


BMJ Open Prevalence and factors associated with multimorbidity among older adults in Malaysia: a population-based cross-sectional study

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ABSTRACT

Objectives To determine the prevalence and factors associated with multimorbidity among community-dwelling older adults in Malaysia.

Design A population-based cross-sectional study.

Setting 13 states and 3 Federal Territories in Malaysia.

Participants A total of 3966 adults aged 60 years and above were extracted from the nationwide National Health and Morbidity Survey (NHMS) 2018 data set.

Primary outcome measures Multimorbidity was defined as co-occurrence of at least two known chronic non-communicable diseases in the same individual. The chronic diseases included hypertension, type 2 diabetes mellitus, dyslipidaemia and cancer.

Results The prevalence of multimorbidity among Malaysian older adults was 40.6% (95% CI: 37.9 to 43.3). The factors associated with multimorbidity were those aged 70–79 years (adjusted OR (AOR)=1.30; 95% CI=1.04 to 1.63; p=0.019), of Indian (AOR=1.69; 95% CI=1.14 to 2.52; p=0.010) and Bumiputera Sarawak ethnicities (AOR=1.81; 95% CI=1.14 to 2.89; p=0.013), unemployed (AOR=1.53; 95% CI=1.20 to 1.95; p=0.001), with functional limitation from activities of daily livings (AOR=1.66; 95% CI=1.17 to 2.37; p=0.005), physically inactive (AOR=1.28; 95% CI=1.03 to 1.60; p=0.026), being overweight (AOR=1.62; 95% CI=1.11 to 2.36; p=0.014), obese (AOR=1.88; 95% CI=1.27 to 2.77; p=0.002) and with abdominal obesity (AOR=1.52; 95% CI=1.11 to 2.07; p=0.009).

Conclusion This study highlighted that multimorbidity was prevalent among older adults in the community. Thus, there is a need for future studies to evaluate preventive strategies to prevent or delay multimorbidity among older adults in order to promote healthy and productive ageing.

INTRODUCTION

Globally, the ageing society is rapidly increasing. It is projected that the world's population aged 60 years and above will double from 12% in 2015 to 22% in 2050.¹ It is estimated that by 2050, about 80% of older adults will live in low-income and

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Large nationally representative sample that covered all states and Federal Territories in Malaysia.
- ⇒ This study allows the examination of relationships between multimorbidity and various determinants of health.
- ⇒ The prevalence of multimorbidity could have been underestimated as it was based on four chronic non-communicable diseases.
- ⇒ Being a cross-sectional data limits the causal effect relationship between multimorbidity and health determinants.

middle-income countries such as Malaysia. Improved public healthcare services has led to the increase in life expectancy.² Worldwide, most older adults aged 60 years and above had at least one chronic non-communicable diseases (NCDs), while a third had at least two NCDs. In addition, older adults living in the low-income and middle-income countries had greater disease burden, where the major causes of death included heart diseases and stroke which are related to NCDs.³

The co-occurrence of two NCDs or more has been defined as multimorbidity.⁴ The prevalence of multimorbidity among older adults in the community were between 15.8% and 83.0%, which was higher in the older age group of 75 years and above.^{5–11} Prospective studies done internationally and in Malaysia had shown that multimorbidity revealed high incidence in old age.^{11 12} Reviews on previous studies showed that factors associated with multimorbidity in older adults were women, oldest old, living alone, low educational level, living in rural region, smoking, alcohol consumption, unscheduled use of health services in the previous week, polypharmacy

and a negative self-perception of health^{6,7} as well as physical inactivity.¹³

A local study conducted in four Malaysian states among older adults aged 60 years and above found that after a one and a half year follow-up, 18.8% without NCD at baseline and 40.9% with one NCD at baseline, developed multimorbidity.¹¹ Moreover, among those without NCD at baseline, variables such as being a woman, a smoker and not regularly involved in food preparation were more likely to develop multimorbidity after one and a half years. Among those with one NCD at baseline, being overweight and having inadequate daily iron intake were related to multimorbidity.

