Abstract

Introduction: Our aim was to study the prevalence of frailty and its associated factors in a subacute geriatric ward.

Methods: This was a cross-sectional study of 167 participants between June 2018 and June 2019. Baseline demographics and participants’ Mini Nutritional Assessment, Geriatric Depression Scale, Mini Mental State Examination, Charlson’s Comorbidity Index and LACE index scores were obtained. Functional measurements such as modified Barthel’s Index scores and hand grip strength (HGS) were taken. Frailty was assessed using the Clinical Frailty Scale (CFS) and the FRAIL scale. Data on history of healthcare utilisation, medications, length of stay, selected blood investigations and presence of geriatric syndromes were also collected.

Results: The prevalence of pre-frailty (CFS 4) and frailty (CFS ≥ 5) was 16.2% and 63.4%, respectively. There were significant associations between CFS and age (pre-frail vs. non-frail: odds ratio [OR] 1.14, 95% confidence interval [CI] 1.04–1.25, \( P = 0.006 \); frail vs. non-frail: OR 1.08, 95% CI 1.01–1.15, \( P = 0.021 \)), HGS at discharge (frail vs. non-frail: OR 0.90, 95% CI 0.82–0.99, \( P = 0.025 \)), serum albumin (frail vs. non-frail: OR 0.90, 95% CI 0.82–0.99, \( P = 0.035 \)) and the presence of urinary incontinence (frail vs. non-frail: OR 3.03, 95% CI 1.19–7.77, \( P = 0.021 \)).

Conclusion: Frailty is highly prevalent in the subacute geriatric setting and has many associated factors. In this study, independent factors associated with frailty were age, HGS at discharge, serum albumin and urinary incontinence. This has implications for future resource allocation for frail older inpatients and may help direct further research to study the effectiveness of frailty-targeted interventions.

Keywords: Albumin, frailty, hand grip strength, subacute, urinary incontinence

INTRODUCTION

Frailty, characterised by a state of low intrinsic capacities, is recognised as an emerging geriatric giant and is a distinct clinical syndrome that has a complex pathophysiology. Frail elderly are highly susceptible to internal and external stressors and are at risk of multiple adverse health outcomes. The worldwide prevalence of pre-frailty and frailty ranges from 34.6% to 50.9% and 5.8% to 27.3%, respectively. Locally, the prevalence of pre-frailty and frailty in a study of 1,051 older adults in the community was 37% and 6.2%, respectively. Among geriatric inpatients in a local tertiary hospital, the prevalence of frailty was 50–87.1% and in one community hospital, it was 45.6%.

Our subacute geriatric ward is situated in a community hospital in eastern Singapore. Most patients are received directly after a period of acute hospital stay or after a comprehensive geriatric assessment in a specialised Emergency Department unit and evaluated for requirements of continued inpatient care for optimisation of medical conditions and rehabilitation.

There are limited studies of the elderly population that requires subacute inpatient care and even less is known about the frailty prevalence in this group of older adults. This has implications for future resource allocation for frail older inpatients and may help direct further research to study the effectiveness of frailty-targeted interventions.
The aim of our study was to evaluate the prevalence of frailty in a subacute ward and its associated factors. This deepens our knowledge of frailty in this subset of inpatients and helps us to identify and institute appropriate interventions that may be effective in the management of frailty and, in turn, to reduce its associated adverse health outcomes.

**METHODS**

This cross-sectional study was conducted from June 2018 to June 2019. Patients or their authorised family members who consented to the study were recruited. Baseline demographics were collected, and survey instruments administered included the Mini Nutritional Assessment (MNA), Geriatric Depression Scale (GDS), Mini Mental State Examination (MMSE) and Charlson’s Comorbidity Index (CCI). Readmission risk was assessed using the LACE (length of stay, acuity of admission, Charlson comorbidity index and number of emergency department visits in preceding six months) score. Frailty status was assessed using both the Clinical Frailty Scale (CFS) and the FRAIL (Fatigue, Resistance, Ambulation, Illness and Loss of Weight) scale. The CFS was chosen because it is simple and easily scored on the basis of a comprehensive geriatric assessment and a quick interview with patients or caregivers. The CFS is also widely used by local senior community networks and services to risk-stratify the elderly and institute appropriate care strategies. The FRAIL questionnaire is also a widely used screening questionnaire. Functional status was measured using the modified Barthel’s Index (MBI). Hand grip strength (HGS) measurements were taken at discharge using a single calibrated digital Jamar Hand Dynamometer according to a standardised protocol (see Appendix).

