JAMDA 23 (2022) 1984.e1–1984.e8

JAMDA

journal homepage: www.jamda.com

Original Study

Validating the Centre of Excellence on Longevity Self-AdMinistered (CESAM) Questionnaire: An Online Self-Reported Tool for Frailty Assessment of Older Adults

Joshua S. Lee MRCP(UK) [a,*], Justin Chew MRCP(UK) [a,b], Yu Rui Lim MRCP(UK) [a,b], Wendy K.G. Ng MSc [a], Audrey J.P. Yeo BSc [b], Lynnett T.J. Ong BSc (Hons) [b], Mark P.C. Chan MRCP(UK) [a,b], Wee Shiong Lim MMed, MHPE [a,b], Olivier Beauchet MD, PhD [c,d,e]

[a] *Department of Geriatric Medicine, Tan Tock Seng Hospital, Singapore*
[b] *Institute of Geriatric and Active Aging, Tan Tock Seng Hospital, Singapore*
[c] *Departments of Medicine, University of Montreal, and Research Centre of the Geriatric University Institute of Montreal, Montreal, Quebec, Canada*
[d] *Division of Geriatric Medicine, Department of Medicine, Sir Mortimer B. Davis Jewish General Hospital and Lady Davis Institute for Medical Research, McGill University, Montreal, Quebec, Canada*
[e] *Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore*

ARTICLE INFO

Article history:
Received 24 March 2022
Received in revised form
27 June 2022
Accepted 30 June 2022

Keywords:
Frailty
self-report
comprehensive geriatric assessment
older adult

ABSTRACT

Objectives: Subjective health measures are often used to assess frailty, but the validity of self-reported online tools to identify frailty remains to be established. We aimed to assess concurrent, known-groups, convergent and predictive validity of the Centre of Excellence on Longevity Self-AdMinistered (CESAM) questionnaire for frailty assessment of older adults in an outpatient setting.
Design: Cross-sectional analysis of 120 participants.
Setting and Participants: Participants of age ≥65 were recruited from an outpatient geriatric clinic. Individuals who had severe neurological, cognitive, or motor deficits were excluded.
Methods: We assessed concurrent validity with area under receiver operating characteristic curve (AUC) against the Frailty Index (FI) and Clinical Frailty Scale (CFS). We analyzed known-groups validity between CESAM scores with frailty status (CFS and FI), Modified Barthel Index (MBI), and modified Chinese Mini-Mental State Examination (mCMMSE) using 1-way analysis of variance. We evaluated convergent validity using correlations with MBI, the Lawton index, mCMMSE, and Geriatric Depression Scale (GDS). Associations between CESAM-identified frailty for clinician-diagnosed geriatric syndromes, and health-related quality of life (HRQoL) was analyzed using regression analysis.
Results: The CESAM questionnaire demonstrated excellent diagnostic performance for frailty using FI ≥0.25 (AUC = 0.88; 95% CI: 0.82–0.94; $P < .001$) and CFS ≥4 (AUC = 0.78; 95% CI: 0.68–0.88; $P < .001$). CESAM scores increased significantly with increasing frailty (both CFS and FI), lower MBI, and lower mCMMSE scores (all $P < .001$), indicating concurrent validity. The moderate-good correlation of CESAM scores with MBI (r = −0.61; $P < 0.001$), Lawton Index (r = −0.54; $P < .001$), mCMMSE (r = −0.53; $P < .001$) and GDS (r = 0.58; $P < .001$) supports convergent validity. Using a cutoff of ≥8 for frailty identification, CESAM-identified frailty was associated with cognitive impairment (OR = 3.7; 95% CI: 1.7–8.2; $P = .001$) depression (OR = 4.0; 95% CI: 1.7–9.6; $P = .002$), falls (OR = 3.1; 95% CI: 1.2–8.2; $P = .021$) and poorer HRQoL (β = −0.1; 95% CI: −0.2 to −0.02; $P = .017$).
Conclusion and Implications: Our results support the validity of an online self-reported tool to identify frailty and geriatric syndromes in an outpatient setting, an approach that is potentially applicable for remote screening of frailty.

Frailty is a condition characterized by the loss of physiological reserves across multiple organ systems and vulnerability to decompensation after a stressor event.[1] Older people with frailty are at

The authors declare no conflicts of interest.

* Address correspondence to Joshua S. Lee, MRCP(UK), Department of Geriatric Medicine, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore 308433.
E-mail address: joshua.lee@mohh.com.sg (J.S. Lee).

https://doi.org/10.1016/j.jamda.2022.06.031
1525-8610/

increased risk of adverse outcomes, including disability, hospitalization, institutionalization, and mortality.[2–4] To identify frailty, several approaches are recommended. These include the deficit-accumulation approach, summarized in the Frailty Index (FI).[5] Another approach uses measurable clinical parameters to define a physical frailty phenotype, as seen in the Fried frailty criteria.[6] A third approach is judgment-based, which incorporates the findings of a Comprehensive Geriatric Assessment (CGA) into a clinical score, such as the Clinical Frailty Scale (CFS).[7] All tools have been validated in multiple cohorts and have been found to reliably predict adverse outcomes.[4,8]

A complementary approach to frailty assessment includes the use of self-reported measures. This approach has several potential advantages. First, self-measures of health and function may potentially encourage health-seeking behavior and active participation to improve one's own health. Second, using self-administered questionnaires for frailty circumvents the need for strength and performance testing required to evaluate existing physical frailty criteria, making frailty assessment more widely accessible outside of specialized care settings, for instance in primary care and in the community. Last, a self-reported approach to frailty assessment is potentially scalable by leveraging on technology to allow for remote frailty assessment by conducting self-reported evaluations online. Although self-reported frailty tools have been validated in prior studies,[9,10] a self-reported frailty tool specifically developed for an online Web-based platform is novel and hitherto not well explored.