Furthermore, multimorbidity was associated with poorer health outcomes such as disability,¹⁴ functional limitation,¹⁵ poor quality of life¹⁶ and mortality,¹⁷ in addition to greater utilisation of healthcare resources.¹⁸ These in turn have serious impact on the disease management and healthcare costs, as well as resource planning for a nation.¹⁹ Currently, there are limited studies using nationwide data on factors associated with multimorbidity among older adults in South East Asia and none in Malaysia. Identification of these factors is essential to facilitate a nation for developing intervention strategies to prevent or delay the decline in the health of older adults. This study aimed to determine the prevalence of multimorbidity and its associated factors among older adults aged 60 years and above living in the community in Malaysia using data from a nationwide health survey.

METHODS

Data sources and participants

This was a cross-sectional study using data from the nationwide National Health and Morbidity Survey 2018 NHMS 2018 on the health of older adults conducted by the Institute for Public Health, National Institutes of Health, Ministry of Health, Malaysia. This study was funded by the Ministry of Health, Malaysia. There were 7117 adults aged 50 years and above in the NHMS 2018 data set. The NHMS 2018 used a two-staged stratified cluster sample to ensure national representativeness of adults aged 50 years and above. The primary stratum was made up of all 13 states and 3 Federal Territories in Malaysia and the secondary stratum was made up of both urban and rural areas within the primary stratum. The detailed description of the sampling methods had been described in the NHMS 2018 Methodology and General Findings report.²⁰

We extracted 3977 data sets of adults aged 60 years and above (defined as older people) for the analysis of the present study. However, a total of 3966 older people were included in the final analysis after removing missing data.

Variables

Dependent variable

Multimorbidity was the main outcome of this study. Multimorbidity was defined as co-occurrence of two or more chronic NCDs in the same individual at the same time.^{4,21}

The chronic diseases in this study included known diagnosis of hypertension, type 2 diabetes mellitus, dyslipidaemia and cancer, which were based on physician's diagnosis. In the NHMS 2018 survey, other chronic NCDs such as heart diseases, chronic respiratory diseases (asthma and COPD), chronic kidney diseases, stroke and arthritis were not captured. Therefore, we only included the NCDs collected in NHMS 2018

Independent variables

The independent variables used for analysis in this study included the sociodemography, probable dementia, probable depression, functional status, nutritional status, lifestyle factors and social support. The sociodemography comprised age (60–69, 70–79, ≥80 years), gender (men, women), ethnicity (Malay, Chinese, Indians, Others, Sabah and Sarawak Bumiputera), strata (rural, urban), highest education level (no formal, primary, secondary, tertiary), occupation (employed, unemployed), individual monthly income and living arrangement (alone, living with spouse/family/relatives/friend).

The presence of dementia was determined by the Identification and Intervention for Dementia in Elderly Africans Cognitive Screen.²² It is a six-item validated cognitive assessment tool used in Malaysia to screen for dementia. A score of 10 and below was considered as probable dementia.²² The presence of depression was determined using the Geriatric Depression Scale-14 items (GDS-14).²³ It is a screening tool and has been validated with high sensitivity (Sn) and specificity (Sp) (Sn=95.5%, Sp=84.2% for clinically significant depression and Sn=100%, Sp=92.0% for major depression).²⁴ A cut-off point of 6 and above was chosen to indicate probable depression.

In this study, functional status included the activities of daily living (ADL) and instrumental activities of daily living (IADL). The ADL was measured using the Barthel index of activities of daily living and consisted of essential elements of self-care such as bowels, bladder, grooming, toilet use, feeding, transfer, mobility, dressing, climbing stairs and bathing.²⁵ A total maximum score of 20 was categorised as the absence of functional limitation and a total score below 20 were categorised as the presence of functional limitation. The Lawton & Brody Instrumental ADL (IADL) scale assesses the ability of the elderly to live independently.²⁶ The eight IADLs included ability to use the telephone, shopping, food preparation, house-keeping, laundry, mode of transportation, responsibility for own medications, and ability to handle finances. A total score of seven and below indicates dependence.

