

BMJ Open Urban–rural disparity in prevalence of multimorbidity in China: a cross-sectional nationally representative study

Xiaochen Ma,¹ Yu He,² Jin Xu ¹

To cite: Ma X, He Y, Xu J.

Urban–rural disparity in prevalence of multimorbidity in China: a cross-sectional nationally representative study. *BMJ Open* 2020;**10**:e038404. doi:10.1136/bmjopen-2020-038404

► Prepublication history and additional materials for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-038404>).

Received 12 March 2020

Revised 19 October 2020

Accepted 30 October 2020



© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹China Center for Health Development Studies, Peking University, Beijing, China

²Department of Non-Communicable Disease Epidemiology, London School of Hygiene & Tropical Medicine, London, UK

Correspondence to

Dr Jin Xu; xujin@hsc.pku.edu.cn

ABSTRACT

Background To address the neglect of depression in multimorbidity measurement and the lack of focus on rural population in previous literature about China, this paper aimed to estimate the prevalence of multimorbidity (including depressive disorders) among the country's rural and urban population.

Methods We used a cross-sectional design and data from a nationally representative survey conducted in 2015–2016 among Chinese people aged 45 years or older involving 19 656 participants. Multimorbidity was measured with a cut-off point of having two or more among 14 chronic illnesses. In that 13 of them were based on self-reported physician diagnosis. In addition, depressive disorders were assessed with the 10-item Centre for Epidemiologic Studies Depression Scale. The weighted prevalence of multimorbidity was calculated, with a non-response adjustment. Multivariate logistic regression was applied to analyse the relation between covariates and multimorbidity.

Findings Multimorbidity was highly prevalent (54.3%) among the studied population. Contrary to previous studies, we found the prevalence of multimorbidity to be higher among the rural dwellers (58.3%) than among the urban population (50.4%). After adjustment for covariates, rural residents had 7.5% higher odds (95% CI of OR (1.003 to 1.151)) of having multimorbidity than their urban counterparts. Above 70% of patients with any of the 14 chronic illnesses above 45 years old had multimorbidity, while 80.6%–97.9% of chronic patients had multimorbidity.

Interpretation Future health system development in China should transform from preventing and controlling non-communicable diseases as individual diseases to addressing people's comprehensive health needs under multimorbidity. The rural population should be prioritised as they suffered more from multimorbidity than the urban population.

INTRODUCTION

As global life expectancy rises, there is an increasing number of middle-aged and elderly with chronic disorders, both physical and mental. The cooccurrence of two or more chronic illnesses within a person is defined as multimorbidity.¹ Multimorbidity is a strong predictor of mortality.² It is also associated with reduced functional independence,^{3 4}

Strengths and limitations of this study

- This is the first study showing that rurality is associated with higher prevalence of multimorbidity in middle-aged and elderly Chinese.
- We used nationally representative sample of the people above the age of 45 in China.
- In our measurement of multimorbidity, we have included depressive disorders, a highly prevalent and important mental health condition in China but ignored in previous studies.
- We used self-reported measurement for 13 of the 14 chronic illnesses studied, which is likely to cause under-reporting as previous studies using administrative data reported higher prevalence of multimorbidity.
- The lower accessibility to healthcare for chronic illnesses for rural population than for urban population means that the study has probably still underestimated the prevalence of multimorbidity in the rural population.

poor quality of life and well-being.^{5 6} Multimorbidity also accounts for a disproportionately large share of healthcare utilisations and expenditures.^{7 8} The implications go beyond extra spending. As most health systems were designed based on single diseases, issues such as polypharmacy pose enormous challenges for care coordination and patients' self-management.⁹

Although populations of low and middle-income countries (LMICs) are generally younger than those in high-income countries, some major LMICs are ageing at particularly rapid paces. China is a case in point. While it took France almost 150 years for the proportion of people above 60 to increase from 10% to 20%,¹⁰ the same proportion in China increased from 10.3% in 2000 to 17.6% in 2018 (those aged between 45 and 60 also increased from 15.4% to 23.6% during the same time).¹¹ The limited epidemiological evidence from LMICs gave a wide range of estimated prevalence of multimorbidity, for example, from 9% to 83% in South Asia.¹²

Given the likelihood of multimorbidity as population ages and its serious impact on health and well-being, accurate estimation of the prevalence of multimorbidity is important for LMICs like China.

Noteworthy, there is a higher percentage (20.5%) of old people (aged at or above 60) among the rural Chinese (accounting for 40.4% of all Chinese) than among their urban counterparts (16.1%),¹¹ likely due to emigration of younger rural adults to the urban area. As findings from a study done in South Africa suggests, multimorbidity may disproportionately affect the less well-off.^{13–15} Despite improvement, quality care is less accessible in rural China compared with its urban areas,¹⁶ as most rural primary care doctors still lack a full university degree.¹⁷ Therefore, rural adults with chronic illnesses were at a higher risk of developing multimorbidity, meaning it is important particularly to study the rural situation.

