## RESEARCH PAPER

# Patterns of multimorbidity and their association with hospitalisation: a population-based study of older adults in urban Tanzania

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## Abstract

**Background:** while the HIV epidemic remains a considerable challenge in sub-Saharan Africa, a dramatic reduction in the associated mortality has led to a fundamental shift in the public health priorities aimed at tackling multimorbidity. Against the unprecedented level of urbanisation taking place in Tanzania, the burden of multimorbidity and its consequences among ageing adults, in the form of costly inpatient hospitalisation, remain unquantified.

**Methods:** we used data from one of Africa's largest urban population cohort, the Dar es Salaam Health and the Demographic Surveillance System, to quantity the extent of multimorbidity (occurrence of $2 \geq$ health conditions) and discordant multimorbidity (occurrence of conditions in $2 \geq$ domains in mental health, non-communicable and communicable health) among 2,299 adults aged $\geq 40$ years in Dar es Salaam, Tanzania. We fitted logistic regression models to investigate the association between multimorbidity and inpatient hospitalisation.

**Results:** the prevalence of multimorbidity and discordant multimorbidity were 25.3 and 2.5%, respectively. Although the severe forms of multimorbidity (2.0% with $\geq 4$ health conditions) and discordancy were low, hospitalisation was significantly higher based on the regression analyses. Household food insecurity was the only socio-economic variable that was significantly and consistently associated with a greater hospitalisation.

**Conclusion:** we found an alarmingly high degree of multimorbidity among this ageing urban population where hospitalisation was driven by multimorbidity. As public health resources remain scarce, reducing costly inpatient hospitalisation requires

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multilevel interventions that address clinical- and structural-level challenges (e.g. food insecurity) to mitigate multimorbidity and promote long-term healthy independent living among older adults in Tanzania.

## Key Points

- In urban Tanzania, multimorbidity, defined as two or more health conditions, is present in over 25% of adults aged over 40.
- Increasing morbidities are associated with inpatient hospitalisation.
- Severe forms of multimorbidity (2.0% for ≥4 health challenges) remain rare, but hospitalisation was the highest in this group.
- Household food insecurity was the only socio-economic variable that was independently and consistently associated with hospitalisation.
- Reducing hospitalisation requires a multilevel strategy that addresses social/clinical challenges that fuel multimorbidity.

## Introduction

Access to and the accelerated community scale-up of highly active antiretroviral therapy (ART) efforts turned the tide of new HIV (human immunodeficiency virus) infections and extended life expectancy throughout parts of sub-Saharan Africa (SSA) [1–3]. Tanzania is no exception, with considerable progress having been made toward achieving the 95–95–95 goals (95% of people living with HIV know their HIV status; 95% of people who know their status are on treatment and 95% of people on treatment have suppressed viral loads) to end the HIV epidemic by 2030 [4]. In 1992, the country's national HIV prevalence in urban areas peaked at 12.6% [5], with a recent survey indicating a stabilising of the epidemic (6.0% among ages 15+ group in 2018) [6], where the burden of the disease is highest in both men (8.4%) and women (11.0%) in the 40–44-year-old age group in urban (6.2%) rather than rural areas (4.3%) [6]. Improved life expectancy [1] and transforming what was a fatal disease into a persisting decade-long chronic condition [7] means that the dynamics of the HIV epidemic are changing in Tanzania, placing a greater emphasis on the care of multimorbidity and the co-existence of multiple health conditions [8] that encompass both non-communicable (e.g. hypertension) and communicable health challenges (e.g. HIV and tuberculosis [TB]).

Providing care for chronic multimorbidity conditions is a major challenge that is further exacerbated by unprecedented levels of urbanisation in Tanzania. This is certain to hold important implications for individuals living longer but facing multiple and complex (unmet) needs in the era of an ageing HIV epidemic. According to the Global Burden of Disease Collaborative Network estimate [9], the prevalence of depression was 6.5% [ages 40–44] – 9.2% [ages 80+], heart disease 0.8% [ages 40–44] – 18.9% [ages 80+], diabetes 2.9% [ages 40–44] – 15.6% [ages 80+], and stroke 0.9% [ages 40–44] – 8.2% [ages 80+]

in 2019 respectively. These estimates point to either relative stability or a gradual increase in certain health challenges compared to the prevalence of depression (6.8–9.3%), heart disease (0.7–16.3%), diabetes (1.8–12.7%) and stroke (1.0–7.6%) in 1990, around the time of the start of the HIV epidemic in SSA. Although urbanisation, specifically greater services in large cities, may provide some benefit [10], the effects of sedentary, less nutritious food consumption and stressful lifestyles [11–13], associated with urban living, on chronic diseases should be acknowledged [14]. According to the most recent census data from the National Bureau of Statistics, urbanisation in Tanzania stood at nearly one-third (29.1%) in 2012 [6]. This is a considerable change from the estimated 5.7% [15] in 1967, the year of the Arusha Declaration, which stressed national development toward self-reliance of the economy and social equality/protection [16]. Dar es Salaam, which is the focus on this investigation, is regarded as the fastest growing urban centre in SSA, being likely to reach 'mega-city' status by 2030, with 10 million residents [17].

