Family Medicine and Community Health

# Frailty, multimorbidity and quality of life in an ageing population in Africa: a cross-sectional, population-based study in rural and urban Rwanda

Michael Boah ,[1] Callixte Cyuzuzo,[1] Francois Uwinkindi,[2] Chester Kalinda,[1] Tsion Yohannes,[1] Carolyn Greig,[3] Justine Davies,[3] Lisa R Hirschhorn,[4] Alemayehu Amberbir[1]

**To cite:** Boah M, Cyuzuzo C, Uwinkindi F, *et al*. Frailty, multimorbidity and quality of life in an ageing population in Africa: a cross-sectional, population-based study in rural and urban Rwanda. *Fam Med Com Health* 2025;**13**:e003512. doi:10.1136/fmch-2025-003512

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/fmch-2025-003512).

Received 26 June 2025
Accepted 11 September 2025



[1]University of Global Health Equity, Kigali, Rwanda
[2]Ministry of Health, Kigali, Rwanda
[3]University of Birmingham, Birmingham, UK
[4]Northwestern University, Chicago, Illinois, USA

**Correspondence to**
Dr Michael Boah;
mboah@ughe.org

## ABSTRACT

**Objective** As populations age, multimorbidity and frailty have emerged as major health challenges. While their associations with disability and mortality are well documented, their impact on quality of life (QoL) in sub-Saharan Africa remains underexplored. We examined the associations between frailty, multimorbidity and QoL among older adults in Rwanda.

**Design** A cross-sectional population-based study. Multimorbidity was defined as having two or more chronic conditions, including hypertension, diabetes, heart disease and mental health conditions. Frailty scores were derived using the Fried phenotype, and QoL was measured using the European Health Instrument Survey-Quality of Life index (scaled 0%–100%). Sequential linear regression models were used to examine independent associations.

**Setting** Rural and urban settings of Rwanda.

**Participant** We analysed data from 4369 adults (≥40 years).

**Results** The mean QoL score was 48.2% (±15.6). Frailty and multimorbidity prevalence were 14.5% (95% CI 13.5 to 15.6) and 55.2% (95% CI 53.7 to 56.6), respectively, while 55.0% (95% CI 53.3 to 56.3) were classified as prefrail. Frailty and multimorbidity are independently associated with poorer QoL. Compared with robust individuals, prefrail and frail individuals experienced a 3.66 (95% CI −4.63 to −2.70) and 7.30 (95% CI −8.76 to −5.83) percentage point reduction in QoL, respectively. Multimorbidity was associated with a 4.66% (95% CI −5.54 to −3.79) point decrease in QoL. Impairments in activities of daily living partly mediated these associations.

**Conclusions** Frailty and multimorbidity showed a strong negative association with QoL, with frailty having a stronger effect. These findings underscore the need for age-responsive healthcare strategies, including frailty screening and integrated chronic care, to enhance QoL among older adults in Rwanda.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Life expectancy has increased in Rwanda over the past three decades.
⇒ As populations age, the number of individuals with chronic conditions also increases.

### WHAT THIS STUDY ADDS

⇒ Frailty and multimorbidity are highly prevalent in this population and appear earlier than typically expected.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Support a shift towards age-responsive care models that include prevention, early detection and management of frailty and multimorbidity.

## INTRODUCTION

The increase in life expectancy is a global phenomenon, attributable to improvements in social and sanitary conditions, as well as advancements in medicine and technology.[1 2] The global population of individuals aged 65 years and older increased by 9% between 1990 and 2019, reaching 703 million persons.[3] Although this growth in the ageing population is a positive achievement, it is associated with a larger number of individuals living with chronic diseases and age-related conditions, particularly multimorbidity and frailty.[4] Global frailty prevalence among adults varies widely, with populations from low- and middle-income countries (LMICs) demonstrating comparable or sometimes higher rates compared with high-income countries (HICs).[4] By contrast, multimorbidity appears to be less prevalent in LMICs than in HICs, potentially due to differences in disease patterns but also ascertainment bias.[5]

Frailty and multimorbidity are distinct constructs with substantial overlap and a possible bidirectional relationship.[6] Frailty is a clinical syndrome in older adults characterised by decreased physiological reserve and increased vulnerability to stressors, while multimorbidity refers to the presence of two or more chronic conditions.[7] The coexistence

of frailty and multimorbidity increases healthcare needs and raises medical costs.[8] We also know that multimorbidity is a key risk factor for developing frailty in older adults in LMICs.[9] However, recent evidence suggests that the burden and impact of these conditions vary across settings. For example, previous work has shown that frailty in LMICs may be more dynamic and potentially reversible, with a less pronounced relationship to mortality than in HICs.[10]

Similar to global trends, life expectancy in Rwanda has increased over the past three decades, reaching an average of 70 years in 2022, up from 46 years in 1978.[11] This demographic shift has been accompanied by a rise in chronic diseases, contributing to multimorbidity.[12] Given the main focus of health and social care systems in LMICs on maternal and child health, including Rwanda, addressing frailty and multimorbidity among older adults is a growing challenge.[13]

Quality of life (QoL) is a critical patient-reported outcome increasingly recognised as essential to understanding the day-to-day challenges of older adults with frailty and multimorbidity.[14 15] While research in LMICs on frailty and multimorbidity has focused on mortality and clinical outcomes,[10 16 17] examining QoL provides richer insights into the lived experiences of older individuals. Research has shown that older adults often prioritise independence, participation in meaningful activities and maintaining social relationships.[18] However, frailty and multimorbidity can undermine these priorities, contributing to reduced social engagement, functional decline and diminished overall well-being, factors consistently linked to lower QoL.[19 20]

Several plausible pathways may explain how frailty and multimorbidity contribute to poorer QoL. Physically, they are associated with increased symptom burden and limitations in daily functioning. Psychologically, they are associated with mental health conditions, including depression and cognitive decline.[21 22] Socially, they can lead to isolation and loneliness,[22] while economically, the high cost of managing chronic conditions may impose additional strain.[23] These pathways are not mutually exclusive; rather, they interact in a complex manner, compounding the negative impact on overall QoL. Despite the growing recognition of QoL as a critical health indicator, its relationship with frailty and multimorbidity remains underinvestigated in Africa, including Rwanda.

