Associations between hospitalization and device-assessed physical activity in a representative sample of European older adults

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Abstract

Background

Evidence investigating associations between hospitalization and physical activity is scarce and limited to specific populations of older adults. The current study aimed to describe the impact of past hospitalization on current physical activity levels of a large representative sample of European older adults with accelerometry data.

Methods

A representative sample of 856 European older adults aged 50 years and over were included in this study. Hospital admission and utilization (i.e., accumulated times and length of stay in hospital) in the last 12 months were self-reported retrospectively. Physical activity volume (m*g*) and distribution of intensity (intensity gradient) were assessed with thigh-worn accelerometers.

Results

Multivariate linear regressions indicated that hospital admission (15% of the sample) was associated with reduced physical activity volume (-4.29 m*g* [95% Confidence Interval, 95%CI, -9.07 to 0.47]) of participants. Each additional hospital admission was associated with lower volume (-2.29 m*g* [95%CI, -4.65 to 0.06]) and poorer distribution of intensity (-0.07 [95%CI, -0.11 to -0.04]). Total length of stay was not assocoiated with physical activity.

Conclusions

This study suggests that hospital admission and the number of times admitted, but not accumulated length of stay, may curb physical activity levels of older adults. Public-health strategies to promote successful aging should target post-hospitalization physical activity.

Keywords: acceleration; data-driven physical activity metrics; inpatients; physical activity intensity; health care use

Introduction

Acute hospitalized older adults spend most of their hospital time sedentary, usually in bed[1]. Firm evidence is now accumulating demonstrating that pathophysiologic mechanisms underlying immobility are associated with an increased general deconditioning[2], including dramatic declines in physical function[3]. This condition of increased vulnerability after hospitalization may also result in higher levels of fatigue and limited long-term engagement in physical activity[4,5]. This is important because low physical activity is a well-established major risk factor for disease, disability, morbidity, and mortality[6].

Notwithstanding this evidence, to date the long-term association between hospitalization and physical activity levels remains under-researched[7,8]. A previous study reported an inverse association between accumulated hospitalization time and device-assessed physical activity time amongst a cohort of US older adults (≥70 years) with impaired mobility[7]. Despite its relevance, this study by Wanigatunga et al. is not representative of the general older population (i.e., they targeted mobility-impaired very old adults) which may limit the generalization of their results to broader populations of older adults.

The current study aimed to describe the impact of past hospitalization on current physical activity levels of a large representative sample of European older adults aged 50 years and over with available accelerometry data.

Methods

Dataset and measures

Data for this retrospective study were drawn from the Survey of Health, Ageing, and Retirement in Europe (SHARE), a study recruiting representative samples of individuals aged

50 or older from 27 European countries and Israel[9]. For the current study, we only considered wave 8 (2019-2020) of SHARE because it was the wave for which accelerometry data was available. A subsample of 856 individuals from Belgium, Czech Republic, Denmark, France, Germany, Italy, Poland, Slovenia, Spain, Sweden provided at least 1 day of valid accelerometer data and were included in this study. Further details on the SHARE ancillary accelerometer study are reported elsewhere[10]. The present study was reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

Participants were asked to wear an Axivity AX3 accelerometer (Axivity Ltd, Newcastle upon Tyne, United Kingdom) for eight consecutive days (day and night) on their upper thigh. The AX3 accelerometers were initialized to collect data with a sampling frequency of 50Hz and a dynamic range between ±8g. Raw accelerometer data were processed with GGIR following previously validated standards[11]. Three different data-driven metrics representative of daily physical activity levels and patterns were derived for each of the participants in this study[12]: (1) average acceleration during the 24-hour day (proxy for physical activity volume, m*g*); (2) intensity gradient during 24 hours (intensity distribution of activity during the day; higher values indicate that a greater proportion of total activity is spent at higher intensity); and (3) minimum acceleration achieved for a given duration—MX where X refers to the duration, e.g. M60 refers to the minimum acceleration for the most active accumulated 60 min of the day. Five different MX metrics were computed to cover different periods of interest for a given day (in minutes; M30, M60, M120, M480, and M960).

Participants self-reported on whether they stayed in hospital overnight during the last 12 months (hospital admission; yes/no). If participants reported to have stayed overnight in hospital, they were asked to report the number of separate hospital overnight admissions during the last 12 months. Lastly, participants were asked to report the total number of nights spent in hospital during the last 12 months (i.e., total accumulated length of stay).

Covariates considered in this study included self-reported age (years), sex (female/male), level of education according to the ISCED-97[13], country of birth, number of major chronic conditions, mobility index (calculated as the sum of self-reported difficulty to walk 100 meters—yes, 1; no, 0—, difficulty to walk across a room, difficulty to climb several flights of stairs and difficulty to climb one flight of stairs; the higher the index (range 0 to 4), the more difficulties with these activities exist and the lower the mobility of the respondent), body mass index (kg/m^2), self-reported ever smoked (yes/no), percentile of household income, depression (EURO-D depression scale[14]), number of valid days of accelerometer data, and Oxford stringency index (i.e., strictness of 'lockdown style' policies that primarily restricted people's behavior during COVID19 times[15]).