Our study investigated the extent of multimorbidity and quantified their effect on hospitalisation in older adults (40 years and older) in an urban Tanzania setting. Clinically, inpatient hospitalisation means failure of the community health care system to prevent severe conditions before they occur and reduce potentially preventable hospital readmissions that require specialised care. However, this clinically focused biomedical view of hospitalisation, driven by Western-based gerontology research approaches, overlooks the ethno-cultural aspect of admission. Our investigation is driven by the ethnogerontological perspective [18], which views ageing from a diversity or multi-culturalism perspective. Although the Arusha Declaration [16] and Ujamaa [19] which called for inclusive and community-oriented social development (including protection of older individuals) date back from the 1960s, their spirit remains the cornerstone of modern Tanzania [20,21]. The discussion on

the success or failure of the Ujamaa policy is outside the purview of this investigation, but receiving 'free' government services has historically been a challenge [22]. Despite the provision of 'free' public sector health care for poor and other priority groups (e.g. older adults and people with certain conditions) in Tanzania [23,24], many patients are often required to cover out-of-pocket expenses for services, including that in hospitals, such as medication and tests [25,26]. We argued that hospitalisation signifies the social failure or a broken social compact to protect those who remain vulnerable (although we acknowledge that hospitalisation due to certain elective procedures may not fall under social failure).

While there are notable investigations based on clinical samples [27,28], few large community-based studies have been conducted using comprehensive data on wide-ranging non-communicable and communicable health challenges which drive hospitalisation among older individuals in urban Tanzania. Large-scale demographic and health surveillances systems in SSA have largely focused on HIV epidemic dynamics, particularly on younger adults, given their high risk of HIV acquisition [29]. This study therefore addressed this knowledge gap on older adults by using data from one of Africa's largest urban population-based data in Dar es Salaam, Tanzania, to (i) investigate the extent of multimorbidity in older adults, and (ii) quantify their association with inpatient hospitalisation, with potential implications to identify modifiable factors to reduce hospitalisation and free up resources in resource-constrained health systems.

## Methods

### Data source

This current investigation used de-identified publicly available data from the Dar es Salaam Health and Demographic Surveillance System (HDSS) (also known as the Dar es Salaam Urban Cohort Study), with the details being provided in a separate report [30]. Briefly, this urban surveillance system (hereafter labelled as the Dar es Salaam HDSS) was established in 2011 to generate evidence on health effects arising due to unpreceded levels of urbanisation. This platform is uniquely designed to generate important information that provides evidence for population health interventions through routine data collection and incorporated a nested cross-sectional study (undertaken during 2017–18) that included specific exposures and outcomes that may not be part of routine data collection. This investigation utilised the nested study data that focus on older adults ages 40+ and documents their health challenges, which included mental health (depressive symptomatology), non-communicable (hypercholesterolemia, hypertension, heart diseases, diabetes and stroke) and communicable diseases (HIV and TB).

The Dar es Salaam HDSS covers all residents from selected households in the study area covering seven administrative streets (within Ukonga and Gongo la Mboto wards). Currently (at the time of this report), 110,882 residents from 21,000 registered households had been enumerated in an area of over 9.91 km [2]. All adult study participants were asked to complete a questionnaire via a computer-assisted personal interviewing system. For the nested study, 4,000 men and women were randomly selected from the HDSS sample, with the goal of enrolling 3,000 study participants, with a final sample size of 2,299 being obtained. The nested study was undertaken by the Muhimbili University of Health and Allied Sciences in Tanzania. The study obtained ethical clearance from the Muhimbili University of Health and Allied Sciences (2017-04-28/AEC/Vol.XII/83) and the use of the dataset was approved by the University of KwaZulu-Natal Biomedical Research Ethics Committee, South Africa (BE559/18).

## Measures

### Outcome

Our main study outcome was inpatient hospital admission (hereafter labelled as hospitalisation), the information being based on study participants, indicating if they were admitted to a health facility in the past 12 months.

### Depression

The information on depression was based on the 10-item abridged version of the Center for Epidemiologic Studies Depression Scale (CES-D) that captures self-reported depression-associated symptoms during the past week. Each of the items has four possible responses in a Likert format, ranging from $0 =$ rarely/none of the time (less than 1 day) to $3 =$ almost/all of the time (5–7 days). Depression symptomatology is based on a composite score of the 10 items (Cronbach's $\alpha = 0.84$), with a greater score indicating a higher risk for the disorder. Consistent with a previous study [31,32], we dichotomized the composite score, where a total score $\geq 10$ represented significant depressive symptoms (hereafter labelled as depression). The CES-D is a screening instrument and does not confer actual clinical diagnosis for depression.

### Non-communicable diseases

The lifetime non-communicable health challenges, based on self-report, consist of hypercholesterolemia, hypertension, heart disease, diabetes and stroke. The participants were considered positive for non-communicable disease (NCD+) when they self-reported to have any of the five abovementioned health challenge. Although mental health is non-communicable in nature, it is treated as one of the major groups of non-communicable diseases, consistent with other studies [33,34].

### Communicable diseases

While the lifetime communicable disease health challenges consist of HIV and TB, due to the lack of biomarkers, we relied on self-report measures. The participants were

regarded as having had a communicable disease when self-reported to either condition.

