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Original Research

Patient-outcomes of a frailty management program for community-dwelling older adults in Singapore: A cohort evaluation

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ABSTRACT

Background: There is urgency to manage frailty due to its increasing prevalence. The Geriatric Service Hub (GSH) is a novel programme in Singapore, which aims to manage frailty amongst community-dwelling older adults.
Objectives: We aimed to (1) assess the effectiveness of the GSH through patient-outcomes including patient activation, functional status, and quality-of-life (QoL), and (2) assess impact on patient-outcomes through different levels of frailty using the Clinical Frailty Scale (CFS) scores.
Design: Single-arm pre-post design.
Setting: Community-based health and social care provider
Participants: 218 GSH patients, aged≥65, with CFS4 to CFS7.
Intervention: Patients received comprehensive geriatric assessments in community-based settings and had individualised care plans formed by a multi-disciplinary care team. Patients were then referred to health and social services located in the community based on identified needs.
Measurements: Functional status (Barthel Index), Patient activation (Patient Activation Measure), health-related QoL (EuroQoL 5-dimension 5-level tool) and the emotional-related QoL (Control, Autonomy, Self-realisation, and Pleasure tool). Measurements administered at baseline, 3- and 6-months post-enrolment. Analysis included unadjusted *t*-tests and multi-level mixed-effects linear regression.
Results: We studied 191 (87.6 %) participants who completed all 3-timepoints. Compared to baseline, functional status was maintained at 3-months (M_{diff}=-0.2, 95 % CI [-1.8;1.3]) and 6-months (M_{diff}=-0.5, 95 % CI[-2.2;1.2]). Patient activation increased slightly at 3-months (M_{diff}=3.0, 95 % CI [0.1;5.9]) but not at 6-months (M_{diff}=1.5, 95 % CI [-1.2;4.1]). There were significant increases for health-related QoL a t 3-months (M_{diff}=0.068, 95 %CI [0.041;0.095]) and 6-months (M_{diff}=0.045, 95 % CI [0.016;0.074]), and for emotional-related QoL at 3-months (M_{diff}=2.3, 95 % CI [1.2;3.3]) and 6-months (M_{diff}=1.5, 95 % CI [0.4;2.7]). For sub-group analyses, there were significant increases for patient activation and both QoL measurements for patients categorised as CFS4 and CFS5, and no significant changes for patient-outcomes for CFS6–7.
Conclusions: Overall, results suggest maintenance in patient activation and functional status, with improvements in QoL. Sub-group analyses suggest that GSH is beneficial for patients categorised as CFS4 and CFS5, but the programme played a largely maintenance role for patients with CFS6–7.

1. Introduction

Frailty denotes a state of increased vulnerability due to an age-associated decline in function and reserve such that the ability to cope with day-to-day or acute stressors is compromised [1]. Frailty among older adults is associated with lower levels of patient activation [2], poorer functional status [3], and poorer quality of life (QoL) [4–7]. These outcomes in turn, are associated with greater occurrence of adverse outcomes including falls [8] and functional decline in older adults 65 years and older [9,10], which is associated with increasing health-

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care expenses due to healthcare utilisation. As the prevalence of frailty increases with life expectancy [11], it is important to ensure that the healthcare systems have effective plans in place to manage frailty.

Frailty can be managed or even reversed [12], especially in its early stages. Frailty management programmes usually include multiple components [13–15] such as comprehensive geriatric assessments (CGAs)/holistic assessments, individualised care plans (ICPs), multidisciplinary team management and access to services including physical (e.g. exercise, physiotherapy), health-related services (e.g. allied health, specialists) and social services (e.g. medical social workers, financial counselling and grant applications). Evidence does suggest that multicomponent care models are associated with increasing patient satisfaction, patients' accessibility to, and perceived quality of care [16,17]. Such programmes are also associated with improved patient outcomes including functional status, mental health outcomes and QoL [18]. However, the overall evidence base continues to highlight heterogeneity in effectiveness due to contextual and cultural differences [16,19,20]. Based on the systematic review by Sum and colleagues [18], out of the 43 identified studies, only 4 were conducted in Asian settings (Hong Kong, Taiwan and South Korea). For the outcomes, 7 out of 22 studies reported improvements in functional status and 8 out of 20 studies reported improvements in QoL. Patient activation was not assessed as an outcome in any of the 43 studies. This strongly suggests that there is insufficient evidence to conclude the effectiveness of frailty management programmes in the community, especially in an Asian context.

Evaluations of frailty management programmes have largely focused on populations residing in countries such as the United Kingdom (UK), United States of America (USA), Canada, Australia, or Europe [21,22], with few conducted in Asian countries. As such, there is a need to assess the implications of such frailty management models on patient outcomes in an Asian context due to the growing prevalence of frailty in Asian countries [23] to further support its implementation to meet the challenges of ageing populations. In addition, frailty detection in countries such as the UK and USA is supported by the electronic Frailty Index (eFI) [24]. Specifically, the UK National Health Service uses the eFI while the USA uses the Veterans Affairs Electronic Health Record Frailty Index (VA-FI). Both electronic systems identify frailty via a combination of markers including clinical encounters, diagnosis codes, medications, and other data [25]. In contrast, Singapore currently does not have a nationwide electronic health record system. Frail older adults are also often identified in inpatient settings at more severe stages of frailty where programmes and interventions might have limited ability to reverse the stage of frailty [26]. In addition, primary care and community-based healthcare providers do not have the necessary capability to accurately identify and manage frailty. Nevertheless, there is a need for such services to also be available in the community and be accessible over time to manage the increasingly complex needs of frail older adults.

The GSH is a multi-disciplinary care model that focuses on identifying and managing frail community-dwelling older adults in Singapore. The programme was piloted by five acute hospital sites that partners with primary care providers, community health and social service providers to deliver care for community-dwelling older adults. The GSHs aims to (1) identify frail older adults in the community, (2) increase frail older adults' accessibility to essential and geriatric services, and (3) build capabilities by providing training to the service providers based in the community. Each programme runs the GSH slightly differently, but the key activities include (1) frailty screening, (2) conducting CGAs, (3) facilitating multi-disciplinary meetings (MDMs) for the development of ICP, followed by (4) referrals and care co-ordination for frailty-related services with partners. Concurrently, the sites provide (5) capability building of primary care and community partners in frailty assessment and management.

