Augmented Exercise in Hospital Improves Physical Performance and Reduces Negative Post Hospitalization Events: A Randomized Controlled Trial

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Abstract

Background: To measure the effects of an augmented prescribed exercise programme versus usual care, on physical performance, quality of life and healthcare utilisation for frail older medical patients in the acute setting.

Study Design: A parallel single-blinded randomised controlled trial Methods: Within two days of admission, older medical inpatients with an anticipated length of stay ≥3 days, needing assistance/aid to walk, were blindly randomly allocated to the intervention or control group. Until discharge, both groups received twice daily, Monday-to-Friday half-hour assisted exercises, assisted by a staff physiotherapist. The intervention group completed tailored strengthening and balance exercises; the control group performed stretching and relaxation exercises. Length of stay was the primary outcome measure. Secondary measures included readmissions within three months, and physical performance (Short Physical Performance Battery) and quality of life (EuroQOL-5D-5L) measured at discharge and at three months. Time-to-event analysis was used to measure differences in length of stay, and linear regression models were used to measure differences in physical performance, quality of life, adverse events (falls, deaths) and negative events (prolonged hospitalisation, institutionalisation).

Results: Of the 199 patients allocated, 190 patients’ (aged 80 ±7.5 years) data were analysed. Groups were comparable at baseline. In intention to treat analysis, length of stay did not differ between groups (HR 1.09 (95% CI, 0.77-1.56) p=0.6). Physical performance was better in the intervention group at discharge (difference 0.88 95% CI, 0.20-1.57) p=0.01), but lost at follow-up (difference 0.45 (95% CI, -0.43 - 1.33) p=0.3). An improvement in quality of life was detected at follow-up in the intervention group (difference 0.28 (95% CI, 0.9 – 0.47) p=0.004). Overall, fewer negative events occurred in the intervention group (OR 0.46 (95% CI 0.23 - 0.92) p=0.03).

Conclusion: Improvements in physical performance, quality of life and fewer negative events suggest that this intervention is of value to frail medical inpatients. Its effect on length of stay remains unclear.

Background
It is well established that older medical inpatients are minimally active in hospital. Patients walk an average of 600 steps daily [1, 2] which equates to twelve minutes of walking [3]; 49% of older patients remain on bedrest or transfer from bed to chair only [4], and less than 19% of patients walk hospital corridors [5]. Our recently conducted observation study suggested that people who walked more had a shorter stay in hospital, where a 50% higher step-count was associated with a 6% shorter hospital stay, and those with poor physical performance on admission were the least active in hospital [1]. These frailer patients are most at risk of functional decline following a hospital admission [6].

Interdisciplinary team care has been found to improve patients’ health outcomes and length of stay [7-11]. While effective, it requires a considerable investment and change in clinical practice. There is emerging evidence of acute sarcopenia secondary to hospitalisation, defined as a loss of muscle mass, loss of muscle strength and low physical performance, which has been linked to poorer quality of life (QoL), increased falls risks and increased mortality [12]. Therefore, a simple exercise programme could be easy to implement but effective in preventing acute sarcopenia. Trials which have included both robust and frail inpatients have shown limited effectiveness of exercise alone on length of stay [13, 14], with conflicting results on physical and functional performance [13, 15]. A meta-analysis of exercise interventions suggested that they were more effective for the frailer patients [15]; potentially as the frailer patients are most at risk of acute sarcopenia [1]. Positive effects on functional and physical capacity were gained in an exercise intervention specifically for very elderly patients in hospital. The patients (n=370) exercised in an equipped gym in the hospital [16]. However, the results of this study are not generalizable to hospitals with limited gym facilities. The question remains whether a simple exercise intervention could have similar results.

Therefore, the primary aim of this trial was to measure the effectiveness of an augmented prescribed exercise programme (APEP) on frail older medical patients in the acute setting. The programme is delivered at the bedside, using body weight as the resistance, and including balance and walking within the programme. Its effectiveness on length of stay (as the primary outcome measure), physical
performance and QoL at discharge and at three months’ post discharge, and readmission rates over the subsequent three months’ post discharge was measured.