## Operationalization of multimorbidity (including discordant multimorbidity)

The total number of health conditions [encompassing (i) depression, (ii) hypercholesterolemia, (iii) hypertension, (iv) heart disease, (v) diabetes, (vi) stroke, (vii) HIV and (viii) TB] were summed, with a possible range from 0 to 8, with multimorbidity being defined as having two or more health challenges. These eight health challenges were assigned to one of the three discordant health multimorbidity domains: mental health, non-communicable and communicable. The total number of challenges across the domains was summed, with a possible range from 0 to 3, with discordant multimorbidity (referred to as discordancy) being defined as having challenges in two or more health domains.

## Household food insecurity and other socio-demographic covariates

We used the three-item Household Hunger Scale (HHS) [35], which was specifically developed and validated for cross-cultural use to measure household hunger experienced within the past year (observed Cronbach's $\alpha = 0.94$). The participants were asked three questions: (i) how often was there no food at all in your household because you lacked money to purchase more, (ii) how often did you or any household members go to sleep at night hungry because there was not enough food and (iii) how often did you or any household members go for a whole day without eating anything because there was not enough food. Response option ranged from 1 = never, 2 = rarely (once or twice), 3 = sometimes (3–10 times), to 4 = often (more than 10 times). As recommended, we recoded 0 (to include never), 1 (rarely/sometimes) and 2 (often). We then summed to calculate the HHS score (where the possible range is from 0 to 6), with a greater score indicating increased household food insecurity. As per scoring guideline [35], we utilised a household food insecurity category, where 0–1 = little-to-no hunger in the household, 2–3 = moderate hunger in the household and 4–6 = severe hunger in the household within 12 months. For our analyses, household food insecurity was dichotomized into 0 = no-to-moderate hunger and 1 = severe hunger. Other study covariates included sex, age, marital status and education.

## Statistical analysis

Four overarching analyses were undertaken to investigate the extent of multimorbidity in older adults and to quantify its effect of hospitalisation. First, we summarised the participants' socio-demographic and clinical characteristics using descriptive analysis. Second, we assessed the relationship between health challenges using a Venn diagram and tetra-choric correlation matrix. Third, we investigated the socio-demographic correlates of multimorbidity. Lastly, bivariate

analysis using Chi-square statistics and multivariable logistic regressions model were fitted to investigate the socio-demographic covariates and clinical challenges (eight health conditions as well as multimorbidity) related to hospitalisation. All analyses were conducted using STATA 16.

## Results

### Socio-demographic and clinical characteristics

The socio-demographic and clinical characteristics of the 2,299 sampled adults ages 40+ are presented in Table 1. Most participants were female ($n = 1,555, 67.6\%$), currently married ($n = 1,596, 70.7\%$), with the mean age being 53 years (SD = 11.06). Approximately two-thirds of the study participants had attained primary-level education ($n = 1,394, 61.8\%$), with 6.8% of those aged 70+ (oldest age group in our study) reporting to achieving high school or above. Approximately 13% of participants had experienced severe household food insecurity within the last 12 months from the time of interview ($n = 302$).

Regarding the clinical characteristics, 8.3% ($n = 186$) had experienced hospitalisation within the last 12 months before the interview. Approximately a third ($n = 708, 31.6\%$) had or exceeded depression symptomatology $\geq 10$ in CES-D. Their past chronic conditions varied, with 31.9% ($n = 713$) having hypertension, 6.9% ($n = 81$) diabetes, 5.2% ($n = 113$) HIV and 10.5% ($n = 235$) TB, and approximately a quarter ($n = 570, 25.3\%$) being classified as multimorbidity overall. We did not detect significant difference in primary outcome (i.e. hospital admission) by gender.

### Correlation between health challenges

The proportions of and overlap between people with mental health, non-communicable and communicable health challenges are depicted in the Venn diagram (Supplementary Figure S1, Supplementary data are available in *Age and Ageing* online), with approximately 3% having experienced all three. Although we observed the greatest overlap between depression and non-communicable diseases as a whole ($n = 298$, 14%), approximately 44 and 38% of study participants with HIV and/or TB had non-communicable diseases and depression challenges, respectively. The results of the correlation matrix of health conditions are provided in Table 2. To highlight four major results, the largest correlation between health challenges were hypertension and heart disease (tetrachoric rho = 0.49). Second, we also detected a large correlation between depression and food insecurity (tetrachoric rho = 0.44), speaking to the importance of socio-economic status. Third, nearly all health conditions were significantly associated with hospitalisation. Lastly, we detected greater number of significant correlations being more frequent within discordant groups, particularly among non-communicable health challenges.

