



The association between frailty and quality of life among rural community-dwelling older adults in Kegalle district of Sri Lanka: a cross-sectional study

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Abstract

Purpose The objective of this study was to estimate the cross-sectional association of frailty status with overall and domain-specific quality of life (QoL) in rural community-dwelling older adults in Kegalle district of Sri Lanka.

Methods A population-based cross-sectional study was conducted with 746 community-dwelling older adults aged ≥ 60 years living in the rural areas of Kegalle district of Sri Lanka in 2016. A three-stage probability sampling design was used to recruit participants. Frailty and QoL were assessed using the Fried phenotype and Older People's Quality of Life Questionnaire, respectively. Multivariable linear regression was used to estimate the association of frailty with QoL after accounting for the complex sampling design.

Results The median (IQR) age of the sample was 68 (64:75) years and comprised of 56.7% women. 15.2% (95% CI 12.4%, 18.7%) were frail and 48.5% (95% CI 43.9%, 53.2%) were pre-frail. The unadjusted means (SE) of the total QoL score for the robust, pre-frail and frail groups were 139.2 (0.64), 131.8 (1.04) and 119.2 (1.35), respectively. After adjusting for covariates in the final multivariable model, the estimated differences in mean QoL were lower for both frail and pre-frail groups versus robust. The estimated reduction in the total QoL score was 7.3% for those frail and 2.1% for those pre-frail. All QoL domains apart from 'social relationships and participation', 'home and neighbourhood' and 'financial circumstances' were associated with frailty.

Conclusions Frailty was associated with a small but significant lower quality of life in this rural Sri Lankan population, which appears largely explained by 'health' and 'independence, control over life and freedom' QoL domains. Interventions aiming to improve quality of life in frail older adults should consider targeting these aspects.

Keywords Frailty · Quality of life · Community-dwelling older adults · Sri Lanka · WHO South-East Asia region

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Introduction

Frailty is an important clinical condition of older age characterised by decreased in-built physiological reserves and dysregulation of multiple physiologic systems [1]. As a consequence, frailty has been shown to increase the risk of

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several adverse health outcomes such as premature mortality, loss of instrumental and basic activities of daily living, hospitalisation, risk of falls and fractures [2]. These poor outcomes along with physical, psychological and social risk factors associated with frailty could have negative impacts on the quality of life (QoL) of frail older adults. Alternatively experiencing poor QoL for long periods could also lead to frailty. Maintaining a strong sense of psychological well-being in later life has been found to be protective against the development of physical frailty [3]. The prevalence of frailty increases with age [4, 5] and the QoL of frail older adults has become an important concern with increased longevity. A systematic review and meta-analysis has demonstrated a consistent inverse association between frailty, pre-frailty and health-related quality of life (HRQoL) [6]. However, these studies have been limited to high-income countries such as Italy [7], Taiwan [8, 9] and USA [10]. We found only one study from upper middle-income countries (Mexico) [11] and no studies were found from low-income or lower middle-income countries.

The concepts of QoL and HRQoL are often used interchangeably [12]. However, QoL is a broad multidimensional construct [13], whereas HRQoL more focuses on the aspects of quality of life that are influenced by one's health status directly, excluding non-health dimensions such as home and neighbourhoods, and financial circumstances. Previous studies have investigated the association between frailty and QoL [11, 14–16], frailty and HRQoL [7–10] and frailty and psychological well-being [3] as well as subjective well-being [17]. The latter two studies used CASP-19: a measure of QoL in early old age that included four domains; control, autonomy, pleasure and self-realisation [18]. Only two studies used quality of life instruments that are specifically designed to assess the QoL of older adults with a broad range of domains [11, 14].

It is widely accepted that the construct of QoL is strongly influenced by culture [19]. Hence, cross-cultural differences of quality of life may exist. Sri Lanka is a multi-ethnic, multi-cultural and multi-faith country which has a deeply rooted culture of caring for older adults predominantly shaped by Buddhist principles and values. The majority of older Sri Lankan adults are supported by their own children, relatives and neighbours [20]. However, along with the urbanisation, migration and changing family structure, these cultural norms are becoming less predominant. Furthermore, Sri Lanka's non-communicable disease burden is rising along with a rapidly ageing population [21, 22]. The prevalence of depression among older adults in Sri Lanka is reported to be higher relative to other Asian countries like Taiwan, China, Korea, Malaysia and Japan [23]. Being a lower middle-income country, Sri Lanka is under huge pressure to provide adequate health

and social care services for its growing older population. Hence, these context-specific micro-, meso- and macro-level factors could be positively or negatively contributing to the QoL of frail older adults.