Methods
A detailed description of the APEP trial protocol has been presented previously [17]. The trial received ethical approval from the local clinical research ethics committee.

Design
The study was a prospective, sham-intervention controlled, randomised trial, with blinded randomisation and outcome measurement. It was completed between March 2015 and January 2017.

Patient Selection and Setting
Recruitment took place in one 350-bedded general teaching hospital. All wards admitted older medical inpatients, including one small geriatric ward. Rehabilitation and general staffing levels were comparable across all wards. Irrespective of ward allocation, medical inpatients aged 65 and over, needing an aid and/or assistance to walk on admission, and admitted from and planned for discharge home (rather than for institutional care), with an anticipated hospital stay $\geq$ 3 days were recruited. The following patients were excluded: inpatients $> 48$ hours prior to screening; unable to follow simple commands in the English language; admitted with an acute psychiatric condition, or requiring end-of-life or critical care; ordered bedrest, or contraindications to walking (eg. hip fracture or high ventricular rate atrial fibrillation); baseline Short Physical Performance Battery score 0/1; participated in the trial within the previous 12 months.

Recruitment process
Recruitment to the trial was completely independent from routine physiotherapy referrals and services. Using the electronic hospital management system, the principal investigator (RMC) identified suitable patients. Patients were not recruited on Fridays as no exercises sessions were delivered over the weekend. The medical team confirmed their suitability prior to the patient being
approached. Patients were verbally informed about the study, and questions were answered. Relatives were contacted by phone if requested. If cognition appeared or was reported poor, their next-of-kin assented to their inclusion. All participants gave written informed consent. Patients were recruited as resources allowed; a maximum of five patients participated in the study simultaneously.

Interventions
Both groups received usual care with additional exercises. The augmented prescribed exercise programme (APEP) was delivered to the intervention group, and a sham programme to the control group. The APEP programme aimed to improve strength, balance and walking, while the sham intervention was mainly breathing and stretching exercises. For a full description, please see Appendix 1: Description of APEP and Sham Exercise Programmes. These additional exercises were performed twice-daily, Monday-Friday, and the sessions lasted up to thirty minutes, (depending upon the patient’s exercise tolerance). At each session, contraindications were reviewed and verbal consent sought. Routine physiotherapy was not affected by the APEP trial and was delivered based on physiotherapy’s assessment of the patient and competing caseload, averaging three sessions per week.

Descriptive Measures
On admission, the patients’ demographics and medical history were noted. Their home situation, medication use, co-morbidity (Cumulative Illness Rating Scale-Geriatrics, CIRS-G [18]), cognition (Six Item Cognitive Impairment Test, 6CIT) [19] frailty, including grip strength (Survey of Health, Ageing and Retirement in Europe, SHARE-FI) [20], falls history over the previous six months, and falls efficacy (Falls Efficacy Scale International, FES-I) [21], were measured on initial assessment.

Outcome Measures
The assessment schedule is described in Table 1.

The effects of the intervention on healthcare utilisation (length of stay and readmission rates),

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physical performance (SPPB) [22] and QoL (EQ5D5L) [23] were measured. In addition, the effects on functional independence (Nottingham Extended Activities of Living, N-EADL[24]), functional ambulation (Functional Ambulatory Classification, FAC[25]), and falls rate, were also measured.

Healthcare Utilisation
The primary outcome measure was length of stay (bed nights) (LOS). The number of readmissions over the subsequent three months was also recorded; both data were readily available from the electronic hospital information system.

Physical Performance and Daily Activity
Functional Independence was measured using N-EADL [24], premorbidly, on admission, and at the three-month follow-up.

The SPPB [26] was used to measure physical performance on admission, at discharge and at follow-up.

The FAC[25] was used to measure their functional ambulation. Patients’ walking was observed on admission, at discharge and at follow-up. On admission, the patients were asked to self-report their premorbid ambulatory level. Self-report was also used at the follow-up when the patient couldn’t attend in person. While the FAC has not been validated as a self-reported tool, it did provide some information about their ambulatory level when observation was impossible.

Patients’ walking was continually measured using the Stepwatch Activity Monitor (SAM).