**Table 1.** Socio-demographic characteristics ($N = 2,299$)

| | Overall | | Female | | Male | | Statistics |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **Sex** | | | | | | | |
| Male | 744 | 32.4 | | | | | |
| Female | 1,555 | 67.6 | | | | | |
| **Age categories (years)** | | | | | | | $\chi^2(3) = 57.58, P < 0.01$ |
| 40–49 | 1,108 | 48.2 | 822 | 52.9 | 286 | 38.4 | |
| 50–59 | 615 | 26.8 | 410 | 26.4 | 205 | 27.6 | |
| 60–69 | 379 | 16.5 | 216 | 13.9 | 163 | 21.9 | |
| 70+ | 197 | 8.6 | 107 | 6.9 | 90 | 12.1 | |
| **Marital status** | | | | | | | $\chi^2(2) = 146.09, P < 0.01$ |
| Never married | 70 | 3.1 | 58 | 3.8 | 12 | 1.7 | |
| Currently married | 1,596 | 70.7 | 963 | 62.8 | 633 | 87.6 | |
| Separated/divorced/widowed | 591 | 26.2 | 513 | 33.4 | 78 | 10.8 | |
| **Highest educational attainment** | | | | | | | $\chi^2(2) = 92.67, P < 0.01$ |
| None | 357 | 15.8 | 304 | 19.8 | 53 | 7.3 | |
| Primary | 1,394 | 61.8 | 955 | 62.3 | 439 | 60.7 | |
| High school and above | 504 | 22.4 | 273 | 17.8 | 231 | 32.0 | |
| **Household food insecurity** | | | | | | | $\chi^2(2) = 15.65, P < 0.01$ |
| Little-to-no household hunger | 1,171 | 51.8 | 757 | 49.3 | 414 | 57.1 | |
| Moderate household hunger | 787 | 34.8 | 549 | 35.8 | 238 | 32.8 | |
| Severe household hunger | 302 | 13.4 | 229 | 14.9 | 73 | 10.1 | |
| **Hospital admission** | | | | | | | $\chi^2(1) = 3.12, P = 0.08$ |
| Yes | 186 | 8.3 | 137 | 9.0 | 49 | 6.8 | |
| **Mental health** | | | | | | | $\chi^2(1) = 1.82, P = 0.18$ |
| Depression | 708 | 31.6 | 495 | 32.5 | 213 | 29.7 | |
| **Non-communicable diseases** | | | | | | | |
| Hypercholesterolemia | 112 | 5.0 | 86 | 5.7 | 26 | 3.6 | $\chi^2(1) = 4.18, P = 0.04$ |
| Hypertension | 713 | 31.9 | 531 | 35.0 | 182 | 25.3 | $\chi^2(1) = 21.09, P < 0.01$ |
| Heart disease | 100 | 4.5 | 82 | 5.4 | 18 | 2.5 | $\chi^2(1) = 9.46, P < 0.01$ |
| Diabetes | 154 | 6.9 | 92 | 6.0 | 62 | 8.6 | $\chi^2(1) = 5.13, P = 0.02$ |
| Stroke | 37 | 1.6 | 22 | 1.4 | 15 | 2.1 | $\chi^2(1) = 1.26, P = 0.26$ |
| **Communicable diseases** | | | | | | | |
| HIV | 113 | 5.2 | 100 | 6.7 | 13 | 1.9 | $\chi^2(1) = 21.98, P < 0.01$ |
| TB | 235 | 10.5 | 152 | 10.0 | 83 | 11.5 | $\chi^2(1) = 1.28, P = 0.26$ |
| **Multimorbidity** | | | | | | | $\chi^2(3) = 18.21, P < 0.01$ |
| 2 Health challenges | 385 | 17.1 | 293 | 19.2 | 92 | 12.7 | |
| 3 Health challenges | 140 | 6.2 | 100 | 6.5 | 40 | 5.5 | |
| ≥4 Health challenges | 45 | 2.0 | 34 | 2.2 | 11 | 1.5 | |
| **Discordant multimorbidity** | | | | | | | $\chi^2(2) = 12.71, P < 0.01$ |
| Health challenge in 2 domains | 384 | 17.1 | 289 | 18.9 | 95 | 13.2 | |
| Health challenge in 3 domains | 56 | 2.5 | 41 | 2.7 | 15 | 2.1 | |

The prevalence of hypertension is 37% based on subsample of 2,174 community-dwelling adults as reported by Zack and colleagues [68]. Degrees of freedom in indicated in round bracket due to space limitation.

**Table 2**. Correlational matrix of health challenges

| | Hospitalisation | Food insecurity | Depression | Hypercholesterolemia | Hypertension | Heart disease | Diabetes | Stroke | HIV | TB |
|---|---|---|---|---|---|---|---|---|---|---|
| Hospitalisation | 1 | | | | | | | | | |
| Food insecurity | 0.17 | 1 | | | | | | | | |
| Depression | 0.16 | 0.44 | 1 | | | | | | | |
| Hypercholesterolemia | | | | 1 | | | | | | |
| Hypertension | 0.30 | | 0.11 | 0.42 | 1 | | | | | |
| Heart disease | 0.34 | | 0.15 | 0.32 | 0.49 | 1 | | | | |
| Diabetes | 0.29 | | | 0.27 | 0.40 | 0.21 | 1 | | | |
| Stroke | | | 0.33 | 0.29 | 0.28 | 0.31 | | 1 | | |
| HIV | 0.22 | 0.17 | | | | | | 0.23 | 1 | |
| TB | 0.19 | | 0.14 | | | 0.17 | | | 0.40 | 1 |

The above values indicate observed correlation coefficients. Correlation with $P > 0.05$ are not displayed for better pattern recognition.

