

# Physical multimorbidity, health service use, and catastrophic health expenditure by socioeconomic groups in China: an analysis of population-based panel data



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## Summary

**Background** Multimorbidity, the presence of two or more mental or physical chronic non-communicable diseases, is a major challenge for the health system in China, which faces unprecedented ageing of its population. Here we examined the distribution of physical multimorbidity in relation to socioeconomic status; the association between physical multimorbidity, health-care service use, and catastrophic health expenditures; and whether these associations varied by socioeconomic group and social health insurance schemes.

**Methods** In this population-based, panel data analysis, we used data from three waves of the nationally representative China Health and Retirement Longitudinal Study (CHARLS) for 2011, 2013, and 2015. We included participants aged 50 years and older in 2015, who had complete follow-up for the three waves. We used 11 physical non-communicable diseases to measure physical multimorbidity and annual per-capita household consumption spending as a proxy for socioeconomic status.

**Findings** Of 17708 participants in CHARLS, 11817 were eligible for inclusion in our analysis. The median age of participants was 62 years (IQR 56–69) in 2015, and 5766 (48·8%) participants were male. 7320 (61·9%) eligible participants had physical multimorbidity in China in 2015. The prevalence of physical multimorbidity was increased with older age (odds ratio 2·93, 95% CI 2·71–3·15), among women (2·70, 2·04–3·57), within a higher socioeconomic group (for quartile 4 [highest group] 1·50, 1·24–1·82), and higher educational level (5·17, 3·02–8·83); however, physical multimorbidity was more common in poorer regions than in the more affluent regions. An additional chronic non-communicable disease was associated with an increase in the number of outpatient visits (incidence rate ratio 1·29, 95% CI 1·27–1·31), and number of days spent in hospital as an inpatient (1·38, 1·35–1·41). We saw similar effects in health service use of an additional chronic non-communicable disease in different socioeconomic groups and among those covered by different social health insurance programmes. Overall, physical multimorbidity was associated with a significantly increased likelihood of catastrophic health expenditure (for the overall population: odds ratio 1·29, 95% CI 1·26–1·32, adjusted for sociodemographic variables). The effect of physical multimorbidity on catastrophic health expenditures persisted even among the higher socioeconomic groups and across all health insurance programmes.

**Interpretation** Concerted efforts are needed to reduce health inequalities that are due to physical multimorbidity, and its adverse economic effect in population groups in China. Social health insurance reforms must place emphasis on reducing out-of-pocket spending for patients with multimorbidity to provide greater financial risk protection.

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## Introduction

Chronic conditions are a major contributor to health burden, inequalities in health outcomes, and economic burden in China.<sup>1,2</sup> With an ageing population and high levels of risk factors for non-communicable diseases, the prevalence of multimorbidity (defined as two or more coexisting chronic conditions<sup>3</sup>) is likely to increase rapidly.<sup>4</sup> Despite the increasing prevalence of multimorbidity, little attention has been given to its implications for individuals, households, health systems, and the economy in China.<sup>5</sup>

The Chinese Government, via its Healthy China 2030 Plan<sup>6</sup> and through a series of far-reaching health reforms, has set a bold vision for achieving universal health coverage and reducing premature mortality due to non-communicable diseases by 30% from 2015 to 2030. As of 2011, approximately 1·2 billion Chinese citizens (more than 95·7% of the total population of 1·3 billion people) are covered by one of three social health insurance programmes: the Urban Employee Basic Medical Insurance (UEBMI) scheme, the Urban Resident Basic Medical Insurance (URBMI) scheme, and the New Rural

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### Research in context

#### Evidence before this study

We searched PubMed and MEDLINE for articles published in English between Jan 1, 1979, and Jan 31, 2019, using the keywords “multimorbidity”, “multiple chronic diseases”, “healthcare utilisation”, “economic burden”, “health expenditure”, and “China”. We identified 12 articles that examined the association between multimorbidity and health-care use and expenditure in China. One study examined the association between multimorbidity and health-care use among 162 464 people in Guangdong province. However, we identified no national-level studies that used panel survey data in their analysis to examine the effect of multimorbidity on health service use and financial protection by socioeconomic group and populations covered by various social health insurance schemes in China. Research is urgently needed to generate evidence to inform health policy and health system responses to multimorbidity.

#### Added value of this study

To our knowledge, this study is the first longitudinal analysis to examine socioeconomic group differences in the prevalence

of physical multimorbidity in China, and its effect on health-care use and catastrophic health expenditures. Our findings indicate that physical multimorbidity is common among Chinese adults aged 50 years and older. Individuals in higher socioeconomic groups have more physical multimorbidity than those in lower socioeconomic groups.

#### Implications of all the available evidence

Our findings differ from the evidence from high-income countries, where the prevalence of physical multimorbidity is higher among lower-income groups than in higher-income groups, but this difference might be due to limitations in the current study data, which excluded mental health conditions and relied mainly on self-report. Further studies examining the effect of multimorbidity due to other common chronic conditions (eg, Alzheimer’s disease, depression, asthma) and infectious diseases (eg, tuberculosis, AIDS, coronavirus disease 2019) are also warranted. The social patterning of multimorbidity in China requires further research that should include a wider range of morbidities, and more robust measures of both mental and physical conditions than has been recorded to date.

Cooperative Medical Scheme (NRCMS; panel).<sup>7,10</sup> To improve fairness in health insurance coverage, the central government in China announced the decision to integrate URBMI and NRCMS into the new Urban-Rural Resident Medical Insurance (URRMI) scheme at the end of 2015.<sup>11</sup> However, low levels of service coverage for some beneficiaries and high levels of patient cost-sharing (from out-of-pocket fees for health services) have raised concerns about the lack of adequate financial protection for patients with non-communicable diseases.<sup>10</sup>

The economic impact of multimorbidity and its implications on financial stress has been an emerging area of research for the past 10 years.<sup>4</sup> To date, the evidence on the economic burden of multimorbidity is mostly from high-income countries. This evidence suggests that multimorbidity imposes high economic costs on individuals and households.<sup>12</sup> Patients with multimorbidity incur substantial health expenditures due to their conditions,<sup>13</sup> and are more likely to be absent from work and less productive, with adverse economic consequences.<sup>12</sup> However, the associations between multimorbidity, health service use, and levels of financial stress in different population groups have not been widely examined in low-income and middle-income countries.