Falls and QoL
Number of falls over the previous six months was self-reported on admission. In-hospital falls were recorded from hospital notes, while post discharge falls were self-reported at follow-up.
QoL was measured using the EuroQol 5 Domain 5 Level Scale [23] on admission, discharge and at follow-up. The next-of-kin was asked to complete this if the patient was unable. The reliability of proxy reports has been debated with evidence suggesting that proxy reports are poorer than self-reports [27]. However, other studies have found little or no difference between self and proxy reports in older adults [28], patients with traumatic brain injury and Parkinson’s Disease [29], therefore, the decision to include proxy reports was made.

Changes in living arrangements (change in accommodation, support or home adaptations) were recorded at discharge and follow-up.

Table 1: Descriptive and Outcome Measurements Assessment Schedule.

**Abbreviations**: SHARE FI: Survey of Health, Ageing and Retirement in Europe Frailty Index; 6CIT: 6-Item Cognitive Impairment Test; CIRS-G: Cumulative Illness Rating Scale-Geriatrics; FES-I: Falls Efficacy Scale-International; N-EADL: Nottingham Extended Activities of Daily Living; FAC: Functional Ambulatory Classification; SPPB: Short Physical Performance Battery; EQ5DSL: EuroQol 5 Domain 5 Level Scale; LOS: length of Stay.

Descriptive Measurements in Purple. Outcome Measurements in Black.

**Procedure for Data Collection**

Patients were assessed within forty-eight hours of admission, and within twenty-four hours of planned discharge, and followed-up between two and three months following discharge home, at their medical check-up appointment, or by phone. After initial assessment, patients were randomly allocated to the intervention or control group using concealed allocation. A blinded research assistant assigned and recorded the patients using a computer-generated randomisation sequence, in varying block size. While patients were informed that they would be allocated to *either* the APEP or control group and upon allocation, they were neither explicitly informed nor encouraged to ask about their allocation.
Patients who had not begun the exercise sessions before withdrawal, transfer or discharge, were replaced, using the same process as above. Patients who began the exercise sessions before withdrawal from the study were not replaced. To prevent contamination, it was planned that patients who were in the same room but allocated to different exercise groups, would complete their exercise sessions in different locations separately. However, this event never occurred. Therefore, all patients were treated by their bedside. The discharge and follow-up assessments were completed by a blinded research physiotherapist.

An adverse event included a fall, cardiac ischaemia or pulmonary embolism during exercise, or an exacerbation of a condition as a result of the intervention (e.g., exacerbation of painful joints). Death or admission to intensive or critical care were considered as Serious Adverse Events. In the occurrence of adverse events, the Sponsor’s Clinical Research Supporting Officer, the Hospital Risk Manager and the treating consultant were informed. All the necessary hospital procedures and documentation was completed.

**Deviations from the published protocol**

There were four significant deviations from the previously published protocol [17]. First, accelerometer-recorded walking activity was collected on a considerably lower number of patients than planned. Second, the trial was terminated early, due to a change in discharge procedures, with 190 patients of the planned 220 patients included. Third, in order to detect a deterioration in physical performance, we only recruited patients with an SPPB score of ≥2 on admission. And finally, we introduced a phone follow-up assessment for patients unable to attend a face-to-face assessment. For further details, please see **Appendix 2: Deviations from the published protocol**.

**Statistical Methods**

All the descriptive information is presented in Table 1. Throughout the results, means (±SD) are
presented for normally distributed data and medians [IQR] are used for non-normally distributed data. Normality of their distribution was determined using histograms.

Intention-to-treat analysis was employed on the length of stay, death and readmission rates as full data was available irrespective of drop-outs. Time-to-event analysis was used to measure the effect of the APEP on length of stay (time to discharge) i.e. discharge being the event. The effects of the APEP on walking activity in hospital, and physical performance and QoL, both at discharge and at follow-up, was estimated using linear regression. Post-hoc logistic regression was used to estimate effects at follow-up of falls, readmissions and deaths combined results. These models estimated the effects of the intervention on the absolute scores, rather than the changes in scores.

