

# BMJ Open Prevalence and patterns of multimorbidity in chronic diseases in Guangzhou, China: a data mining study in the residents' health records system among 31 708 community-dwelling elderly people

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## ABSTRACT

**Objectives** Examination of the prevalence, influence factors and patterns of multimorbidity among the elderly people in Guangzhou, China.

**Design** Cross-sectional study.

**Participants** 31 708 community-dwelling elderly people aged 65 and over.

**Primary and secondary outcome measures** Prevalence, influence factors and patterns of multimorbidity in seven chronic conditions among the participants. A multistage, stratified random sampling was adopted for selection of health records in the residents' health records system of Guangzhou. Data mining by association rule mining analysis was used to explore the correlations and multimorbidity patterns between seven chronic diseases.

**Results** The prevalence of morbidity was 55.0% (95% CI 40.1% to 60.1%) and the multimorbidity was 15.2% (95% CI 12.4% to 18.4%) among the participants. Elderly, women, higher education level, being single, living in urban areas and having medical insurance were more likely to have chronic diseases and multimorbidity. Data mining by association rule mining analysis reveals patterns of multimorbidity among the participants, including coexistence of hypertension and diabetes (support: 12.5%, confidence: 17.6%), hypertension and coronary heart disease (support: 4.4%, confidence: 5.7%), diabetes and coronary heart disease (support: 1.6%, confidence: 5.7%), diabetes, coronary heart disease and hypertension (support: 1.4%, confidence: 4.4%).

**Conclusions** A high prevalence of morbidity (especially on hypertension and diabetes) and a relatively low multimorbidity of chronic diseases exist in elderly people. Data mining of residents' health records will help for strengthening the management of residents' health records in community health service centres of Guangzhou, China.

## INTRODUCTION

China is experiencing a rapidly growing ageing population. Data from seventh

## Strengths and limitations of this study

- ⇒ The report on data mining of electronic health records in community health service centres is limited in China.
- ⇒ 31 708 elderly people health records were adopted by a multistage, stratified random sampling method.
- ⇒ Selection bias and recall bias were introduced in this study.
- ⇒ Only seven chronic diseases were included in this study.
- ⇒ The prevalence of chronic diseases and multimorbidity may be underestimated in this study.

national census of National Bureau of Statistic in China showed that individuals aged 65 years or older constitute about 13.5% (191 million) of the total population in 2020.<sup>1</sup> With the population ageing, chronic diseases have become an important public health challenge in China. It is estimated that chronic diseases will cause 122 million people deaths in China in 2030, and the mortality rate of chronic diseases would increase up to 40.0% (859.2 vs 613.5/100 000) compared with 2013.<sup>2</sup> What makes the situation worse is multimorbidity, which is defined as the coexistence of two or more chronic diseases in one person,<sup>3</sup> has increasingly gained attention in recent decades. Multimorbidity is associated with poor health outcomes, such as reduced function levels (ability of activities of daily living), increased psychological distress,<sup>4 5</sup> impaired quality of life<sup>6 7</sup> and increased rates of disability and mortality.<sup>8 9</sup> Moreover, chronic diseases and multimorbidity can cause the heavy illness and treatment burden, especially in elderly population.<sup>10</sup> It was reported

that 72.7% of outpatient services and 77.3% of inpatient services were used by patients with multimorbidity.<sup>11</sup> Another study in Beijing China reported that the expenditure on elderly people with two and three conditions was 3.4 times and 5.3 times higher than that on elderly people with a single condition.<sup>12</sup>

Although reported previously,<sup>13 14</sup> the prevalence and pattern of multimorbidity among elderly people varied significantly. The overall prevalence of multimorbidity ranged from 6.4% to 76.5% in the elderly people in China,<sup>15 16</sup> even, 90.5% among older Chinese adults living in rural areas.<sup>17</sup> The wide variations in prevalence of multimorbidity in those studies may be related to differences of the included diseases, the assessment methods and instruments, differences in environment and lifestyles and so on. For example, a systematic review study in South Asia found that prevalence of multimorbidity ranged from 4.5% to 83%, and the included number of diseases in a given study varied from 7 to 22.<sup>18</sup> Meanwhile, the various patterns of multimorbidity were reported in different studies, which used different statistical methods, such as factor analysis, cluster analysis and association rule mining analysis. The common multimorbidity patterns included pattern of osteoarthritis and rheumatoid arthritis with hypertension,<sup>19</sup> pattern of hypertension and diabetes,<sup>6</sup> pattern of cardiopulmonary mental degenerative disorder, pattern of cerebrovascular metabolic disorder<sup>17</sup> and so on. Nonetheless, it is indisputable that multimorbidity is prevalent among elderly people in China.