In China, little evidence exists on the economic effect of multimorbidity on individuals and the health system. To date, published studies have examined regional-level or district-level populations and used cross-sectional study designs.<sup>14–16</sup> None of these studies has used nationally representative panel survey data. We present the first study from China that uses panel survey data for the period 2011–15 to examine physical multimorbidity, its

association with socioeconomic status, and its effect on health service use and catastrophic health expenditure. The data are representative of the largest middle-aged and older population group (people aged  $\geq 50$  years) in the world, comprising more than 337 million people.<sup>17</sup>

## Methods

### Study design and data sources

In this population-based, panel data analysis we used data from the three waves of the China Health and Retirement Longitudinal Study (CHARLS) run in 2011, 2013, and 2015.<sup>18</sup> Briefly, CHARLS collects high-quality data via one-to-one interviews with a structured questionnaire, from a nationally representative sample of Chinese residents aged 45 years and older, selected using multistage stratified probability-proportionate-to-size sampling. The overall response rate to CHARLS was 80·5% in the first wave. The total sample size of the CHARLS baseline survey in 2011 was 17708 individual respondents and these participants were followed up once every 2 years to repeat the survey. The data included individual weighting variables to ensure that the survey sample was nationally representative. A detailed description of the objectives and methods of CHARLS has been reported elsewhere.<sup>18</sup>

The Biomedical Ethics Review Committee of Peking University approved CHARLS, and all participants were required to provide written informed consent. The ethical approval number was IRB00001052-11015.

For this study, we included data from participants who were not lost to follow-up over the three waves and aged 50 years and older in wave three, and we excluded

participants who had missing values of dependent or independent variables.

### Procedures

In this study, we defined multimorbidity as the presence of two or more physical chronic non-communicable diseases.<sup>4</sup> We used 11 non-communicable diseases to measure physical multimorbidity, including diagnosed hypertension and ten self-reported diagnosed chronic diseases (diabetes, dyslipidaemia, heart disease, stroke, cancer, chronic lung disease, digestive disease, liver disease, kidney disease, and arthritis). We counted the number of non-communicable diseases for each participant to identify those who had physical multimorbidity. We did not include individuals with self-reported psychiatric and memory-related diseases due to potential recall bias.

In CHARLS, each respondent's systolic and diastolic blood pressure was recorded three times by a trained nurse using a HEM-7112 electronic monitor (OMRON, Tokyo, Japan). Diagnosed hypertension was defined as systolic blood pressure of 140 mm Hg or higher, diastolic blood pressure of 90 mm Hg or higher, being on anti-hypertensive medication for increased blood pressure, or a combination of these factors.<sup>19</sup>

In CHARLS, participants were asked about their use of outpatient and inpatient services via the following questions: "How many times did you visit a general hospital, specialised hospital, clinic, or other medical facilities for outpatient care in the past month?" and "How many days did you stay in hospital over the past year?" CHARLS collected self-reported information on how much respondents paid in total and how much they paid out of pocket (deducting the reimbursed expenses) for their outpatient visits during the past month and for inpatient visits during the past year. We multiplied the monthly spending by 12 to calculate the annual out-of-pocket spending for each participant for outpatient care. The same information was also collected for spouses of all participants. To calculate catastrophic health expenditures at the household level, we used the out-of-pocket spending data for spouses as well.

We defined a household as incurring catastrophic health expenditures when out-of-pocket spending on health equalled or exceeded 40% of a household's capacity to pay.<sup>20</sup> We defined a household's capacity to pay as the total consumption expenditure of the household minus the food-based household spending. This expenditure level was the denominator and the numerator was the sum of participant's and their spouses' out-of-pocket spending for outpatient and inpatient care in the past year. We defined a binary variable, which indicated whether the participant's household had catastrophic health expenditures or not.

We analysed differences between socioeconomic groups. We used annual per-capita household consumption spending as a proxy for socioeconomic status. We defined four socioeconomic groups on the basis of quartiles of

per-capita household consumption expenditure (quartile 1, <US\$662·50; quartile 2, \$662·50 to <1203·00; quartile 3, \$1203·00 to <2151·50; and quartile 4 ≥\$2151·5).

We included the following variables as covariates: age, sex, marital status (married and partnered, unmarried, and others), education (primary school and below, secondary school, and college and above), residence (rural, urban, and rural-to-urban, defined as people with agricultural household registration but living in urban areas), socioeconomic status quartiles, health insurance (UEBMI, URBMI, NRCMS, other insurance, and without insurance), and economic development region (five regional classes). Overall, we identified five economic development regions and ranked them on the basis of their 2015 gross domestic product per-capita income at the province level in China (group 1, >\$12000; group 2, \$12000 to >10000; group 3, \$10000 to >7000; group 4, \$7000 to >6000; and group 5, ≤\$6000).<sup>21</sup>

### Statistical analysis

We used a panel data approach of random-effects logistic regression to examine the associations between socioeconomic status and the presence of physical multimorbidity.

#### Panel: China's main social health insurance schemes

The China New Health System Reform, introduced in 2009, has expanded social health insurance coverage such that in 2011 95·7% of the Chinese population were covered.<sup>7</sup> Three main social health insurance schemes exist.

