Patterns of multimorbidity in community health centres in Shanghai, China: a retrospective, cross-sectional study based on outpatient data from 2014 to 2018

Hua Jin, Zhaoxin Wang, Aizhen Guo, Hanzhi Zhang, Wei Liu, Yuqin Zhu, Ming Hua, Jianjun Shi, Jianwei Shi, Dehua Yu

ABSTRACT

Objective Caring for patients with multimorbidity is an important part of primary care. It has become increasingly relevant that understanding the spectrum of multimorbidity will help general practitioners (GPs) acquire working knowledge and improve management skills. However, there was little research on characteristics of multimorbidity in primary care in China. This study aimed to identify the spectrum of frequency, proportion and ranking of multimorbidity patterns in adult patients seen at community health centres (CHCs) in Shanghai, China.

Design and setting This was an observational, retrospective, cross-sectional study analysis of outpatient data of 244 CHCs in Shanghai, China.

Participants Adult patients with chronic disease who visited Shanghai CHCs during 2014–2018 were selected from Shanghai CHC electronic medical records database using the International Classification of Diseases 10th Revision codes matched to the Second Version of International Classification of Primary Care codes.

Primary and secondary outcome measures A number of adult patients with chronic disease were counted. Then frequency, proportion and rank of disease patterns of multimorbidity were analysed.

Results Analysis of 301 651 158 electronic health records of 5 909 280 adult patients (54.2% females) found the multimorbidity proportion to be 81.2%. The prevalence of multimorbidity increased with age, which climbed from 43.7% among those aged 19–34 to 94.9% among those more than 80 years of age. The proportion of multimorbidity was higher in females (83.2%) than males (79.7%). Vascular and metabolic diseases were the most frequent diseases for patients over 45 years old.

Conclusions Multimorbidity has brought huge challenges to primary care practice in Shanghai. The Shanghai government should strengthen its support for the multitudinous prevention of chronic diseases and the improvement of GPs’ management capabilities.

INTRODUCTION

Multimorbidity is defined as having two or more chronic diseases at the same time in one person.1 As the elderly population rapidly increases, it has emerged as an important factor threatening public health. As of 2016, 20%–30% of the global population is experiencing the coexistence of multiple diseases, and multimorbidity among people over 65 has reached 66%–90%.2

Multimorbidity leads to more functional decline and disability, lower quality of life, but also higher mortality and risk of harmful drug-related events.3–5 Patients with multimorbidity have higher requirements for continuous, comprehensive and coordinated care,6 which is an important part of primary settings. It brings a great challenge for general practitioners (GPs). Under the current single-disease diagnosis and treatment model, GPs lack the understanding of multimorbidity.7 8 Therefore, it is urgent to be informed by data about the status of multimorbidity in primary care practice in order
to further improve GPs’ understanding and management ability of multimorbidity.

WHO had stated the advantage of analysis based on electronic medical records (EMR), including help to insight areas of concern and the provision of health services.9 Analysis of EMRs was considered, providing more comprehensive information and more accurate diagnoses than self-reported results by patients in the study of multimorbidity.10

However, there was little research on the patterns of multimorbidity based on EMRs in China. Only several studies based on administrative data involved relatively small numbers of patients.11 12 Furthermore, results of studies based on surveys vary due to differences in study population or study settings.13 Due to the lagging development of medical information in China, even in Shanghai, which is one of the most developed cities in information technology and medical care in China, the informationisation of medical data has only begun to develop rapidly in recent years. The construction and storage of medical data were incomplete in the early stage. In addition, general practice started late in China, the information system platform of community health centres (CHCs) was also delayed accordingly.14 Since 2010, the Shanghai Municipal Government has gradually attached the importance to medical big data. The database was built and improved by the government information department, the medical and health supervision department and the data technology companies, which makes it possible to acquire and analyse large patient data with multimorbidity.

Hence, this study aimed to identify the patterns of multimorbidity in CHCs in Shanghai through analysing the EMRs of adult patients with chronic disease during 2014–2018. The findings of this study would provide better understanding of the characteristics of multimorbidity in primary care and offer insights for medical service plan and disease prevention for multimorbidity in Shanghai.