### Socio-demographic correlates of multimorbidity

Bivariate analysis detected several significant associations between socio-demographic characteristics and multimorbidity (Table 3). We found older age, female, currently separated, including divorced/widowed, and severe household hunger to be associated with the greater likelihood of multimorbidity. Similar results were found between socio-demographic characteristics and discordant multimorbidity. The prevalence of multimorbidity and discordant multimorbidity by sex–age group is depicted in Supplementary Figure S2 (Supplementary data are available in *Age and Ageing* online), and it indicates a gender disparity, being significantly higher in women than men in certain age groups (i.e. 40–49 and 50–59).

### Socio-demographic and clinical correlates of hospitalisation

With the exception of stroke, all other seven health conditions, including multimorbidity and discordant multimorbidity, were significantly associated with the likelihood of hospitalisation (Table 4). In terms of socio-economic status, we detected significant associations between hospitalisation and age, marital status and household food insecurity, but not with sex or educational attainment. Lastly, we found that the percentage of study participants with extreme forms of multimorbidity (2.0%) and discordant multimorbidity (2.5%) were small, as mentioned previously, and accounted for 9.1 and 7.6% of all hospitalisation, respectively.

The multivariable logistic regression (Model 1a, Table 5) indicated that the odds of hospitalisation were higher among individuals with hypertension (adjusted odds ratio [aOR] = 1.92, 95% CI: 1.37–2.70), heart disease (aOR = 2.69, 95% CI: 1.57–4.58), diabetes (aOR = 2.25, 95% CI: 1.39–3.62), HIV (aOR = 1.87, 95% CI: 1.05–3.32) and TB (aOR = 1.73, 95% CI: 1.12–2.67). We also fitted two additional multivariable logistic regressions, which indicated that multimorbidity (Model 1b) and discordant multimorbidity (Model 1c) were significantly associated with greater odds of hospitalisation. Household food insecurity was the only socio-economic variable that was significantly associated with a greater odd of hospitalisation across Models 1a–1c.

## Discussion

Based on a large urban community sample in Tanzania, this study investigated the extent of multimorbidity in older adults and quantified their association with hospitalisation, which fielded four significant findings. First, the extent of multimorbidity was found to be modest (~25%). Second, the severe forms of multimorbidity and discordant multimorbidity remained relatively low, but they were significantly associated with the greater likelihood of hospitalisation. Third, we found that approximately 40% of the participants with HIV and/or TB had non-communicable diseases and depression challenges, respectively. Lastly, we found food insecurity to be the only socio-demographic variable that was consistently and independently associated with the likelihood of hospitalisation, attesting to the importance of social conditions. This association among older adults is well established [36–39], with our finding being consistent with studies in which individuals with greater co-occurring chronic conditions may represent a small proportion of the patient population, but nonetheless account for a substantial proportion of health care utilisation due to their complex needs [40–43] (e.g. emergency department, inpatient or other high-cost services). Multiple morbidities across disease domains (i.e. discordant multimorbidity) are particularly clinically complex and often require specialist treatment that is beyond the scope of an outpatient clinic [44].

Multimorbidity remains an under-investigated topic in resource-limited settings [45], thus making comparison difficult, with similar findings in the older adults to a recent large-scale study using the Nouna HDSS in Burkina Faso [46] (hereafter labelled as the Nouna HDSS study). Approximately, one quarter of our study participants (25.3%), compared to 22.8% in the Nouna HDSS study, were classified with multimorbidity. While the extent of non-communicable diseases is very similar, the distribution of health challenges diverges for communicable diseases and mental health, which can be explained by two reasons. First,