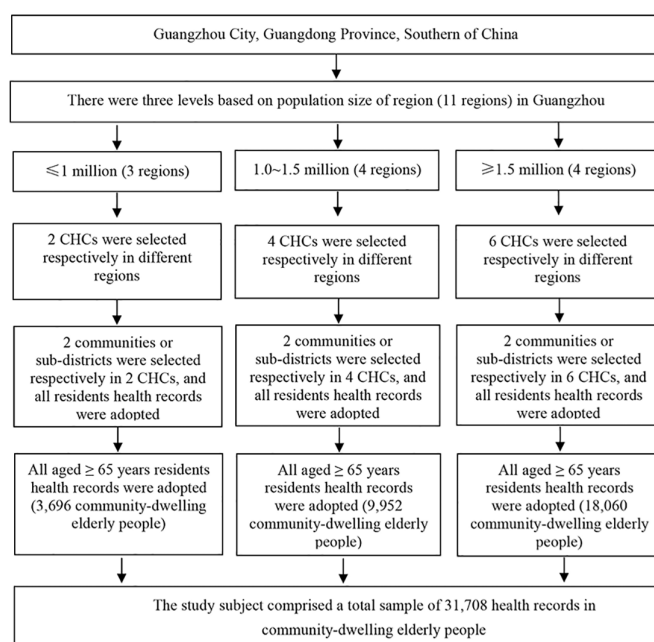
The project of health records of residents in community health service centres, one of the national basic public health service projects, has been implemented in China. As part of the national project, the city of Guangzhou established an electronic health record system since 2010.<sup>20</sup> To 2020, 91.23% residents of Guangzhou have established health records in their community health service centres in different districts. Data mining of electronic health records thus becomes a novel way to understand disease morbidity and multimorbidity among residents. However, studies with application of electronic health records in community health service centres are limited in China.

By taking advantage of the abundant data, we therefore set out a data mining study in the electronic health record of residents in community health service centres of Guangzhou. We aim to assess prevalence and influence factors of chronic diseases and multimorbidity and to explore patterns of multimorbidity among community-dwelling elderly people in Guangzhou, China.

## METHODS

### Study design and data source

From October to December 2020, a multistage, stratified random sampling was adopted for selection of residents' health records in Guangzhou. First, based on the population per district, we selected 2, 4 or 6 community health



**Figure 1** Sampling framework in this study in Guangzhou, China. CHCs, community health centres.

service centres in each district (figure 1). Second, in each selected community health service centre, we further selected two subdistrict community health service centres, and all community-dwelling residents' health records were adopted. Finally, among them, 31 708 health records were derived from residents aged 65 years or above. The sampling framework was shown in detail in figure 1.

### Patient and public involvement

Patients or public were not involved in study design or conduct of the study. There are no plans to disseminate the research results to study participants.

### Instruments

#### Sociodemographic characteristics

The sociodemographic information, including age, gender, marital status, educational level, living area and medical insurance, was selected in residents' health records in the present study.

#### Morbidity coding

All the seven chronic conditions were reported in the medical history in residents' health records in community health service centres, which were selected in the present study. International Classification of Diseases codes was used for all diagnoses. And the seven chronic conditions as following: hypertension (I10.x09), diabetes (E11.900), coronary heart disease (I25.103), apoplexy (I64.x00), chronic obstructive pulmonary disease (COPD, J44.900), tumour (M80000/3) and mental disorder (F99.x00). For this study, multimorbidity was defined as the coexistence of two or more chronic conditions in one person.<sup>3</sup>

