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Prevalence and correlates of Multimorbidity among older adults in rural Nepal: a cross sectional study

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Abstract

Objectives: The objective of the present study was to estimate the prevalence of major chronic diseases and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.

Design: This was a cross-sectional study, conducted between January to April 2018.

Setting: Community setting of Rural Nepal

Participants: 794 Nepalese older adults recruited using a multi-stage cluster sampling approach in two rural setting of *Sunsari* and *Morang* District of Nepal

Primary and secondary outcome measure(s): Prevalence of major chronic diseases and multimorbidity among older adults in rural Nepal. Secondary outcomes include correlates of multi-morbidity.

Results: 48.9% of the participants had at least one chronic condition, and 14% were multimorbid. The prevalence of individual conditions were osteoarthritis- 41.7%, CVD- 2.39%, diabetes- 5.29%, and COPD- 15.7%. In the adjusted model, older adults aged 70-79 years, those from underprivileged Madhesi and other ethnic groups, without a history of alcohol drinking, and those physically inactive, were significantly associated with multimorbidity.

Conclusions: Our study found a sizeable proportion of the older adults had multimorbidity in our studied population. This prevalence of multimorbidity and its socioeconomic and behavioural correlates, need to be addressed through multi-level preventive strategies, including clinical guidelines and the development of a multidisciplinary workforce to address the needs of the multimorbid older adults.

Keywords: Community, Correlates, Chronic disease, Multimorbidity, Older adults

Strengths and limitations of this study

- This is the first study that estimated the prevalence of major chronic diseases and multimorbidity among older adults in rural Nepal.

- In addition to informing prevalence of morbidity we examined older adults aged 70-79 years, those from underprivileged Madhesi and other ethnic groups, without a history of alcohol drinking, and those physically inactive, were significantly associated with multimorbidity.

- A cause-effect relationship between multimorbidity and its correlates cannot be inferred due to the cross-sectional design of the study.

- We have included only four chronic conditions in the definition of multimorbidity.

Introduction

The population of older adults is increasing globally [1] and is projected to increase to over 1.5 billion by 2050. [2] A similar demographic transition is occurring in Nepal. The Senior Citizen Act in Nepal 2006 defines "an individual aged 60 and over as a senior citizen". [3] In the most recent census in Nepal in 2011, there were 2.5 million population older adults (8.1%). This population is growing at a rate of 3.5% annually, which exceeds the nation's overall population growth rate at 1.35% . [4] While we celebrate longevity [5,6], health and quality of life are two crucial agendas for the older population which significantly increases the demand on health services. [7-9]

Multimorbidity is the simultaneous coexistence of two or more chronic conditions in the same individual. [10] Multimorbidity has a significant impact on the quality of life and the demand for health care. [11-12] The impact of multimorbidity is greater than the cumulative effect of the single disease. [13] Individuals with multimorbidity are at substantially greater risk of death compared to those with single conditions. [14] Multimorbidity also adds to the existing challenges of providing quality geriatric health care, especially in developing countries with limited resources.

The prevalence of chronic multimorbidity has increased substantially across the globe, especially among those aged 65+ with a reported prevalence of 33.1%. [15] Longevity, coupled with an increase in incident chronic disease and sedentary and unhealthy lifestyles, suggests that the burden of multimorbidity, especially among the older population, will continue to rise globally. [10] Momentum to recognize and address multimorbidity in clinical settings has increased in many high income countries. [16] However, in developing countries, this emerging public health issue is often overlooked. [17] South Asians are comparatively at an elevated risk for developing cardio-metabolic and other chronic diseases [18], which makes them more susceptible to multimorbidity. The Nepal

STEPS survey, 2013 reported that 99.6% of the Nepali adults had at least one (of the eight known risk factors for chronic diseases).[19] Hence, the burden of multimorbidity among Nepalese is anticipated to be higher. There is, however, comparatively little information on its prevalence. Previously, using data from the 2003 World Health Survey, a 15.2% prevalence of multimorbidity among the Nepali population was estimated, which doubled for the older age groups (30.2%). [20] Previous research on multimorbidity has mostly focused on quantifying the prevalence [20,21] and has not analysed its association with risk behaviours or underlying social and economic factors.

Although multimorbidity requires a multitude of specialists' referrals, biomedical investigations, and polypharmacy, current health care is based on a single disease approach to treatment, which may not be appropriate to manage patients with multimorbidity. Multimorbidity is challenging for both patients and health professionals, especially in setting priority goals for self-management. As we understand more about the multimorbidity and the inequalities in its burden, subpopulations at risk may be identified for preventive strategies. Till date, there has been no specific study that focused on multi-morbidity in Nepalese older adults. Therefore, this study aimed to assess the prevalence of major chronic diseases and multimorbidity among Nepali older adults and examine the associated socioeconomic and behavioural risk factors.

Methods

Study designs and participants

This study was a community based cross sectional study conducted among Nepalese older adults 60 years or older living rural part of *Sunsari* and *Morang* districts of Nepal. We recruited study samples using a multi-stage cluster sampling approach and data was collected from 794 study participants through face to face interview. The data collection period was between January to April 2018. Details of the methodology of this study are documented elsewhere. [22] Data were collected using a validated Nepali version survey questionnaire administered through trained research assistant in the field. Prior to the interview, thumb impressions were obtained from those who were unable to read and write and written informed consent from all literate participants.

Patient and public involvement

Patients and the public were not involved in the conception of this study, development of the research question, interpretation of the results or manuscript writing.

Measurements

Multimorbidity

The information on a range of chronic conditions was collected using self-reported information from the patients. The self-reports were verified, with participant's consent, from a family member, or by accessing health records from the health facilities. Table 1 presents the definition of the individual condition and multimorbidity.

Co-variates

Included independent variable were age; gender; religion; ethnicity; living arrangement; marital status; occupation; literacy status; monthly personal income; alcohol drinking habits; smoking habit; habit of tobacco chewing and physical activity. These co-variates have been described in the previous work published by Yadav et.al. [23] The study protocol was approved by the Ethics Board of Nepal Health Research Council, Government of Nepal, Kathmandu.

Statistical analysis

Stata (Version 13.0). was used to analyze the data. Descriptive analysis was performed on each of the studied variables. Univariate analysis was performed using the chi-square ($\chi2$) test and the variables with p-value <0.2 were included in a mixed-effected logistic regression model. The generalized estimating equation (GEE) approach with 95% confidence intervals (95% CI) was employed to examine the association between multimorbidity and its associated factors.

Results

The mean age of the participants was 69.9 years, and there was equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), illiterate (80.1%), married (53.8%), from indigenous or Madhesi ethnic groups (72.0%), unemployed (54.2%) and had a family income of 44 USD or less at the time of the survey. The majority

of the participants were physically inactive (77.1%) and had a history of tobacco smoking (62.2%), but no history of alcohol use (63.4%) (Table 2).

Prevalence of multimorbidity

The prevalence of the individual chronic diseases and their combinations is presented in Table 2. The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%, respectively. While 48.9% of the participants were suffering from at least one chronic condition, 14.7% were suffering from multimorbidity.

Socioeconomic, lifestyle characteristics and multimorbidity

Table 3 shows the distribution of multiple morbidities by different socioeconomic and lifestyle characteristics of the participants. The mean age of the participants suffering from multimorbidity was 70.3 years. The prevalence of multimorbidity was similar in both genders (16.8% vs. 12.5%, p=0.09). Participants who were from Muslim communities had a relatively higher prevalence of multimorbidity (16.0%). The prevalence of multimorbidity was significantly higher among unemployed (18.4% vs. 10.2%, p=0.001), those who never had alcohol drinking habit (16.9% vs. 10.7%, p=0.01) and physically inactive (18.3% vs. 2.2%, p<0.001).

Risk factors associated with multimorbidity

Factors associated with multimorbidity, estimated in the crude and adjusted logistic regression model, are shown in Table 4. In the final adjusted model, age, ethnicity, alcohol drinking habit, and physical inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years) had 62% higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54; p-value=0.033) compared to the individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had a 52% lower probability of multimorbidity than those of the higher caste (AOR: 0.48; 95% CI: 0.31-0.77; p-value=0.002). Unemployed participants had 50% higher odds of multimorbidity than those employed, although the statistical significance was at the borderline (p-value = 0.060). Surprisingly, study participants with no alcohol drinking history had around 50% higher probability of multimorbidity than those with a history. However, physically inactive individuals had five times higher odds of multimorbidity than those with regular physical activities (AOR: 5.02; 95% CI: 1.47-17.17; p-value=0.010).

Discussion

This is the first study to assess the prevalence and correlates of multimorbidity among older adults in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD conditions. Approximately, 15% had multimorbidity – most frequently involving osteoarthritis and COPD. Participant's age and behavioral risk factors (alcohol use and physical inactivity) were associated with multimorbidity.

A sizeable proportion of the older adults had multimorbidity, despite having a mean age of 69.9 years which is low compared to studies in other countries Previous studies of multimorbidity among the Nepalese population are limited, and the only available estimates come from the World Health Survey (2003), which showed a prevalence of 15.2% among the Nepali population, which doubled for the age group 65+ (30.2%). [20] Since Nepal is in the epidemiologic transition, we would expect to see a higher prevalence of multimorbidity compared to the estimates from 2003. [20] However, our prevalence estimate (14%) is half that of the 2003 World Health Survey for the older age group. In our study, the possible reasons behind this discrepancy could be due to the measurement of a limited number of common chronic conditions (only four conditions were included), methodological differences, or geographical variation. In this regard, we suggest the need to develop a uniform standardized definition of multimorbidity, including the specific conditions to be included. A study from India showed that illiterate participants tend to overestimate health problems when self-reported.[24] In the present context, illiteracy is high among older Nepali adults [4], which may explain the higher prevalence of multimorbidity in the World Health Survey, resulting from overestimates of self-reported conditions. Second, in the study of multimorbidity, the number, and type of chronic conditions included in the count contributed to greater variability in estimates between the studies. [25] Given that the high prevalence of depression among older Nepali adults (50%) [26], the inclusion of depression (included in World Health Survey but not in our study) is likely to explain the higher prevalence of multimorbidity estimated in that survey.

The finding that one in seven older people in the study had multimorbidity is, however, not surprising given the high prevalence of chronic diseases and the increasing rates of physical inactivity and excessive alcohol consumption. [19] These risk behaviors increase the incidence of chronic conditions as well as the progression into multimorbidity from a single condition. The observed prevalence of multimorbidity is of concern because the impact of multimorbidity is greater than the cumulative effects of single disease. [13] Multimorbidity substantially reduces the

quality of life and increases the risk of premature death. [11,14] It increases the demand for health care and thus adds to the existing challenges faced by health and social services. [11,12]

Significant differences in multimorbidity by ethnicity were noted: minority groups, particularly the Madhesi ethnic group, were slightly more likely to suffer from multimorbidity than the upper caste groups. Our finding is consistent with previous literature from Nepal, which documented a higher burden of chronic disease among the Madhesi ethnic group. [22,27] Historically, the Madhesi ethnic group was considered disadvantaged in the society as they were discriminated against by the upper caste groups and had limited access to education and employment. [28] As one of the marginalized groups, these groups have a comparatively lower socioeconomic status increasing threats to their poor outcomes in health and wellbeing. [29]

The increased risk of multimorbidity among physically inactive individuals is consistent with other research. [30-32] However, surprisingly, study participants with no prior history of alcohol use had 50% higher odds of multimorbidity than those with alcohol use. The literature on the association between alcohol consumption and multimorbidity has been inconsistent since previous studies have reported lower odds of having multimorbidity among those who consumed alcohol daily [30], whereas other studies found no association between alcohol consumption and multimorbidity. [31,33] Two things may explain the findings. First, in a society where alcohol consumption is prohibited, self-reported measures of alcohol consumption are not reliable, and participants' responses may be subjected to social desirability bias. Second, in a low-income setting such as ours, the ability to consume alcohol also indicates an individual's purchase capacity and relative wealth. Hence, older adults who could afford to consume alcohol may have had a relatively better socio-economic status that may have provided an advantage to better health in later life.

In light of our findings, we suggest the need to shift from the approach of treating and management of single conditions to a more integrated approach where patients' needs can be more comprehensively met. Our study demonstrated the strong association between multimorbidity and physical inactivity, which suggests both the opportunity for early prevention and the need for tailoring the physical activity to the level of disability (especially for osteoarthritis). In this regard, our findings have implications at the primary health care level as well as at the secondary/tertiary levels, where health care providers can assess physical activity level among the multimorbidity patients and can tailor interventions accordingly to avert the further health consequences among

the people with multimorbidity, especially among socioeconomically deprived communities.., Physical activity needs to be mainstreamed in existing community health programs and at all levels of care. We also underscore the need for the attention of policymakers and the implementors to invest more in the development of multidisciplinary management packages for chronic multimorbid conditions.

Moreover, we suggest the need for a community based longitudinal study that can look at a large number of conditions with a more precise measurement of the lifestyle factors. Further, we also suggest the need for qualitative research to understand the problems at the individual and population levels, community/family level, and organizational level, which might be help to develop a comprehensive intervention package for people with chronic multimorbid conditions.

Strengths and limitations

Some of the strengths of this study include a very high response rate, data collection by trained enumerators who were fluent local languages (Maithili/Tharu/Nepali). Limitations included: a) cross-sectional design that precludes examination of the cause-effect relationship; b) limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal. Additional limitation includes the inclusion of only four chronic conditions in the definition of multimorbidity. Further, our lifestyle measures may be subject to social desirability bias.

Conclusions

This study found a high prevalence of multimorbidity among older adults in rural Nepal. There is a need to conduct a more comprehensive, nationally representative study to obtain a more reliable estimate of prevalence and correlates of its multimorbidity. In recent years, there have been increased concerns and commitments from the Nepal government to identify and address the health and social needs of older Nepali adults. As such, the findings will help policymakers and stakeholders to identify needs, develop preventive strategies and clinical guidelines, and address the needs of a growing multi-morbid older population.

Abréviations

NCD: Non-communicable disease

COPD: Chronic Obstructive Pulmonary Disease

CVD: Cardiovascular disease

CI : Confidence Interval

AOR: Adjusted Odds Ratio

RMs: Rural Municipalities

Declarations

Acknowledgements

Contributions

Conceived and designed the experiments: UNY, SG, LBR and MFH. Performed field work: UNY, SG, SKM and LBR. Analysed the data: UNY, SG SKM, SS, LBR and MFH. Wrote the paper: UNY, SG SKM, SS, LBR and MFH. All authors read and approved the final manuscript.

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Ethics approval and consent to participate

The study was approved by the Institutional Review Board of Nepal Health Research Council, Government of Nepal, Ministry of Health, Kathmandu. After detailed information, all study participants gave their written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Table.1. Definition of chronic conditions included in the study

Conditions	Definition
Diabetes	Taking diabetic medications (insulin, hypoglycemic); self-report of diabetes; or diabetes recorded as a diagnosis in the medical record.
Chronic obstructive pulmonary disease (COPD)	Clinical assessment as evident in the medical records or use of bronchodilators, or self-reported production of sputum for last three months with any smoking history.
Cardiovascular disease	Presence of any of the following conditions: - • Hypertension – self-report of diagnosed hypertension; verified by blood pressure level in the provided medical records. • Self-report of heart attack, angina, or "heart trouble" • Stroke – self-reported presence of valve disease or taking medications for those.
Osteoarthritis	Self-report of joint pain problems
Multimorbidity	Presence of more than one of the four aforementioned conditions in the same individual. Multimorbidity was then dichotomized as present (i.e. 2–4 conditions) or absent (i.e., single condition) for assessing relationships with the independent variables.

Table 2 Prevalence of chronic diseases and multiple morbidities (n=794)

Conditions	Osteoarthritis n (%)	CVD n (%)	Diabetes n (%)	COPD n (%)
Osteoarthritis (OA)	331 (41.7%)			
Cardiovascular diseases (CVD)	13 (1.6%)	19 (2.4%)		
Diabetes	16 (2.0%)	3 (0.4%)	42 (5.3%)	
Chronic Obstructive Pulmonary Diseases (COPD)	90 (11.3%)	8 (1.0%)	6 (0.8%)	122 (15.4%)
OA and CVD			1 (0.1%)	5 (0.6%)
Diabetes & COPD	4 (0.5%)	0		
Any co-morbidities[1] n (%)	388 (48.9)			
Multiple morbidities[2] n (%)	116 (14.7)			

[1]Suffering from at least one of the chronic conditions: osteoarthritis, CVD, diabetes, and COPD.
[2]Suffering from two or more chronic conditions.