Frailty status was derived from the CFS scores and categorised as follows: non-frail for CFS score <4, pre-frail for CFS score of 4 and frail for CFS score ≥5.

The original study aimed to study readmission and its associated factors. A sample size of 308 subjects would have 90% power at 5% significance level to detect 20% difference in the proportion of readmission between frail and non-frail subjects (see Appendix).

Subject characteristics were summarised in frequency and percentage for categorical data. Numerical data was presented in mean ± standard deviation or median (25th percentile, 75th percentile) according to the data distribution. Data was considered skewed or not normally distributed if $P < 0.05$ in the Kolmogorov-Smirnov test.

Univariate multinomial regression was performed to assess factors associated with frailty status. Variables that showed statistical significance in univariate analysis were included in the multivariate multinomial regression model, using backward elimination.

![Figure 1](image)

*Figure 1: Consort diagram shows the flow of subjects screened, enrolled and included in the analysis. AOR: at own risk, CFS: Clinical Frailty Scale, MMSE: Mini Mental State Examination, MNA: Mini Nutritional Assessment*
elimination, to identify independent associations with frailty. Both univariate and multivariate multinomial regression used non-frail as the reference group.

All statistical analysis was performed using IBM SPSS version 23.0 (IBM Corp, Armonk, NY, USA), and statistical significance was set at $P < 0.05$. Ethics approval was obtained from the SingHealth Centralised Institutional Review Board, Singapore (CIRB reference no. 2017/3000).

RESULTS

In total, 167 participants were included in the final analysis: 34 were non-frail (CFS <4), 27 were pre-frail (CFS 4) and 106 were frail (CFS ≥5) as illustrated in Figure 1. Table 1 summarises the participants’ characteristics categorised into the three CFS groups. The prevalence of pre-frailty in our study population was 16.2% and that of frailty was 63.4%. Within the frail group, they were mainly mildly frail (CFS 5: 43.4%) and moderately frail (CFS 6: 47.2%). In total, 8.5% (n = 9) of the group were severely frail (CFS 7) and 0.9% (n = 1) were very severely frail (CFS 8).

Univariate multinomial logistics regression [Table 2] revealed that age, HGS at discharge, serum albumin level, depression, urinary incontinence, hospitalisation history six months before admission, malnutrition, MMSE and MBI scores were associated with pre-frailty and frailty.

From the multivariate multinomial regression model [Table 3], age (odds ratio [OR] 1.08, 95% confidence interval [CI] 1.01–1.15, $P = 0.021$), HGS at discharge (OR 0.90, 95% CI 0.82–0.99, $P = 0.025$), serum albumin level (OR 0.90, 95% CI 0.82–0.99, $P = 0.035$) and urinary incontinence (OR 3.03, 95% CI 1.19–7.77, $P = 0.021$) had independent associations with frailty.

DISCUSSION

This is the first local study of frailty in a subacute geriatric ward. The high prevalence of frailty was expected because these patients often had complex medical and functional issues. Our study revealed several independent associations with frailty, which were consistent with a number of other studies.\(^{21-25}\)