METHODS

Study design
This is an observational, retrospective, cross-sectional study of multimorbidity using the outpatient data of all CHCs in Shanghai, China. All data were sourced from the outpatient and emergency system database platform of Shanghai, which covered the clinic data of all level hospitals in Shanghai.

Data source
CHCs performed as primary care institutions in China. With implementation of medical reform since 2010, general practice has been developed rapidly in Shanghai. The total number of permanent residents in Shanghai is 24.8709 million in 2021. More than 200 CHCs have been set up in Shanghai, with annual outpatient visits of over 40 million and patient information of over 100 million. By 2012, the outpatient and emergency information system platform of primary care institutions had been basically set up and functional. The data on this platform of primary care institutions are comprehensive and standardised. They include the personal information and medical records of all patients seen at all CHCs in Shanghai. Meanwhile, the diagnostic codes for diseases for GPs are unified under the International Classification of Diseases 10th Revision (ICD-10).

The data of patients who visited outpatient and emergency department in any CHC were successfully captured by the outpatient system platform of primary care institutions in Shanghai. Then the data were reported to the departments of district health government further, and finally data reported by all districts formed a large database of outpatient and emergency treatment in CHCs in Shanghai. The database is used by government departments and researchers after authorisation.

Study population
To better understand the current status of multimorbidity among patients with chronic diseases and their medical needs, this study selected adult patients with chronic diseases who visited a CHC in Shanghai from 2014 to 2018 as study population. For the integrity and accuracy of the study, first, all the records of the outpatients in CHCs in Shanghai (number of CHCs: 221 in 2014; 268 in 2015; 266 in 2016; 271 in 2017; 284 in 2018) from 1 January 2014 to 31 December 2018 were selected to compose the panel for analysis. A total of 301 651 169 patient visits were totally involved. After removing 8 904 788 incomplete data and 9 180 156 erroneous records (ie, the demographic information is incomplete, the patient’s age is too high or too low), there were 283 566 225 records remained. Then we integrated each record to a ‘person’ by their identification card number in the database, and finally 5 909 280 adult (over 18 years of age) patients were selected. Demographic information including age and gender of these patients was collected to build the data set. (See figure 1 for the flow chart of data collection.)

Figure 1 Flow chart of data collection.
Measurement

Due to the lack of consensus on which diseases should be included in the definition of multimorbidity, we included chronic diseases in analysing multimorbidity based on the current literature on multimorbidity by ICD-10 codes.\textsuperscript{10,15} Similar to most previous studies on multimorbidity,\textsuperscript{16,17} a patient who has more than two chronic diseases was identified as a multimorbid patient.

To avoid the bias that patients with multiple diseases were counted more than once, each patient was identified by their identification card number in the database and duplicated diagnoses in the database were excluded. Also, ICD-10 codes were matched to the Second Version of International Classification of Primary Care codes proposed by the World Organization of National Colleges, Academies and Academic Associations of General Practice/Family Medicine in order to better identify the diseases and health problems existing in one person\textsuperscript{18} (see online supplemental appendix A1).

Statistical analysis

This study analysed the spectrum of the frequency, proportion and ranking of multimorbidity patterns of all adult chronic outpatients from all CHCs in Shanghai in different age groups (19–34, 35–49, 50–64, 65–79, 80+) and both genders (male and female).

Patient and public involvement

No patients or public were involved in the design, outcome measures, recruitment to or conduct of this study. Since the personal information of all patients has been deleted in this study, it is not necessary to disseminate this information to the patients.

RESULTS

Demographics of adult patients from all CHCs between 2014 and 2018 in Shanghai

The demographics of all the extracted outpatients were presented in table 1. There were a total of 5 909 280 adult patients with chronic diseases seen in CHCs during 2014–2018. There were more female patients than male patients (female: n=3 203 222; 54.2%, male: n=2 706 058; 45.8%). Regarding age, the majority of outpatients were in the range of 50–64 (n=2 170 436; 36.7%) and 65–79 (n=1 906 987; 32.3%). The overall ratio of multimorbidity was 81.2% (n=4 822 277). 50.4% of the patients had more than five chronic diseases (n=2 975 664).