Table.3. Socio-demographic and lifestyle characteristics and status of multimorbidity

	[1] Multimorbidity		
	No N=678, (%)	Yes N=116, (%)	P value
Age (mean, SD)	69.9(8.9)	70.3(7.8)	0.627
Age (year, %)			

60 - 69	381(86.6)	59(13.4)	0.235
70 - 79	193(82.1)	42(17.9)	
≥ 80	104(87.3)	15(12.7)	
Gender			
Male	350(87.5)	50(12.5)	0.090
Female	328(83.2)	66(16.8)	
District			
Morang	351(86.9)	53(13.1)	0.226
Sunsari	327(83.9)	63(16.1)	
Religion			
Hinduism	529(84.7)	96(15.3)	0.046
Buddhism	19(100.0)	0(0.0)	
Islam	105(84.0)	20(16.0)	
Christianity	25(100.0)	0(0.0)	
Ethnicity			
Brahmin/Chettri/ Thakuri	62(89.9)	7(10.1)	0.706
Aadiwasi/Janjatis	255(85.6)	43(14.4)	
Dalit	132(84.1)	25(15.9)	
Madhesi and other ethnic groups	229(84.9)	41(15.1)	
Marital status			
Married	365(85.9)	60(14.1)	0.674
[2]Others	313(84.9)	56(15.1)	
Literacy			
Illiterate	538(84.6)	98(15.4)	0.201
literate	140(88.7)	18(11.3)	
Past occupation			
Employed	327(89.9)	37(10.1)	0.001
Unemployed	351(81.7)	79(18.3)	

Family monthly income			
USD < 49	331(86.9)	50(13.1)	0.453
USD 49 - 88	120(82.8)	25(17.2)	
USD > 88	227(84.8)	41(15.2)	
Tobacco smoking			
Never smoker	257(85.7)	43(14.3)	0.864
Having smoking history	421(85.2)	73(14.8)	
Tobacco chewing habit			
Never tobacco chewer	354(86.1)	57(13.9)	0.540
Having tobacco chewing history	324(84.7)	59(15.4)	
Alcohol drinking habit			
Never drinker	419(83.1)	85(16.9)	0.018
Having alcohol drinking history	259(89.3)	31(10.7)	
Physical activity			
No physical exercise at all	500(81.7)	112(18.3)	<0.001
Daily physical exercise	178(97.8)	4(2.2)	

[1]Suffering from at least two of the chronic conditions: osteoarthritis, CVD, diabetes, and COPD.
[2]Others denotes widowed/divorced/separated/unmarried.

Table. 4. Factors associated with multimorbidity in a multiple logistic regression model

	Crude			Adjusted		
	OR	P-value	95% CI	OR	P-value	95% CI
Age (year, %)						
60 - 69	1.00			1.00		
70 - 79	1.61	**0.027**	1.06-2.45	1.62	**0.033**	1.04-2.54
≥ 80	1.24	0.155	0.92-1.67	0.97	0.834	0.75-1.26
Gender						

Male	1.00			Not taken in the model		
Female	1.34	0.132	0.92-1.96			
District						
Morang	1.00			Not taken in the model		
Sunsari	1.27	0.713	0.36-4.49			
Religion						
Hinduism	1.00			Not taken in the model		
Buddhism	1.00	-	-			
Islam	0.69	0.396	0.79-1.62			
Christianity	1.00	-	-			
Ethnicity						
Brahmin/Chettri/Thakur	1.00			1.00		
Aadiwasi/Janjatis	0.66	**0.042**	0.44-0.99	0.80	0.489	0.44-1.49
Dalit	0.58	**0.000**	0.44-0.76	0.80	0.392	0.48-1.33
Madheshi and other ethnic groups	0.45	**0.002**	0.28-0.75	0.48	**0.002**	0.31-0.77
Marital status						
Married	1.00			Not taken in the model		
[1]Others	1.01	0.951	0.67-1.54			
Literacy						
Literate	1.00			Not taken in the model		
Illiterate	1.40	0.465	0.57-3.43			
Occupation						
Employed	1.00			1.00		
Unemployed	1.72	**0.012**	1.12-2.62	1.49	0.060	0.98-2.26
[2]Income						
USD < 49	1.00			Not taken in the model		

USD 49 - 88	0.98	0.972	0.42-2.31			
USD > 88	1.11	0.656	0.69-1.82			
Smoking habit						
Never tobacco user	1.00			Not taken in the model		
Having tobacco use history	1.05	0.713	0.81-1.35			
Tobacco chewing habit						
Never tobacco chewer	1.00			Not taken in the model		
Having tobacco chewing history	0.99	0.942	0.72-1.36			
Alcohol drinking habit						
Having alcohol drinking history	1.00			1.00		
Never drinker	1.41	**0.006**	1.10-1.81	1.53	**0.002**	1.18-2.01
Physical activity						
Daily physical exercise	1.00			1.00		
No physical exercise at all	5.51	**0.007**	1.60-19.05	5.02	**0.010**	1.47-17.17

Significant p-values are bolded. [2]Others denotes widowed/divorced/separated/unmarried. [2]113 Nrs approximates 1 US Dollar. Abbreviation: CVD- Cardiovascular disease, COPD- Chronic Obstructive Pulmonary Disease.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) a cross sectional study
		(*b*) Although multimorbidity has gained global attention, it remains a less studied area in Nepal. Our study aimed to estimate the prevalence of major chronic diseases and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.
Introduction		
Background/rationale	2	Although multimorbidity requires a multitude of specialists' referrals, biomedical investigations, and polypharmacy, current health care is based on a single disease approach to treatment, which may not be appropriate to manage patients with multimorbidity. Multimorbidity is challenging for both patients and health professionals, especially in setting priority goals for self-management. As we understand more about the multimorbidity and the inequalities in its burden, subpopulations at risk may be identified for preventive strategies. Till date, there has been no specific study that focused on multi-morbidity in Nepalese older adults.
Objectives	3	This study aimed to assess the prevalence of major chronic diseases and multimorbidity among Nepali older adults and examine the associated socioeconomic and behavioral risk factors.
Methods		
Study design	4	Cross-sectional study design
Setting	5	This study was a community based cross sectional study conducted among Nepalese older adults 60 years or older living rural part of *Sunsari* and *Morang* districts of Nepal. We recruited study samples using a multi-stage cluster sampling approach and data was collected from 794 study participants through face to face interview. The data collection period was between January to April 2018.
Participants	6	(*a*) Older adults aged 60 years or above
Variables	7	Health conditions data [*Osteoarthritis, Cardiovascular diseases (CVD), Diabetes, Chronic Obstructive Pulmonary Diseases (COPD)*] were collected for defining multi-morbidity- a dependent variable.
		Included independent variable were age; gender; religion; ethnicity; living arrangement; marital status; occupation; literacy status; monthly personal income; alcohol drinking habits; smoking habit; habit of tobacco chewing and physical activity
Data sources/ measurement	8*	NA
Bias	9	Multivariate analysis was done to adjust confounders.
Study size	10	This study involves the data from a samples[n=794]that was collected for frailty study using standard assumptions.[https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0]

Quantitative variables	11	
Statistical methods	12	(*a*) Stata (Version 13.0). was used to analyze the data. Descriptive analysis was performed on each of the studied variables. Univariate analysis was performed using the chi-square ($\chi2$) test and the variables with p-value <0.2 were included in a mixed-effected logistic regression model. The generalized estimating equation (GEE) approach with 95% confidence intervals (95% CI) was employed to examine the association between multimorbidity and its associated factors.
		(*b*) VIF was calculated and was found to be less than 0.2
		(*c*) No missing data
		(*d*) NA

Results

Participants	13*	(a) 794 participated
		(b) NA
		(c) Presented in previous publication [https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0/tables/1]
Descriptive data	14*	(a) The mean age of the participants was 69.9 years, and there was equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), illiterate (80.1%), married (53.8%), from indigenous or Madhesi ethnic groups (72.0%), unemployed (54.2%) and had a family income of 44 USD or less at the time of the survey. The majority of the participants were physically inactive (77.1%) and had a history of tobacco smoking (62.2%), but no history of alcohol use (63.4%) (Table 2).
		(b) NA
Outcome data	15*	The prevalence of the individual chronic diseases and their combinations is presented in Table 2. The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%, respectively. While 48.9% of the participants were suffering from at least one chronic condition, 14.7% were suffering from multimorbidity.
Main results	16	(*a*) Factors associated with multimorbidity, estimated in the crude and adjusted logistic regression model, are shown in Table 4. In the final adjusted model, age, ethnicity, alcohol drinking habit, and physical inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years) had 62% higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54; p-value=0.033) compared to the individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had a 52% lower probability of multimorbidity than those of the higher caste (AOR: 0.48; 95% CI: 0.31-0.77; p-value=0.002). Unemployed participants had 50% higher odds of multimorbidity than those employed, although the statistical significance was at the borderline (p-value = 0.060). Surprisingly, study participants with no alcohol drinking history had around 50% higher

probability of multimorbidity than those with a history. However, physically inactive individuals had five times higher odds of multimorbidity than those with regular physical activities (AOR: 5.02; 95% CI: 1.47-17.17; p-value=0.010).

		(*b*) NA
		(*c*) NA
Other analyses	17	NA

Discussion

Key results	18	We found that almost half (48.9%) of the older adults had at least one NCD conditions. Fourteen percent had multimorbidity – most frequently involving osteoarthritis and COPD. Participant's age and behavioral risk factors (alcohol use and physical inactivity) were associated with multimorbidity
Limitations	19	Some of the strengths of this study include a very high response rate, data collection by trained enumerators who were fluent local languages (Maithili/Tharu/Nepali). Limitations included: a) cross-sectional design that precludes examination of the cause-effect relationship; b) limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal. Additional limitation includes the inclusion of only four chronic conditions in the definition of multimorbidity. Further, our lifestyle measures may be subject to social desirability bias
Interpretation	20	Provided in discussion section
Generalisability	21	limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal.

Other information

Funding	22	No role of funding agency in this study.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study

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1

Abstract

Objectives: This study's objectives were to estimate the prevalence of major non-communicable conditions and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.

Design: This was a community-based cross-sectional study conducted between January to April 2018.

Setting: Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal.

Participants: 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage cluster sampling approach.

Primary outcome measure(s): Prevalence of four major non-communicable chronic conditions (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and multimorbidity.

Results: Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of four non-communicable chronic conditions, and 14.6% (male 12.5% ; female 16.8%) had two or more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8% ; female 2.0%), diabetes- 5.3% (male 6.0% ; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those from Madhesi and other ethnic groups (AOR: 1.08; 95% CI: 1.02-1.72), without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95% CI: 1.47-17.17) had significantly higher odds of multimorbidity.

Conclusions: This study found one in seven study participants had multimorbidity. The prevalence of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed by integrating social programs with health prevention and management at multiple levels. Moreover, a longitudinal study is suggested to understand the temporal relationship between lifestyle predictors and multimorbidity among Nepalese older adults.

2

Strengths and limitations of this study

- This is the first study that estimated the prevalence of four major non-communicable conditions and multimorbidity among older adults in rural Nepal.

- In addition to informing prevalence of morbidity, we examined its correlates and found older adults aged 70-79 years, without a history of alcohol drinking, and those physically inactive had significantly higher odds of multimorbidity.

- A cause-effect relationship between multimorbidity and these correlates cannot be inferred due to the cross-sectional design of the study.

- We have included only four non-communicable conditions in the definition of multimorbidity, and thus the estimated prevalence may be underestimated.

Introduction

88

89 The population of older adults is increasing globally[1] and is projected to increase to over 1.5

90 billion by 2050.[2] A similar demographic transition is occurring in Nepal. The Senior Citizen Act

91 in Nepal 2006 defines "an individual aged 60 and over as a senior citizen".[3] In the most recent

92 census in Nepal in 2011, there were 2.5 million population older adults (8.1%).[4] This population

93 is growing at a rate of 3.5% annually, which exceeds the nation's overall population growth rate

94 at 1.35%.[4] While we celebrate longevity,[5, 6] health and quality of life are two crucial agendas

95 for the older population.[7, 8] Older adults have a higher prevalence of non-communicable chronic

96 conditions, and with longevity, the likelihood of experiencing more than one non-communicable

97 chronic condition also increases.[9]

98 Multimorbidity is the simultaneous coexistence of two or more non-communicable conditions in

99 the same individual.[10] Multimorbidity has a significant impact on the quality of life and the

100 demand for health care.[11, 12] The impact of multimorbidity is greater than the cumulative effect

101 of the single condition.[13] Individuals with multimorbidity are at a substantially greater risk of

102 death compared to those with single conditions.[14] Multimorbidity also adds to the existing

103 challenges of providing quality geriatric health care, especially in developing countries with

104 limited resources. Although multimorbidity requires a multitude of specialists' referrals,

105 biomedical investigations, and polypharmacy, current health care is based on a single condition

106 approach to treatment, which may not be appropriate for patients with multimorbidity.[15, 16]

107 Multimorbidity is challenging for both patients and health professionals, especially in setting

108 priority goals for self-management. As we understand more about multimorbidity and the

109 inequalities in its burden, subpopulations at risk may be identified for preventive and self-

110 management strategies.

111 The prevalence of non-communicable conditions related to multimorbidity has increased

112 substantially across the globe, especially among those aged 65+ with a reported prevalence of

113 33.1%.[17] Longevity, coupled with an increase in incident non-communicable conditions and

114 sedentary and unhealthy lifestyles, suggest that the burden of multimorbidity, especially among

115 the older population, will continue to rise globally.[10] Efforts to recognize and address

116 multimorbidity in clinical settings has increased in many high-income countries.[18] However, in

117 developing countries, this emerging public health issue is often overlooked.[19]

4

118 The 2013, the Nepal STEPwise approach to surveillance (STEPS) survey reported that 99.6% of
119 the Nepalese adults had at least one of the eight known risk factors for non-communicable
120 conditions (smoking, alcohol consumption, less than five servings of fruits and vegetables per day,
121 low physical activity, raised blood pressure, raised blood glucose, overweight and obesity, and
122 raised total cholesterol).[17] Similarly, a study conducted by Yadav et al. found 74.8% of the
123 people with COPD had two or more non-communicable conditions.[20] Previously, using data
124 from the 2003 World Health Survey, a 15.2% prevalence of multimorbidity among the Nepalese
125 population was estimated, which doubled for the older age groups (30.2%).[21]

126 Previous research on multimorbidity has mostly focused on quantifying the prevalence[21, 22] and
127 has not analyzed its association with risk behaviors or underlying social and economic factors.
128 Rural areas in Nepal– are characterized by higher poverty rates and lower health literacy, lack of
129 human resources for health and regular supply of medications at the peripheral health system and
130 means (transportation and financial) to access healthcare- both inter-and intra-personal
131 characteristics.[23-25] Malnutrition, an important determinant of health and wellbeing, is also
132 more prevalent among older adults in rural than in urban Nepal.[26] Socioeconomic characteristics
133 play an important role in determining the prevalence and management of both single chronic
134 conditions and multimorbidity. Despite older adults being at increased risk, to date, there has been
135 no specific study that focused on multimorbidity and its risk factors in rural Nepalese older adults.
136 Therefore, this study aimed to assess the prevalence of major more non-communicable conditions
137 and multimorbidity among rural Nepalese older adults and examine the associated socioeconomic
138 and behavioral risk factors.

139 **Methods**

140 **Study design and participants**

141 This study was a community-based cross-sectional study conducted among Nepalese older adults
142 60 years or older living in the rural settings of *Sunsari* and *Morang* districts of Nepal. We recruited
143 study samples from the community settings using a multi-stage cluster sampling approach. In the
144 first stage, four rural municipalities (RMs) were randomly selected from each district. Secondly,
145 five wards were randomly selected in each of the selected RMs, and then finally, study participants
146 were randomly selected from the list of eligible subjects in each RMs. Data were collected between
147 January to April 2018 from 794 study participants through face-to-face interviews (a response rate

5

148 of 93.7%). The 53 who declined to participate were of similar characteristics that of included

149 sample in this study. Details of the methodology of this study are documented elsewhere.[27] Data

150 were collected using a validated Nepalese version survey questionnaire administered through

151 trained research assistants in the field. The inclusion criteria included Nepalese older adults aged

152 ≥60 years, residents of the community for the past year. The exclusion criteria included residing

153 in nursing care, being mentally disabled (clinically proved schizophrenia, bipolar mood disorder),

154 being seriously ill (terminal illness like cancer, chronic kidney condition), having a hearing

155 disability or being unable to communicate. Prior to the interview, thumb impressions were

156 obtained from those who were unable to read and write (n=636) and written informed consent was

157 obtained from all literate participants.

158 **Patient and public involvement**

159 Patients and the public were not involved in the conception of this study, development of the

160 research question, interpretation of the results, or manuscript writing.

161 **Measurements**

162 **Multimorbidity**

163 The data on four non-communicable chronic conditions (osteoarthritis, cardiovascular disease,

164 diabetes and COPD) was collected using self-reported information from the participants.

