



Patterns of multimorbidity among a community-based cohort in rural India

Journal of Multimorbidity and Comorbidity
Volume 13: 1–11
© The Author(s) 2023
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/26335565221149623
journals.sagepub.com/home/cob


Balaji Gummidi¹ , Vaishali Gautam¹, Oommen John^{1,2}, Arpita Ghosh^{1,2} and Vivekanand Jha^{1,2,3,4}

Abstract

Background: Multimorbidity estimates are expected to increase in India primarily due to the population aging. However, there is a lack of research estimating the burden of multimorbidity in the Indian context using a validated tool. We estimated the prevalence and determinants of multimorbidity amongst the adult population of the rural Uddanam region, Andhra Pradesh.

Methods: This community-based cross-sectional study was conducted as a part of an ongoing research program. Multistage cluster sampling technique was used to select 2419 adult participants from 40 clusters. Multimorbidity was assessed using Multimorbidity Assessment Questionnaire for Primary Care (MAQ-PC) tool, collecting information on 13 chronic diseases. Patient Health Questionnaire (PHQ-12) was used to screen for depression. Multiple logistic regression was conducted to identify the strongest determinants of multimorbidity.

Results: Of the 2419 participants, 2289 completed the MAQ-PC tool. Mean age (standard deviation) of participants was 48.1 (13.1) years. The overall prevalence of multimorbidity was 58.5% (95% CI 56.5–60.6); with 30.7%, 15.6%, and 12.2% reporting two, three, and four chronic conditions, respectively. Acid peptic disease-musculoskeletal disease (44%) and acid peptic disease-musculoskeletal disease-hypertension (14.9%) were the most common dyad and triad. Among metabolic diseases, diabetes-hypertension (28.3%) and diabetes-hypertension-chronic kidney disease (7.6%) were the most common dyad and triad, respectively. Advancing age, female gender, and being obese were the strongest determinants of the presence of multimorbidity. Depression was highly prevalent among the study population, and participants with higher PHQ-12 score had 3.7 (2.5–5.4) greater odds of having multimorbidity.

Conclusions: Our findings suggest that six of 10 adults in rural India are affected with multimorbidity. We report a higher prevalence of multimorbidity as compared with other studies conducted in India. We also identified vulnerable groups which would guide policy makers in developing holistic care packages for individuals with multimorbidity.

Keywords

Multimorbidity, rural, multimorbidity assessment questionnaire for primary care tool, chronic kidney disease, India

Received 14 September 2022; accepted: 19 December 2022

Background

Multimorbidity, defined as the presence of two or more chronic diseases, is increasing globally.^{1,2} According to a systematic review of 39 studies, the pooled prevalence of multimorbidity was 36.4% (95% CI: 32.2–40.6) in low and

¹The George Institute for Global Health, New Delhi, India
²Manipal Academy of Higher Education, Manipal, India
³Faculty of Medicine, Imperial College London, London, UK
⁴University of New South Wales, Sydney, Australia

Corresponding author:

Vivekanand Jha, George Institute for Global Health, 308, Third Floor, Elegance Tower, Plot No. 8, Jasola District Centre, New Delhi 110025 India.
Email: vjha@georgeinstitute.org.in



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

middle-income countries (LMICs) and 42.4% (95% CI: 38.9-46.0) among high-income countries.³ Multimorbidity is a complex construct and goes beyond measuring counts of co-existing diseases to ascertaining weighted counts of diseases, measuring various body systems affected (complex multimorbidity), ascertaining the presence of concordant or discordant diseases, and determining clusters of physical and mental health disorders and chronic infectious diseases.^{1,4} Multimorbidity poses several challenges for the affected patients, such as declining functional status, impaired quality of life, need for multiple healthcare visits, and polypharmacy leading to economic burden, resulting in an overburdened health system.⁵⁻¹¹

In LMICs, such as India, understanding the patterns of multimorbidity is essential, as it has implications for developing multimodal strategies that when implemented, would improve disease management.^{2,12} Of the studies available from India, the prevalence of multimorbidity has ranged from 18% to 83%.¹³⁻²² The wide gap in prevalence is due to inconsistencies in defining multimorbidity, different permutations of included morbidities, or an overestimation of prevalence due to the inclusion of self-reported morbidities. Most studies have focused on the elderly population,¹⁵⁻¹⁸ were conducted in health facilities,^{19,20} studied urban populations,²¹ or explored multimorbidity amongst patients with non-communicable diseases.^{15,22} Few studies have explored the prevalence and correlation of multimorbidity amongst the rural population.^{13,22}

We established a general population-based cohort in the Uddanam region of Srikakulam district in rural Andhra Pradesh, primarily to study chronic kidney disease (CKD).²³ Uddanam region is a rural area where the main occupation is farming and coconut and cashew harvesting. We surveyed this population to determine the prevalence of multimorbidity and its determinants, and the results are presented here.

Methodology

Study design and participants

The study was conducted as a part of an ongoing research program - Study to Test and Operationalize Preventive Approaches for Chronic Kidney Disease of Undetermined Etiology (STOP CKDu) - in the Uddanam region of Srikakulam District of Andhra Pradesh, the details of which are published elsewhere.²⁴ Briefly, the study, focusing on ascertaining the prevalence and incidence of CKD in this area, is being conducted among the seven administrative regions (mandals). A total of 2419 subjects were recruited using a cluster sampling technique from 40 clusters (villages) in the defined area. The sample size was estimated assuming a prevalence of CKD of 10% in the low-prevalence clusters, a relative precision of 20%, a design effect of 2, and inflated to

account for an estimated 25% loss to follow-up in the prospective component of the study. The cohort was set up in July 2018 to ascertain the incidence and progression factors of CKD in this region. All participants who were alive and still living in the region were approached between Nov 2021 and Feb 2022 to ascertain the patterns of multimorbidity and depression.

Data collection and study variables

Data was collected using a structured multimorbidity assessment tool. The questionnaire entails the assessment of self-reported (informed by the healthcare professional to participant) multimorbidity in which respondents reacted to a list of common chronic conditions. The development and validation of the tool and its components are published elsewhere.²⁵ For data collection we approached the selected participants at their homes. If, after two consecutive attempts, the participant was unavailable, we contacted them telephonically.