| Variables | Group | n    | Proportion (%) |
|-----------|-------|------|----------------|
| Total     |       | 5 909 280 | 100.0         |
| Gender    |       |       |                |
| Male      |       | 2 706 058 | 45.8          |
| Female    |       | 3 203 222 | 54.2          |
| Age       |       |       |                |
| 19–34     |       | 358 019  | 6.1           |
| 35–49     |       | 787 300  | 13.3          |
| 50–64     |       | 2 170 436 | 36.7         |
| 65–79     |       | 1 906 987 | 32.3         |
| >80       |       | 686 538  | 11.6          |
| Number of diseases | | | |
| 1         |       | 1 087 003 | 18.4        |
| 2         |       | 746 679   | 12.6         |
| 3         |       | 599 673   | 10.2         |
| 4         |       | 500 261   | 8.5          |
| ≥5        |       | 2 975 664 | 50.4         |

CHC, community health centre.

Distribution of multimorbidity for adult patients with chronic diseases stratified by gender in all CHCs in Shanghai between 2014 and 2018

As can be seen in figure 2, the proportion of multimorbidity in female patients was a bit higher than that in male patients (male: 79.7%; female: 83.2%). The proportions of patients who had more than five chronic diseases were 45.7% among males and 54.3% among females. Patients with four chronic diseases accounted for 9.0% in males and 8.0% in females. Patients with three chronic diseases accounted for 11.1% in males and 9.4% in females. The proportion of patients with only one chronic disease was 20.3% in males and 16.8% in females.

Distribution of multimorbidity for adult patients with chronic diseases stratified by age in all CHCs in Shanghai between 2014 and 2018

Figure 3 shows the proportion of multimorbidity in terms of age of patients. The trends of multimorbidity went higher with increase in age. The proportion of at least two chronic diseases ranged from 43.7% in patients aged 19–34 years to 94.9% in those aged more than 80 years. The proportion of two diseases in patients aged 19–34,
Distribution of disease patterns for adult patients with chronic diseases stratified by age in all community health centres (CHCs) in Shanghai between 2014 and 2018.

Table 2 demonstrates the top disease patterns of multimorbidity among total patient population and by gender. Hypertension was found to be the most common chronic disease, either alone or in combination with other diseases. Hypertension and ischaemic heart disease were the most prevalent dyad (0.6% overall, 0.7% in men and 0.5% in women), followed by diabetes and hypertension (0.5% overall, 0.7% in men and 0.4% in women). The most common triad was hyperlipidaemia, hypertension and ischaemic heart disease (0.1% overall, 0.2% in men and 0.1% in women).

Table 3 demonstrates the top five disease dyads and triads of multimorbidity among five age groups. Among patients aged 19–34 years, teeth/gum disease, stomach function disorder and other skin infection were the most common single diagnoses. Chronic disease and gynecological disease, and bronchitis/bronchiolitis/stomach function disorder and teeth/gum disease/stomach function disorder are the most frequent dyads.

However, unlike the young group and young people, cardiovascular and metabolic diseases were the most common diseases in patients over the age of 50. Hyperlipidaemia+hypertension+ischaemic heart disease and diabetes+hypertension+ischaemic heart disease were common disease patterns in age groups of 50–64, 65–79 and over 80 years. The disease pattern of hyperlipidaemia+hypertension+ischaemic heart disease accounted for 0.2%, 0.2% and 0.1% of the patients in the groups aged 50–64, 65–79 and over 80 years, respectively.

DISCUSSION

In this study, we identified the disease patterns among patients with chronic disease in CHCs in Shanghai. To the best of our knowledge, it is the first study to describe the spectrum of multimorbidity in primary care setting of China based on data extracted from EMRs, which would provide more comprehensive information on multimorbid patients’ needs in Shanghai through comparison between different age and gender groups.

We found that 81% of adult patients with chronic diseases who visited CHCs had multiple chronic conditions, which is higher than that reported in studies in western and other middle-income countries. For instance, a study of primary care for all adult patients in Canada showed nearly half of patients suffered more than two diseases. A Swiss study found a similar prevalence of 52.6%. In Odisha, India, the proportion of multimorbidity was 28.9% among patients attending primary care. The disparity may be due to demographic characteristics among the samples. In this study, adult patients with chronic disease who visited CHCs in Shanghai were selected as the denominator. On the one hand, because general practice in China is still in the development stage, GPs’ gatekeeping role has not been fully realised. Thus, patients could choose freely different levels of hospitals in China. Although the number of young people visiting CHCs has been increasing year by year, the overall CHC patient population is still dominated by the elderly. On the other hand, chronic diseases accounted for 91.41% of visits to CHCs between 2014 and 2018 in Shanghai, the proportion of patients with other types of diseases was relatively small. Therefore, the high proportion of multimorbidity in the Shanghai CHCs reflected the characteristics of ageing and chronic diseases of patients in CHCs. It also reminds that the health management department needs to pay attention to the challenges of multimorbidity in primary care.

