Changes in Muscle Strength and Physical Function in Older Patients During and After Hospitalisation: a Prospective Repeated-Measures Cohort Study

Peter Hartley [1,2]*, Roman Romero-Ortuno[3], Ian Wellwood[1], Christi Deaton[1]

[1]Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK
[2]Department of Physiotherapy, Cambridge University Hospital NHS Foundation Trust, Cambridge, UK
[3]Discipline of Medical Gerontology, Trinity College Dublin, Mercer's Institute for Successful Ageing, St James's Hospital, Dublin, Ireland.

* Corresponding author: Peter Hartley ph492@medschl.cam.ac.uk

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Key points:

- Functional ability was reduced at 4-6 weeks after hospital discharge compared to two weeks prior to hospital admission.
- Functional mobility improved during hospitalisation but no changes were observed after discharge from hospital.
- There was an average 11% average reduction in knee-extension strength during hospitalisation.
- There was no recovery in knee extension strength at four to six weeks post hospitalisation.
- Higher levels of reduction in knee extension strength were associated with an increased amount in sedentary time.

ABSTRACT

Aim

To investigate changes in knee-extension strength and physical function in older adults during and after acute hospital admission, and the contributions of illness severity, frailty and sedentary activity to changes in knee-extension strength.

Methods
Prospective repeated-measures cohort study on a sample of participants aged ≥75 recruited within 24 hours of acute hospital admission. Knee-extension, grip strength and functional mobility (de Morton Mobility Index (DEMMI)) were measured at recruitment, day 7 (or discharge if earlier), and at follow-up 4-6 weeks later. During the first 7 days, continuous measurement of physical activity and daily measurements of muscle strength were taken. Participants recalled the functional ability they had 2-weeks before admission and self-reported it at follow-up (Barthel Index).

Results
Sixty-five of 70 participants (median age 84 years) had at least one repeated measure of muscle strength in hospital. Knee-extension strength declined during hospitalisation by 11% ($p < 0.001$) but did not change post-hospitalisation ($p = 0.458$). Grip strength did not change during hospitalisation ($p = 0.665$) or from discharge to follow-up ($p = 0.508$). General functional ability (Barthel Index) deteriorated between 2 weeks before admission and follow-up ($p < 0.001$). Functional mobility (DEMMI) improved during hospitalisation ($p < 0.001$) but did not change post-hospitalisation ($p = 0.508$).

A repeated-measures mixed model showed that greater loss in knee-extension strength during hospitalisation was associated with increased sedentary time, frailty, and baseline strength, and lower baseline inflammatory levels.

Conclusions
Our observations add to a growing body of evidence on potential risk factors for hospital-associated deconditioning.

Background

Approximately 30% of older people admitted to an acute hospital ward develop new dependencies in activities of daily living (ADLs) [1]. Whilst causes are not well understood, one is thought to be skeletal muscle wasting and/or loss of muscle strength [2]. A systematic review and meta-analysis suggested that adults experiencing an unplanned hospital admission may lose mid-arm circumference and knee-extension strength [3]. This may not be generalisable to all adults; however, it is consistent with results of studies on the effect of bed rest in healthy volunteers [3].

The extent to which muscle strength and function deteriorate during an acute hospital admission has been theorised to be a product of three factors: acute illness severity (stressor), pre-existing vulnerability (frailty), and physical inactivity during admission [4]. Several studies have demonstrated an association between reduced muscle strength and inflammation [3]. Frailty results from a multi-system reduction in reserve capacity to the extent that a number of physiological systems are close to, or past, the threshold of symptomatic clinical failure [5]. Regarding the potential contribution of physical inactivity to muscle strength loss, there is considerable supporting evidence in healthy populations [6], but less so in acutely hospitalised older adults [3], where organisational factors and processes of care may play a significant role. Recent evidence has shown that in older inpatients, physical activity levels can be feasibly measured by wearable accelerometery [7].

This study aimed to investigate changes in knee-extension muscle strength in older patients during and after acute hospital admission. We also explored the potential contributions of acute illness severity, frailty and sedentary activity to these changes.

Method

Setting

Patients were recruited from Cambridge University Hospitals NHS Foundation Trust (CUH), a large tertiary hospital in England with 1000 acute beds. Follow-up measures were collected at participants' residences or in an outpatient clinic.

Study Design

This was a prospective repeated-measures cohort study. Ethical approval was granted by the London Queen Square Research Ethics Committee (17/LO/1817). All participants provided written informed consent.