## Data analyses

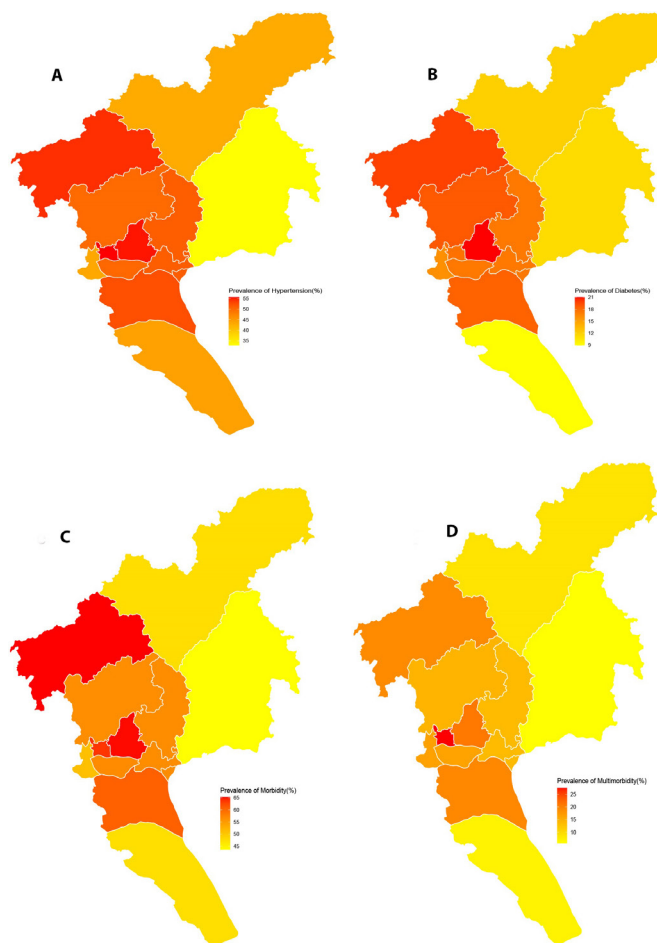
Statistical analysis was performed using R and SPSS V.21.0 (SPSS). Sample size was calculated by the formula,  $n = (Z_{\alpha}^2 \times P_0 (1 - P_0) / d^2)$ . With the data of elderly adults in southwest China,  $P_0$  was 16.1%,<sup>14</sup>  $d$  was 0.1 $P_0$ ,  $\alpha$  was 0.05, the minimal sample size of 2084 participants was required. The  $\chi^2$ , t-test and one-way analysis of variance were used to assess the differences in sociodemographic characteristics between subjects. Binary logistic regression analysis was conducted to examine factors associated with chronic diseases and multimorbidity, and a forward stepwise selection strategy was adopted when the regression models performed. To increase the representativeness of the study population, all statistics were calculated by using base weights adjustment (population weight and poststratification sample weights). The complex samples module in SPSS V.21.0 was adopted to account for the multistage sample design. Geographic heat map of chronic diseases was drawn by R V.3.2.1 programme. The association rule mining analysis was used to explore the correlations and patterns of multimorbidity between chronic diseases among community-dwelling elderly people.  $P < 0.05$  was considered statistically significant in the present study.

## RESULTS

Seven chronic conditions in the residents' health records system among 31 708 community-dwelling elderly people exist in Guangzhou. The prevalence of morbidity was 55.0% (95% CI 40.1% to 60.1%) and the most common chronic disease was hypertension (47.8%, 95% CI 44.5% to 51.0%). Prevalence of other selected chronic conditions was also reported, including 15.9% (95% CI 14.4% to 17.6%) for diabetes, 4.9% (95% CI 3.0% to 7.8%) for coronary heart disease, 1.3% (95% CI 0.8% to 2.1%) for apoplexy, 0.7% (95% CI 0.4% to 1.4%) for COPD, 1.3% (95% CI 0.8% to 2.0%) for tumour and 0.5% (95% CI 0.3% to 0.7%) for mental disorder.

The prevalence of chronic conditions in community-dwelling elderly people showed regional differences in Guangzhou China (figure 2). According to the heat map of prevalence by region, elderly people living in urban areas were more likely to have chronic conditions. The risk of morbidity and multimorbidity in elderly people was growing up as people get older (figure 3). Half of the people aged 65–69 had at least one disorder and the number gradually increased with age.

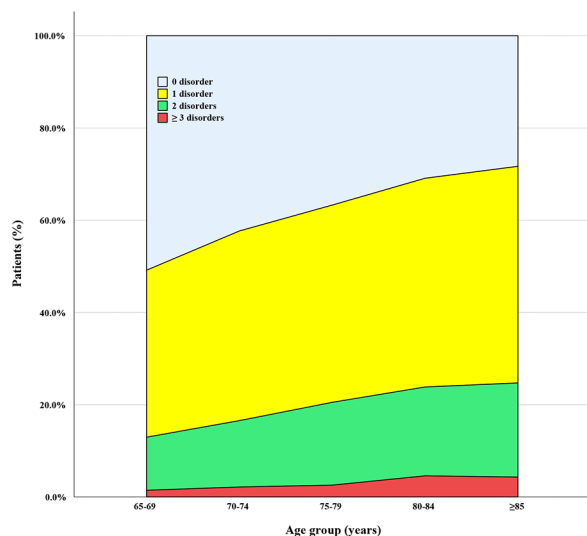
Of the 31 708 respondents, 15.2% (95% CI 12.4% to 18.4%) of elderly people had multimorbidity (table 1). Results of logistic regression analysis showed that socio-demographic factors associated with morbidity and multimorbidity (table 2). Elderly, women, higher education level, being single, living in urban areas and having medical insurance were more likely to have chronic diseases and multimorbidity.