Analytical approach

We described the sample by hospital admission status (admitted vs not admitted) using the mean (standard deviation) and percentages for continuous and categorical variables respectively. We used multivariate linear regression models to explore the associations between hospitalization and physical activity in the study sample. Calibrated wave-specific weights were used in all models to ensure the representativeness of the sample. All models were adjusted for the covariates described above. Variation inflation factor (VIF) indicated no multicollinearity amongst predictors in all cases (i.e., VIF<2). To enhance the interpretation of our data, the marginal means MX metrics were plotted on radar plots so that the distribution of physical activity volume and intensity across the day could be visualized and compared across participants previously admitted to hospital and those who were not[16]. To further explore whether the distribution of physical activity intensity differed when activity volume was similar, we plotted the distribution of the marginal means of the MX metrics (standardized) for participants in the mid-tertile average acceleration separately for non-admitted, admitted only once, and admitted 2 times or more (i.e., median of admissions) participants[16]. All computations were done in R 4.2.1 (R Core Team, 2017).

Results

eTable 1 shows the baseline sample characteristics stratified by hospital admission status. Participants who were admitted to hospital had more chronic conditions, had more mobility issues, and were significantly less active overall than their counterparts not hospitalized

In fully adjusted analyses, hospital admission was associated with lower average 24h acceleration by -4.29 m*g* (95% Confidence Interval, 95%CI, -9.07 to 0.47; Table 1). Figure 1 illustrates the intensity distribution of physical activity of hospitalized and non-hospitalized individuals using the MX metrics. Overall, hospitalized participants reached similar intensities for the most active 30 and 60 minutes of the day, but tended to reach lower intensities for the longer durations (>120 min).

Results from adjusted models indicate that increasing the number of times admitted to hospital was associated with lower average 24h acceleration (-2.29 m*g* per additional admission [95%CI, -4.65 to 0.06]; Table 1). Accruing more times in hospital was also associated with a significantly lower intensity gradient (-0.07 per additional admission [95%CI, -0.11 to -0.04]; Table 1). Total length of stay was not associated with any of the assessed physical activity metrics in the study sample (Table 1).

Figure 2 illustrates the marginal means for the MX metrics for study participants with similar average acceleration (mid-tertile), but with a different hospital overnight admissions profile (i.e., non-admitted, admitted only once, and admitted 2 or more times). Lower intensity as the number of admissions increased was particularly evident for M960 and M480. Participants admitted 2 or more times additionally displayed a lower intensity for M120, M60, and M30 compared with those non-admitted or admitted only once.

Discussion

Hospital admission may result in substantial reductions of physical activity amongst older adults. We found that every additional hospitalization may reduce total volume of physical activity by 4 mg, an amount of activity 4-*fold* of what is considered clinically relevant[17]. In addition, those who had accrued more times in hospital had a less favorable 24 h intensity distribution, characterized by a higher proportion of low intensity activity. This less favorable intensity distribution profile was especially evident amongst participants admitted to hospital 2 times or more. Future public health strategies should target post-hospitalization physical activity to promote healthy aging.

Our findings, particularly the lower intensity across the most active 8-16 h per day in those that had been hospitalized, are consistent with those from a previous study conducted in older stroke survivors that reported higher sedentary behavior levels after hospitalization—a behavior that remained 6 months after discharge[8]. Analogous observations have also been documented among mobility-impaired very old adults[7]. The loss of muscle mass and declines in physical functioning consequential of the large bedrest periods during acute hospitalization[18] may explain the large decreases in physical activity observed in this, and previous studies.

A novelty in this study was the use of data-driven metrics to document the impact of hospitalization on the intensity distribution of physical activity (i.e., MX and intensity gradient). This facilitated examination of the entire profile of physical activity, avoiding the well-known limitations of applying cut-points, and demonstrating that the lower volume of physical activity resulted from decreased intensity of activity across the whole day.

A key strength of our study is the large, representative, geographically diverse sample of European older adults with available accelerometry data, which permitted the objective assessment of physical activity in our sample. However, a study limitation is its reliance on a self-reported measurement of hospitalization, which may be affected by recall bias. Time elapsed from hospitalization to physical activity assessment was not available, which may have introduced further unmeasured uncertainty in our models. Despite the comprehensive set of covariates used in this study, residual confounding may still be present. Nevertheless, the retrospective nature of the exposure assessment allowed the temporal sequence of risk factors (i.e., hospitalization) and outcomes (i.e., physical activity) to be assessed. Because prior levels of physical activity were not available, caution should be executed when interpreting our results.

In conclusion, this study shows that hospital admission may reduce the overall physical activity level of older adults. Accruing more admissions to hospital may lower both the volume and intensity of physical activity of older adults. Total length of stay was not associated with physical activity in this study. Public-health strategies to promote successful aging should target post-hospitalization physical activity, particularly among older adults with a history of admission to hospitals.

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Conflict of interest

The authors declare no conflict of interest.