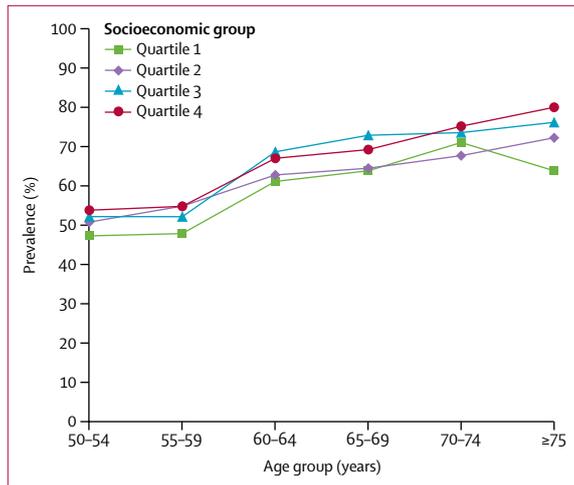
The UEBMI scheme, which covers urban workers, was launched by the Chinese State Council in 1998. All urban employees are required to join this scheme, which consists of a pooled fund for inpatient stays and individual medical savings accounts for outpatient visits. Approximately 283 million people were enrolled in UEBMI in 2014.<sup>8</sup> It is financed by payroll income from employees (2% of their salary) and employers (equivalent to 6% of employee's salary).<sup>9</sup> The per-capita fund of this scheme is US\$424·7.<sup>10</sup>

The URBMI scheme aims to insure the rest of the urban population, including children, students, and other unemployed urban residents who are not covered by UEBMI. In 2014, 315 million people were covered by URBMI. The scheme is funded by a government subsidy (70%) and individual contributions (30%).<sup>9</sup> The per-capita fund of this scheme is \$66·2.<sup>10</sup>

The NRCMS was launched in 2003 for the rural population, and expanded rapidly to cover about 802 million rural residents by 2013.<sup>10</sup> NRCMS funds are pooled at the county level. The NRCMS is financed by the premiums of those enrolled (approximately 20%) and generous subsidies from both central and local governments (approximately 80%). Annual government subsidies per enrollee increased from ¥20 (US\$2·9) in 2003 to ¥380 (\$55·2) in 2015. The per-capita funding for NRCMS is \$61·2.<sup>9</sup>

China has also established a medical assistance programme for subsistence allowance recipients, people in poverty, low-income household members, and critically-ill patients in poor families. This programme is jointly funded by the central and local governments. At the end of 2015, the Chinese Government announced the decision to integrate URBMI and NRCMS as the URRMI scheme, to achieve universal health coverage.<sup>11</sup> This integration has enabled a further extension of funding pools and narrowing of disparities in access to health-care services and medications, which existed between different insurance schemes.

UEBMI=Urban Employee Basic Medical Insurance. URBMI=Urban Resident Basic Medical Insurance. NRCMS=New Rural Cooperative Medical Scheme. URRMI=Urban-Rural Resident Medical Insurance.



**Figure 1: Prevalence of physical multimorbidity in China, by age and socioeconomic status, in 2015**  
On the socioeconomic status scale, quartile 1 is the lowest quartile and quartile 4 is the highest quartile.

We used random-effects negative binomial regression models to investigate the association between the number of non-communicable diseases and the number of outpatient visits and inpatient hospital days. We adopted a negative binomial model instead of a Poisson regression model because the variances were greater than the means in outcome variables (appendix pp 4–5), suggesting that overdispersion was present in the outcome variables (likelihood ratio test of  $\alpha=0$ ,  $p<0.001$ ). The negative binomial model allows for overdispersion by assuming that the individual error terms come from a particular probability distribution (the  $\gamma$  distribution).<sup>22</sup> We used a random-effects logistic regression model to estimate the association between the number of non-communicable diseases and the likelihood of catastrophic health expenditure.

To explore the differential effect in population groups, we did subgroup analyses, stratified by socioeconomic status and membership of insurance schemes, using the same regression analyses but with the stratification variable removed.

For the logistic regression analyses, we report associations as odds ratios (ORs) adjusted for age, sex, marital status, education, residence, socioeconomic status quartiles, health insurance, and economic development regions, with 95% CIs. For the negative binomial regression analysis, we report incidence rate ratios (IRRs) adjusted for age, sex, marital status, education, residence, socioeconomic status quartiles, health insurance, and economic development regions, with 95% CIs.

We did three sensitivity analyses. First, we examined factors associated with the number of multimorbid conditions using a random-effects Poisson regression model with robust standard error. Second, we investigated the association between the number of non-communicable

	Adjusted odds ratio (95% CI)*	p value
<b>Socioeconomic group</b>		
Quartile 1 (lowest)	1 (ref)	..
Quartile 2	1.13 (0.96–1.34)	0.15
Quartile 3	1.25 (1.04–1.49)	0.016
Quartile 4 (highest)	1.50 (1.24–1.82)	<0.0001
Age, per 5 years	2.93 (2.71–3.15)	<0.0001
<b>Sex</b>		
Male	1 (ref)	..
Female	2.70 (2.04–3.57)	<0.0001
<b>Marital status</b>		
Married	1 (ref)	..
Unmarried and others	1.37 (1.03–1.82)	0.030
<b>Education</b>		
Primary school and below	1 (ref)	..
Secondary school	9.27 (5.85–14.67)	<0.0001
College and above	5.17 (3.02–8.83)	<0.0001
<b>Residence status</b>		
Urban	1 (ref)	..
Rural	0.59 (0.41–0.85)	0.005
Rural-to-urban	0.76 (0.53–1.10)	0.14
<b>Economic development region</b>		
Group 1 (most affluent)	1 (ref)	..
Group 2	5.37 (3.10–9.31)	<0.0001
Group 3	4.06 (2.42–6.82)	<0.0001
Group 4	3.25 (2.10–5.02)	<0.0001
Group 5 (most deprived)	3.88 (2.25–6.69)	<0.0001
<b>Health insurance</b>		
None	1 (ref)	..
Urban Employee Basic Medical Insurance	0.92 (0.63–1.35)	0.68
Urban Resident Basic Medical Insurance	0.84 (0.58–1.20)	0.33
New Rural Cooperative Medical Scheme	0.81 (0.62–1.04)	0.10
Others†	0.77 (0.47–1.24)	0.28

\* Adjusted for age, sex, marital status, education, residence, socioeconomic status quartiles, health insurance, and economic development regions. † Examples include government health care, private medical insurance.

**Table 1: Longitudinal analysis of determinants of multimorbidity among people aged 50 years and older in China, 2011–15**

diseases, outpatient visits, and inpatient hospital days using a Poisson model instead of a negative binomial model. Finally, we used the WHO and World Bank’s definitions of catastrophic health expenditure at various thresholds: 10% and 25% of the total household consumption expenditure by WHO definitions and 25% and 40% of the non-food household consumption expenditure by World Bank definitions.<sup>20</sup>

All descriptive analyses were weighted to account for the complex, multistage design of the study, and non-response in the CHARLS data. Other studies using CHARLS data, including CHARLS reports, suggest that results from regression analyses with and without weighting are similar.<sup>23</sup> We considered p values of less than 0.05 to be significant.