**Figure 2** Prevalence of chronic conditions by region in community-dwelling elderly people in Guangzhou, China. (A) Prevalence of hypertension. (B) Prevalence of diabetes. (C) Prevalence of morbidity. (D) Prevalence of multimorbidity.

Results of data mining study by association rule mining analysis showed that seven selected chronic conditions, most of them accompanied with one or more other chronic diseases. Figure 4 showed that 66.4% of elderly people with hypertension had only one condition (hypertension), while 33.7% experienced one or more additional chronic diseases (multimorbidity). On the contrary, 85.7% of elderly people with apoplexy reported experiencing one or more additional chronic diseases (multimorbidity), only 14.3% of those had apoplexy alone. Moreover, web diagram analysis revealed that these chronic diseases were highly related to each other (figure 5).

Table 3 showed the patterns of multimorbidity in the present study, and the most common pattern of multimorbidity was model of hypertension and diabetes (support: 12.5%, confidence: 17.6%). Meanwhile, model of hypertension and coronary heart disease (support: 4.4%, confidence: 5.7%), model of diabetes and coronary heart disease (support: 1.6%, confidence: 5.7%), model of diabetes, coronary heart disease and hypertension (support: 1.4%, confidence: 4.4%) were also reported.



**Figure 3** Number of chronic conditions by age group in community-dwelling elderly people in Guangzhou, China.

## DISCUSSION

### Main findings

In this study, we found that the prevalence was 55.0% for morbidity and 15.2% for multimorbidity, and which were associated with several factors among 31 708 community-dwelling elderly people. Data mining of association rule mining analysis can explore the correlations and patterns of multimorbidity between chronic diseases, which will help for strengthening the management of residents' health records in community health service centres of Guangzhou, China.

### Comparison with previous studies

Chronic diseases are becoming more and more common and their prevalence is rapidly increasing.<sup>21</sup> In the present study, the prevalence of morbidity was 55.0% among elderly people in Guangzhou, China, which was similar to previous studies.<sup>14</sup> 47.8%, 15.9%, 4.9% of elderly people with hypertension, diabetes, coronary heart disease, respectively, which was consistent with previous studies.<sup>13 14 22 23</sup> In the present study, we found that the prevalence of multimorbidity was 15.2% among 31 708 community-dwelling elderly people in Guangzhou, China, which is consistent with previous reports from Li *et al* (16.1% among the elderly adults aged  $\geq 60$  years in southwest China),<sup>14</sup> and Bao *et al* (20.8% of middle-aged and elderly residents in southern China).<sup>6</sup> However, Zhang *et al* found that multimorbidity was 43.6% of elderly people in a nationally representative sample of China,<sup>13</sup> and Yao *et al* found that multimorbidity occurred in 42.4% of the participants from the China Health and Retirement Longitudinal Study.<sup>24</sup> Moreover, Wang *et al* found that multimorbidity prevalence was 81.3% among one million older group in China, even, 90.5% among older adults living in rural areas of China.<sup>17</sup> Compare with those studies, the wide variations in prevalence of multimorbidity may due to differences of the included chronic diseases and the assessment method and instrument. In

the present study, only seven chronic conditions were included. And the assessment method and instrument were based on residents' health records in community health service centres of Guangzhou, the imperfection of residents' health records may also contribute to low prevalence. Nevertheless, chronic diseases and multimorbidity should not be overlooked among community-dwelling elderly people.

We found that age was associated with multimorbidity. With ageing, the prevalence of multimorbidity was higher.<sup>25 26</sup> With ageing and immunity declining, risk of illnesses will increase naturally among elderly people. Study of China Kadoorie Biobank was found that a higher increase in the number of chronic conditions was found in the older people.<sup>27</sup> The prevalence of multimorbidity was higher among women<sup>25</sup> and living in urban areas,<sup>23 27</sup> which was consisted with previous studies.<sup>24</sup> Elderly people in rural areas may have limited medical resources than urban residents, which might lead to a lower probability of being diagnosed. Interestingly, higher education level and having medical insurance were also found to be associated with higher prevalence of multimorbidity.<sup>26</sup> People of higher education level generally had higher health literacy level and had more healthcare-seeking behaviours; meanwhile, regular physical examinations in elderly people who had medical insurance also helped them of being diagnosed. Compare with married status, elderly people being single (unmarried, divorced or widowed) was positively associated with multimorbidity.<sup>28</sup> One alternative explanation might be that loneliness may result in a higher risk of multimorbidity.<sup>29</sup> Loneliness can cause emotional changes, which in turn affect multimorbidity,<sup>30</sup> and these emotional changes can activate neurobiological and behavioural mechanisms which can decrease health.<sup>31</sup>