**Table 3.** Socio-demographic correlates of multimorbidity

| | No health challenge | | Mono-health challenge | | Any multimorbidity (2 or more health challenges) | | Test statistics | | | None | | Mono-health domain challenge | | Any discordant multimorbidity (challenge in two or more health domains) | | Test statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Row % | n | Row % | n | Row % | $\chi^2$ | df | P | n | Row % | n | Row % | n | Row % | $\chi^2$ | df | P |
| **Sex** | | | | | | | | | | | | | | | | | | |
| Male | 315 | 43.6 | 264 | 36.6 | 143 | 19.8 | 18.3 | 2 | <0.01 | 315 | 43.6 | 297 | 41.1 | 110 | 15.2 | 15.1 | 2 | <0.01 |
| Female | 570 | 37.3 | 531 | 34.8 | 427 | 27.9 | | | | 570 | 37.3 | 628 | 41.1 | 330 | 21.6 | | | |
| **Age category** | | | | | | | | | | | | | | | | | | |
| 40–49 | 493 | 45.5 | 385 | 35.5 | 206 | 19.0 | 61.7 | 6 | <0.01 | 493 | 45.5 | 416 | 38.4 | 175 | 16.1 | 48.3 | 6 | <0.01 |
| 50–59 | 221 | 36.4 | 204 | 33.6 | 182 | 30.0 | | | | 221 | 36.4 | 250 | 41.2 | 136 | 22.4 | | | |
| 60–69 | 119 | 32.2 | 140 | 37.9 | 110 | 29.8 | | | | 119 | 32.2 | 177 | 48.0 | 73 | 19.8 | | | |
| 70+ | 52 | 27.4 | 66 | 34.7 | 72 | 37.9 | | | | 52 | 27.4 | 82 | 43.2 | 56 | 29.5 | | | |
| **Marital status** | | | | | | | | | | | | | | | | | | |
| Never married | 23 | 32.9 | 30 | 42.9 | 17 | 24.3 | 40.0 | 4 | <0.01 | 23 | 32.9 | 34 | 48.6 | 13 | 18.6 | 41.8 | 4 | <0.01 |
| Currently married | 685 | 43.0 | 550 | 34.5 | 358 | 22.5 | | | | 685 | 43.0 | 638 | 40.1 | 270 | 16.9 | | | |
| Separated/divorced/widowed | 177 | 30.2 | 215 | 36.6 | 195 | 33.2 | | | | 177 | 30.2 | 253 | 43.1 | 157 | 26.7 | | | |
| **Education** | | | | | | | | | | | | | | | | | | |
| Less than high school | 191 | 35.8 | 200 | 37.5 | 143 | 26.8 | 3.7 | 2 | 0.16 | 191 | 35.8 | 222 | 41.6 | 121 | 22.7 | 5.7 | 2 | 0.06 |
| High school and above | 693 | 40.4 | 595 | 34.7 | 427 | 24.9 | | | | 693 | 40.4 | 703 | 41.0 | 319 | 18.6 | | | |
| **Household food insecurity** | | | | | | | | | | | | | | | | | | |
| No-to-moderate household hunger | 818 | 42.0 | 666 | 34.2 | 464 | 23.8 | 44.6 | 2 | <0.01 | 818 | 42.0 | 790 | 40.6 | 340 | 17.5 | 60.0 | 2 | <0.01 |
| Severe household hunger | 67 | 22.2 | 129 | 42.7 | 106 | 35.1 | | | | 67 | 22.2 | 135 | 44.7 | 100 | 33.1 | | | |

**Table 4.** Socio-demographic and clinical correlates of hospitalisation

| | Hospitalisation | | | | Test statistics | | |
|---|---|---|---|---|---|---|---|
| | No (n) | No (Row %) | Yes (n) | Yes (Row %) | df | $\chi^2$ | P |
| **Sex** | | | | | 1 | 3.12 | 0.08 |
| Male | 674 | 93.2 | 49 | 6.8 | | | |
| Female | 1,390 | 91.0 | 137 | 9.0 | | | |
| **Age categories** | | | | | 3 | 10.2 | 0.02 |
| 40–49 | 1,012 | 93.4 | 72 | 6.6 | | | |
| 50–59 | 547 | 90.3 | 59 | 9.7 | | | |
| 60–69 | 338 | 91.6 | 31 | 8.4 | | | |
| 70+ | 167 | 87.4 | 24 | 12.6 | | | |
| **Marital status** | | | | | 2 | 9.9 | 0.01 |
| Never married | 63 | 90.0 | 7 | 10.0 | | | |
| Currently married | 1,479 | 92.9 | 113 | 7.1 | | | |
| Separated/divorced/widowed | 522 | 88.8 | 66 | 11.2 | | | |
| **Highest educational attainment** | | | | | 1 | 1.5 | 0.47 |
| Less than high school | 321 | 90.2 | 35 | 9.8 | | | |
| High school and above | 166 | 92.7 | 13 | 7.3 | | | |
| **Household food insecurity** | | | | | 1 | 9.9 | <0.01 |
| No-to-moderate household hunger | 1,801 | 92.5 | 147 | 7.5 | | | |
| Severe household hunger | 263 | 87.1 | 39 | 12.9 | | | |
| **Depression** | | | | | 1 | 9.93 | <0.01 |
| No-to-moderate depressive symptomatology | 1,425 | 93.1 | 105 | 6.9 | | | |
| Severe depressive symptomatology | 629 | 88.8 | 79 | 11.2 | | | |
| **Hypercholesterolemia** | | | | | 1 | 4.1 | 0.04 |
| Hypercholesterolemia− | 1,953 | 92.0 | 170 | 8.0 | | | |
| Hypercholesterolemia+ | 97 | 86.6 | 15 | 13.4 | | | |
| **Hypertension** | | | | | 1 | 42.2 | <0.01 |
| Hypertension− | 1,433 | 94.3 | 86 | 5.7 | | | |
| Hypertension+ | 613 | 86.2 | 98 | 13.8 | | | |
| **Heart disease** | | | | | 1 | 34.2 | <0.01 |
| Heart disease− | 1,978 | 92.5 | 161 | 7.5 | | | |
| Heart disease+ | 76 | 76 | 24 | 24 | | | |
| **Diabetes** | | | | | 1 | 28.1 | <0.01 |
| Diabetes− | 1,928 | 92.6 | 153 | 7.4 | | | |
| Diabetes+ | 124 | 80.5 | 30 | 19.5 | | | |
| **Stroke** | | | | | 1 | 0.34 | 0.56 |
| Stroke− | 2,024 | 91.8 | 180 | 8.2 | | | |
| Stroke+ | 33 | 89.2 | 4 | 10.8 | | | |
| **HIV** | | | | | 1 | 11.9 | <0.01 |
| HIV− | 1,889 | 92.2 | 159 | 7.8 | | | |
| HIV+ | 93 | 83.0 | 19 | 17.0 | | | |
| **TB** | | | | | 1 | 12.3 | <0.01 |
| TB− | 1,856 | 92.5 | 150 | 7.5 | | | |
| TB+ | 201 | 85.9 | 33 | 14.1 | | | |
| **Multimorbidity** | | | | | 3 | 95.7 | <0.01 |
| None/Mono-health challenge | 1,585 | 94.5 | 93 | 5.5 | | | |
| 2 health challenges | 333 | 86.7 | 51 | 13.3 | | | |
| 3 health challenges | 116 | 82.9 | 24 | 17.1 | | | |
| ≥4 health challenges | 28 | 62.2 | 17 | 37.8 | | | |
| **Discordant multimorbidity** | | | | | 2 | 59.1 | <0.01 |
| None/mono-health challenge | 1,696 | 93.9 | 111 | 6.1 | | | |
| Health challenge in 2 domains | 324 | 84.4 | 60 | 15.6 | | | |
| Health challenge in 3 domains | 42 | 75.0 | 14 | 25.0 | | | |