Sample

Patients admitted to CUH between January and December 2018, aged 75 or older, and expected to be hospitalised for at least 48 hours were eligible for inclusion. Patients were excluded if: they were admitted for more than 24 hours before recruitment; unable to provide informed consent; receiving end-of-life care or treatment for diagnosed cancer; unable to co-operate in muscle strength testing; transferred to or from the intensive care unit; bed-bound; or requiring a hoist to transfer from bed to chair 2 weeks before hospitalisation. Sampling was convenience-based and recruitment took place Monday to Friday, 08:00 to 18:00. On recruitment days, all patients admitted in the previous 24 hours and aged 75 years or older were consecutively screened.

Procedures

All measurements were taken by a single assessor. Measurements of muscle strength and functional mobility were taken at recruitment, day 7 of admission (or discharge if earlier) and at follow-up 4-6 weeks after discharge. During the first 7 days of admission, daily measurements of muscle strength were taken. A procedural target was for subsequent measurements of strength to be taken no sooner or later than 2 hours of the initial time of assessment. A summary of measurements taken and at what time points is presented in Appendix 1 (available in *Age and Ageing* online).

Measurements

Knee-extensor muscle strength and grip strength were measured using hand-held dynamometry (HHD). Knee-extensor HHD (using the microFET 2, Hoggan Scientific, Salt Lake City, Utah) was measured in participants seated with their knee at 90° with the HDD perpendicular to the leg above the superior border of the lateral malleolus; patients were asked to push against it with maximum effort [8]. The HHD was tethered to a stationary object whilst the researcher held it in place to prevent the leg from moving. Force was converted to torque (Nm) by multiplying the result by the distance between the superior border of the lateral malleolus and superior border of the lateral femoral epicondyle. Grip strength HHD (using the JAMAR device, Sammons Preston, Bolingbrook, Illinois) was measured with participants seated with their elbow at 90° and their wrist in neutral position; participants were instructed to squeeze as hard as possible for at least five seconds, or until the reading of force started to drop [9]. With both knee-extensor and grip strength dynamometry readings, participants were asked to repeat the procedure three times on both their left and right sides; the highest force measurements from each side were then averaged to provide the score.

The de Morton Mobility Index (DEMMI) [10] was used to measure functional mobility. The DEMMI is a 100-point practitioner-measured scale for the assessment of mobility in older acute medical patients and consists of

15 items ranging from bed mobility to high levels of dynamic balance. A score of 100 represents best functional mobility. The assessor scored the DEMMI during the baseline assessment by observing each participant perform the standard mobility tasks.

Self-reported general functional ability on admission and at follow-up was measured with the Barthel Index (BI) [11]. The BI is a 10-item scale (0–100) of functional independence in ADLs. A score of 100 represents highest functional independence. After recruitment, participants were asked to recall their functional ability two weeks before admission on the BI scale. No specific script was used, but the assessor confirmed this time frame via discussion with each participant.

The following variables were also collected after recruitment: age; sex; weight; Charlson Comorbidity Index (CCI) [12]; Falls Efficacy Scale – International (FES-I) [13]; Mini Addenbrooke's Cognitive Examination (Mini-ACE) [14]; and length of hospital stay. Serum C-reactive protein (CRP) levels, collected routinely on admission, were used as a proxy measure of acute illness severity.

Frailty was measured using the Frailty Instrument of the Survey of Health, Ageing and Retirement in Europe (SHARE-FI), which is a physical phenotype-based tool measuring markers of exhaustion, unexplained weight loss, weakness, slowness and low physical activity [15]. SHARE-FI was collected by the assessor following measurement of grip strength and four additional self-reported questions from participants; data was entered on the freely available SHARE-FI online calculators [15].

Finally, the objective levels of physical activity in hospital were measured by wearable accelerometry. For this, we used two AX3 accelerometers (Axivity, Newcastle upon Tyne, UK) attached with adhesive dressing to each participant's leg; one was attached to the mid-thigh and one to the lower leg. The accelerometers were fitted after participants provided consent and removed after the last measurements of functional mobility and muscle strength on day 7 (or discharge if earlier). Using a validated methodology, data collected included amount of time lying, sitting, standing and walking [16].

Analysis

Data were analysed with R software [17]. A paired t-test was used to assess changes in strength and function at the various assessment points. To examine the association between possible risk factors and change in knee-extension strength during hospital admission, a repeated-measures mixed model was fitted using the R packages lme4 [18] and lmerTest [19]. This model used a random intercept to account for repeated measures of the same individual during the hospital stay. Time in hospital (days) was treated as a categorical variable so that the relationship between strength and time was not forced to be linear and because patients were discharged from the study from day 2 onwards, such that the sample reduced and characteristics changed daily. The effect of sedentary time on strength each day was of interest, therefore the interaction between sedentary time and day was analysed. For the regression analysis, sedentary time was defined as time spent lying or sitting, as captured by accelerometry.