Cluster analysis and association rule mining analysis are the common data mining methods to calculating the associations between different diseases. Different from cluster analysis, association rule mining analysis can directly calculate the probability of multimorbidity, when participants had a chronic disease. Therefore, association rule mining analysis was adopted for analysing patterns of multimorbidity in the present study, and the most common pattern of multimorbidity was reported: model of hypertension and diabetes. Specifically, when the elderly people have diabetes, 17.58% of them are more likely to have hypertension (table 3). Similar result was reported in a prospective cohort study, prevalent of multimorbidity of diabetes-hypertension was 12.5%.<sup>32</sup> Blümel *et al* found that hypertension coexisted in 22.0% of women with diabetes.<sup>33</sup> Prathapan *et al* found that a fourth of the sample was affected by multimorbidity of diabetes and hypertension, and the combinations of coronary heart disease with hypertension and diabetes were also significantly prevalent.<sup>34</sup> Bao *et al* demonstrated that the most prevalent chronic diseases pair was hypertension and diabetes among community middle-aged and elderly residents in southern China.<sup>6</sup> Meanwhile, in the

**Table 1** Sociodemographic and comorbidity characteristics in community-dwelling elderly people in Guangzhou, China

Variables	Total		Prevalence of hypertension (95% CI)*		Prevalence of diabetes (95% CI)*		Prevalence of coronary heart disease (95% CI)*		Prevalence of apoplexy (95% CI)*	
	N	%	Pt	P§	Pt	P§	Pt	P§	Pt	P§
All participants	31708	100	47.76 (44.54 to 50.99)	0.001	15.94 (14.38 to 17.64)	0.001	4.90 (3.02 to 7.84)	0.001	1.33 (0.84 to 2.09)	0.001
Age groups, years										
65-74	19853	62.61	42.34 (39.32 to 45.43)	0.001	14.99 (13.82 to 16.25)	0.001	3.98 (2.48 to 6.32)	0.001	1.15 (0.78 to 1.70)	0.001
75-84	9023	28.46	55.29 (50.96 to 59.53)	0.001	17.93 (15.56 to 20.57)	0.001	6.26 (3.88 to 9.94)	0.001	1.53 (0.88 to 2.65)	0.001
≥85	2832	8.93	59.91 (54.35 to 65.23)	0.001	15.37 (11.71 to 19.91)	0.001	6.65 (3.63 to 11.86)	0.001	1.88 (0.99 to 3.54)	0.001
Gender										
Male	14046	44.3	45.33 (42.09 to 48.61)	0.001	14.32 (12.78 to 16.01)	0.001	4.66 (2.97 to 7.24)	0.001	1.51 (0.96 to 2.36)	0.001
Female	17662	55.7	49.85 (46.56 to 53.14)	0.001	17.33 (15.66 to 19.15)	0.001	5.10 (3.06 to 8.39)	0.001	1.17 (0.73 to 1.88)	0.001
Education levels										
No school	3372	10.63	51.63 (45.22 to 57.98)	0.001	15.73 (12.59 to 19.48)	0.001	2.31 (1.27 to 4.18)	0.001	1.12 (0.47 to 2.67)	0.001
Primary school	11258	35.51	49.98 (45.94 to 54.01)	0.001	16.19 (14.12 to 18.49)	0.001	4.31 (2.70 to 6.79)	0.001	1.58 (0.92 to 2.70)	0.001
Secondary school	12668	39.95	43.90 (40.32 to 47.55)	0.001	15.56 (14.34 to 16.87)	0.001	5.82 (3.47 to 9.63)	0.001	1.14 (0.76 to 1.71)	0.001
College and above	4410	13.91	50.22 (45.26 to 55.17)	0.001	17.42 (14.67 to 20.56)	0.001	8.56 (6.36 to 11.42)	0.001	1.61 (1.05 to 2.47)	0.001
Marital status										
Single d	3685	11.62	50.88 (44.98 to 56.75)	0.001	16.18 (14.23 to 18.33)	0.02	5.07 (2.87 to 8.80)	0.004	2.00 (1.04 to 3.81)	0.001
Married	28023	88.38	47.34 (44.34 to 50.36)	0.001	15.91 (14.29 to 17.68)	0.001	4.87 (3.03 to 7.74)	0.001	1.24 (0.81 to 1.89)	0.001
Living Areas										
Rural areas	6447	20.33	41.71 (35.60 to 48.09)	0.001	12.47 (10.54 to 14.70)	0.001	1.63 (0.89 to 2.94)	0.001	0.82 (0.43 to 1.56)	0.001
Urban areas	25261	79.67	50.38 (47.03 to 53.74)	0.001	17.45 (16.24 to 18.73)	0.001	6.32 (4.04 to 9.75)	0.001	1.55 (1.00 to 2.39)	0.001
Medical insurance										
Uninsured	1126	3.55	42.37 (36.63 to 48.32)	0.001	16.95 (13.55 to 20.98)	0.001	3.52 (2.48 to 4.99)	0.001	1.79 (1.13 to 2.82)	0.001
Insured	30582	96.45	47.90 (44.58 to 51.23)	0.001	15.92 (14.32 to 17.65)	0.001	4.93 (3.01 to 7.97)	0.001	1.32 (0.83 to 2.09)	0.001
<b>Variables</b>	<b>Mean of morbidities</b>		<b>Prevalence of morbidity (≥ 1 chronic diseases, 95% CI)*</b>		<b>Prevalence of morbidity (≥ 2 chronic diseases, 95% CI)*</b>		<b>Prevalence of multimorbidity (≥ 2 chronic diseases, 95% CI)*</b>		<b>Pt</b>	
All participants	M± SD		P§							
Age groups, years	0.72±0.77	54.99 (40.11 to 60.11)	0.001	54.99 (40.11 to 60.11)	0.001	15.17 (12.38 to 18.44)	0.001	15.17 (12.38 to 18.44)	0.001	0.001
65-74	0.65±0.74	50.21 (46.95 to 53.47)	0.001	50.21 (46.95 to 53.47)	0.001	12.87 (10.82 to 15.23)	0.001	12.87 (10.82 to 15.23)	0.001	0.001
75-84	0.84±0.80	61.77 (56.43 to 66.84)	0.001	61.77 (56.43 to 66.84)	0.001	18.99 (15.30 to 23.33)	0.001	18.99 (15.30 to 23.33)	0.001	0.001
≥85	0.87±0.79	65.14 (59.15 to 70.68)	0.001	65.14 (59.15 to 70.68)	0.001	17.81 (11.56 to 26.42)	0.001	17.81 (11.56 to 26.42)	0.001	0.001
Gender										