We conducted a systematic literature search for published papers on prevalence of multimorbidity in China on 31 January 2020. We used search terms related to multimorbidity, prevalence and China on PubMed and Web of Science and did not apply language restrictions. Our search resulted in one systematic review that reported findings from local areas in China and five papers that covered nationwide prevalence. The systematic review (published in 2015) showed that most previous work about China focused on urban populations. Among the five papers, one was also restricted to urban population. The other four papers reported national prevalence of multimorbidity among middle-aged and elderly Chinese.^{18–21} These papers all used the same data set from the China Health and Retirement Longitudinal Study and reported consistently higher prevalence of multimorbidity among urban population than rural population. Zhao *et al*, for example, reported that rurality was associated with an OR of 0.76 of multimorbidity in people above 50 years old.²¹

These studies have two important limitations. First, measurement of multimorbidity was all based on self-report. This is likely to cause underreporting that disproportionately affects rural population for whom healthcare is usually less accessible than urban population.²² Second, these studies had neglected depression,^{19–21} a most prevalent mental health condition among Chinese²³ and a condition widely covered in previous international multimorbidity studies.^{24 25} As Lei *et al* reported, prevalence of depressive symptoms in 2011/2012 was also found to be much higher among rural middle-aged and elderly (35% for men and 49% for women) than among urban ones (23% for men and 35% for women),²⁶ though other estimation arrived at a range between 6.3% and 53.6%. Given the higher prevalence of depression among women than men, neglecting depression is also problematic from a gender equity perspective.

Limited scholarly focus on rural multimorbidity, reliance on self-reported diagnosis and neglect of depression all mean potentially substantial underestimation of the prevalence of multimorbidity and its consequences for health and well-being, particularly among China's rural

population. This knowledge gap profoundly hinders the development of equity-oriented and need-oriented health policies. Hence, it is important to include investigator-assessed health conditions and measurement of depression with a focus on urban–rural disparity in studies on multimorbidity in China. This paper aimed to provide an updated estimation of national prevalence of multimorbidity among middle-aged and older adults in China with the inclusion of depression and through the lens of urban–rural comparison.

METHODS

Study design and participants

The study used a cross-sectional design and data from the China Health and Retirement Longitudinal Study (CHARLS). The longitudinal survey covers a nationally representative sample of adults aged 45 years or older. It includes assessments of social, economic and health circumstances of community residents. The detailed cohort profile was previously published. The participants of CHARLS closely resembled the Chinese national census population in terms of demographic characteristics.²⁷

We used data from the latest wave of CHARLS collected in 2015–2016.²⁷ Of the 19 656 participants, a total of 2751 (14.0%) contained missing observations in variables. To address potential non-response bias, we weighed the samples using a survey weight variable provided by CHARLS, which gave sampled units (households and individuals) weights inversely proportional to their probability of having been selected and responded.²⁸

Measurement of multimorbidity

In line with previous systematic review and studies done in China,^{7 24 25} we used a disease count approach to measure multimorbidity. Following suggested cut-off point, a binary variable of coexistence of two or more chronic diseases/conditions within one individual constituted our main indication of multimorbidity. Partly due to the data restriction, the selection and definition of morbidities vary across previous multimorbidity studies, and no uniform operational measurement exists. We sought to include morbidities that were prevalent, which resulted in a list of 14 chronic illnesses.

Among these chronic illnesses, 13 (hypertension, diabetes, cancer, lung disease, heart problem, stroke, arthritis, dyslipidaemia, liver disease, kidney disease, stomach disease, asthma and memory problem) were assessed based on self-reported diagnosis by a doctor. Participants were asked 'have you been diagnosed with (conditions listed below, read by interviewers one by one) by a doctor?' Due to the health system reform in the recent decade, most people in China are covered by basic social health insurance and the Essential Public Health Service Scheme that covered the screening and management (eg, follow-up) of a range of prevalent non-communicable conditions (hypertension, diabetes, severe mental disorders, breast cancer etc).²⁹ Regular

check-up is now universally provided to all elderly above 65 years old. Most also have a community-based primary healthcare facility in their neighbourhood. Access to care is generally good, though quality differs. On average, every Chinese visit health facilities 5.6 times per year in 2015.³⁰ However, continued urban–rural gaps in health service benefits and access meant that there would likely be underreporting of chronic conditions.^{22 31} In addition, depressive disorders were assessed with 10-item Center for Epidemiologic Studies Depression Scale (CES-D 10). We consider the implications of using alongside self-reported physician diagnosis in the discussion section. In a sensitive analysis, an ordinal measure of multimorbidity (absence or single illness, two illnesses, three illnesses, four illnesses, five illnesses or more) was considered.

Covariates

This study collected a range of demographic, socio-economic, behavioural and health insurance covariates, including age group (45–54 years old, 55–64 years old, 65–74 years old, 75 years and above), sex (male or female), marital status (married, otherwise), educational attainment (illiterate, partial primary school, completed primary school, middle school or high school or above), smoking (current, former or never), alcohol drinking (current, former or never), health insurance status (covered or not) and urbanity (urban vs rural residence).