Results

The study recruited 70 participants, of whom 89% remained on discharge (or day 7 of hospitalisation). Follow-up assessments were completed on 50 of the original cohort. Figure 1 reports reasons for withdrawals during the study.

Baseline characteristics of the cohort are presented in Table 1. Patients participated in the study for a median of 6 (inter-quartile range (IQR): 3 – 7) days whilst in hospital and had a median stay of 8 (IQR: 5 – 14) days. Admission diagnoses are summarised in Appendix 2 (available in *Age and Ageing* online). Of the 50 participants who had follow-up visits, 2 who previously lived in their own homes were discharged to residential care and 7 had new care packages. Before follow-up, 6 of the 50 participants had subsequent admissions to hospital, and 7 reported having fallen.

Hospital activity was measured in 62 of the 65 patients with repeated hospital data for a minimum of 24 hours. In the other three, two had insufficient data, as accelerometers were removed for MRI scans, and one accelerometer had a battery failure. Fifteen participants wore an accelerometer only on their thigh due to skin condition on their lower leg (n = 14) or because the lower-leg accelerometer fell off (n = 1). Patients spent a median 96% of time sitting or lying (sedentary). Further breakdown is presented in Appendices 3 and 4 (available in *Age and Ageing* online).

The changes in physical function and muscle strength observed during and after hospitalisation are presented in Table 2. There was a significant reduction (95% confidence interval (CI) -13.9; -4.5) in the BI in the 50 patients followed up 4-6 weeks after discharge compared to their reported pre-admission level of function. Conversely, DEMMI scores improved from admission to discharge (95% CI: 3.5; 9.5), though there was no significant difference between discharge and follow-up (95% CI: -2.7; 4.6). Knee-extension torque significantly decreased between admission and discharge (95% CI: -8.0; -3.2) a mean change of 11%, and as with the DEMMI there was no difference between the discharge and follow-up values (95% CI: -4.6; 2.1). On average, measurements of strength were a mean of 0.4 (±1.5) hours off the target of being at the same time as the initial assessment. Eighty-eight percent of participants had all strength measurements within the same 2-hour window on subsequent days as their initial readings. The main reasons for the difference in time of day were patient activity, measurements taken early due to the patient discharge, and the availability of the assessor.

The repeated-measures mixed model included 292 in-hospital observations from the 62 participants with accelerometery data, and showed a significant increase in loss of muscle strength as patients' sedentary time increased on days 2 to 7 of the study (Table 3). The relationship between sedentary time and change in knee-extension strength is illustrated in Figure 2. Additionally, the model showed that a higher frailty score and higher baseline knee strength were associated with greater loss in knee strength during the hospital admission.

Discussion

This repeated-measures observational study found that knee-extension strength declined during hospitalisation, but grip strength did not significantly change. A reduction in self-reported ADL performance observed between 2 weeks prior to admission and follow-up (despite improvements in functional mobility during hospitalisation) suggests increased dependence and an incomplete recovery.

The findings of loss of knee-extension strength during hospitalisation are consistent with a systematic review showing small reductions in knee extension strength and muscle mass during unplanned hospital admissions in adults [3]. In a longitudinal study, Alley, Koster [20] showed that hospitalisation was associated with knee extensor strength declines in men, especially for stays of 8 or more days. As regards changes in grip strength, we did not observe change in our study; accordingly, a systematic review observed heterogeneity between studies, in that in some settings or populations it may deteriorate or remain unchanged [3]. The difference between changes in knee-extension strength and grip strength also accord with experimental studies of muscle atrophy during bedrest [21]. Improvement in functional mobility during hospitalisation is a common finding [22-25] and probably reflects recovery from acute illness, though trajectories are known to be heterogenous [26].

As regards the potential contribution of sedentary time, we observed an association with change in knee-extension strength during hospitalisation. This contrasts with negative findings by Bodilsen, Pedersen [22] that knee-extension strength did not change during hospitalisation or at 30 days after discharge in acutely admitted older medical patients; however, this was in a small sample of 33. The phenomenon of hospital-associated functional decline has been frequently hypothesised to be a product of inactivity [27, 28], and the association between sedentary activity and change in muscle strength is well documented in healthy individuals [6]. Our findings contribute new evidence to strengthen the link between observations in clinical practice and in experimental research.

Our study suggested an association between frailty and change in muscle strength during hospitalisation. The results of the repeated-measures mixed model suggested that increased frailty is associated with a higher loss of knee-extension strength during hospitalisation, which seems reasonable in the context of frailty being related to higher risk of poor resolution of homeostasis after stressor events [29]. In addition, the physical frailty phenotype is related to sarcopenia [5], so changes in muscle strength and function are likely to mirror changes in frailty phenotype status.