See Online for appendix

	Number of outpatient visits		Inpatient hospital days		Catastrophic health expenditure	
	Adjusted incidence rate ratio*	p value	Adjusted incidence rate ratio*	p value	Adjusted odds ratio*	p value
Number of non-communicable diseases	1.29 (1.27–1.31)	<0.0001	1.38 (1.35–1.41)	<0.0001	1.29 (1.26–1.32)	<0.0001
Age, per 5 years	1.00 (0.98–1.02)	0.85	1.17 (1.15–1.20)	<0.0001	1.14 (1.12–1.17)	<0.0001
Sex						
Male	1 (ref)	..	1 (ref)	..	1 (ref)	..
Female	1.24 (1.17–1.31)	<0.0001	0.93 (0.87–1.01)	0.079	0.97 (0.90–1.04)	0.42
Marital status						
Married	1 (ref)	..	1 (ref)	..	1 (ref)	..
Unmarried or other	1.03 (0.95–1.11)	0.53	0.97 (0.87–1.07)	0.52	0.40 (0.35–0.46)	<0.0001
Education						
Primary school and below	1 (ref)	..	1 (ref)	..	1 (ref)	..
Secondary school	0.99 (0.92–1.06)	0.74	0.97 (0.88–1.08)	0.57	1.01 (0.92–1.11)	0.84
College and above	1.00 (0.90–1.11)	0.99	0.85 (0.74–0.98)	0.026	0.91 (0.80–1.04)	0.17
Residence status						
Urban	1 (ref)	..	1 (ref)	..	1 (ref)	..
Rural	1.29 (1.15–1.43)	<0.0001	1.01 (0.88–1.16)	0.87	1.29 (1.12–1.48)	0.0010
Rural-to-urban	1.23 (1.10–1.39)	0.0010	1.15 (0.99–1.34)	0.064	1.12 (0.96–1.31)	0.15
Economic development region						
Group 1 (most affluent)	1 (ref)	..	1 (ref)	..	1 (ref)	..
Group 2	1.06 (0.95–1.18)	0.28	1.19 (1.02–1.38)	0.028	1.22 (1.06–1.41)	0.0070
Group 3	0.96 (0.85–1.08)	0.50	1.51 (1.29–1.78)	<0.0001	1.23 (1.05–1.43)	0.011
Group 4	1.27 (1.15–1.40)	<0.0001	1.52 (1.32–1.75)	<0.0001	1.32 (1.15–1.50)	<0.0001
Group 5 (most deprived)	1.00 (0.89–1.13)	0.95	1.70 (1.45–1.20)	<0.0001	1.04 (0.89–1.22)	0.63
Socioeconomic group						
Quartile 1 (the lowest)	1 (ref)	..	1 (ref)	..	1 (ref)	..
Quartile 2	1.10 (1.03–1.18)	0.0080	1.16 (1.05–1.28)	0.0040	0.97 (0.88–1.06)	0.45
Quartile 3	1.09 (1.01–1.17)	0.023	1.48 (1.35–1.63)	<0.0001	1.01 (0.92–1.11)	0.83
Quartile 4 (the highest)	1.20 (1.11–1.29)	<0.0001	1.77 (1.61–1.96)	<0.0001	0.99 (0.89–1.09)	0.80
Health insurance						
None	1 (ref)	..	1 (ref)	..	1 (ref)	..
Urban Employee Basic Medical Insurance	1.31 (1.11–1.55)	0.0010	1.56 (1.27–1.90)	<0.0001	0.98 (0.79–1.21)	0.84
Urban Resident Basic Medical Insurance	1.25 (1.05–1.48)	0.013	1.35 (1.09–1.67)	0.0060	1.14 (0.91–1.42)	0.25
New Rural Cooperative Medical Scheme	1.39 (1.22–1.58)	<0.0001	1.36 (1.16–1.60)	<0.0001	1.34 (1.14–1.57)	<0.0001
Others†	1.35 (1.09–1.68)	0.0060	1.19 (0.91–1.57)	0.20	0.87 (0.65–1.17)	0.35

\*Adjusted for age, sex, marital status, education, residence, socioeconomic status quartiles, health insurance, and economic development regions. †Examples include government health care, private medical insurance.

**Table 2: The association between the number of non-communicable diseases and health service use and spending in China, 2011–15**

We did all statistical analyses using Stata (version 15.0).

### Role of the funding source

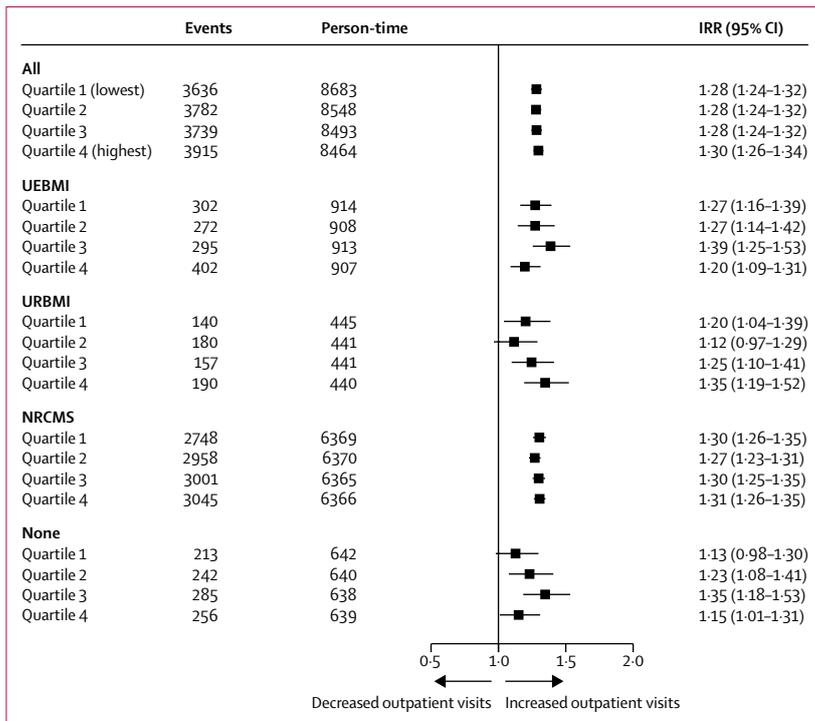
There was no funding source for this study. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