165 Information on self-reported non-communicable chronic conditions was verified either by

166 checking the medical records of the study participants or by asking about prescribed medicines

167 that they were taking for the relevant condition[28]. **Table 1** presents the definition of the

168 individual condition. Each of the individual conditions were coded as a binary response (0=absent,

169 1=present). The cumulative of the four conditions (range 0=absence of all four conditions to 4=

170 all four conditions present) were further dichotomized into presence or absence of multimorbidity,

171 where multimorbidity was defined as the presence of two or more conditions (cumulative score of

172 ≥2).

173 *Co-variates*

174   Included independent variables were age (continuous age recoded into 60-69, 70-79, and ≥80),

175 gender (male and female), study district (Morang and Sunsari), religion (Hinduism, Buddhism,

176 Islam, and Christianity), ethnicity, marital status, educational status, past occupation, family

6

177 monthly income, history of smoking, tobacco use and alcohol drinking (yes/no), and physical

178 activity. Based on the Nepal government's classification, ethnicity was categorized into

179 Brahmin/Chettri/Thakuri, Aadiwasi/Janjatis, Dalit, Madheshi and other ethnic groups.

180 Historically, the Brahmin/Chettri/Thakuri is considered as the upper caste group. Other ethnic

181 groups are relatively disadvantaged and minority groups. Marital status was dichotomized into

182 married and others; the latter included widowed, divorced, separated, and never married.

183 Educational status was defined in terms of the number of formal schooling years and was

184 categorized into with (any numbers of years of formal schooling) without (no formal schooling)

185 formal schooling. Participants were asked about their participation in different types of moderate-

186 to-vigorous intensity activities (such as regular walk, jogging, yoga, cycling, exercise, swimming,

187 weightlift, activities related to the farmhouse, etc.) over the previous seven days. Participants were

188 categorized as physically inactive if they reported not being involved in any activities; otherwise,

189 they were classified as physically active. Further details on these co-variates are also available in

190 the previous work published by Yadav et al.[27, 28]

Ethics

191

192 The study was approved by the Institutional Review Board of Nepal Health Research Council,

193 Government of Nepal, Ministry of Health, Kathmandu (Reg no: 545/2017). After detailed

194 information, all study participants gave their written informed consent.

Statistical analysis

195

196 Stata (Version 13.0) [29]was used to analyze the data. Descriptive analyses (mean with standard

197 deviation and frequency with percentage) are reported on each studied variable. Univariate

198 analysis was performed using the chi-square ($\chi2$) test, and the variables with p-value <0.2 were

199 included in a mixed-effected logistic regression model. The generalized estimating equation (GEE)

200 approach with 95% confidence intervals (95% CI) was employed to examine the association

201 between multimorbidity and its associated factors.

Results

202

Study participants characteristics

203

204 The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was

205 almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants

206 were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous
207 (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half
208 (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The
209 majority of the participants reported lack physical activity (77.1%) and had a history of smoking
210 (62.2%). However only 36.5% gave history of alcohol consumption. The descriptive findings have
211 been reported in our previous paper.[28]

Prevalence of individual chronic conditions/conditions and multimorbidity

213 The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%,
214 respectively. While 48.9% of the participants were suffering from at least one chronic condition,
215 14.6% had multimorbidity (**Table 2**). The prevalence of osteoarthritis, COPD, any comorbidities,
216 and multimorbidity was higher among females compared to male participants, whereas that for
217 cardiovascular disease and diabetes were more prevalent in males than females (**Table 3**). The
218 only significant differences in prevalence between males and females were for osteoarthritis and
219 any comorbidities (**Table 3**).

Socioeconomic and lifestyle characteristics by multimorbidity

221 The mean age of the participants with multimorbidity was 70.3 years (**Table 4**). The prevalence
222 of multimorbidity was similar in males compared to females (16.8%; 12.5%, p=0.090). The
223 prevalence of multimorbidity was significantly higher among unemployed (18.4%; 10.2%,
224 p<0.001), those without a history of drinking alcohol (16.9%; 10.7%, p=0.018), and those who
225 were physically inactive (18.3%; 2.2%, p<0.001) compared the other respondents (Table 2).

Risk factors associated with multimorbidity

227 In the final adjusted model (**Table 5**), age, ethnicity, history of alcohol drinking, and physical
228 inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years)
229 had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the
230 individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher
231 odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95%
232 CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-
233 2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically
234 inactive individuals had five times higher odds of multimorbidity compared with those who were
235 physically active (AOR: 5.02; 95% CI: 1.47-17.17).

8

Discussion

236

237 This is the first study to assess the prevalence and correlates of multimorbidity among older adults
238 in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD
239 conditions. Approximately one in seven had multimorbidity – most frequently involving
240 osteoarthritis and COPD. This proportion was low compared to reported from India (>35%),
241 China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the Nepalese
242 population are limited, and the only available estimates come from a World Health Survey
243 (WHS)[21] conducted in 2003 that defined multimorbidity as the presence of two or more of the
244 six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or psychosis,
245 and diabetes. This survey found a prevalence of 15.2% among the Nepalese population, which
246 doubled for the age group 65+ (30.2%).[21] Since Nepal has an ageing population and is in the
247 process the epidemiologic transition, we would expect to see a higher prevalence of multimorbidity
248 compared to the estimates from 2003. However, our prevalence estimate was half that of the 2003
249 World Health Survey for the older age group. In our study, the possible reasons behind this
250 discrepancy could be the measurement of a limited number of common non-communicable
251 conditions (only four conditions included), methodological differences, or geographical variation.
252 In multimorbidity studies, the number and type of conditions included in the count contributed to
253 greater variability in estimates between the studies.[33]Given that the high prevalence of
254 depression among older Nepalese adults (>50%),[28] the inclusion of depression in World Health
255 Survey but not in the currently reported result is likely to explain most of the difference in
256 prevalence of multimorbidity. Moreover, in our current study those who were mentally disabled
257 (clinically proved schizophrenia, bipolar mood disorder) or seriously ill (terminal illness like
258 cancer, chronic kidney condition) were excluded from the study, and this could have contributed
259 to an underestimation of multimorbidity prevalence. In this regard, this suggests the need to
260 develop a uniform standardized definition of multimorbidity, including which specific conditions
261 should be included.

262 The impact of multimorbidity is greater than the cumulative effects of a single condition.[13] In
263 the Nepalese context, patients with multimorbidity rely on specialist services at secondary or
264 tertiary hospitals as the primary health care system is not have the capacity to adequately assess
265 and manage non-communicable chronic conditions, including multimorbidity. There is a need for

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266 a multi-sectoral integrated primary care approach[34] to address the needs of pre-existing non-
267 communicable chronic conditions, including multimorbidity.

268 Significant differences in multimorbidity by ethnicity were noted: underprivileged minority
269 groups, particularly the Madhesi ethnic group, were slightly more likely to suffer from
270 multimorbidity than the upper caste groups. Our finding is consistent with previous literature from
271 Nepal, which documented a higher burden of non-communicable chronic conditions among the
272 Madhesi ethnic group.[20, 27] Historically, the Madhesi ethnic group were discriminated against
273 by the upper caste groups and had limited access to education and employment.[35] As one of the
274 marginalized groups, they have a comparatively lower socioeconomic status increasing their risk
275 of poor health and wellbeing.

276 The increased risk of multimorbidity among physically inactive individuals is consistent with other
277 research.[36-38] However, surprisingly, study participants without a history of alcohol drinking
278 had 50% higher odds of multimorbidity than those with such history. The literature on the
279 association between alcohol consumption and multimorbidity has been inconsistent since previous
280 studies have reported lower odds of having multimorbidity among those who consumed alcohol
281 daily,[36] whereas other studies found no association between alcohol consumption and
282 multimorbidity.[37, 39]. Likewise, few studies have reported that use of alcohol may have
283 protective effects against some NCDs like type II diabetes [40]and cardiovascular disease[41, 42],
284 however a large metanalysis results evidenced that alcohol use is a risk for non-communicable
285 disease. A number of explanations may justify our findings. First, in a society where alcohol
286 consumption is unaccepted, self-reported measures of alcohol consumption are not reliable, and
287 participants' responses may be subjected to social desirability bias. Second, people with
288 multimorbidity might have stopped drinking alcohol and could have been reluctant is reporting the
289 history of alcohol use at the time of field survey. Third, in a low-income setting such as ours, the
290 ability to consume alcohol also indicates an individual's purchasing power and relative wealth.
291 Hence, older adults who could afford to consume alcohol may have had a relatively better
292 socioeconomic status, good access to health services and had associated better health in later life.
293 In this light, our finding warrants the need of longitudinal research to access the temporal
294 relationship between alcohol use and multimorbidity.

295

Policy Implications

296   In light of our findings, we suggest the need to shift from the approach of treating and management
297   of single conditions to a more integrated approach where peoples' needs can be more
298   comprehensively met.[43] Our study demonstrated the strong association between multimorbidity
299   and lack of physical activity, which suggests both the opportunity for early prevention and the
300   need for tailoring the physical activity to the level of disability (especially for osteoarthritis). In
301   this regard, our findings have implications at the primary health care level as well as at the
302   secondary/tertiary levels, where health care providers can assess physical activity level among the
303   multimorbidity patients and can tailor interventions accordingly to avert the further health
304   consequences among the people with multimorbidity, especially among socioeconomically
305   deprived communities. Promotion of physical activity needs to be mainstreamed in existing
306   community health programs and at all levels of care. There is a need for national population-based
307   data on non-communicable conditions, to assess their burden on Nepalese society and to guide
308   policies and strategies to tackle NCDs.

Strengths and limitations

311   Some of the strengths of this study include a very high response rate (93.7%), data collection by
312   trained enumerators fluent in local languages (Maithili/Tharu/Nepalese). It is the first community-
313   based study to report multimorbidity prevalence from Nepal. Limitations included: a) cross-
314   sectional design that precludes examination of the cause-effect relationship; b) limited
315   generalizability to younger age groups and geography other than Morang and Sunsari districts of
316   Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A
317   major limitation was the inclusion of only four chronic conditions in the survey and in the
318   definition of multimorbidity. The study analysed survey data conducted for the main objective of
319   assessing frailty among older adults. These factors may have contributed to an underestimation of
320   the prevalence of multimorbidity. The assessment of lifestyle behaviour may be subject to social
321   desirability bias. All this suggests the need for a community-based longitudinal study that can
322   include a larger number of conditions and assess the impact of lifestyle behaviours over time.
323   There is also a need for qualitative research to understand the problems at the individual,
324   community/family, and organization level which influence the development and management of
325   multimorbidity and inform more comprehensive interventions to address it.

11

Conclusions

This study found a modest prevalence of multimorbidity among older adults in rural Nepal. There is a need to conduct a more comprehensive, nationally representative study to obtain a more reliable estimate of prevalence and correlates of multimorbidity. The prevalence of multimorbidity and its socioeconomic and behavioral correlates needs to be addressed by integrating social programs with health prevention and management at multiple levels. As such, the findings will help policymakers and stakeholders identify needs and develop comprehensive multi-sectoral strategies to address the needs of a growing older population with multimorbidity.

Acknowledgments

Contributions

Conceived and designed the experiments: UNY, LBR, and MFH. Performed fieldwork: UNY, SKM and LBR. Analysed the data: UNY, SG SKM, SS, LBR and MFH. Wrote the paper: UNY, SG, SKM, SS, LBR, and MFH. All authors read and approved the final manuscript.

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The authors declare that they have no competing interests.

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The de-identified data are available on request from the corresponding author.

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495 **Table 1.** Definition of chronic conditions included in the study

Conditions	Definition
Diabetes	Taking diabetic medications (insulin, hypoglycemic); self-report of diabetes; or diabetes recorded as a diagnosis in the medical record. *In line with operational definition, the diabetes condition was coded as "1" and its absence as "0".*
Chronic obstructive pulmonary disease (COPD)	Clinical assessment as evident in the medical records or use of bronchodilators, or self-reported production of sputum for last three months with any smoking history. *In line with operational definition, COPD was coded as "1" and its absence as "0".*
Cardiovascular disease (CVD)	Presence of any of the following conditions: - • Hypertension – self-report of diagnosed hypertension; verified by blood pressure level in the provided medical records. • Self-report of heart attack, angina, or "heart trouble" • Stroke – self-reported presence of valve condition or taking medications for those. *In line with operational definition, CVD condition was coded as "1" and its absence as "0".*
Osteoarthritis	Self-report of joint pain problems. *In line with operational definition, joint problem was coded as "1" and its absence as "0".*
Multimorbidity	Presence of more than one of the four aforementioned conditions in the same individual. Multimorbidity was then dichotomized as present (i.e. 2–4 conditions) or absent (i.e., single or no condition) for assessing relationships with the independent variables.

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502 **Table 2.** Prevalence of chronic conditions and multiple morbidities (n=794)

Conditions	Osteoarthritis n (%)	CVD n (%)	Diabetes n (%)	COPD n (%)
Osteoarthritis (OA)	331 (41.7)			
Cardiovascular disease (CVD)	13 (1.7)	19 (2.4)		
Diabetes	16 (2.0)	3 (0.4)	42 (5.3)	
Chronic obstructive pulmonary disease (COPD)	90 (11.3)	8 (1.0)	6 (0.8)	122 (15.4)
OA and CVD			1 (0.1)	5 (0.6)
Diabetes & COPD	4 (0.5)	0.0		
Any comorbidities[1] n (%)	388 (48.9)			
Multiple morbidities[2] n (%)	116 (14.6)			

503 [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.
504 [2]Two or more chronic conditions were prevalent.
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507 **Table 3.** Gender-wise distribution of non-communicable chronic conditions and multimorbidity.

Prevalent conditions	Male	Female	*P-value*
Osteoarthritis	150 (37.5)	181 (45.9)	**0.016**
CVD	11 (2.8)	8 (2.0)	0.507
Diabetes	24 (6.0)	18 (4.6)	0.368
COPD	53 (13.3)	69 (17.5)	0.096
OA and CVD	8 (2.0)	5 (1.3)	0.417
OA and Diabetes	8 (2.0)	8 (2.0)	0.976
OA and COPD	37 (9.3)	53 (13.5)	0.062
CVD and Diabetes	2 (0.5)	1 (0.3)	0.572
CVD and COPD	6 (1.5)	2 (0.5)	0.162
Diabetes and COPD	3 (0.8)	3 (0.8)	0.985
OA, CVD and Diabetes	1 (0.3)	0 (0.0)	0.321
OA, CVD and COPD	4 (1.0)	1 (0.3)	0.184
OA, Diabetes and COPD	2 (0.5)	2 (0.5)	0.988
Diabetes, CVD, and COPD	-	-	-
OA, Diabetes, CVD, and COPD	-	-	-
[1]Any comorbidities	181 (45.3)	207 (52.5)	**0.040**
[2]Multimorbidity	50 (12.5)	66 (16.8)	0.090

508 Abbreviation: COPD: Chronic obstructive pulmonary disease, CVD: Cardiovascular disease,
509 OA: Osteoarthritis.
510 [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.
511 [2]Two or more chronic conditions were prevalent.
512 Significant p-values are bolded.

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533 **Table 4.** Socio-demographic and lifestyle characteristics by participant's multimorbidity status.

	[1] Multimorbidity		
	No N=678 (85.4%)	Yes N=116 (14.6%)	P-value
Age (mean, SD)	69.87 (8.8)	70.29 (7.7)	0.627
Age (year, %)			
60-69	381 (86.5)	59 (13.4)	0.235
70-79	193 (82.1)	42 (17.8)	
≥80	104 (87.3)	15 (12.6)	
Gender			
Male	350 (87.5)	50 (12.5)	0.090
Female	328 (83.2)	66 (16.7)	
Study district			
Morang	351 (86.8)	53 (13.1)	0.220
Sunsari	327 (83.8)	63 (16.1)	
Religion			
Hinduism	529 (84.6)	96 (15.3)	**0.046**
Buddhism	19 (100.0)	0 (0.0)	
Islam	105 (84.0)	20 (16.0)	
Christianity	25 (100.0)	0 (0.0)	
Ethnicity			
Brahmin/Chettri/ Thakuri	62 (89.8)	7 (10.1)	0.706
Aadiwasi/Janjatis	255 (85.5)	43 (14.4)	
Dalit	132 (84.0)	25 (15.9)	
Madhesi and other ethnic groups	229 (84.8)	41 (15.1)	
Marital status			
Married	365 (85.8)	60 (14.1)	0.674
[2]Others	313 (84.8)	56 (15.1)	

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Education status			
Without formal education	538 (84.5)	98 (15.4)	0.201
With formal education/schooling	140 (88.6)	18 (11.3)	
Past occupation			
Employed	327 (89.8)	37 (10.1)	**<0.001**
Unemployed	351 (81.6)	79 (18.3)	
Family monthly income			
USD <49	331 (86.8)	50 (13.1)	0.453
USD 49-88	120 (82.7)	25 (17.2)	
USD >88	227 (84.7)	41 (15.3)	
History of smoking			
No	257 (85.6)	43 (14.3)	0.864
Yes	421 (85.2)	73 (14.7)	
History of tobacco use			
No	354 (86.1)	57 (13.8)	0.540
Yes	324 (84.6)	59 (15.4)	
History of alcohol drinking			
No	419 (83.1)	85 (16.8)	**0.018**
Yes	259 (89.3)	31 (10.6)	
Physical activity			
Inactive	500 (81.7)	112 (18.3)	**<0.001**
Active	178 (97.8)	4 (2.2)	

534 [1] At least two chronic conditions (osteoarthritis, cardiovascular disease, diabetes, and chronic
535 obstructive pulmonary disease) were prevalent.
536 [2]Others denotes widowed/divorced/separated/unmarried.
537 Significant P-values are bolded.
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542 **Table 5.** Factors associated with multimorbidity in adjusted and unadjusted binary logistic
543 regression models.