In the repeated-measures mixed model, higher admission CRP was associated with smaller losses in knee-extension strength. This could be explained by the possibility that higher inflammation during acute illness may more severely impair muscle function and introduce floor effects to muscle strength testing [3], which may disappear if inflammation improves over the hospital stay. In other words, a person with raised initial inflammation may appear to lose less knee-extension strength than an otherwise identical person but with no inflammation. In a situation of persistent high inflammation, there may not be improvements in muscle strength, as seen with grip strength in Norheim, Bautmans [30]. Therefore, due to improvement in strength associated with improved inflammation, it may appear that patients with no inflammation are more likely to experience deterioration in strength during hospitalisation (but remain closer to their pre-illness level of strength), compared to patients with high inflammation.

Our 'real world' observational study has limitations. The use of a convenience sample, the fixed recruitment period based on the availability of a single assessor, and the strict eligibility criteria all mean that the observed functional trajectories may not necessarily be representative of a typical inpatient population. Due to discharges, the repeated measures mixed model became less reliable each day, and patients not lost to follow-up may be healthier than those who were lost. Furthermore, due to the small range of variation in sedentary activity, predicting the response to low level of sedentary activity is not possible. Another limitation is that we did not collect serial CRP measures.

Conclusion

We observed a reduction in knee-extension strength during hospitalisation that was not recovered at 4-6 weeks post hospitalisation. The reduction in knee-extension strength was associated with increased sedentary time during hospitalisation, higher frailty, higher baseline strength and lower baseline inflammatory levels. This adds to a growing body of evidence on risk factors for hospital-associated functional decline, but further research is needed to identify effective multifaceted interventions for its minimisation. A randomised controlled trial of additional physiotherapy during early hospitalisation, which would control for illness severity trends and pre-admission frailty could be a helpful way forward.

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Table 1. Baseline characteristics of included participants with repeated hospital data.

	All	Female	Male
n	65	28	37
Age (years)	84.0 (80.0 — 87.0)	84.0 (80.8 — 87.0)	84.0 (80.0 — 88.0)
CCI	2.0 (0.8 — 3.0)	1.0 (0.0 — 2.0)	3.0 (1.0 — 4.0)
CFS	4.0 (4.0 — 5.2)	4.0 (4.0 — 5.0)	5.0 (4.0 — 6.0)
Weight (kg)	68.0 (56.2 — 77.8)	65.4 (53.9 — 74.5)	73.9 (59.6 — 81.1)
SHARE-FI	3.4 (1.5 — 4.3)	2.2 (1.5 — 3.4)	4.2 (2.5 — 4.9)
FES-I	26.0 (20.0 — 35.0)	27.0 (21.0 — 34.2)	25.0 (19.0 — 35.0)
Mini-ACE	27.0 (25.0 — 29.0)	27.0 (25.8 — 29.0)	27.0 (25.0 — 28.0)

Formal package of care prior to admission	9 (14%)	4 (14%)	5 (14%)
Admissions in previous 12 months	1.0 (0.0 — 2.0)	0.0 (0.0 — 1.2)	1.0 (0.0 — 2.0)
Falls in previous 12 months	1.0 (0.0 — 2.0)	1.0 (0.0 — 2.2)	1.0 (0.0 — 1.0)
Admission CRP (mg/L)	45.9 (7.8 — 124.0)	42.9 (20.1 — 98.6)	45.9 (6.9 — 133.6)
Barthel Index	18.0 (15.0 — 20.0)	19.0 (17.0 — 20.0)	18.0 (15.0 — 20.0)
DEMMI	41.0 (33.0 — 53.0)	37.5 (32.2 — 45.0)	41.0 (39.0 — 57.0)
Right grip strength (kg)	19.0 (14.0 — 25.0)	15.5 (10.0 — 18.0)	24.0 (19.5 — 29.2)
Left grip strength (kg)	19.0 (12.0 — 22.0)	14.0 (10.0 — 19.0)	21.0 (16.0 — 26.2)
Right knee torque (Nm)	45.7 (36.4 — 62.0)	40.0 (35.0 — 48.6)	52.7 (40.0 — 65.5)
Left knee torque (Nm)	46.9 (35.0 — 55.6)	36.7 (30.7 — 47.0)	50.5 (39.7 — 59.4)

Data presented as median (inter-quartile range)

CCI: Charlson Comorbidity Index; CFS: Clinical Frailty Scale; SHARE FI: Survey of Health, Ageing and Retirement in Europe Frailty Instrument; FES-I: Falls Efficacy Scale – International; Mini-ACE: Mini-Addenbrooke's Cognitive Assessment; CRP: C-reactive protein; DEMMI: de Morton Mobility Index; kg: kilograms; Nm: Newton-metres.