Continued

Table 1 Continued

Variables	Mean of morbidities		P§	Prevalence of morbidity ( $\geq 1$ chronic diseases, 95% CI)*	P†	Prevalence of multimorbidity ( $\geq 2$ chronic diseases, 95% CI)*	P‡
	M± SD						
Male	0.69±0.76			52.72 (48.94 to 56.46)		14.06 (11.40 to 17.22)	
Female	0.75±0.78			56.94 (53.28 to 60.54)		16.11 (13.19 to 19.53)	
Education levels			0.001		0.001		0.001
No school	0.72±0.72			57.98 (50.43 to 65.18)		12.91 (9.51 to 17.30)	
Primary school	0.74±0.77			57.09 (53.32 to 60.77)		14.92 (11.70 to 18.84)	
Secondary school	0.69±0.79			51.37 (47.05 to 55.68)		15.59 (12.85 to 18.78)	
College and above	0.81±0.82			58.70 (52.97 to 64.20)		19.27 (15.65 to 23.49)	
Marital status			0.001		0.001		0.001
Single†	0.77±0.78			58.37 (52.61 to 63.90)		15.92 (11.69 to 21.31)	
Married	0.72±0.77			54.53 (51.00 to 58.02)		15.06 (12.44 to 18.13)	
Living Areas			0.001				
Rural areas	0.58±0.67			48.17 (41.88 to 54.53)		8.92 (6.29 to 12.49)	
Urban areas	0.79±0.80			57.95 (54.39 to 61.42)		17.88 (15.27 to 20.82)	
Medical insurance			0.001		0.001		0.001
Uninsured	0.67±0.74			51.81 (45.43 to 58.12)		13.72 (11.19 to 16.71)	
Insured	0.73±0.77			55.07 (51.30 to 58.78)		15.20 (12.34 to 18.58)	

\*Weighted estimates of prevalence of with proportional to population size and poststratification sample weights adjustment.

†Differences between categories within each variable,  $\chi^2$  test for each variable.