The Centre of Excellence Self-AdMinistered (CESAM) questionnaire was developed as an online self-assessment questionnaire premised on the concept of a self-reported approach to CGA and frailty identification.[11] The questionnaire assesses multiple domains including demographic data, social factors, polypharmacy, cognition, mood, activity level, function, and falls.[12] Items and scoring of the CESAM questionnaire are shown in Supplementary Table 1. A digitized version of the CESAM questionnaire is accessible on a Web-based platform from a computer or mobile device. In addition, the platform highlights the assessor potential domains of deficiency that warrant further evaluation and management, allowing the treating physician to plan specific, personalized interventions for frail individuals. The CESAM questionnaire has already been shown to be feasible in the clinical setting, even among older patients with cognitive impairment and shows concordance with a clinician-administered CGA.[13] CESAM questionnaire scores have also been used as a frailty measure in recent studies.[14,15] However, there are limited studies on the validity of this questionnaire to accurately identify frailty and other adverse outcomes.

Therefore, the aim of the study was to validate the CESAM questionnaire as a frailty assessment tool in the outpatient geriatric assessment clinic. We aimed to demonstrate the concurrent validity of the CESAM for frailty identification against the FI and CFS; known-groups validity and convergent validity of the CESAM score against functional status and geriatric syndromes; and associations between CESAM-identified frailty for clinician-identified geriatric syndromes, caregiver stress, as well as health-related quality of life (HRQoL). Validating the CESAM questionnaire will provide evidence for an online self-reported tool to identify frail individuals who would benefit from CGA and further interventions, an approach applicable to remote frailty screening amidst a pandemic or in resource-limited settings.

Methods

Study Setting and Design

We conducted a cross-sectional study of older patients attending an outpatient geriatric assessment clinic at a single tertiary referral hospital from October 2020 to October 2021. Participants were referred to the geriatric clinic by primary care physicians, specialist outpatient clinics, or inpatient services for assessment of geriatric syndromes or related issues. Participants were recruited consecutively except for 2 periods from May to mid-June 2021 and in August 2021 when recruitment for research ceased in view of COVID-19 restrictions. We included participants who were aged ≥65 years and understood English or Mandarin. If the participant was unable to comprehend or complete the CESAM independently, we involved caregiver proxies aged ≥21 years in completing the questionnaire. We excluded individuals who had severe neurological, cognitive, or motor deficits in whom proxy caregivers were unavailable. Three participants who had incomplete or missing data were also excluded from the final analysis. All clinical assessments were conducted on the same day. The local Institutional Review Board approved the research protocol (DSRB reference number: 2020/00153). All participants provided informed consent for the study.

The CESAM Questionnaire

CESAM is a 27-item questionnaire that comprises items that include age, sex, nutrition, living place, social resources, number of drugs taken daily, memory complaints, mood and general feeling, fatigue, basic activities of daily living (ADLs), instrumental ADLs (IADLs), physical activity, hearing, vision, and falls. Items correspond to a question with a forced choice in closed ended format: either "Yes" or "No" or calling for a specific answer. The responses of these questions are combined into an overall CESAM score. It is translated into Mandarin in accordance with the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes Measures.[16] All participants and/or caregivers completed the CESAM on a mobile device or computer before clinical consultation. If the participant was unable to use an electronic device, the study team member would assist by administering the survey in verbatim to the participant.

Frailty Assessments

We performed 2 frailty assessments: the FI and the CFS. The FI is a multidomain 32-item assessment comprising function, physical activity, physical symptoms, chronic disease, cognition, mood, falls, vision, hearing, weight loss, social circumstance, and an overall rating of health (Supplementary Table 2). A cutoff of ≥0.25[17] is used to determine frailty. The CFS is a judgment-based frailty tool that ascribes a score from 1 (very fit) to 9 (terminally ill) and has been validated in the population studied in an inpatient setting.[18] We used a CFS cutoff of ≥4 to define frailty.[19] The FI was calculated with information gleaned from electronic health records, and the CFS was scored by the clinician after the clinic consult.

Comprehensive Geriatric Assessment

All participants underwent a CGA conducted by a nurse, which included demographic data, a medical history as well as assessing the number of comorbidities, social history, cognition including the Abbreviated Mental Test (AMT) and the modified version of the Chinese Mini-Mental State Examination (mCMMSE),[20] a screen for depressive symptoms using the locally validated 15-item Geriatric Depression Scale (GDS),[21] a functional history comprising a Modified Barthel Index (MBI)[22] for basic ADLs, and Lawton's Index[23] for assessment of IADLs, falls assessment, visual, hearing, and nutritional screening.