This study aims to examine associations between QoL and frailty and multimorbidity in a Rwandan context. We hypothesise that frailty and multimorbidity are independently associated with lower QoL among Rwandan older adults.

## METHODS

### Study design, setting and population

Rwanda, a small, landlocked country in East Africa, has made significant progress in health and economic development over the past few decades. With a population of over 13 million, the country has a relatively young demographic, but the proportion of older adults is gradually increasing due to improvements in life expectancy and healthcare. This cross-sectional study was conducted across four Rwandan districts: three urban areas within Kigali (Gasabo, Kicukiro and Nyarugenge) and the rural Burera district. It is important to note that, while the study sample is not nationally representative, we designed the study by purposively selecting three urban districts and one rural district to capture urban–rural differences in ageing-related health outcomes rather than to estimate nationally representative prevalence. As a result, the proportion of participants from urban areas is higher than the national average, where approximately 70% of the population resides in rural areas.[11]

We enrolled participants aged 40 years and older, aligning with our previous studies in sub-Saharan Africa (SSA) that showed earlier onset of ageing-related conditions in these populations compared with high-income nations.[10 24] Eligible participants had lived in their respective villages for a minimum of 1 year prior to the study.

We calculated a required sample size using an online sample size calculator, assuming a 7% frailty prevalence rate,[25] 95% confidence level and 5% margin of error. Allowing for 10% non-response, the minimum required sample was 4280. In total, 4369 participants were enrolled, with no dropouts. Sampling used the 2022 Rwanda Population and Housing Census data.[11] First, we selected a total of 127 villages from the four districts, with the number of villages per district proportional to the district's population size. Within each village, we interviewed at least 30 respondents, selecting one eligible respondent per household through random selection when multiple eligible respondents were present.

### Data collection procedures and variable definitions

Data collection was conducted between March and June 2024 using Android tablets and the web-based Research Electronic Data Capture (REDCap) platform. Full details of the study protocol have been described in detail elsewhere.[26] In brief, trained data collectors carried out household interviews in Kinyarwanda, the local language, using a questionnaire adapted from previous studies conducted in SSA.[16 24] Data collectors were supervised by the study investigators throughout the data collection period to ensure adherence to protocols and maintain data quality. The questionnaire captured sociodemographic information, including age, sex, marital status, education and place of residence (urban or rural). Age was categorised as 40–49, 50–59, 60–69 and 70+ years for analysis. Education was classified as no formal education, primary education and secondary or higher. Place of residence was categorised as rural and urban.[11] Additionally, data were collected on household asset ownership, including items such as a television, refrigerator, electricity, watch and mobile phone. Wealth quintiles were derived from household assets using principal component analysis, as outlined by Filmer and Pritchett.[27]

Self-reported medical history (disease status was captured for cancer, HIV, chronic respiratory disease, stroke and heart disease) was based on the question 'Have you ever been told by a doctor or other health worker that you have (disease of interest)?' and physical measurements. Symptoms of mental ill-health were evaluated using three instruments: the Generalised Anxiety Disorder 2-item scale;[28] the Community Screening Instrument for Dementia[29] and the Patient Health Questionnaire.[30]

QoL was measured using the eight-item European Health Instrument Survey-Quality of Life (EUROHIS-QoL) scale, which covers psychological, physical, social and environmental domains of QoL.[31] Each item was rated on a 5-point Likert scale (1=no difficulty to 5=extreme difficulty/unable to perform). Total scores (range: 8–40) were summed up and normalised to a 0%–100% scale, with higher scores representing better QoL. Functional status was assessed through individuals' reported difficulty (none, mild, moderate, severe, extreme or unable to perform the task) in independently performing basic activities of daily living (ADLs), namely dressing, walking, toileting, transferring, bathing and eating.[32] Functional status was classified as no impairment for those who did not have any difficulty performing any of the ADLs and any impairment for those who reported difficulty in performing any of them (≥1 ADL).

Height was measured in metres (m) and weight in kilograms (kg). Body mass index (BMI) was calculated by dividing weight in kilograms by height in metres squared (kg/m$^2$). Blood pressure was measured using an Omron HEM-7322 automatic digital monitor (OMRON Healthcare, Kyoto, Japan) following a 15-min rest period. Three readings were taken from the left arm at 5-min intervals, with the average of the second and third readings used for analyses. Hypertension was defined as systolic blood pressure ≥140 mm Hg diastolic blood pressure ≥90 mmHg, self-reported prior diagnosis or current use of antihypertensive medication.