Table 2. Changes in physical function measures over time in included participants.

	Admission to Discharge	Discharge to Follow-Up	Admission to Follow-Up	Pre-admission to Follow-Up
Barthel Index	-	-	-	-9.2 (-13.9; -4.5) n = 50 p = <.001*
DEMMI	6.5 (3.5; 9.5) n = 62	1.0 (-2.7; 4.6) n = 49	8.9 (3.7; 14.0) n = 49	-

	p = <.001*	p = .599	p = .001*	
Grip strength (kg)	0.3 (-1.2; 1.9) n = 62 p = .665	-0.6 (-2.3; 1.2) n = 49 p = .508	0.3 (-1.2; 1.7) n = 49 p = .720	-
Knee torque (Nm)	-5.6 (-8.0; -3.2) n = 62 p = <.001*	-1.3 (-4.6; 2.1) n = 49 p = .458	-6.4 (-10.9; -1.9) n = 49 p = .006*	-

Data presented as mean (95% confidence intervals).

DEMMI: de Morton Mobility Index; Kg: kilograms; Nm: Newton-metres.

Table 3. Results of the repeated-measures mixed model for the prediction of change in knee-extension strength (Nm) in included participants (n=62).

Term	Estimate (Nm)	Standard Error	P value	Lower 95% CI	Upper 95% CI
Age	0.13	0.15	.399	-0.16	0.41
Sex = male	3.52	1.80	.055	0.00	7.04
SHARE-FI	-1.27	0.49	.012*	-2.23	-0.31
Baseline knee strength (Nm)	-0.29	0.05	<.001*	-0.39	-0.19
Admission CRP (mg/L)	0.02	0.01	.016*	0.00	0.03
Baseline DEMMI	0.09	0.05	.078	-0.01	0.18
Day 2: Sedentary Hours	-1.56	0.75	.038*	-3.02	-0.10
Day 3: Sedentary Hours	-1.63	0.75	.030*	-3.09	-0.16
Day 4: Sedentary Hours	-2.02	0.80	.013*	-3.59	-0.44
Day 5: Sedentary Hours	-2.59	0.83	.002*	-4.22	-0.96
Day 6: Sedentary Hours	-2.89	0.91	.002*	-4.67	-1.10
Day 7: Sedentary Hours	-2.52	0.93	.007*	-4.33	-0.71

SHARE-FI: Survey of Health, Ageing and Retirement in Europe Frailty Instrument; Nm: Newton-metres; CRP:

C-reactive protein; DEMMI: de Morton Mobility Index

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Figure 1. Flow-chart of participants.