The GSH is a complex intervention where the key elements of the intervention and its functions are clearly specified but is operationalised in a form that is tailored to the local conditions [27,28]. This differs from traditional Randomised Controlled Trials (RCTs), where the interventions are designed and tested under tightly, controlled, standardised conditions. Hence, a mixed-methods evaluation focusing on standardising the key elements and functions of the intervention was planned to allow for adaptation to the local context while still testing for the intervention's effectiveness [29]. The GSH evaluation was designed to provide a comprehensive overview of the programme though its impact on patient outcomes, healthcare utilisation and the identification of barriers and enablers to implementation. This study is part of the GSH evaluation and utilises a pre-post survey to capture participant-level impacts as the programme seeks to improve the health-related outcomes of older adults through early detection and management of frailty. System-level impacts on healthcare utilisation has been examined in another study using healthcare utilisation data extracted from a national level database and compared against an identified comparator group using propensity score matching [30].

The current study aims to evaluate the effectiveness of the GSH by assessing the impact on patient outcomes (specifically functional status, patient activation, health-related QoL and emotional-related QoL). We believe the current study will enhance our understanding of whether the programme achieves its primary objectives through measurable changes in patient outcomes. We hypothesised that GSH participants are expected to benefit from the CGA, development of an ICP and referrals to health and social services to meet any unmet needs. This is expected to result in improved patient outcomes.

In addition, although frailty status is associated with patient outcomes [2,4,31], few studies have directly assessed the association between different levels of frailty and patient outcomes. It is important to understand the effectiveness of these multi-component programmes on patients across different levels of frailty. Hence, we would assess the patient outcomes of patient activation, health-related and emotional-related QoL by frailty status using the CFS categorisation score. This would allow better customisation of the programmes for patients and potentially improve frailty management.

2. Study methods

2.1. The intervention

The GSH is a frailty management program to identify and manage frailty for community-dwelling older adults. The programme is spearheaded by five acute hospital sites that deliver care through primary care providers and community partners. Primary care providers include private general practitioner (GP) clinics and polyclinics, which are public sector organisations that provide subsidised healthcare services for patients [32]. Community partners include healthcare and social service agencies that may operate day care centres, rehabilitation centres and senior activity centres. Senior activity centres (SACs) are found in housing areas of communities and act as communal spaces for older adults to socialise with their peers [33]. Some community nursing posts are also housed within the SACs. The role of the community partners depends on pre-discussed and agreed upon contractual agreements with the acute hospital sites. They can act as referral sites, sites to conduct the CGA, to provide doctors' consultations and to provide rehabilitative services (e.g. PT, OT).

Older adults in the community are assessed by the GSH's partners (e.g. primary care providers and community partners) if they would benefit from the programme and before referral to a GSH site. All patients are screened for their frailty status using the Clinical Frailty Scale (CFS) [34], a tool 9-point scale ranging from CFS1 (very fit) to CFS9 (terminally ill). The CFS tool was selected by the Ministry of Health, Singapore [35] as the national community screening tool for frailty. Individuals aged 65 years and above, with a CFS score of 4 (very mildly frail) to 7 (frail) were eligible to join the programme.

Upon enrolment into the GSH, all GSH patients received a CGA (around 60 min) which assessed their functional status, health conditions, psychological and cognitive functioning, social well-being, and

socio-demographics. The initial CFS categorisation might be adjusted based on the results of the CGA. The CGA was conducted mainly by trained clinicians (i.e. geriatricians, family physicians, GPs) and/or nurses (i.e. geriatric-trained, advanced nurse practitioners), supplemented by allied health professionals such as physiotherapist and medical social workers. Multi-disciplinary meetings (MDMs) were conducted one to three times a week with the core service delivery team from both the hospital and the community partners, including geriatricians, geriatric-trained nurses, community-nurses, allied-health professionals (e.g. physiotherapists, occupational therapists, medical social workers) administrative staff and community-partners, to discuss and develop ICPs based on the complex needs of each patient identified during the CGA. Once the ICPs have been developed, older adults were referred to frailty-related healthcare services by trained providers (e.g. physiotherapy, occupational therapy, dietician services, medical social worker services, mental health services, community-nursing support and community-care support services) based in the hospitals, rehabilitation centres or polyclinics. Referred services were based on pre-established referral pathways through partnering with healthcare and community-care partners in the community. The modes of services offered was dependent on the partners' resources and facilities. In addition, patients would attend follow-up consultations with either the clinicians or community nurses every 2- to 3-months, depending on the severity of their conditions. GSH patients also received care co-ordination services to monitor and remind them of their existing and upcoming medical and healthcare appointments (e.g. clinical follow-ups, therapy sessions etc.). The MDMs were also conducted regularly to review the ICPs based on the patients' health status and emerging needs. Overall, the programme for each participant lasted between 6- to 12-months, depending on the complexity and severity of their condition. Finally, all GSH sites did some form of capability building through a combination of paired sessions and workshops. The paired sessions, conducted a few times each month, were usually hands-on sessions where the primary care doctors and nurses were trained to conduct the CGA guided by hospital-based geriatricians and geriatric-trained nurses respectively. Workshops (conducted once every 2- to 3-months) were open to the rest of the healthcare providers, and focused on topics on identifying and managing frailty, nutrition, and simple exercises for older adults.

2.2. Study sample

The intention of the programme evaluation, as jointly agreed between the evaluation team and the funders, was to evaluate the GSH programme as a whole. The minimum sample size required to detect a small effect size of 0.2 (based on $\beta = 0.80$, $\alpha = 0.05$) [36] on the Barthel Index (100 points), using within participant *t*-test, was 156. Allowing for a 20 % rejection rate and a subsequent attrition rate of 30 %, we needed to approach 300 individuals in the first instance. However, to allow each site to conduct their own analysis, we also initially aimed to recruit a target sample of 300 participants per GSH programme [29]. However, our study recruitment occurred during the COVID-19 pandemic (from October 2020 till March 2022) and recruitment for both the GSH programme and evaluation study were badly affected. This led to a final decision to only focus the evaluation on the outcomes of the programme as a whole.