### Results

Of the 17708 participants in CHARLS, we identified 13565 without loss to follow-up, of whom 11817 were eligible for inclusion in our analysis. Eligible participants' socioeconomic and sociodemographic characteristics are shown in the appendix (pp 1–2). The median

age of participants was 62 years (IQR 56–69) in 2015. 5766 (48.8%) participants were male, 6051 (51.2%) were female, and 10036 (84.9%) were married or partnered. 8144 (68.9%) participants had primary education or below, and 7650 (64.7%) were residing in rural areas. 10933 (92.5%) had at least one kind of health insurance, with 8808 (74.5%) respondents enrolled in the NRCMS.

The proportion of people with physical multimorbidity increased substantially with age. In 2015, the overall prevalence of physical multimorbidity was 61.9% (7320 of 11817), with 1209 (51.7%) of 2339 aged 50–54 years having physical multimorbidity and 978 (68.5%) of 1427 aged 75 years and above having physical multimorbidity (appendix p 3).



**Figure 2: Association between physical multimorbidity and number outpatient visits by health insurance scheme and economic status**

UEBMI=Urban Employee Basic Medical Insurance. URBMI=Urban Resident Basic Medical Insurance. NRCMS=New Rural Cooperative Medical Scheme. None=people without health insurance. IRR=incidence rate ratio.

The prevalence of physical multimorbidity increased with increasing socioeconomic status. For example, among people aged 50–54 years, 204 (50.3%) of 406 in the lowest socioeconomic quartile had physical multimorbidity versus 365 (53.9%) of 677 in the highest quartile (figure 1). Overall, the prevalence of physical multimorbidity in the highest socioeconomic quartile in a given age group was often similar to the prevalence in the lowest socioeconomic quartile in the next youngest age group.

Participants in the highest socioeconomic quartile were more likely to report physical multimorbidity, than those in the quartile with the lowest economic status (adjusted OR 1.50, 95% CI 1.24–1.82; table 1). Participants with higher educational attainment were more likely to report having physical multimorbidity than those with lower educational attainment.

Additionally, the prevalence of physical multimorbidity was higher in women than in men, and was higher in the most deprived region than in the most affluent region (table 1). We did not find an association between health insurance status and prevalence of physical multimorbidity (table 1).

Additional chronic non-communicable disease was associated with an increase in the number of outpatient visits and inpatient hospital days (table 2). Overall, the associations between the presence of additional non-communicable diseases and health service use were

similar across socioeconomic groups—ie, for each socioeconomic group, those with an additional non-communicable disease had greater health service use (figures 2, 3). Moreover, differences between socioeconomic groups in the association between physical multimorbidity and outpatient visits were similar across health insurance schemes (figure 2). A similar pattern was seen for the number of days spent in hospital as an inpatient (figure 3).

A higher number of non-communicable diseases was associated with increased likelihood of catastrophic health expenditures (table 2). The effect of physical multimorbidity on catastrophic health expenditures persisted even in the highest socioeconomic quartile and those with more generous health insurance coverage (eg, UEBMI; panel, figure 4).

We did three sensitivity analyses. First, we examined factors associated with the number of multimorbid conditions (appendix p 6). Consistent with our main findings, the likelihood of having an increased number of multimorbid conditions was increased with older age, among women, and in the highest socioeconomic group, and in the most deprived regions ( $p < 0.01$ ). However, lower educational attainment was found to be associated with slightly lower number of non-communicable diseases (IRR 0.95 [95% CI 0.92–0.99] for those who completed secondary school; and IRR 0.94 [0.89–0.99] for those who completed a college course, compared with those who completed primary school and below). Second, we investigated the association between number of non-communicable diseases and number of outpatient visits and inpatient hospital days (appendix p 7). The results were consistent with our main findings, showing physical multimorbidity was associated with an increase in the number of outpatient visits and inpatient hospital days. Finally, we repeated our catastrophic health expenditure analysis using the WHO and World Bank’s definitions at various household expenditure thresholds. We found similar associations between physical multimorbidity and catastrophic health expenditures at different thresholds (appendix p 8).

### Discussion

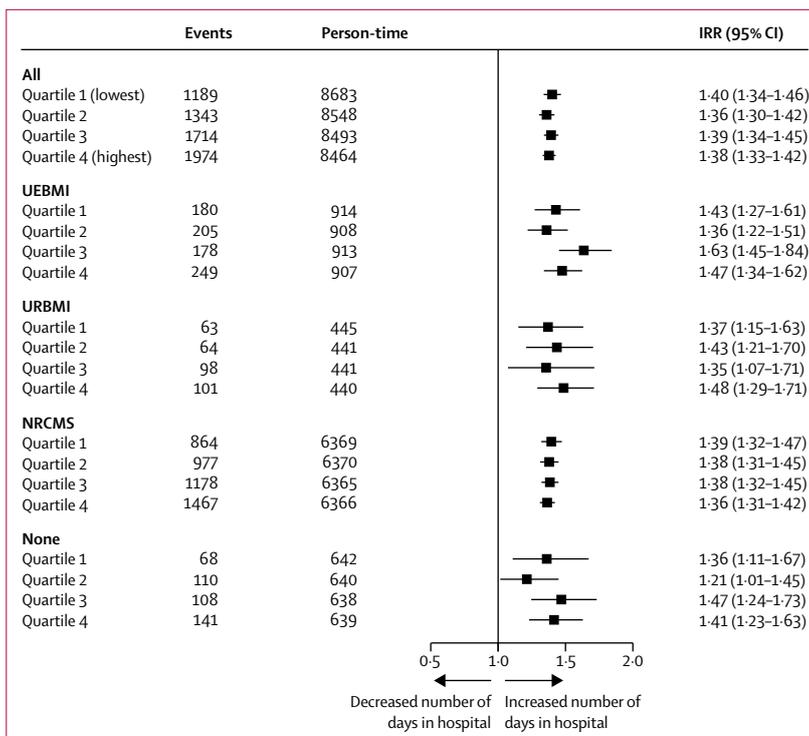
To our knowledge, this study is the first panel data analysis of a nationally representative longitudinal survey of middle-aged and older Chinese people—representing a population group of more than 300 million people<sup>27</sup>—which examined differences between socioeconomic groups in the prevalence of physical multimorbidity, and the effect of these differences on health-care use and the risk of catastrophic health expenditure.<sup>14</sup> We found that physical multimorbidity is common among Chinese people aged 50 years and older. The likelihood of physical multimorbidity increased with older age, among women, with higher per capita household expenditure (ie, in higher socioeconomic groups), and possibly with higher