Frailty scores were derived using the Fried frailty phenotype, which includes five domains of weakness: slow walk speed, unintentional weight loss, exhaustion and low physical activity.[33] These domains were operationalised using previously used thresholds in an African setting and align with those in the original Fried model.[25 33] Handgrip strength was measured with a CAMRY hand dynamometer (CAMRY EH101, Sensun251 Weighing Apparatus Group, Guangdong, China); two measurements were taken per hand, with the highest value used for the current analysis. Low grip strength was defined as the lowest BMI-adjusted quintile by sex. Walking speed was assessed over a 4 m course at a normal pace, with the fastest time converted to metres per second.[34] Slow walk speed was defined as the lowest height-adjusted quintile of walking speed by sex.[10] Weight loss was defined as a self-reported loss of more than 4 kg over the past year. Low physical activity was defined as being in the top 20% of self-reported weekly hours spent sitting or reclining by sex. Self-reported exhaustion was assessed using two items from the Centre for Epidemiologic Studies Depression scale: 'Everything I did in the last week was an effort' and 'I could not get going'[35]; responses indicating applying for ≥3–4 days per week were considered positive. The scores from the five Fried frailty domains were summed, with scores ranging from 0 to 5. Frailty was categorised as non-frail (score=0), prefrail (score=1–2) and frail (score ≥3). Participants with missing data for any of the physical frailty domains were classified as frail, based on previous evidence indicating that individuals with incomplete data tend to have a prognosis comparable to or worse than those classified as frail.[16] Blood glucose was assessed via finger-prick sampling using an Accu-Chek glucose monitor (Roche Diabetes Care, India).[36] Diabetes mellitus was defined as non-fasting glucose >200 mg/dL, fasting glucose >126 mg/dL, self-reported diagnosis or current use of diabetes medication. Multimorbidity was categorised as present or not; participants with fewer than two chronic conditions were classified as not having multimorbidity, while those with two or more conditions were classified as having multimorbidity.

## Outcome and main explanatory variables

Our primary outcome variable was QoL. The two main explanatory variables were frailty and multimorbidity status.

## Statistical analysis

Variables were described as measures of central tendency and spread, depending on distribution. We used four sequential linear regression models to examine the association between frailty, multimorbidity and QoL, adjusting progressively for covariables. First, we examined the association between frailty and QoL adjusting for sociodemographic characteristics (model I). Second, we examined the association between multimorbidity and QoL, adjusting for the same characteristics as in model I (model II). Then we included both frailty and multimorbidity together in the model while adjusting for the same characteristics to assess their independent association with QoL (model III). An interaction analysis was also performed, with frailty and multimorbidity as an interaction term. Finally, we extended our model III by including functional status (ADLs) as a covariable to examine if the relationship between QoL, frailty and multimorbidity is mediated by functional status (model IV).

Sociodemographic characteristics included were age, sex, marital status, level of education, wealth quintiles and place of residence; these have been shown to be associated with QoL in older adults living in LMICs.[24 25 37]

The variance-covariance estimator (vce) robust option in STATA was applied in the multivariable linear regression models to obtain robust standard errors. We assessed multicollinearity between the covariables using the variance inflation factor (VIF) test prior to their inclusion in the model. All analyses were performed using StataNow 18/SE (StataCorp, College Station, Texas, USA),

with a two-tailed p value of <0.05 considered statistically significant.

## Ethical considerations

All study procedures adhered to the ethical principles outlined in the Declaration of Helsinki for research involving human participants.[38] Ethical approval was obtained from the Rwanda National Ethics Committee (reference number: RNEC262/2023), Northwestern University, USA (IRB ID: STU00220814), and the University of Birmingham, UK (IRB ID: ERN-23–0421). Permissions for data collection were obtained from the National Institute of Statistics of Rwanda, district authorities and local village leaders. Participants provided written informed consent, with appropriate support provided for illiterate individuals. Participants who screened positive for hypertension and/or diabetes were referred to health facilities for further evaluation and management, with transportation costs covered by the study team. All data were anonymised prior to analysis to ensure confidentiality.

## Patient and public involvement

Patients and members of the public were not involved in the design, conduct or reporting of this study.

## RESULTS

A total of 4369 individuals were interviewed, with the majority, 1165 (38.1%), aged 40–49 years and 2757 (63.1%) being female. The majority were married or cohabited (64.6%); 610 (13.8%) had completed secondary or higher education. The majority resided in urban areas (80.9%). The demographic characteristics of participants are presented in table 1.

The average QoL score in the sample was 48.2% (±15.6). Online supplemental appendix table 1 provides a detailed distribution of responses across all eight QoL dimensions. Of the 4368 individuals, 54.8% (95% CI 53.3 to 56.3) were classified as prefrail, while 14.5% (95% CI 13.5 to 15.6) were frail, including 207 individuals with incomplete data on one or more physical measurements. Multimorbidity was present in 55.2% of participants (95% CI 53.7 to 56.6). The prevalence of both frailty and multimorbidity increased significantly with age and was higher among females than males. Online supplemental appendix table 2 summarises the distribution of frailty components and chronic conditions.

In bivariable analyses, frailty status and multimorbidity were significantly associated with QoL. Both prefrail and frail were significantly associated with lower QoL. Similarly, individuals with multimorbidity reported poorer QoL. In addition, all background characteristics examined, including age, sex, marital status, wealth and place of residence, were also significantly associated with QoL (online supplemental appendix table 3).

**Table 1** Background characteristics of respondents in the present study

| Variable | Category | Frequency (%) |
|---|---|---|
| Age groups | Mean±SD | 55.6 (±12.2) |
| | 40–49 | 1665 (38.1) |
| | 50–59 | 1176 (26.9) |
| | 60–69 | 865 (19.8) |
| | 70+ | 633 (15.2) |
| Sex | Female | 2757 (63.1) |
| | Male | 1612 (36.9) |
| Marital status | Married/cohabiting | 2822 (64.6) |
| | Single/divorced/ separated/ widowed | 1547 (35.4) |
| Education level | No education | 1767 (40.4) |
| | Primary | 2001 (45.8) |
| | Secondary or higher | 610 (13.8) |
| Wealth quintiles | Poorest | 874 (20.0) |
| | Poorer | 874 (20.0) |
| | Middle | 886 (20.3) |
| | Richer | 867 (219.8) |
| | Richest | 868 (19.9) |
| Place of residence | Rural | 833 (19.1) |
| | Urban | 3536 (80.9) |

We found no evidence of multicollinearity from the VIF test. Multivariable analysis (table 2) showed that QoL declined with increasing age, with a reduction of approximately 6% points among those aged ≥70 years (β=−5.64, 95% CI −7.15 to −4.13). Participants who were single, widowed or separated reported lower QoL compared with those married or cohabiting (β=−1.15, 95% CI −2.19 to −0.11). Higher wealth was positively associated with QoL, whereas urban residence was associated with lower QoL (β=−1.25, 95% CI −2.46 to −0.04). The model explained 14.2% of the variance in QoL ($R^2$ = 0.142).