2.3. Study design, recruitment, and procedure

We used a prospective single-arm pre-post design without controls. The study was approved by the Domain Specific Review Board by the National Healthcare Group (NHG) in Singapore (DSRB approval number: 2019/00925). This study was conducted as part of a larger evaluation and the evaluation protocol has been published [29].

Recruitment took place in four GSH sites from October 2020 till March 2022. The fifth site was not included in this portion of the evaluation [29]. For the four GSH sites that were included in the survey, programme funding was utilised to subsidise the healthcare costs for their patients, including the CGA, follow-up consultations and referred frailty-related services. Meanwhile, funding for the fifth site was mainly utilised to cover the time spent by the trainers and trainees for capability building. Based on these differences, the fifth site was not included in this portion of the evaluation.

GSH patients from the remaining four sites who were 65 years and above, willing to participate in the survey, and were categorised between clinical frailty scale (CFS) score 4 to 7 were eligible to participate in the study. Patients categorised as CFS3 and below or CFS8 and above were excluded from the study. The criteria for CFS4 to CFS7 was set by MOH as it was expected that the programme would bring the greatest benefit to this group of frail older adults. All GSH patients were assigned the CFS score category based on the CGA conducted by the multi-disciplinary healthcare team implementing the programme.

The survey was face-to-face interviewer administered and took 1.5- to 2-hours to complete. The baseline survey was administered within 2- to 4-weeks from date of enrolment in the GSH programme. Two follow-up surveys were administered at 3-months and 6-months after the baseline survey (within ± 2-week period). The follow-up period was set at 3- and 6-months to capture the early and mid-term effects of the programme respectively.

2.4. Measurements

The key outcome measures include patient activation, functional status, health-related QoL and emotional-related QoL. These measures were chosen as they are often included as part of patient outcomes for frailty and/or complex conditions, and have been found to be sensitive to changes over shorter periods of time (e.g. 6-months) [37–41]. The survey at baseline also obtained sociodemographic variables (e.g. age, sex, ethnicity, education level, housing type, living arrangements and employment status) and participants' presence of chronic conditions.

Functional status. Functional status was assessed with the Barthel Index (BI), a 10-item instrument that evaluated independence in basic activities of daily living (BADLs), including bowel control, bladder control, grooming, toilet use, feeding, transfer from bed to chair and back, mobility on level surfaces, using the stairs, bathing, and dressing [42]. The BI score was calculated by summing the scores from each of the 10-items, following by multiplication by 5 to convert to percentage values that would range from 0 to 100 [43]. The higher the score, the greater the independence in BADLs.

Patient activation. Patient activation was assessed with the 13-item Patient Activation Measure [44] (PAM), that evaluated patient's knowledge, skills and confidence in their management of disease conditions and ability to self-care [45,46]. Patient activation was included as despite its direct association with frailty [2], it is not a commonly assessed indicator for frailty interventions [18]. Furthermore, individuals with higher levels of patient activation are also more likely to adopt healthy behaviours such as health management [45] and better programme compliance [47]. Higher levels of patient activation is also associated with better health outcomes including functional status and QoL [48,49]. To calculate the patient activation scores, survey data was uploaded onto an online platform from Insignia Health, which generated each participants' the activation score (range from 0 to 100) and level (range from 1 to 4) [50]. The higher the score or level, the better the patient activation.

Health-related quality of life. Health-related QoL was assessed by the EuroQol 5-dimension 5-level (EQ-5D-5L) instrument. The tool assessed areas of mobility, self-care, usual activities, pain or discomfort and anxiety or depression [51]. Each dimension was scored on a 5-point rating scale (1=no problems, 2=slight problems, 3=moderate problems, 4=severe problems, and 5=extreme problems). The lower the scores of each dimension, the better the QoL for that dimension. Subsequently, scores of each item were combined, which ranged from no problem on all 5 dimensions (11111) to severe/extreme problems on all 5 dimen-