**Table 5.** Socio-demographic and clinical correlates of hospitalisation using logistic regression models

| | Bivariate | Model 1a | | | Model 1b | | | Model 1c | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OR | aOR | SE | 95% CI | aOR | SE | 95% CI | aOR | SE | 95% CI |
| Sex: [Male] | | | | | | | | | | |
| Female | 1.36 | 1.12 | 0.22 | 0.75  1.66 | 1.19 | 0.23 | 0.81  1.75 | 1.24 | 0.24 | 0.85  1.81 |
| Age categories: [40–49] | | | | | | | | | | |
| 50–59 | 1.52* | 1.37 | 0.27 | 0.93  2.02 | 1.34 | 0.26 | 0.92  1.96 | 1.45 | 0.27 | 1.01  2.11 |
| 60–69 | 1.29 | 1.18 | 0.3 | 0.72  1.94 | 1.2 | 0.29 | 0.74  1.92 | 1.3 | 0.31 | 0.82  2.09 |
| 70+ | 2.02** | 1.59 | 0.52 | 0.85  3.00 | 1.76 | 0.52 | 0.98  3.16 | 1.99 | 0.59 | 1.12  3.55 |
| Marital status: [Currently married] | | | | | | | | | | |
| Never married | 1.45 | 1.61 | 0.71 | 0.68  3.80 | 1.43 | 0.61 | 0.62  3.28 | 1.44 | 0.61 | 0.63  3.28 |
| Separated/divorced/widowed | 1.65** | 1.26 | 0.24 | 0.86  1.84 | 1.24 | 0.23 | 0.86  1.78 | 1.27 | 0.23 | 0.83  1.85 |
| Highest educational attainment: [Less than high school] | | | | | | | | | | |
| High school and above | 0.88 | 1.25 | 0.27 | 0.82  1.91 | 1.16 | 0.24 | 0.77  1.73 | 1.24 | 0.25 | 0.83  1.85 |
| Household food insecurity: [No-to-moderate household hunger] | | | | | | | | | | |
| Severe household hunger | 1.82** | 1.62 | 0.35 | 1.06  2.49 | 1.58 | 0.32 | 1.06  2.36 | 1.54 | 0.31 | 1.04  2.28 |
| Depression: [No-to-moderate depressive symptomatology] | | | | | | | | | | |
| Severe depressive symptomatology | 1.70** | 1.38 | 0.24 | 0.98  1.93 | | | | | | |
| Hypercholesterolemia: [Hypercholesterolemia−] | | | | | | | | | | |
| Hypercholesterolemia | 1.78* | 1.12 | 0.35 | 0.61  2.06 | | | | | | |
| Hypertension: [Hypertension−] | | | | | | | | | | |
| Hypertension+ | 2.66** | 1.92 | 0.33 | 1.37  2.70 | | | | | | |
| Heart disease: [Heart disease−] | | | | | | | | | | |
| Heart disease+ | 3.88** | 2.69 | 0.73 | 1.57  4.58 | | | | | | |
| Diabetes: [Diabetes−] | | | | | | | | | | |
| Diabetes+ | 3.05** | 2.25 | 0.55 | 1.39  3.62 | | | | | | |
| Stroke: [Stroke−] | | | | | | | | | | |
| Stroke+ | 1.36 | 0.90 | 0.50 | 0.30  2.69 | | | | | | |
| HIV status: [HIV−] | | | | | | | | | | |
| HIV+ | 2.43** | 1.87 | 0.55 | 1.05  3.32 | | | | | | |
| TB status: [TB−] | | | | | | | | | | |
| TB+ | 2.03** | 1.73 | 0.38 | 1.12  2.67 | | | | | | |
| Multimorbidity: [None/mono-health challenge] | | | | | | | | | | |
| 2 Health challenges | 2.61** | | | | 2.33 | 0.44 | 1.61  3.37 | | | |
| 3 Health challenges | 3.53** | | | | 3.11 | 0.79 | 1.89  5.11 | | | |
| ≥4 Health challenges | 10.35** | | | | 8.90 | 2.95 | 4.64  17.06 | | | |
| Discordant multimorbidity: [None/mono-health challenge] | | | | | | | | | | |
| Health challenge in 2 domains | 2.89** | | | | | | | 2.45 | 0.43 | 1.74  3.47 |
| Health challenge in 3 domains | 5.09** | | | | | | | 4.65 | 1.53 | 2.44  8.85 |
| Model fit (for the adjusted models) | | | | | | | | | | |
| Number of observations | | 2,133 | | | 2,246 | | | 2,246 | | |
| Pseudo $R^2$ | | 0.08 | | | 0.07 | | | 0.05 | | |
| −2 Log Likelihood | | −562.71 | | | −596.99 | | | −606.80 | | |
| AIC | | 1,159.41 | | | 1,217.99 | | | 1,235.6 | | |
| BIC | | 1,255.72 | | | 1,286.59 | | | 1,298.49 | | |