	Crude			Adjusted		
	OR	P-value	95% CI	OR	P-value	95% CI
Age (year)						
60-69	1.00			1.00		
70-79	1.61	**0.027**	1.06-2.45	1.62	**0.033**	1.04-2.54
≥ 80	1.24	0.155	0.92-1.67	0.97	0.834	0.75-1.26
Gender						
Male	1.00			Not taken in the model		
Female	1.34	0.132	0.92-1.96			
Study district						
Morang	1.00			Not taken in the model		
Sunsari	1.27	0.713	0.36-4.49			
Religion						
Hinduism	1.00			Not taken in the model		
Buddhism	1.00	-	-			
Islam	0.69	0.396	0.79-1.62			
Christianity	1.00	-	-			
Ethnicity						
Brahmin/Chettri/Thakuri	1.00			1.00		
Aadiwasi/Janjatis	1.46	**0.042**	1.01-1.60	0.80	0.489	0.44-1.29
Dalit	1.08	**<0.001**	1.04-1.76	0.98	0.392	0.91-1.20
Madheshi and other ethnic groups	1.45	**<0.001**	1.28-1.75	1.08	**0.002**	1.02-1.72
Marital status						
Married	1.00			Not taken in the model		
[1]Others	1.01	0.951	0.67-1.54			

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Education status						
With formal education/schooling	1.00			Not taken in the model		
Without formal education	1.40	0.465	0.57-3.43			
Past occupation						
Employed	1.00			1.00		
Unemployed	1.72	**0.012**	1.12-2.62	1.49	0.060	0.98-2.26
Family monthly income						
USD < 49	1.00			Not taken in the model		
USD 49-88	0.98	0.972	0.42-2.31			
USD >88	1.11	0.656	0.69-1.82			
History of smoking						
No	1.00			Not taken in the model		
Yes	1.05	0.713	0.81-1.35			
History of tobacco use						
No	1.00			Not taken in the model		
Yes	0.99	0.942	0.72-1.36			
History of alcohol drinking						
Yes	1.00			1.00		
No	1.41	**0.006**	1.10-1.81	1.53	**<0.001**	1.18-2.01
Physical activity						
Active	1.00			1.00		
Inactive	5.51	**0.007**	1.60-19.05	5.02	**0.010**	1.47-17.17

544
545 Significant p-values are bolded. [2]Others denotes widowed/divorced/separated/unmarried.
546 Abbreviation: CVD- Cardiovascular disease, COPD- Chronic obstructive pulmonary disease.
547

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page number
Title and abstract	1	**(*a*)** Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study	1
		(*b*) **Objectives:** This study's objectives were to estimate the prevalence of major non-communicable conditions and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.	2
		Design: This was a community-based cross-sectional study conducted between January to April 2018.	
		Setting: Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal.	
		Participants: 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage cluster sampling approach.	
		Primary outcome measure(s): Prevalence of four major non-communicable chronic conditions (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and multimorbidity.	
		Results: Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of four non-communicable chronic conditions, and 14.6% (male 12.5% ; female 16.8%) had two or more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8% ; female 2.0%), diabetes- 5.3% (male 6.0% ; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those from Madhesi and other ethnic groups (AOR: 1.08; 95% CI:	

1.02-1.72), without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95% CI: 1.47-17.17) had significantly higher odds of multimorbidity.

Conclusions: This study found one in seven study participants had multimorbidity. The prevalence of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed by integrating social programs with health prevention and management at multiple levels. Moreover, a longitudinal study is suggested to understand the temporal relationship between lifestyle predictors and multimorbidity among Nepalese older adults.

Introduction			
Background/rationale	2	Although multimorbidity requires a multitude of specialists' referrals, biomedical investigations, and polypharmacy, current health care is based on a single disease approach to treatment, which may not be appropriate to manage patients with multimorbidity. Multimorbidity is challenging for both patients and health professionals, especially in setting priority goals for self-management. As we understand more about the multimorbidity and the inequalities in its burden, subpopulations at risk may be identified for preventive strategies. Till date, there has been no specific study that focused on multi-morbidity in Nepalese older adults.	4-5
Objectives	3	This study aimed to assess the prevalence of major chronic diseases and multimorbidity among Nepali older adults and examine the associated socioeconomic and behavioral risk factors.	5
Methods			
Study design	4	Cross-sectional study design	5
Setting	5	This study was a community based cross sectional study conducted among Nepalese older adults 60 years or older living rural part of *Sunsari* and *Morang* districts of Nepal. We recruited study samples using a multi-stage cluster sampling approach and data was collected from 794 study participants through face to face interview. The data collection period was between January to April 2018.	5
Participants	6	(*a*) Older adults aged 60 years or above	5
Variables	7	Health conditions data [*Osteoarthritis, Cardiovascular diseases (CVD), Diabetes, Chronic Obstructive Pulmonary Diseases (COPD)*] were collected for defining multi-morbidity- a dependent variable.	6

		Included independent variable were age; gender; religion; ethnicity; living arrangement; marital status; occupation; literacy status; monthly personal income; alcohol drinking habits; smoking habit; habit of tobacco chewing and physical activity	
Data sources/ measurement	8*	NA	
Bias	9	Multivariate analysis was done to adjust confounders.	7
Study size	10	This study involves the data from a samples[n=794]that was collected for frailty study using standard assumptions.[https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0]	6
Quantitative variables	11		
Statistical methods	12	(*a*) Stata (Version 13.0). was used to analyze the data. Descriptive analysis was performed on each of the studied variables. Univariate analysis was performed using the chi-square (χ2) test and the variables with p-value <0.2 were included in a mixed-effected logistic regression model. The generalized estimating equation (GEE) approach with 95% confidence intervals (95% CI) was employed to examine the association between multimorbidity and its associated factors.	7
		(*b*) VIF was calculated and was found to be less than 0.2	7
		(*c*) No missing data	6
		(*d*) NA	

Results

Participants	13*	(a) 794 participated	6
		(b) NA	
		(c) Presented in previous publication [https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0/tables/1]	7
Descriptive data	14*	The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The majority of the participants reported lack physical activity (77.1%) and had a history of smoking (62.2%). However only 36.5% gave history of alcohol	7-8

consumption. The descriptive findings have been reported in our previous paper.[28]

a) The mean age of the participants was 69.9 years, and there was equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), illiterate (80.1%), married (53.8%), from indigenous or Madhesi ethnic groups (72.0%), unemployed (54.2%) and had a family income of 44 USD or less at the time of the survey. The majority of the participants were physically inactive (77.1%) and had a history of tobacco smoking (62.2%), but no history of alcohol use (63.4%) (Table 2).

(b) NA

Outcome data	15*	The prevalence of the individual chronic diseases and their combinations is presented in Table 2. The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%, respectively. While 48.9% of the participants were suffering from at least one chronic condition, 14.7% were suffering from multimorbidity.	6
Main results	16	In the final adjusted model (Table 5), age, ethnicity, history of alcohol drinking, and physical inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years) had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95% CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically inactive individuals had five times higher odds of multimorbidity compared with those who were physically active (AOR: 5.02; 95% CI: 1.47-17.17).	8
		(*b*) NA	
		(*c*) NA	
Other analyses	17	NA	

Discussion

| Key results | 18 | This is the first study to assess the prevalence and correlates of multimorbidity among older adults in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD conditions. Approximately one in seven had multimorbidity – most frequently involving osteoarthritis and COPD. This proportion was low compared to reported from India (>35%), China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the Nepalese population are limited, and the only available estimates come from a World Health Survey (WHS)[21] conducted in 2003 that defined multimorbidity as the presence of two or more of the six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or psychosis, and diabetes. This survey found a prevalence of 15.2% among the Nepalese population, which doubled for the age group 65+ (30.2%).[21] Since Nepal has an ageing population and is in the process the epidemiologic transition, we would expect to see a higher prevalence of multimorbidity compared to the estimates from 2003. However, our prevalence estimate was half that of the 2003 World Health Survey for the older age group. In our study, the possible reasons behind this discrepancy could be the measurement of a limited number of common non-communicable conditions (only four conditions included), methodological differences, or geographical variation. In multimorbidity studies, the number and type of conditions included in the count contributed to greater variability in estimates between the studies.[33]Given that the high prevalence of depression among older Nepalese adults (>50%),[28] the inclusion of depression in World Health Survey but not in the currently reported result is likely to explain most of the difference in prevalence of multimorbidity. Moreover, in our current study those who were mentally disabled (clinically proved schizophrenia, bipolar mood disorder) or seriously ill (terminal illness like cancer, chronic kidney condition) were excluded from the study, and this could have contributed to an underestimation of multimorbidity prevalence. In this regard, this suggests the need to develop a uniform standardized definition of multimorbidity, including which specific conditions should be included. | 9 |
| Limitations | 19 | Some of the strengths of this study include a very high response rate (93.7%), data collection by trained enumerators fluent in local languages (Maithili/Tharu/Nepalese). It is the first community-based study to report multimorbidity prevalence from Nepal. | 11 |

Limitations included: a) cross-sectional design that precludes examination of the cause-effect relationship; b) limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A major limitation was the inclusion of only four chronic conditions in the survey and in the definition of multimorbidity. The study analysed survey data conducted for the main objective of assessing frailty among older adults. These factors may have contributed to an underestimation of the prevalence of multimorbidity. The assessment of lifestyle behaviour may be subject to social desirability bias. All this suggests the need for a community-based longitudinal study that can include a larger number of conditions and assess the impact of lifestyle behaviours over time. There is also a need for qualitative research to understand the problems at the individual, community/family, and organization level which influence the development and management of multimorbidity and inform more comprehensive interventions to address it.

| Interpretation | 20 | Provided in discussion section | 9-11 |
| Generalisability | 21 | limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal. | 11 |

| **Other information** | | | |
| Funding | 22 | No role of funding agency in this study. | |

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study

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1 **Prevalence of non-communicable chronic conditions, multimorbidity and its**
2 **correlates among older adults in rural Nepal: a cross-sectional study**

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1

36 **Abstract**

37 **Objectives:** This study's objectives were to estimate the prevalence of major non-communicable

38 conditions and multimorbidity among older adults in rural Nepal and examine the associated

39 socioeconomic and behavioral risk factors.

40 **Design:** This was a community-based cross-sectional study conducted between January to

41 April 2018.

42 **Setting:** Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal.

43 **Participants:** 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage

44 cluster sampling approach.

45 **Primary outcome measure(s):** Prevalence of four major non-communicable chronic conditions

46 (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and

47 multimorbidity.

48 **Results:** Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of

49 four non-communicable chronic conditions, and 14.6% (male 12.5%; female 16.8%) had two or

50 more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male

51 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8%; female 2.0%), diabetes- 5.3%

52 (male 6.0% ; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted

53 model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those

54 from Madhesi and other ethnic groups (AOR: 1.08; 95% CI: 1.02-1.72), without a history of

55 alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95%

56 CI: 1.47-17.17) had significantly higher odds of multimorbidity.

57 **Conclusions:** This study found one in seven study participants had multimorbidity. The prevalence

58 of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed

59 by integrating social programs with health prevention and management at multiple levels.

60 Moreover, a longitudinal study is suggested to understand the temporal relationship between

61 lifestyle predictors and multimorbidity among Nepalese older adults.

62 *Keywords: Community, Correlates, Chronic condition, Multimorbidity, Older adults*

2

Strengths and limitations of this study

- This is the first community-based cross-sectional study that estimated the prevalence of multimorbidity among older adults in rural Nepal.

- This the unique study that reported gender wise prevalence of osteoarthritis, COPD, any comorbidities, and multimorbidity where cardiovascular disease and diabetes were more prevalent in males than females.

- This study found that older adults aged 70-79 years, without a history of alcohol drinking, and those physically inactive have significantly higher odds of multimorbidity.

- A cause-effect relationship between multimorbidity and the identified correlates cannot be inferred due to the cross-sectional design of the study.

- We have included only four non-communicable conditions in the definition of multimorbidity, and thus the estimated prevalence may be underestimated.

3

Introduction

90 The population of older adults is increasing globally[1] and is projected to increase to over 1.5

91 billion by 2050.[2] A similar demographic transition is occurring in Nepal. The Senior Citizen Act

92 in Nepal 2006 defines "an individual aged 60 and over as a senior citizen".[3] In the most recent

93 census in Nepal in 2011, there were 2.5 million population older adults (8.1%).[4] This population

94 is growing at a rate of 3.5% annually, which exceeds the nation's overall population growth rate

95 at 1.35%.[4] While we celebrate longevity,[5, 6] health and quality of life are two crucial agendas

96 for the older population.[7, 8] Older adults have a higher prevalence of non-communicable chronic

97 conditions, and with longevity, the likelihood of experiencing more than one non-communicable

98 chronic condition also increases.[9]

99 Multimorbidity is the simultaneous coexistence of two or more non-communicable conditions in

100 the same individual.[10] Multimorbidity can have a significant impact on an individuals' quality

101 of life and the demand for health care.[11, 12] The impact of multimorbidity is greater than the

102 cumulative effect of the single condition.[13] Individuals with multimorbidity are at a substantially

103 greater risk of death compared to those with single conditions.[14] Multimorbidity also adds to the

104 existing challenges of providing quality geriatric health care, especially in developing countries

105 with limited resources. Although multimorbidity requires a multitude of specialists' referrals,

106 biomedical investigations, and polypharmacy, current health care is based on a single condition

107 approach to treatment, which may not be appropriate for patients with multimorbidity.[15, 16]

108 Multimorbidity is challenging for both patients and health professionals, especially in setting

109 priority goals for self-management. As we understand more about multimorbidity and the

110 inequalities in its burden, subpopulations at risk may be identified for preventive and self-

111 management strategies.

112 The prevalence of non-communicable conditions related to multimorbidity has increased

113 substantially across the globe, especially among those aged 65 years and older with a reported

114 prevalence of 33.1%.[17] Longevity, coupled with an increase in incident non-communicable

115 conditions and sedentary and unhealthy lifestyles, suggest that the burden of multimorbidity,

116 especially among the older population, will continue to rise globally.[10] Efforts to recognize and

117 address multimorbidity in clinical settings has increased in many high-income countries.[18]

118 However, in developing countries, this emerging public health issue is often overlooked.[19]

4

119 In 2013, the Nepal STEPwise approach to surveillance (STEPS) survey reported that 99.6% of the

120 Nepalese adults had at least one of the eight known risk factors for non-communicable conditions

121 (smoking, alcohol consumption, less than five servings of fruits and vegetables per day, low

122 physical activity, raised blood pressure, raised blood glucose, overweight and obesity, and raised

123 total cholesterol).[17] Similarly, a study conducted by Yadav et al. found 74.8% of the people with

124 COPD had two or more non-communicable conditions.[20] Previously, using data from the 2003

125 World Health Survey, a 15.2% prevalence of multimorbidity among the Nepalese population was

126 estimated, which doubled for the older age groups (30.2%).[21]

127 Previous research on multimorbidity has mostly focused on quantifying the prevalence[21, 22] and

128 has not analyzed its association with risk behaviors or underlying social and economic factors.

129 Rural areas in Nepal are characterized by higher poverty rates and lower health literacy, lack of

130 human resources for health and regular supply of medications at the peripheral health system and

131 means (transportation and financial) to access healthcare which include both inter- and intra-

132 personal characteristics.[23-25] Malnutrition, an important determinant of health and wellbeing,

133 is also more prevalent among older adults in rural than in urban Nepal.[26] Socioeconomic

134 characteristics play an important role in determining the prevalence and management of both single

135 chronic conditions and multimorbidity. Despite older adults being at increased risk, to date, there

136 has been no specific study that focused on multimorbidity and its risk factors in rural Nepalese

137 older adults. Therefore, this study aimed to assess the prevalence of major more non-

138 communicable conditions and multimorbidity among rural Nepalese older adults and examine the

139 associated socioeconomic and behavioral risk factors.