The nutritional status was measured using Mini Nutritional Assessment and anthropometric measurements such as body mass index (BMI), waist circumference (WC) and calf circumference. The Mini Nutritional Assessment Short Form (MNA-SF) identifies older adults who are malnourished or at risk of malnutrition. The MNA-SF has been validated for usage among Malaysian older adults.²⁷ Scores of 8–12 indicates those at risk for malnutrition, while a score of <7 is categorised as having

malnutrition. For BMI, the weight was measured with TANITA HD319 weighing scale and height was measured using the SECA 213 stadiometer in standing position. These instruments had been validated and calibrated before use according to schedule. Waist and calf circumference were measured with SECA 201 measuring tape. The BMI was categorised as: (a) underweight: <18.5 kg/m²; (b) normal: 18.5–24.9 kg/m²; (c) overweight: 25.0–29.9 kg/m² and (d) obese: ≥30.0 kg/m².²⁸ WC was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest using a measuring tape in centimetres.²⁹ Excessive WC was considered as >102 cm for men and >88 cm for women.³⁰ The risk of muscle wasting was determined by calf circumference of <30.1 cm for men and <27.3 cm for women based on a Malaysian study.³¹

The Global Physical Activity Questionnaire was used to assess physical activity and sedentary behaviour.³² The total amount of physical activity of total amount in three domains (work-related, travel-related and leisure time) in a typical week was calculated as metabolic equivalent (MET) in minutes per week. Paid or unpaid work, household chores or daily activities that a person had to do was included in the work-related domain. Walking or cycling activities to travel from one place to another were in the work-related domain. Leisure time domain included sports, fitness and recreational (leisure) activities. Being 'physically active' was defined as at least: (1) 30 min of moderate intensity activity or walking a day on at least 5 days/week; or (2) 20 min of vigorous-intensity activity a day on at least 3 days/week or (iii) any combination of walking and moderate-intensity or vigorous-intensity activities for 5 days achieving at least 600 MET-minutes/week. 'High level of sedentary behaviour' was defined as at least 8 hours of total sedentary time a day which is associated with all-cause mortality.^{33,34}

Smoking status included current smoker, ex-smoker and never smoked. Social support and networking was measured using the DUKE Social support index-11 items (DSSI-11)³⁵ which has been used for older adults.³⁶ It has two sub-scales: (1) social interaction subscale with four items measuring the size and structure of social network; and (2) subjective support subscale with seven items which measured perceived satisfaction with the behavioural or emotional support obtained from this network. The score was a summation of scores for the 11 items and higher scores indicates more social support received. Reliability and validity of the DSSI-11 for the Malaysian population had a Cronbach's alpha coefficient for overall score of 0.77.³⁷ The scores were categorised into low to fair, high and very high.³⁸

Data collection

The data collection was conducted by the NHMS trained research assistants through face-to-face interview in the participants' homes using mobile devices with a structured questionnaire, who also conducted the anthropometric assessments. All anthropometric measurements were

taken twice by trained research assistants. The questionnaire was pretested in both Malay and English languages. A participant information sheet was provided to every participant. Informed verbal and written consents were obtained prior to data collection. For illiterate participants, the participants' thumb print impressions were taken and witnessed by a literate person. Participants who were found to have medical or social problems were referred to the nearest health facility.

Data analysis

We described the characteristics of the study sample using the prevalence and estimated population. Bivariate analysis was performed to determine the association between each possible factor and multimorbidity using a complex sample logistic regression. Variables having a p-value less than 0.25 from the univariate analysis were then selected to be included in the initial multivariable logistics regression. Multivariable logistics regression was used to determine the association between the possible factors and multimorbidity. Multicollinearity and interaction terms were checked. The classification table and Nagelkerke R² were reported. The strength of association for each risk factor was reported using crude and adjusted OR (AOR). All the analyses were performed using SPSS software V.26.0 (SPSS, Chicago). Sample weights were used in the analysis to represent the general population aged 60 years and over. We removed variables with missing data.

Patient and public involvement

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

RESULTS

The sociodemographic characteristics of the study participants are presented in [table 1](#). A majority of the participants were urban dwellers (73.1%), aged 60–69 years (66.5%), Malay (57.6%), women (51.1%) and attended secondary school (43.6%). More than half of the respondents were unemployed (75.8%) with personal monthly income of less than US\$239. Almost all the participants (93.7%) lived either with spouse, family, relatives or friends.