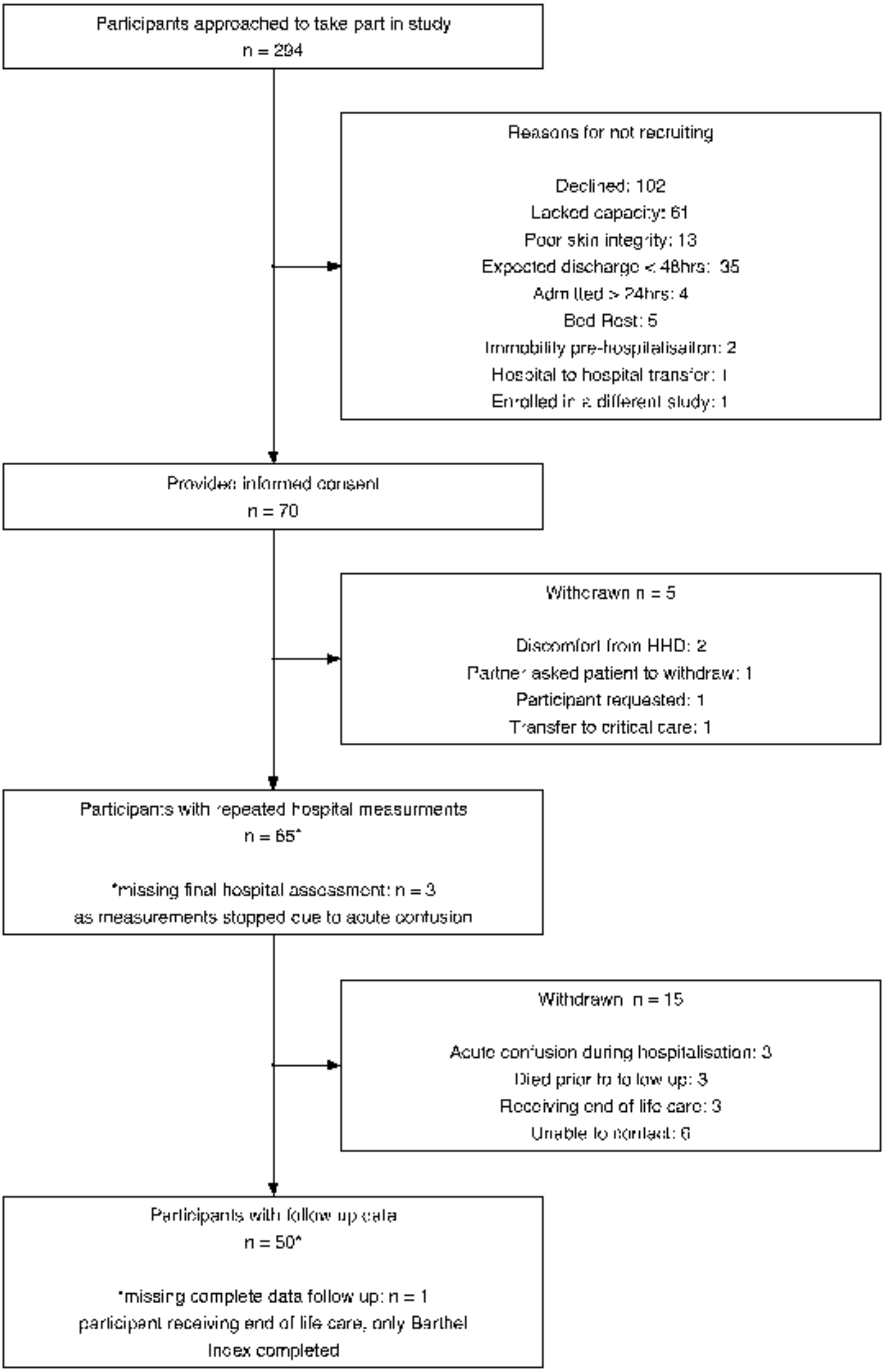
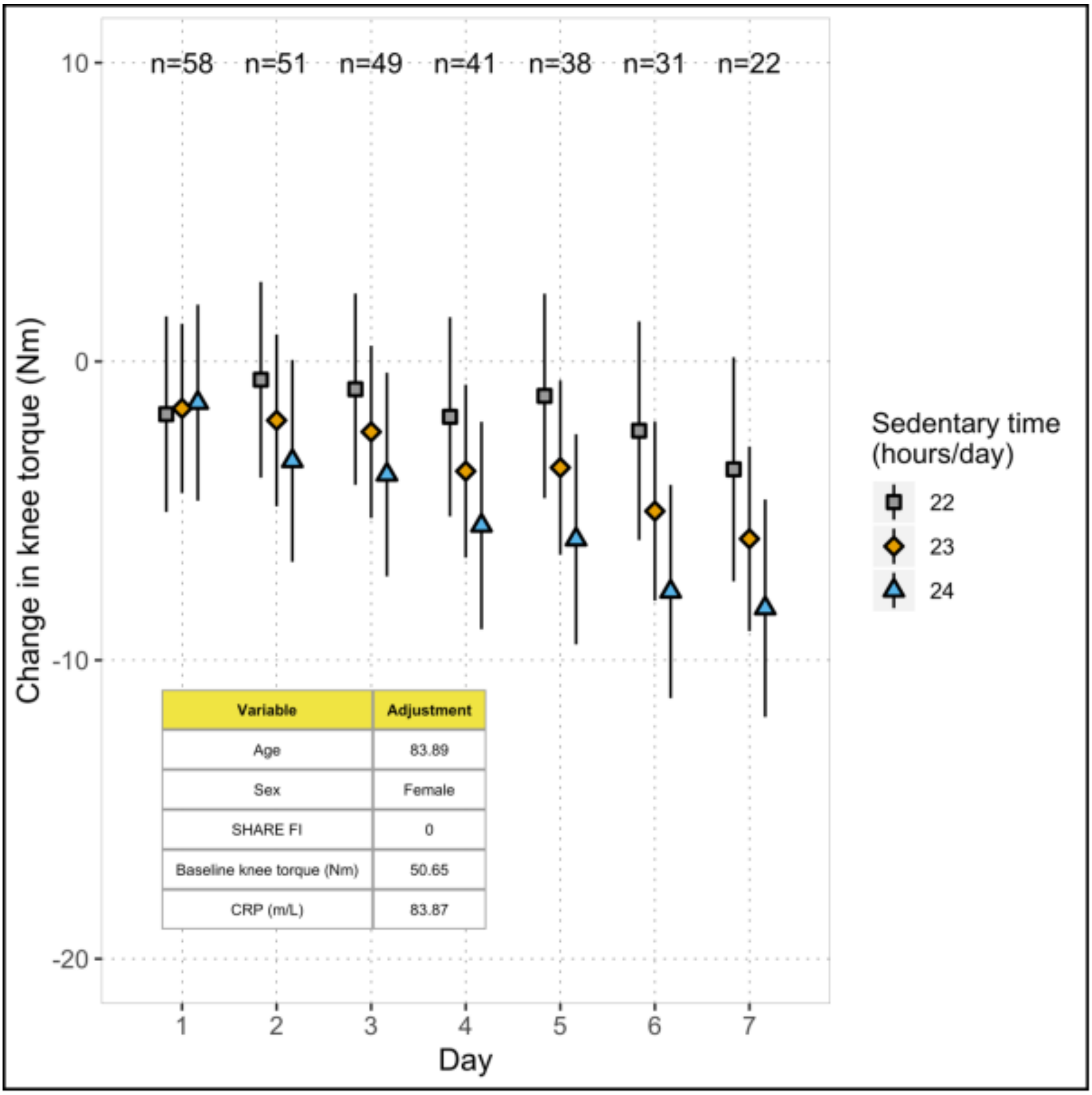