educational level (although our sensitivity analysis did not support this finding). However, physical multimorbidity was more common in the most deprived regions than in the most affluent regions. Our findings suggest a significant association between physical multimorbidity in higher socioeconomic groups in China, at least when measured using household per-capita consumption expenditure as a proxy.

The number of chronic non-communicable diseases was positively associated with increased use of both outpatient and inpatient care. This association appeared to be similar across socioeconomic groups and health insurance schemes. Physical multimorbidity was associated with increased likelihood of catastrophic health expenditure, with similar effect sizes between the highest and lowest income groups. Because greater absolute levels of expenditures are required to trigger the so-called catastrophic expenditure threshold for those in higher income brackets than those in lower brackets, these results suggest that people in higher socioeconomic groups might have more intensive health-care use or use more expensive health-care services than those in lower socioeconomic groups.

We found that people with a higher socioeconomic status had a greater prevalence of multimorbid conditions than those in lower socioeconomic groups, across all age categories analysed. This finding might be partly explained by the fact that people in higher-income groups, who have better access to health-care services and better health literacy, are more likely to have their non-communicable diseases diagnosed (or even overdiagnosed) than people in lower-income groups.<sup>24,25</sup> Furthermore, the recall of specific chronic conditions that have been diagnosed in the past, might be improved in those in higher socioeconomic groups, for example, because they are paying for ongoing treatment. Also, low capacity and accessibility of rural facilities could mean that physical multimorbidity is under-reported in rural areas. Our results might reflect a combination of true underlying prevalence, access to health care, and health literacy.

Our findings contrast with evidence from high-income countries that shows an increased prevalence of multimorbidity in populations with low socioeconomic status.<sup>26,27</sup> For instance, a study of 16 European countries found that individuals in the highest income quintile and those with higher levels of education were less likely to have physical multimorbidity than those with lower levels of income and education.<sup>26</sup> Our findings are consistent with other studies that have examined physical multimorbidity in low-income and middle-income countries (eg, India and Bangladesh), which found that obesity, physical inactivity, and consumption of tobacco, alcohol, fat, salt, and processed food are more prevalent among high socioeconomic groups.<sup>24,28</sup> These differences in findings might be due to low-income and middle-income countries being in an earlier stage of the epidemiological transition than high-income countries are.<sup>29,30</sup> Additionally,



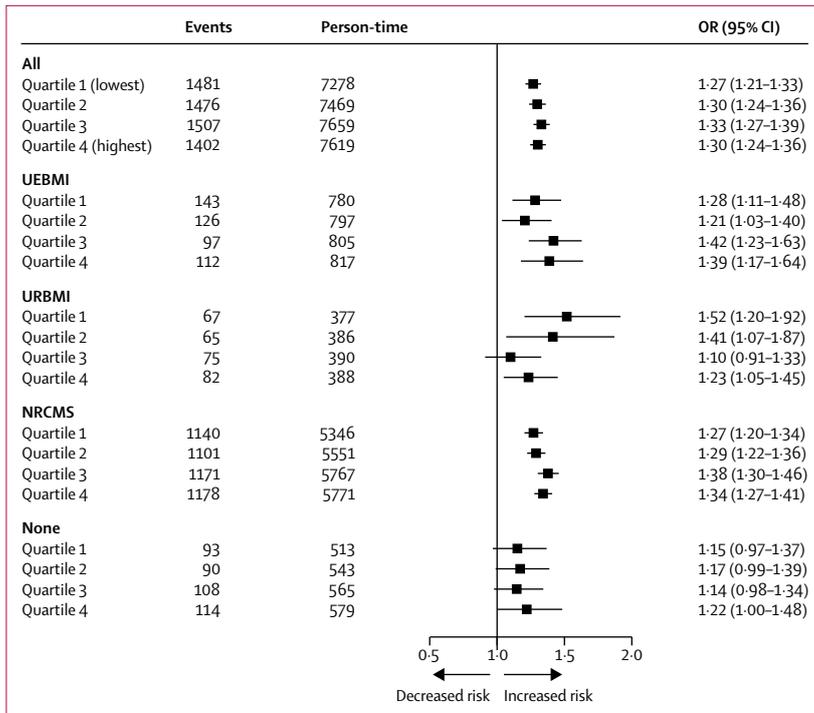
**Figure 3: Association between physical multimorbidity and inpatient hospital days by health insurance scheme and economic status**

UEBMI=Urban Employee Basic Medical Insurance. URBMI=Urban Resident Basic Medical Insurance. NRCMS=New Rural Cooperative Medical Scheme. None=people without health insurance. IRR=incidence rate ratio.

most studies in high-income countries include mental health conditions in their measurement of multimorbidity, and most of the excess multimorbidity in lower socioeconomic groups is accounted for by the combination of mental and physical multimorbidity.<sup>27</sup> Here, we did not include mental health conditions in our calculation of multimorbidity.