Operational definition of multimorbidity: Multimorbidity was defined as presence of two or more chronic morbidities. Respondents were asked, "Have you ever been told by a doctor/health care professional that you have any of the following conditions": diabetes, hypertension, ischemic heart disease, heart failure, chronic kidney disease, chronic respiratory disease, stroke, cancer, arthritis, depression, thyroid, chronic backache, and acid peptic disease. Where available, we verified this information from the medical records, including consultation details, diagnostic reports, treatment details, and current medication usage. Finally, via an open-ended follow-up question, participants were asked to specify other conditions that were not captured.

Each morbidity was categorised as present or absent, and summed up to get a cumulative score which was used to create dichotomized multimorbidity variable. Highly prevalent morbidities (prevalence > 5%) were further studied to find the most common dyads and triads. Further, we also constructed dyads and triads of cardio-metabolic morbidities (hypertension, diabetes, ischemic heart disease, heart failure, stroke, CKD). There were no missing variables.

Age, gender, education (no formal education, school education, college), and occupation (unemployed, sedentary work, manual worker/farmer) were also captured. Socio-economic status was calculated using a modified Kuppaswamy scale.²⁶ Data on current or past tobacco or alcohol consumption, anthropometric variables (height and weight), and blood pressure were determined for all recruited participants. Blood pressure was measured using an Omron Blood pressure monitor of model number (HEM-7121J-IN), three readings were recorded at five minutes intervals, and the average of three values was calculated.

Depression was measured using Patient Health Questionnaire (PHQ-12), a 12-item self-reported questionnaire. The response categories were further dichotomised as yes and no, such that the patient would be asked whether they felt each of the twelve symptoms and their frequency during the last two weeks. Depression was defined as a PHQ-12 score of above 4.

Data management and Statistical Analysis Plan

Data were entered in Microsoft Excel 2013 (v 15.0). Data cleaning and analysis were performed in STATA version 16. Frequencies and proportions were used as descriptive measures for categorical variables, with 95% confidence limits and mean with standard deviation for continuous variables. Bivariate analysis was done using Chi-square test. Logistic regression analyses were performed to estimate odds ratios (ORs) of factors associated with multimorbidity. To conduct univariate and multivariate analysis, education (no formal education/any formal education), occupation (outdoor work/others including unemployed and sedentary workers), family income (monthly family income <INR 10,000/>INR 10,000) and socio-economic status (lower/middle including lower middle and upper middle SES) were recategorized as categorical variables. We present both un-adjusted and adjusted for age, gender, education, occupation, family income, socioeconomic status, tobacco, alcohol use, and Asia-specific body mass index categories²⁷ in the multivariate model.

Ethical statement

The study was approved by the institutional ethics committee of The George Institute India (#001/2017), and written informed consent was obtained from every participant.

Results

The original cohort consisted of 2419 individuals, of which 2289 were eligible to be included in the study, giving a response rate of 94.6%. A total of 126 members of the original cohort had died, two participants had permanently emigrated, and two declined to participate in this study. Face to face interview were conducted for 2160 participants and the remainder (n=126) were contacted telephonically as they were unavailable at their home.

Of the total population, 1193 (41.3%) were female, and nearly half (1131, 49.4%) of the population were in the age group 30-50 years [median age (IQR): 41 (10)]. The mean age (SD) of the cohort was 48.1 (13.1) years and was comparable for both males and females. A total of 865 (37.8%) were illiterate, and the majority belonged to lower middle socio-economic groups. Consumption of tobacco

was common among the female population (370, 31.0%), while males reported consuming both tobacco (592, 54%) and alcohol (617, 56.2%). A total of 797 (34.8%) participants had a BMI ≥ 23 kg/m² [male: 396, 36.1%; female: 401, 33.6%]. The socio-demographic characteristics of the population are depicted in [Table 1](#).

Prevalence of individual chronic conditions and multimorbidity

The number of health conditions per individual ranged from none to eight [[Figure 1](#)]. Of those reporting a chronic health condition, a majority (58.5%, 95% confidence interval [CI] 56.5-60.6) had more than one morbidity. Overall, the prevalence of a single chronic condition was 21.8% (95% CI 20.2-23.6). Dyads were more common (702, 30.7%) than triads (356, 15.6%), and a total of 282 (12.2%) had four or more conditions. A comparable proportion of males and females were affected with chronic conditions; however, a higher proportion of males were affected by stroke ([Table 2](#) and [supplementary table 1](#)). At the time of data collection, 117, 5.1%, had been diagnosed with COVID (not included in multimorbidity counts).

Patterns of multimorbidity

The combination of acid peptic ulcer disease (APD) and musculoskeletal disorders (MSD) was the most prevalent dyad (1005, 44%), followed by acid peptic ulcer diseases and hypertension (HTN) (441, 19.3%), and musculoskeletal disorders and hypertension (426, 18.6%) [[Figure 2a](#)]. Of the triads of multimorbidity, acid-peptic ulcer diseases (APD)-musculoskeletal disorders (MSD)-hypertension (HTN) ranked highest with 340 (14.9%) affected participants, followed by acid peptic diseases-hypertension-diabetes (199, 8.7%), and acid peptic diseases-musculoskeletal disorders-respiratory disorders (149, 6.9%) [[Figure 2b](#)].

On examining the cardiometabolic multimorbidity, diabetes-hypertension was the most prevalent (148, 28.3%) dyad, followed by hypertension-chronic kidney disease (120, 22.9%) and diabetes-chronic kidney diseases (44, 8.4%). Of the total study population having triads of metabolic multimorbidity, diabetes-hypertension-chronic kidney diseases ranked highest with 34 (7.6%) affected participants, followed by diabetes-hypertension-ischemic heart diseases (15, 3.3%), and diabetes-hypertension-stroke (15, 3.3%) [[supplementary table 2](#)].

Age and multimorbidity

The prevalence of multimorbidity increased with advancing age [[Figure 3](#)]. Amongst individuals between the ages of 18

Table 1. Characteristics of study participants.