* $P < 0.05$, ** $P < 0.01$ for the significance bivariate analysis (OR) only, given space limitation to display 95% CI. Refer 95% CI for the significance of aOR. The above analyses stratified by gender did not alter the significant findings about the role of multimorbidity and discordant multimorbidity. Reference category for the regression is noted in square bracket.

the higher level of communicable diseases found in the Dar es Salaam HDSS is consistent where HIV is a health challenge, as the prevalence remains highly concentrated in southern SSA and in certain sub-national levels in Tanzania [47]. Second, higher prevalence of depression found in our urban sample compared to the Nouna HDSS rural cohort may be attributed to urban/rural differences, with substantial research pointing to the impact of urban living-induced stress (e.g. overcrowding, pollution) on mental health [48–51].

Despite noted inconsistency [52], studies have found greater likelihood of social isolation and loneliness being higher in urban compared to more rural areas [53,54], which may explain the higher prevalence of depression found in our urban sample than the Nouna HDSS rural cohort. Urban bias [55] is one of the political economy arguments in the development discourse, with rural areas being more vulnerable due to developmental priority and resource allocation for industrialisation that disproportionly benefits the urban population. Consistent with the others [56], we also question the notion of urban advantage in our study context based on the health vulnerability found in our sample in comparison with rural populations.

Four limitations warrant discussion, the first being the health status of the study participants based on self-report, with no laboratory tests of disease status and diagnosis information being available. Second, our investigation could not differentiate planned and unplanned hospitalisation. Third, we used lifetime measures of communicable and non-communicable disease status. It is possible that certain health challenges may not have occurred before hospitalisation. Given that our study is based on cross-sectional design, our investigation precludes any causal inference about the temporal sequence of association between multimorbidity and hospitalisation. Lastly, post-stratification weight was not available for our study results to reflect the population representativeness. Notwithstanding these limitations, this investigation provides unique insights into the extent of multimorbidity in older adults and their association with hospitalisation using comprehensive data on wide-ranging communicable and non-communicable health challenges in an urban older population.

Our findings have far-reaching public health implications for older populations and signify the need for fundamentally restructuring the social welfare state and for building culturally competent health systems that can address multimorbidity in the midst of the unprecedented level of urbanisation taking place in Tanzania. According to the Arusha Declaration of 1967 [16], care for the aged rests with the family, village and state [57]. However, the level of social status and support previously experienced among older individuals during pre-colonial/pre-capitalist agrarian society (derived from yielding authority over land and its economic production) is more difficult to achieve in a modern urban society due to ageism labour market exclusion [58]. This is consistent with the modernization theory of ageing [59], where the roles and status of older individuals decline

with the technological progression and changes, devaluing their life experiences. While there has historically been some level of ambivalence regarding the families' willingness and capacity to provide care, evidence also points to neglect and deteriorating family support [26], where older individuals are seen as a social burden or 'Umepitwa na wakati', which means 'You are outdated', particular in an urban setting, such as Dar es Salaam [60]. Although the 2003 national ageing policy ensures that older people are provided with basic services [61], the implementation of formal social protection mechanism that target older adults falls short [26]. In the last decade, there has been greater global health movement toward people-centred care (PCC) that recognises the perspectives of individuals, families and communities as equal partners [62] and adheres to the five United Nations Principles for Older Persons, comprising of independence, participation, care, self-fulfilment and dignity [63], with Ujamaa upholding many of such values behind PCC. Older adults are valued source of wisdom [64] and are an important part of a mature human society [65]. Providing support that is based on people-centred and culturally competent care to address complex health challenges, such as multimorbidity, is truly commendable. Collective social action of individuals, family and community lay at the root of Afrocentric social welfare policy for equal human dignity [66]. However traditional (extended) family and community models of older adult protection and support are already strained, a condition that is expected to accentuate further, given the rapid urbanisation and changing social values taking place in Tanzania [67]. As the nation rises from the catastrophe of the HIV epidemic and transitions itself to face perhaps the most pressing and inevitable challenge in ageing, new and effective ways to support older persons living with multimorbidity is critically needed.

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**Supplementary Data:** Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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