This study found that the estimated prevalence of multimorbidity among Malaysians aged 60 years and over was 40.6% (95% CI: 37.9 to 43.3). Of this, the two prevalent chronic non-communicable diseases (NCDs) were hypertension with a prevalence of 51.1% (95% CI: 48.9 to 53.3) and dyslipidaemia with a prevalence of 41.8% (95% CI: 39.3 to 44.4). The list of NCDs are presented in an online supplemental table. In addition, the estimated prevalence of having probable depression and probable dementia among the participants were 5.3% (95% CI: 4.1 to 6.8) and 8.4% (95% CI: 6.9 to 10.2), respectively.

Majority of the participants had no functional limitations based on ADLs (83.0%; 95% CI: 80.7 to 85.0) and were independent in their IADLs (57.0%; 95% CI: 53.9 to

Table 1 Sociodemographic characteristics of the participants

Variable	Estimated population	N	%	95% CI	
				Lower	Upper
Non-communicable diseases					
Diabetes mellitus					
Yes	891 213	1018	27.7	25.5	30
No	2 329 986	2948	72.3	70	74.5
Hypertension					
Yes	1 645 628	2027	51.1	48.9	53.3
No	1 575 571	1939	48.9	46.7	51.1
Dyslipidaemia					
Yes	1 347 075	1576	41.8	39.3	44.4
No	1 874 124	2390	58.2	55.6	60.7
Cancer					
Yes	52 497	51	1.6	1.1	2.4
No	14 229	20	0.4	0.2	0.8
Multimorbidity					
Yes	1 306 393	1543	40.6	37.9	43.3
No	1 914 806	2423	59.4	56.7	62.1
Age group					
60–69 years	2 143 248	2557	66.5	63.8	69.2
70–79 years	834 890	1100	25.9	23.7	28.3
≥80 years	243 062	309	7.5	6.4	8.9
Gender					
Women	1 644 429	2098	51.1	49.4	52.7
Men	1 576 770	1868	48.9	47.3	50.6
Ethnicity					
Malay	1 856 535	2582	57.6	48.6	66.2
Chinese	853 632	708	26.5	19.8	34.5
Indian	209 635	126	6.5	4.1	10.2
Bumiputera Sabah	120 131	278	3.7	1.8	7.5
Bumiputera Sarawak	121 902	158	3.8	1.6	8.8
Others	59 364	114	1.8	1.0	3.5
Locality					
Rural	2 354 485	1683	73.1	69.0	76.8
Urban	866 714	2283	26.9	23.2	31.0
Highest education level					
No formal education	308 157	263	9.6	7.4	12.3
Primary education	1 039 569	966	32.3	28.8	35.9
Secondary education	1 403 819	1932	43.6	39.4	47.9
Tertiary education	469 653	805	14.6	12.5	17.0
Occupation					
Employed	779 589	1045	24.2	22.1	26.4
Unemployed	2 441 610	2921	75.8	73.6	77.9
Individual monthly income (US\$)					
477 and above	645 096	567	20.3	17.1	23.9
239–476	680 846	842	21.5	19.0	24.1
<239	1 847 771	2514	58.2	54.5	61.9