Urban or rural residence was measured based on the administrative classification of the participants' basic residing community. The basic rural resident community is a cun (literally meaning village), while a basic urban resident community is a jiedao (literally meaning street). Rural communities are usually far away from city or county centres, while urban ones are much closer. Equally important as physical distance was the fact that separated social policies applied for urban and rural communities in China. In recent years, entitlement differences between rural and urban areas regarding healthcare and social welfare are being reduced, though substantial prourban gaps remain.³² In 2015, the average annual disposable income of urban residents was 31 194.8¥ (6.23¥=1US\$ in 2015) or 2.73 times that of rural residents (11 421.7¥).³³

Statistical analysis

Frequencies (percentages) are reported to summarise the distribution of participants' characteristics. Weighted prevalence of individual chronic diseases and multimorbidity was calculated with adjustment using the survey weight. The distribution of multimorbidity by subpopulations was examined by stratified analysis of urbanity, sex and age groups. Multivariate logistic regression was applied to analyse the associations between covariates and the binary outcome of multimorbidity. A sensitivity analysis was conducted using ordered logit regressions to examine the relation between the same covariates and the ordinal outcome of multimorbidity.

RESULTS

Table 1 presents the characteristics of the study population and their weighted prevalence of multimorbidity. Among the 19 656 participants, the mean age was 60.2 years, 51.3% were women and 59.8% were from rural areas. 54.3% of the weighted sample had multimorbidity. Among the remainder, about half (22.8% of the sample) had only one of the 14 conditions, while the other half (22.9%) had none. In other words, 70.4% of all chronic patients had multimorbidity. The prevalence of multimorbidity generally increased as people aged.

Figure 1 shows the weighted proportion of population subgroups by number of chronic illnesses, urbanity, sex and age. Except for men above 75 years old, prevalence of multimorbidity was consistently higher among rural population in all age groups in both sexes. Women, no matter urban or rural, were more likely to suffer from multimorbidity in all age groups. People in general were more likely to have more chronic illnesses as they aged. The trends became inconsistent when people became older than 75 years. Detailed prevalence is provided in online supplemental appendix table 1.

Table 2 presents the factors associated with multimorbidity. In the multivariate logistic model, older age, being woman, not in marriage, without education level of middle school or above, former smoking and alcohol drinking, health insurance coverage and rural residence were significantly associated with higher odds of having multimorbidity. After adjusting for age, sex, education, marital status, smoking, alcohol consumption and insurance coverage, rural residents had 7.5% higher odds (95% CI of OR (1.003 to 1.151)) of having multimorbidity than urban residents. In the sensitivity analysis, multivariate ordered logistic model using an ordinal measure of multimorbidity yields a similar pattern that rural residents had 6.4% higher odds (95% CI of OR (1.003 to 1.128)) of having multimorbidity compared with urban residents, adjusted for the same covariates (see online supplemental appendix table 2).

Table 3 reports the proportion of people with a given condition among the 14 chronic diseases, and the prevalence of multimorbidity among patients with the given conditions. As much as 42.8% of Chinese at or above 45 years old had arthritis, which was the most prevalent condition. This was followed by hypertension (34.6%), depressive disorders (31.1%) and stomach disease (31%). Compared with urban residents, rural population was particularly more likely to be affected by arthritis (rural vs urban=48.3% vs 36.5%), depressive disorders (36.8% vs 24.7%), while urban population were much more likely to have dyslipidaemia (26.1% vs 14.3%).

Patients with chronic from both urban and rural areas were predominantly having multimorbidity (83.6%–97.6% overall, 80.6%–97.6% in urban population and 84.5%–97.9% in rural population). Only among patients with kidney disease were urban conditional prevalence of multimorbidity higher than rural conditional prevalence of multimorbidity. For any of the remaining 13 types, rural

Table 1 Characteristics of study population and weighted prevalence of multimorbidity

	N (%)	Weighted prevalence*		
		No illness	One illness	Multimorbidities (≥2)
Total	19656 (100)	22.9%	22.8%	54.3%
Age (year)				
45–54	6792 (34.6)	35.0%	26.3%	38.7%
55–64	6604 (33.6)	19.3%	23.2%	57.6%
65–74	4310 (21.9)	13.7%	19.1%	67.1%
≥75	1950 (9.9)	13.5%	17.6%	68.9%
Sex				
Male	9573 (48.7)	25.7%	23.9%	50.4%
Female	10083 (51.3)	20.3%	21.7%	58.0%
Educational level				
Illiterate	4985 (25.4)	15.8%	22.5%	61.7%
Part of primary school	3252 (16.6)	14.8%	20.0%	65.2%
Primary school	5352 (27.3)	32.7%	22.8%	44.5%
Junior middle school	3804 (19.4)	21.4%	24.0%	54.5%
Senior middle school or above	2237 (11.4)	25.9%	24.4%	49.7%
Unknown†	26 (0.1)			
Marital status				
Not in marriage	2666 (13.6)	15.6%	17.8%	66.6%
Married	16989 (86.4)	24.2%	23.6%	52.2%
Unknown†	1 (0.0)			
Smoking				
Current	5568 (28.4)	25.6%	24.3%	50.1%
Former	3112 (15.9)	17.8%	20.6%	61.5%
Never	10929 (55.7)	22.8%	22.7%	54.5%
Unknown†	47 (0.2)			
Alcohol consumption				
Current	6947 (35.5)	27.7%	24.8%	47.6%
Former	2213 (11.3)	13.8%	19.5%	66.7%
Never	10427 (53.2)	21.3%	22.1%	56.6%
Unknown†	69 (0.4)			
Health insurance status				
Covered	15406 (90.9)	16.2%	22.0%	61.7%
Not covered	1549 (9.1)	20.3%	21.9%	57.7%
Unknown†	2701 (13.7)			
Urbanity				
Urban	7908 (40.2)	26.7%	23.0%	50.4%
Rural	11748 (59.8)	19.2%	22.6%	58.3%