Figure 2. Graphical representation of change in knee torque over time, by sedentary time in included participants (n=62).



Model adjusted for age, sex, frailty, baseline knee torque and baseline CRP.

SHARE FI: Survey of Health, Ageing and Retirement in Europe Frailty Instrument; Nm: Newton-metres.

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SUPPLEMENTARY MATERIAL

Appendix 1: Summary of which measurements were taken at different time points during the study

Appendix 2: Main admission diagnoses based on ICD-10 codes

Appendix 3: Values of participant's hospital activity based on accelerometry data, by gender.

Appendix 4: Participants' hospital activity levels based on accelerometry data.

Appendix 1: Summary of which measurements were taken at different time points during the study

Measure	Baseline assessment	During hospital stay	Day 7 (or day of discharge if earlier)	Follow-Up (4-6 weeks)
HHD (Knee extension + grip strength)	Y	Y- daily	Y	Y
DEMMI	Y		Y	Y
Barthel Index	Y (based on functional ability 2 weeks before hospital admission)			Y
CCI	Y			
SHARE-FI	Y			
CFS	Y			
Mini-ACE	Y			
FES-I	Y			
Activity	Accelerometers attached	Continuous measurement	Accelerometers removed	
CRP	Y - only if part of routine clinical care			

HHD: Hand held dynamometry; CCI: Charlson Comorbidity Index; CFS: Clinical Frailty Scale; SHARE FI:

Survey of Health, Ageing and Retirement in Europe Frailty Instrument; FES-I: Falls Efficacy Scale – International; Mini-ACE: Mini-Addenbrooke's Cognitive Assessment; CRP: C-reactive protein; DEMMI: de Morton Mobility Index.

Appendix 2 Main admission diagnoses based on ICD-10 codes (https://icd.who.int/browse10/2016/en)

International Classification of Diseases' Codes	All	Female	Male
A00-A09 Intestinal infectious diseases	1	0	1
A30-A49 Other bacterial diseases	7	3	4
B00-B09 Viral infections characterized by skin and mucous membrane lesions	1	0	1
D80-D89 Certain disorders involving the immune mechanism	1	0	1
H80-H83 Diseases of inner ear	1	1	0
I20-I25 Ischaemic heart diseases	2	1	1
I26-I28 Pulmonary heart disease and diseases of pulmonary circulation	1	1	0
I30-I52 Other forms of heart disease	7	3	4
I70-I79 Diseases of arteries, arterioles and capillaries	1	0	1
J09-J18 Influenza and pneumonia	12	4	8
J40-J47 Chronic lower respiratory diseases	4	2	2
J60-J70 Lung diseases due to external agents	1	1	0
J80-J84 Other respiratory diseases principally affecting the interstitium	1	0	1
K20-K31 Diseases of oesophagus, stomach and duodenum	1	1	0
K55-K64 Other diseases of intestines	3	2	1
K80-K87 Disorders of gallbladder, biliary tract and pancreas	1	0	1
K90-K93 Other diseases of the digestive system	1	0	1
M00-M25 Arthropathies	3	2	1
N10-N16 Renal tubulo-interstitial diseases	1	1	0

N17-N19 Renal failure	5	2	3
S00-S09 Injuries to the head	1	0	1
S30-S39 Injuries to the abdomen, lower back, lumbar spine and pelvis	3	3	0
S40-S49 Injuries to the shoulder and upper arm	1	1	0
S80-S89 Injuries to the knee and lower leg	1	0	1
V01-X59 Accidents	4	0	4

Appendix 3: Values of participant's hospital activity based on accelerometry data, by gender.