In model I, which explained 17.8% of the variance in QoL ($R^2$=0.178), frailty status was significantly associated with lower QoL (table 3). Compared with non-frail individuals, prefrail and frail individuals had QoL scores that were 4.57 (95% CI −5.54 to −3.60) and 10.07 (95% CI −11.56 to −8.58) percentage points lower, respectively. Multimorbidity was also significantly associated with reduced QoL, with those affected reporting scores 6.17% points lower than those without (model II: β=−6.17, 95% CI −7.06 to −5.29; $R^2$=0.176). In model III, where frailty and multimorbidity were included concurrently, both remained significantly associated with poorer QoL, though the effect sizes were slightly attenuated compared with when they were included individually (prefrail: β=−3.93; frail: β=−8.77; multimorbidity: β=−5.31). Model III explained about 20.3% of the variance in QoL

**Table 2** Multivariable linear regression analysis of the association between quality of life and sociodemographic characteristics

| | Quality of life | |
|---|---|---|
| **Variable** | **β (95% CI)** | **P value** |
| **Age group (years)** | | |
| 40–49 | Reference | |
| 50–59 | −1.67 (−2.74 to 0.59) | 0.002 |
| 60–69 | −3.18 (−4.44 to 1.92) | <0.001 |
| 70+ | −5.64 (−7.15 to 4.13) | <0.001 |
| **Sex** | | |
| Female | Reference | |
| Male | 0.49 (−0.48 to 1.45) | 0.326 |
| **Marital status** | | |
| Married/ cohabiting | Reference | |
| Single/divorced/ separated/widowed | −1.15 (−2.19 to 0.11) | 0.030 |
| **Education level** | | |
| No education | Reference | |
| Primary | 0.40 (−0.63 to 1.43) | 0.449 |
| Secondary or higher | 0.58 (−0.99 to 2.14) | 0.469 |
| **Wealth quintiles** | | |
| Poorest | Reference | |
| Poorer | 6.14 (4.72 to 7.57) | <0.001 |
| Middle | 7.64 (6.20 to 9.09) | <0.001 |
| Richer | 10.23 (8.68 to 11.78) | <0.001 |
| Richest | 15.54 (13.89 to 17.19) | <0.001 |
| **Residence place** | | |
| Rural | Reference | |
| Urban | −1.25 (−2.46 to 0.04) | 0.043 |

Model statistics: $R^2$=0.142.

($R^2$=0.203). Interaction analysis (see online supplemental appendix table 4) indicated an additive negative effect of coexisting frailty and multimorbidity, reducing QoL by an additional 3.64% points (β=−3.64, 95% CI −6.58 to −0.70, p=0.015; $R^2$=0.204).

The final model (Model IV) further adjusted for impairment in ADLs, which was significantly associated with reduced QoL (β=−7.54, 95% CI −8.90 to −6.17). Controlling for ADL impairment slightly reduced the effect sizes for both frailty and multimorbidity. In this final model, prefrail individuals had QoL scores 3.66% points lower (95% CI −4.63 to −2.70), frail individuals 7.30% points lower (95% CI −8.76 to −5.83) and those with multimorbidity 4.66% points lower (95% CI −5.54 to −3.79), relative to their respective reference groups. The final model explained about 22.7% of the variance in QoL ($R^2$=0.227).

Among other covariables, wealth status and place of residence remained significantly associated with QoL. Higher wealth quintiles were consistently associated with better QoL, with the richest group experiencing the most substantial benefit (model IV: β=14.22, 95% CI 12.65 to 15.79). Living in an urban area was associated with a lower QoL score (β=−1.65, 95% CI −2.79 to −0.51) (table 3).

## DISCUSSION

This study sought to address a critical knowledge gap in the African ageing literature by examining the associations between frailty, multimorbidity and QoL among older adults in Rwanda, using data from a large, population-based study of both rural and urban individuals. To our knowledge, this is the first study in Rwanda to concurrently assess these indicators and their inter-relationships in such a comprehensive manner. Our findings show a high burden of both frailty and multimorbidity among older adults; over half (54.8%) were classified as prefrail, approximately 15% were frail, and multimorbidity was present in 55.2%. These prevalence estimates exceed those reported in some LMICs but remain lower than in others. Studies from South Africa reported frailty rates between 5.5% and 13.2% and a multimorbidity prevalence of nearly 69%.[16 37] In rural Burkina Faso, our previous studies found lower rates, with frailty and multimorbidity affecting 7% and 23% of older adults in the same age range, respectively.[24 25] Consistent with prior studies in Africa, our study also revealed that both frailty and multimorbidity increased with age and were more common among women than men.[16 25]

The observed variability in prevalence of frailty and multimorbidity across studies is, however, unsurprising, given the lack of international consensus on the most appropriate tool for assessing frailty and on which conditions should be included in defining multimorbidity.[39 40] Specifically, the tools and thresholds used, as well as the number and profile of conditions included in multimorbidity definitions, differ widely across studies and geographical settings.[39] These inconsistencies highlight the urgent need for contextually appropriate and standardised measurement frameworks tailored to African populations, where both communicable and non-communicable conditions contribute to the ageing experience.[41] Differences in study populations may also account for some of the variation. For instance, South Africa has a higher HIV prevalence than Rwanda, which may partly explain the higher rates of frailty and chronic conditions observed there, as HIV and its long-term treatment are associated with immune activation, inflammation and accelerated biological ageing.[42] Similarly, the study in rural Burkina Faso focused on a farming population, where high levels of physical activity may have contributed to the lower prevalence of frailty and multimorbidity compared with our findings.[16 25] Despite variations in prevalence rates, the broader picture is clear: they reflect a growing public health challenge posed by ageing and chronic diseases in SSA. The findings may