Geriatric Syndromes and Outcomes

Data on clinician-identified geriatric syndromes after CGA were collected via a retrospective review of case notes by trained fellows in geriatric medicine who were also members of the study team. We defined cognitive impairment using locally validated age- and education-specific cutoffs of mCMMSE[20] and depression using a cutoff of ≥5 for GDS.[21] Malnutrition was determined based on clinical assessment using anthropometric measurements (body mass index and weight loss). We also collected data on falls, and bladder or bowel incontinence, as determined by clinical judgment. The fellows involved in data collection were blinded to CESAM scores, as were the managing clinicians involved in CGA and rating of CFS. Other outcome measures included caregiver burden, assessed using the locally validated 22-item Zarit Burden Index (ZBI),[24] as well as both self- and proxy-rated HRQoL using Visual Analogue Scores (VAS) and index scores of the 5-level version of the EuroQol 5-dimensional (EQ-5D-5L) questionnaire based on Singapore preference weights.[25]

Statistical Analysis

Baseline characteristics were analyzed using descriptive statistics with continuous variables recorded as mean and SD, while categorical variables are expressed as absolute numbers and percentages. All statistical tests were 2-tailed, with $P < .05$ considered statistically significant. STATA Version 15 (StataCorp LLC, College Station, TX) was used for all statistical analysis.

To examine concurrent validity, we performed receiver operating characteristic curve (ROC) analysis against CFS ≥4 and FI ≥0.25 as the gold standard. Diagnostic performance was ascertained via area under the ROC curve (AUC), and Youden index was used to identify the optimum cutoff scores that maximized sensitivity and specificity. The positive predictive value (PPV), negative predictive value (NPV), specificity, and sensitivity were calculated to evaluate the diagnostic performance of the CESAM questionnaire for frailty identification. To examine known-groups validity, we used 1-way analysis of variance with Bonferroni correction for post hoc comparison between groups stratified by frailty status (CFS 1–3, 4–6, and 7–9[26,27] and FI: 0–<0.25, 0.25–<0.36, ≥0.36),[28] functional status (MBI 0–50, 50–94, and 95–100),[29] and severity of cognitive impairment (mCMMSE 0–9, 10–20, 21–28).[30] To demonstrate convergent validity, we performed Spearman's correlation with functional scores (MBI and Lawton's Index), cognition (AMT and mCMMSE), and mood (GDS), and point biserial correlation with the presence of falls and polypharmacy. Last, we used the ROC optimal cutoff score to derive 2 groups (frail vs nonfrail) and performed binary logistic regression to determine the association between CESAM-identified frailty with geriatric syndromes (falls, cognitive impairment, depression, urinary/bowel incontinence, and malnutrition), and multiple linear regression to analyze the association with the MBI, ZBI total scores, and EQ-5D-5L VAS and index scores.

We based our sample size calculation on the assumption that AUC >0.70 for frailty identification is considered acceptable. At 80% power and alpha level 0.05, a minimum sample size of 62 is required.

Results

Cohort Characteristics

The mean (SD) age of all participants in the cohort was 79.7 (6.2) years. Most were Chinese (n = 109, 90.8%) and female (n = 75, 62.5%); 66 (55%) participants completed the survey unaided by the study team. Mean (SD) FI score was 0.34 (0.2) and CFS score was 4.9 (1.2), respectively. Most (n = 93, 77.5%) required assistance in some of their ADLs and had a mean (SD) mCMMSE score of 18.6 (5.7). A large proportion (n = 82, 68.3%) were exposed to polypharmacy (≥5 medications) and had fallen at least once in the preceding year (n = 64, 52.3%).

Concurrent Validity

Concurrent validity was assessed using AUC analysis between the CESAM score with the CFS and FI. AUC of CESAM was excellent for both CFS and FI: FI: AUC = 0.88; 95% CI: 0.82–0.94; $P < .001$ (Figure 1A); CFS: AUC = 0.78; 95% CI: 0.68–0.88; $P < .001$ (Figure 1B). Using Youden's Index, the optimal cutoff point for the CESAM score to diagnose frailty was ≥8 for both CFS- and FI-defined frailty, yielding a sensitivity of 0.76, specificity of 0.83, PPV of 0.82, and NPV of 0.76 for FI-defined frailty and a sensitivity of 0.61, specificity of 0.92, PPV of 0.88, and NPV of 0.70 for CFS-defined frailty.

Known-groups Validity

The CESAM score was highest among those who have advanced frailty (CFS 7–9 and FI ≥0.36), severe functional impairment (MBI 0–50), and among those with low cognitive scores (mCMMSE 0–9), when compared with those who were not frail (CFS 1–3 and FI 0–0.25), independent in ADLs (MBI 95–100), and have higher cognitive scores (mCMMSE 21–28) ($P < .001$) (Table 1).