Continued

Table 1 Continued

Variable	Estimated population	N	%	95% CI	
				Lower	Upper
Living arrangements					
Live with spouse/family/relatives/friends	3018002	3671	93.7	92.5	94.7
Alone	203198	295	6.3	5.3	7.5
Probable depression					
No	2915933	3549	94.7	93.2	95.9
Yes	162524	217	5.3	4.1	6.8
Probable dementia					
No	2813420	3360	91.6	89.8	93.1
Yes	258613	405	8.4	6.9	10.2
Functional status					
ADLs					
Absence of functional limitation	2668630	3275	83.0	80.7	85.0
Presence of functional limitation	547881	683	17.0	15.0	19.3
IADLs					
Independent	1835547	2036	57.0	53.9	60.0
Dependent	1383835	1924	43.0	40.0	46.1
Physical activity					
Active	2260890	2668	70.2	66.9	73.3
Inactive	960309	1298	29.8	26.7	33.1
High level of sedentary behaviour					
No	2462397	2996	76.8	70.1	82.4
Yes	743573	958	23.2	17.6	29.9
BMI (kg/m ²)					
Underweight	154999	221	5.2	4.2	6.5
Normal	1194983	1523	40.2	37.7	42.7
Overweight	1100775	1292	37.0	35.0	39.1
Obese	524966	609	17.6	15.8	19.6
Waist circumference (cm)					
No abdominal obesity	974607	1304	32.6	29.9	35.5
Abdominal obesity	2012485	2369	67.4	64.5	70.1
Calf circumference (cm)					
No wasting	2677180	3220	89.4	87.7	91.0
Wasting	315984	477	10.6	9.0	12.3
Malnutrition assessment					
Normal nutritional status	2232051	2557	69.3	66.3	72.2
At risk of malnutrition	758652	1079	23.6	21.2	26.1
Malnutrition	230496	330	7.2	5.9	8.7
Smoking status					
Never smoker	2388012	2825	74.1	71.8	76.3
Current smoker	833188	1141	25.9	23.7	28.2
Social support					
Very high	1069223	1252	33.3	30.0	36.7
High	1155315	1444	35.9	33.0	39.0
Low to fair	989468	1260	30.8	27.3	34.5

ADLs, activities of daily livings; BMI, body mass index; IADLs, instrumental activities of daily livings; US\$, US Dollar.

60.0). High proportion of participants were found to be physically active (70.2%; 95% CI: 66.9 to 73.3) and did not adopt sedentary behaviour (76.8%; 95% CI: 70.1 to 82.4). The prevalence of normal BMI was 40.2% (95% CI: 37.7 to 42.7) and normal calf circumference was 89.4% (95% CI: 87.7 to 91.0), while 67.4% (95% CI: 64.5 to 70.1) had abdominal obesity. More than half of participants had good nutrition (69.3%; 95% CI: 66.3 to 72.2) and never smoked (74.1%; 95% CI: 71.8 to 76.3).

From the bivariable logistic regression, variables age 70–79 years, ≥80 years, women, of Chinese and Indian ethnicities, rural dwellers, unemployed, personal income of <US\$239 and US\$239–476, presence of probable depression, presence of functional limitations, dependent on IADLs, physically inactive, underweight, overweight, being obese, presence of abdominal obesity, calf muscle wasting, at-risk of malnutrition and smoker were included in the multivariable logistic regression as the p-values were <0.25 (see [table 2](#)).

The multivariable logistic regression showed that multimorbidity was significantly higher among those aged 70–79 years (adjusted OR (AOR)=1.30; 95% CI=1.04 to 1.63), of Indian (AOR=1.69; 95% CI=1.14 to 2.52) and Bumiputera Sarawak ethnicity (AOR=1.81; 95% CI=1.14 to 2.89), unemployed (AOR=1.53; 95% CI=1.20 to 1.95), with functional limitation from ADLs (AOR=1.66; 95% CI=1.17 to 2.37) and physically inactive (AOR=1.28; 95% CI=1.03 to 1.60). In addition, multimorbidity was significantly associated with older adults who were overweight (AOR=1.62; 95% CI=1.11 to 2.36), obese (AOR=1.88; 95% CI=1.27 to 2.77) and with abdominal obesity (AOR=1.52; 95% CI=1.11 to 2.07). Being underweight (AOR=0.42; 95% CI=0.25 to 0.72) was less likely to be associated with multimorbidity.

DISCUSSION

Our study evaluated the prevalence of multimorbidity and its associated factors among community dwelling older adults using data from a nationwide health survey. Modifiable factors found to be associated with multimorbidity were functional limitation, physical inactivity, abdominal obesity, overweight and obesity. The prevalence of multimorbidity among older adults from both cross-sectional and prospective studies were between 15.8% and 80.8%.^{5 7–10 12} The variability observed could be due to different age groups being studied, differences in the study settings as well as in the numbers of chronic diseases investigated and different ways of assessing the presence of diseases either self-reported, based on existing databases and prospectively being assessed for the presence of the chronic diseases. Compared with a local study by Hussin *et al*, the prevalence among older adults in our study was lower at 40.6%, while in their study it was 68.6%.¹¹ The prevalence in our study could be underestimated as we only included four reported physician diagnosed NCDs, while Hussin *et al* included 15 types of chronic diseases. A systematic review suggested

that relying on 4–7 diagnoses will underestimate the prevalence of multimorbidity.³⁹ Hence, this posed a limitation for our study in reporting the exact prevalence of multimorbidity among the Malaysian older population.