In all socioeconomic quartiles, levels of multimorbidity are increasing. For any individual, given that a chronic condition might not be resolved, the likelihood of multimorbid conditions increases with older age. We observed a decrease in the prevalence of physical multimorbidity in the lowest socioeconomic group from those aged 70–74 years to those aged 75 years and older, which might indicate a cohort effect (and a chance variation), suggesting that those aged 75 years and older were less exposed to relevant risk factors than the younger cohorts. These findings are consistent with the explanation of increasing cumulative exposure to risk factors over time by Lynch and Smith,<sup>31</sup> in which the accumulation of chronic conditions over an individual's lifespan, differential exposure according to socioeconomic status, and the adoption of lifestyles associated with risk factors increasing over the past few decades in the lowest socioeconomic group.<sup>32</sup>

Previous studies have shown that multimorbidity is associated with substantially increased use of health care,



**Figure 4: Association between physical multimorbidity and risk of catastrophic health expenditure by health insurance scheme and economic status**  
 UEBMI=Urban Employee Basic Medical Insurance. URBMI=Urban Resident Basic Medical Insurance. NRCMS=New Rural Cooperative Medical Scheme. None=people without health insurance. OR=odds ratio.

and this association has been well documented in high-income countries,<sup>26,33</sup> and other studies in China.<sup>14,16</sup> However, to date, no studies have assessed the differences in this association due to socioeconomic group and health insurance schemes in China.<sup>34</sup> Our study provides new evidence on the association between physical multimorbidity and use of health services across socioeconomic groups enrolled in different insurance schemes. We found no different effects of physical multimorbidity on health-care use between groups with different types of insurance.

Consistent with previous studies, the presence of an increased number of chronic non-communicable conditions was associated with increased health expenditure.<sup>16,24</sup> Although this association generally appeared to be similar across different socioeconomic groups in our study, our research also shows that the effect of multimorbidity on catastrophic health expenditure was increased for individuals at lower socioeconomic levels in the population covered by URBMI. A possible explanation for this observation is that less financial risk protection was available to people in the lowest income quartile who were enrolled in URBMI due to restricted benefits packages and a lack of coverage for some medications and inpatient services, which has probably led to a high incidence of catastrophic health expenditures. The cost of health care in urban health facilities is higher than that of rural health facilities. This

difference could explain why lower socioeconomic groups covered by URBMI had a higher likelihood of catastrophic health expenditures than those covered by UEBMI. A previous study has indicated that the per-capita annual fund contribution for UEBMI was about six times higher than that for URBMI, suggesting that beneficiaries of UEBMI are likely to have smaller out-of-pocket spending than individuals enrolled in URBMI.<sup>9</sup>

Our study had several limitations. First, the use of self-reported measures of chronic disease and health-care use might have underestimated their prevalence, particularly among older people and those from lower socioeconomic and educational backgrounds who might be more likely to under-report these factors. Second, the CHARLS questionnaire did not ask about all chronic diseases typically included in clinical database studies. Further studies examining the effect of multimorbidity due to other common chronic conditions (eg, Alzheimer’s disease, depression, asthma) and infectious diseases (eg, tuberculosis, AIDS, coronavirus disease 2019) are also warranted. The social patterning of multimorbidity in China requires further research that should include a wider range of morbidities, and more robust measures of both mental and physical conditions than has been recorded to date. Finally, this study only included people from China aged 50 years and older in 2015. The prevalence of multimorbidity and its effect among younger populations should be considered in future studies.

Our findings provide new evidence to inform the development of targeted policies and interventions to tackle the increasing burden of physical multimorbidity in China. Health systems need to shift from single-disease models to new methods of financing and service delivery to more effectively manage multimorbidity.<sup>35</sup> Strong primary health care, underpinned by multidisciplinary teams, is essential for cost-effective management of multimorbidity.<sup>4</sup> In 2009, China began to rebuild its primary health care by developing community health centres, although progress has been mixed.<sup>36</sup> A trial in China that is testing the roll-out of the so-called people-centred integrated care programme, which incentivises primary health-care centres to manage patients with chronic diseases holistically, is an example of such a new approach.<sup>37</sup>

Disease-specific guidelines are inadequate for the effective management of individuals with multimorbid conditions and new clinical guidelines for multimorbidity are needed. Countries such as the UK and Sri Lanka have developed clinical guidelines for multimorbidity that emphasise integration and patient-centred health-care services.<sup>38</sup>

Our findings also provide new evidence on the growing financial burden of multimorbidity in China. Multimorbidity is costly to individuals and health systems. Out-of-pocket spending on medicines can severely compromise financial risk protection.<sup>16,39</sup> A 2015 systematic review of studies on Chinese populations showed that as the

number of chronic diseases increases from one to two, an individual's annual out-of-pocket health spending increased by an average of 5.2 times, and as the number increased from two to three, their annual out-of-pocket health expenditures increased by an average of 10.1 times.<sup>10</sup>

Concerted efforts are needed in China and other low-income and middle-income countries with ageing populations to reduce inequalities due to multimorbidity, and its adverse effect on financial risk protection. China, which has the largest ageing population in the world, should develop targeted policies to ensure appropriate health services and financial risk protection for individuals with multimorbidity, particularly those in low socioeconomic groups who are at an increased risk of catastrophic health expenditures.

#### Contributors

YZ and JTL conceived and designed the study. YZ and BO carried out the initial analysis. RA, TEC, and BM interpreted the data. VMQ and YZ analysed the literature. YZ and JTL wrote the first draft of the report. RA, BO, BM, ST, SWM, TEC, GS, and VMQ provided advice on the first draft and revised the report critically for important intellectual content. All authors reviewed and had final approval of the submitted and published versions.

#### Declaration of interests

We declare no competing interests.