| Parameter | \(n\) (%)/Mean±standard deviation | \(P\) |
|-----------|---------------------------------|------|
| **Age (yr)** | Non-frail \((n=34)\) | Pre-frail \((n=27)\) | Frail \((n=106)\) | |
| Male | 15 (22.7) | 17 (25.8) | 34 (51.5) | 0.011 |
| Female | 19 (18.8) | 10 (9.9) | 72 (71.3) | - |
| **Ethnicity** | - | - | - | - |
| Chinese | 27 (21.6) | 24 (19.2) | 84 (59.2) | 0.039 |
| Malay | 3 (9.1) | 3 (9.1) | 27 (81.8) | - |
| Indian and others | 4 (44.4) | 0 (0) | 5 (55.6) | - |
| **BMI (kg/m\(^2\))** | \([n=29]\) 22.0±4.9 | \([n=22]\) 22.5±4.4 | \([n=94]\) 23.1±6.4 | 0.664 |
| **MBI** | On admission | 53.3±16.1 | 54.7±14.1 | 38.7±16.0 | <0.001 |
| At discharge* | 61.0 (80.7, 76.0) | 55.0 (80.0, 67.0) | 44.0 (32.0, 63.0) | 0.226 |
| Efficiency* † | \([n=34]\) –0.4 (–0.8, 0.3) | \([n=27]\) –0.1 (–0.7, 2.0) | \([n=104]\) –0.3 (–0.8, 0.0) | 0.336 |
| **Length of stay (day)** | - | - | - | - |
| Acute ward | 10.5 (3.8, 23.3) | 11.0 (6.0, 17.0) | 11.0 (7.0, 17.3) | 0.959 |
| Subacute ward | 20.0 (14.0, 25.3) | 21.0 (15.0, 25.0) | 21.0 (15.0, 27.0) | 0.613 |
| HGS at discharge (kg) | 13.1 (10.5, 18.3) | 15.1 (12.8, 20.0) | 8.8 (6.4, 12.7) | <0.001 |
| **CCI** | 2.5 (0.0, 6.0) | 2.0 (2.0, 4.0) | 3.0 (1.8, 5.0) | 0.171 |
| Taking >5 medication | - | - | - | - |
| No | 2 (33.3) | 0 (0) | 4 (66.7) | 0.465 |
| Yes | 32 (19.9) | 27 (16.8) | 102 (63.4) | - |
| Sodium (mmol/L) | 139.5±3.2 | 139.5±3.2 | 138.6±3.8 | 0.586 |
| Haemoglobin (g/dL) | 11.3±1.8 | 11.6±1.6 | 10.9±1.5 | 0.105 |
| eGFR* (mL/min/1.73 m\(^2\)) | 59.5 (47.5, 84.3) | 69.0 (49.0, 82.0) | 63.0 (40.8, 80.0) | 0.786 |
| Albumin* (g/L) | 40.5 (36.0-42.3) | 40.0 (36.0-43.0) | 36.0 (33.0-39.0) | <0.001 |
| **Cognitive impairment** | - | - | - | - |
| No | 28 (23.7) | 16 (13.6) | 74 (62.7) | 0.137 |
| Yes | 6 (12.2) | 11 (22.4) | 32 (65.2) | - |

Contd...
Table 1. Contd...

| Parameter                  | n (%)/Mean± standard deviation | P       |
|----------------------------|--------------------------------|---------|
|                            | Non-frail (n=34)               | Pre-frail (n=27) | Frail (n=106) |
| BPSD                       |                                |         |               |
| No                         | 31 (20.5)                      | 21 (17.9)| 93 (61.6)     | 0.152     |
| Yes                        | 3 (18.8)                       | 0 (0)   | 13 (81.2)     |           |
| Delirium                   |                                |         |               |
| No                         | 28 (20.7)                      | 24 (17.8)| 83 (61.5)     | 0.445     |
| Yes                        | 6 (18.8)                       | 3 (9.4) | 23 (71.9)     | -         |
| Depression                 |                                |         |               |
| No                         | 32 (23.4)                      | 23 (16.8)| 82 (59.9)     | 0.077     |
| Yes                        | 2 (6.7)                        | 4 (13.3)| 24 (80.0)     | -         |
| Falls                      |                                |         |               |
| No                         | 12 (21.4)                      | 9 (16.1)| 35 (62.5)     | 0.982     |
| Yes                        | 22 (20.2)                      | 18 (16.5)| 69 (63.3)     | -         |
| Unknown                    | 0 (0)                          | 0 (0)   | 2 (100.0)     | -         |