For the post-hoc adjusted models, the most important covariates were selected based on the results from the preceding observation study [1] subject matter expertise and clinical judgement, with each model included their corresponding baseline score. Similar covariates appeared to have the most statistical effect on each model and were the most clinically meaningful, and therefore, the same covariates were used for most post hoc adjusted linear and logistic models. However, the effects of APEP on time to discharge and step-count appeared to fit best when adjusted for age and frailty only.

All models were tested for multicollinearity. Goodness of fit was assessed using the adjusted R² score for linear model testing, the Hosmer Lemeshow test for logistic model testing, and proportional hazards assumption for survival model testing.

Results

Participant Description

During the 23-month recruitment period, approximately 5,569 medical patients, aged 65 and over were admitted to the hospital. We were able to screen 1,614 patients, of which 1,398 did not meet the inclusion criteria and 17 declined to participate. One hundred and ninety-nine patients were randomised, and a further nine were excluded post randomisation as they failed to begin the exercise sessions. One patient dropped out from the study, leaving results from 189 patients who had
completed the exercise programme for data analysis (11.7% of those screened). As per the CONSORT guidelines [30], details, including adherence, are provided in the flow diagram, (Figure 1).

Please insert Figure 1: CONSORT Flow diagram of the completed APEP here

Patients’ average age was 80 (±7.47) years, and there was a higher proportion of women in the trial (61%). Co-morbidity in this sample was common, with an average score of 10.15 (±3.93) on the CIRS-G and 7.4 (±3.86) medications prescribed on admission. One hundred and forty-four patients (76%) were categorised as frail, and overall, their physical performance was poor (SPPB 3.46 ±2.06) and fear of falling high (FES-I, 46.71 ±15.92). On admission, 39 (20%) patients walked independently with an aid, 45 (24%) needed assistance but no walking aid, and the remaining 105 (55%) patients needed both an aid and assistance. Most common presentations were respiratory complaints (n=52, 26%), and falls (n=45, 24%). Other common complaints included renal complaints (n=25, 13%), strokes or transient ischaemic attacks (n=12, 6%), general malaise (n=11, 6%), cardiac (n=10, 5%), and gastric complaints (n=8, 4%). There were no significant differences between the intervention groups on admission except in the control group there was a considerably larger number of women (n=61 (64%) versus n=39 (41%) in the intervention group). Further patient characteristics are provided in Table 2.

Please insert Table 2 : Baseline Characteristics of the APEP Participants (n=190) here

Please insert Table 3: Unadjusted and Adjusted regression and Time-to-Event analyses results between groups here

Length of stay

The total number of bed nights for the control group was 970 (median 8 (IQR 6-13)) nights and 880 nights (median 8 (IQR 5-11)) in the intervention group (HR 1.11 (CI 0.83-1.5) p=0.48). An equal
number of patients were transferred to sub-acute rehabilitation in each group, which, in effect, artificially truncated their length of stay. There was little change to the results when we removed these patients (n=128), (HR 1.09 (CI 0.77-1.56), p=0.6; Table 3). However, when adjusted post hoc for age and frailty, while it remained insignificant, the effect was greater and differences became clearer (n=125), (HR 1.3 (CI 0.90-1.87) p=0.16; Table 3). Kaplan Meier curves display the differences between the models (Figure 2).

Figure 2: Length of Stay between Groups (APEP Trial) (n=128)

Step-count in hospital

Step-count data was collected on only 48 patients and their range of activity is wide. The APEP group were found to be more active outside of the exercise sessions (average daily steps= 889 (IQR 575-1088) compared to the control group (steps= 597 (IQR 346-846)), (p=0.1). The difference between the groups became more apparent when adjusted post hoc for age and frailty (additional steps 316 (95% CI -25 to 656), p=0.07).