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#### References

- Yang G, Kong L, Zhao W, et al. Emergence of chronic non-communicable diseases in China. *Lancet* 2008; **372**: 1697–705.
- Wang L, Kong L, Wu F, Bai Y, Burton R. Preventing chronic diseases in China. *Lancet* 2005; **366**: 1821–24.
- Boyd CM, Fortin M. Future of multimorbidity research: how should understanding of multimorbidity inform health system design? *Public Health Rev* 2010; **32**: 451–74.
- Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012; **380**: 37–43.
- Guthrie B, Payne K, Alderson P, McMurdo MET, Mercer SW. Adapting clinical guidelines to take account of multimorbidity. *BMJ* 2012; **345**: e6341.
- Tan X, Liu X, Shao H. Healthy China 2030: a vision for health care. *Value Health Reg Issues* 2017; **12**: 112–14.
- Meng Q, Xu L, Zhang Y, et al. Trends in access to health services and financial protection in China between 2003 and 2011: a cross-sectional study. *Lancet* 2012; **379**: 805–14.
- State Council, Health and Family Planning Committee. China Health and Family Planning Statistical Yearbook 2016. Beijing: Peking Union Medical College Press, 2017.
- He AJ, Wu S. Towards universal health coverage via social health insurance in China: systemic fragmentation, reform imperatives, and policy alternatives. *Appl Health Econ Health Policy* 2017; **15**: 707–16.
- Meng Q, Fang H, Liu X, Yuan B, Xu J. Consolidating the social health insurance schemes in China: towards an equitable and efficient health system. *Lancet* 2015; **386**: 1484–92.
- Pan XF, Xu J, Meng Q. Integrating social health insurance systems in China. *Lancet* 2016; **387**: 1274–75.
- Bloom DE, Cafiero ET, Jané-Llopis E, et al. The global economic burden of non-communicable diseases. Geneva: World Economic Forum, 2011.
- Glynn LG, Valderas JM, Healy P, et al. The prevalence of multimorbidity in primary care and its effect on health care utilization and cost. *Fam Pract* 2011; **28**: 516–23.
- Wang HH, Wang JJ, Wong SY, et al. Epidemiology of multimorbidity in China and implications for the healthcare system: cross-sectional survey among 162,464 community household residents in southern China. *BMC Med* 2014; **12**: 188.
- Chen H, Cheng M, Zhuang Y, Broad JB. Multimorbidity among middle-aged and older persons in urban China: prevalence, characteristics and health service utilization. *Geriatr Gerontol Int* 2018; **18**: 1447–52.
- Lee JT, Hamid F, Pati S, Atun R, Millett C. Impact of noncommunicable disease multimorbidity on healthcare utilisation and out-of-pocket expenditures in middle-income countries: cross sectional analysis. *PLoS One* 2015; **10**: e0127199.
- National Bureau of Statistics of China. Tabulation on the 2010 population census of the People's Republic of China. China Statistics Press, 2012.
- Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS). *Int J Epidemiol* 2014; **43**: 61–68.
- Chobanian AV, Bakris GL, Black HR, et al. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003; **289**: 2560–72.
- Cylus J, Thomson S, Evetovits T. Catastrophic health spending in Europe: equity and policy implications of different calculation methods. *Bull World Health Organ* 2018; **96**: 599–609.
- National currency per U.S. dollar, end of period. Principal global indicators (PGI) database. Washington: International Monetary Fund, 2018. <http://www.principalglobalindicators.org/regular.aspx?key=60942001> (accessed March 31, 2020).
- Cameron AC, Trivedi PK. Regression analysis of count data, 2nd edn. Cambridge University Press, 2014.
- 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; published online Aug 13. DOI:10.1093/gerona/glz185.
- Pati S, Agrawal S, Swain S, et al. Non communicable disease multimorbidity and associated health care utilization and expenditures in India: cross-sectional study. *BMC Health Serv Res* 2014; **14**: 451.
- Hudon C, Fortin M, Poitras ME, Almirall J. The relationship between literacy and multimorbidity in a primary care setting. *BMC Fam Pract* 2012; **13**: 33.
- Palladino R, Tayu Lee J, Ashworth M, Triassi M, Millett C. Associations between multimorbidity, healthcare utilisation and health status: evidence from 16 European countries. *Age Ageing* 2016; **45**: 431–35.
- McLean G, Gunn J, Wyke S, et al. The influence of socioeconomic deprivation on multimorbidity at different ages: a cross-sectional study. *Br J Gen Pract* 2014; **64**: e440–47.
- Biswas T, Townsend N, Islam MS, et al. Association between socioeconomic status and prevalence of non-communicable diseases risk factors and comorbidities in Bangladesh: findings from a nationwide cross-sectional survey. *BMJ Open* 2019; **9**: e025538.
- Geldsetzer P, Manne-Goehler J, Theilmann M, et al. Geographic and sociodemographic variation of cardiovascular disease risk in India: a cross-sectional study of 797,540 adults. *PLoS Med* 2018; **15**: e1002581.
- Hosseinpoor AR, Bergen N, Kunst A, et al. Socioeconomic inequalities in risk factors for non communicable diseases in low-income and middle-income countries: results from the World Health Survey. *BMC Public Health* 2012; **12**: 912.
- Lynch J, Smith GD. A life course approach to chronic disease epidemiology. *Annu Rev Public Health* 2005; **26**: 1–35.
- Allen L, Williams J, Townsend N, et al. Socioeconomic status and non-communicable disease behavioural risk factors in low-income and lower-middle-income countries: a systematic review. *Lancet Glob Health* 2017; **5**: e277–89.
- Jankovic J, Mirkovic M, Jovic-Vranes A, Santric-Milicevic M, Terzic-Supic Z. Association between non-communicable disease multimorbidity and health care utilization in a middle-income country: population-based study. *Public Health* 2018; **155**: 35–42.
- Wang HHX, Wang JJ, Lawson KD, et al. Relationships of multimorbidity and income with hospital admissions in 3 health care systems. *Ann Fam Med* 2015; **13**: 164–67.

- 35 Sturmberg JP, Bennett JM, Martin CM, Picard M. 'Multimorbidity' as the manifestation of network disturbances. *J Eval Clin Pract* 2017; **23**: 199–208.
- 36 Salisbury C, Man MS, Bower P, et al. Management of multimorbidity using a patient-centred care model: a pragmatic cluster-randomised trial of the 3D approach. *Lancet* 2018; **392**: 41–50.
- 37 Wei X, Li H, Yang N, et al. Changes in the perceived quality of primary care in Shanghai and Shenzhen, China: a difference-in-difference analysis. *Bull World Health Organ* 2015; **93**: 407–16.
- 38 Chandraratne NK, Pathirathna KGRV, Harrison C, Siriwardena AN. A comparison of policies and guidelines related to multimorbidity in the UK, Australia and Sri Lanka. *Aust J Gen Pract* 2018; **47**: 14–19.
- 39 Kuo RN, Lai MS. The influence of socio-economic status and multimorbidity patterns on healthcare costs: a six-year follow-up under a universal healthcare system. *Int J Equity Health* 2013; **12**: 69.