Characteristics	Males (n = 1096)	Females (n = 1193)
Sociodemographic, economic, lifestyle	n (%)	n (%)
Age (years) [Mean (SD)]	48.9 (13.7)	47.4 (12.4)
18 - <30	111 (4.8)	103 (4.6)
31-40	226 (9.9)	296 (12.9)
41-50	267 (11.6)	342 (14.9)
51-60	276 (12.1)	269 (11.8)
Above 60	216 (9.5)	183 (7.9)
Education		
No formal education	265 (11.6)	600 (26.2)
School education	447 (19.5)	402 (17.6)
College	384 (16.8)	191 (8.3)
Occupation		
Not working	74 (3.2)	336 (14.7)
Sedentary workers	111 (4.9)	48 (2.1)
Manual workers/farmers	911 (39.8)	809 (35.3)
Socio-economic status according to Kuppuswamy scale		
Upper lower	624 (27.2)	270 (11.8)
Lower middle	454 (19.8)	832 (36.3)
Upper middle	18 (0.8)	91 (4.0)
Current or past tobacco use		
Yes	592 (25.9)	370 (16.2)
No	504 (22.0)	823 (36.0)
Alcohol use		
Yes	617 (27.0)	16 (0.7)
No	479 (20.9)	1177 (51.4)
Anthropometric indicators (n = 2888^a)		
Height [Median (IQR)]	162 (12)	155 (7)
Weight [Median (IQR)]	62 (15)	57 (13)
BMI [Median (IQR)]	23.6 (5.3)	23.4 (5.1)
BMI category kg/m ² (n%)	(n%)	(n%)
Underweight (< 18.5)	111 (4.8)	111 (4.8)
Normal (≥18.5 to 24.9)	588 (25.7)	681 (29.8)
Overweight (≥25 to 29.9)	331 (14.5)	328 (14.3)
Obese (≥30)	65 (2.9)	73 (3.2)

^aOne participant was bedridden

and 30 years, only 29 (2.0%) of the population were found to have multimorbidity, which increased to 411 (28.5%) in those 40 - 50 years old.

Depression

The crude prevalence of depression was 29.1% (95% CI: 27.2-30.9). Females had a higher prevalence of depression (34.9; 95% CI: 32.2-37.6) compared to males (22.6; 95% CI: 20.1-25.1) (Table 2). The commonest symptom was feeling of tiredness (40.9%), followed by difficulty staying asleep (39.8%) and depressed mood. Nearly one-fourth of

the population reported having suicidal thoughts. The symptom profile as reported by the study participants, is shown in Table 3.

Factors associated with multimorbidity

Multimorbidity became more common as people got older. Those above the age of 60 years had the highest odds of having multimorbidity [aOR:36.8; 95%CI: 20.2-67.1] compared to the individual of age 18 to less than 30 years. Females had higher odds of having multimorbidity (aOR: 1.9; 95%CI: 1.5-2.5). Being overweight and obese both

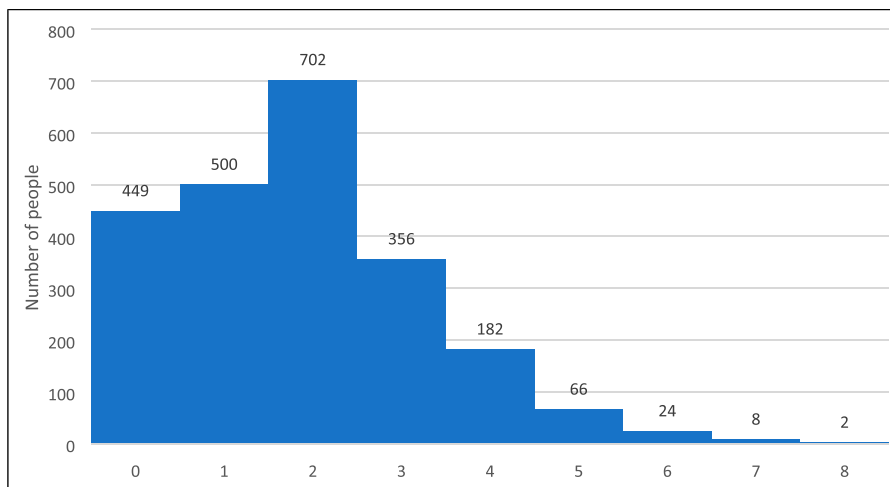


Figure 1. Proportion of participants with and without multimorbidity conditions among study population (n = 2289).

Table 2. Gender distribution of the disease profile confirmed by health professionals as reported by participants (N = 2289).

Condition	Males n = 1096 (%)	Females n = 1193 (%)	Total n = 2289
Musculoskeletal disorders	596 (26.1)	875 (38.2)	1471 (64.3)
Acid Peptic disease	584 (25.5)	706 (30.8)	1290 (56.4)
Hypertension	299 (13.1)	287 (12.5)	586 (25.6)
Diabetes	125 (5.5)	110 (4.8)	235 (10.3)
Respiratory diseases	88 (3.8)	118 (5.2)	206 (9.0)
CKD	122 (5.3)	76 (3.3)	198 (8.6)
Depression	25 (1.1)	56 (2.4)	81 (3.5)
Thyroid diseases	10 (0.4)	56 (2.4)	66 (2.8)
Stroke	39 (1.7)	5 (0.2)	44 (1.9)
Ischemic Heart Disease	28 (1.2)	22 (1.0)	50 (2.2)
Heart Failure	11 (0.5)	4 (0.2)	15 (0.7)
Cancer	2 (0.1)	2 (0.1)	4 (0.2)

carried a higher risk of developing multimorbidity. The prevalence of depression was high, and participants with depression had higher odds of being affected by multimorbidity than people without depression [aOR: 3.7; 95% CI: 2.5-5.4] (Table 4). On multivariate analysis, no statistically significant association was observed for socioeconomic status, education, occupation, and risk factors like tobacco and alcohol consumption.

Discussion

In this first of a kind study that examined the prevalence and patterns of multimorbidity among the Indian rural agricultural population, we found that six out of ten adults are affected by multimorbidity, with over 80% of the adult population reporting one chronic condition for which they had sought medical care. Age, female gender, and being obese were the strongest determinants of the presence of multimorbidity.

Depression was also common, more so in the population with multimorbidity. Further, most of the common metabolic disorders were evenly distributed among both genders, except stroke (3.5% in males and 0.4% in females) and heart failure (1.0% in males and 0.3% in females). On the other hand, the females showed a higher proportion of suicide ideation compared to males (21.1% v 31.3%).