**Table 3** Sequential multivariable analysis results of the associations between frailty, multimorbidity and quality of life

| | Model I | | Model II | | Model III | | Model IV | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **β (95% CI)** | **P value** | **β (95% CI)** | **P value** | **β (95% CI)** | **P value** | **β (95% CI)** | **P value** |
| Frail status | | | | | | | | |
| Non-frail | Reference | | | | Reference | | Reference | |
| Prefrail | −4.57 (−5.54 to −3.60) | <0.001 | | | −3.93 (−4.90 to −2.96) | <0.001 | −3.66 (−4.63 to −2.70) | <0.001 |
| Frail | −10.07 (−11.56 to −8.58) | <0.001 | | | −8.77 (−10.25 to −7.29) | <0.001 | −7.30 (−8.76 to −5.83) | <0.001 |
| Multimorbidity | | | | | | | | |
| No | | | Reference | | Reference | | Reference | |
| Yes | | | −6.17 (−7.06 to −5.29) | <0.001 | −5.31 (−6.19 to −4.43) | <0.001 | −4.66 (−5.54 to −3.79) | <0.001 |
| Age groups | | | | | | | | |
| 40–49 | Reference | | Reference | | Reference | | Reference | |
| 50–59 | −1.48 (−2.54 to −0.43) | 0.006 | −0.91 (−1.98 to 0.16) | 0.095 | −0.86 (−1.91 to 0.20) | 0.111 | −0.47 (−1.52 to 0.57) | 0.376 |
| 60–69 | −1.89 (−3.13 to −0.64) | 0.003 | −1.60 (−2.85 to −0.35) | 0.012 | −0.70 (−1.95 to 0.54) | 0.266 | 0.14 (−1.08 to 1.37) | 0.818 |
| 70+ | −3.28 (−4.76 to −1.79) | <0.001 | −3.43 (−4.92 to −1.94) | <0.001 | −1.68 (−3.16 to −0.21) | 0.025 | 1.00 (−0.52 to 2.51) | 0.198 |
| Sex | | | | | | | | |
| Female | Reference | | Reference | | Reference | | Reference | |
| Male | −0.49 (−1.46 to 0.47) | 0.315 | −0.06 (−1.01 to 0.90) | 0.907 | −0.83 (−1.78 to 0.12) | 0.086 | −0.88 (−1.82 to 0.05) | 0.064 |
| Marital status | | | | | | | | |
| Married/cohabiting | Reference | | Reference | | Reference | | Reference | |
| Single/divorced/separated/widowed | −0.97 (−1.98 to 0.05) | 0.063 | −0.79 (−1.81 to 0.23) | 0.127 | −0.68 (−1.69 to 0.32) | 0.183 | −0.64 (−1.63 to 0.35) | 0.203 |
| Education level | | | | | | | | |
| No education | Reference | | Reference | | Reference | | Reference | |
| Primary | 0.42 (−0.58 to 1.43) | 0.408 | 0.56 (−0.45 to 1.57) | 0.276 | 0.56 (−0.43 to 1.55) | 0.269 | 0.50 (−0.48 to 1.48) | 0.315 |
| Secondary or higher | 0.77 (−0.78 to 2.32) | 0.329 | 0.73 (−0.81 to 2.26) | 0.345 | 0.87 (−0.65 to 2.40) | 0.262 | 1.04 (−0.45 to 2.54) | 0.171 |
| Wealth quintile | | | | | | | | |
| Poorest | Reference | | Reference | | Reference | | Reference | |
| Poorer | 5.90 (4.52 to 7.28) | <0.001 | 5.78 (4.38 to 7.17) | <0.001 | 5.61 (4.25 to 6.97) | <0.001 | 5.49 (4.15 to 6.83) | <0.001 |
| Middle | 7.18 (5.78 to 8.59) | <0.001 | 7.11 (5.70 to 8.52) | <0.001 | 6.78 (5.41 to 8.16) | <0.001 | 6.44 (5.07 to 7.81) | <0.001 |
| Richer | 9.98 (8.47 to 11.49) | <0.001 | 9.64 (8.11 to 11.17) | <0.001 | 9.50 (8.01 to 10.99) | <0.001 | 9.12 (7.64 to 10.59) | <0.001 |
| Richest | 14.86 (13.23 to 16.48) | <0.001 | 14.86 (13.24 to 16.48) | <0.001 | 14.36 (12.76 to 15.96) | <0.001 | 14.22 (12.65 to 15.79) | <0.001 |
| Residence place | | | | | | | | |
| Rural | Reference | | Reference | | Reference | | Reference | |
| Urban | −2.20 (−3.38 to −1.02) | <0.001 | −0.63 (−1.80 to 0.54) | 0.293 | −1.54 (−2.70 to −0.38) | 0.009 | −1.65 (−2.79 to −0.51) | 0.004 |
| Functional status (ADL) | | | | | | | | |
| No impairment | | | | | | | Reference | |
| Any impairment | | | | | | | −7.54 (−8.90 to −6.17) | <0.001 |

ADLs, activities of daily living.

also reflect gendered disparities in health status in this ageing population.

