# Physical Activity Interventions are Delivered Consistently Across Hospitalized Older Adults but Multi-Morbidity is Associated with Poorer Rehabilitation Outcomes: A Population Based Cohort Study

# ABSTRACT

**Background**: Older adults live with multi-morbidity including frailty and cognitive impairment often requiring hospitalization. While physical activity interventions (PAIs) are a normal rehabilitative treatment, their clinical effect in hospitalized older adults is uncertain.

**Objective**: To observe PAI dosing characteristics and determine their impact on clinical performance parameters.

**Design**: A single-site prospective observational cohort study in an older persons’ unit (OPU).

**Subjects**: 75 OPU patients’ ≥65 years.

**Intervention:** PAI; therapeutic contact between physiotherapy clinician and patient.

**Measurements**: Parameters included changes in activities-of-daily-living (Barthel Index), hand-grip strength, balance confidence (CONFbal), and gait velocity (GVel); measured between admission and discharge (episode). Dosing characteristics were PAI temporal initiation, frequency, and duration. Frailty/cognition status was dichotomized independently per participant yielding 4 subgroups; frail/non-frail (Fr/NFr); cognitively-impaired/cognitively-unimpaired (CoGIM/CoGUN).

**Results**: Median (IQR) PAI initiation occurred after 2 days (1-4), frequency was 0.4 PAIs/day (0.3-0.5), and PAI duration per episode was 3.75 hours (1.8-7.2). All clinical parameters improved significantly across episodes; grip strength median (IQR) change 2.0kg (0.0-2.3) [p<0.01]; Barthel index 5 (3-8) [p<0.01], GVel 0.06m.s-1 (0.06-0.16) [p<0.01], and CONFbal -3 (-6 - -1) [p<0.01]. PAI dosing remained consistent within subgroups. While several moderate to large associations between amount of PAIs and change in clinical parameters were observed, most were within unimpaired subgroups.

**Conclusions**: PAI dosing is consistent. However, while clinical changes during hospital episodes are positive, more favorable responses to PAIs occur if patients are NFr/CoGUN. Therefore, in order to deliver a personalized rehabilitation approach, adaptation of PAI dose based on patient presentation is desirable.

# INTRODUCTION

A consequence of the success of single disease medicine has been the virtue of increased life expectancy but as a result the ageing population are more likely to grow old with 2 or more conditions, commonly termed multi-morbidity[1](#_ENREF_1). Reduced quality of life and function with increased healthcare utilization are associated with multi-morbidity[2](#_ENREF_2), which in addition to other age-related health problems including frailty and dementia, increases illness burden and associated disability[3](#_ENREF_3). United Kingdom (UK) data suggests that 1 in 6 people have >1 disease and represent a third of primary care consultations[4](#_ENREF_4), moreover a large Scottish study observed 82% of people over 85 years lived with ≥2 chronic conditions[5](#_ENREF_5). Within this context, UK non-elective older adult admissions to secondary care are increasing[6](#_ENREF_6) of which 60% are admitted with or go on to develop cognitive impairment[7](#_ENREF_7) and 80% present with frailty[8](#_ENREF_8). It is therefore expected that most older patients admitted to hospital present with multi-morbidity, which results in many challenges for multi-disciplinary teams[9](#_ENREF_9).

Physical deterioration in older adults is mediated by complex processes influenced by physiological, psychological, environmental, and sociological factors[10](#_ENREF_10),[11](#_ENREF_11). The hospitalization process itself is also a factor where environmental and cultural constraints on physical activity occur [12](#_ENREF_12). Rehabilitation of functional movement can reverse physical deterioration[13](#_ENREF_13) and is typically delivered by physiotherapists whose training in physical activity interventions (PAIs) affecting strength/balance, physical fitness, gait, respiratory, and cognitive systems positively influences patient deconditioning, mobility, activity and participation[14](#_ENREF_14). Nonetheless, evidence of effective PAIs in hospitalized medical older adults is at best assumed not least due to considerable unexplained variation in PAI outcomes[15](#_ENREF_15), meaning there remains incomplete knowledge of what works, for whom and at what dose.