*Individual weight with household and individual non-response adjustment was used to calculate the weighted prevalence.

†'Unknown' means that no response from the interviewed participants was recorded for the question.

patients with chronic were more likely to have multimorbidity than urban ones. The maximal difference between rural and urban conditional prevalence of multimorbidity among patients with chronic of any of the 14 types was 4.4 percentage point, observed in dyslipidaemia.

DISCUSSION

Our study using nationally representative data revealed a high prevalence (54.3%) of multimorbidity among middle-aged or elderly adults in China. Extrapolating this figure to the entire national population of adults aged

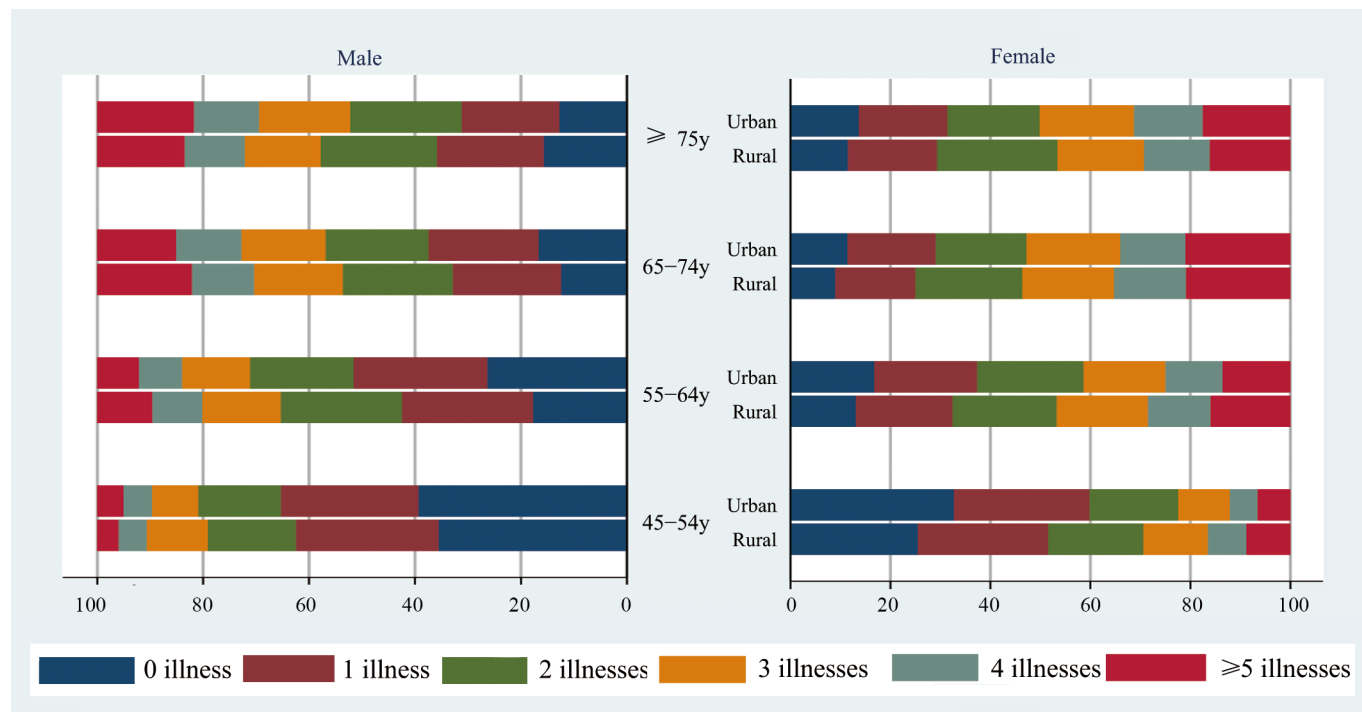


Figure 1 Weighted percentage of population subgroups by number of chronic illness, urbanity, sex and age.