Two recent studies from Sri Lanka reported moderate levels of QoL [24] and poor levels of HRQoL [25] among community-dwelling older adults. To date, no studies have examined the association between frailty and QoL in World Health Organization South-East Asia region and in low- and lower middle-income countries more generally. Understanding the association between frailty and QoL will inform policy on service delivery to meet the needs of frail older adults in order to improve QoL. The aim of this study was to estimate the cross-sectional association of frailty status with overall and domain-specific quality of life after adjusting for sociodemographic and health-related covariates in rural community-dwelling older adults in Kegalle district of Sri Lanka.

Materials and methods

Study design, setting and participants

This is a population-based cross-sectional study with older adults aged ≥ 60 years permanently living in the rural areas of Kegalle district of Sri Lanka. We excluded those unable to give informed consent including people with severe dual hearing and vision impairment, aphasia, severe stages of dementia, those with unstable severe mental illnesses and those who were terminally ill. The sample size was calculated using the standard formula for prevalence studies [26]. The expected prevalence of frailty in rural Sri Lanka was considered as 11% based on the results of a similar study conducted in Chennai, South India [27]. The absolute precision required on either side of the prevalence estimate was set as 3.5% and the z statistics for the 95% level of confidence was set as 1.96. To account for the complex sampling design, we inflated the estimated sample size by a design effect of 2.4 [28], giving a minimum sample of 737 participants. Hence, the final sample required was estimated as 750 participants. A three-stage probability sampling was used to recruit older adults representing the rural areas of the entire district, which has been described in detail elsewhere [29].

Measurements

Assessment of frailty

Frailty was defined using the Fried phenotype [1] comprising five components; shrinking, self-reported exhaustion,

weakness, slowness and low physical activity level. Components were operationalised as follows: shrinking was defined as having a body mass index (BMI) < 18.5 kg/m². Self-reported exhaustion was assessed using two questions (“I felt that everything I did was an effort” and “I could not get going”) from the Center for Epidemiological Studies-Depression scale [30]. If the answer was three or more days in the last week to either of these two questions, the respondent was considered as frail for this component. Weakness was defined as being in the lowest grip strength quintile after adjusting for BMI quartiles and sex. Slowness was evaluated by being in the slowest quintile for the time taken to walk 15 feet after adjusting for median height and sex. Low physical activity level was defined as being in the lowest quintile for weekly kilocalories expenditure adjusted for sex measured using the International Physical Activity Questionnaire (Short Form) [31]. Cut-offs for weakness and slowness components were computed based on the anthropometry of our study sample accounting for the complex sampling design. As proposed in the original study [1], participants with three or more components were considered as frail, those with one or two components were considered as pre-frail and those with none of the five components described above were considered as robust/non-frail.

Assessment of quality of life

The quality of life of participants was assessed using the Older People’s Quality of Life (OPQOL)-35 questionnaire, developed to measure QoL in older adults, and validated on a community-dwelling older population in Britain [32–34]. It has 35 items and participants were asked to what extent they agree with each item, with response options on a five-point likert scale (from “strongly agree” to “strongly disagree”) coded from 1 to 5. The OPQOL-35 questionnaire has eight subscales; ‘life overall’, ‘health’, ‘social relationships and participation’, ‘independence, control over life and freedom’, ‘home and neighbourhood’, ‘psychological and emotional well-being’, ‘financial circumstances’, ‘leisure activities and religion’. After reverse coding for positive items, the total QoL score ranges from 35 (worst possible) to 175 (best possible). The Sinhala version of the questionnaire demonstrated good internal consistency (a measure of the extent to which items in a questionnaire (sub)scale are correlated, thus measuring the same construct) in a previous study conducted in Sri Lanka [24]. We further calculated the internal consistency of the overall OPQOL-35 questionnaire in our study, and this was also estimated as good ($\alpha = 0.86$). Acceptable values of alpha range from 0.70 to 0.95 [35]. However, the internal consistency of the different domains varied from poor in the ‘leisure activities and religion’ domain

($\alpha = 0.33$) to good in the ‘financial circumstances’ domain ($\alpha = 0.82$) (Table 1).