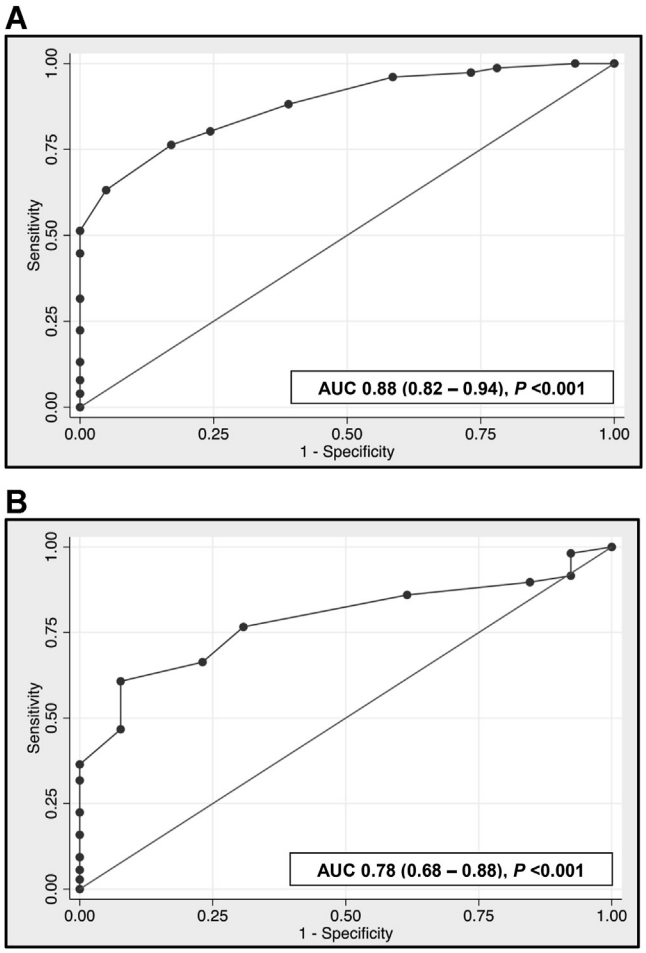

Fig. 1. AUC comparing CESAM scores against frailty defined by the FI (FI ≥ 0.25) and CFS (CFS ≥ 4). (A) CESAM score against FI. (B) CESAM score against CFS.

Table 1
Known-Groups Validity: CESAM Scores Across CFS, FI, MBI, and mCMMSE Categories

	CESAM Score	*P*
CFS		
CFS 1–3	5.0 ± 2.0	<.001
CFS 4–6	7.9 ± 3.5*	
CFS 7–9	13.1 ± 1.6*,**	
FI		
0 − < 0.25	5.1 ± 2.4	<.001
0.25 − < 0.36	7.2 ± 2.8†	
≥ 0.36	11.4 ± 2.6†,††	
MBI		
95–100	6.4 ± 2.9	<.001
51–94	9.3 ± 3.2‡	
0–50	12.4 ± 3.0‡,‡‡	
mCMMSE		
21–28	6.0 ± 3.2	<.001
10–20	8.8 ± 3.5§	
0 − 9	12.1 ± 2.5§,§§	

All values are reported as mean ± SD unless otherwise stated.
Post hoc comparisons with Bonferroni correction.
$P < .05$ compared with *CFS 1–3 and **CFS 4–6; †FI 0 − <0.25 and ††FI 7.2 ± 2.8; ‡MBI 95–100 and ‡‡ MBI 51–94; and §mCMMSE 21–28 and §§mCMMSE 10–20.

Convergent Validity

The CESAM score was moderately correlated with the MBI (r = −0.61; $P < .001$), Lawton's IADL Index (r = −0.54; $P < .001$), mCMMSE (r = −0.53; $P < .001$), and the GDS (r = 0.58; $P < .001$) (Table 2).

Associations With Geriatric Syndromes, Function, Caregiver Stress, and Quality of Life

With a CESAM cutoff score of ≥8, 66 (55%) individuals were identified to be frail. Frail participants had lower cognitive scores, poorer physical function, higher depressive symptoms, and greater exposure to polypharmacy (Table 3). A CESAM score of ≥8 was also associated with higher odds of cognitive impairment (based on mCMMSE age- and education-specific cutoffs) (OR 3.7; 95% CI: 1.7–8.2; $P = .001$), depression (based on GDS score of ≥5) (OR 4.0; 95% CI: 1.7–9.6; $P = .002$), and falls (OR 3.1; 95% CI: 1.2–8.2; $P = .021$). No significant associations with bladder or bowel incontinence and malnutrition were found. A CESAM score of ≥8 was also associated with poor ADL and IADL function, poorer self- and proxy-rated HRQoL (self-reported EQ-5D-5L utility scores (β = −0.1; 95% CI: −0.2 to −0.02; $P = .017$), and proxy-rated EQ-5D-5L utility scores (β = −0.4; 95% CI: −0.6 to −0.2; $P < .001$). We found no significant associations for caregiver burden (Table 4).

Discussion

We evaluated the concurrent, known-groups, convergent validity of the CESAM questionnaire as an online self-reported tool for frailty assessment. Specifically, AUC analysis of CESAM scores demonstrated excellent diagnostic performance for both FI- and CFS-defined frailty, with an optimal CESAM cutoff score of ≥8 for frailty diagnosis. Mean CESAM scores were significantly higher among participants with advanced frailty, severe functional impairment, and severe cognitive impairment. CESAM scores demonstrated moderate correlations with objective cognitive scores, ADL function, and depressive symptoms. CESAM-diagnosed frailty is associated with the diagnosis of geriatric syndromes (cognitive impairment, falls, and depression), and poor self- and proxy-rated HRQoL. These findings are consistent with the existing literature that relates frailty with cognitive impairment,[31,32] impaired function, and depression.[33] Taken together, our study demonstrates the validity of an online, self-reported tool for frailty assessment.