| Osteoporosis               |                                |         |               |
| No                         | 12 (21.1)                      | 11 (19.3)| 34 (59.6)     | 0.664     |
| Yes                        | 18 (22.0)                      | 11 (13.4)| 53 (64.6)     | -         |
| Unknown                    | 4 (14.3)                       | 5 (17.9)| 19 (67.9)     | -         |
| Urinary incontinence       |                                |         |               |
| No                         | 24 (25.8)                      | 23 (24.7)| 46 (49.5)     | <0.001    |
| Yes                        | 10 (13.5)                      | 4 (5.4) | 60 (81.1)     | -         |
| Immobility                 |                                |         |               |
| No                         | 5 (25.0)                       | 4 (20.0)| 11 (55.0)     | 0.703     |
| Yes                        | 29 (19.7)                      | 23 (15.6)| 95 (64.6)     | -         |
| ED visits (previous 6 mth) |                                |         |               |
| No                         | 23 (24.5)                      | 17 (18.1)| 54 (57.4)     | 0.174     |
| Yes                        | 11 (15.1)                      | 10 (13.7)| 52 (71.2)     | -         |
| Hospitalisation history (previous 6 mth) |                                 |         |               |
| No                         | 24 (25.0)                      | 18 (18.8)| 54 (56.2)     | 0.075     |
| Yes                        | 10 (14.1)                      | 9 (12.7)| 52 (73.2)     | -         |
| LACE index                 | 12.5±2.7                       | 12.5±2.0| 13.5±2.7      | 0.074     |
| FRAIL score                | 34                              | 27      | 106           | -         |
| Robust (0)                 | 11 (91.7)                      | 0 (0)   | 1 (8.3)       | <0.001    |
| Pre-frail (1-2)            | 13 (21.3)                      | 17 (27.9)| 31 (50.8)     | -         |
| Frail (≥3)                 | 4 (5.9)                        | 6 (8.8) | 58 (85.3)     | -         |
| Missing                    | 6 (23.1)                       | 4 (15.4)| 16 (61.5)     | -         |
| MNA score                  |                                |         |               |
| Normal nutrition (≥12)     | 7 (53.8)                       | 3 (23.1)| 3 (23.1)      | 0.004     |
| At risk of malnutrition (8-11) | 18 (23.1)                   | 13 (16.7)| 47 (60.3)     | -         |
| Malnourished (<8)          | 9 (11.8)                       | 11 (14.5)| 56 (73.7)     | -         |
| GDS score                  |                                |         |               |
| ≥5                         | 13 (18.1)                      | 13 (18.1)| 46 (63.9)     | 0.533     |
| <5                         | 20 (25.6)                      | 13 (16.7)| 45 (67.7)     | -         |
| Missing                    | 1 (5.9)                        | 1 (5.9) | 15 (88.2)     | -         |
| MMSE score                 |                                |         |               |
| ≥23                        | 20 (35.7)                      | 14 (25.0)| 22 (39.3)     | <0.001    |
| <23                        | 14 (12.6)                      | 13 (11.7)| 84 (75.7)     | -         |