There are few studies on the burden of multimorbidity in India, especially in rural communities. The prevalence of multimorbidity in the population we studied was higher than those reported from rural populations with similar age profiles (39% to 55%).^{20,28,29} A nationally representative study (Longitudinal Aging Study from India) reported a multimorbidity prevalence of 24.1% amongst those above the age of 60 years.¹⁸ Similar estimates of multimorbidity have been reported from LMICs such as Ghana³⁰ and Brazil.³¹ Together, these findings highlight the growing burden of multimorbidity,

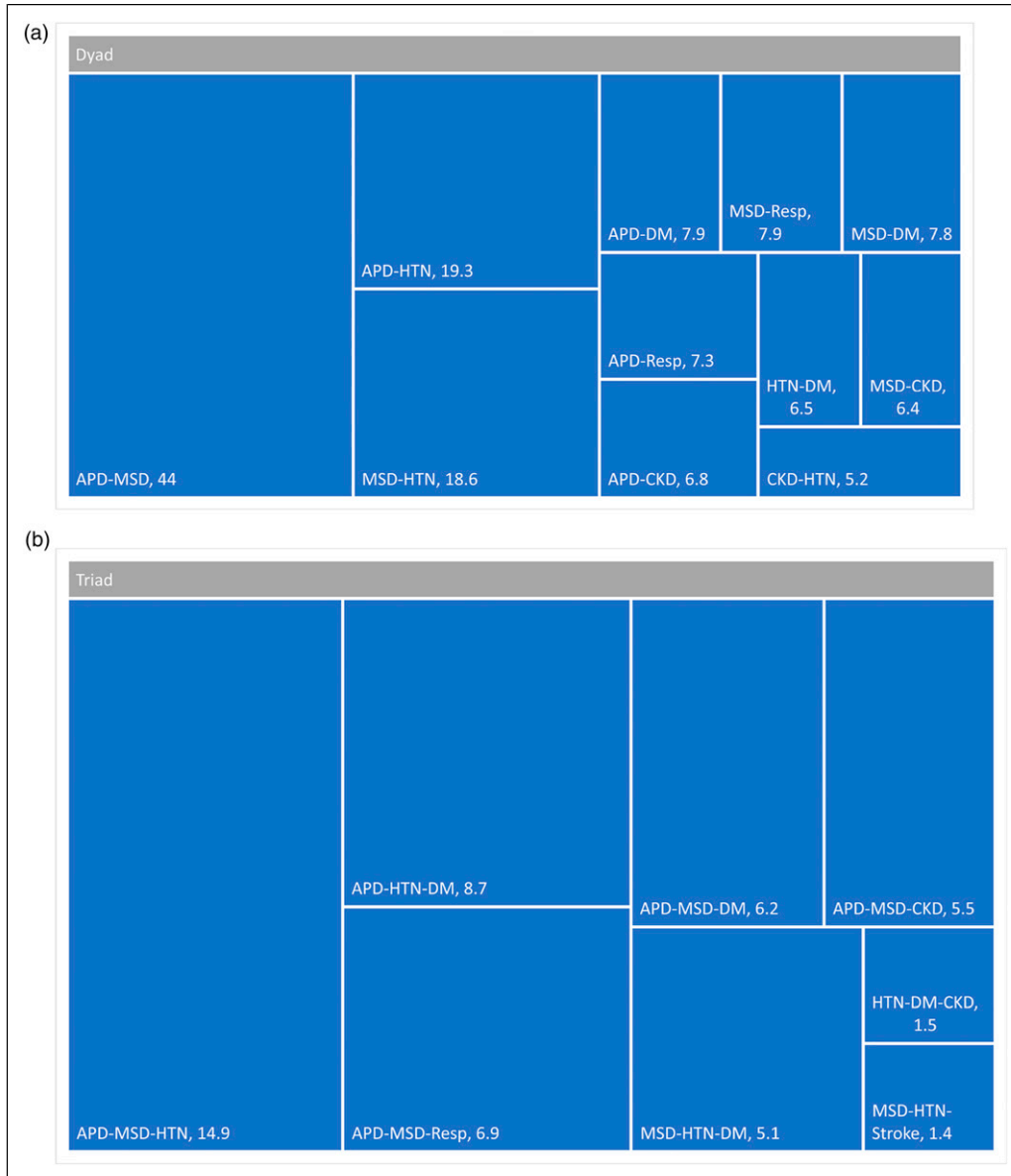


Figure 2. (a): Tree map depicting burden of morbidity combinations among common dyads. (b): Tree map depicting burden of morbidity combinations among common triads.

which is no longer limited to wealthier countries and affluent segments of society.

Studies limited to selected population groups such as patients recruited from healthcare setting, or elderly population, report higher prevalence. Soji et al estimated the prevalence of multimorbidity to be 74% among patients with diabetes in Kerala.²² Khan et al determined that 83% of the older adults (age 60 years and above) in Punjab had multimorbidity.¹⁷ Similarly, in China, Wang et al. reported that 90.5% of the rural elderly population has multimorbidity.³² Aging and the presence of chronic conditions are shown to increase the occurrence of multimorbidity.^{33–36}

An important source of variation that influences the prevalence of multimorbidity is inconsistencies in the definition of variables and the lists of chronic conditions. To overcome these challenges and assess multimorbidity comprehensively, we used the MAQ-PC tool, which is validated for Indian settings and has been shown to have high internal reliability measures.²⁵ Further, we used a standardised operational definition of multimorbidity from the list of the 13 most common chronic conditions and studied a wider age group.

Acid-peptic disease and musculoskeletal disorders were most frequently associated together and in combination with

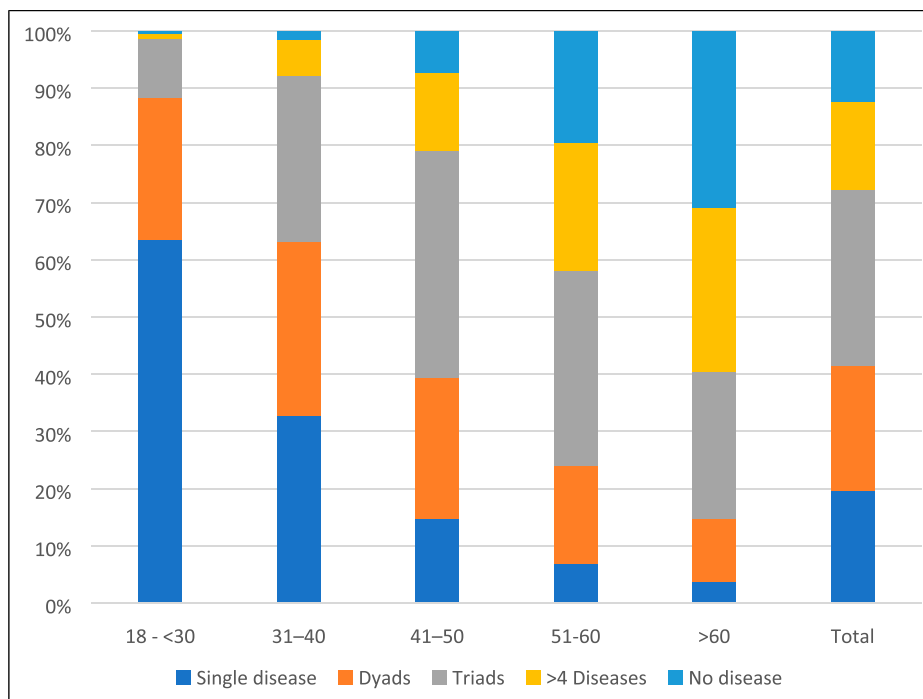


Figure 3. Age wise distribution of the morbidities among study cohort.