In our study, multimorbidity was associated with advanced aged and being unemployed which was similar to the findings in another study.¹⁰ It has been suggested that oldest old were more likely to have multimorbidity than younger older adults because of the physiological changes that occur with advancing age.^{7 40} As for being unemployed, a study in Korea showed the proportion of unemployed older adults were higher among those with obesity and physical inactivity.⁴¹ Additionally, obesity and physical inactivity have been shown to be associated with increased risk for multimorbidity in older adults.¹⁰

Indian individuals and abdominal obesity were associated with multimorbidity in our study. Similar to a study in Singapore, Indian ethnicity showed higher prevalence of multimorbidity when compared with Chinese individuals.⁴² In addition, Malaysian Indian individuals had higher prevalence of abdominal obesity and being overweight or obese.⁴³ Hence, strategies are needed in the Malaysian healthcare system that focus on chronic disease and multimorbidity prevention for Indian individuals.

The presence of functional limitations with advanced age has been shown to be associated with multimorbidity which was consistent in another study from India.⁴⁴ The relationship can be bidirectional where the presence of multimorbidity were associated with deterioration of ADLs.⁴⁵ On the other hand, the presence of functional limitations leads to poorer health status and increased the risk for multimorbidity.⁶

Being physically inactive, overweight and obese were associated with multimorbidity in our study, which was in line with the older adults with multimorbidity in Indonesia.¹⁰ In their study, it was shown that lower level of physical activity and less consumption of fruits and vegetables were associated with multimorbidity. A longitudinal study showed a 33% increased risk of multimorbidity among older adults who were physical inactive. The risk had increased by about three times higher when physical inactivity was combined with obesity.¹³ In addition, physical inactivity has been shown to be associated with NCDs such as diabetes, hypertension and dyslipidaemia as well as increases in the incidence of overweight and obesity.⁴⁶ Hence, being underweight and normal weight would be less likely to be associated with multimorbidity.

The strength of our study was the use of data from a large nationally representative sample. This allows the examination of relationships between multimorbidity and various determinants of health. However, this study does have limitations. First, the prevalence of multimorbidity was based on only four chronic NCDs, while other relevant NCDs that were prevalent among older adults such as chronic respiratory diseases, osteoarthritis and heart disease were not included because such data were not available in the NHMS 2018 data set. Hence, the prevalence of multimorbidity in our study could have been

Table 2 Factors associated with multimorbidity among Malaysian older adults

Variable	Bivariable		Multivariable	
	COR (95% CI)	P value	AOR (95% CI)	P value
Age group				
60–69	Ref.		Ref.	
70–79	1.29 (1.08 to 1.55)	0.006*	1.30 (1.04 to 1.63)	0.019†
80 and above	0.74 (0.51 to 1.06)	0.098*	0.79 (0.51 to 1.23)	0.291
Sex				
Women	1.36 (1.16 to 1.60)	<0.001*	0.99 (0.80 to 1.22)	0.903
Men	Ref.		Ref.	
Ethnicity				
Chinese	0.84 (0.69 to 1.04)	0.105*	1.04 (0.81 to 1.32)	0.759
Indian	1.45 (0.96 to 2.18)	0.079*	1.69 (1.14 to 2.52)	0.010†
Bumiputera Sabah	0.79 (0.53 to 1.17)	0.236	1.07 (0.64 to 1.77)	0.802
Bumiputera Sarawak	1.31 (0.77 to 2.22)	0.322	1.81 (1.14 to 2.89)	0.013†
Others	1.07 (0.60 to 1.90)	0.828	1.53 (0.85 to 2.76)	0.155
Malay	Ref.		Ref.	
Locality				
Rural	0.88 (0.73 to 1.07)	0.190*	0.95 (0.79 to 1.15)	0.582
Urban	Ref.		Ref.	
Education				
No formal education	1.13 (0.82 to 1.57)	0.457	–	
Primary	1.05 (0.77 to 1.43)	0.759		
Secondary	1.04 (0.78 to 1.39)	0.789		
Tertiary	Ref.			
Occupation				
Unemployed	1.92 (1.51 to 2.45)	<0.001*	1.53 (1.20 to 1.95)	0.001†
Employed	Ref.		Ref.	
Individual monthly income (US\$)				
<239	1.30 (1.04 to 1.63)	0.022*	1.14 (0.88 to 1.46)	0.320
239–476	1.26 (0.93 to 1.72)	0.139*	1.20 (0.85 to 1.69)	0.291
477 and above	Ref.		Ref.	
Living alone				
Yes	1.04 (0.75 to 1.43)	0.825	–	
No	Ref.			
Presence of probable depression				
Yes	1.65 (1.00 to 2.73)	0.049*	1.28 (0.8 to 2.07)	0.300
No	Ref.			
Presence of probable dementia				
Yes	0.95 (0.70 to 1.28)	0.718		
No	Ref.			
ADL				
Presence of functional limitations	1.74 (1.31 to 2.32)	<0.001*	1.66 (1.17 to 2.37)	0.005†
Absence of functional limitations	Ref.		Ref.	
IADL				
Dependent	1.18 (0.97 to 1.45)	0.105*	1.01 (0.79 to 1.30)	0.937
Independent	Ref.		Ref.	