Methods

140

Study design and participants

141

142 This study was a community-based cross-sectional study conducted among Nepalese older adults

143 60 years or older living in the rural settings of *Sunsari* and *Morang* districts of Nepal. We recruited

144 study samples from the community settings using a multi-stage cluster sampling approach. In the

145 first stage, four rural municipalities (RMs) were randomly selected from each district. Secondly,

146 five wards were randomly selected in each of the selected RMs, and then finally, study participants

147 were randomly selected from the list of eligible subjects in each RMs. Data were collected between

148 January to April 2018 from 794 study participants through face-to-face interviews (a response rate

5

149 of 93.7%). The 53 individuals who declined to participate were of similar characteristics to that of

150 included sample in this study. Details of the methodology of this study are documented

151 elsewhere.[27] Data were collected using a validated Nepalese version survey questionnaire

152 administered through trained research assistants in the field. The inclusion criteria included

153 Nepalese older adults aged ≥60 years, residents of the community for the past year. The exclusion

154 criteria included residing in nursing care, being mentally disabled (clinically proved schizophrenia,

155 bipolar mood disorder), being seriously ill (terminal illness like cancer, chronic kidney condition),

156 having a hearing disability or being unable to communicate.

157 **Patient and public involvement**

158 Patients and the public were not involved in the conception of this study, development of the

159 research question, interpretation of the results, or manuscript writing.

160 **Measurements**

161 **Multimorbidity**

162 The data on four non-communicable chronic conditions (osteoarthritis, cardiovascular disease,

163 diabetes and COPD) was collected using self-reported information from the participants.

164 Information on self-reported non-communicable chronic conditions was verified either by

165 checking the medical records of the study participants or by asking about prescribed medicines

166 that they were taking for the relevant condition[28]. **Table 1** presents the definition of the

167 individual condition. Each of the individual conditions were coded as a binary response (0=absent,

168 1=present). The cumulative of the four conditions (range 0=absence of all four conditions to 4=

169 all four conditions present) were further dichotomized into presence or absence of multimorbidity,

170 where multimorbidity was defined as the presence of two or more conditions (cumulative score of

171 ≥2).

172 *Co-variates*

173 Included independent variables were age (continuous age recoded into 60-69, 70-79, and ≥80 to

174 see the comparison and to explore statistical relationships between the age categories) , gender

175 (male and female), study district (Morang and Sunsari), religion (Hinduism, Buddhism, Islam, and

176 Christianity), ethnicity, marital status, educational status, past occupation, family monthly income,

177 history of smoking, tobacco use and alcohol drinking (yes/no), and physical activity. Based on the

178 Nepal government's classification, ethnicity was categorized into Brahmin/Chettri/Thakuri,

179 Aadiwasi/Janjatis, Dalit, Madheshi and other ethnic groups. Historically, the

180 Brahmin/Chettri/Thakuri is considered as the upper caste group. Other ethnic groups are relatively

181 disadvantaged and minority groups. Marital status was dichotomized into married and others; the

182 latter included widowed, divorced, separated, and never married. Educational status was defined

183 in terms of the number of formal schooling years and was categorized into with (any numbers of

184 years of formal schooling) or without (no formal schooling) formal schooling. Participants were

185 asked about their participation in different types of moderate-to-vigorous intensity activities (such

186 as regular walk, jogging, yoga, cycling, exercise, swimming, weightlift, activities related to the

187 farmhouse, etc.) over the previous seven days. Participants were categorized as physically inactive

188 if they reported not being involved in any activities; otherwise, they were classified as physically

189 active. Further details on these co-variates are also available in the previous work published by

190 Yadav et al.[27, 28]

Ethics

191

192 The study was approved by the Institutional Review Board of Nepal Health Research Council,

193 Government of Nepal, Ministry of Health, Kathmandu (Reg no: 545/2017). After detailed

194 information, all study participants gave their written informed consent (included both written

195 consent and thumb impressions). Prior to the interview, thumb impressions were obtained from

196 those who were unable to read and write (n=636) and written informed consent was obtained from

197 all literate participants.

198

Statistical analysis

199

200 Stata (Version 13.0) [29]was used to analyze the data. Descriptive analyses (mean with standard

201 deviation and frequency with percentage) are reported on each studied variable. Univariate

202 analysis was performed using the chi-square (χ2) test, and the variables with p-value <0.2 were

203 included in a mixed-effected logistic regression model. The generalized estimating equation (GEE)

204 approach with 95% confidence intervals (95% CI) was employed to examine the association

205 between multimorbidity and its associated factors.

7

Results

Study participants characteristics

208 The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was
209 almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants
210 were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous
211 (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half
212 (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The
213 majority of the participants reported lack physical activity (77.1%) and had a history of smoking
214 (62.2%). However only 36.5% gave history of alcohol consumption. The descriptive findings have
215 been reported in our previous paper.[28]

Prevalence of individual chronic conditions/conditions and multimorbidity

217 The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%,
218 respectively. While 48.9% of the participants were living from at least one chronic condition,
219 14.6% had multimorbidity (**Table 2**). The prevalence of osteoarthritis, COPD, any comorbidities,
220 and multimorbidity was higher among females compared to male participants, whereas that for
221 cardiovascular disease and diabetes were more prevalent in males than females **(Table 3)**. The
222 only significant differences in prevalence between males and females were for osteoarthritis and
223 any comorbidities (**Table 3**).

Socioeconomic and lifestyle characteristics by multimorbidity

225 The mean age of the participants with multimorbidity was 70.3 years (**Table 4**). The prevalence
226 of multimorbidity was similar in males compared to females (16.8%; 12.5%, p=0.090). The
227 prevalence of multimorbidity was significantly higher among unemployed (18.4%; 10.2%,
228 p<0.001), those without a history of drinking alcohol (16.9%; 10.7%, p=0.018), and those who
229 were physically inactive (18.3%; 2.2%, p<0.001) compared the other respondents (Table 2).

Risk factors associated with multimorbidity

231 In the final adjusted model (**Table 5**), age, ethnicity, history of alcohol drinking, and physical
232 inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years)
233 had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the
234 individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher
235 odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95%

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236 CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-
237 2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically
238 inactive individuals had five times higher odds of multimorbidity compared with those who were
239 physically active (AOR: 5.02; 95% CI: 1.47-17.17).

Discussion

241 This is the first study to assess the prevalence and correlates of multimorbidity among older adults
242 in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD
243 conditions. Approximately one in seven had multimorbidity – most frequently involving
244 osteoarthritis and COPD. This proportion was low compared to prevalence reported from India
245 (>35%), China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the
246 Nepalese population are limited, and the only available estimates come from a World Health
247 Survey (WHS) [21] conducted in 2003 that defined multimorbidity as the presence of two or more
248 of the six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or
249 psychosis, and diabetes. This survey found a prevalence of 15.2% among the Nepalese population,
250 which doubled for the age group 65 years and older (30.2%). [21] Since Nepal has an ageing
251 population and is in the process the epidemiologic transition, we would expect to see a higher
252 prevalence of multimorbidity compared to the estimates from 2003. However, our prevalence
253 estimate was half that of the 2003 World Health Survey for the older age group. In our study, the
254 possible reasons behind this discrepancy could be the measurement of a limited number of
255 common non-communicable conditions (only four conditions included), methodological
256 differences, or geographical variation. In multimorbidity studies, the number and type of
257 conditions included in the count contributed to greater variability in estimates between the
258 studies.[33]Given that the high prevalence of depression among older Nepalese adults (>50%),[28]
259 the inclusion of depression in World Health Survey but not in the currently reported result is likely
260 to explain most of the difference in prevalence of multimorbidity. Moreover, in our current study
261 those who were mentally disabled (clinically proved schizophrenia, bipolar mood disorder) or
262 seriously ill (terminal illness like cancer, chronic kidney condition) were excluded from the study,
263 and this could have contributed to an underestimation of multimorbidity prevalence. In this regard,
264 this suggests the need to develop a uniform standardized definition of multimorbidity, indicating
265 which specific conditions should be included.

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266 The impact of multimorbidity is greater than the cumulative effects of a single condition.[13] In
267 the Nepalese context, patients with multimorbidity rely on specialist services at secondary or
268 tertiary hospitals as the primary health care system does not have the capacity to adequately assess
269 and manage non-communicable chronic conditions, including multimorbidity. There is a need for
270 a multi-sectoral integrated primary care approach[34] to address the needs of pre-existing non-
271 communicable chronic conditions, including multimorbidity.

272 Significant differences in multimorbidity by ethnicity were noted: underprivileged minority
273 groups, particularly the Madhesi ethnic group, were slightly more likely to suffer from
274 multimorbidity than the upper caste groups. Our finding is consistent with previous literature from
275 Nepal, which documented a higher burden of non-communicable chronic conditions among the
276 Madhesi ethnic group.[20, 27] Historically, the Madhesi ethnic group were discriminated against
277 by the upper caste groups and had limited access to education and employment.[35] As one of the
278 marginalized groups, they have a comparatively lower socioeconomic status increasing their risk
279 of poor health and wellbeing.

280 The increased risk of multimorbidity among physically inactive individuals is consistent with other
281 research.[36-38] However, surprisingly, study participants without a history of alcohol drinking
282 had 50% higher odds of multimorbidity than those with such history. The literature on the
283 association between alcohol consumption and multimorbidity has been inconsistent since previous
284 studies have reported lower odds of having multimorbidity among those who consumed alcohol
285 daily,[36, 39] whereas other studies found no association between alcohol consumption and
286 multimorbidity.[37, 40]. Likewise, few studies have reported that use of alcohol may have
287 protective effects against some NCDs like type II diabetes [41]and cardiovascular disease[42, 43],
288 however a large metanalysis results evidenced that alcohol use is a risk for non-communicable
289 disease. A number of explanations may justify our findings. First, in a society where alcohol
290 consumption is unaccepted, self-reported measures of alcohol consumption may not be reliable,
291 and participants' responses may be subjected to social desirability bias. Second, people with
292 multimorbidity might have stopped drinking alcohol and could have been reluctant in reporting
293 their history of alcohol use at the time of field survey. Third, in a low-income setting such as ours,
294 the ability to consume alcohol also indicates an individual's purchasing power and relative wealth.
295 Hence, older adults who could afford to consume alcohol may have had a relatively better
296 socioeconomic status, good access to health services and had associated better health in later life.

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297 In this light, our finding warrants the need of longitudinal research to access the temporal
298 relationship between alcohol use and multimorbidity.

Policy Implications

300 In light of our findings, we suggest the need to shift from the approach of treating and management
301 of single conditions to a more integrated approach where peoples' needs can be more
302 comprehensively met.[44] Our study demonstrated the strong association between multimorbidity
303 and lack of physical activity, which suggests both the opportunity for early prevention and the
304 need for tailoring the physical activity to the level of disability (especially for osteoarthritis). In
305 this regard, our findings have implications at the primary health care level as well as at the
306 secondary/tertiary levels, where health care providers can assess physical activity level among
307 individuals who access health services and can tailor interventions accordingly to avert the further
308 health consequences, especially among socioeconomically deprived communities. Moreover,
309 promotion of physical activity needs to be mainstreamed in existing community health programs
310 and at all levels of care. There is a need for national population-based data on non-communicable
311 conditions, to assess their burden on Nepalese society and to guide policies and strategies to tackle
312 non-communicable diseases.

Strengths and limitations

314 Some of the strengths of this study include a very high response rate (93.7%), data collection by
315 trained enumerators fluent in local languages (Maithili/Tharu/Nepalese). It is the first community-
316 based study to report multimorbidity prevalence from Nepal. Limitations included: a) cross-
317 sectional design that precludes examination of the cause-effect relationship; b) limited
318 generalizability to younger age groups and geography other than Morang and Sunsari districts of
319 Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A
320 major limitation was the inclusion of only four chronic conditions in the survey and in the
321 definition of multimorbidity. The study analysed survey data conducted for the main objective of
322 assessing frailty among older adults. These factors may have contributed to an underestimation of
323 the prevalence of multimorbidity. The assessment of lifestyle behavior may be subject to social
324 desirability bias. All this suggests the need for a community-based longitudinal study that can
325 include a larger number of conditions and assess the impact of lifestyle behaviors over time. There
326 is also a need for qualitative research to understand the problems at the individual,

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327 community/family, and organization level which influence the development and management of
328 multimorbidity and inform more comprehensive interventions to address it.

Conclusions

330 This study found a modest prevalence of multimorbidity among older adults in rural Nepal. There
331 is a need to conduct a more comprehensive, nationally representative study to obtain a more
332 reliable estimate of prevalence and correlates of multimorbidity. The prevalence of multimorbidity
333 and its socioeconomic and behavioral correlates needs to be addressed by integrating social
334 programs with health prevention and management at multiple levels. As such, the findings will
335 help policymakers and stakeholders identify needs and develop comprehensive multi-sectoral
336 strategies to address the needs of a growing older population with multimorbidity.

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Contributions

343 Conceived and designed the experiments: UNY. Performed fieldwork: UNY. Analysed the data:
344 UNY, SG SKM, SS, LBR and MFH. Wrote the paper: UNY, SG, SKM, SS, LBR, and MFH. All
345 authors read and approved the final manuscript.

Consent for publication

351 Not applicable.

Competing interests

353 The authors declare that they have no competing interests.

Data availability statement:

355 The de-identified data are available on request from the corresponding author.

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502 **Table 1.** Definition of chronic conditions included in the study

Conditions	Definition
Diabetes	Taking diabetic medications (insulin, hypoglycemic); self-report of diabetes; or diabetes recorded as a diagnosis in the medical record. *In line with operational definition, the diabetes condition was coded as "1" and its absence as "0".*
Chronic obstructive pulmonary disease (COPD)	Clinical assessment as evident in the medical records or use of bronchodilators, or self-reported production of sputum for last three months with any smoking history. *In line with operational definition, COPD was coded as "1" and its absence as "0".*
Cardiovascular disease (CVD)	Presence of any of the following conditions: - • Hypertension – self-report of diagnosed hypertension; verified by blood pressure level in the provided medical records. • Self-report of heart attack, angina, or "heart trouble" • Stroke – self-reported presence of valve condition or taking medications for those. *In line with operational definition, CVD condition was coded as "1" and its absence as "0".*
Osteoarthritis	Self-report of joint pain problems. *In line with operational definition, joint problem was coded as "1" and its absence as "0".*

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Multimorbidity	Presence of more than one of the four aforementioned conditions in the same individual. Multimorbidity was then dichotomized as present (i.e. 2–4 conditions) or absent (i.e., single or no condition) for assessing relationships with the independent variables.

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509 **Table 2.** Prevalence of chronic conditions and multiple morbidities (n=794)

Conditions	Osteoarthritis n (%)	CVD n (%)	Diabetes n (%)	COPD n (%)
Osteoarthritis (OA)	331 (41.7)			
Cardiovascular disease (CVD)	13 (1.7)	19 (2.4)		
Diabetes	16 (2.0)	3 (0.4)	42 (5.3)	
Chronic obstructive pulmonary disease (COPD)	90 (11.3)	8 (1.0)	6 (0.8)	122 (15.4)
OA and CVD			1 (0.1)	5 (0.6)
Diabetes & COPD	4 (0.5)	0.0		
Any comorbidities[1] n (%)	388 (48.9)			
Multiple morbidities[2] n (%)	116 (14.6)			

510 [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.
511 [2]Two or more chronic conditions were prevalent.
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514 **Table 3.** Gender-wise distribution of non-communicable chronic conditions and multimorbidity.

Prevalent conditions	Male	Female	*P-value*
Osteoarthritis	150 (37.5)	181 (45.9)	**0.016**
CVD	11 (2.8)	8 (2.0)	0.507
Diabetes	24 (6.0)	18 (4.6)	0.368
COPD	53 (13.3)	69 (17.5)	0.096
OA and CVD	8 (2.0)	5 (1.3)	0.417
OA and Diabetes	8 (2.0)	8 (2.0)	0.976
OA and COPD	37 (9.3)	53 (13.5)	0.062
CVD and Diabetes	2 (0.5)	1 (0.3)	0.572
CVD and COPD	6 (1.5)	2 (0.5)	0.162
Diabetes and COPD	3 (0.8)	3 (0.8)	0.985
OA, CVD and Diabetes	1 (0.3)	0 (0.0)	0.321
OA, CVD and COPD	4 (1.0)	1 (0.3)	0.184
OA, Diabetes and COPD	2 (0.5)	2 (0.5)	0.988
Diabetes, CVD, and COPD	-	-	-
OA, Diabetes, CVD, and COPD	-	-	-
[1]Any comorbidities	181 (45.3)	207 (52.5)	**0.040**
[2]Multimorbidity	50 (12.5)	66 (16.8)	0.090

515 Abbreviation: COPD: Chronic obstructive pulmonary disease, CVD: Cardiovascular disease,
516 OA: Osteoarthritis.
517 [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.
518 [2]Two or more chronic conditions were prevalent.
519 Significant p-values are bolded.
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540 **Table 4.** Socio-demographic and lifestyle characteristics by participant's multimorbidity status.