Physical performance and functional independence

At discharge, physical performance scores were better in the intervention group (4.6 ±2.5) than in the control group (3.0 ±2.1), (difference 0.88 (95% CI 0.20 – 1.57), p=0.01), (Table 3). In the participants who attended the face-to-face follow-up appointment, this benefit was lost (n=124) (difference 0.45, (95% CI -0.43 to 1.33) p=0.3). In order to capture information on those who did not attend, we used a self-reported functional ambulation collected by a phone call (n=145), and grouped the responses into independent or non-independent walkers (assistance required/not required to walk). Simple analysis suggested a greater proportion were independent in the intervention group (n=58 of the 77 patients versus n=44 of the 68 patients respectively, OR 3.64 (95% CI 1.3 – 10.2), p=0.01; however, when adjusted post hoc for age, gender, frailty, baseline physical performance and fear of falling, the association was attenuated (OR 2.47 (95% CI 0.82 – 7.44) p=0.1) (Table 3)).
QoL

At discharge, differences in QoL were not detected. Both simple and post hoc adjusted regression suggested no difference between groups (62.4 ±21.3 in the control group versus 67.7 ±18.4 in the intervention group), (difference 3.96 (95% CI: -1.65 to 9.6) p=0.1); (Table 3). However, at follow-up, the intervention group reported significantly better QoL than the control group (65.2 ±21.2 versus 58.5 ±21.6), (difference 0.28 (95% CI 0.09 – 0.47), p=0.004); post hoc adjustment for age, gender, frailty, fear of falling and physical performance at baseline did not materially change the estimate difference.

Negative Events

Negative events can be described as all adverse events that occurred in the hospital and negative outcomes which included deaths, falls, prolonged hospitalisation and institutionalisation. Six patients died in hospital; three in each group. At follow-up, 12 patients had died in the control group, and five in the intervention group (OR 0.42 (95% CI 0.14 – 1.26) p=0.12). A difference in prolonged hospitalisation seemed evident at follow-up; of the six patients who had not been discharged at all, five from the control group were in sub-acute care, and one from the intervention group. Also, three patients from the control group were in long-term care, with no-one from the intervention group. Once again, a difference seemed to emerge in falls. At discharge, equal numbers had fallen in hospital; three in each group. However, at follow-up, 30 patients had fallen during the study period; 18 in the control group and 12 in the intervention group (OR 0.6 (95%CI, 0.26-1.36) p=0.2). Using a combined score of these negative events, post hoc logistic regression analysis showed lower odds of negative events occurring (falls, prolonged hospital stay, long-term care admission, or death) in the intervention than the control (OR 0.46 (95% CI 0.23 – 0.92) p=0.03).

To examine readmission rates, those remaining in hospital were excluded. In the 176 patients, 46 medical readmissions occurred in the follow-up period; 16 in the control group and 30 in the intervention group (OR 1.95 (95% CI 0.93 – 3.93) p=0.06); post hoc adjusted scores (OR 2.25 (95% CI
Discussion
There were three main results from this study. Firstly, the APEP programme appeared to reduce length of stay by 30% in patients who were discharged home, however, this did not reach statistical significance. Secondly, patients’ physical performance was significantly better at discharge in the intervention group, however this improvement was lost at follow-up. Finally, while significantly more readmissions occurred in the intervention group, more prolonged hospital stays, deaths and falls and admissions to long-term care occurred in the control group.

The effect of the APEP on length of stay is similar to previous findings. Neither Siebens et al. [14] nor de Morton et al. [13] detected a shorter stay with additional exercises in hospital. Jones et al. [15] detected a difference, but only when sub-acute care was included. A previously conducted individual patient meta-analysis [31] found that the additional exercises mostly benefitted non-independently mobile patients on admission, and Jones et al. [15], also found that their exercise intervention was most effective for those with poorer physical performance on admission. Our post hoc multivariable analysis appeared to support this finding; when we adjusted for frailty and age. The results would suggest that this intervention has a greater impact on length of stay in the frailer patients.

Our power calculations for this study, based on a previously completed pilot study [32] suggested that 220 patients were required. The length of stay is artificial in those transferred for continuing care. When transferred patients were omitted from the analysis, the intervention effect was greater on length of stay, but the power was weakened (n=125), which may explain its failure to reach statistical significance. Future studies should consider this subgroup and if possible, sufficiently power the study to detect changes.