Continued

Table 2 Continued

Variable	Bivariable		Multivariable	
	COR (95% CI)	P value	AOR (95% CI)	P value
Physical activity				
Inactive	1.39 (1.12 to 1.73)	0.004*	1.28 (1.03 to 1.60)	0.026†
Active	Ref.		Ref.	
Sedentary behaviour				
Yes	1.07 (0.88 to 1.30)	0.473	–	
No	Ref.			
BMI				
Underweight	0.46 (0.27 to 0.79)	0.005*	0.42 (0.25 to 0.72)	0.002†
Overweight	1.89 (1.41 to 2.53)	<0.001*	1.62 (1.11 to 2.36)	0.014†
Obese	2.46 (1.91 to 3.16)	<0.001*	1.88 (1.27 to 2.77)	0.002†
Normal	Ref.		Ref.	
Waist circumference				
Abdominal obesity	2.40 (2.02 to 2.85)	<0.001*	1.52 (1.11 to 2.07)	0.009†
No abdominal obesity	Ref.		Ref.	
Calf circumference				
Wasting	0.62 (0.45 to 0.84)	0.003*	1.16 (0.78 to 1.75)	0.458
No wasting	Ref.		Ref.	
Malnutrition assessment				
Normal nutritional status	Ref.		Ref.	
At risk of malnutrition	0.88 (0.73 to 1.06)	0.175*	1.02 (0.76 to 1.37)	0.878
Malnutrition	1.10 (0.76 to 1.59)	0.612	1.05 (0.52 to 2.10)	0.897
Smoking status				
Smoker	0.67 (0.53 to 0.84)	0.001*	0.77 (0.59 to 1.01)	0.056
Non-smoker	Ref.		Ref.	
Social support				
Low to fair	1.14 (0.90 to 1.45)	0.273	–	
High	1.06 (0.85 to 1.32)	0.599		
Very high	Ref.			

Classification table 64.0%, Nagelkerke R² 11.3%.

*P value <0.250.

†P value <0.05

ADL, activities of daily living; AOR, adjusted OR; BMI, body mass index; COR, crude OR; IADL, instrumental activities of daily living; Ref, reference group.

underestimated. Second, the measure of multimorbidity did not take into account other possible chronic NCDs which may be unknown to participants. Third, being a cross-sectional survey data, it limits the causal effect inferences and may have introduced recall and information biases.

Conclusion

This study highlighted that multimorbidity was prevalent among older adults in the community and was associated with modifiable factors such as physical inactivity, overweight and obesity. These findings are useful to primary care professionals for the early identification and care of the health status of older adults through healthy

lifestyle promotion programme. Besides, these findings could assist the policymakers to develop strategies at the national level in preventing or delaying multimorbidity in older age to ensure healthy and productive ageing.

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