Value of n is listed in cases where some data was unavailable, and percentages were calculated based on available data. *Data presented as median (interquartile range). †MBI efficiency refers to MBI on discharge-MBI on admission/length of stay. BMI: body mass index, BPSD: behavioural and psychological symptoms of dementia, CCI: Charlson’s Comorbidity Index, ED: emergency department, eGFR: estimated glomerular filtration rate, FRAIL: Fatigue, Resistance, Ambulation, Illness and Loss of Weight, GDS: Geriatric Depression Scale, HGS: hand grip strength, LACE: length of stay, acuity of admission, Charlson comorbidity index and number of emergency department visits in preceding 6 months, MBI: Modified Barthel’s Index, MMSE: Mini Mental State Examination, MNA: Mini Nutritional Assessment
### Table 2. Univariate multinomial logistics regression.

| Factor                        | OR (95% CI) | P     | OR (95% CI) | P     |
|-------------------------------|-------------|-------|-------------|-------|
|                               | Pre-frail vs. non-frail | Frail vs. non-frail |
| Age                           | 1.09 (1.01-1.17) | 0.026 | 1.11 (1.05-1.18) | 0.001 |
| Gender                        |             |       |             |       |
| Male                          | 2.15 (0.77-6.05) | 0.146 | 0.60 (0.27-1.32) | 0.202 |
| Female                        |             |       |             |       |
| Ethnicity                     |             |       |             |       |
| Chinese                       | 2.07 (0.48-8.93) | 0.327 | 0.60 (0.24-1.52) | 0.280 |
| Non-Chinese                   | ref         | -     | ref         | -     |
| MBI                           |             |       |             |       |
| On admission                  | 1.01 (0.98-1.05) | 0.498 | 0.95 (0.92-0.97) | <0.001 |
| Efficiency                    | 1.23 (0.95-1.59) | 0.125 | 0.83 (0.64-1.09) | 0.182 |
| Length of stay                |             |       |             |       |
| Acute ward                    | 0.99 (0.95-1.01) | 0.291 | 0.99 (0.97-1.01) | 0.426 |
| Subacute ward                 | 1.08 (0.99-1.12) | 0.083 | 0.86 (0.80-0.93) | <0.001 |
| HGS at discharge              | 0.94 (0.76-1.16) | 0.563 | 1.10 (0.95-1.28) | 0.205 |
| CCI                           | 0.99 (0.86-1.16) | 0.983 | 0.94 (0.84-1.05) | 0.295 |
| Sodium                        | 0.99 (0.89-1.10) | 0.809 | 0.86 (0.79-0.94) | 0.001 |
| Haemoglobin                   | 1.09 (0.80-1.49) | 0.572 | 0.85 (0.67-1.09) | 0.202 |
| eGFR                          | 1.01 (0.98-1.03) | 0.658 | 0.99 (0.98-1.02) | 0.840 |
| Cognitive impairment          |             |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | 3.21 (0.99-10.33) | 0.051 | 2.02 (0.76-5.35) | 0.158 |
| BPDS                          |             |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | NA          | NA    | 1.44 (0.39-5.41) | 0.585 |
| Delirium                      |             |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | 0.58 (0.13-2.59) | 0.478 | 1.29 (0.48-3.50) | 0.613 |
| Depression                    |             |       |             |       |
| No                            | ref         | -     | ref         | -     |
| Yes                           | 2.78 (0.50-16.50) | 0.260 | 4.68 (1.05-20.97) | 0.044 |
| Falls                         |             |       |             |       |
| No                            | ref         | -     | ref         | -     |
| Yes                           | 1.09 (0.38-3.17) | 0.873 | 1.08 (0.48-2.42) | 0.861 |
| Urinary incontinence          |             |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | 0.42 (0.12-1.52) | 0.185 | 3.13 (1.36-7.19) | 0.007 |
| Immobility                    |             |       |             |       |
| No                            | ref         | -     | ref         | -     |
| Yes                           | 0.99 (0.24-4.12) | 0.990 | 1.49 (0.48-4.64) | 0.492 |
| ED visits (previous 6 mth)    |             |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | 1.23 (0.43-3.56) | 0.702 | 2.01 (0.89-4.54) | 0.092 |
| Hospitalisation history (previous 6 mth) |     |       |             |       |
| No                            | ref         | ref   | ref         | ref   |
| Yes                           | 1.20 (0.40-3.56) | 0.742 | 2.31 (1.01-5.30) | 0.048 |
| LACE index                    | 0.99 (0.81-1.21) | 0.942 | 1.15 (0.99-1.35) | 0.070 |
| MNA                           |             |       |             |       |
| Normal nutrition (score≥12)   | ref         | -     | ref         | -     |
| At risk of malnutrition (score 8-11) | 1.69 (0.37-7.78) | 0.504 | 6.09 (1.42-26.17) | 0.015 |
| Malnourished (score <8)       | 2.85 (0.67-14.33) | 0.203 | 14.52 (3.16-66.69) | 0.001 |

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Age is a well-known association with frailty.\textsuperscript{[21,22,25]} With increasing age, biomedical and psychosocial deficits are accumulated, reducing the individual’s functional and reserve capacity. Hence, frailty screening and intervention should start earlier in the life course so that the individual can build up their reserve capacities earlier.\textsuperscript{[24]}

HGS is also an independent association. Being a marker of muscle strength,\textsuperscript{[20,26]} it can be easily measured and possibly used as another independent marker of frailty in the inpatient setting.

Serum albumin is reflective of nutritional status, and nutritional status is closely related to frailty.\textsuperscript{[21,27]} Frail elderly often have unintentional weight loss, indicating a state of malnutrition or being at risk of malnutrition. Hence, routine evaluation of nutritional status in geriatric inpatients is important, allowing appropriate nutritional interventions to be instituted.

Urinary incontinence has been shown in previous studies\textsuperscript{[28,29]} to be associated with frailty. It is also a component of FRAIL-NH (Fatigue, Resistance, Ambulation, Incontinence, Illness, Loss of Weight, Nutritional Approach altered, Help with Dressing),\textsuperscript{[30]} a frailty tool used in nursing homes. Urinary incontinence is often accompanied by medical conditions linked to reduced functional capacity such as lower gait speed, physical inactivity and reduced muscle strength.\textsuperscript{[31]} Because the aetiology of urinary incontinence may be multifactorial, evaluation of urinary incontinence in elderly inpatients to target and treat reversible causes may improve frailty states.