	[1] Multimorbidity		
	No N=678 (85.4%)	Yes N=116 (14.6%)	P-value
Age (mean, SD)	69.87 (8.8)	70.29 (7.7)	0.627
Age (year, %)			
60-69	381 (86.5)	59 (13.4)	0.235
70-79	193 (82.1)	42 (17.8)	
≥80	104 (87.3)	15 (12.6)	
Gender			
Male	350 (87.5)	50 (12.5)	0.090
Female	328 (83.2)	66 (16.7)	
Study district			
Morang	351 (86.8)	53 (13.1)	0.220
Sunsari	327 (83.8)	63 (16.1)	
Religion			
Hinduism	529 (84.6)	96 (15.3)	**0.046**
Buddhism	19 (100.0)	0 (0.0)	
Islam	105 (84.0)	20 (16.0)	
Christianity	25 (100.0)	0 (0.0)	
Ethnicity			
Brahmin/Chettri/ Thakuri	62 (89.8)	7 (10.1)	0.706
Aadiwasi/Janjatis	255 (85.5)	43 (14.4)	
Dalit	132 (84.0)	25 (15.9)	
Madhesi and other ethnic groups	229 (84.8)	41 (15.1)	
Marital status			
Married	365 (85.8)	60 (14.1)	0.674
[2]Others	313 (84.8)	56 (15.1)	

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Education status			
Without formal education	538 (84.5)	98 (15.4)	0.201
With formal education/schooling	140 (88.6)	18 (11.3)	
Past occupation			
Employed	327 (89.8)	37 (10.1)	**<0.001**
Unemployed	351 (81.6)	79 (18.3)	
Family monthly income			
USD <49	331 (86.8)	50 (13.1)	0.453
USD 49-88	120 (82.7)	25 (17.2)	
USD >88	227 (84.7)	41 (15.3)	
History of smoking			
No	257 (85.6)	43 (14.3)	0.864
Yes	421 (85.2)	73 (14.7)	
History of tobacco use			
No	354 (86.1)	57 (13.8)	0.540
Yes	324 (84.6)	59 (15.4)	
History of alcohol drinking			
No	419 (83.1)	85 (16.8)	**0.018**
Yes	259 (89.3)	31 (10.6)	
Physical activity			
Inactive	500 (81.7)	112 (18.3)	**<0.001**
Active	178 (97.8)	4 (2.2)	

541 [1] At least two chronic conditions (osteoarthritis, cardiovascular disease, diabetes, and chronic
542 obstructive pulmonary disease) were prevalent.
543 [2]Others denotes widowed/divorced/separated/unmarried.
544 Significant P-values are bolded.
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Table 5. Factors associated with multimorbidity in adjusted and unadjusted binary logistic regression models.

	Crude			Adjusted		
	OR	P-value	95% CI	OR	P-value	95% CI
Age (year)						
60-69	1.00			1.00		
70-79	1.61	**0.027**	1.06-2.45	1.62	**0.033**	1.04-2.54
≥ 80	1.24	0.155	0.92-1.67	0.97	0.834	0.75-1.26
Gender						
Male	1.00			Not taken in the model		
Female	1.34	0.132	0.92-1.96			
Study district						
Morang	1.00			Not taken in the model		
Sunsari	1.27	0.713	0.36-4.49			
Religion						
Hinduism	1.00			Not taken in the model		
Buddhism	1.00	-	-			
Islam	0.69	0.396	0.79-1.62			
Christianity	1.00	-	-			
Ethnicity						
Brahmin/Chettri/Thakuri	1.00			1.00		
Aadiwasi/Janjatis	1.46	**0.042**	1.01-1.60	0.80	0.489	0.44-1.29
Dalit	1.08	**<0.001**	1.04-1.76	0.98	0.392	0.91-1.20
Madheshi and other ethnic groups	1.45	**<0.001**	1.28-1.75	1.08	**0.002**	1.02-1.72
Marital status						
Married	1.00			Not taken in the model		
[1]Others	1.01	0.951	0.67-1.54			

21

Education status						
With formal education/schooling	1.00			Not taken in the model		
Without formal education	1.40	0.465	0.57-3.43			
Past occupation						
Employed	1.00			1.00		
Unemployed	1.72	**0.012**	1.12-2.62	1.49	0.060	0.98-2.26
Family monthly income						
USD < 49	1.00			Not taken in the model		
USD 49-88	0.98	0.972	0.42-2.31			
USD >88	1.11	0.656	0.69-1.82			
History of smoking						
No	1.00			Not taken in the model		
Yes	1.05	0.713	0.81-1.35			
History of tobacco use						
No	1.00			Not taken in the model		
Yes	0.99	0.942	0.72-1.36			
History of alcohol drinking						
Yes	1.00			1.00		
No	1.41	**0.006**	1.10-1.81	1.53	**<0.001**	1.18-2.01
Physical activity						
Active	1.00			1.00		
Inactive	5.51	**0.007**	1.60-19.05	5.02	**0.010**	1.47-17.17

551

552 Significant p-values are bolded. [2]Others denotes widowed/divorced/separated/unmarried.

553 Abbreviation: CVD- Cardiovascular disease, COPD- Chronic obstructive pulmonary disease.

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22

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page number
Title and abstract	1	**(*a*)** Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study	1
		(*b*) **Objectives:** This study's objectives were to estimate the prevalence of major non-communicable conditions and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors. **Design:** This was a community-based cross-sectional study conducted between January to April 2018. **Setting:** Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal. **Participants:** 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage cluster sampling approach. **Primary outcome measure(s):** Prevalence of four major non-communicable chronic conditions (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and multimorbidity. **Results:** Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of four non-communicable chronic conditions, and 14.6% (male 12.5% ; female 16.8%) had two or more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8% ; female 2.0%), diabetes- 5.3% (male 6.0% ; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those from Madhesi and other ethnic groups (AOR: 1.08; 95% CI:	2

1.02-1.72), without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95% CI: 1.47-17.17) had significantly higher odds of multimorbidity.

Conclusions: This study found one in seven study participants had multimorbidity. The prevalence of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed by integrating social programs with health prevention and management at multiple levels. Moreover, a longitudinal study is suggested to understand the temporal relationship between lifestyle predictors and multimorbidity among Nepalese older adults.

Introduction			
Background/rationale	2	Although multimorbidity requires a multitude of specialists' referrals, biomedical investigations, and polypharmacy, current health care is based on a single disease approach to treatment, which may not be appropriate to manage patients with multimorbidity. Multimorbidity is challenging for both patients and health professionals, especially in setting priority goals for self-management. As we understand more about the multimorbidity and the inequalities in its burden, subpopulations at risk may be identified for preventive strategies. Till date, there has been no specific study that focused on multi-morbidity in Nepalese older adults.	4-5
Objectives	3	This study aimed to assess the prevalence of major chronic diseases and multimorbidity among Nepali older adults and examine the associated socioeconomic and behavioral risk factors.	5

Methods			
Study design	4	Cross-sectional study design	5
Setting	5	This study was a community based cross sectional study conducted among Nepalese older adults 60 years or older living rural part of *Sunsari* and *Morang* districts of Nepal. We recruited study samples using a multi-stage cluster sampling approach and data was collected from 794 study participants through face to face interview. The data collection period was between January to April 2018.	5
Participants	6	(*a*) Older adults aged 60 years or above	5
Variables	7	Health conditions data [*Osteoarthritis, Cardiovascular diseases (CVD), Diabetes, Chronic Obstructive Pulmonary Diseases (COPD)*] were collected for defining multi-morbidity- a dependent variable.	6

Included independent variable were age; gender; religion; ethnicity; living arrangement; marital status; occupation; literacy status; monthly personal income; alcohol drinking habits; smoking habit; habit of tobacco chewing and physical activity

Data sources/ measurement	8*	NA	
Bias	9	Multivariate analysis was done to adjust confounders.	7
Study size	10	This study involves the data from a samples[n=794]that was collected for frailty study using standard assumptions.[https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0]	6
Quantitative variables	11		
Statistical methods	12	(*a*) Stata (Version 13.0). was used to analyze the data. Descriptive analysis was performed on each of the studied variables. Univariate analysis was performed using the chi-square (χ2) test and the variables with p-value <0.2 were included in a mixed-effected logistic regression model. The generalized estimating equation (GEE) approach with 95% confidence intervals (95% CI) was employed to examine the association between multimorbidity and its associated factors.	7
		(*b*) VIF was calculated and was found to be less than 0.2	7
		(*c*) No missing data	6
		(*d*) NA	

Results

Participants	13*	(a) 794 participated	6
		(b) NA	
		(c) Presented in previous publication [https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0/tables/1]	7
Descriptive data	14*	The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The majority of the participants reported lack physical activity (77.1%) and had a history of smoking (62.2%). However only 36.5% gave history of alcohol	7-8

consumption. The descriptive findings have been reported in our previous paper.[28]

a) The mean age of the participants was 69.9 years, and there was equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), illiterate (80.1%), married (53.8%), from indigenous or Madhesi ethnic groups (72.0%), unemployed (54.2%) and had a family income of 44 USD or less at the time of the survey. The majority of the participants were physically inactive (77.1%) and had a history of tobacco smoking (62.2%), but no history of alcohol use (63.4%) (Table 2).

(b) NA

Outcome data	15*	The prevalence of the individual chronic diseases and their combinations is presented in Table 2. The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%, respectively. While 48.9% of the participants were suffering from at least one chronic condition, 14.7% were suffering from multimorbidity.	6
Main results	16	In the final adjusted model (Table 5), age, ethnicity, history of alcohol drinking, and physical inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years) had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95% CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically inactive individuals had five times higher odds of multimorbidity compared with those who were physically active (AOR: 5.02; 95% CI: 1.47-17.17).	8
		(*b*) NA	
		(*c*) NA	
Other analyses	17	NA	

Discussion

Key results	18	This is the first study to assess the prevalence and correlates of multimorbidity among older adults in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD conditions. Approximately one in seven had multimorbidity – most frequently involving osteoarthritis and COPD. This proportion was low compared to reported from India (>35%), China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the Nepalese population are limited, and the only available estimates come from a World Health Survey (WHS)[21] conducted in 2003 that defined multimorbidity as the presence of two or more of the six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or psychosis, and diabetes. This survey found a prevalence of 15.2% among the Nepalese population, which doubled for the age group 65+ (30.2%).[21] Since Nepal has an ageing population and is in the process the epidemiologic transition, we would expect to see a higher prevalence of multimorbidity compared to the estimates from 2003. However, our prevalence estimate was half that of the 2003 World Health Survey for the older age group. In our study, the possible reasons behind this discrepancy could be the measurement of a limited number of common non-communicable conditions (only four conditions included), methodological differences, or geographical variation. In multimorbidity studies, the number and type of conditions included in the count contributed to greater variability in estimates between the studies.[33]Given that the high prevalence of depression among older Nepalese adults (>50%),[28] the inclusion of depression in World Health Survey but not in the currently reported result is likely to explain most of the difference in prevalence of multimorbidity. Moreover, in our current study those who were mentally disabled (clinically proved schizophrenia, bipolar mood disorder) or seriously ill (terminal illness like cancer, chronic kidney condition) were excluded from the study, and this could have contributed to an underestimation of multimorbidity prevalence. In this regard, this suggests the need to develop a uniform standardized definition of multimorbidity, including which specific conditions should be included.	9
Limitations	19	Some of the strengths of this study include a very high response rate (93.7%), data collection by trained enumerators fluent in local languages (Maithili/Tharu/Nepalese). It is the first community-based study to report multimorbidity prevalence from Nepal.	11

Limitations included: a) cross-sectional design that precludes examination of the cause-effect relationship; b) limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A major limitation was the inclusion of only four chronic conditions in the survey and in the definition of multimorbidity. The study analysed survey data conducted for the main objective of assessing frailty among older adults. These factors may have contributed to an underestimation of the prevalence of multimorbidity. The assessment of lifestyle behaviour may be subject to social desirability bias. All this suggests the need for a community-based longitudinal study that can include a larger number of conditions and assess the impact of lifestyle behaviours over time. There is also a need for qualitative research to understand the problems at the individual, community/family, and organization level which influence the development and management of multimorbidity and inform more comprehensive interventions to address it.

Interpretation	20	Provided in discussion section	9-11
Generalisability	21	limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal.	11
Other information			
Funding	22	No role of funding agency in this study.	

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study

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Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study

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Abstract

Objectives: This study's objectives were to estimate the prevalence of major non-communicable conditions and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.

Design: This was a community-based cross-sectional study conducted between January to April 2018.

Setting: Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal.

Participants: 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage cluster sampling approach.

Primary outcome measure(s): Prevalence of four major non-communicable chronic conditions (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and multimorbidity.

Results: Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of four non-communicable chronic conditions, and 14.6% (male 12.5%; female 16.8%) had two or more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8%; female 2.0%), diabetes- 5.3% (male 6.0%; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those from Madhesi and other ethnic groups (AOR: 1.08; 95% CI: 1.02-1.72), without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95% CI: 1.47-17.17) had significantly higher odds of multimorbidity.

Conclusions: This study found one in seven study participants had multimorbidity. The prevalence of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed by integrating social programs with health prevention and management at multiple levels. Moreover, a longitudinal study is suggested to understand the temporal relationship between lifestyle predictors and multimorbidity among Nepalese older adults.

Keywords: Community, Correlates, Chronic condition, Multimorbidity, Older adults

2

Strengths and limitations of this study

- This is the first community-based study that estimated the prevalence of multimorbidity among older adults using a multi-stage cluster sampling approach in rural Nepal.

- This study presented the data from 794 older adults collected through face-to-face interviews (a response rate of 93.7%) using trained enumerators fluent in local languages (Maithili/Tharu/Nepali) of rural Nepal.

- We have included only four non-communicable conditions in the definition of multimorbidity, and thus the estimated prevalence may be underestimated.

- The study findings may not be generalizable to younger age groups and geography other than Morang and Sunsari districts of Nepal.

- A cause-effect relationship between multimorbidity and the identified correlates cannot be inferred due to the cross-sectional design of the study.

3

Introduction

90 The population of older adults is increasing globally[1] and is projected to increase to over 1.5
91 billion by 2050.[2] A similar demographic transition is occurring in Nepal. The Senior Citizen Act
92 in Nepal 2006 defines "an individual aged 60 and over as a senior citizen".[3] In the most recent
93 census in Nepal in 2011, there were 2.5 million population older adults (8.1%).[4] This population
94 is growing at a rate of 3.5% annually, which exceeds the nation's overall population growth rate
95 at 1.35%.[4] While we celebrate longevity,[5, 6] health and quality of life are two crucial agendas
96 for the older population.[7, 8] Older adults have a higher prevalence of non-communicable chronic
97 conditions, and with longevity, the likelihood of experiencing more than one non-communicable
98 chronic condition also increases.[9]

99   Multimorbidity is the simultaneous coexistence of two or more non-communicable conditions in
100 the same individual.[10] Multimorbidity can have a significant impact on an individual's quality
101 of life and the demand for health care.[11, 12] The impact of multimorbidity is greater than the
102 cumulative effect of the single condition.[13] Individuals with multimorbidity are at a substantially
103 greater risk of death compared to those with single conditions.[14] Multimorbidity also adds to the
104 existing challenges of providing quality geriatric health care, especially in developing countries
105 with limited resources. Although multimorbidity requires a multitude of specialists' referrals,
106 biomedical investigations, and polypharmacy, current health care is based on a single condition
107 approach to treatment, which may not be appropriate for patients with multimorbidity.[15, 16]
108 Multimorbidity is challenging for both patients and health professionals, especially in setting
109 priority goals for self-management. As we understand more about multimorbidity and the
110 inequalities in its burden, subpopulations at risk may be identified for preventive and self-
111 management strategies.