45 or above, we estimate that there are over 240 million middle-aged or elderly Chinese with multimorbidity.³⁴ Our estimation of multimorbidity prevalence among people aged at or above 45 in China is higher than previous estimations (42.4%) using a similar data set.¹⁹

The main reason for the difference seems to be our inclusion of depression. As 24.7% of urban residents and 36.8% of rural residents above the age of 45 had depressive symptoms, depression is indeed a highly prevalent condition that merits inclusion in disease counts for multimorbidity. The level of prevalence of depression is consistent with previous studies using a similar data set.²⁶ Of note, the numbers are substantially lower compared with a nationwide study on mental health using the World Mental Health Composite International Diagnostic Interview developed by the WHO, which reported a 12-month prevalence of 3.6% among all Chinese in 2013.²³ However, the Composite International Diagnostic Interview was found to have high specificity and low sensitivity, thus the tool likely leads to substantial underestimation of the prevalence of depression.³⁵

We also found that women were more likely to be multimorbid, consistent with a previous study in China.¹⁹ It is likely due to the fact that women are better at expressing their conditions³⁶ and take better care of their health by checking out their illnesses with doctors.³⁷ In addition, multimorbidity is associated with a range of social and behavioural factors, such as lower education status, former smoking and alcohol consumption, being unmarried or divorced and lacking health insurance coverage.

Most (70.4%) chronic patients with chronic were multimorbid. People with a given condition out of our index chronic illnesses were very likely to be multimorbid

(83.6%–97.6%). In other words, chronic illnesses rarely existed in a person as a single morbidity. A previous study using claims data found that 82% of all elderly patients (aged at or above 60) covered by Urban Employees Basic Medical Insurance in Beijing had multimorbidity.³⁸

Given that conditional prevalence of multimorbidity is very high (ie, above 83%) among patients with a given condition from the 14 chronic diseases, the most prevalent ones (ie, arthritis, hypertension, depressive disorders, stomach disease, with a prevalence higher than 30%) seem to have substantially contributed to the high prevalence of multimorbidity. The list of prevalent conditions (arthritis, hypertension, depressive disorders, stomach disease, dyslipidaemia, heart problem, lung disease, diabetes and kidney disease, all with a prevalence above 10%) is very similar with the findings of a systematic review from South Asia,¹² except that the studies included in that systematic review had not counted in depressive disorders, stomach disease and dyslipidaemia, which were prevalent in China, and that skin diseases, prevalent in South Asia, was left out in the survey we used.

Physical chronic diseases have also been found associated with an increased risk of depressive symptoms. A previous study using CHARLS data also reported that patients with one, two and three or more chronic physical conditions were 21%, 66% and 111% more likely than those without any chronic physical condition to be affected by depressive symptoms.³⁹ The relation seems to work both ways. Patients with baseline hypertension were more likely to have depressive symptoms than those without hypertension in follow-up surveys, particularly in rural areas.⁴⁰ Meanwhile, major depression in the previous year was also found to be associated with

Table 2 ORs for multimorbidity by age, sex, marital status, education, former smoking and alcohol consumption, health insurance status and urbanity

	Logistic model
	OR (95% CI)
Age (year)	
45–54	Reference
55–64	1.546 (1.428 to 1.674)
65–74	2.177 (1.982 to 2.392)
≥75	1.908 (1.676 to 2.173)
Sex	
Male	Reference
Female	1.649 (1.484 to 1.832)
Educational level	
Illiterate	Reference
Part of primary school	1.15 (1.039 to 1.274)
Primary school	1.077 (0.974 to 1.190)
Junior middle school	0.932 (0.840 to 1.034)
Senior middle school or above	0.838 (0.742 to 0.947)
Marital status	
Not in marriage	Reference
Married	0.843 (0.761 to 0.934)
Smoking	
Current	Reference
Former	1.478 (1.336 to 1.634)
Never	0.956 (0.862 to 1.061)
Alcohol consumption	
Current	Reference
Former	1.769 (1.575 to 1.987)
Never	1.061 (0.980 to 1.150)
Insurance coverage	
Covered	Reference
Not covered	0.816 (0.730 to 0.912)
Urbanity	
Urban	Reference
Rural	1.075 (1.003 to 1.151)
N	16905

Logistic model was applied for binary outcome which refers to 1 as coexistence of two or more chronic diseases and/or conditions within one person.

an increased risk of ischaemic heart disease in Chinese adults, independent of other major cardiovascular risk factors. In terms of access to care, despite reforms aiming at primary care strengthening and development in programmes to address non-communicable diseases, there is still much challenge in the quality of primary care that hinders control of prevalent chronic physical conditions like hypertension and diabetes in China.^{31 41} Furthermore, mental health service is yet to be well integrated into China's general health system.⁴² These health

system constraints probably contributed to the coexistence of high prevalence of chronic physical conditions and depression.