		All	Female	Male
Posture and movement				
	n (wore two accelerometers, one on thigh, one lower leg)	47	20	27
	Time spent lying (%)	75.9 (63.2 — 87.2)	74.8 (62.9 — 83.8)	78.8 (64.2 — 87.4)
	Time spent sitting (%)	18.8 (12.3 — 31.8)	19.8 (13.4 — 33.2)	18.5 (12.3 — 30.6)
	Time spent standing (%)	2.0 (0.7 — 3.8)	1.5 (0.8 — 4.1)	2.5 (0.7 — 3.3)
	Time spent moving (%)	1.5 (0.5 — 2.7)	1.4 (0.8 — 2.3)	1.5 (0.4 — 3.0)
Sedentary versus active				
	n (wore at least 1 accelerometer on their thigh)	62	27	35
	Time spent sedentary (%)	96.6 (94.0 — 98.7)	97.5 (93.9 — 98.2)	95.8 (94.2 — 99.0)
	Time spent active (%)	3.8 (1.6 — 6.5)	2.5 (1.9 — 6.8)	4.2 (1.2 — 6.3)

Appendix 4: Participants' hospital activity levels based on accelerometry data.

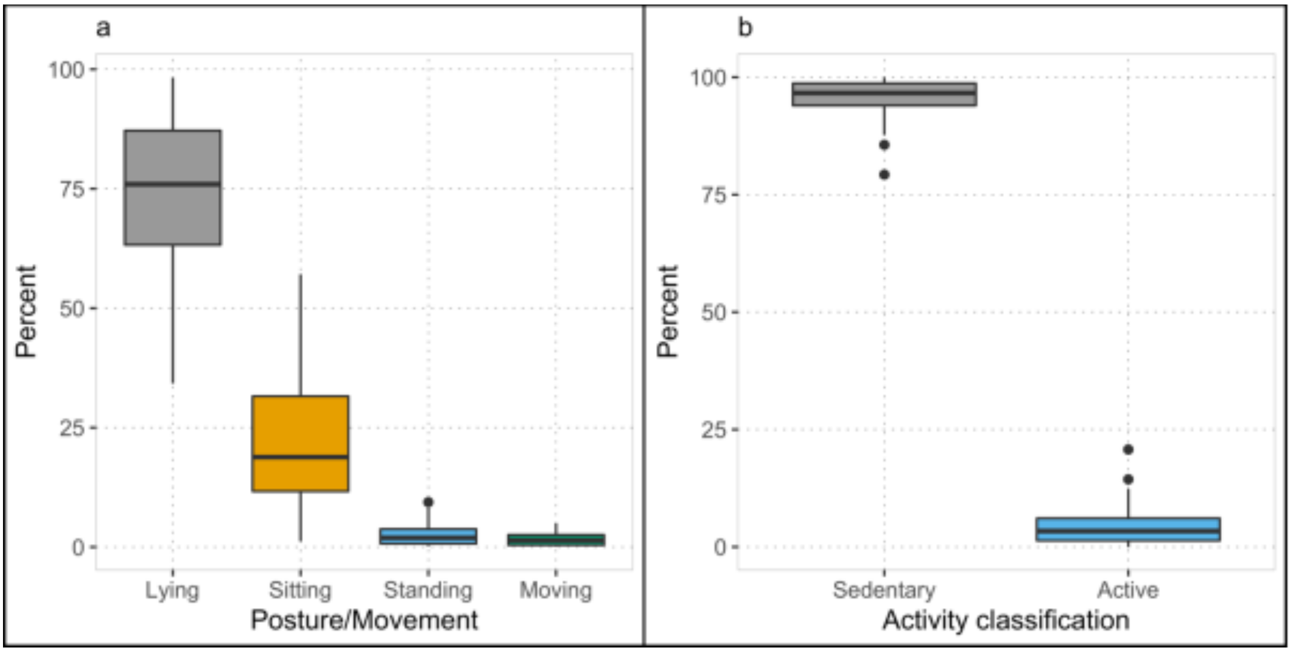

Figure Ba is a breakdown of posture and movement of the 48 participants who had data from thigh and lower leg accelerometers. Figure Bb is a breakdown of sedentary time (defined as lying or sitting) versus active time, for all participants (n = 64) who wore a thigh accelerometer.