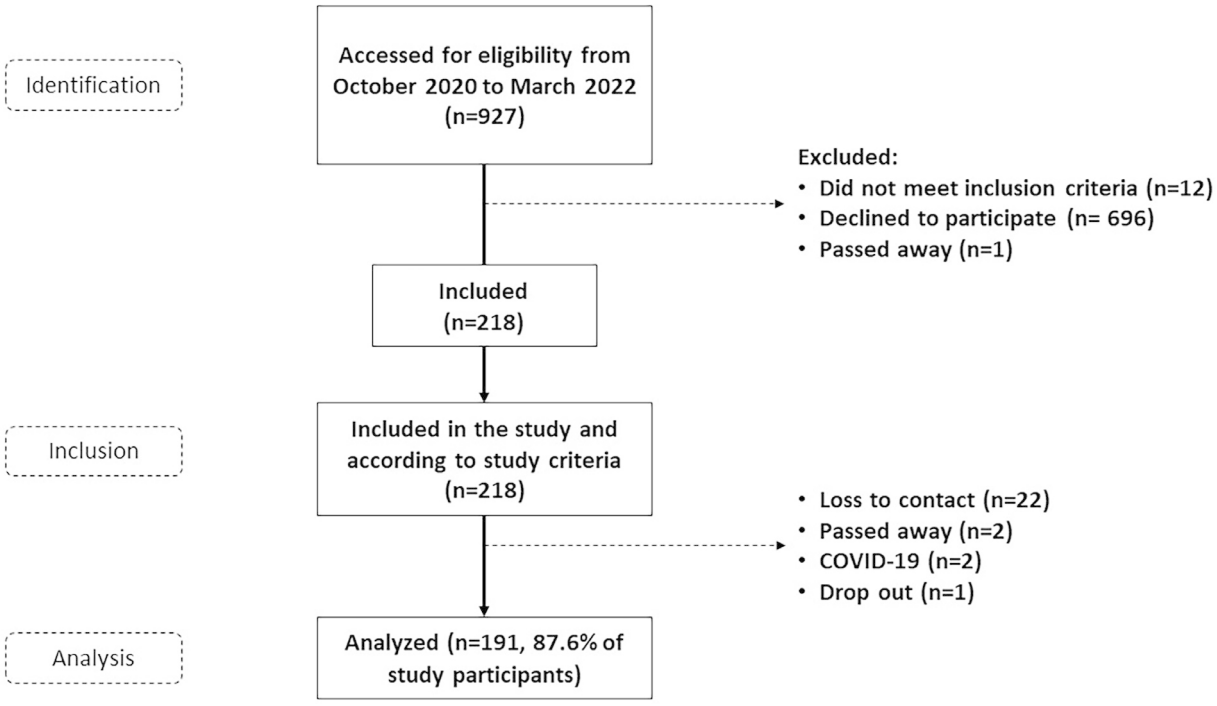

Fig. 1. Study participant flow chart (n Analysed= 191).

sions (55555). This was converted to an index value [51] where the higher the score, the better the health-related QoL.

Emotional-related quality of life. Emotional-related QoL was assessed using the 19-item Control, Autonomy, Self-realisation, and Pleasure (CASP-19) tool. The tool assesses the QoL in individuals in early old age, with a greater emphasis on emotional QoL based on four life domains [52–54]. The CASP-19 also distinguishes overall subjective QoL from factors that influence it, like health, finances, social support, and participation [52–54]. The control domain examines an individual's ability to actively control their environments. The autonomy domain examines the freedom from unwanted interference of others. Self-realisation and pleasure domains examine aspects of living that the participants derives reward and happiness from in their later life. All 19 items have a 4-point rating scale (3=often; 2=sometimes; 1=not often; 0=never) [55]. Scores for 4-items in control and autonomy domains were reverse-coded. All items were summed to obtain an overall CASP-19 composite score [55]. The composite score ranged from 0 to 57, with higher scores indicating better QoL in later life.

2.5. Data analyses

Descriptive statistics (mean, standard deviation) were reported for all outcomes. To assess the differences between participants included and excluded, parametric (*t*-test) and non-parametric (chi-square) tests were conducted to assess the differences. Unadjusted within-participant *t*-tests comparing participants' baseline scores to scores at 3-months and 6-months to baseline were performed. Unadjusted multi-levels mixed-effects linear regression was used to predict outcome change over time. Unadjusted models were chosen as the pre-post study design reduced levels of heterogeneity amongst participants. In addition, the scores were nested at the participant level to account for within-participant changes over time. All models employed use of a Gaussian distribution with an identity link function. Diagnostic testing of homoscedasticity (plot residuals against fitted values) and normality of residuals (Shapiro Wilks test, QQ Plots) were conducted for all Models to test for model fit. Inter-class correlations (ICC) were also conducted to ensure sufficient nesting effect at the participant level. Although our models failed the assumption of normality of residuals, we decided to accept the violation of the normality assumption as mixed-effects model with a Gaussian distribution are generally robust with lower Type 1 error. At the same time, the distribution is also unlikely to affect validity of the results [56]. We did Bonferroni correction to address for possibility of Type 1 error from multiple analyses. The p-value for each analysis was multiplied by 4. The p-value for the analyses on the EQ-5D-5 L and CASP-19 domains were multiplied by 5 and 4 respectively, as the domains were interrelated. The analysis would only be significant if the adjusted p-value was less than the threshold of $\alpha = 0.05$.

To test our secondary aim of testing the effects of the GSH on patients with different levels of frailty, participants were stratified into three separate categories based on their CFS categories – CFS4, CFS5 and CFS 6–7. Descriptive statistics (mean, SD), along with unadjusted within-participant *t*-tests comparing 3- and 6-months post-GSH enrolment to baseline were conducted for patient activation and QoL (health-related and emotional). Analyses for functional status was not conducted as functional status was a key measurement in the determinant of the CFS. Bonferroni correction was also conducted for the subgroup analyses. The p-value for each analysis was multiplied by 3, and the analysis would only be significant if the adjusted p-value was less than the threshold of $\alpha = 0.05$. Multi-level mixed-effects linear regression was also not conducted as the sample size in each subgroup was unlikely to provide sufficient power. All analyses were performed using STATA version 14 [57].

3. Study results

3.1. Participants

Please refer to Fig. 1 for our participant flow. Out of the recruited sample of 218, 191 participants (87.6 %) completed all 3-survey timepoints and formed our analytical sample. A summary of their characteristics can be found in Table 1.

In addition, we conducted a comparison of the baseline socio-demographic and Clinical Frailty Scale score between the participants included in the study and those lost to follow-up. Their results can be

Table 1
Sociodemographic characteristics of study participants by clinical frailty scale score (n = 191).