We found the prevalence of multimorbidity to be higher among the rural dwellers (58.3%) than among the urban population (50.4%) in 2015. This revised the previously consistent finding that urban residents were more likely to have multimorbidity than rural population.^{18 19 21} The higher prevalence of multimorbidity among rural residents than among urban residents was shown in almost all age groups in both sexes in our study. The rural–urban difference seems to be driven by the higher rural prevalence of arthritis and depressive disorders than among urbanites. We have further shown that multimorbidity was more prevalent among rural patients with at least one of 13 of the 14 chronic illnesses studied than among their urban counterparts. Again, our inclusion of depression seems to be a main reason that we have found higher prevalence of multimorbidity among rural population than among urban population. Compared with urban population, rural population's lower socioeconomic status, poorer childhood health, poorer social services and poorer access to quality health services (including diagnostic testing), as well as the very nature of rural residence and lifestyle, might all have contributed to their substantially higher prevalence of depression.^{26 31 39}

Our findings have some important implications. First, given the prevalence of the multimorbidity epidemic and its dominance among patients with chronic, it is imperative that China moves from its current hospital-centric model with fragmented care across specialties and facilities towards an approach of people-centred integrated care built on strong primary care. Second, since rural population have higher prevalence of multimorbidity, priority for health system transformation (and related research) to address multimorbidity lies in the rural areas, where the needs are the greatest and service providers are less qualified and located more sparsely. Third, within the shorter life expectancy among rural population,⁴³ they also seem more severely affected by multimorbidity. The impact of multimorbidity on rural people's lives therefore deserves greater attention. Fourth, one out of four Chinese aged 45 or above were affected by depression and at least one chronic physical disorder. This combination came with potentially severe consequences on their well-being.⁶ It is particularly important that mental health be integrated at an affordable cost to primary care.

Considering the importance of primary care in addressing multiple diseases in a coordinated and continuous manner, it seems critical to strengthen primary care so that equally good-quality integrated services can be provided to both rural and urban Chinese. Meanwhile, improving physical capacity and human resources at primary care facilities may be a long-term process. Digital health solutions such as telemedicine may be potentially valuable in facilitating support for front-liner providers (by facilitating better communication and information sharing), patients and their care givers (by providing

Table 3 Prevalence of chronic diseases and conditional prevalence of multimorbidity among patients with at least one of 14 chronic diseases (aged at or above 45 years old)

Chronic diseases	Proportion of patients with a given condition			Prevalence of multimorbidity among patients with the given condition		
	Total (%)	Urban	Rural	Total	Urban	Rural
Arthritis	42.8	36.5	48.3	86.7	86.6	86.7
Hypertension	34.6	37.1	32.3	86.9	85.7	88.1
Depressive disorders	31.1	24.7	36.8	83.0	80.6	84.5
Stomach disease	31.0	27.3	34.2	87.3	84.8	89.1
Dyslipidaemia	19.8	26.1	14.3	91.4	89.8	94.2
Heart problem	18.8	21.8	16.0	94.4	93.3	95.8
Lung disease	15.0	13.7	16.1	92.8	92.4	93.1
Diabetes	10.9	13.9	8.3	94.0	93.1	95.4
Kidney disease	10.2	10.3	10.1	94.4	95.2	93.7
Liver disease	7.4	8.5	6.4	91.8	90.2	93.6
Asthma	6.0	5.3	6.7	97.6	97.6	97.7
Stroke	3.8	4.3	3.4	96.6	95.4	97.9
Memory problem	2.8	2.8	2.9	94.6	94.1	95.1
Cancer	1.9	2.0	1.7	87.2	85.2	89.4

Individual weight with household and individual non-response adjustment was used to calculate prevalence.

self-management tools)⁴⁴ both in the short term and in the long run. Meanwhile, issues like cost and mobilisation of health professionals need to be addressed, for digital health interventions to work at all. As the Chinese government continuously pushed forward the agenda of digital health, how digital health interventions can better address the prourban gaps in multimorbidity deserves greater attention. Public finance is needed to allow resources online to flow towards the remote rural areas.

The present study has two strengths. First, we used nationally representative sample of the people above the age of 45 in China. Second, we have included depression in our measurement of multimorbidity following the practice suggested in two systematic reviews.^{24 25}

There are also limitations of the study. First, we used self-reported diagnosis by physicians for 13 of the 14 chronic illnesses studied. Despite China's recent health system development, which extended essential health-care coverage to all its population, healthcare for chronic illnesses is still less accessible for rural population.³¹ Underdiagnosis of chronic illnesses (eg, diabetes) is likely to be more common in rural areas than in urban areas.²² Hence, the actual urban–rural multimorbidity difference might be even larger than the current estimate.

Second, depression was measured by a scale (ie, CES-D 10), unlike the other 13 self-reported conditions. The main reason is that depression was only available through CES-D 10. As the capacity of mental health service is weak in China, particularly at the primary care level,⁴² depression is likely underdiagnosed in China overall and particularly among rural population. Hence, self-reported diagnosis would mean substantial underestimation. A study has reported that a substantial proportion of rural

Chinese women would attribute depressive disorders to social causes and were not likely to visit a doctor when having depressive disorders.⁴⁵ The CES-D 10 scale was validated as a screening instrument for depression⁴⁶ and appeared more suitable for our measurement of depression within the constraints of available data. Meanwhile, some had claimed that the scale has high sensitivity (low false negative) but low specificity (high false positive).⁴⁷ This means that we might have overestimated prevalence of depressive symptoms and its impact on overall prevalence of multimorbidity, though the effects are not likely to differ substantially across urban and rural areas.