Covariates

Sociodemographic covariates of participants included sex, age at last birthday, ethnicity, marital status, living arrangements, education level (according to the International Standard Classification of Education [36]), longest-held income generation activity (according to the Sri Lanka Standard Classification of Occupation [37] based on the International Standard Classification of Occupations 2008 (ISCO-08)) [38] and subjective financial strain [39] and social support assessed using the Oslo-3 social support scale [40]. The total score of the Oslo-3 social support scale ranged from 3 to 14 and participants were classified into three categories as follows: a score of 3–8 was classified as ‘poor support’, 9–11 as ‘moderate support’ and 12–14 as ‘strong support’. Health-related variables included multimorbidity which was defined for the present study as co-existence of two or more concurrent chronic medical conditions [41, 42], existence of chronic pain in any part of the body, cognitive status assessed using Montreal Cognitive Assessment (MoCA) [43] and self-perceived vision and hearing ability assessed using a Likert scale. The total score of the MoCA ranged from 0 to 31, with higher scores representing higher cognition. All assessments have been validated in Sri Lanka [44, 45] except the Oslo-3 social support scale.

Data collection and ethical considerations

Five trained nursing graduates collected data from the entire sample through home visits. Participation for the study was voluntary and informed written consent was obtained from all participants. The ethical clearance for this study was obtained from two ethics review committees at University College London (Project ID: 8155/001) and Faculty of Medicine, University of Colombo, Sri Lanka (Protocol No. EC-16-071).

Statistical analyses

All statistical analyses were performed in Stata version 15 accounting for complex survey design unless otherwise stated [46].

Descriptive statistics

Participants were stratified into three groups according to the lowest (76–127), intermediate (128–139) and highest (140–171) tertiles of the total OPQOL-35 score.

Table 1 Internal consistency of different domains of quality of life in OPQOL-35 questionnaire

Domain	Questions representing each domain	Cronbach's alpha (n)
D1-Life overall	1. I enjoy my life overall (+) 2. I am happy much of the time (+) 3. I look forward to things (+) 4. Life gets me down (–)	0.57 (745)
D2-Health	5. I have a lot of physical energy (+) 6. Pain affects my well-being (–) 7. My health restricts me looking after myself or my home (–) 8. I am healthy enough to get out and about (+)	0.80 (746)
D3-Social relationships and participation	9. My family, friends or neighbours would help me if needed (+) 10. I would like more companionship or contact with other people (+) 11. I have someone who gives me love and affection (+) 12. I would like more people to enjoy life with (+) 13. I have my children around which is important (+)	0.64 (746)
D4-Independence, control over life, freedom	14. I am healthy enough to have my independence (+) 15. I can please myself what I do (+) 16. The cost of things compared to my pension/income restricts my life (–) 17. I have a lot of control over the important things in my life (+)	0.57 (745)
D5-Home and neighbourhood	18. I feel safe where I live (+) 19. The local shops, services and facilities are good overall (+) 20. I get pleasure from my home (+) 21. I find my neighbourhood friendly (+)	0.51 (745)
D6-Psychological and emotional well-being	22. I take life as it comes and make the best of things (+) 23. I feel lucky compared to most people (+) 24. I tend to look on the bright side (+) 25. If my health limits social/leisure activities, then I will compensate and find something else I can do (+)	0.52 (742)
D7-Financial circumstances	26. I have enough money to pay for household bills (+) 27. I have enough money to pay for household repairs or help needed in the house (+) 28. I can afford to buy what I want to (+) 29. I cannot afford to do things I would enjoy (–)	0.82 (746)
D8-Leisure activities and religion	30. I have social or leisure activities/hobbies that I enjoy doing (+) 31. I try to stay involved with things (+) 32. I do paid or unpaid work or activities that give me a role in life (+) 33. I have responsibilities to others that restrict my social or leisure activities (–) 34. Religion, belief or philosophy is important to my quality of life (+) 35. Cultural/religious events/festivals are important to my quality of life (+)	0.33 (745)

(+) positively worded questions (–) negatively worded questions

Sociodemographic, health characteristics and frailty status of the overall sample and across the QoL tertiles were calculated using frequencies, percentages and medians (interquartile range, IQR) where appropriate. Unadjusted means (standard errors, SEs) of total and raw domain-specific quality of life scores were calculated and compared between the frailty groups using an adjusted Wald test. The maximum possible scores are not constant across the eight domains. Hence, unadjusted standardised domain-specific mean scores were computed as follows: (unadjusted mean score /maximum possible score)*100 [24]. Therefore, the standardised scores have a minimum of 0 and maximum of 100. Unadjusted standardised domain-specific mean scores were plotted on a radar chart by frailty status.

Part I: association between frailty status and overall QoL

As missing data were minimal (2.3%), a complete case analysis was performed. The total QoL score was found to be normally distributed and we therefore used linear regression models to estimate the unadjusted, 'age-and sex-adjusted' and multivariable-adjusted association between frailty status and overall QoL, with total QoL score as the dependent variable. Multivariable models were built by a step-wise addition of covariates to the 'age-and sex-adjusted' models. Variables included in the multivariable model were based a priori on the literature and clinical relevance. The final multivariable-adjusted model was further evaluated for model assumptions. Goodness of fit (R^2 statistic) was reported.

