, -1.93)	<0.001
Age (years)	0.23	(0.17, 0.29)	<0.001
Sex	2.78	(2.05, 3.52)	<0.001
Men (women=reference)			
Civil status	1.89	(0.67, 3.12)	0.002
Single (not single=reference)			
Education level (primary=reference)			
Secondary	0.83	(-0.11, 1.77)	0.084
Higher	1.54	(0.39, 2.69)	0.009
Number of current medications	0.36	(0.24, 0.47)	<0.001
BMI (Kg/m^2) (obese=reference)			

Under or normal weight	-2.77	(-3.74, -1.80)	<0.001
Overweight	-1.98	(-2.79, -1.17)	<0.001
Gait speed (m/sec)	-4.29	(-5.83, -2.75)	<0.001

[a] Expressed as percentage of total wear time.

Likelihood test for the cluster component p=0.0098

SE: Unstandardized regression coefficients and standard errors; CI: confidence interval; BMI:
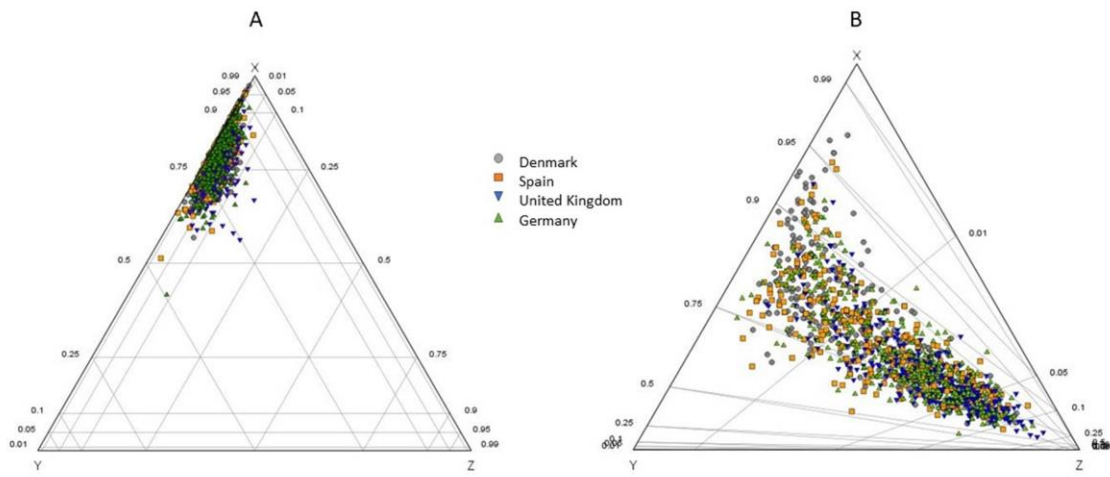
body mass index

Figure 1. Ternary plots of the sample composition of time spent in sedentary behavior (X),
light physical activity (Y), and moderate-to-vigorous physical activity (Z) for the whole
sample (A), and for the whole sample centered (B).

Figure 2. Distribution of daily time spent in context-specific sedentary behaviors by sex and
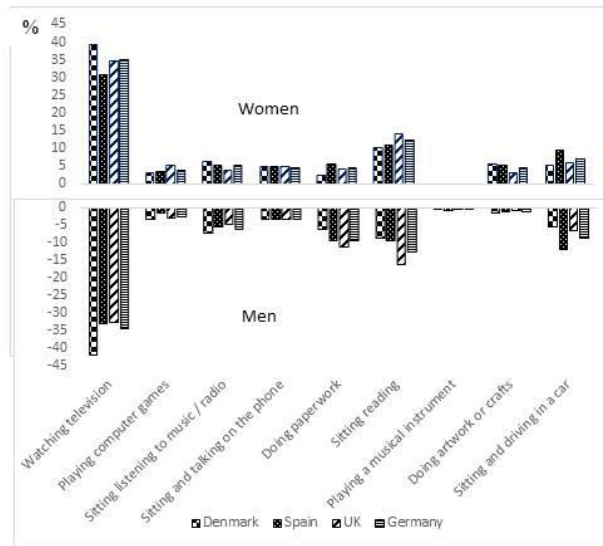country

Figure_1

Figure_2