CONCLUSION

Our study estimated that over half of Chinese aged 45 years or above have two or more chronic medical conditions. Contrary to previous studies, we have provided clear evidence that multimorbidity is more prevalent among rural population (58.3%) than among their urban counterparts (50.4%). Above 70% of patients with chronic aged 45 years or above have multimorbidity. The prevalence of multimorbidity among patients with one of the 14 chronic illnesses included in this study was even higher and ranged between 80.6% and 97.9%. A critical driver of the rural–urban disparity in multimorbidity is the high prevalence of depression in rural areas. Future health system development in China should transform from preventing and controlling non-communicable diseases as individual diseases to addressing people's comprehensive health need under multimorbidity. The priority for such transformation is the rural areas.

Contributors JX and YH did the literature review. JX and XM did the study design. All authors participated in data analysis. JX, YH and XM jointly wrote the first draft, participated in the revision of the draft and versions of the manuscript. All authors provided comments and confirmed the finalised version.

Funding The study is funded by Natural Science Foundation of China (No. 71804004). The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. We used data from the China Health and Retirement Longitudinal Study (CHARLS). The data depository is accessible via the official website of CHARLS: <http://charls.pku.edu.cn/index.html>.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Jin Xu <http://orcid.org/0000-0002-6364-0887>

REFERENCES

- 1 WHO. *World report on ageing and health*. Geneva: World Health Organization, 2015.
- 2 Dugravot A, Fayosse A, Dumurgier J, et al. Social inequalities in multimorbidity, frailty, disability, and transitions to mortality: a 24-year follow-up of the Whitehall II cohort study. *Lancet Public Health* 2020;5:e42–50.
- 3 Marventano S, Ayala A, Gonzalez N, et al. Multimorbidity and functional status in community-dwelling older adults. *Eur J Intern Med* 2014;25:610–6.
- 4 Wang X-X, Lin W-Q, Chen X-J, et al. Multimorbidity associated with functional independence among community-dwelling older people: a cross-sectional study in Southern China. *Health Qual Life Outcomes* 2017;15:73.
- 5 Gu J, Chao J, Chen W, et al. Multimorbidity and health-related quality of life among the community-dwelling elderly: a longitudinal study. *Arch Gerontol Geriatr* 2018;74:133–40.
- 6 Coventry PA, Dickens C, Todd C. How does mental-physical multimorbidity express itself in lived time and space? A phenomenological analysis of encounters with depression and chronic physical illness. *Soc Sci Med* 2014;118:108–18.
- 7 Chen H, Cheng M, Zhuang Y, et al. Multimorbidity among middle-aged and older persons in urban China: prevalence, characteristics and health service utilization. *Geriatr Gerontol Int* 2018;18:1447–52.
- 8 Hopman P, Heins MJ, Korevaar JC, et al. Health care utilization of patients with multiple chronic diseases in the Netherlands: differences and underlying factors. *Eur J Intern Med* 2016;35:44–50.
- 9 Pearson-Stuttard J, Ezzati M, Gregg EW. Multimorbidity—a defining challenge for health systems. *Lancet Public Health* 2019;4:e599–600.
- 10 WHO. 10 facts on ageing and the life course, 2020. Available: https://www.who.int/features/factfiles/ageing/ageing_facts/en/ [Accessed 1 Jul 2020].
- 11 Academy of Medical Sciences. *Multimorbidity: a priority for global health research*, 2018.
- 12 Pati S, Swain S, Hussain MA, et al. Prevalence and outcomes of multimorbidity in South Asia: a systematic review. *BMJ Open* 2015;5:e007235.
- 13 Ataguba JE-O. Inequalities in multimorbidity in South Africa. *Int J Equity Health* 2013;12:64.
- 14 Khanam MA, Streatfield PK, Kabir ZN, et al. Prevalence and patterns of multimorbidity among elderly people in rural Bangladesh: a cross-sectional study. *J Health Popul Nutr* 2011;29:406–14.
- 15 Boutayeb A, Boutayeb S, Boutayeb W. Multi-morbidity of non communicable diseases and equity in who eastern Mediterranean countries. *Int J Equity Health* 2013;12:60.
- 16 Li J, Shi L, Liang H, et al. Urban-rural disparities in health care utilization among Chinese adults from 1993 to 2011. *BMC Health Serv Res* 2018;18:102.
- 17 Xu J, Mills A. Challenges for gatekeeping: a qualitative systems analysis of a pilot in rural China. *Int J Equity Health* 2017;16:106.
- 18 Yi JY, Kim H, Chi I. Urban-rural differences in multimorbidity and associated factors in China and Korea: a population-based survey study. *Geriatr Gerontol Int* 2019;19:1157–64.
- 19 Yao SS, Cao GY, Han L, et al. Prevalence and patterns of multimorbidity in a nationally representative sample of older Chinese: results from CHARLS. *J Gerontol A Biol Sci Med Sci* 2019.
- 20 Zhang R, Lu Y, Shi L, et al. Prevalence and patterns of multimorbidity among the elderly in China: a cross-sectional study using national survey data. *BMJ Open* 2019;9:e024268-e.
- 21 Zhao Y, Atun R, Oldenburg B, et al. Physical multimorbidity, health service use, and catastrophic health expenditure by socioeconomic groups in China: an analysis of population-based panel data. *Lancet Glob Health* 2020;8:e840–9.
- 22 Yuan X, Liu T, Wu L, et al. Validity of self-reported diabetes among middle-aged and older Chinese adults: the China health and retirement longitudinal study. *BMJ Open* 2015;5:e006633.
- 23 Huang Y, Wang Y, Wang H, et al. Prevalence of mental disorders in China: a cross-sectional epidemiological study. *Lancet Psychiatry* 2019;6:211–24.
- 24 Prados-Torres A, Calderón-Larrañaga A, Hanco-Saavedra J, et al. Multimorbidity patterns: a systematic review. *J Clin Epidemiol* 2014;67:254–66.
- 25 Johnston MC, Crilly M, Black C, et al. Defining and measuring multimorbidity: a systematic review of systematic reviews. *Eur J Public Health* 2019;29:182–9.
- 26 Lei X, Sun X, Strauss J, et al. Depressive symptoms and SES among the mid-aged and elderly in China: evidence from the China health and retirement longitudinal study national baseline. *Soc Sci Med* 2014;120:224–32.
- 27 Zhao Y, Hu Y, Smith JP, et al. Cohort profile: the China health and retirement longitudinal study (CHARLS). *Int J Epidemiol* 2014;43:61–8.
- 28 Zhao Y, Strauss J, Yang G, et al. *China health and retirement longitudinal study – 2011–2012 National baseline users' guide*, 2013.
- 29 Yuan B, Balabanova D, Gao J, et al. Strengthening public health services to achieve universal health coverage in China. *BMJ* 2019;365:12358.
- 30 National Health and Family Planning Commission. *China health and family planning statistical yearbook 2016*. Beijing, 2016.
- 31 Feng XL, Pang M, Beard J. Health system strengthening and hypertension awareness, treatment and control: data from the China health and retirement longitudinal study. *Bull World Health Organ* 2014;92:29–41.
- 32 Meng Q, Fang H, Liu X, et al. Consolidating the social health insurance schemes in China: towards an equitable and efficient health system. *Lancet* 2015;386:1484–92.
- 33 National Bureau of Statistics of China. *China statistical yearbook 2019*. Beijing, 2019.
- 34 National Bureau of Statistics of China. *China statistical yearbook 2016*. Beijing, 2016.
- 35 Gelaye B, Williams MA, Lemma S, et al. Diagnostic validity of the composite international diagnostic interview (CIDI) depression module in an East African population. *Int J Psychiatry Med* 2013;46:387–405.
- 36 Alimohammadian M, Majidi A, Yaseri M, et al. Multimorbidity as an important issue among women: results of a gender difference investigation in a large population-based cross-sectional study in West Asia. *BMJ Open* 2017;7:e013548.
- 37 Jankovic J, Mirkovic M, Jovic-Vranes A, et al. Association between non-communicable disease multimorbidity and health care utilization in a middle-income country: population-based study. *Public Health* 2018;155:35–42.
- 38 Chen H, Chen Y, Cui B. The association of multimorbidity with healthcare expenditure among the elderly patients in Beijing, China. *Arch Gerontol Geriatr* 2018;79:32–8.
- 39 Yao S-S, Cao G-Y, Han L, et al. Associations between somatic multimorbidity patterns and depression in a longitudinal cohort of middle-aged and older Chinese. *J Am Med Dir Assoc* 2020;21:1282–7.