‡Single: unmarried, divorced or widowed.

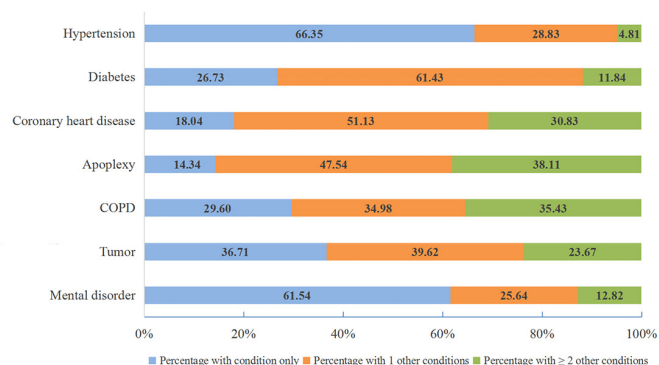
§Differences between means within each variable, t-test for independent samples for gender, marital status, register status, living areas, medical insurance; one-way analysis of variance for age group, education level.

CI, confidence interval; SD, standard deviation.

**Table 2** Associations between sociodemographic and comorbidity characteristics in community-dwelling elderly people in Guangzhou, China

Variables	Hypertension		Diabetes		Coronary heart disease		Apoplexy		Morbidity		Multimorbidity	
	OR (95% CI)*	P value	OR (95% CI)*	P value	OR (95% CI)*	P value	OR (95% CI)*	P value	OR (95% CI)*	P value	OR (95% CI)*	P value
Age groups, years												
65–74	Reference		Reference		Reference		Reference		Reference		Reference	
75–84	1.59 (1.58 to 1.60)	0.001	1.19 (1.18 to 1.21)	0.001	1.65 (1.61 to 1.68)	0.001	1.20 (1.16 to 1.25)	0.001	1.50 (1.49 to 1.52)	0.001	1.55 (1.53 to 1.57)	0.001
≥85	1.87 (1.84 to 1.90)	0.001	0.97 (0.95 to 0.99)	0.004	1.98 (1.91 to 2.05)	0.001	1.43 (1.35 to 1.53)	0.001	1.68 (1.66 to 1.71)	0.001	1.47 (1.44 to 1.50)	0.001
Gender												
Male	Reference		Reference		Reference		Reference		Reference		Reference	
Female	1.14 (1.13 to 1.15)	0.001	1.26 (1.25 to 1.28)	0.001	1.21 (1.18 to 1.23)	0.001	0.69 (0.67 to 0.72)	0.001	1.14 (1.13 to 1.15)	0.001	1.20 (1.19 to 1.22)	0.001
Education levels												
No school	Reference		Reference		Reference		Reference		Reference		Reference	
Primary school	1.03 (1.02 to 1.05)	0.001	1.03 (1.02 to 1.05)	0.001	2.01 (1.93 to 2.08)	0.001	1.43 (1.35 to 1.52)	0.001	1.04 (1.03 to 1.06)	0.001	1.23 (1.21 to 1.25)	0.001
Secondary school	0.83 (0.82 to 0.84)	0.001	0.97 (0.96 to 0.99)	0.002	2.72 (2.62 to 2.82)	0.001	0.97 (0.91 to 1.03)	0.331	0.84 (0.83 to 0.85)	0.001	1.28 (1.26 to 1.31)	0.001
College and above	0.92 (0.90 to 0.94)	0.001	1.03 (1.01 to 1.06)	0.025	3.23 (3.09 to 3.38)	0.001	1.16 (1.07 to 1.26)	0.001	0.97 (0.95 to 0.99)	0.002	1.38 (1.34 to 1.42)	0.001
Marital status												
Married	Reference		Reference		Reference		Reference		Reference		Reference	
Single†	1.10 (1.08 to 1.11)	0.001	1.07 (1.05 to 1.09)	0.001	1.04 (1.01 to 1.07)	0.018	0.61 (0.58 to 0.64)	0.001	1.05 (1.04 to 1.06)	0.001	1.07 (1.05 to 1.08)	0.001
Living areas												
Urban areas	Reference		Reference		Reference		Reference		Reference		Reference	
Rural areas	0.70 (0.70 to 0.71)	0.001	0.68 (0.67 to 0.69)	0.001	0.31 (0.30 to 0.32)	0.001	0.53 (0.50 to 0.55)	0.001	0.67 (0.67 to 0.68)	0.001	0.49 (0.48 to 0.49)	0.001
Medical insurance												
Insured	Reference		Reference		Reference		Reference		Reference		Reference	
Uninsured	0.85 (0.83 to 0.87)	0.001	1.06 (1.03 to 1.10)	0.001	0.72 (0.67 to 0.77)	0.001	1.44 (1.30 to 1.59)	0.001	0.92 (0.89 to 0.94)	0.001	0.90 (0.87 to 0.94)	0.001