The predicament is in part explained by our inability to characterize interventions - the purported ‘black box’ of rehabilitation[16](#_ENREF_16). Furthermore, regular exclusion of hospitalized multi-morbidity patients from PAI studies[15](#_ENREF_15) emphasizes our inadequate understanding of rehabilitation for older patients. Therefore, we need to understand rehabilitation at a population level to ensure all older hospitalized patients receive a targeted, high quality service defined by patient outcomes. An alternative approach first needs to; establish PAI dose-response relationships[14](#_ENREF_14),[15](#_ENREF_15); determine associations between patient characteristics and responsiveness to PAIs during acute hospitalization, and adopt standard PAI descriptors (frequency, intensity, duration, and type)[17](#_ENREF_17).

Thus, the aims of this study were to first observe PAI frequency and duration data for a representative sample of older adults admitted to hospital. Then, determine the impact PAIs have on the sample’s clinical and hospital performance parameters, and examine if their cognition and frailty status affects outcomes and associations with their PAIs.

# METHODS

## Study Design and Ethics

A single-site prospective observational cohort study was undertaken following ethical approval from the study site, who considered the project a service evaluation (RJ112/N250) and the University of Surrey (EC 2013 03). The researchers have followed the STROBE statement[18](#_ENREF_18) for improving the reporting of observational studies.

## Setting

A 3 ward (84 bed) older persons’ unit (OPU) providing specialist, acute, inpatient inter-disciplinary care to adults ≥65 years; part of a large, UK urban NHS Foundation Trust.

## Participants

All patients ≥65 years admitted to the OPU over a 2-month period were eligible for inclusion. Patients admitted for ≤48 hours, readmitted to OPU within 30 days of discharge, or identified for palliation were excluded yielding a convenience sample size (n=75). Local trust consenting policy for PAIs was upheld.

## PAI Interventions

A PAI constituted a face-to-face therapeutic contact between a physiotherapy clinician and patient as part of their rehabilitation delivered Monday to Friday. To limit PAI type and intensity variability, clinician-led PAIs were framed by an evidence-based algorithm based on needs-assessment (please see supplementary Table S1).

## Measures

The primary clinical parameter was change in patient activities-of-daily-living (ADL) function (Barthel Index (BI) score) during their admission to discharge episode. Other clinical measures of change were: dominant hand grip strength as a discriminatory measure of frailty[19](#_ENREF_19); balance confidence (CONFbal), and 6m self-selected average gait velocity (GVel)as a measure of community function. Hospital performance parameters included length of stay (LOS), discharge destination, and readmission within 30 days. Independent variables included the temporal initiation (days), frequency (contacts per day), and duration (total mins) of PAI delivered by physiotherapy clinicians. Participants were characterized by: age, gender, ethnicity, reason for admission, co-morbidity, pre-morbid functional ability (BI score) 2 weeks prior to admission from participant or proxy recall, and frailty and cognitive status at admission (≤48 hours from OPU arrival).

Frailty and cognition status was dichotomized independently per participant; frail/non-frail (Fr/NFr); cognitively-impaired/cognitively-unimpaired (CoGIM/CoGUN). A participant was frail if they presented with less-than age-equivalent norm dominant hand grip strength using a standardized hand-held dynamometer protocol[20](#_ENREF_20). A participant was cognitively impaired if they presented with a score more than zero on a recognized cognitive test (4AT[21](#_ENREF_21)).

## Data Collection

Patients admitted to the OPU over a 2-month period meeting the inclusion criteria were prospectively and consecutively recruited by a single researcher (JJ) working Monday-Friday. Clinical measurements were completed within 30 minutes and did not affect normal care. They were undertaken twice: within 48 hours of admission, and discharge. Other measures (patient characteristics, physiotherapy intervention metrics and hospital performance parameters) were obtained retrospectively from patient records.

## Data analysis

After normality was confirmed (Shapiro-Wilk test), admission/discharge change in clinical measures was determined using independent student t-tests for all participants and within frailty/cognition subgroups. Mann-Whitney U tests were used in the event of non-normality. Baseline subgroup differences in the categorical variables were assessed using Chi-square tests. Descriptive data are reported using appropriate measures of central tendency.

Data were modelled with Spearman’s correlation coefficients to indicate relationships between PAI delivery (temporal initiation, frequency, and total duration) and hospital performance/clinical outcomes (hospital LOS and change in ADL function, GVel, grip strength, and balance confidence) within the sample overall, and within each sub-group. Only complete sets of data were analyzed. Coefficients were interpreted as small (0.10-0.29), medium (0.3-0.49), and large (0.5-1.0). All statistical analyses were undertaken using proprietary software (SPSSv21, IBM), and p values <0.05 considered statistically significant.