The average QoL score in our sample of Rwandan adults was somewhat low (48.2%). This figure suggests that many older individuals within this population experience considerable limitations across key dimensions of well-being, such as physical health, psychological status, social relationships and functional independence, aligning with broader patterns observed across LMICs; comparable results have been reported in other SSA contexts, such as Ghana (45.5%) and South Africa (49.5%), where structural and systemic challenges, including gaps in the provision of age-appropriate healthcare and social care services, and the absence of comprehensive long-term care systems, significantly constrain the well-being of older individuals.[43] In rapidly ageing LMICs like Rwanda, promoting healthy ageing requires not just clinical care but also integrated strategies addressing social, economic and environmental factors affecting older adults' well-being.

Both frailty and multimorbidity were independently and significantly associated with lower QoL. The relationship was dose-dependent in the case of frailty: prefrail individuals experienced a modest reduction in QoL, while those classified as frail reported substantially poorer QoL. Our findings reflect similar associations seen in existing literature, including systematic reviews and meta-analyses.[15 44] Multimorbidity also showed a clear negative association with QoL. When both conditions were examined simultaneously, they each retained their independent associations with QoL, although with slightly attenuated effect sizes, indicating that the effect of each on QoL is partly mediated through the other. Moreover, our interaction analysis revealed an additive negative effect of coexisting frailty and multimorbidity; specifically, the coexistence of both conditions led to a further reduction in QoL beyond their individual effects. This finding aligns with prior work showing that although frailty and multimorbidity are distinct constructs, their combination heightens vulnerability to poor health outcomes.[17] As noted earlier, the associations between QoL, frailty and multimorbidity are likely mediated through physical, psychological and social pathways.[22 45]

ADL impairment represents a key dimension of functional health, reflecting an individual's ability to perform basic self-care tasks necessary for independent living.[32] The attenuation of effect of multimorbidity and frailty on QoL following adjustment for ADL impairment suggests that impairments in daily functioning serve as a mediating pathway through which frailty and multimorbidity impact QoL. The results suggest that these conditions may contribute to reduced QoL not only through their direct effects, such as symptom burden, treatment complexity and psychological stress, but also indirectly, by increasing the risk of losing independence in daily functioning.[46] Previous studies have also acknowledged the mediating role of impairment in ADLs in the relationship between frailty, multimorbidity and QoL among older populations.[22 47] This mediating role of ADL impairment highlights the importance of maintaining functional ability in efforts to preserve QoL among older adults. Moreover, ADL limitations themselves had a substantial negative association with QoL, reinforcing the critical importance of functional ability in determining well-being in later life. Therefore, while clinical management of chronic diseases and frailty syndromes remains crucial, interventions that focus on preserving or restoring functional capacity, such as physical rehabilitation and supportive home environments, may be equally important in mitigating the downstream effects of multimorbidity and frailty on overall well-being.[48]

The findings of this study have several important implications for public health policy, clinical practice and health system planning in Rwanda and similar LMICs undergoing demographic and epidemiological transitions. First, the high prevalence of frailty and multimorbidity, particularly among women and the oldest age groups, signals an urgent need to integrate geriatric assessments into routine primary healthcare. Current health systems in many African settings, including Rwanda, are primarily structured around acute and maternal–child health needs, with limited focus on the complex and chronic care demands of ageing populations.[43] A paradigm shift is required towards age-responsive care that proactively identifies individuals at risk of frailty and multimorbidity and supports early intervention. However, preventing these conditions through public health interventions, including physical activity and healthy diets, must remain a priority.

Second, the independent and additive negative effects of frailty and multimorbidity on QoL highlight the necessity of addressing these conditions not only as clinical problems but also as determinants of well-being. Interventions should extend beyond disease management to encompass functional rehabilitation, social support and mental health services, which are important domains of QoL.[19]

Finally, the finding that limitations in ADL partially mediate the relationship between frailty and multimorbidity and QoL underlines the importance of maintaining functional ability as a key objective of healthy ageing strategies. Community-based interventions that promote physical activity, good nutrition and social participation can help delay or mitigate functional decline and, in turn, preserve QoL.[49]

## Strengths and limitations

This study has several strengths, including the purposive selection of districts, which allowed meaningful comparisons of older adults in urban and rural settings. The use of validated tools further strengthens the reliability of the collected data. Additionally, we employed robust statistical techniques, including adjustments for confounding and heteroskedasticity, to ensure the accuracy and validity of our findings for making inferences.

Despite these strengths, there were a number of limitations. Given approximately 70% of Rwanda's population lives in rural areas, the higher proportion of urban participants in our study means the findings are not nationally representative and should not be interpreted as reflecting national prevalence. While the EUROHIS-QoL scale is standardised and intended for cross-cultural use, some items, such as those relating to financial resources ('having enough money to meet needs') or satisfaction with living conditions, may not fully reflect well-being in rural Rwandan settings, where subsistence lifestyles are common. This may introduce cultural bias in the measurement of QoL. However, although formal cross-cultural validation was not conducted, the scale was translated into Kinyarwanda and pretested, which allowed us to identify items that could be misinterpreted and ensure clarity for older adults in both urban and rural contexts. Disease status for some of the conditions, including cancer, chronic liver and kidney conditions and HIV infection, was self-reported, which may introduce bias in reporting. Specifically, it may miss undiagnosed conditions, especially in rural and socioeconomically disadvantaged groups with limited access to diagnostic care. Additionally, our approach combined self-reported diagnoses with objective measurements for elevated blood pressure and diabetes to allow for comparison with existing studies. However, we acknowledge that hypertension and diabetes measurements were based on a single visit (though blood pressure used multiple readings), which may not fully capture usual levels and could lead to misclassification. Furthermore, we acknowledge that we did not capture the full spectrum of chronic conditions affecting older adults. Instead, we prioritised conditions that are frequently reported in multimorbidity studies in LMICs.[50]