112 The prevalence of non-communicable conditions related to multimorbidity has increased
113 substantially across the globe, especially among those aged 65 years and older with a reported
114 prevalence of 33.1%.[17] Longevity, coupled with an increase in incident non-communicable
115 conditions and sedentary and unhealthy lifestyles, suggest that the burden of multimorbidity,
116 especially among the older population, will continue to rise globally.[10] Efforts to recognize and
117 address multimorbidity in clinical settings has increased in many high-income countries.[18]
118 However, in developing countries, this emerging public health issue is often overlooked.[19]

4

119 In 2013, the Nepal STEPwise approach to surveillance (STEPS) survey reported that 99.6% of the

120 Nepalese adults had at least one of the eight known risk factors for non-communicable conditions

121 (smoking, alcohol consumption, less than five servings of fruits and vegetables per day, low

122 physical activity, raised blood pressure, raised blood glucose, overweight and obesity, and raised

123 total cholesterol).[17] Similarly, a study conducted by Yadav et al. found 74.8% of the people with

124 COPD had two or more non-communicable conditions.[20] Previously, using data from the 2003

125 World Health Survey, a 15.2% prevalence of multimorbidity among the Nepalese population was

126 estimated, which doubled for the older age groups (30.2%).[21]

127 Previous research on multimorbidity has mostly focused on quantifying the prevalence[21, 22] and

128 has not analyzed its association with risk behaviors or underlying social and economic factors.

129 Rural areas in Nepal are characterized by higher poverty rates and lower health literacy, lack of

130 human resources for health and regular supply of medications at the peripheral health system and

131 means (transportation and financial) to access healthcare which include both inter- and intra-

132 personal characteristics.[23-25] Malnutrition, an important determinant of health and wellbeing,

133 is also more prevalent among older adults in rural than in urban Nepal.[26] Socioeconomic

134 characteristics play an important role in determining the prevalence and management of both single

135 chronic conditions and multimorbidity. Despite older adults being at increased risk, to date, there

136 has been no specific study that focused on multimorbidity and its risk factors in rural Nepalese

137 older adults. Therefore, this study aimed to assess the prevalence of major more non-

138 communicable conditions and multimorbidity among rural Nepalese older adults and examine the

139 associated socioeconomic and behavioral risk factors.

140 **Methods**

141 **Study design and participants**

142 This study was a community-based cross-sectional study conducted among Nepalese older adults

143 60 years or older living in the rural settings of *Sunsari* and *Morang* districts of Nepal. We recruited

144 study samples from the community settings using a multi-stage cluster sampling approach. In the

145 first stage, four rural municipalities (RMs) were randomly selected from each district. Secondly,

146 five wards were randomly selected in each of the selected RMs, and then finally, study participants

147 were randomly selected from the list of eligible subjects in each RMs. Data were collected between

148 January to April 2018 from 794 study participants through face-to-face interviews (a response rate

5

149 of 93.7%). The 53 individuals who declined to participate were of similar characteristics to that of

150 included sample in this study. Details of the methodology of this study are documented

151 elsewhere.[27] Data were collected using a validated Nepali version survey questionnaire

152 administered through trained research assistants in the field. The inclusion criteria included

153 Nepalese older adults aged ≥60 years, residents of the community for the past year. The exclusion

154 criteria included residing in nursing care, being mentally disabled (clinically proved schizophrenia,

155 bipolar mood disorder), being seriously ill (terminal illness like cancer, chronic kidney condition),

156 having a hearing disability or being unable to communicate.

157 **Patient and public involvement**

158 Patients and the public were not involved in the conception of this study, development of the

159 research question, interpretation of the results, or manuscript writing.

160 **Measurements**

161 **Multimorbidity**

162 The data on four non-communicable chronic conditions (osteoarthritis, cardiovascular disease,

163 diabetes and COPD) was collected using self-reported information from the participants.

164 Information on self-reported non-communicable chronic conditions was verified either by

165 checking the medical records of the study participants or by asking about prescribed medicines

166 that they were taking for the relevant condition[28]. **Table 1** presents the definition of the

167 individual condition. Each of the individual conditions were coded as a binary response (0=absent,

168 1=present). The cumulative of the four conditions (range 0=absence of all four conditions to 4=

169 all four conditions present) were further dichotomized into presence or absence of multimorbidity,

170 where multimorbidity was defined as the presence of two or more conditions (cumulative score of

171 ≥2).

172 *Co-variates*

173 Included independent variables were age (continuous age recoded into 60-69, 70-79, and ≥80 to

174 see the comparison and to explore statistical relationships between the age categories), gender

175 (male and female), study district (Morang and Sunsari), religion (Hinduism, Buddhism, Islam, and

176 Christianity), ethnicity, marital status, educational status, past occupation, family monthly income,

177 history of smoking, tobacco use and alcohol drinking (yes/no), and physical activity. Based on the

6

178 Nepal government's classification, ethnicity was categorized into Brahmin/Chettri/Thakuri,

179 Aadiwasi/Janjatis, Dalit, Madheshi and other ethnic groups. Historically, the

180 Brahmin/Chettri/Thakuri is considered as the upper caste group. Other ethnic groups are relatively

181 disadvantaged and minority groups. Marital status was dichotomized into married and others; the

182 latter included widowed, divorced, separated, and never married. Educational status was defined

183 in terms of the number of formal schooling years and was categorized into with (any numbers of

184 years of formal schooling) or without (no formal schooling) formal schooling. Participants were

185 asked about their participation in different types of moderate-to-vigorous intensity activities (such

186 as regular walk, jogging, yoga, cycling, exercise, swimming, weightlift, activities related to the

187 farmhouse, etc.) over the previous seven days. Participants were categorized as physically inactive

188 if they reported not being involved in any activities; otherwise, they were classified as physically

189 active. Further details on these co-variates are also available in the previous work published by

190 Yadav et al.[27, 28]

191 **Ethics**

192 The study was approved by the Institutional Review Board of Nepal Health Research Council,

193 Government of Nepal, Ministry of Health, Kathmandu (Reg no: 545/2017). After detailed

194 information, all study participants gave their written informed consent (included both written

195 consent and thumb impressions). Prior to the interview, thumb impressions were obtained from

196 those who were unable to read and write (n=636) and written informed consent was obtained from

197 all literate participants.

198

199 **Statistical analysis**

200 Stata (Version 13.0) [29]was used to analyze the data. Descriptive analyses (mean with standard

201 deviation and frequency with percentage) are reported on each studied variable. Univariate

202 analysis was performed using the chi-square ($\chi2$) test, and the variables with p-value <0.2 were

203 included in a mixed-effected logistic regression model. The generalized estimating equation (GEE)

204 approach with 95% confidence intervals (95% CI) was employed to examine the association

205 between multimorbidity and its associated factors.

7

Results

Study participants characteristics

208 The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was
209 almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants
210 were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous
211 (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half
212 (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The
213 majority of the participants reported lack physical activity (77.1%) and had a history of smoking
214 (62.2%). However only 36.5% gave history of alcohol consumption. The descriptive findings have
215 been reported in our previous paper.[28]

Prevalence of individual chronic conditions/conditions and multimorbidity

217 The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%,
218 respectively. While 48.9% of the participants were living from at least one chronic condition,
219 14.6% had multimorbidity (**Table 2**). The prevalence of osteoarthritis, COPD, any comorbidities,
220 and multimorbidity was higher among females compared to male participants, whereas that for
221 cardiovascular disease and diabetes were more prevalent in males than females **(Table 3)**. The
222 only significant differences in prevalence between males and females were for osteoarthritis and
223 any comorbidities (**Table 3**).

Socioeconomic and lifestyle characteristics by multimorbidity

225 The mean age of the participants with multimorbidity was 70.3 years (**Table 4**). The prevalence
226 of multimorbidity was similar in males compared to females (16.8%; 12.5%, p=0.090). The
227 prevalence of multimorbidity was significantly higher among unemployed (18.4%; 10.2%,
228 p<0.001), those without a history of drinking alcohol (16.9%; 10.7%, p=0.018), and those who
229 were physically inactive (18.3%; 2.2%, p<0.001) compared the other respondents (Table 2).

Risk factors associated with multimorbidity

231 In the final adjusted model (**Table 5**), age, ethnicity, history of alcohol drinking, and physical
232 inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years)
233 had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the
234 individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher
235 odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95%

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236 CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-
237 2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically
238 inactive individuals had five times higher odds of multimorbidity compared with those who were
239 physically active (AOR: 5.02; 95% CI: 1.47-17.17).

Discussion

241 This is the first study to assess the prevalence and correlates of multimorbidity among older adults
242 in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD
243 conditions. Approximately one in seven had multimorbidity – most frequently involving
244 osteoarthritis and COPD. This proportion was low compared to prevalence reported from India
245 (>35%), China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the
246 Nepalese population are limited, and the only available estimates come from a World Health
247 Survey (WHS) [21] conducted in 2003 that defined multimorbidity as the presence of two or more
248 of the six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or
249 psychosis, and diabetes. This survey found a prevalence of 15.2% among the Nepalese population,
250 which doubled for the age group 65 years and older (30.2%). [21] Since Nepal has an ageing
251 population and is in the process the epidemiologic transition, we would expect to see a higher
252 prevalence of multimorbidity compared to the estimates from 2003. However, our prevalence
253 estimate was half that of the 2003 World Health Survey for the older age group. In our study, the
254 possible reasons behind this discrepancy could be the measurement of a limited number of
255 common non-communicable conditions (only four conditions included), methodological
256 differences, or geographical variation. In multimorbidity studies, the number and type of
257 conditions included in the count contributed to greater variability in estimates between the
258 studies.[33]Given that the high prevalence of depression among older Nepalese adults (>50%),[28]
259 the inclusion of depression in World Health Survey but not in the currently reported result is likely
260 to explain most of the difference in prevalence of multimorbidity. Moreover, in our current study
261 those who were mentally disabled (clinically proved schizophrenia, bipolar mood disorder) or
262 seriously ill (terminal illness like cancer, chronic kidney condition) were excluded from the study,
263 and this could have contributed to an underestimation of multimorbidity prevalence. In this regard,
264 this suggests the need to develop a uniform standardized definition of multimorbidity, indicating
265 which specific conditions should be included.

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266 The impact of multimorbidity is greater than the cumulative effects of a single condition.[13] In

267 the Nepalese context, patients with multimorbidity rely on specialist services at secondary or

268 tertiary hospitals as the primary health care system does not have the capacity to adequately assess

269 and manage non-communicable chronic conditions, including multimorbidity. There is a need for

270 a multi-sectoral integrated primary care approach[34] to address the needs of pre-existing non-

271 communicable chronic conditions, including multimorbidity.

272 Significant differences in multimorbidity by ethnicity were noted: underprivileged minority

273 groups, particularly the Madhesi ethnic group, were slightly more likely to suffer from

274 multimorbidity than the upper caste groups. Our finding is consistent with previous literature from

275 Nepal, which documented a higher burden of non-communicable chronic conditions among the

276 Madhesi ethnic group.[20, 27] Historically, the Madhesi ethnic group were discriminated against

277 by the upper caste groups and had limited access to education and employment.[35] As one of the

278 marginalized groups, they have a comparatively lower socioeconomic status increasing their risk

279 of poor health and wellbeing.

280 The increased risk of multimorbidity among physically inactive individuals is consistent with other

281 research.[36-38] However, surprisingly, study participants without a history of alcohol drinking

282 had 50% higher odds of multimorbidity than those with such history. The literature on the

283 association between alcohol consumption and multimorbidity has been inconsistent since previous

284 studies have reported lower odds of having multimorbidity among those who consumed alcohol

285 daily,[36, 39] whereas other studies found no association between alcohol consumption and

286 multimorbidity.[37, 40]. Likewise, few studies have reported that use of alcohol may have

287 protective effects against some NCDs like type II diabetes [41]and cardiovascular disease[42, 43],

288 however a large metanalysis results evidenced that alcohol use is a risk for non-communicable

289 disease. A number of explanations may justify our findings. First, in a society where alcohol

290 consumption is unaccepted, self-reported measures of alcohol consumption may not be reliable,

291 and participants' responses may be subjected to social desirability bias. Second, people with

292 multimorbidity might have stopped drinking alcohol and could have been reluctant in reporting

293 their history of alcohol use at the time of field survey. Third, in a low-income setting such as ours,

294 the ability to consume alcohol also indicates an individual's purchasing power and relative wealth.

295 Hence, older adults who could afford to consume alcohol may have had a relatively better

296 socioeconomic status, good access to health services and had associated better health in later life.

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297 In this light, our finding warrants the need of longitudinal research to access the temporal
298 relationship between alcohol use and multimorbidity.

Policy Implications

300 In light of our findings, we suggest the need to shift from the approach of treating and management
301 of single conditions to a more integrated approach where peoples' needs can be more
302 comprehensively met.[44] Our study demonstrated the strong association between multimorbidity
303 and lack of physical activity, which suggests both the opportunity for early prevention and the
304 need for tailoring the physical activity to the level of disability (especially for osteoarthritis). In
305 this regard, our findings have implications at the primary health care level as well as at the
306 secondary/tertiary levels, where health care providers can assess physical activity level among
307 individuals who access health services and can tailor interventions accordingly to avert the further
308 health consequences, especially among socioeconomically deprived communities. Moreover,
309 promotion of physical activity needs to be mainstreamed in existing community health programs
310 and at all levels of care. There is a need for national population-based database on non-
311 communicable conditions, to assess their burden on Nepalese society and to guide policies and
312 strategies to tackle non-communicable diseases.

Strengths and limitations

314 Some of the strengths of this study include a very high response rate (93.7%), data collection by
315 trained enumerators fluent in local languages (Maithili/Tharu/Nepali). It is the first community-
316 based study to report multimorbidity prevalence from Nepal. Limitations included: a) cross-
317 sectional design that precludes examination of the cause-effect relationship; b) limited
318 generalizability to younger age groups and geography other than Morang and Sunsari districts of
319 Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A
320 major limitation was the inclusion of only four chronic conditions in the survey and in the
321 definition of multimorbidity. The study analysed survey data conducted for the main objective of
322 assessing frailty among older adults. These factors may have contributed to an underestimation of
323 the prevalence of multimorbidity. The assessment of lifestyle behavior may be subject to social
324 desirability bias. All this suggests the need for a community-based longitudinal study that can
325 include a larger number of conditions and assess the impact of lifestyle behaviors over time. There
326 is also a need for qualitative research to understand the problems at the individual,

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327 community/family, and organization level which influence the development and management of
328 multimorbidity and inform more comprehensive interventions to address it.

Conclusions

330 This study found a modest prevalence of multimorbidity among older adults in rural Nepal. There
331 is a need to conduct a more comprehensive, nationally representative study to obtain a more
332 reliable estimate of prevalence and correlates of multimorbidity. The prevalence of multimorbidity
333 and its socioeconomic and behavioral correlates needs to be addressed by integrating social
334 programs with health prevention and management at multiple levels. As such, the findings will
335 help policymakers and stakeholders identify needs and develop comprehensive multi-sectoral
336 strategies to address the needs of a growing older population with multimorbidity.

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Contributions

344 Conceived and designed the experiments: UNY. Performed fieldwork: UNY. Analysed the data:
345 UNY, SG SKM, SS, LBR and MFH. Wrote the paper: UNY, SG, SKM, SS, LBR, and MFH. All
346 authors read and approved the final manuscript.

Consent for publication

352 Not applicable.

Competing interests

354 The authors declare that they have no competing interests.

Data availability statement:

356 The de-identified data are available on request from the corresponding author.

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492   **Table 1.** Definition of chronic conditions included in the study

Conditions	Definition
Diabetes	Taking diabetic medications (insulin, hypoglycemic); self-report of diabetes; or diabetes recorded as a diagnosis in the medical record. *In line with operational definition, the diabetes condition was coded as "1" and its absence as "0".*
Chronic obstructive pulmonary disease (COPD)	Clinical assessment as evident in the medical records or use of bronchodilators, or self-reported production of sputum for last three months with any smoking history. *In line with operational definition, COPD was coded as "1" and its absence as "0".*
Cardiovascular disease (CVD)	Presence of any of the following conditions: - - Hypertension – self-report of diagnosed hypertension; verified by blood pressure level in the provided medical records. - Self-report of heart attack, angina, or "heart trouble" - Stroke – self-reported presence of valve condition or taking medications for those. *In line with operational definition, CVD condition was coded as "1" and its absence as "0".*
Osteoarthritis	Self-report of joint pain problems. *In line with operational definition, joint problem was coded as "1" and its absence as "0".*
Multimorbidity	Presence of more than one of the four aforementioned conditions in the same individual. Multimorbidity was then dichotomized as present (i.e. 2–4 conditions) or absent (i.e., single or no condition) for assessing relationships with the independent variables.

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499   **Table 2.** Prevalence of chronic conditions and multiple morbidities (n=794)

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Conditions	Osteoarthritis n (%)	CVD n (%)	Diabetes n (%)	COPD n (%)
Osteoarthritis (OA)	331 (41.7)			
Cardiovascular disease (CVD)	13 (1.7)	19 (2.4)		
Diabetes	16 (2.0)	3 (0.4)	42 (5.3)	
Chronic obstructive pulmonary disease (COPD)	90 (11.3)	8 (1.0)	6 (0.8)	122 (15.4)
OA and CVD			1 (0.1)	5 (0.6)
Diabetes & COPD	4 (0.5)	0.0		
Any comorbidities[1] n (%)	388 (48.9)			
Multiple morbidities[2] n (%)	116 (14.6)			

500   [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.