This study provides a better understanding of what may be a unique group of patients with largely different characteristics from a more heterogeneous population in the acute inpatient setting. They have a much longer length of hospital stay with more intensive utilisation of hospital resources, possibly leading to increased healthcare costs. Identification of possible reversible associated factors and their management, as well as implementation of frailty-targeted programmes, may possibly improve frailty status and decrease the risk of adverse health outcomes.\textsuperscript{[3,4]} This knowledge may have future implications for the design of healthcare systems and delivery as well as resource allocation, because such patients have more complex needs. Severely and very severely frail elderly may also benefit from palliative care, including initiating discussions on the preferred plan of care.

Future funding models could also explore bundled payment, incorporating frailty interventions beyond the inpatient setting to immediate post-discharge support services. Because current evidence of such frailty intervention programmes is not robust, opportunity exists for further research exploring outcome measures, including reversing or reducing transitions to more severe states of frailty, injurious falls, quality of life, caregiver burden and mortality.

This study is limited by its small sample size. Larger sample sizes and exploration of associations with clinical outcomes may be beneficial for future studies. Because this was a cross-sectional study, we could only uncover frailty associations rather than risk factors or predictors. Future studies could also include clinical data of referrals to post-discharge services or the type of frailty-targeted interventions implemented. Cost-effectiveness studies could further explore the burden

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**Table 2. Contd...**

| Factor                  | OR (95% CI) | P     | OR (95% CI) | P     |
|-------------------------|-------------|-------|-------------|-------|
| MMSE                    |             |       |             |       |
| Score ≥23               | ref         | -     | ref         | -     |
| Score <23               | 1.33 (0.48-3.67) | 0.586 | 5.46 (2.38-12.49) | <0.001 |

**Table 3. Independent factors associated with frailty in a multivariate model (N=167).**

| Factor                     | Odds ratio (95% CI) | P     | Odds ratio (95% CI) | P     |
|----------------------------|---------------------|-------|---------------------|-------|
| Age                       | 1.14 (1.04-1.25)    | 0.006 | 1.08 (1.01-1.15)    | 0.021 |
| HGS at discharge           | 1.14 (1.02-1.27)    | 0.020 | 0.90 (0.82-0.99)    | 0.025 |
| Albumin                   | 0.98 (0.87-1.03)    | 0.709 | 0.90 (0.82-0.99)    | 0.035 |
| Urinary incontinence       |                     |       |                     |       |
| No                        | ref                 | -     | ref                 | -     |
| Yes                       | 0.31 (0.08-1.25)    | 0.151 | 3.03 (1.19-7.77)    | 0.021 |

CI: confidence interval, HGS: hand grip strength, ref: reference group
of managing frail subacute patients to better inform resource allocation and improvements to healthcare delivery in a rapidly ageing population.[4]

In conclusion, frailty is a highly prevalent geriatric syndrome in the subacute geriatric inpatient population. Independent associations identified in our study were age, HGS at discharge, serum albumin levels and presence of urinary incontinence. Further research in a larger population should be done to explore predictors of frailty and to study the impact of targeted interventions on frailty states and adverse health outcomes.

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Conflicts of interest

There are no conflicts of interest.

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APPENDIX

Hand grip strength measurement

The test is completed using a dynamometer which measures grip strength in kilograms. The purpose of using a hand dynamometer is to measure the maximum isometric strength of the hand and forearm muscles.

Procedure: The subject holds the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required – the base should rest on the first metacarpal (heel of palm), while the handle should rest on middle of the four fingers. When ready the subject squeezes the dynamometer with maximum isometric effort, which is maintained for about 5 seconds. No other body movement is allowed. The subject should be strongly encouraged to give a maximum effort.

Scoring: The best result from several trials for each hand is recorded, with at least 15 seconds recovery between each effort.

Reliability: The dynamometer may need to be calibrated regularly to ensure consistent results. Having consistent technique and adequate rest is required to ensure reliability.

Advantages: This is a simple and commonly used test of general strength level, well researched and many norms are available.

Disadvantages: The dynamometer must be adjusted for hand size, how successfully this is done will affect the accuracy of the measurement.

Statistics

Post-hoc power analysis was performed for hand grip strength at discharge for the frail group. 99% power was achieved using ANOVA test, number with mean of each group and two-tailed test for an alpha of 0.05. Power was calculated using G*Power version 3.1 (Heinrich Heine University, Dusseldorf, Germany).