# RESULTS

## Study Participants

Overall, 178 patients were eligible during July and August 2013 and 103 were excluded (58 assessed >48h from admission, 35 discharged ≤48h, 8 palliated, 2 died) meaning 75 participants were recruited. Most (64%) were female, Caucasian (76%) and admitted following a fall (40%). Median (IQR) hospital LOS (episode) was 14 days (9-26). Over half of all participants (n=43, 57%) were cognitively impaired and of patients able to undertake a grip strength assessment (n=67), 49 (73%) were classified as frail (Table 1).

[Insert Table 1 here]

## Physical Activity Intervention Dosing Characteristics and Clinical Parameter Changes

For each episode, PAI commenced after a median of 2 days (1-4). Median frequency was 0.4 PAIs/day (0.3-0.5), equivalent to a physiotherapy contact every 2.8 days, and participants received a median PAI duration of 3.75 hours (1.8-7.2) per episode.

All clinical parameters showed significant improvement changes across admission-discharge episodes (Figure 1); median change in dominant grip strength was 2.0kg (0.0-2.3) [z=-4.000 p<0.01]; in BI 5 (3-8) [z=-6.857 p<0.01], in GVel 0.06m.s-1 (0.06-0.16) [z=-4.732 p<0.01], and change in CONFbal score, established for 52 patients, was -3 (-6 - -1) [z=-4.340, p<0.01]. Although the sample remained functionally dependent at discharge (median GVel 0.15m.s-1 [0.00-0.36]), 63 (84%), patients were discharged home with or without enhanced supported discharge. Fifteen participants (20%) were re-admitted within 30 days of their discharge, an event acknowledged to represent a failed discharge.



Figure 1: All participant median admission and discharge functional health measure scores. Error bars represent the inter-quartile range.  
†dominant hand grip strength (kg)  
¶Barthel Index (ordinal scale /20)  
‡GVel – average self-selected gait velocity over 6m (cm.s-1)  
§CONFbal self-rated confidence in balance measure (ordinal scale /30)  
\*represents difference between scores at ≤0.05 statistical significance level

No statistically significant differences were found within any subgroupings in participant admission characteristics except for higher Charlson scores (more co-morbidity) within the Fr group [U=306, p=0.04]. There were no statistically significant between-group differences in total duration, frequency or time to first PAI. Furthermore, there was no difference within subgroups in BI change or any other clinical parameter variables, except GVel and dominant handgrip strength where statistically significant improvements were observed in the CoGUN and NFr groups [U=439, p=0.01; U=303.5, p=0.049 respectively] and the Fr group [U=203.5, p=0.004] respectively (Table 2).

[Insert Table 2 here]

Overall there was a significant association between LOS and PAI duration [r=0.707 p<0.01]. No other moderate or large associations between clinical outcomes and PAIs were observed. In all subgroups, there was a large statistically significant positive association between PAI duration and hospital LOS [p<0.01].

Subgroup analysis revealed no statistically significant associations in either of the impaired groups (CoGIM and Fr) except a positive significant association between PAI frequency and grip strength change [r=.319; p<0.05]. Although a positive association, indicating a negative effect of PAI, between frequency of intervention and CONFbal [r=.470] was observed in cognitively impaired patients, this was not significant (Table 3).

[Insert Table 3 here]

In contrast, within the unimpaired groups (CoGUN and NFr) total PAI duration was associated with ADL functional change [CoGUN; r=0.511, p<0.05 and NFr; 0.470, p<0.05], and balance confidence [CoGUN; r=-0.438, p<0.05, NFr; r=-320]. In the NFr group, there was a negative (non-significant) association between duration of PAI and change in dominant grip strength [r=-.412]. Furthermore, positive associations in this group with time to first physiotherapy intervention and change in GVel [r=.419], balance confidence [r=.309] and change in dominant grip strength [r=.327] were observed but were also non-significant.

# DISCUSSION

This study investigated the association between PAIs delivered by physiotherapists and changes in clinical parameters in hospitalized medical older adults. Our main finding is that while PAI dosing is consistent and changes in clinical outcomes over hospital episodes are positive, patients respond more favorably to PAIs if they are not frail or cognitively impaired.