Table 2
Convergent Validity: Correlation Between CESAM Score With Various Instruments

Correlation	CESAM Score	
	r	*P*
MBI Total	−0.61	<.001
Lawton IADL index	−0.54	<.001
Modified Chinese Mini-Mental State Examination	−0.53	<.001
GDS	0.58	<.001
Falls in the past 1 year	0.24	.009
Polypharmacy (≥5 medications)	0.26	.004

We found that the CESAM questionnaire demonstrated better discriminatory ability when compared against the FI than the CFS because it assessed frailty over multiple domains and closely resembled the FI. Other validated self-reported frailty assessment tools include the Groningen Frailty Indicator,[9] the FRAIL scale,[34] and the Tilburg Frailty Indicator (TFI).[35] In a study conducted in our population, the TFI and the FRAIL scale had an AUC of 0.87 and 0.81, respectively, when compared with the FI as the gold standard for frailty.[18] Our study using the CESAM questionnaire showed similar discriminating ability for frailty.

Unlike the aforementioned tools, the CESAM questionnaire comprehensively addresses multidimensional domains relevant to the health of an older individual, including functional assessment, falls, vision, and hearing: elements that are not included in other self-reported frailty tools. Furthermore, the CESAM questionnaire allows for identification of specific areas of deficiency that contribute to frailty, in contrast to other frailty instruments that primarily describe a physical frailty construct. The integration of the CESAM questionnaire into a Web-based platform improves accessibility and provides an opportunity for remote geriatric assessment. This is particularly salient in settings in which distance or the lack of availability of geriatric expertise limits provision of care to older adults.

CESAM-identified frailty is associated with cognitive impairment, depression, falls, and poor quality of life (both patient- and caregiver-rated), highlighting the potential for identifying at-risk frail older individuals for further evaluation and management of important geriatric syndromes. However, CESAM-identified frailty was not associated with other geriatric syndromes. As we captured clinician-identified geriatric syndromes by review of case notes, these findings may partially be explained by varying practices in documentation. On the other hand, these findings also may be attributed to differences between a patient's self-perception of their health and the clinician's prioritization of what is important to the patient. This further supports the complementarity and utility of a self-reported approach toward a patient-centered CGA, whereby the patient perspective supports and enriches the clinical consultation by providing the clinician with insights about what is most relevant to the individual.

The study contributes to the emerging body of literature that examines the use of technology and self-measurement of health in the practice of geriatric medicine, such as the measure of intrinsic capacity using the integrated care of older people (ICOPE) application.[36] We see the implementation of the CESAM questionnaire similarly to the ICOPE application, leveraging on the accessibility provided by technology to allow for quick and rapid frailty identification, with subsequent onward referral to a specialist center for a CGA. This has much applicability in primary care, where resource scarcity can be a limiting factor in the implementation of frailty assessment for older individuals. In the setting of the COVID-19 pandemic where geriatric services may be curtailed, this capability for online assessment also may prove valuable in allowing for continued assessment for frailty despite a lack of in-person assessment.

Table 3
Comparison of Baseline Characteristics Between Total Population, CESAM identified Frail and Nonfrail Participants

	All Participants N = 120	Frail (CESAM ≥8) n = 66	Nonfrail (CESAM <8) n = 54	*P*
Demographics				
Age, y	79.7 ± 6.2	80.6 ± 0.8	78.6 ± 0.8	.088
Female gender	75 (62.5)	43 (65.2)	32 (59.3)	.510
Chinese ethnicity	109 (90.8)	61 (92.4)	48 (88.9)	.500
Years of education	5.9 ± 4.7	4.2 ± 4.2	8.0 ± 4.6	<.001
Frailty				
FI (0 to 1)	0.3 ± 0.1	0.42 ± 0.1	0.24 ± 0.1	<.001
FI ≥ 0.25	66 (55.0)	58 (89.2)	18 (34.6)	<.001
CFS (1 to 9)	4.9 ± 1.2	5.4 ± 1.1	4.4 ± 1.0	<.001
CFS ≥4	107 (89.6)	65 (98.5)	42 (77.8)	<.001
Cognitive function				
mCMMSE (0 to 28)	18.6 ± 5.8	15.9 ± 5.7	21.6 ± 4.0	<.001
Physical function				
MBI (0 to 100)	80.6 ± 29.2	69.6 ± 4.3	94.4 ± 1.5	<.001
Lawton's IADL Index (0 to15)	11.6 ± 7.3	8.8 ± 6.9	15.1 ± 6.2	<.001
Depressive symptoms				
GDS (0 to 15)	5.2 ± 3.8	7.0 ± 3.9	3.1 ± 2.2	<.001
Medication use				
Number of medications	7.0 ± 4.4	8.0 ± 4.6	5.9 ± 3.8	.007
Falls				
Falls in the past 1 year	64 (53.3)	43 (65.2)	21 (38.9)	.004
Comorbidities				
Hypertension	93 (77.5)	54 (81.8)	39 (72.2)	.210
Hyperlipidemia	80 (66.7)	40 (60.6)	40 (74.1)	.119
Diabetes	43 (35.8)	27 (40.9)	16 (29.6)	.200
Ischemic heart disease	18 (15.0)	12 (18.2)	6 (11.1)	.281
Stroke/Transient ischemic attack	37 (30.8)	22 (33.3)	15 (27.7)	.512
Cancer	14 (11.7)	7 (10.6)	7 (13.0)	.689
Kidney disease	20 (16.7)	15 (22.7)	5 (9.3)	.049
Arthritis	24 (20.0)	13 (19.7)	11 (20.3)	.927

All values expressed as mean ± SD or n (%).