	Overall Cohort (n = 191)	CFS4 (n = 92)	CFS5 (n = 77)	CFS6–7 (n = 22)
Age at enrolment, years, mean (SD)	79.10 (7.1)	78.3 (7.2)	79.5 (6.7)	81.3 (7.9)
Age, n (%)				
65–75 years	61 (31.9)	36 (39.1)	20 (26.0)	5 (22.7)
76–85 years	95 (49.7)	42 (45.7)	44 (57.1)	9 (40.9)
86–90 years	25 (13.1)	10 (10.9)	10 (13.0)	5 (22.7)
≥ 90 years	10 (5.2)	4 (4.4)	3 (3.9)	3 (13.6)
Gender, n (%)				
Female	122 (63.9)	57 (62.0)	48 (62.3)	17 (77.3)
Male	69 (36.1)	35 (38.0)	29 (37.7)	5 (22.7)
Ethnicity, n (%)				
Chinese	159 (83.3)	82 (89.1)	60 (77.9)	17 (77.3)
Non-chinese	32 (16.7)	10 (10.9)	17 (22.1)	5 (22.7)
Education, n (%)				
No formal education	91 (47.6)	37 (40.2)	40 (52.0)	14 (63.6)
Primary education	57 (29.8)	32 (34.8)	21 (27.3)	4 (18.2)
Secondary education	29 (15.2)	15 (16.3)	12 (15.6)	2 (9.1)
Post-secondary and above	14 (7.3)	8 (8.7)	4 (5.2)	2 (9.1)
Housing type, n (%)				
HDB 1–2room	82 (42.9)	36 (39.1)	38 (49.4)	8 (36.4)
HDB 3-room	43 (22.5)	23 (25.0)	12 (15.6)	8 (36.4)
HDB 4-room	45 (23.6)	23 (25.0)	19 (24.7)	3 (13.6)
HDB 5-room and private	21 (11.0)	10 (10.9)	8 (10.4)	3 (13.6)
Living Arrangements, n (%)				
Living alone	47 (24.6)	24 (26.1)	21 (27.3)	2 (9.1)
Living with others (e.g. family, domestic helper, others)	144 (75.4)	68 (73.9)	56 (72.7)	20 (90.9)
Employment Status, n (%)				
Employed (full-time, part-time, self-employed)	12 (6.30)	12 (13.00)	0 (0.0)	0 (0.0)
Retired	171 (89.5)	74 (80.4)	76 (98.7)	21 (95.5)
Others (Unemployed, Housewife)	8 (4.2)	6 (6.5)	1 (1.3)	1 (4.6)
Number of co-morbids, n (%)				
0	4 (2.1)	4 (4.3)	0 (0.0)	0 (0.0)
1	13 (6.8)	7 (7.6)	5 (6.5)	1 (4.5)
2	36 (18.9)	19 (20.7)	13 (16.9)	4 (18.2)
3	51 (26.7)	27 (29.3)	20 (26.0)	4 (18.2)
4	39 (20.4)	18 (19.6)	15 (19.5)	6 (27.3)
5	33 (17.3)	11 (12.0)	17 (22.1)	5 (22.7)
6 and above	15 (7.9)	6 (6.5)	7 (9.1)	2 (9.1)

*CFS = Clinical Frailty Scale;.

found in supplementary Table 1. Those who were included in the analytical sample and participants who were lost to follow-up (n = 22) did not differ significantly in terms of age, gender, socioeconomic status, and Clinical Frailty Scale categories. However, participants who were lost to follow-up had higher counts of co-morbid conditions than those included.

3.2. Functional status

Compared to baseline (Mean = 93.3; SD = 14.9), participants' functional status at 3-months (Mean = 93.0; SD = 15.5; $\text{Mean}_{\text{diff}}$ = −0.2; 95 % CI [−1.8 to 1.3], p = 0.767) and 6-months are maintained (Table 2). In addition, almost 90 % of the participants have a Barthel Index score of 76 and above out of 100, suggesting that most participants are relatively independent and able, with mild impairment in some domains.

Mirroring our t-test results, the linear analyses for functional status were also not statistically significant, where the results indicate an average increase of 0.0 points per 3-month period (Table 3).

3.3. Patient activation

Compared to baseline (Mean = 62.1; SD = 16.9), participants' PAM-13 composite scores increased slightly at 3-months (Mean = 65.0; SD = 20.2; $\text{Mean}_{\text{diff}}$ = 3.0; 95 % CI [0.1 to 5.9],p = 0.046). While there was a 1.5-point increase in PAM-13 composite scores between baseline and 6-months, the results were not statistically significant (Table 2). The linear analyses for patient activation were also not statistically significant, where the results indicate an average increase of 0.7 points per 3-month period (Table 3).

3.4. Health-related quality of life

Compared to baseline (Mean = 0.787; SD = 0.238), participants' health-related QoL at 3-months (Mean = 0.855; SD = 0.242; $\text{Mean}_{\text{diff}}$ = 0.068; 95 % CI [−0.041 to 0.095], $p > 0.001$) and 6-months were significantly higher than baseline (Table 2). The increase between baseline and 3-/6- months is above the minimal clinical important difference (MCID) of 0.04 [58]. Domain analysis indicate that overall score increase was due to improvements in two of the five domains – (1) mobility and (2) pain and discomfort. Linear analyses also suggest significant improvements in QoL, with EQ-5D index increasing on average 0.022 every 3-months post-GSH enrolment.

3.5. Emotional-related quality of life

Compared to baseline (Mean = 42.7; SD = 9.0), participants' emotional-related QoL at 3-months (Mean = 44.9; SD = 9.1), and 6-months CASP-19 composite scores were significantly higher (Table 2). Domain analysis indicate that the increase at 3-months were due to improvements in all domains except Self-realisation, while the increase at 6-months was due to improvements in two domains – (1) Autonomy and (2) Pleasure. Linear analyses also suggest significant improvements in emotional QoL, with the CASP-19 composite score increasing on average 0.8 points every 3-months post-GSH enrolment.

Table 2
Unadjusted patient outcomes (functional status, patient activation, health-related quality-of-life and domain scores, emotional quality-of-life and domain scores.