Although our sample was ~7 years older than the national average [6](#_ENREF_6), it was otherwise representative of UK older patient population data in terms of LOS[6](#_ENREF_6), cognitive impairment proportions[7](#_ENREF_7), frailty[8](#_ENREF_8), multi-morbidity[22](#_ENREF_22), and functional dependence on admission with deterioration 2 weeks prior[23](#_ENREF_23). Additionally, there were no patient characteristic differences between sub-groups other than more multi-morbidity participants in the frail group, meaning our sample demonstrated internal consistency.

Overall, participants received similar PAI duration and frequency indicative of equality in access to physiotherapy. This interpretation withstood subgroup analyses, where statistically significant associations between LOS and PAI duration were observed, and confirms that PAIs are delivered consistently regardless of clinical episode length. Subgroup analysis revealed several moderate to large associations between amount of PAIs and change in clinical measures although most of these were in unimpaired subgroups. This suggests that while PAI dosing is consistent, it likely to have more clinical impact when delivered to cognitively-unimpaired and non-frail individuals. This is the first time this finding has been reported.

A review of the current literature to explain our results reveals inconsistent findings. For instance studies have reported worse functional outcomes with rehabilitation for patients with cognitive impairment and frailty compared to unimpaired participants[24](#_ENREF_24),[25](#_ENREF_25). Equally, others have concluded that rehabilitation benefits these patients[26](#_ENREF_26),[27](#_ENREF_27). Our clinical practice observations suggest that when interventions are delivered consistently they yield favorable outcomes but only for some patients (cognitively unimpaired and non-frail) and not others. Thus, a contemporary approach is now indicated where adjustments of PAI dose relationships are investigated in hospitalized medical patients with multi-morbidity.

A recent UK study provides an example of manipulating the PAI for a certain clinical subgroup[26](#_ENREF_26). They report encouraging results where a higher frequency of physiotherapy was associated with shorter LOS and greater functional recovery in frail hospitalized adults. Our observations lead us to hypothesize that altering the dose relationship would lead to optimal clinical outcomes for our most impaired patients. This may include the frequency of intervention as Hartley and colleagues[26](#_ENREF_26) report but attention to the duration of PAI is also important, particularly to patients who are vulnerable to in-hospital deteriorations in physical function[28](#_ENREF_28). For example; more frequent and shorter PAIs are indicated in frail patients because of their poor tolerance of exercise[29](#_ENREF_29); and multi-morbidity patients’ reliance on help for functional tasks[30](#_ENREF_30) means self-administered PAI adherence is likely to be poor with alternative modalities of delivery required.

Consideration of the greater needs of those cognitively impaired and those older people with frailty and multi-morbidity may require additional physiotherapy resource to achieve health status changes during hospital stay. This may be an unrealistic goal for rehabilitation during hospital care without service redesign decisions such as development of 7-day working services. A process which would do well to contemplate that an outcome-driven, more equitable and efficient service prevails by offering consistent but needs-based targeting of physiotherapy resources. Equally, if physiotherapy is to produce consistent improvement in PAI outcomes, it must embark on research processes to identify factors that predict rehabilitation success for hospitalized older adults.

It is possible PAI durations might have been misrepresented in our study because capturing scheduled therapy time alone can overestimate active time[31](#_ENREF_31). We acknowledge that while attempts were made to standardize PAIs in terms of their mode and intensity (PAI algorithm; supplementary Table S1) we remain unable to report confidently what proportion of session times constituted physical activity in our study. Therefore, it is conceivable that multi-morbidity patients spent longer unengaged with therapy because they perceived PAIs to be too effortful[32](#_ENREF_32), and session duration was not adjusted by the therapists to develop a therapeutic relationship and undertake physical activity[33](#_ENREF_33). Thus, amounts of meaningful physical activity during PAI sessions may partly explain our observations between subgroups.

As is frequently experienced in studies in clinical settings, we were not able to capture complete data for all participants. A pragmatic, complete-case data analysis approach was adopted in this study and this may have biased our results. However, the findings of this observational study undertaken in a clinical setting are important and can contribute to generating further hypotheses worthy of more rigorous testing[34](#_ENREF_34). Consequently, development of creative frequency/duration dosing that is targeted to hospitalized patients in consideration of multi-morbidity including frailty or cognitive impairment is now indicated to maximize PAI efficacy.