The study's strengths include the comprehensive evaluation of the validity of an online self-reported approach to frailty assessment, with an adequately powered sample size. The study population is also representative of patients commonly encountered in geriatric clinics. However, the following limitations were identified. First, the cross-sectional design of this study limited our ability to evaluate the predictive validity of CESAM scores with longitudinal outcomes. Second, the results of this study may not be generalizable to a cohort of older adults who are less frail, as participants referred for specialist geriatric assessment were likely to be frailer compared with the general population of older adults. Third, we were not able to compare CESAM-measured frailty with other measures of frailty, including the Fried physical frailty phenotype,[6] as the data were not available. Last, the caregiver proxies completed the CESAM questionnaire if participants were unable to. Therefore, we were unable to verify whether responses on the CESAM questionnaire accurately reflected the subject's self-perception of his or her own health. Furthermore, participants who required assistance to complete the questionnaire were frailer and had lower cognitive scores compared with those who were able to complete the questionnaire independently. Participants may have experienced difficulties with the online questionnaire because of cognitive and functional impairment or lack of familiarity with the web interface or devices. This highlights the challenges faced by older adults in adopting technology-based modes of assessment, potentially affecting the feasibility and implementation of the CESAM questionnaire in wider practice. Further evaluation of the reliability, usability, and acceptance of the online CESAM questionnaire is required.

We recommend the following for future studies. First, the CESAM questionnaire can be validated in primary care and in other health care settings in which geriatric expertise may not be widely available. Second, the predictive validity of the CESAM questionnaire can be examined in a prospective study, looking for longitudinal associations between CESAM-identified frailty and important adverse outcomes. Last, the responsiveness of the CESAM questionnaire to change also should be examined over time, to evaluate if it can monitor the longitudinal trajectory of frailty in older adults.

Conclusion and Implications

The study validates the CESAM questionnaire as an online self-reported tool for identifying frailty. As a Web-based frailty assessment tool, the CESAM questionnaire can be applied remotely

Table 4
Associations Among CESAM-identified Frailty With Geriatric Syndromes, Physical Function, HRQoL, and Caregiver Burden

Outcome Variables	Adjusted OR (95% CI)	*P*
Cognitive impairment (by mCMMSE age- and education-specific cutoffs)*	3.7 (1.7–8.2)	.001
Falls*	3.1 (1.2–8.2)	.021
GDS ≥5†	4.0 (1.7–9.6)	.002
Bladder/bowel incontinence*	1.0 (0.9–1.2)	.445
Malnutrition*	1.2 (1.0–1.4)	.087
	β (95% CI)	*P*
Physical function*		
Modified Barthel Index	−24.2 (−34.2 to −14.1)	<.001
Lawton's IADL Index	−5.8 (−8.2 to −3.4)	<.001
HRQoL†		
EQ-5D utility values (self)	−0.1 (−0.2 to −0.02)	.017
EQ-5D VAS (self)	−5.3 (−13.0 to 2.4)	.180
EQ-5D utility values (proxy)	−0.4 (−0.6 to −0.2)	<.001
EQ-5D VAS (proxy)	−8.2 (−15.9 to −0.4)	.039
Caregiver burden†		
Total Zarit Burden Index	0.5 (−0.4 to 1.5)	.279

*Adjusted for age and gender.
†Adjusted for age, gender, and education.

and may potentially serve as a triage tool for onward geriatric assessment and a means for monitoring the health of the older adult over time. The comprehensive nature of the CESAM questionnaire allows for interventions that can be tailored to specific domains identified by the questionnaire, reinforcing an approach to health assessment that empowers an individual to take charge of his or her own health.

Acknowledgments

We thank all patients and caregivers who participated in the study. We also acknowledge the clinicians and staff at the Centre for Geriatric Medicine, Tan Tock Seng Hospital, who have contributed to the study.