Part II: association between frailty status and domain-specific QoL

We fitted further multivariable linear regression models to explore how the different domains of QoL were associated with frailty and pre-frailty. All models were adjusted for the covariates used in the final multivariable model of the part I analysis.

For parts I and II, we present the results using the estimated difference in means between frailty groups (with the robust group as reference category) and also computed the reduction from the maximum possible score as a percentage as follows: (mean difference in QoL score /maximum possible score)*100.

Results

Data screening and missing values

Of 750 persons approached, 746 participated in the study. We could not determine the frailty status of one participant due to missing data on frailty components. Therefore, that participant was excluded from the analysis. The total QoL score was missing for seven participants as they had missing data for one or more domain-specific scores. Of all covariates, chronic pain and social support score were missing for seven and four participants, respectively.

Sociodemographic, health characteristics and frailty status of the overall sample and by OPQOL-35 score tertiles

The median (IQR) age of the sample was 68 (64:75) years. The sample was 56.7% women and the majority (97.4%) were Sinhalese ethnicity and had lower secondary or above education level (71.3%). The median (IQR) cognitive assessment (MoCA) score of the sample was 20 (15:23). According to the Fried phenotype of frailty, 15.2% (95% CI 12.4%, 18.7%) of study participants were frail, 48.5% (95% CI 43.9%, 53.2%) were pre-frail and 36.2% (95% CI 32.4%, 40.3%) were robust. A higher proportion of men were in the highest QoL tertile compared with women (36.6% and 30.6%, respectively). 82.4% of older adults in the 'poor' social support category were in the lowest QoL tertile (Table 2). The median (IQR) cognitive assessment (MoCA) scores of older adults in the lowest, intermediate and highest QoL tertiles were 16 (12:20), 20 (16:23) and 22 (19:24), respectively. 47.5% of participants in the robust group were in the highest QoL tertile compared with 9.6% of participants in the frail group.

Distribution of total and domain-specific quality of life scores according to frailty status

Figure 1 illustrates the distribution of the total QoL score according to frailty status. The median QoL score decreased across the frailty spectrum. The unadjusted means (SE) of the total QoL score for the robust, pre-frail and frail groups were 139.2 (0.64), 131.8 (1.04) and 119.2 (1.35), respectively (Table 3).

Participants in the frail group had on average a worse total QoL score compared with their pre-frail and robust counterparts (Table 3). According to this unadjusted mean comparison, all domains were associated with frailty except 'social relationships and participation' and 'home and neighbourhood'. Appendix I reports the distribution of domain-specific QoL scores according to frailty status. Figure 2 shows the unadjusted standardised domain-specific mean scores by frailty status.

Part I: association between frailty status and total QoL

Table 4 presents the association between frailty and pre-frailty with the total QoL score in unadjusted, 'age-and sex-adjusted' and five multivariable linear regression models adjusted for different covariates at each stage. In the unadjusted model, the estimated mean difference of the QoL score between the frail and robust groups was -20.0 (95% CI $-23.3, -16.7$) points, an 11.4% reduction from the maximum possible score of the scale (175). However, the mean difference in QoL scores was gradually attenuated with the addition of other covariates that are associated with both frailty and QoL. The final model showed an association of frailty and pre-frailty with total QoL after adjusting for other sociodemographic covariates, multimorbidity, chronic pain, cognitive assessment score and self-perceived vision and hearing ability. The estimated reduction in the total QoL score between the frail and robust groups in the final multivariable model was -12.7 (95% CI $-16.3, -9.0$) points, a 7.3% reduction from the maximum possible score. Similarly, there was a significant association between pre-frailty and total QoL in the final multivariable model. The estimated reduction in the total QoL score between the pre-frail and robust groups was -3.7 (95% CI $-6.4, -1.1$) points, a 2.1% reduction from the maximum possible score. Appendix II presents the full results of each model (model 1 to model 7) reported in Table 4.