	Baseline (reference) Mean (SD)	3-months Mean (SD)	Difference (95 % CI)	p-value	6-months Mean (SD)	Difference (95 % CI)	p-value
Functional Status (Barthel Index)							
Barthel Index (range: 0 to 20)	93.3 (14.9)	93.0 (15.5)	−0.2 (−1.8 to 1.3)	0.767	92.8 (15.5)	−0.5 (−2.2 to 1.2)	0.582
Proportion of participants functional status in each score category, n (%)							
Score 0 – 25	3 (1.6)	3 (1.6)	–	–	3 (1.6)	–	–
Score 26 – 50	2 (1.1)	4 (2.1)	–	–	5 (2.6)	–	–
Score 51 – 75	15 (7.9)	13 (6.8)	–	–	11 (5.8)	–	–
Score > 76	171 (89.5)	171 (89.5)	–	–	172 (90.1)	–	–
Patient Activation (13-item Patient Activation Measure)							
PAM-13 (range: 0 to 100)	62.1 (16.9)	65.0 (20.2)	3.0 (0.1 to 5.9)	0.046	63.5 (19.0)	1.5 (−1.2 to 4.1)	0.281
Proportion of participants leve l of activation status, n (%)							
Level 1	5 (2.6)	6 (3.1)	–	–	5 (2.6)	–	–
Level 2	108 (56.5)	105 (55.0)	–	–	111 (58.1)	–	–
Level 3	30 (15.7)	22 (11.5)	–	–	18 (9.4)	–	–
Level 4	48 (25.1)	58 (30.4)	–	–	57 (29.8)	–	–
Health-related quality of life (EQ-5D-5L)							
EQ-5D Index (Range: <0 to 1.000)	0.787 (0.238)	0.855 (0.242)	**0.068 (0.041 to 0.095)**	**>0.001**	0.832 (0.244)	**0.045 (0.016 to 0.074)**	**0.003**
EQ-5D-5L domain scores							
Mobility (Range: 0.101 to 0.411)	0.086 (0.105)	0.061 (0.102)	**−0.025 (−0.037 to −0.013)**	**>0.001**	0.077 (0.110)	−0.009 (−0.023 to 0.005)	0.019
Self-care (Range: 0.093 to 0.378)	0.033 (0.077)	0.028 (0.079)	−0.005 (−0.014 to 0.004)	0.279	0.038 (0.085)	0.005 (−0.006 to 0.015)	0.370
Usual activities (Range: 0.074 to 0.300)	0.047 (0.080)	0.041 (0.084)	−0.007 (−0.017 to 0.003)	0.176	0.045 (0.082)	−0.003 (−0.013 to 0.007)	0.571
Pain and discomfort (Range: 0.110 to 0.448)	0.092 (0.095)	0.050 (0.079)	**−0.042 (−0.055 to −0.030)**	**>0.001**	0.057 (0.085)	**−0.035 (−0.048 to −0.022)**	**>0.001**
Anxiety and depression (Range: 0.110 to 0.447)	0.040 (0.074)	0.026 (0.073)	−0.014 (−0.026 to −0.002)	0.019	0.029 (0.066)	−0.012 (−0.022 to −0.001)	0.026
Emotional-related quality of life (Control, Autonomy, Self-realisation, and Pleasure Scale)							
CASP-19 (Range: 0 to 57)	42.7 (9.0)	44.9 (9.1)	**2.3 (1.2 to 3.3)**	**>0.001**	44.2 (8.7)	**1.5 (0.4 to 2.7)**	**0.010**
CASP-19 domain scores							
Control (Range: 0 to 12)	7.7 (2.9)	8.3 (2.8)	**0.6 (0.2 to 1.0)**	**0.004**	8.0 (2.8)	0.3 (−0.2 to 0.7)	0.229
Autonomy (Range: 0 to 15)	11.5 (2.4)	12.0 (2.5)	**0.6 (0.2 to 0.9)**	0.002	12.1 (2.2)	**0.6 (0.3 to 1.0)**	**>0.001**
Self-realisation (Range: 0 to 15)	10.1 (3.3)	10.6 (3.2)	0.5 (0.0 to 0.9)	0.029	10.1 (3.2)	−0.1 (−0.5 to 0.4)	0.813
Pleasure (Range: 0 to 15)	13.4 (2.5)	14.0 (1.9)	**0.7 (0.4 to 0.9)**	**>0.001**	14.1 (1.9)	**0.7 (0.4 to 1.0)**	**>0.001**

*PAM-13 = 13-item patient activation measure; PAM = Patient Activation Measure; Level 1 = disengaged and overwhelmed; Level 2 = becoming aware, but still struggling; Level 3 = taking action; Level 4 = maintaining behaviours and pushing further. EQ-5D Index = EuroQoL 5-dimension Index; EQ-5D-5 *L* = EuroQoL 5-dimension 5-level; CASP-19 = 19-item Control, Autonomy, Self-realisation and Pleasure scale; Significant changes after Bonferroni adjustment are bolded.

Table 3
Multi-level mixed-effects linear regression results predicting change over time for patient activation, functional status and quality of life (n = 191).

	B (S.E.)	95 %CI	p-value
Functional status (Barthel Index) (range: 0 to 20)	−0.2 (0.4)	−1.0 to 0.6	0.564
Patient activation (PAM-13) (range: 0 to 100)	0.7 (0.7)	−0.7 to 2.1	0.313
Health-related quality of life (EQ-5D Index) (range: <0 to 1)	**0.022 (0.007)**	**0.008 to 0.036**	**0.002**
Emotional quality of life (CASP-19) (range: 0 to 57)	**0.8 (0.3)**	**0.2 to 1.3**	**0.004**

*PAM-13 = 13-item patient activation measure; EQ-5D Index = EuroQoL 5-dimension Index; CASP-19 = 19-item Control, Autonomy, Self-realisation and Pleasure scale; Significant changes after Bonferroni adjustment are bolded.

3.6. Subgroup analyses for patient activation and quality of life

Subgroup analyses for patient activation and QoL were conducted for groups of participants with CFS4, CFS5 and CFS6–7. Participants with CFS4 sub-group reported higher levels of patient activation QoL than participants with CFS5 and CFS6–7 (Table 4). For participants with CFS4, we observed significant improvements in patient activation and QoL at 3-months compared to baseline, and significant improvements in health-related QoL at 6-months compared to baseline. Meanwhile, participants with CFS5 report better QoL at 3-months compared to baseline, but not at 6-months. Participants with CFS6–7 reported maintenance of patient activation and QoL.

4. Discussion

Our study evaluated the impact of the GSH, a multi-component frailty management programme on patient outcomes of patient activation, functional status, health- and emotional-related QoL. Our key findings suggest slight improvements in patient activation in the earlier stages of the GSH, but this improvement was not sustained over a longer period. Functional status was maintained throughout the duration of the programme. We also noted improvements in health-related and emotional-related QoL after participation in GSH, particularly for patients with CFS4 and CFS5. Improvements in patient activation were also found for patients with CFS4.