References

1. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *Lancet*. 2013;381:752–762.
2. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ*. 2005;173:489–495.
3. Wallis S, Wall J, Biram R, Romero-Ortuno R. Association of the clinical frailty scale with hospital outcomes. *QJM*. 2015;108:943–949.
4. Vermeiren S, Vella-Azzopardi R, Beckwee D, et al. Frailty and the prediction of negative health outcomes: a meta-analysis. *J Am Med Dir Assoc*. 2016;17:1163.e1–1163.e17.
5. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. *ScientificWorldJournal*. 2001;1:323–336.
6. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56:M146–M157.
7. Church S, Rogers E, Rockwood K, Theou O. A scoping review of the Clinical Frailty Scale. *BMC Geriatr*. 2020;20:1–18.
8. Lim WS, Wong CH, Ding YY, Rockwood K, Lien C. Translating the science of frailty in Singapore: results from the National Frailty Consensus Discussion. *Ann Acad Med Singap*. 2019;48:25–31.
9. Peters LL, Boter H, Buskens E, Slaets JP. Measurement properties of the Groningen Frailty Indicator in home-dwelling and institutionalized elderly people. *J Am Med Dir Assoc*. 2012;13:546–551.
10. Daniels R, van Rossum E, Beurskens A, van den Heuvel W, de Witte L. The predictive validity of three self-report screening instruments for identifying frail older people in the community. *BMC Public Health*. 2012;12:1–7.
11. Olivier B, Vilcocq-Merjagnan C. Online administration of a quantified self-questionnaire for elderly people: a user satisfaction survey. *J Am Geriatr Soc*. 2015;63:194–195.
12. CESAM. Evaluate Your Health Status. Accessed January 30, 2022. https://cesam.ceexlo.ca/en/project/MzEyZDV
13. Beauchet O, Launay CP, Merjagnan C, Kabeshova A, Annweiler C. Quantified self and comprehensive geriatric assessment: older adults are able to evaluate their own health and functional status. *PLoS One*. 2014;9:e100636.
14. Colucci E, Nadeau S, Higgins J, et al. COVID-19 lockdowns' effects on the quality of life, perceived health and well-being of healthy elderly individuals: A longitudinal comparison of pre-lockdown and lockdown states of well-being. *Arch Gerontol Geriatr*. 2022;99:104606.
15. Beauchet O, Cooper-Brown LA, Hayashi Y, Deveault M, Ho AHY, Launay CP. Health benefits of "Thursdays at the Montreal Museum of Fine Arts": Results of a randomized clinical trial. *Maturitas*. 2021;153:26–32.
16. Wild D, Grove A, Martin M, et al. Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: report of the ISPOR task force for translation and cultural adaptation. *Value Health*. 2005;8:94–104.
17. Searle SD, Mitnitski A, Gahbauer EA, Gill TM, Rockwood K. A standard procedure for creating a frailty index. *BMC Geriatr*. 2008;8:1–10.
18. Chong E, Ho E, Baldevarona-Llego J, et al. Frailty in hospitalized older adults: comparing different frailty measures in predicting short-and long-term patient outcomes. *J Am Med Dir Assoc*. 2018;19:450–457.e3.
19. Rockwood K, Theou O. Using the clinical frailty scale in allocating scarce health care resources. *Can Geriatr J*. 2020;23:210.
20. Sahadevan S, Lim PiPJ, Tan NJL, Chan SP. Diagnostic performance of two mental status tests in the older Chinese: influence of education and age on cut-off values. *Int J Geriatr Psychiatry*. 2000;15:234–241.
21. Lim PiPJ, Ng LL, Chiam PC, Ong PS, Ngui FTS, Sahadevan S. Validation and comparison of three brief depression scales in an elderly Chinese population. *Int J Geriatr Psychiatry*. 2000;15:824–830.
22. Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. *J Clin Epidemiol*. 1989;42:703–709.
23. Lawton MP, Elaine MB. Assessment of older people: self-maintaining and instrumental activities of daily living. *The gerontologist*. 1969;(9.3_Part_1):179–186.
24. Cheah WK, Han HC, Chong MS, Anthony PV, Lim WS. Multidimensionality of the Zarit Burden Interview across the severity spectrum of cognitive impairment: an Asian perspective. *Int Psychogeriatr*. 2012;24:1846–1854.
25. Van Hout B, Janssen M, Feng Y-S, et al. Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. *Value Health*. 2012;15:708–715.
26. Pranata R, Henrina J, Lim MA, et al. Clinical frailty scale and mortality in COVID-19: a systematic review and dose-response meta-analysis. *Arch Gerontol Geriatr*. 2021;93:104324.
27. Chong E, Chia JQ, Law F, Chew J, Chan M, Lim WS. Validating a standardised approach in administration of the Clinical Frailty Scale in hospitalised older adults. *Ann Acad Med Singap*. 2019;48:115–124.
28. Stow D, Matthews FE, Barclay S, et al. Evaluating frailty scores to predict mortality in older adults using data from population based electronic health records: case control study. *Age Ageing*. 2018;47:564–569.
29. Sulter G, Steen C, De Keyser J. Use of the Barthel index and modified Rankin scale in acute stroke trials. *Stroke*. 1999;30:1538–1541.
30. Bond M, Rogers G, Peters J, et al. The effectiveness and cost-effectiveness of donepezil, galantamine, rivastigmine and memantine for the treatment of Alzheimer's disease (review of Technology Appraisal No. 111): a systematic review and economic model. *Health Technol Assess*. 2012;16:1–470.
31. Auyeung TW, Lee J, Kwok T, Woo J. Physical frailty predicts future cognitive decline—a four-year prospective study in 2737 cognitively normal older adults. *J Nutr Health Aging*. 2011;15:690–694.
32. Kulmala J, Nykänen I, Mänty M, Hartikainen S. Association between frailty and dementia: a population-based study. *Gerontology*. 2014;60:16–21.
33. St. John PD, Tyas SL, Montgomery PR. Depressive symptoms and frailty. *Int J Geriatr Psychiatry*. 2013;28:607–614.
34. Morley JE, Malmstrom T, Miller D. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. *J Nutr Health Aging*. 2012;16:601–608.
35. Gobbens RJ, van Assen MA, Luijkx KG, Wijnen-Sponselee MT, Schols JM. The Tilburg frailty indicator: psychometric properties. *J Am Med Dir Assoc*. 2010;11:344–355.
36. Sanchez-Rodriguez D, Annweiler C, Gillain S, Vellas B. *Implementation of the integrated care of older people (ICOPE) app in primary care: new technologies in geriatric care during quarantine of COVID-19 and beyond*. Springer; 2021. p. 139–140.