Table 2 Sociodemographic, health characteristics and frailty status of the overall sample and by OPQOL-35 score tertiles

Covariate	Unweighted sample % ^a , (n)	Weighted sample (%) ^a	Weighted percentage (%) ^b (OPQOL-35 score tertiles)		
			Lowest	Intermediate	Highest
Sex					
Men	46.8 (349)	43.3	29.1	34.3	36.6
Women	53.2 (396)	56.7	37.7	31.7	30.6
Age category (years)					
60–64	33.3 (248)	35.7	23.1	37.0	39.9
65–69	26.7 (199)	25.3	26.8	37.4	35.8
70–74	13.3 (99)	17.0	44.5	28.2	27.3
75–79	13.4 (100)	11.2	55.5	24.8	19.7
≥ 80	13.3 (99)	10.8	48.1	24.0	27.9
Ethnicity					
Sinhalese	96.9 (722)	97.4	34.0	32.8	33.2
Other	3.1 (23)	2.6	33.2	34.0	32.8
Marital status					
Married/cohabiting	61.3 (457)	59.6	29.1	34.1	36.8
Never-married/widowed/separated/divorced	38.7 (288)	40.4	41.3	31.0	27.7
Living arrangement					
Children/other family	82.7 (616)	82.9	33.1	33.1	33.8
With spouse only	11.3 (84)	10.8	29.0	33.8	37.2
Alone	6.0 (45)	6.3	53.3	28.5	18.2
Social support					
Poor	4.3 (32)	4.3	82.4	15.3	2.3
Moderate	16.7 (124)	16.7	58.1	23.3	18.6
Strong	79.0 (585)	79.0	26.4	35.6	38.0
Education level					
No formal education/primary	28.7 (214)	28.7	48.3	33.2	18.5
Lower secondary	35.2 (262)	35.3	34.3	37.7	28.0
Upper secondary or above	36.1 (269)	36.0	22.1	27.8	50.1
Longest-held occupation					
Never-employed/skill level 1	42.4 (316)	43.8	43.6	32.7	23.7
Skill level 2	39.3 (293)	38.5	31.4	38.0	30.6
Skill level 3 or 4	18.3 (136)	17.7	15.7	22.0	62.3
Perceived financial strain					
Finding it difficult/very difficult	20.4 (152)	20.4	59.4	29.6	11.0
Just about getting by	54.5 (406)	55.0	32.5	37.2	30.3
Living comfortably	25.1 (187)	24.6	16.7	25.7	57.6
Multimorbidity					
No	59.1 (440)	58.6	30.2	30.3	39.5
Yes	40.9 (305)	41.4	39.3	36.5	24.2
Chronic pain					
No	42.4 (313)	41.3	19.0	30.6	50.4
Yes	57.6 (425)	58.7	44.8	34.7	20.5
Self-perceived vision ability					
Poor/fair	50.9 (379)	50.0	44.8	30.2	25.0
Good/very good/excellent	49.1 (366)	50.0	23.2	35.5	41.3
Self-perceived hearing ability					
Poor/fair	34.0 (253)	32.8	42.7	29.3	28.0
Good/very good/excellent	66.0 (492)	67.2	29.7	34.6	35.7
Frailty status					
Robust	35.0 (261)	36.3	11.5	41.0	47.5
Pre-frail	48.7 (363)	48.5	37.7	32.4	29.9
Frail	16.3 (121)	15.2	75.8	14.6	9.6

^aColumn percentages^bRow percentages

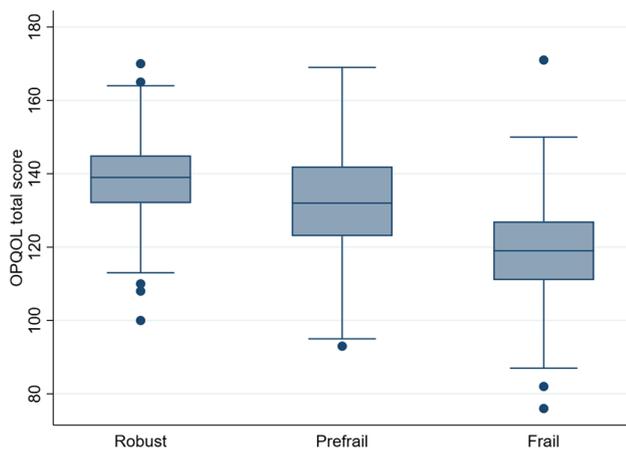


Fig. 1 Distribution of total quality of life score according to frailty status

Part II: association between frailty status and domain-specific quality of life

After adjusting for covariates in the final multivariable model in the main analysis (model 7 in Table 4), the estimated differences in means were lower for the frail group versus robust group in the ‘health’, ‘independence, control over life and freedom’, ‘life overall’, ‘psychological and emotional well-being’ and ‘leisure activities and religion’ domains. Likewise, the estimated differences in means were lower for the pre-frail group versus robust group in the ‘health’, ‘independence, control over life and freedom’ and ‘financial circumstances’ domains (Table 5). Full results can be found in appendix III.