4.1. Maintenance of functional status and patient activation

In line with the literature [59], GSH participants did not report significant improvements in their functional status. Programmes that do report improved functional status usually aim to reduce or even reverse frailty by incorporating exercise or resistance training [12,13]. For these programmes, patients are closely tracked on their compliance of the prescribed exercises to ensure adherence. While the GSH did refer its patients to physiotherapy sessions or prescribed them recommended exercises, GSH patients were not actively tracked on their completion of these activities. In addition, the aim of the GSH was to help its patients manage their needs (physical and psychosocial) as a whole, and this could have led to a lack of focus on improving functional status. Finally, as the GSH targets community-dwelling older adults, there is a higher possibility that their functional status and general health would be more stable than frail older adults who receive inpatient treatments. This may result in a ceiling effect such that it would be difficult to demonstrate a positive intervention effect. This is evident in the high baseline functional status scores of our participants, where almost 70 % have a BADL score of 20). As a result, it is unlikely that participants would show further improvement in functional status post-GSH enrolment.

Although there were no significant changes in patient activation, our results suggested slight improvements in patient activation in the study sample in the initial 3-months which were not sustained. This is in contrast to the results reported in a local patient-centred medical home (PCMH) program that aimed to deliver integrated and patient-centred care for older adults [60], which suggest evidence of participants becoming more engaged in managing their health from 3-months to 6-months post-enrolment. Patient activation is affected by the patient's own knowledge of their condition and their confidence in self-managing [61]. It is also affected by the patient-doctor relationship [62]. Improvement in the initial 3-months suggests that there are aspects of the GSH that have improved their confidence and knowledge for self-care. Conduct of the initial CGA and communication of the CGA results could have resulted in an immediate shift in patient activation due to increased awareness of health conditions and unmet needs, knowledge gain, and patient-doctor communication [63]. These improvements in patient activation might be hard to sustain over time as this change was not internalised within the short period patients were in the study (6-months). Meanwhile, for the PCMH study, emphasis was placed upon the relationship-based care. Hence, patient engagement provided by the healthcare staff in the discussion of the ICP could have provided the required social support to improve patient activation amongst the PCMH patients. Other interventions that found positive improvements in patient activation include some emphasis on psychosocial services or motivational training [63]. Programmes can also consider training healthcare professionals in evidence-based person-centred counselling techniques to support positive health behavioural changes in patients. It is also important to incorporate approaches to sustain patient motivation by training healthcare professionals in evidence-based person-centred counselling techniques such as goal setting. Behavioural interventions based on behavioural change models such as the COM-B model could also be used to encourage patients to maintain better adherence [64]. As frailty requires long term management, continual and persistent management is vital for patients, which further emphasises the importance of patient activation in such programmes. Further studies can assess the effectiveness of psychosocial services and motivational training in improving patient activation frailty management programmes.

4.2. Improvements in quality of life

Our results suggest that GSH improves both health-related and emotional-related QoL. Domain analyses suggest that improvements in both types of QoL are driven by the psycho-social domains. For health-related QoL (assessed by the EQ-5D-5L), improvements were noted in the domains of pain and discomfort, and anxiety and depression. Meanwhile, improvements in emotional-related QoL (CASP-19) suggest that the GSH has potential effects on contextual influences on QoL in early old age [65], such as social support and participation, health and financial security, trust, and reciprocity.

Most multi-component programmes for frailty care or complex conditions have found inconclusive results for both health-related and emotional-related QoL [18,22,66]. However, a preventive home visit trial implemented in Finland [67] by a multi-disciplinary team with CGA reported an overall increase in health-related QoL. The results suggest a maintenance of QoL in the intervention group and significant decreases in the control group. Like the GSH, both programmes linked their patients to services based on the needs identified during the CGA. Meeting

Table 4
Subgroup analysis for patient activation and quality of life ($n = 191$).

	Baseline (reference) Mean (SD)	3-months Mean (SD)	Difference (95 % CI)	p-value	6-months Mean (SD)	Difference (95 % CI)	p-value
Patient activation (PAM-13)							
CFS4 ($n = 92$)	65.7 (17.8)	72.5 (21.3)	**6.7 (2.1 to 11.3)**	**0.005**	70.7 (21.2)	4.9 (0.4 to 9.5)	0.034
CFS5 ($n = 77$)	59.8 (15.8)	58.5 (15.6)	−1.3 (−5.5 to 2.9)	0.546	58.8 (14.1)	−1.0 (−4.3 to 2.3)	0.556
CFS6–7 ($n = 22$)	54.6 (13.8)	56.8 (19.1)	2.2 (−5.1 to 9.5)	0.538	50.0 (10.9)	−4.6 (−10.3 to 1.1)	0.107
Health related QoL (EQ-5D Index)							
CFS4 ($n = 92$)	0.862 (0.148)	0.940 (0.113)	**0.078 (0.044 to 0.111)**	**>0.001**	0.922 (0.114)	**0.060 (0.029 to 0.092)**	**>0.001**
CFS5 ($n = 77$)	0.768 (0.258)	0.845 (0.214)	**0.077 (0.035 to 0.119)**	**>0.001**	0.810 (0.237)	0.042 (−0.014 to 0.097)	0.138
CFS6–7 ($n = 22$)	0.545 (0.300)	0.544 (0.414)	−0.001 (−0.131 to 0.128)	0.983	0.539 (0.385)	−0.006 (−0.109 to 0.097)	0.904
Emotional QoL (CASP-19)							
CFS4 ($n = 92$)	45.3 (7.8)	48.0 (6.7)	**2.7 (1.1 to 4.4)**	**0.002**	47.1 (7.1)	1.8 (−0.0 to 3.6)	0.056
CFS5 ($n = 77$)	41.2 (9.4)	43.7 (9.2)	**2.6 (1.1 to 4.0)**	**>0.001**	42.7 (1.0)	1.6 (−0.2 to 3.4)	0.090
CFS6–7 ($n = 22$)	36.9 (9.1)	36.3 (11.3)	−0.6 (−4.3 to 3.0)	0.722	37.4 (2.0)	0.5 (−2.2 to 3.1)	0.728

*CFS = Clinical Frailty Scale; PAM-13 = 13-item patient activation measure; EQ-5D Index = EuroQoL 5-dimension Index; CASP-19 = 19-item Control, Autonomy, Self-realisation and Pleasure scale; Significant changes after Bonferroni adjustment are bolded.

patients' previously unmet needs could have been a potential reason for the overall increase in health-related QoL across studies between both studies. Given the short timeframe of our study, we are unable to discern the longer terms effect of participating in the GSH. Future frailty management programmes can also seek to assess changes in QoL for longer periods of time.