Our definition of multimorbidity as a simple count of conditions does not capture the severity or specific combinations of diseases, which may differentially affect frailty and QoL. For example, our previous research in rural Burkina Faso demonstrated that multimorbidity involving mental health conditions, or a combination of mental health and non-communicable diseases, was associated with greater frailty and lower QoL compared with multimorbidity involving only non-communicable diseases.[24] Finally, our study employs a cross-sectional design, which limits our ability to establish causal inferences. Nonetheless, evidence from longitudinal studies from high-income settings highlights causal relationships between these outcomes.[20]

## CONCLUSIONS

Our research revealed that ageing adults in Rwanda experience both significant rates of multimorbidity and a substantial burden of frailty, particularly among older adults and females. Both frailty and multimorbidity were independently associated with lower QoL, with frailty exerting the stronger effect. Our findings provide valuable insights to inform health policy and the development of age-friendly healthcare interventions, both preventative and treatment, tailored to the needs of older adults in Rwanda. Strategies such as frailty screening and prevention and management programmes, integrated chronic disease care and community-based support systems could prove effective in reducing prevalence and mitigating their impacts.

**Contributors** AA, CG, JD and LRH designed the study and led the submission of the grant application. MB, CC and FW contributed to the design of the study, development of data collection tools, planning of the fieldwork and coordination of the study. CG led the data collectors' training. CK and TY participated in study design, data collection procedures and approach to the study. MB drafted the initial version of the manuscript. All authors critically reviewed, provided feedback and approved the final manuscript. MB is responsible for the overall content as guarantor. Language editing assistance was provided using QuillBot, an AI-powered writing tool, which was used solely to improve clarity, grammar and sentence structure. The tool was not used for content generation or analysis.

**Funding** The authors would like to acknowledge the financial support by Robert J. Havey, MD Institute for Global Health's innovation award at Northwestern University, Feinberg School of Medicine, USA (award no: 1001E).

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants. Ethical approval was obtained from the Rwanda National Ethics Committee (RNEC262/2023), Northwestern University (IRB ID: STU00220814) and the University of Birmingham (IRB ID: ERN-23-0421). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article or uploaded as supplementary information.



**ORCID iD**

Michael Boah http://orcid.org/0000-0002-5660-2292

## REFERENCES

1 Gu D, Andreev K, Dupre ME. Major Trends in Population Growth Around the World. *China CDC Wkly* 2021;3:604–13.
2 Johnson LF, May MT, Dorrington RE, *et al*. Estimating the impact of antiretroviral treatment on adult mortality trends in South Africa: A mathematical modelling study. *PLoS Med* 2017;14:e1002468.
3 United nations department of economics and social affairs population division. World Population Ageing; 2019.
4 Majid Z, Welch C, Davies J, *et al*. Global frailty: The role of ethnicity, migration and socioeconomic factors. *Maturitas* 2020;139:33–41.
5 Chowdhury SR, Chandra Das D, Sunna TC, *et al*. Global and regional prevalence of multimorbidity in the adult population in community