Of five domains associated with frailty, the ‘health’ and ‘independence, control over life and freedom’ domains

appeared to have the largest reduction in sub-scale score. In the multivariable model, the estimated mean difference in the ‘health’ domain score between participants in the frail and robust groups was -5.36 points (27.0% reduction in maximum possible sub-scale score). We performed a sensitivity analysis excluding the question “I have a lot of physical energy” from the ‘health’ domain as it was highly related to the self-reported exhaustion component of the frailty assessment. This did not change the reduction in the health domain sub-scale score.

Discussion

Summary of main findings

The results of this study demonstrate that frailty and pre-frailty were associated with lower quality of life in rural community-dwelling older adults in Kegalle district of Sri Lanka, and this remained after adjustment for a range of covariates. However, while statistically significant in the fully adjusted model, the contribution of frailty and pre-frailty was small (7.3% and 2.1% reduction, respectively, from the maximum possible total score). Of the eight domains of QoL, five domains were associated with frailty and three domains were associated with pre-frailty in rural Sri Lankan older adults.

Comparison with the existing literature

Our findings corroborate the findings of previous studies: frailty and/or pre-frailty were significantly associated with lower QoL or HRQoL compared with robust older adults [6, 11, 14]. However, direct comparisons of our findings with

Table 3 Unadjusted mean comparison of total and raw domain-specific QoL scores according to frailty status

Domain	Weighted mean (SE)			p-value ^a
	Robust	Pre-frail	Frail	
Total OPQOL-35 score (score 35–175)	139.2 (0.64)	131.8 (1.04)	119.2 (1.35)	<0.001
Life overall (score 4–20)	15.2 (0.18)	14.3 (0.12)	12.9 (0.22)	0.007
Health (score 4–20)	15.4 (0.19)	13.1 (0.18)	8.4 (0.29)	<0.001
Social relationships and participation (score 5–25)	21.2 (0.15)	21.1 (0.16)	21.0 (0.26)	0.777
Independence, control over life and freedom (score 4–20)	15.7 (0.12)	14.4 (0.17)	11.4 (0.24)	<0.001
Home and neighbourhood (score 4–20)	16.4 (0.20)	16.1 (0.18)	15.8 (0.21)	0.252
Psychological and emotional well-being (score 4–20)	16.5 (0.12)	16.1 (0.14)	15.1 (0.18)	0.005
Financial circumstances (score 4–20)	13.5 (0.21)	12.1 (0.32)	11.3 (0.42)	0.010
Leisure activities and religion (score 6–30)	25.0 (0.16)	24.5 (0.16)	23.2 (0.33)	0.018

^ap-values for mean difference calculated using Wald tests adjusted for complex sampling design

Fig. 2 Unadjusted standardised domain-specific mean scores by frailty status

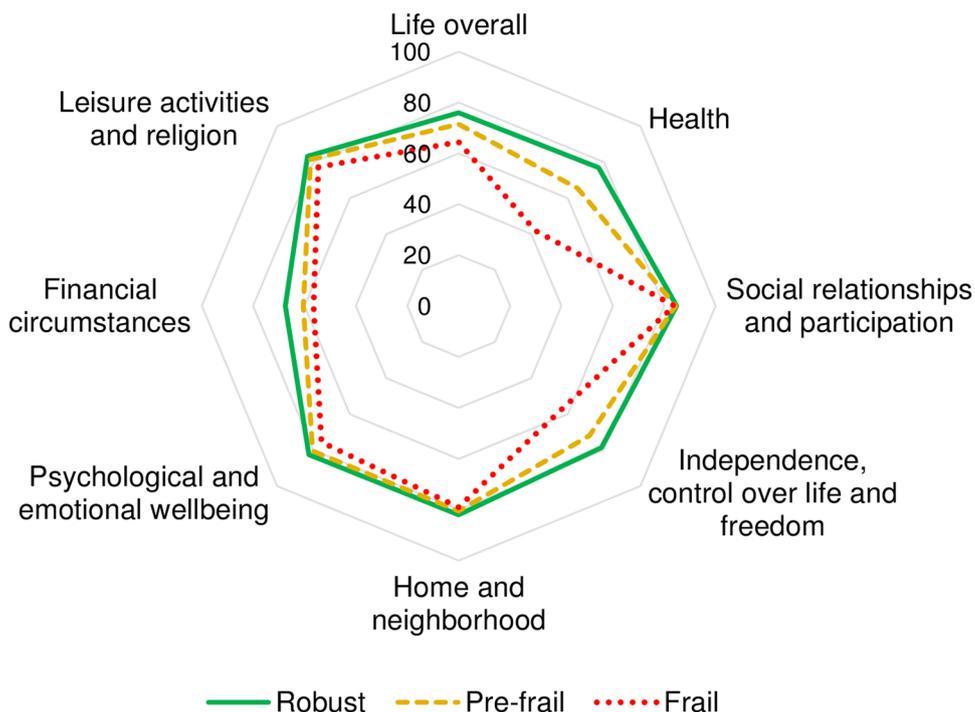


Table 4 Multivariable linear regression models: association between pre-frailty, frailty and total quality of life