Table 3. Distribution of symptoms of depression in the study population.

Symptoms	Number (%) (n = 2289)	Males (n = 1096)	Females (n = 1193)
Tiredness	936 (40.9)	359 (15.7)	576 (25.2)
Difficulty in staying asleep	911 (39.8)	373 (16.3)	537 (23.5)
Depressed Mood	835 (36.5)	357 (15.6)	476 (20.8)
Loss of appetite or weight	730 (31.9)	288 (12.6)	441 (19.3)
Suicidal thoughts	606 (26.5)	231 (10.1)	373 (16.3)
Loss interest	595 (26)	238 (10.4)	357 (15.6)
Lack of concentration	453 (19.8)	171 (7.5)	286 (12.5)
Trouble falling sleep	414 (18.1)	178 (7.8)	235 (10.3)
Sleeping too much	315 (13.8)	141 (6.2)	176 (7.7)
Overeating or weight gain	311 (13.6)	137 (6)	173 (7.6)
Being restless	125 (5.5)	48 (2.1)	77 (3.4)
Moved or spoke slowly	64 (2.8)	22 (1)	41 (1.8)

Figures in parentheses are percentages.

other chronic disease conditions. Acid peptic disease is a commonly used term that collectively includes digestive system disorders with common symptomology, such as gastro-oesophageal reflux disease (GERD), peptic ulcer disease, gastritis, and duodenitis. Clusters of multimorbidity with acid peptic diseases have been reported by Pati et al,³⁷ Dutta et al,³⁸ and Kshartri et al.³⁹ The high prevalence of APD possibly attributed to the lifestyle and dietary preferences of the rural agricultural population (predominantly rice-based diet, consumption of caffeinated drinks, and/or tobacco use).^{40,41} Furthermore, APD can often develop or

worsen as a side effect of commonly used drugs, such as non-steroidal anti-inflammatory drugs (available over the counter and used rampantly as pain killers), calcium channel blockers, beta-blockers, routinely prescribed for musculo-skeletal disorders and hypertension.^{42,43}

As expected, diabetes and hypertension were the most common dyads among metabolic disorders in both males and females. Notable was the high prevalence (17.3%) of CKD in this population, which ranked second and third highest in combination with hypertension and diabetes, respectively. Triads of diabetes, hypertension and chronic

Table 4. Bivariate and multivariate analysis of the factors associated with multimorbidity.

Variables	Multimorbidity				
	N (%)	Crude Odds Ratio (95%CI)	P value	Adjusted Odds Ratio (95%CI)	P value
	N = 1,340				
Age (years)					
18 - <30	25 (1.9)	Ref			
31-40	192 (14.3)	3.6 (2.6-5.0)	0.001	3.2 (2.2-4.5)	0.001
41-50	369 (27.5)	10.1 (7.0-14.4)	0.001	8.9 (6.1-12.9)	0.001
51-60	414 (30.9)	23.9 (15.5-37.0)	0.001	20.6 (13.2-32.2)	0.001
Above >60	340 (25.4)	44.6 (24.8-80.2)	0.001	36.8 (20.2-67.1)	0.001
Sex					
Male	595 (44.4)	Ref			
Female	745 (55.6)	1.8 (1.5-2.2)	0.001	1.9 (1.5-2.5)	0.001
Body mass index					
Underweight	152 (11.3)	1.6 (1.0-2.4)	0.03	0.9 (0.6-1.5)	0.7
normal	714 (53.3)	Ref			
Overweight	390 (29.1)	0.9 (0.7-1.1)	0.3	1.0 (0.8-1.3)	1
Obese	83 (6.2)	1.0 (0.6-1.5)	0.9	1.2 (0.7-1.9)	0.5
Depression					
Yes	793 (59.2)	6.2 (4.3-8.8)	0.001	3.7 (2.5-5.4)	0.001
No	547 (40.8)	Ref			
Education					
No Formal education	621 (46.3)	2.5 (2.1-2.9)	0.001	1.0 (0.7-1.1)	0.353
Any Formal education	719 (53.6)	ref			
Occupation					
Outdoor workers	1036 (77.3)	ref		1.0 (0.8-1.3)	0.85
Others (no work and sedentary work)	304 (22.7)	1.3 (1.1-1.6)	0.04		
Socioeconomic scale					
Upper lower	468 (34.9)	ref		Ref	
Lower middle	818 (61)	1.3 (1.1-1.6)	.001	1.1 (0.8-1.4)	0.565
Upper middle	54 (4)	1.1 (0.7-1.4)	0.92	1 (0.8-1.7)	0.45
Tobacco use					
Yes	671 (50.1)	2.3 (1.9-2.7)	0.001	1.2 (0.9-1.5)	0.163
No	669 (49.9)	Ref			
Alcohol use					
Yes	393 (29.3)	1.2 (1.0-1.5)		1.1 (0.8-1.5)	0.526
No	947 (70.7)	Ref	0.03		

kidney diseases were the most prevalent. This finding is unique to the current cohort.

Understanding multimorbidity patterns is crucial for developing successful policies tailored to the local context in a way that efficiently utilises available resources to develop disease and population-specific approaches. Interventions can be made efficient when they target the most common multimorbidity clusters. Currently, the Indian national program for non-communicable diseases primarily focuses on diabetes and hypertension,⁴⁴ however, musculoskeletal conditions, gastrointestinal disorders, respiratory diseases, and CKD management are yet to be incorporated as priorities.

Consistent with other studies, we also found an age gradient for multimorbidity. Various authors have documented the compounding of multimorbidity with advancing age, with the burden rising after the age of 45 years.^{1,20,33-35,45,46} The long-standing accumulation of risk factors due to environmental exposure, sedentary lifestyle, poor dietary or behavioural practices, and gradual functional and physiological decline make the aging population susceptible to a constellation of morbidities.^{47,48}

Females had a higher prevalence of multimorbidity. This gender disparity can be due to higher exposure to risk factors like poor nutrition, physical inactivity,⁴⁹ and socio-cultural barriers which impede their access to healthcare.⁵⁰

It has been suggested that females are more likely to report morbidities while self-reporting.⁵¹ These findings suggest the need to develop better tools to understand the determinants and age and gender-specific interventions for managing complex multimorbidity. There were other differences between the two sexes – for example, the higher prevalence of stroke and heart failure in males and suicidal ideation in females. Apart from biological reasons, possible causes for this could include differences in lifestyle, health seeking behaviour, and/or medication adherence.