A significant difference in physical performance was detected at discharge in the intervention group
and this is similar to the findings of Jones et al. [15]. The changes that we detected suggest that they were also clinically meaningful. The change in SPPB scores of 0.78 (adjusted scores) lies well within the estimates for clinically meaningful change of between 0.3 and 0.8, and within the estimates for substantial clinical change of between 0.4 and 1.5 [33].

QoL was statistically different between groups at follow-up; a difference of 6.7 units (range 0-100 units) was detected. While there is no clearly defined minimal clinical important change in the older population, a difference of seven units has been defined as the cut-off point for patients with chronic pulmonary disease [34], suggesting that the difference detected in this cohort is clinically relevant.

The differences in negative events became apparent at follow-up, and when analysed together (post hoc) occurred significantly more often in the control group. One adverse outcome was detected in the intervention group; a considerably greater number of readmissions occurred (30 versus 16 in the control group). Potentially, as a greater number of frailer patients were discharged home, they may have a natural tendency for readmissions.

While the results of this trial need to be interpreted with caution, they can be used to inform future research in this area. Firstly, many frailer patients are not discharged directly home, with the health service provide developing “step-down” pathways. The APEP programme may sit well within these services as patients recover from their acute illness. Finally, many older inpatients are robust, but remain inactive in hospital. While physiotherapists lead patients exercise and activity, everyone is responsible for exercise promotion. Future research should measure the effectiveness of a broader, more inclusive intervention including changes to the hospital environmental and interdisciplinary management of walking activity in hospital.

Study Limitations

There are a number of limitations in this study. Two factors may have resulted in only 12% of
screened older medical patients being recruited. Firstly, we aimed to recruit frailer inpatients. We recruited those needing assistance of one, but resources prevented recruitment of those needing two people, resulting in a narrow patient selection. Secondly, to maintain an adequate dosage of the APEP intervention, we recruited patients early; within two days of admission. However, many were too unwell to recruit within that timeframe, but gradually did improve thereafter, and became clinically, very suitable for the intervention. In future studies, the dosage or simply patients’ ability to participate should be debated.

While we intended to recruit 220 patients, we decided to terminate the trial after 190 patients were recruited, when it was obvious that a newly-opened transitional care unit accepted many patients in the trial, rather than directly discharged home. This resulted in an artificially shorter LOS, and did not reflect “readiness for discharge home”. This premature termination led to our study being underpowered, leaving the exact effect of the intervention unclear. It was also noted that the intervention did not affect the transfer rate; once the clinical decision to offer sub-acute rehabilitation was made, it was difficult to withdraw this offer.

The improvement in physical performance was lost at the three-month follow-up. The patients were not supported after discharge, nor were their activity levels monitored. Future studies should incorporate some support and or measurement of activity post discharge. Finally, more information regarding patients’ fear of falling and frailty at follow-up may provide a better indication of changes in their self-efficacy.

**Conclusion**

The results suggest that the APEP intervention improves patients’ physical performance and QoL. Length of stay was considerably reduced, however this failed to reach statistical significance. Insufficient study participant numbers as a result of the new subacute care unit offsite may explain the lack of significance.
Abbreviations
6-CIT: Six-Item Cognitive Impairment Test
APEP: Augmented prescribed exercise programme
CIRS-G: Cumulative Illness Rating Scale – Geriatrics
EQ-5D-5L: EuroQol 5-Domain 5-Level Scale
FES-I: Falls Efficacy Scale International
N-EADL – Nottingham Extended Activities of Daily Living Scale
PI: Principal Investigator
RA: Research Assistant
RPT: Research Physiotherapist
SAM: Stepwatch Activity Monitor
SHARE-FI: Survey of Health, Aging and Retirement in Europe Frailty Instrument
SPPB: Short Physical Performance Battery

Declarations
Ethics Approval and consent to participate
Ethics approval was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals [EMC (vv) 13/10/15]. Patient informed written consent was gained by all participants. The next-of-kin also gave written consent when consenting participants were deemed to have poor cognition.

Consent for publication
Not applicable

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
Competing Interests

The author declare that they have no competing interests. This study has not received funding or assistance from a commercial organisation.