Model	Coefficient (95% CI)		R ² (%)
	Pre-frailty	Frailty	
Model 1: Unadjusted	-7.4 (-10.0, -4.8)	-20.0 (-23.3, -16.7)	20.3
Model 2: Model 1 + age and sex	-6.9 (-9.5, -4.4)	-19.8 (-23.3, -16.3)	21.5
Model 3: Model 2 + longest-held occupation	-6.3 (-8.7, -3.9)	-18.0 (-21.9, -14.1)	26.3
Model 4: Model 3 + social support	-5.3 (-7.9, -2.6)	-16.0 (-20.0, -12.1)	33.6
Model 5: Model 4 + multimorbidity, chronic pain	-4.5 (-7.3, -1.8)	-14.5 (-18.1, -10.9)	37.0
Model 6: Model 5 + cognitive assessment score	-3.9 (-6.4, -1.3)	-12.9 (-16.4, -9.5)	39.1
Model 7: model 6 + perceived vision and hearing ability	-3.7 (-6.4, -1.1)	-12.7 (-16.3, -9.0)	39.3

Coefficients represents the estimated difference in QoL score between pre-frailty and robust, and between frailty and robust

Table 5 Domains of quality of life associated with pre-frailty and frailty

Domain of quality of life	Coefficient (95% CI) ^a		R ² (%)
	Pre-frailty	Frailty	
Health	-1.43 (-1.98, -0.88)	-5.36 (-6.19, -4.54)	49.1
Independence, control over life and freedom	-0.64 (-1.15, -0.13)	-2.93 (-3.72, -2.14)	40.1
Financial circumstances	-0.83 (-1.52, -0.13)	-0.96 (-1.95, 0.03)	25.2
Life overall	-0.43 (-0.95, 0.07)	-1.39 (-2.14, -0.63)	20.0
Psychological and emotional well-being	-0.16 (-0.62, 0.28)	-0.97 (-1.56, -0.38)	14.3
Home and neighbourhood	-0.01 (-0.57, 0.54)	-0.17 (-0.86, 0.52)	10.9
Leisure activities and religion	-0.18 (-0.63, 0.27)	-1.09 (-1.99, -0.19)	10.6
Social relationships and participation	0.18 (-0.40, 0.77)	0.38 (-0.42, 1.17)	10.0

Coefficients represent the estimated difference in QoL score between pre-frailty and robust, and between frailty and robust

Significant coefficients are displayed in bold

^aAdjusted for sex, age group, longest-held occupation, social support category, multimorbidity, chronic pain, cognitive assessment (MoCA) score, self-perceived vision ability and self-perceived hearing ability

these studies are not feasible due to the differences in study methodology; mainly the method of assessment of frailty and QoL/HRQoL, study participants and analysis techniques. Previous studies that have estimated the associations between frailty and HRQoL adjusted for several covariates [8–10]. However, we only found one study (conducted by Bilotta and colleagues) that had attempted to estimate the association between frailty and the broader concept of QoL after adjusting for other covariates [14].

In a similar study to ours, Bilotta and colleagues conducted a study with community-dwelling older adults referred to an outpatient geriatric clinic in Milan, Italy [14]. They used the same QoL instrument as used in our study but used a different frailty evaluation method (Study of Osteoporotic Fractures (SOF) criteria). QoL tertiles and respective ranges were lower compared to our study. Findings of the unadjusted analysis reported that of the eight QoL domains, all were associated with frailty except ‘social relationships and participation’ and ‘financial circumstances’. In our unadjusted mean comparison, all the QoL domains were associated with frailty except ‘social relationships and participation’ and ‘home and neighbourhood’. Bilotta and colleagues also constructed a multivariable linear regression model, with OPQOL-35 total as the dependent variable and the following as independent variables: frailty status, age, basic activities of daily living, instrumental activities of daily living, cognitive status (assessed with the Mini-Mental State Examination instrument), depression, comorbidity (assessed by means of the Cumulative Illness Rating Scale), any fall in the past year and number of drugs taken. Frailty (as assessed by SOF criteria) was associated with a lower OPQOL-35 total: -6.4 (95% CI $-10.4, -2.4$) points compared with robust in this multivariable-adjusted model. The R^2 of the model was 32.0%. The estimated mean difference of the QoL score between the frail and robust groups in this study was smaller compared with our study. This can at least be partly explained by the difference in the frailty assessment method used and the different set of covariates included in the final multivariable model.