We also found that the proportion of multimorbidity increased with age. Multimorbidity accounted for 43.7% among the patients aged 18–34 years, 62.9% among the patients aged 35–49 years, but 82.0% among the patients aged over 50 years. The result is similar to a study of 543 patients over age 65 in Ghent, Belgium, which showed a multimorbidity rate as high as 82.6%, and is lower than the reported prevalence of 93.1% in Spain. In addition, it is worth noting that previous studies on multimorbidity have mostly targeted the elderly and evidence for young people was limited. But we have found that multimorbidity was prevalent in young and middle-aged population. It implies that research and prevention strategies for
multimorbidity should focus on the elderly and recognise its impact in the entire life cycle.24

Consistent with other findings, the proportion of multimorbidity in female patients was higher than that in male patients.25 This may be due to gender differences in medical treatment behaviours. Studies have reported that women may be more likely to use outpatient care services than men; therefore, their chronic diseases may be more likely to be detected than men.26

| Number of diseases | Rank | Total ICD code | n (%) | Male ICD code | n (%) | Female ICD code | n (%) |
|--------------------|------|----------------|-------|---------------|-------|-----------------|-------|
| Single disease     | 1    | I10            | 229145 (3.9) | I10           | 139287 (5.2) | I10             | 88858 (2.8) |
|                    | 2    | K01/K02/K04/ K05/K08 | 113692 (1.9) | K01/K02/K04/K05/K08 | 59182 (2.2) | K01/K02/K04/K05/K08 | 53361 (1.7) |
|                    | 3    | K29            | 46724 (0.8) | E14           | 27281 (1.0) | J40             | 22747 (0.7) |
|                    | 4    | J40            | 45971 (0.8) | K29           | 24137 (0.9) | K29             | 22587 (0.7) |
|                    | 5    | E14            | 43947 (0.7) | J40           | 23224 (0.9) | N76             | 20663 (0.7) |
|                    | 6    | M13            | 39416 (0.7) | L08           | 19886 (0.7) | M13             | 20203 (0.6) |
|                    | 7    | I25            | 34772 (0.6) | M13           | 19213 (0.7) | I25             | 18098 (0.6) |
|                    | 8    | L08            | 31404 (0.5) | I25           | 16674 (0.6) | E14             | 16666 (0.5) |
|                    | 9    | L30            | 31376 (0.5) | L30           | 15649 (0.6) | L30             | 15727 (0.5) |
|                    | 10   | H10            | 25536 (0.4) | H10           | 11824 (0.4) | H10             | 13712 (0.4) |

| Dyads              | 1    | I10+I25        | 35505 (0.6) | I10+I25       | 19252 (0.7) | I10+I25         | 16253 (0.5) |
|                    | 2    | E14+I10        | 29882 (0.5) | E14+I10       | 18627 (0.7) | E14+I10         | 11255 (0.4) |
|                    | 3    | I10+K01/K02/ K04/K05/K08 | 20918 (0.4) | I10+K01/K02/K04/K05/K08 | 13957 (0.5) | I10+K01/K02/K04/K05/K08 | 6961 (0.2) |
|                    | 4    | I10+J40        | 14942 (0.3) | I10+J40       | 8654 (0.3)  | I10+J40         | 6288 (0.2)  |
|                    | 5    | E78+I10        | 13623 (0.2) | E78+I10       | 7897 (0.3)  | E78+I10         | 5726 (0.2)  |
|                    | 6    | I10+K29        | 12834 (0.2) | I10+K29       | 7672 (0.3)  | I10+K29         | 5162 (0.2)  |
|                    | 7    | I10+I67/I69   | 10972 (0.2) | I10+M13       | 6087 (0.2)  | I10+I67/I69     | 5143 (0.2)  |
|                    | 8    | I10+M13        | 8882 (0.2)  | I10+I67/I69   | 5953 (0.2)  | I10+M13         | 4885 (0.2)  |
|                    | 9    | I10+L30        | 8054 (0.1)  | I10+L30       | 5400 (0.2)  | I10+L30         | 3482 (0.1)  |
|                    | 10   | H10+I10        | 7623 (0.1)  | H10+I10       | 4201 (0.2)  | H10+I10         | 3422 (0.1)  |