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Table 1. Associations between hospitalization and different metrics of physical activity (n= 856)

	Exposure (Hospitalization)		
Outcomes	Hospital admission (yes/no)	Accumulated hospital stays (total times)	Accumulated length of stay (total nights)
Physical activity volume (mg)	-4.29 (-9.07 to 0.47)	-2.29 (-4.65 to 0.06)	-0.10 (-0.24 to 0.04)
Intensity gradient	-0.02 (-0.10 to 0.06)	-0.07 (-0.11 to -0.04)	0.00 (-0.00 to 0.00)

Estimates are beta and 95% Confidence Interval, CI.
All models were adjusted for age, sex, level of education, country of birth, number of major chronic conditions, mobility index, body mass index, ever smoked status, percentile of household income, depression, number of valid days of accelerometer, and Oxford stringency index. Calibrated wave-specific (household) weights were used in all models to ensure the representativeness of the sample.

Figure legends

Figure 1. Radar plot illustrating MX metrics (marginal means) for (clockwise) the most active 960 min of the day (M960), 480 min (M480), 120 min (M120), 60 min (M60), and 30 min (M30) for admitted and non-admitted participants.

Figure 2. Illustration of the distribution of the MX metrics (marginal means, standardised) for participants in the mid-tertile average acceleration separately for non-admitted, admitted only once, and admitted 2 times or more (i.e., median of admissions) participants. As the MX metrics are standardised within metric the mean = 0 (dashed black line) and SD =1.

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List of Online-Only Supplemental Materials

eTable 1. Baseline characteristics of study participants by hospital admission status (n=856)

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	Overall	Admitted	Non-admitted	*p*-value[b]
Sample size	856	133	723	
Number of separate hospital overnight admissions (total times)	0.24 (0.70)	1.56 (1.07)	-	-
Accumulated length of all hospital stays (total nights)	1.70 (11.00)	10.91 (26.11)	-	-
Age (years)	69.09 (8.96)	71.38 (8.78)	68.67 (8.93)	0.001
Female, *yes*, n (%)	499 (58.3)	71 (53.4)	428 (59.2)	0.248
Education (ISCED 97), n (%)				0.731
None	14 (1.6)	1 (0.8)	13 (1.8)	
Primary education or first stage of basic education	117 (13.7)	19 (14.3)	98 (13.6)	
Lower secondary or second stage of basic education	138 (16.1)	20 (15.0)	118 (16.3)	
(Upper) secondary education	341 (39.8)	56 (42.1)	285 (39.4)	
Post-secondary non-tertiary education	32 (3.7)	3 (2.3)	29 (4.0)	
First stage of tertiary education	203 (23.7)	32 (24.1)	171 (23.7)	
Second stage of tertiary education	6 (0.7)	2 (1.5)	4 (0.6)	
Other	5 (0.6)	0 (0.0)	5 (0.7)	
Chronic conditions[a] (number)	1.29 (1.24)	1.95 (1.44)	1.17 (1.16)	<0.001
Mobility index (0-4, higher values represent increased mobility issues)	0.53 (0.99)	0.92 (1.18)	0.46 (0.93)	<0.001
Body Mass Index (Kg/m^2)	26.98 (6.73)	27.05 (7.59)	26.97 (6.56)	0.897
Ever smoked, *no*, n (%)	444 (51.9)	64 (48.1)	380 (52.6)	0.397
Household income percentile (0-10, higher levels represent wealthier households)	5.64 (2.82)	5.41 (2.75)	5.68 (2.84)	0.314
Depression (EURO-D scale, 0-12; 0, not depressed; 12, very depressed)	2.32 (2.51)	2.67 (2.80)	2.25 (2.45)	0.077
Total volume of physical activity (average 24h acceleration, m*g*)	27.85 (19.89)	24.75 (17.67)	28.42 (20.23)	0.050
Intensity Gradient	-2.47 (0.47)	-2.56 (0.55)	-2.45 (0.46)	0.021
M30 (m*g*)	118.00 (69.62)	112.18 (78.51)	119.07 (67.86)	0.294
M60 (m*g*)	95.86 (58.10)	90.11 (63.16)	96.92 (57.10)	0.214
M120 (m*g*)	74.36 (44.59)	68.23 (42.71)	75.48 (44.86)	0.085
M480 (m*g*)	45.95 (29.08)	41.40 (25.83)	46.79 (29.58)	0.049
M960 (m*g*)	35.78 (24.35)	31.60 (21.01)	36.55 (24.86)	0.031
Number of valid accelerometry days	7.48 (1.57)	7.60 (1.68)	7.45 (1.55)	0.318

Oxford stringency index (0-100, higher values represent more stringent policies against people's behaviors during COVID19)	14.50 (20.59)	15.23 (21.05)	14.37 (20.52)	0.658

Values represent Mean (SD) unless specified otherwise.

[a]Count of chronic conditions including heart attack, high blood cholesterol, stroke or cerebral vascular disease, diabetes or high blood sugar, chronic lung disease, cancer or malignant tumour, stomach or duodenal ulcer, peptic ulcer, Parkinson disease, cataracts, hip fracture or femoral fracture.

[b]One-way ANOVA for continuous variables and Chi Square Test for categorical variables