- 40 Jin Y, Luo Y, He P. Hypertension, socioeconomic status and depressive symptoms in Chinese middle-aged and older adults: findings from the China health and retirement longitudinal study. *J Affect Disord* 2019;252:237–44.
- 41 Li X, Krumholz HM, Yip W, *et al.* Quality of primary health care in China: challenges and recommendations. *Lancet* 2020;395:1802–12.
- 42 Liang D, Mays VM, Hwang W-C. Integrated mental health services in China: challenges and planning for the future. *Health Policy Plan* 2018;33:107–22.
- 43 Zimmer Z, Kaneda T, Spess L. An examination of urban versus rural mortality in China using community and individual data. *J Gerontol B Psychol Sci Soc Sci* 2007;62:S349–57.
- 44 Barbabella F, Melchiorre MG, Quattrini S, *et al.* European observatory policy briefs. In: Richardson E, van Ginneken E, eds. *How can eHealth improve care for people with multimorbidity in Europe?* 2017. Copenhagen: European Observatory on Health Systems and Policies NIVEL and TU Berlin, 2017.
- 45 Qiu P, Caine ED, Hou F, *et al.* Depression as seen through the eyes of rural Chinese women: implications for help-seeking and the future of mental health care in China. *J Affect Disord* 2018;227:38–47.
- 46 Andresen EM, Malmgren JA, Carter WB, *et al.* Screening for depression in well older adults: evaluation of a short form of the CES-D (center for epidemiologic studies depression scale). *Am J Prev Med* 1994;10:77–84.
- 47 Chen Y, Hicks A, While AE. Depression and related factors in older people in China: a systematic review. *Rev Clin Gerontol* 2012;22:52–67.