Few programmes have assessed emotional-related QoL as an outcome. We compare our findings against another Singaporean PCMH study for community-dwelling older adults [60]. Improvements in emotional-related QoL were observed across both studies. Although the effects in our study spanned the four domains of CASP-19, the improvement in the PCMH study was only evidenced in the pleasure domain. PCMH patients had lower average baseline CASP-19 scores (33.3) as compared to GSH patients (42.7). Having more complex bio-psycho-social health needs than GSH participants could explain the differences in results.

4.3. *Impact outcomes differentiated by CFS groups*

An important aspect our study uncovered was the impact of patient activation and QoL differentiated by levels of frailty. Few studies assessed patient activation and QoL by frailty levels, and studies that do are often cross-sectional [2,6]. A cross-sectional study on 200 frail community-dwelling older adults [2] reported that frailty is negatively associated with patient activation. This suggests that frail older adults are less likely to manage their own health. Our study's findings are in line with this result. In addition, our results further suggest that patients who were categorised as CFS4 (*mildly-frail*) showed improvements in patient activation post-GSH enrolment, but not patients who are categorised as CFS5 (*frail*) and CFS6–7 (*very frail*). These results suggest that older adults who are less frail are better able to self-manage their conditions and improve in their self-management over time. Further engagement might be needed to facilitate patients categorised as CFS4 to be more activated and independent in maintaining their health.

Quality of life is quite commonly associated with frailty. In line with results from other studies, our study did also find that patients who were categorised as CFS4 had higher QoL as compared to patients categorised as CFS5 and CFS6–7 [68]. However, this association is often assessed cross-sectionally [6] and not longitudinally. Our results further suggest that GSH patients who were very mildly-frail (CFS4) and frail (CFS5) reported improvements in QoL. It is likely that patients with CFS4 and CFS5 are more independent and have more energy, and hence are better able to adhere to the recommendations by the GSH healthcare team. The higher energy levels could also lead to more activity time [69]. Compared to patients with CFS6–7, who might need more assistance in more aspects of their lives [34], to the extent of being bed/wheelchair bound for the more severe cases.

Taken together, our results suggest the benefits of GSH intervention for patients with CFS4 and CFS5. These patients are relatively mobile and independent and hence likely to have the physical ability to partake in the activities recommended by the clinical team. This could ultimately lead to the improvements in both patient activation and QoL identified in the study. On the other hand, patients with CFS6–7 are more dependent in ADLs [34], While our results suggest maintenance of both patient activation and QoL, the lack of a control group precludes definitive conclusions about the extent of this trend without the intervention of the GSH programme.

4.4. *Strengths and limitations*

This is one of the first few studies that looked at patient activation as an outcome for a frailty management programme evaluation. In addition, we evaluated a comprehensive range of outcomes including patient activation, health-related QoL and emotional-related QoL by frailty status. Nonetheless, some study limitations should be noted. First, our study adopted a single arm design instead of a randomised controlled

trial (RCT), or waitlist RCT. While a waitlist RCT could have reduced unobserved confounding, there were practical concerns that would have limited its usefulness. Firstly, the GSH teams were funded to deliver the new service and enrol targeted numbers of enrolees within a timeframe of 3-years. To randomise consenting participants to the waitlist might result in an under-utilisation of resources allocated to deliver the service within this timeframe, which was not acceptable. Next, we were also concerned about being able to reach the minimum sample size within the funding frame of the evaluation. Third, frail older adults may be more susceptible to sudden deterioration in health conditions during the waiting period. Based on the above-mentioned reasons, we chose a pre-post study design. To ensure rigour and validity of our results, we have designed our study and analysis based on the National Health, Lung and Blood Institute (NHLBI) quality assessment tool for pre-post studies [70]. Although we had intended to report our results for each participating site, the intra-class correlation at the group level was low and no hierarchical analysis was carried out. Future studies could include a control group to better account for potential confounders to confirm our results. Second, our study monitored the outcomes over a period of 6-months, which was a relatively short follow-up time period. Future studies can consider monitoring patients over a long period of time. Another limitation is that we did not have individual level data on the level of continued adherence to each frailty-related service. We collected only aggregated data on the number of referrals to frailty-related services and percentages of first appointment (e.g. care managers, medical social workers, community nurses, occupational therapists, dieticians and pharmacists) actualised. Between October 2020 and March 2022, 70 % of referrals were actualised. Future studies can also incorporate processes and workflows to capture patient-level data to better determine adherence rate. Lastly, it is important to consider that our results are more representative of patients who were able to participate in a 1.5- to 2-hour survey. This includes participants with fewer co-morbid conditions, as well as participants who were more receptive to face-to-face encounters amidst periods of safe-distancing measures enacted throughout the Covid-19 pandemic [71].

5. Conclusion

Overall, our results suggest slight improvements in patient activation at the start, with overall maintenance of functional status. We found improvements in health-related and emotional-related QoL. Improvements in patient activation and QoL were also observed for participants categorised as CFS4 and CFS5. Unfortunately, our study did not find conclusive results for patients who are categorised between CFS6–7. These results need to be treated with caution due to the possible lack of statistical power from inadequate sample size, and the lack of a parallel control group to account for the natural history of progression without intervention. Nevertheless, based on these results, we do believe the GSH programme can be beneficial to patients who are mildly frail to frail and should continue to be implemented amongst this group of participants.

Ethics approval and consent of participants

The study has received ethical approval from the NHG Domain Specific Review Board (DSRB Ref: 2019/00925). Data obtained from survey was anonymised.

Consent for publication

All authors consent to the publication of this article.

Declaration of generative AI and AI-assisted technologies in the writing process

The authors declare that no generative AI and AI-assisted technologies were used in the writing process.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2025.100048.

Appendix A

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