# CONCLUSION

The effectiveness of PAIs on hospitalized older patients, often presenting with multi-morbidity, is not supported by a strong evidence base. It remains unclear to what extent PAI dose, natural recovery, or other factors combine to affect their functional status.

While we observed consistent PAI dosing, we found that patient presentation influenced the therapeutic capability of PAIs. As a consequence, adaptation of PAI dose based on patient presentation is desirable. Given these findings, services redesigned to deliver a personalized rehabilitation approach through targeting PAIs may be required.

CLINICAL MESSAGES

* Hospitalized older adults present with multi-morbidity including frailty and cognitive impairment
* Associations between physical activity interventions and clinical outcomes are larger for non-frail or cognitively unimpaired patients
* Targeting physical activity interventions by adjusting dosing factors is indicated
* Identification of factors that predict favorable outcomes is required to improve acute rehabilitation services

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# CONFLICT OF INTEREST

None Declared

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Table 1: Subject Characteristics. Data are shown for the entire sample; missing data are indicated where applicable

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | n† | %† |
| Patient Characteristics |  |  |  |
| Sample Total |  | 75 | (100%) |
| Age at Assessment | Mean years (±SD) | 84.77 | (±7.06) |
| Gender | Male | 27 | (36%) |
|  | Female | 48 | (64%) |
| Ethnicity | White British | 57 | (76%) |
|  | White Other | 10 | (13%) |
|  | Black Caribbean | 4 | (5%) |
|  | Other | 4 | (5%) |
| Reason for admission | Fall | 30 | (40%) |
|  | Respiratory Condition | 12 | (16%) |
|  | Musculoskeletal Condition | 11 | (14.7%) |
|  | Urinary tract Infection | 8 | (10.7%) |
|  | Cardiac Condition | 7 | (9.3%) |
|  | Other | 7 | (9.3%) |
| Hospital Performance Parameters |  |  |  |
| Length of Hospital Stay (Episode) | Median (IQR) Days | 14 | (9-26) |
| Discharge Destination | Home | 41 | (55%) |
|  | Early Supportive Discharge | 22 | (29%) |
|  | Residential or Nursing Care | 6 | (8%) |
|  | Bed-based Rehabilitation (BBR) Facility | 6 | (8%) |
| Failed Discharge | Readmissions | 15 | (20%) |
| Physical Activity Interventions |  |  |  |
| Duration | Median (IQR) per Episode (mins) | 210 | (110-430) |
|  | Median (IQR) Daily (mins) | 13.8 | (8.4-20.9) |
| Time to First PAI | Median (IQR) (days) | 2.0 | (1.0-4.0) |
| PAI Frequency | Median (IQR) per day | 0.4 | (0.3-0.5) |
| Patient Clinical Parameters |  |  |  |
| Comorbidity | Charlson Index Score 0 | 33 | (44%) |
|  | Charlson Index Score 1 | 27 | (36%) |
|  | Charlson Index Score ≥2 | 15 | (20%) |
|  | Median (IQR) Score | 1 | (0-1) |
| Cognition | Cognitively Impaired (CoGIM) | 43 | (57%) |
|  | Cognitive unimpaired (CoGUM) | 32 | (43%) |
| Frailty | Frail (Fr) | 49 | (73%) |
|  | Non-frail (NFr) | 18 | (27%) |
| Patient Frailty - Grip Strength (n=67) | Median (IQR) Dominant Grip (kg)on admission | 10.0 | (7.0-14.5) |
|  | Median (IQR) Dominant Grip (kg)on discharge | 11.8 | (9.0-17.0) |
| Patient Activities of Daily Living | Median (IQR) Barthel Index (/20) pre-admission | 17 | (15-18) |
|  | Median (IQR) Barthel Index (/20) on admission | 10 | (4-13) |
|  | Median (IQR) Barthel Index (/20) on discharge | 16 | (12-18) |
| Patient Community Function | Median (IQR) Gait Velocity (m.s-1) on admission | 0.00 | (0.00-0.20) |
|  | Median (IQR) Gait Velocity (m.s-1) on discharge | 0.15 | (0.00-0.36) |
| Patient Balance Confidence (n=52) | Median (IQR) CONFbal (/30) on admission | 25 | (21-28) |
|  | Median (IQR) CONFbal (/30) on discharge | 20 | (18-24) |
| † Unless otherwise stated | | | |
|  | | | |
|  | | | |