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Authors contributions

RMcc: concept and design, acquisition of subjects and baseline data collection, delivery of the intervention, analysis and interpretation of the data, manuscript preparation. EO’C: outcome data acquisition, manuscript preparation. SO’M patient allocation process, data entry, manuscript preparation. DD: concept and design, data analysis. EO’R: data analysis. KO’C: concept and design, safety monitoring, manuscript preparation. NFH: concept and design, study oversight, manuscript preparation. ST: concept and design, study oversight, analysis and interpretation of the data, manuscript preparation.

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Tables

Table 2: Baseline Characteristics of the APEP Participants (n=190)

| Variable     | Control Group (n=95) | Intervention Group (n=95) |
|--------------|----------------------|---------------------------|
|              | N (%)                | N (%)                     |
| Female       | 39 (41%)             | 61 (64%)                  |
| Smoke        |                      |                           |
| Never        | 57 (60%)             | 55 (58%)                  |
| Former       | 26 (27%)             | 26 (27%)                  |
| Current      | 12 (13%)             | 14 (15%)                  |
| Marital Status |                    |                           |
| single       | 21 (22%)             | 17 (18%)                  |
| partner      | 33 (35%)             | 30 (32%)                  |
| widowed      | 41 (43%)             | 48 (51%)                  |
| Alcohol      |                      |                           |
| SHARE F-I category | Never/Former | Current |
|-------------------|--------------|---------|
| Not Frail         | 74 (78%)     | 73 (77%)|
| Pre-frail         | 18 (20%)     | 14 (15%)|
| Frail             | 74 (77%)     | 74 (78%)|

| No of falls | none | 1-2 | > 2 |
|-------------|------|-----|-----|
| none        | 50 (53%) | 49 (52%) | 50 (52%) |
| 1-2         | 31 (32%) | 34 (36%) | 31 (32%) |
| > 2         | 14 (14%) | 12 (13%) | 14 (14%) |

| IND           | | |
|---------------|-------------------|
| Independent Walking | 10 (11%) | 14 (15%) |
| Not Independently Walking | 84 (89%) | 81 (85%) |

| Mean (SD) | Mean (SD) |
|-----------|-----------|
| Age       | 81.7 (7.3) | 79.7 (7.5) |
| BMI (kg/m²) | 26.8 (6.8) | 26.3 (6.5) |
| No. of medications | 6.9 (3.87) | 7.2 (3.9) |
| CIRS-G     | 10 (3.9)   | 10.3 (4)  |
| VAS SR Health | 52.9 (18.9) | 56.5 (18.7) |
| FacA       | 3.49 (0.77)| 3.59 (0.9) |

| Median (IQR) | Median (IQR) |
|--------------|--------------|
| 6CIT Score   | 6 (2-16)     | 8 (2-18)   |
| FES-I        | 3.7 (2.8-4.6)| 3.8 (2.7-4.6)|
| Walking Speed (sec) | 11.3 (7.4-17.2) | 10 (7.6-14.9) |
| SPPB score   | 3 (2-4)     | 3 (2-5)    |
| PreN-EADL    | 6 (0-11)    | 7 (0-13)   |
| N-EADL       | 2 (0-4)    | 1 (0-4)    |

Abbreviations and possible score ranges: **CIRS-G**: Cumulative Illness Rating Scale-Geriatrics [higher score reflects greater impairment in several systems, range 0-56]; **6CIT**: 6-Item Cognitive Impairment Test [a higher score reflects a higher cognitive impairment, range 0-28]; **SHARE F-I**: Survey of Health, Ageing and Retirement in Europe Frailty Index [a higher score reflects a higher level of frailty, range -2.55 to 6.505]; **FES-I**: Falls Efficacy Scale-International [a higher score reflects a greater concern about falling, range 0-64]; **SPPB**: Short Physical Performance Battery [a higher score reflects a better physical performance, range 0-12]; **IND**: ability to walk independently on level surfaces. **PreN-EADL**: Premorbid Nottingham Extended Activities of Daily Living [a higher score reflects a better level of independence, range 0-22]; **N-EADL**: Nottingham Extended Activities of Daily Living on Admission [a higher score reflects a better level of independence, range 0-22]; **VAS SR Health** (EQ5D5L): Visual Analogue Scale EuroQol 5-Domain 5-Level, [range 1-100]; **FacA**: Functional Ambulatory Classification on Admission [a higher score reflects a better level of ambulation, range 0-6]
### Table 3: Unadjusted and Adjusted regression and Time-to-Event analyses results between groups