A study conducted in Mexico reported that the perception of QoL was lower among community-dwelling frail older adults identified with the Fried phenotype compared with pre-frail and non-frail (robust) older adults with both generic HRQoL (SF-36) and specific (WHOQOL-OLD) QoL instruments. The lowest mean scores were observed for the frail group followed by the pre-frail group for the total score and for all the sub domains of both instruments [11].

Strengths and limitations

To the best of our knowledge, this is the first study conducted in the World Health Organization South-East Asia region to assess the association of frailty with quality of

life. We conducted this study with a large representative sample of community-dwelling older adults with a high response rate (99.5%). We used the Fried phenotype frailty assessment method which is used extensively and has been shown to have good predictive validity [1] and we used a quality of life questionnaire specifically designed to assess the overall QoL of older adults (OPQOL-35). However, use of this questionnaire to assess the association of frailty with QoL is still scarce, limiting direct comparisons with studies in other settings. Older age, poor financial situation, poor social support, multimorbidity, chronic pain, cognitive impairment, and hearing and vision impairment are associated with both frailty and lower QoL scores [47–58]. We therefore adjusted our final regression model for all these variables to estimate the independent association of frailty with QoL. We did not include further adjustment for depression and limitations of instrumental and basic activities of daily living as we felt that these factors are potentially on the causal pathway between frailty and QoL. However, the cross-sectional nature of the study design does not allow us to establish temporal relationships or causality.

We did not have access to valid repeated weight measures to calculate unintentional weight loss. Therefore, shrinking was operationalised as having a body mass index (BMI) < 18.5 kg/m². This is often used as a measure for being underweight rather than shrinking/unintentional weight loss and is a different construct to the original proposed by Fried and colleagues [1], though it has been widely used in the literature [59]. Ethnic homogeneity (Sinhalese) and having a sample exclusively drawn from the rural areas limit the generalisability of findings across older adults from other ethnic groups and urban and estate areas in Sri Lanka. The internal consistency for the overall OPQOL-35 questionnaire was estimated as good in our study. However, not all the QoL domains reported satisfactory internal consistency. Values of Cronbach’s alpha (a common measure of internal consistency) are affected by the length of the instrument, for instance, if an instrument has a higher number of items, the alpha values tended to be higher. Low values of alpha could be due to the low number of items, poor inter-relatedness between items, or heterogeneous constructs [60]. Therefore, a comprehensive psychometric evaluation including the structural validity of the OPQOL-35 questionnaire in Sri Lankan context is warranted. Our part II analysis included multiple testing and were performed for exploratory purposes only; therefore our findings should be interpreted with caution.

Implications for health, social services and future research

We found a smaller than expected (though still significant) reduction of QoL associated with frailty. This may be due to

the strong social support systems in Sri Lankan rural society that mitigate the non-health impacts of frailty in older adults. Due to existing strong family support, institutionalised mechanisms for care of the elderly have not been widely established. With the demographic and social transformations happening in the country and the region, sustainability of informal support systems is doubtful. The association between frailty and QoL appears to be largely explained by ‘health’ and ‘independence, control over life and freedom’ domains. Health services for older adults with frailty should consider ways they can maximise independence and life control as well as optimising their health. Further work should explore more in-depth associations between frailty and QoL e.g. how factors such as depression and limitations of instrumental and basic activities of daily living mediate this association.

Conclusions

Frailty was associated with a small but significantly lower quality of life in this rural Sri Lankan population of older adults. This was largely explained by ‘health’ and ‘independence, control over life and freedom’ domains in our sample. Interventions aiming to improve quality of life in frail older adults should consider targeting these aspects.

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Author contributions DDS, KW, MCW and GR conceived and designed the study. DDS and MCW collected the data. DDS and SS analysed the data. DDS drafted the manuscript. KW, MCW, GR and SS critically revised the manuscript.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution or practice at which the study was conducted. The ethical clearance for this study was obtained from two ethics review committees at University College London (Project ID: 8155/001) and Faculty of Medicine, University of Colombo, Sri Lanka (Protocol No. EC-16-071).

Informed consent Informed written consent was obtained from all individual participants included in the study.

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