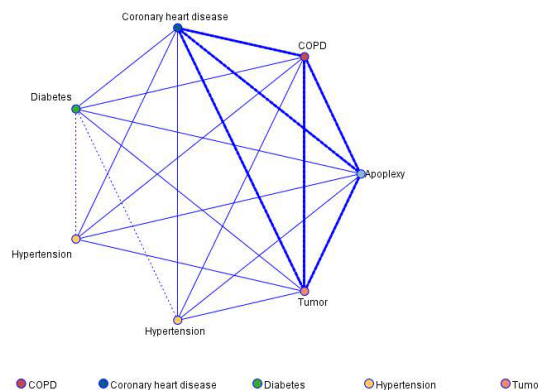
\*Adjusted for all variables listed in the table.  
 †Single: unmarried, divorced or widowed.  
 CI, confidence interval; OR, odds ratio.



**Figure 4** Number of chronic conditions in community-dwelling elderly people in Guangzhou, China. COPD, chronic obstructive pulmonary disease.

present study, model of hypertension and coronary heart disease, model of diabetes and coronary heart disease, model of diabetes, coronary heart disease and hypertension were also reported. A nationally representative sample of middle-aged and older adults study showed that three top prevalent multimorbidity combinations were diabetes arthritis hypertension; diabetes hypertension; and diabetes arthritis hypertension heart disease.<sup>32</sup> Other study of community-dwelling elderly people in Nanjing, China, found that hypertension and diabetes, hypertension and coronary heart disease, hypertension and dyslipidaemia, diabetes and cataract, diabetes and hearing disorder, hypertension and stroke were the common patterns of multimorbidity.<sup>16</sup> Exploring patterns of multimorbidity may contribute to implement the effective prevention, interventions, treatment measures and management strategies of multimorbidity, and more attention are required for researchers.

Some limitations were included in this study. First, only seven chronic diseases were included in this study. Second, the old records (invalid records) or deaths records were not included. Third, some chronic diseases were lower than other studies, such as apoplexy, COPD and tumour. Those may lead to a low prevalence of multimorbidity. At the same time, the residents' health records in communities were based on self-reporting; thus, the selection bias and recall bias were introduced. Therefore, a larger and prospective cohort design based on residents' health records to infer the causal relationship is needed in future research.



**Figure 5** Web diagram of comorbidity in community-dwelling elderly people in Guangzhou, China. COPD, chronic obstructive pulmonary disease.

Some strengths were also included in present study. There are few studies on data mining of residents' health records in community health service centres in China. In the present study, a multistage, stratified random sampling method was selected, and 31 708 elderly people were adopted, which can explore representatively the current status and quality of residents' health records in community health service centres of Guangzhou, southern of China. And the results will help for strengthening the management of residents' health records of Guangzhou, China.

### CONCLUSIONS

Our study indicated a high prevalence of morbidity and a relatively low multimorbidity of chronic diseases among 31 708 community-dwelling elderly people in Guangzhou, China. Elderly, woman, higher education level, being single, living in urban areas and having medical insurance were more likely to have chronic diseases and multimorbidity. Data mining of residents' health records in community health service centres by association rule mining analysis showed that pattern of multimorbidity was model of hypertension and diabetes, model of hypertension and coronary heart disease, model of diabetes and coronary heart disease, model of diabetes, coronary heart disease and hypertension.

**Table 3** The pattern of multimorbidity based on mining association rules of apriori algorithm in community-dwelling elderly people in Guangzhou, China

Left hand side	Right hand side	Support (%)	Confidence (%)	Lift
Diabetes*	Hypertension	12.495	17.579	1.404
Coronary heart disease*	Hypertension	4.377	5.718	1.512
Coronary heart disease*	Diabetes	1.615	5.718	1.606
Coronary heart disease, hypertension†	Diabetes	1.385	4.377	1.799

\*The results of association rules for relationship between chronic diseases with 1 left-hand side.

†The results of association rules for relationship between chronic diseases with 2 left-hand side.



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**Patient consent for publication** Consent obtained directly from patient(s).

**Ethics approval** Ethical approval for this survey was obtained from the Ethics Committee of Center for Disease Control and Prevention of Guangzhou (GZCDC-ECHR-2020P0004). Participants gave informed consent to participate in the study before taking part.

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