| Variable                  | N   | Control | N   | APEP | N   | Co-ef | Unadjusted | p    | N   | Adjusted | p    |
|---------------------------|-----|---------|-----|------|-----|-------|------------|------|-----|----------|------|
| **LOS (bed nights)**      | 94  | 970     | 95  | 880  | 199 | HR    | 1.09       | 0.6  | 125 | 1.3      | 0.16 |
| **Steps median [IQR]**    | 23  | 597 [346-846] | 25  | 889 [575-1088] | 48  | β     | 262.1 (-80 - 604) | 0.1  | 48  | 316 (-25 - 656) | 0.07 |
| **SPPB Score Discharge m (±SD)** | 89  | 3.0 (±2.1) | 86  | 4.6 (±2.5) | 178 | β     | 0.88 (0.20 - 1.57) | 0.01* | 174 | 0.78 (0.28 - 1.29) | 0.003* |
| **SPPB Score Follow-up m (±SD)** | 52  | 4.7 (±2.5) | 72  | 5.12 (±2.3) | 123 | β     | 0.45 (-0.43 - 1.33) | 0.3  | 122 | 0.67 (-0.74 - 0.87) | 0.87 |
| **VAS SR Health Discharge m (±SD)** | 89  | 62.4 (±21.3) | 86  | 67.7 (±18.38) | 178 | β     | 3.96 (-1.65 - 9.6) | 0.1  | 172 | 5.10 (-0.78 - 10.98) | 0.9 |
| **VAS SR Health Follow-up m (±SD)** | 68  | 58.5 (±21.6) | 77  | 65.2 (±21.2) | 145 | β     | 0.28 (0.09 - 0.47) | 0.004* | 143 | 0.26 (0.07 - 0.45) | 0.008* |
| **READMISSION Follow-up** | 94  | 16      | 95  | 30   | 176 | β     | 0.73 (0.03 - 1.43) | 0.04* | 172 | 0.87 (0.13 - 1.62) | 0.02* |
| **FALLS Follow-up**       | 68  | 18      | 77  | 12   | 189 | OR    | 0.6 (0.26 - 1.36) | 0.2  | 184 | 0.57 (0.24 - 1.38) | 0.2 |
| **DEATH**                 | 94  | 12      | 95  | 5    | 189 | OR    | 0.42 (0.14 - 1.36) | 0.12 | 184 | 0.38 (0.11 - 1.36) | 0.13 |
| Follow-up | IND Follow-up | OR: 3.64 (1.3 - 10.2) | 0.01* | 165 - 1.33) | 0.1 |
|-----------|--------------|------------------------|-------|-------------|-----|
| NEGA- | TIVE EVEN- | TS Follow-up | OR: 0.46 (0.23 - 0.92) | 0.03* | 184 - 0.03* |

LOS and Steps multivariate models adjusted for age and frailty only.
All other multivariable models adjusted for age, gender, frailty, fear of falling, physical performance on admission and the baseline score.

**Abbreviations and possible score ranges:**
- **LOS**: length of stay (nights);
- **Steps**: average daily step-count;
- **SPPB Score**: Short Physical Performance Battery (a higher score reflects a better physical performance, range 0-12);
- **IND**: ability to walk independently on level surfaces;
- **VAS SR Health (EQ5DSL)**: Visual Analogue Scale EuroQol 5-Domain 5-Level, [range 1-100];
- **READMISSION**: medical readmissions.

**Table 1**

Due to technical limitations, table 1 is only available as a download in the supplemental files section.

**Figures**
Figure 1: CONSORT Flow diagram of the completed APEP

Supplementary Files
This is a list of supplementary files associated with this preprint. Click to download.

Appendix 1_Description of APEP and Sham Exercises.docx
CONSORT-Checklist-completed.doc
Appendix 2_Deviations from the published protocol.docx
Table 1.docx