Supplementary Table 1
Scoring System for CESAM Questionnaire

Domains	Scoring			Score
	0	1	2	
Nutrition Item 1: Have you involuntarily lost weight in the past year? Was the loss of weight more than 3 kg?	Item 1: NO	-	Item 1: YES	
Multimorbidity Item 2: How many different drugs do you take daily?	Item 2: < 5	Item 2: 5–9	Item 2: ≥ 10	
Communication Item 3: Do you have vision problems? Item 4: Do you have hearing problems?	Item 3: NO AND Item 4: NO	Item 3 OR Item 4: YES	Item 3 AND Item 4: YES	
Cognition Item 5: Has someone around you noticed that you have memory problems?	Item 5: NO	-	Item 5: YES	
ADL*	Item 7–11: ≥ 4 NO	Item 7–11: 2–3 NO	Item 7–11: ≤ 1 NO	
Item 7: Do you need help for grooming?				
Item 8: Do you need help for bathing?				
Item 9: Do you need help to get dressed?				
Item 10: Do you need help for walking and/or other displacements?				
Item 11: Do you need help for eating?				
IADL	Item 12–15: 4 NO	Item 12–15: 3 NO	Item 12–15: ≤ 2 NO	
Item 12: Do you need help to use the phone?				
Item 13: Do you need help to take public transports?				
Item 14: Do you need help to manage your medications				
Item 15: Do you need help to handle your own finances?				
Continence Item 16: Are you incontinent (urine and/or stool)?	Item 16: NO		Item 16: YES	
Mood Item 17: How do you feel today? (happy/unhappy/neither one nor the other) Item 18: Do you feel energetic?	Item 17: Happy AND Item 18: Yes	Item 17: Neither one nor the other AND Item 18: Yes	Item 17: Sad AND/OR Item 18: NO	
Mobility Item 19: Did you do regular physical activities (walking, bicycle, etc), at least 1 hour per week in the past month? Item 20: Did you fall in the previous year? (at least 1 fall)	Item 19: YES AND Item 20: NO	Item 19: NO AND Item 20: NO	Item 20: YES	
Total Score				

*Item 6 is not required in scoring the CESAM score.

Supplementary Table 2. Frailty Index
Frailty index used to assess frailty in the study

Physical Function		
Q1	Help with dressing	0: Independent 0.5: some assistance 1: Dependent
Q2	Help with feeding	0: Independent 0.5: some assistance 1: Dependent
Q3	Help with bladder/bowel care	0: Independent 0.5: some assistance 1: Dependent
Q4	Help with ambulation	0: Independent 0.5: some assistance 1: Dependent
Q5	Help with toileting	0: Independent 0.5: some assistance 1: Dependent
Q6	Help with bathing	0: Independent 0.5: some assistance 1: Dependent
Q7	Help using telephone	0: Independent 0.5: some assistance 1: Dependent
Q8	Help with transportation	0: Independent 0.5: some assistance 1: Dependent
Q9	Help taking medication	0: Independent 0.5: some assistance 1: Dependent
Q10	Help with finances	0: Independent 0.5: some assistance 1: Dependent
Activity		
Q11	Physical activity level	0: Low 0.5: Moderate 1: High
Q12	Restriction of activity due to poor health	0: No 1: Yes
Medical		
Q13	Pain	0: No 1: Yes
Q14	Shortness of breath	0: No 1: Yes
Q15	Weakness	0: No 1: Yes
Q16	Fatigue/slowed down	0: No 1: Yes
Q17	Hypertension	0: No 1: Yes
Q18	Ischemic heart disease	0: No 1: Yes
Q19	Diabetes mellitus	0: No 1: Yes
Q20	Chronic lung disease	0: No 1: Yes
Q21	Back problems	0: No 1: Yes
Q22	Arthritis	0: No 1: Yes
Q23	Stroke	0: No 1: Yes
Psych/Cognitive		
Q24	Memory loss/dementia	0: No 1: Yes
Q25	Feeling sad	0: No 1: Yes
Q26	History of depression	0: No 1: Yes
Falls		
Q27	Falls in past 1 year	0: No 1: Yes
Sensory		
Q28	Problem due to poor hearing	0: No 1: Yes
Q29	Problem due to poor vision	0: No 1: Yes
Weight loss		
Q30	Unintentional weight loss	0: No 1: Yes
Self-rated health		
Q31	Self-rating of health	1: poor 0.75: fair 0.5: good 0.75: Very Good 1: Excellent
Social		
Q32	Do you live alone?	0: No 1: Yes