Our study also shows a high prevalence of depression, with nearly one-fourth of the population having suicidal thoughts. Gender disparity with a female preponderance of suicidal behaviour can be attributed to a higher prevalence of mental health disorders (such as depression), psychological distress (due to domestic violence), social constraints (lack of financial independence), or poor emphasis on suicide prevention among them. Patients with multimorbidity have a higher risk of depression than those with no disease or single morbidity.^{52,53} Depression and multimorbidity are complex phenomena and show bidirectionality. Multimorbidity and depression both present an economic burden on the patients.⁵⁴ Early identification and timely management of depression among patients with multimorbidity is necessary to improve health outcomes and quality of life.

The principal strength of our work is that we conducted a population-based multimorbidity survey in an area identified to be at high risk of developing one chronic condition (CKD). We used a validated tool for the rural Indian population to assess the pattern and burden of multimorbidity. Our operational definition of multimorbidity was based on the definition from the Academy of Medical Sciences.¹ We collected information on conditions that were important to patients and relied on confirmation of the diagnosis via medical and treatment records.

A few limitations also need to be recognised. Firstly, due to the cross-sectional design, no causal inference can be established as the time of onset of diseases could not be explored. Secondly, our study was not powered to accurately estimate the prevalence and/or subgroup differences of each chronic condition, so the findings should be confirmed in larger studies. Thirdly, since the prevalence of depression was high, reporting bias may be present; however, attempts were made to verify self-reported data whenever possible. Finally, we measured morbidities based on self-reporting or confirmation from a doctor, which is influenced by health seeking behaviour and likely leads to underestimation of multimorbidity burden.

Conclusions

The burden of multimorbidity is high in the rural population of the Uddanam region, which has policy implications.

Understanding the burden of multimorbidity will guide policymakers to develop a robust healthcare system that explores potentially causal associations among multiple coexisting conditions and targets the constellation rather than singleton diseases. Identification of risk factors suggests the need to develop targeted approaches for high-risk groups.

Acknowledgements

We thank the participants for their patience while conducting the study. We also acknowledge the support from Government of Andhra Pradesh

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Government of Andhra Pradesh (GoAP) (grant no. 38248/CKD/NCD/2017).

ORCID iD

Balaji Gummidu  <https://orcid.org/0000-0002-1444-3262>

References

1. *Multimorbidity: a priority for global health research*. The Academy of Medical Sciences, 2018.
2. Barnett K, Mercer SW, Norbury M, et al. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012; 380: 37–43. 2012/05/15. DOI: [10.1016/s0140-6736\(12\)60240-2](https://doi.org/10.1016/s0140-6736(12)60240-2)
3. Asogwa OA, Boateng D, Marzà-Florensa A, et al. Multimorbidity of non-communicable diseases in low-income and middle-income countries: a systematic review and meta-analysis. *BMJ Open* 2022; 12: e049133. 2022/01/23. DOI: [10.1136/bmjopen-2021-049133](https://doi.org/10.1136/bmjopen-2021-049133)
4. Harrison C, Britt H, Miller G, et al. Examining different measures of multimorbidity, using a large prospective cross-sectional study in Australian general practice. *BMJ Open* 2014; 4: e004694. 2014/07/13. DOI: [10.1136/bmjopen-2013-004694](https://doi.org/10.1136/bmjopen-2013-004694)
5. Aubert CE, Streit S, Da Costa BR, et al. Polypharmacy and specific comorbidities in university primary care settings. *Eur J Intern Med* 2016; 35: 35–42. 2016/06/13. DOI: [10.1016/j.ejim.2016.05.022](https://doi.org/10.1016/j.ejim.2016.05.022)
6. Ryan A, Wallace E, O'Hara P, et al. Multimorbidity and functional decline in community-dwelling adults: a systematic review. *Health Qual Life Outcomes* 2015; 13: 168. 2015/10/16. DOI: [10.1186/s12955-015-0355-9](https://doi.org/10.1186/s12955-015-0355-9)