501   [2]Two or more chronic conditions were prevalent.

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504   **Table 3.** Gender-wise distribution of non-communicable chronic conditions and multimorbidity.

Prevalent conditions	Male	Female	*P-value*
Osteoarthritis	150 (37.5)	181 (45.9)	**0.016**
CVD	11 (2.8)	8 (2.0)	0.507
Diabetes	24 (6.0)	18 (4.6)	0.368
COPD	53 (13.3)	69 (17.5)	0.096
OA and CVD	8 (2.0)	5 (1.3)	0.417
OA and Diabetes	8 (2.0)	8 (2.0)	0.976
OA and COPD	37 (9.3)	53 (13.5)	0.062
CVD and Diabetes	2 (0.5)	1 (0.3)	0.572
CVD and COPD	6 (1.5)	2 (0.5)	0.162
Diabetes and COPD	3 (0.8)	3 (0.8)	0.985
OA, CVD and Diabetes	1 (0.3)	0 (0.0)	0.321
OA, CVD and COPD	4 (1.0)	1 (0.3)	0.184
OA, Diabetes and COPD	2 (0.5)	2 (0.5)	0.988
Diabetes, CVD, and COPD	-	-	-
OA, Diabetes, CVD, and COPD	-	-	-
[1]Any comorbidities	181 (45.3)	207 (52.5)	**0.040**
[2]Multimorbidity	50 (12.5)	66 (16.8)	0.090

505   Abbreviation: COPD: Chronic obstructive pulmonary disease, CVD: Cardiovascular disease,
506   OA: Osteoarthritis.
507   [1]At least two chronic conditions (osteoarthritis, CVD, diabetes, and COPD) were prevalent.
508   [2]Two or more chronic conditions were prevalent.
509   Significant p-values are bolded.

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530   **Table 4.** Socio-demographic and lifestyle characteristics by participant's multimorbidity status.

	[1] Multimorbidity		
	No N=678 (85.4%)	Yes N=116 (14.6%)	P-value
Age (mean, SD)	69.87 (8.8)	70.29 (7.7)	0.627
Age (year, %)			
60-69	381 (86.5)	59 (13.4)	0.235
70-79	193 (82.1)	42 (17.8)	
≥80	104 (87.3)	15 (12.6)	
Gender			
Male	350 (87.5)	50 (12.5)	0.090
Female	328 (83.2)	66 (16.7)	
Study district			
Morang	351 (86.8)	53 (13.1)	0.220
Sunsari	327 (83.8)	63 (16.1)	
Religion			
Hinduism	529 (84.6)	96 (15.3)	**0.046**
Buddhism	19 (100.0)	0 (0.0)	
Islam	105 (84.0)	20 (16.0)	
Christianity	25 (100.0)	0 (0.0)	
Ethnicity			
Brahmin/Chettri/ Thakuri	62 (89.8)	7 (10.1)	0.706
Aadiwasi/Janjatis	255 (85.5)	43 (14.4)	
Dalit	132 (84.0)	25 (15.9)	
Madhesi and other ethnic groups	229 (84.8)	41 (15.1)	
Marital status			
Married	365 (85.8)	60 (14.1)	0.674
[2]Others	313 (84.8)	56 (15.1)	

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Education status			
Without formal education	538 (84.5)	98 (15.4)	0.201
With formal education/schooling	140 (88.6)	18 (11.3)	
Past occupation			
Employed	327 (89.8)	37 (10.1)	**<0.001**
Unemployed	351 (81.6)	79 (18.3)	
Family monthly income			
USD <49	331 (86.8)	50 (13.1)	0.453
USD 49-88	120 (82.7)	25 (17.2)	
USD >88	227 (84.7)	41 (15.3)	
History of smoking			
No	257 (85.6)	43 (14.3)	0.864
Yes	421 (85.2)	73 (14.7)	
History of tobacco use			
No	354 (86.1)	57 (13.8)	0.540
Yes	324 (84.6)	59 (15.4)	
History of alcohol drinking			
No	419 (83.1)	85 (16.8)	**0.018**
Yes	259 (89.3)	31 (10.6)	
Physical activity			
Inactive	500 (81.7)	112 (18.3)	**<0.001**
Active	178 (97.8)	4 (2.2)	

531 [1] At least two chronic conditions (osteoarthritis, cardiovascular disease, diabetes, and chronic
532 obstructive pulmonary disease) were prevalent.
533 [2]Others denotes widowed/divorced/separated/unmarried.
534 Significant P-values are bolded.
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539 **Table 5.** Factors associated with multimorbidity in adjusted and unadjusted binary logistic
540 regression models.

	Crude			Adjusted		
	OR	P-value	95% CI	OR	P-value	95% CI
Age (year)						
60-69	1.00			1.00		
70-79	1.61	**0.027**	1.06-2.45	1.62	**0.033**	1.04-2.54
≥ 80	1.24	0.155	0.92-1.67	0.97	0.834	0.75-1.26
Gender						
Male	1.00			Not taken in the model		
Female	1.34	0.132	0.92-1.96			
Study district						
Morang	1.00			Not taken in the model		
Sunsari	1.27	0.713	0.36-4.49			
Religion						
Hinduism	1.00			Not taken in the model		
Buddhism	1.00	-	-			
Islam	0.69	0.396	0.79-1.62			
Christianity	1.00	-	-			
Ethnicity						
Brahmin/Chettri/Thakuri	1.00			1.00		
Aadiwasi/Janjatis	1.46	**0.042**	1.01-1.60	0.80	0.489	0.44-1.29
Dalit	1.08	**<0.001**	1.04-1.76	0.98	0.392	0.91-1.20
Madheshi and other ethnic groups	1.45	**<0.001**	1.28-1.75	1.08	**0.002**	1.02-1.72
Marital status						
Married	1.00			Not taken in the model		
[1]Others	1.01	0.951	0.67-1.54			

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Education status						
With formal education/schooling	1.00			Not taken in the model		
Without formal education	1.40	0.465	0.57-3.43			
Past occupation						
Employed	1.00			1.00		
Unemployed	1.72	**0.012**	1.12-2.62	1.49	0.060	0.98-2.26
Family monthly income						
USD < 49	1.00			Not taken in the model		
USD 49-88	0.98	0.972	0.42-2.31			
USD >88	1.11	0.656	0.69-1.82			
History of smoking						
No	1.00			Not taken in the model		
Yes	1.05	0.713	0.81-1.35			
History of tobacco use						
No	1.00			Not taken in the model		
Yes	0.99	0.942	0.72-1.36			
History of alcohol drinking						
Yes	1.00			1.00		
No	1.41	**0.006**	1.10-1.81	1.53	**<0.001**	1.18-2.01
Physical activity						
Active	1.00			1.00		
Inactive	5.51	**0.007**	1.60-19.05	5.02	**0.010**	1.47-17.17

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542 Significant p-values are bolded. [2]Others denotes widowed/divorced/separated/unmarried.
543 Abbreviation: CVD- Cardiovascular disease, COPD- Chronic obstructive pulmonary disease.
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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page number
Title and abstract	1	**(*a*)** Prevalence of non-communicable chronic conditions, multimorbidity and its correlates among older adults in rural Nepal: a cross-sectional study	1
		(*b*) **Objectives:** This study's objectives were to estimate the prevalence of major non-communicable conditions and multimorbidity among older adults in rural Nepal and examine the associated socioeconomic and behavioral risk factors.	2
		Design: This was a community-based cross-sectional study conducted between January to April 2018.	
		Setting: Rural municipalities of *Sunsari* and *Morang* districts in eastern Nepal.	
		Participants: 794 Nepalese older adults, 60 years and older, were recruited using a multi-stage cluster sampling approach.	
		Primary outcome measure(s): Prevalence of four major non-communicable chronic conditions (osteoarthritis, cardiovascular disease, diabetes and chronic obstructive disease (COPD) and multimorbidity.	
		Results: Almost half (48.9%; male 45.3% ;. female 52.4%) of the participants had at least one of four non-communicable chronic conditions, and 14.6% (male 12.5% ; female 16.8%) had two or more conditions. The prevalence of individual conditions included: osteoarthritis- 41.7% (male 37.5%; female 45.9%), cardiovascular disease- 2.4% (male 2.8% ; female 2.0%), diabetes- 5.3% (male 6.0% ; female 4.6%), and COPD- 15.4% (male 13.3% ; female 17.5%). In the adjusted model, older adults aged 70-79 years (adjusted odds ratio [AOR]: 1.62; 95% CI: 1.04-2.54), those from Madhesi and other ethnic groups (AOR: 1.08; 95% CI:	

1.02-1.72), without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01), and those physically inactive (AOR: 5.02; 95% CI: 1.47-17.17) had significantly higher odds of multimorbidity.

Conclusions: This study found one in seven study participants had multimorbidity. The prevalence of multimorbidity and associated socioeconomic and behavioral correlates need to be addressed by integrating social programs with health prevention and management at multiple levels. Moreover, a longitudinal study is suggested to understand the temporal relationship between lifestyle predictors and multimorbidity among Nepalese older adults.

Introduction			
Background/rationale	2	Although multimorbidity requires a multitude of specialists' referrals, biomedical investigations, and polypharmacy, current health care is based on a single disease approach to treatment, which may not be appropriate to manage patients with multimorbidity. Multimorbidity is challenging for both patients and health professionals, especially in setting priority goals for self-management. As we understand more about the multimorbidity and the inequalities in its burden, subpopulations at risk may be identified for preventive strategies. Till date, there has been no specific study that focused on multi-morbidity in Nepalese older adults.	4-5
Objectives	3	This study aimed to assess the prevalence of major chronic diseases and multimorbidity among Nepali older adults and examine the associated socioeconomic and behavioral risk factors.	5
Methods			
Study design	4	Cross-sectional study design	5
Setting	5	This study was a community based cross sectional study conducted among Nepalese older adults 60 years or older living rural part of *Sunsari* and *Morang* districts of Nepal. We recruited study samples using a multi-stage cluster sampling approach and data was collected from 794 study participants through face to face interview. The data collection period was between January to April 2018.	5
Participants	6	(*a*) Older adults aged 60 years or above	5
Variables	7	Health conditions data [*Osteoarthritis, Cardiovascular diseases (CVD), Diabetes, Chronic Obstructive Pulmonary Diseases (COPD)*] were collected for defining multi-morbidity- a dependent variable.	6

		Included independent variable were age; gender; religion; ethnicity; living arrangement; marital status; occupation; literacy status; monthly personal income; alcohol drinking habits; smoking habit; habit of tobacco chewing and physical activity	
Data sources/ measurement	8*	NA	
Bias	9	Multivariate analysis was done to adjust confounders.	7
Study size	10	This study involves the data from a samples[n=794]that was collected for frailty study using standard assumptions.[https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0]	6
Quantitative variables	11		
Statistical methods	12	(*a*) Stata (Version 13.0). was used to analyze the data. Descriptive analysis was performed on each of the studied variables. Univariate analysis was performed using the chi-square ($\chi2$) test and the variables with p-value <0.2 were included in a mixed-effected logistic regression model. The generalized estimating equation (GEE) approach with 95% confidence intervals (95% CI) was employed to examine the association between multimorbidity and its associated factors.	7
		(*b*) VIF was calculated and was found to be less than 0.2	7
		(*c*) No missing data	6
		(*d*) NA	
Results			
Participants	13*	(a) 794 participated	6
		(b) NA	
		(c) Presented in previous publication [https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-019-1290-0/tables/1]	7
Descriptive data	14*	The participants' mean age was 69.9 years (male: 70.2±8.5; female: 69.7±8.9), and there was almost equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), without formal education (80.1%), married (53.5%), from indigenous (Aadiwasi/Janjatis) or Madhesi ethnic groups (71.5%) and unemployed (54.2%). Just under half (48.0%), reported a family monthly income of 44 USD or less at the time of the survey. The majority of the participants reported lack physical activity (77.1%) and had a history of smoking (62.2%). However only 36.5% gave history of alcohol	7-8

consumption. The descriptive findings have been reported in our previous paper.[28]

a) The mean age of the participants was 69.9 years, and there was equal participation by gender; 50.4% male and 49.6% female. The majority of participants were Hindu (78.7%), illiterate (80.1%), married (53.8%), from indigenous or Madhesi ethnic groups (72.0%), unemployed (54.2%) and had a family income of 44 USD or less at the time of the survey. The majority of the participants were physically inactive (77.1%) and had a history of tobacco smoking (62.2%), but no history of alcohol use (63.4%) (Table 2).

(b) NA

Outcome data	15*	The prevalence of the individual chronic diseases and their combinations is presented in Table 2. The prevalence of osteoarthritis, CVD, diabetes, and COPD was 41.7%, 2.4%, 5.3%, and 15.4%, respectively. While 48.9% of the participants were suffering from at least one chronic condition, 14.7% were suffering from multimorbidity.	6
Main results	16	In the final adjusted model (Table 5), age, ethnicity, history of alcohol drinking, and physical inactivity were significantly associated with multimorbidity. Individuals in their 70s (70-79 years) had 1.6 times higher odds of multimorbidity (AOR: 1.62; 95% CI: 1.04-2.54) compared to the individuals aged 60-69 years. Individuals from the *Madhesi* and other ethnic groups had 8% higher odds of multimorbidity than those of the upper caste (Brahmin/Chettri/Thakuri) (AOR: 1.08; 95% CI: 1.02-1.72). Study participants without a history of alcohol drinking (AOR: 1.53; 95% CI: 1.18-2.01) had 1.5 times higher odds of multimorbidity than those with a history. However, physically inactive individuals had five times higher odds of multimorbidity compared with those who were physically active (AOR: 5.02; 95% CI: 1.47-17.17).	8
		(*b*) NA	
		(*c*) NA	
Other analyses	17	NA	

Discussion

| Key results | 18 | This is the first study to assess the prevalence and correlates of multimorbidity among older adults in rural Nepal. We found that almost half (48.9%) of the older adults had at least one NCD conditions. Approximately one in seven had multimorbidity – most frequently involving osteoarthritis and COPD. This proportion was low compared to reported from India (>35%), China (>35%), and Bangladesh (14.9%).[30-32] Studies on multimorbidity among the Nepalese population are limited, and the only available estimates come from a World Health Survey (WHS)[21] conducted in 2003 that defined multimorbidity as the presence of two or more of the six conditions: arthritis, angina or angina pectoris, asthma, depression, schizophrenia or psychosis, and diabetes. This survey found a prevalence of 15.2% among the Nepalese population, which doubled for the age group 65+ (30.2%).[21] Since Nepal has an ageing population and is in the process the epidemiologic transition, we would expect to see a higher prevalence of multimorbidity compared to the estimates from 2003. However, our prevalence estimate was half that of the 2003 World Health Survey for the older age group. In our study, the possible reasons behind this discrepancy could be the measurement of a limited number of common non-communicable conditions (only four conditions included), methodological differences, or geographical variation. In multimorbidity studies, the number and type of conditions included in the count contributed to greater variability in estimates between the studies.[33]Given that the high prevalence of depression among older Nepalese adults (>50%),[28] the inclusion of depression in World Health Survey but not in the currently reported result is likely to explain most of the difference in prevalence of multimorbidity. Moreover, in our current study those who were mentally disabled (clinically proved schizophrenia, bipolar mood disorder) or seriously ill (terminal illness like cancer, chronic kidney condition) were excluded from the study, and this could have contributed to an underestimation of multimorbidity prevalence. In this regard, this suggests the need to develop a uniform standardized definition of multimorbidity, including which specific conditions should be included. | 9 |
| Limitations | 19 | Some of the strengths of this study include a very high response rate (93.7%), data collection by trained enumerators fluent in local languages (Maithili/Tharu/Nepalese). It is the first community-based study to report multimorbidity prevalence from Nepal. | 11 |

Limitations included: a) cross-sectional design that precludes examination of the cause-effect relationship; b) limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal and c) partial reliance on self-reported data on non-communicable chronic conditions. A major limitation was the inclusion of only four chronic conditions in the survey and in the definition of multimorbidity. The study analysed survey data conducted for the main objective of assessing frailty among older adults. These factors may have contributed to an underestimation of the prevalence of multimorbidity. The assessment of lifestyle behaviour may be subject to social desirability bias. All this suggests the need for a community-based longitudinal study that can include a larger number of conditions and assess the impact of lifestyle behaviours over time. There is also a need for qualitative research to understand the problems at the individual, community/family, and organization level which influence the development and management of multimorbidity and inform more comprehensive interventions to address it.

Interpretation	20	Provided in discussion section	9-11
Generalisability	21	limited generalizability to younger age groups and geography other than Morang and Sunsari districts of Nepal.	11

Other information

Funding	22	No role of funding agency in this study.	

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.