Table 2: Subgroup Characteristics. Data are shown within cognition (impaired/unimpaired) and frailty (frail/non-frail) subgroupings by patient characteristics; hospital performance; physiotherapy intervention; and patient health status; missing data are indicated as n-numbers in parenthesis where applicable

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Cognition | |  |  | Frailty | |  |  |
|  |  |  | Impaired n=43 | Unimpaired n=32 | Statistic | p | Frail n=49 | Non-frail n=18 | Statistic | p |
| Patient Characteristics |  |  |  |  |  |  |  |  |  |  |
| Age at assessment | mean (SD) |  | 85.56 (7.06) | 83.7 (7.05) | *t*=-1.12 | 0.27 | 85.6 (5.85) | 83.0 (8.55) | *t*=1.4 | 0.17 |
| Gender | n(%) | Male  Female | 19 (44%)  24 (56%) | 24 (75%)  8 (25%) | χ2=2.93§ | 0.87 | 15 (31%)  34 (69%) | 9 (50%)  9 (50%) | χ2=2.15  (df=1) | 0.14 |
| Ethnicity | n(%) | White British/Irish  Other | 38 (88%)  5 (12%) | 29 (91%)  3 (9%) |  | 0.99 Ϯ | 44 (90%)  5 (10%) | 16 (89%)  2 (11%) |  | 0.99Ϯ |
| Reason for admission | n(%) | Fall  MSK UTI  Cardiac  Respiratory  Other | 18 (42%) 6 (14%) 4 (9%) 5 (12%) 5 (12%) 5 (11%) | 12 (38%) 5 (16%) 4 (13% 2 (6%) 2 (6%) 7 (21%) |  | 0.78Ϯ | 22 (45%)  4 (8%)  6 (12%)  4 (8%)  6 (12%)  7 (14%) | 4 (22%)  2 (11%)  5 (28%)  4 (22%)  1 (6%)  2 (11%) |  | 0.26Ϯ |
| Hospital Performance Parameters |  |  |  |  |  |  |  |  |  |  |
| LOS (days) | Median (IQR) |  | 17(8-26) | 12.5 (10-22.8) | *U*=668 | 0.83 | 17.92 (9-22.5) | 19.67 (9-33) | *U*=389 | 0.71 |
| Discharge destination | n(%) | Home  ESD  BBR  NH/RH | 22 (51%) 12 (28%) 3 (7%) 6 (14%) | 19 (59%) 10 (32%) 3 (9%) 0 (0%) |  | 0.18Ϯ | 27 (55%)  16 (33%)  3 (6%)  3 (6%) | 9 (50%)  5 (28%)  2 (11%)  2 (11%) |  | 0.79Ϯ |
| Readmission (<30 days) |  |  | 10 (67%) | 5 (33%) | χ2=0.67§ | 0.56 | 12 (25%) | 1 (13%) |  | 0.16Ϯ |
| Physical Activity Interventions | |  |  |  |  |  |  |  |  |  |
| Duration direct PAIs (mins) Daily direct PAIs (mins/day) Time to first PAI (days) Frequency of PAI (no/day) | Median (IQR) |  | 170 (80-410) 13.75 (7.1-21.8) 2.0 (1.0-3.0) 0.38 (0.26-0.46) | 210 (110-430) 13.81 (11.8-20.3) 2.5 (1-4.8) 0.40 (0.31 – 0.51) | *U*=653 *U*=653 *U*=553 *U*=524 | 0.71 0.60 0.14 0.27 | 190 (110-400)  14.3 (10.7-20.7)  2 (1-3.5)  0.39 (0.3-0.5) | 140 (65-528)  11.6 (7.2-23.3)  2.5 (1-4.25)  0.36 (0.3-0.5) | *U*=400  *U*=395  *U*=426  *U*=389 | 0.56  0.52  0.89  0.46 |
| Patient Clinical Parameters |  |  |  |  |  |  |  |  |  |  |
| Charlson index | n(%) | 0  1  ≥2 | 15 (35%) 18 (42%) 10 (23%) | 18 (56%) 9 (28%) 5 (16%) | χ2=3.34¶ *U*=541 | 0.18 | 20 (41%)  16 (33%)  13 (26%) | 11 (61%)  7 (39%)  0 (0%) | *U*=306 | 0.03Ϯ |
| Median (IQR) |  | 1 (0-1) | 0 (0-1) |  | 0.09 | 1.0 | 0.0 |  | 0.04 |
| Admission BI  Change BI | Median (IQR) |  | 8 (4-12)  5 (2-8) | 12 (6.5-13)  5 (3-7) | *U*=671 | 0.11  0.86 | 10 (4.0-12.0)  5 (2.5-8) | 12 (5.0-14.5)  6 (2.3-8) | *U*=319  *U*=431 | 0.08  0.90 |
| Change Gait velocity (m/s) | Median (IQR) |  | 0.00 (0.00-0.10) | 0.11 (0.00-0.24) | *U*=439 | 0.01 | 0.05 (0.0-0.13) | 0.13 (0.02-0.32) | *U*=304 | 0.049 |
| Change Dominant Grip strength (kg), | Median (IQR) |  | 0.5 (0.0-4.0) (n=33) | 2.0 (0.0-4.0) (n=32) | *U*=473 | 0.51 | 2.0 (0.0-5.0) (n=49) | 0.0(-2.0-2.0) (n=18) | *U*=204 | 0.004 |
| Change CONFbal (/30) | Median (IQR) |  | -4 (-6 – -0.5) (n=20) | -3 (-7 – -1) (n=32) | *U*=192 | 0.91 | -4 (-6 – -1) (n=38) | -1 (-7 – -1) (n=14) | *U*=113 | 0.400 |
| Ϯ Fischer Exact Test; MSK: Musculoskeletal; UTI: Urinary tract infection; PT: Physiotherapy; ESD: Early Supported Discharge;  BBR: Bed Based rehabilitation; NH/RH: Nursing/Residential home; BI: Barthel index; §df=1; ¶df=2 | | | | | | | | | | |