7. Nunes BP, Flores TR, Mielke GI, et al. Multimorbidity and mortality in older adults: A systematic review and meta-analysis. *Arch Gerontol Geriatr* 2016; 67: 130–138. 2016/08/09. DOI: [10.1016/j.archger.2016.07.008](https://doi.org/10.1016/j.archger.2016.07.008)
8. Reddy MM, Zaman K, Yadav R, et al. Prevalence, Associated Factors, and Health Expenditures of Noncommunicable Disease Multimorbidity-Findings From Gorakhpur Health and Demographic Surveillance System. *Front Public Health* 2022; 10: 842561. 2022/04/26. DOI: [10.3389/fpubh.2022.842561](https://doi.org/10.3389/fpubh.2022.842561)
9. Pati S, Swain S, Knottnerus JA, et al. Health related quality of life in multimorbidity: a primary-care based study from Odisha, India. *Health Qual Life Outcomes* 2019; 17: 116. 2019/07/07. DOI: [10.1186/s12955-019-1180-3](https://doi.org/10.1186/s12955-019-1180-3)
10. Pati S, Mahapatra P, Dwivedi R, et al. Multimorbidity and Its Outcomes Among Patients Attending Psychiatric Care Settings: An Observational Study From Odisha, India. *Front Public Health* 2020; 8: 616480. 2021/05/11. DOI: [10.3389/fpubh.2020.616480](https://doi.org/10.3389/fpubh.2020.616480)
11. 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. DOI: [10.1136/bmjopen-2021-057017](https://doi.org/10.1136/bmjopen-2021-057017)
12. Basto-Abreu A, Barrientos-Gutierrez T, Wade AN, et al. Multimorbidity matters in low and middle-income countries. *J Multimorb Comorb* 2022; 12: 26335565221106074. 2022/06/24. DOI: [10.1177/26335565221106074](https://doi.org/10.1177/26335565221106074)
13. Gupta P, Patel SA, Sharma H, et al. Burden, patterns, and impact of multimorbidity in North India: findings from a rural population-based study. *BMC Public Health* 2022; 22: 1101. 2022/06/03. DOI: [10.1186/s12889-022-13495-0](https://doi.org/10.1186/s12889-022-13495-0)
14. Pati S, Swain S, Hussain MA, et al. Prevalence and outcomes of multimorbidity in South Asia: a systematic review. *BMJ Open* 2015; 5: e007235. DOI: [10.1136/bmjopen-2014-007235](https://doi.org/10.1136/bmjopen-2014-007235)
15. Mini GK and Thankappan KR. Pattern, correlates and implications of non-communicable disease multimorbidity among older adults in selected Indian states: a cross-sectional study. *BMJ Open* 2017; 7: e013529. 2017/03/10. DOI: [10.1136/bmjopen-2016-013529](https://doi.org/10.1136/bmjopen-2016-013529)
16. Banjare P and Pradhan J. Socio-economic inequalities in the prevalence of multi-morbidity among the rural elderly in Bargarh District of Odisha (India). *PLoS One* 2014; 9: e97832. 2014/06/06. DOI: [10.1371/journal.pone.0097832](https://doi.org/10.1371/journal.pone.0097832)
17. Khan MR, Malik MA, Akhtar SN, et al. Multimorbidity and its associated risk factors among older adults in India. *BMC Public Health* 2022; 22: 746. 2022/04/16. DOI: [10.1186/s12889-022-13181-1](https://doi.org/10.1186/s12889-022-13181-1)
18. Chauhan S, Patel R and Kumar S. Prevalence, factors and inequalities in chronic disease multimorbidity among older adults in India: analysis of cross-sectional data from the nationally representative Longitudinal Aging Study in India (LASI). *BMJ Open* 2022; 12: e053953. 2022/03/31. DOI: [10.1136/bmjopen-2021-053953](https://doi.org/10.1136/bmjopen-2021-053953)
19. Pati S, Swain S, Hussain MA, et al. Prevalence, correlates, and outcomes of multimorbidity among patients attending primary care in Odisha, India. *Ann Fam Med* 2015; 13: 446–450. 2015/09/16. DOI: [10.1370/afm.1843](https://doi.org/10.1370/afm.1843)
20. R C and Jeemon P. Prevalence and patterns of multi-morbidity in the productive age group of 30–69 years: A cross-sectional study in Pathanamthitta District, Kerala. *Wellcome Open Res* 2020; 5: 233. 2020/12/29. DOI: [10.12688/wellcomeopenres.16326.2](https://doi.org/10.12688/wellcomeopenres.16326.2)
21. Sinha A, Kerketta S, Ghosal S, et al. Multimorbidity Among Urban Poor in India: Findings From LASI, Wave-1. *Front Public Health* 2022; 10: 881967. 2022/06/21. DOI: [10.3389/fpubh.2022.881967](https://doi.org/10.3389/fpubh.2022.881967)
22. Soji DJ, Lordson J and Mini GK. Multimorbidity patterns among rural adults with Type-2 diabetes mellitus: A cross-sectional study in Kerala, India. *WHO South East Asia J Public Health* 2021; 10: 32–36. 2022/01/21. DOI: [10.4103/who-seajph.Who-seajph_73_21](https://doi.org/10.4103/who-seajph.Who-seajph_73_21)
23. John O, Gummudi B, Jha A, et al. Chronic Kidney Disease of Unknown Etiology in India: What Do We Know and Where We Need to Go. *Kidney Int Rep* 2021; 6: 2743–2751. 2021/11/23. DOI: [10.1016/j.ekir.2021.07.031](https://doi.org/10.1016/j.ekir.2021.07.031)
24. John O, Gummidi B, Tewari A, et al. Study to Test and Operationalize Preventive Approaches for CKD of Undetermined Etiology in Andhra Pradesh, India. *Kidney International Reports* 2019; 4: 1412–1419. DOI: [10.1016/j.ekir.2019.06.003](https://doi.org/10.1016/j.ekir.2019.06.003)
25. Pati S, Hussain MA, Swain S, et al. Development and Validation of a Questionnaire to Assess Multimorbidity in Primary Care: An Indian Experience. *Biomed Res Int* 2016; 2016: 6582487. 2016/03/12. DOI: [10.1155/2016/6582487](https://doi.org/10.1155/2016/6582487)
26. Wani RT. Socioeconomic status scales-modified Kuppusswamy and Udai Pareekh's scale updated for 2019. *J Family Med Prim Care* 2019; 8: 1846–1849. DOI: [10.4103/jfmpc.jfmpc_288_19](https://doi.org/10.4103/jfmpc.jfmpc_288_19)
27. Pan WH and Yeh WT. How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations. *Asia Pac J Clin Nutr* 2008; 17: 370–374.
28. Ismail S, Stanley A and Jeemon P. Prevalence of multimorbidity and associated treatment burden in primary care settings in Kerala: a cross-sectional study in Malappuram District, Kerala, India. *Wellcome Open Res* 2022; 7: 67. 2022/05/24. DOI: [10.12688/wellcomeopenres.17674.2](https://doi.org/10.12688/wellcomeopenres.17674.2)
29. Puri P, Sinha A, Mahapatra P, et al. Multimorbidity among midlife women in India: well-being beyond reproductive age. *BMC Womens Health* 2022; 22: 117. 2022/04/12. DOI: [10.1186/s12905-022-01693-2](https://doi.org/10.1186/s12905-022-01693-2)
30. Nimako BA, Baiden F, Sackey SO, et al. Multimorbidity of chronic diseases among adult patients presenting to an inner-city clinic in Ghana. *Globalization and Health* 2013; 9: 61. DOI: [10.1186/1744-8603-9-61](https://doi.org/10.1186/1744-8603-9-61)
31. Nunes BP, Camargo-Figuera FA, Guttier M, et al. Multimorbidity in adults from a southern Brazilian city: occurrence