settings: a systematic review and meta-analysis. *eClinicalMedicine* 2023;57:101860.
6 Villacampa-Fernández P, Navarro-Pardo E, Tarín JJ, *et al*. Frailty and multimorbidity: Two related yet different concepts. *Maturitas* 2017;95:31–5.
7 Vetrano DL, Palmer K, Marengoni A, *et al*. Frailty and Multimorbidity: A Systematic Review and Meta-analysis. *The Journals of Gerontology* 2019;74:659–66.
8 Zhao L, Chang B, Hu Q, *et al*. The health care needs of multidimensional frail elderly patients with multimorbidity in primary health-care settings: a qualitative study. *BMC Prim Care* 2025;26:128.
9 Luo Y, Chen Y, Wang K, *et al*. Associations between multimorbidity and frailty transitions among older Americans. *J Cachexia Sarcopenia Muscle* 2023;14:1075–82.
10 Goodman-Palmer D, Greig C, Agyapong-Badu S, *et al*. Frailty progression in adults aged 40 years and older in rural Burkina Faso: a longitudinal, population-based study. *The Lancet Healthy Longevity* 2024;5:e493–502.
11 National Institute of Statistics of Rwanda (NISR). The fifth rwanda population and housing census, main indicators report kigali. 2023.
12 Ntaganda E, Mugeni R, Harerimana E, *et al*. High rates of undiagnosed and uncontrolled hypertension upon a screening campaign in rural Rwanda: a cross-sectional study. *BMC Cardiovasc Disord* 2022;22:197.
13 Goodman-Palmer D, Ferriolli E, Gordon AL, *et al*. Health and wellbeing of older people in LMICs: a call for research-informed decision making. *Lancet Glob Health* 2023;11:e191–2.
14 Crocker TF, Brown L, Clegg A, *et al*. Quality of life is substantially worse for community-dwelling older people living with frailty: systematic review and meta-analysis. *Qual Life Res* 2019;28:2041–56.
15 Makovski TT, Schmitz S, Zeegers MP, *et al*. Multimorbidity and quality of life: Systematic literature review and meta-analysis. *Ageing Res Rev* 2019;53:100903.
16 Payne CF, Wade A, Kabudula CW, *et al*. Prevalence and correlates of frailty in an older rural African population: findings from the HAALSI cohort study. *BMC Geriatr* 2017;17:293.
17 Woo J, Leung J. Multi-morbidity, dependency, and frailty singly or in combination have different impact on health outcomes. *Age (Dordr)* 2014;36:923–31.
18 van Leeuwen KM, van Loon MS, van Nes FA, *et al*. What does quality of life mean to older adults? A thematic synthesis. *PLoS One* 2019;14:e0213263.
19 Gobbens RJJ, van Assen MALM. The prediction of quality of life by physical, psychological and social components of frailty in community-dwelling older people. *Qual Life Res* 2014;23:2289–300.
20 Veronese N, Noale M, Cella A, *et al*. Multidimensional frailty and quality of life: data from the English Longitudinal Study of Ageing. *Qual Life Res* 2022;31:2985–93.
21 Sargent L, Nalls M, Starkweather A, *et al*. Shared biological pathways for frailty and cognitive impairment: A systematic review. *Ageing Res Rev* 2018;47:149–58.
22 Sieber S, Roquet A, Lampraki C, *et al*. Multimorbidity and Quality of Life: The Mediating Role of ADL, IADL, Loneliness, and Depressive Symptoms. *Innov Aging* 2023;7:igad047.
23 Chi J, Chen F, Zhang J, *et al*. Impacts of frailty on health care costs among community-dwelling older adults: A meta-analysis of cohort studies. *Arch Gerontol Geriatr* 2021;94:104344.
24 Odland ML, Payne C, Witham MD, *et al*. Epidemiology of multimorbidity in conditions of extreme poverty: a population-based study of older adults in rural Burkina Faso. *BMJ Glob Health* 2020;5:e002096.
25 Witham MD, Davies JI, Bärnighausen T, *et al*. Frailty and physical performance in the context of extreme poverty: a population-based study of older adults in rural Burkina Faso. *Wellcome Open Res* 2019;4:135.
26 Amberbir A, Cyuzuzo C, Boah M, *et al*. Understanding needs and solutions to promote healthy ageing and reduce multimorbidity in Rwanda: a protocol paper for a mixed methods, stepwise research study. *BMJ Open* 2025;15:e089344.
27 Filmer D, Pritchett LH. Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. *Demography* 2001;38:115–32.
28 Hughes AJ, Dunn KM, Chaffee T, *et al*. Diagnostic and Clinical Utility of the GAD-2 for Screening Anxiety Symptoms in Individuals With Multiple Sclerosis. *Arch Phys Med Rehabil* 2018;99:2045–9.
29 Prince M, Acosta D, Ferri CP, *et al*. A brief dementia screener suitable for use by non-specialists in resource poor settings--the cross-cultural derivation and validation of the brief Community Screening Instrument for Dementia. *Int J Geriatr Psychiatry* 2011;26:899–907.
30 Kroenke K, Spitzer RL. The PHQ-9: A New Depression Diagnostic and Severity Measure. *Psychiatr Ann* 2002;32:509–15.
31 Schmidt S, Mühlan H, Power M. The EUROHIS-QOL 8-item index: psychometric results of a cross-cultural field study. *Eur J Public Health* 2006;16:420–8.
32 Katz S. Studies of Illness in the Aged. *JAMA* 1963;185:914.
33 Fried LP, Tangen CM, Walston J, *et al*. Frailty in Older Adults: Evidence for a Phenotype. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 2001;56:M146–57.
34 Guralnik JM, Simonsick EM, Ferrucci L, *et al*. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol* 1994;49:M85–94.
35 Radolff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1977;1:385–401.
36 Sachse D, Bolstad N, Jonsson M, *et al*. The Accu-Chek Mobile blood glucose monitoring system used under controlled conditions meets ISO 15197 standards in the hands of diabetes patients. *Scand J Clin Lab Invest* 2012;72:374–9.
37 Chang AY, Gómez-Olivé FX, Payne C, *et al*. Chronic multimorbidity among older adults in rural South Africa. *BMJ Glob Health* 2019;4:e001386.
38 World Medical Association. World Medical Association Declaration of Helsinki. *JAMA* 2013;310:2191.
39 Ho IS-S, Azcoaga-Lorenzo A, Akbari A, *et al*. Variation in the estimated prevalence of multimorbidity: systematic review and meta-analysis of 193 international studies. *BMJ Open* 2022;12:e057017.
40 Siriwardhana DD, Hardoon S, Rait G, *et al*. Prevalence of frailty and prefrailty among community-dwelling older adults in low-income and middle-income countries: a systematic review and meta-analysis. *BMJ Open* 2018;8:e018195.
41 Kaluvu L, Asogwa OA, Marzà-Florensa A, *et al*. Multimorbidity of communicable and non-communicable diseases in low- and middle-income countries: A systematic review. *Journal of Multimorbidity and Comorbidity* 2022;12:1–14.
42 Blanco J-R, Negredo E, Bernal E, *et al*. Impact of HIV infection on aging and immune status. *Expert Rev Anti Infect Ther* 2021;19:719–31.
43 Cassim B, Tipping B. Healthcare for older people in Africa. *Age Ageing* 2022;51:afac217:1–4:.
44 Kojima G, Iliffe S, Jivraj S, *et al*. Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. *J Epidemiol Community Health* 2016;70:716–21.
45 Ye L, Bally E, Korenhof SA, *et al*. The association between loneliness and frailty among community-dwelling older adults in five European countries: a longitudinal study. *Age Ageing* 2024;53:afae210:1–10:.
46 Liu LH, Kao CC, Wang RH, *et al*. Impacts of multi-morbidity, hemoglobin levels, and frailty on functional disability of older adult residents of long-term care facilities: A structural equation analysis. *Geriatr Gerontol Int* 2021;21:532–7.
47 Hao W, Li J, Fu P, *et al*. Physical frailty and health-related quality of life among Chinese rural older adults: a moderated mediation analysis of physical disability and physical activity. *BMJ Open* 2021;11:e042496.
48 Crocker TF, Ensor J, Lam N, *et al*. Community based complex interventions to sustain independence in older people: systematic review and network meta-analysis. *BMJ* 2024;384:e077764.
49 Cunningham C, O' Sullivan R, Caserotti P, *et al*. Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. *Scandinavian Med Sci Sports* 2020;30:816–27.
50 Abebe F, Schneider M, Asrat B, *et al*. Multimorbidity of chronic non-communicable diseases in low- and middle-income countries: A scoping review. *J Comorb* 2020;10:2235042X2096191.