Table 3: Associations between outcomes and physiotherapy intervention. A) shows data for the whole sample; B) shows data within cognition subgroups; C) shows data within frail subgroups. Statistically significant associations are labelled.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Whole Sample | | | | |
| A) | Hosp LOS | GV change | BI change | CONFbal change | Dom GS change |
| Time to first PAI | r=-.088 | r=.137 | r=-.009 | r=.037 | r=.024 |
| PAI Duration | r=.707\*\* | r=-.031 | r=.212 | r=-.200 | r=.104 |
| Frequency PA | r=.127 | r=.045 | r=.226 | r=.151 | r=.176 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Cognitively Unimpaired (n=32) | | | | | Cognitively Impaired (n=43) | | | | |
| B) | Hosp LOS | GV change | BI change | CONFbal change | Dom GS change | Hosp LOS | GV change | BI change | CONFbal change | Dom GS change |
| Time to first PAI | r=-.003 | r=.156 | r=.076 | r=.052 | r=-.040 | r=-.186 | r=.097 | r=-.064 | r=-.036 | r=.075 |
| Duration  PAI | r=.706\*\* | r=.023 | r=.511\*\* | r=-.438\* | r=-.229 | r=.706\*\* | r=-.030 | r=.042 | r=.054 | r=.260 |
| Frequency PAI | r=.150 | r=-.096 | r=.270 | r=-.090 | r=.030 | r=.144 | r=.081 | r=.213 | r=.470 | r=.242 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Non-frail (n=18) | | | | | Frail (n=49) | | | | |
| C) | Hosp LOS | GV change | BI change | CONFbal change | Dom GS change | Hosp LOS | GV change | BI change | CONFbal change | Dom GS change |
| Time to first PAI | r=.128 | r=.419 | r=.053 | r=.309 | r=.327 | r=-.032 | r=-.072 | r=-.086 | r=-.074 | r=-.135 |
| Duration  PAI | r=.770\*\* | r=-.084 | r=.470\*\* | r=-.320\* | r=-.412 | r=.702\*\* | r=.090 | r=.130 | r=-.028 | r=.211 |
| Frequency PAI | r=.113 | r=-.241 | r=.257 | r=-.028 | r=-.326 | r=.187 | r=.265 | r=.249 | r=.256 | r=.319\* |

\*Correlation is significant at the 0.05 level (2-tailed); \*\*Correlation is significant at the 0.01 level (2-tailed).

PAI: Physical Activity Intervention; mins: minutes; Hosp. LOS: Hospital length of stay; GV: Gait velocity, BI: Barthel index;   
Dom.GS: Dominant grip strength.