- and patterns. *Int J Public Health* 2016; 61: 1013–1020. 2016/04/24. DOI: [10.1007/s00038-016-0819-7](https://doi.org/10.1007/s00038-016-0819-7)
32. Wang SB, D'Arcy C, Yu YQ, et al. Prevalence and patterns of multimorbidity in northeastern China: a cross-sectional study. *Public Health* 2015; 129: 1539–1546. 20150722. DOI: [10.1016/j.puhe.2015.06.013](https://doi.org/10.1016/j.puhe.2015.06.013)
33. Puri P, Singh SK and Pati S. Temporal dynamics, patterns and correlates of single and multimorbidity in India, 1994–2018. *Journal of Multimorbidity and Comorbidity* 2021; 11: 263355652110627. DOI: [10.1177/26335565211062756](https://doi.org/10.1177/26335565211062756)
34. Arokiasamy P. India's escalating burden of non-communicable diseases. *Lancet Glob Health* 2018; 6: e1262–e1263. 2018/10/08. DOI: [10.1016/s2214-109x\(18\)30448-0](https://doi.org/10.1016/s2214-109x(18)30448-0)
35. Siegel KR, Patel SA and Ali MK. Non-communicable diseases in South Asia: contemporary perspectives. *Br Med Bull* 2014; 111: 31–44. 2014/09/06. DOI: [10.1093/bmb/ldu018](https://doi.org/10.1093/bmb/ldu018)
36. Kudesia P, Salimrouny B, Stanley M, et al. The incidence of multimorbidity and patterns in accumulation of chronic conditions: A systematic review. *Journal of Multimorbidity and Comorbidity* 2021; 11: 26335565211032880. DOI: [10.1177/26335565211032880](https://doi.org/10.1177/26335565211032880)
37. Pati S, Swain S, Metsemakers J, et al. Pattern and severity of multimorbidity among patients attending primary care settings in Odisha, India. *PLoS One* 2017; 12: e0183966. 2017/09/15. DOI: [10.1371/journal.pone.0183966](https://doi.org/10.1371/journal.pone.0183966)
38. Dutta AK, Chacko A, Balekuduru A, et al. Time trends in epidemiology of peptic ulcer disease in India over two decades. *Indian J Gastroenterol* 2012; 31: 111–115. 2012/07/07. DOI: [10.1007/s12664-012-0201-5](https://doi.org/10.1007/s12664-012-0201-5)
39. Kshatri JS, Palo SK, Bhoi T, et al. Prevalence and Patterns of Multimorbidity Among Rural Elderly: Findings of the AH-SETS Study. *Front Public Health* 2020; 8: 582663. 2020/12/01. DOI: [10.3389/fpubh.2020.582663](https://doi.org/10.3389/fpubh.2020.582663)
40. Ghoshal UC, Singh R and Rai S. Prevalence and risk factors of gastroesophageal reflux disease in a rural Indian population. *Indian J Gastroenterol* 2021; 40: 56–64. 20210114. DOI: [10.1007/s12664-020-01135-7](https://doi.org/10.1007/s12664-020-01135-7)
41. Rai S, Kulkarni A and Ghoshal UC. Prevalence and risk factors for gastroesophageal reflux disease in the Indian population: A meta-analysis and meta-regression study. *Indian J Gastroenterol* 2021; 40: 209–219. 20210106. DOI: [10.1007/s12664-020-01104-0](https://doi.org/10.1007/s12664-020-01104-0)
42. Brune K and Patrignani P. New insights into the use of currently available non-steroidal anti-inflammatory drugs. *J Pain Res* 2015; 8: 105–118. 20150220. DOI: [10.2147/jpr.S75160](https://doi.org/10.2147/jpr.S75160)
43. Kaplan RC, Heckbert SR, Koepsell TD, et al. Use of calcium channel blockers and risk of hospitalized gastrointestinal tract bleeding. *Arch Intern Med* 2000; 160: 1849–1855. DOI: [10.1001/archinte.160.12.1849](https://doi.org/10.1001/archinte.160.12.1849)
44. Directorate General of Health Services. MOHFW GoI. National programme for Prevention and control of Cancer, Diabetes, Cardiovascular diseases and Stroke (NPCDCS). 2013. Revised: 2013-17.
45. Fabbri E, An Y, Zoli M, et al. Aging and the burden of multimorbidity: associations with inflammatory and anabolic hormonal biomarkers. *J Gerontol A Biol Sci Med Sci* 2015; 70: 63–70. 2014/08/12. DOI: [10.1093/gerona/glu127](https://doi.org/10.1093/gerona/glu127)
46. 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. 2020/10/30. DOI: [10.1177/2235042x20961919](https://doi.org/10.1177/2235042x20961919)
47. Canizares M, Hogg-Johnson S, Gignac MAM, et al. Increasing Trajectories of Multimorbidity Over Time: Birth Cohort Differences and the Role of Changes in Obesity and Income. *J Gerontol B Psychol Sci Soc Sci* 2018; 73: 1303–1314. 2017/02/16. DOI: [10.1093/geronb/gbx004](https://doi.org/10.1093/geronb/gbx004)
48. Divo MJ, Martinez CH and Mannino DM. Ageing and the epidemiology of multimorbidity. *Eur Respir J* 2014; 44: 1055–1068. 2014/08/22. DOI: [10.1183/09031936.00059814](https://doi.org/10.1183/09031936.00059814)
49. Bonita R and Beaglehole R. Women and NCDs: overcoming the neglect. *Glob Health Action* 2014; 7: 23742. 20140505. DOI: [10.3402/gha.v7.23742](https://doi.org/10.3402/gha.v7.23742)
50. Pati S, Swain S, Knottnerus JA, et al. Magnitude and determinants of multimorbidity and health care utilization among patients attending public versus private primary care: a cross-sectional study from Odisha, India. *Int J Equity Health* 2020; 19: 57. 20200429. DOI: [10.1186/s12939-020-01170-y](https://doi.org/10.1186/s12939-020-01170-y)
51. Alimohammadian M, Majidi A, Yaseri M, et al. Multimorbidity as an important issue among women: results of a gender difference investigation in a large population-based cross-sectional study in West Asia. *BMJ Open* 2017; 7: e013548. 20170509. DOI: [10.1136/bmjopen-2016-013548](https://doi.org/10.1136/bmjopen-2016-013548)
52. Read JR, Sharpe L, Modini M, et al. Multimorbidity and depression: A systematic review and meta-analysis. *J Affect Disord* 2017; 221: 36–46. 2017/06/20. DOI: [10.1016/j.jad.2017.06.009](https://doi.org/10.1016/j.jad.2017.06.009)
53. Triolo F, Harber-Aschan L, Belvederi Murri M, et al. The complex interplay between depression and multimorbidity in late life: risks and pathways. *Mech Ageing Dev* 2020; 192: 111383. 2020/10/13. DOI: [10.1016/j.mad.2020.111383](https://doi.org/10.1016/j.mad.2020.111383)
54. Gummidi B, John O, John R, et al. Catastrophic Health Expenditure and Distress Financing Among Patients With Nondialysis Chronic Kidney Disease in Uddanam, India. *Kidney Int Rep* 2022; 7: 319–321. 2022/02/15. DOI: [10.1016/j.ekir.2021.10.015](https://doi.org/10.1016/j.ekir.2021.10.015)