| Triads             | 1    | E78+I10+I25   | 75664 (0.1) | E78+I10+I25   | 43321 (0.2) | I10+I25+I67/I69 | 32722 (0.1) |
|                    | 2    | E14+I10+I25   | 7201 (0.1)  | E14+I10+I25   | 3992 (0.2)  | E78+I10+I25     | 3233 (0.1)  |
|                    | 3    | I10+I25+I67/I69 | 6351 (0.1)  | I10+I25+I67/I69 | 3079 (0.1)  | E14+I10+I25     | 3210 (0.1)  |
|                    | 4    | I10+I25+K29   | 3580 (0.1)  | I10+I25+K29   | 1959 (0.1)  | I10+I25+J40     | 1692 (0.1)  |
|                    | 5    | I10+I25+J40   | 3575 (0.1)  | I10+I25+J40   | 1883 (0.1)  | I10+I25+K29     | 1621 (0.1)  |
|                    | 6    | I10+I25+K01/ K02/K04/K05/K08 | 2989 (0.1)  | I10+I25+K01/K02/K04/K05/K08 | 1798 (0.1)  | I10+I25+M13     | 1534 (0.1)  |
|                    | 7    | I10+I25+M13   | 2971 (0.1)  | E14+E78+I10   | 1627 (0.1)  | I10+I25+K01/K02/ K04/K05/K08 | 1191 (0.0) |
|                    | 8    | E14+E78+I10   | 2664 (0.1)  | E14+I10+K01/K02/ K04/K05/K08 | 1463 (0.1)  | E14+E78+I10     | 1037 (0.0)  |
|                    | 9    | E14+I10+J40   | 2222 (0.0)  | I10+I25+M13   | 1437 (0.1)  | I10+I25+I49     | 1029 (0.0)  |
|                    | 10   | I10+I25+I49   | 2176 (0.0)  | E14+I10+J40   | 1331 (0.1)  | H10+I10+I25     | 978 (0.0)   |

CHC, community health centre; ICD, International Classification of Diseases.

In this study, hypertension was found to be the most common chronic disease, either alone or in combination with other diseases. Hypertension and ischaemic heart disease, diabetes and hypertension, and hypertension and chronic bronchitis were the most important dyads in this study. Hyperlipidaemia, hypertension and ischaemic heart disease were the most common triad in our findings. Cardiovascular diseases and metabolic diseases were the main patterns of multimorbidity in CHCs in Shanghai.
Table 3 Distribution of disease patterns for adult patients with chronic diseases stratified by age in all CHCs in Shanghai between 2014 and 2018

| Number of diseases | Rank | ICD code | 19–34 years | ICD code | 35–49 years | ICD code | 50–64 years | ICD code | 65–79 years | ICD code | More than 80 years |
|--------------------|------|----------|-------------|----------|-------------|----------|-------------|----------|-------------|----------|-------------------|
| Single disease     | 1    | K01/K02/K04/K05/K08 | 27 894 (7.8) | I10      | 44 432 (5.6) | I10      | 115 477 (5.3) | I10      | 51 513 (2.7) | I10      | 10 778 (1.6)     |
|                    | 2    | K29      | 12 525 (3.5) | K01/K02/K04/K05/K08 | 33 522 (4.3) | K01/K02/K04/K05/K08 | 39 660 (1.8) | K01/K02/K04/K05/K08 | 11 442 (0.6) | I25     | 3732 (0.5)      |
|                    | 3    | L08      | 10 518 (2.9) | J40      | 15 003 (1.9) | E14      | 22 144 (1.0) | I25      | 9998 (0.5)   | M13      | 1708 (0.3)       |
|                    | 4    | J40      | 10 425 (2.9) | K29      | 14 504 (1.8) | M13      | 15 539 (0.7) | E14      | 9518 (0.5)   | E14      | 1623 (0.2)       |
|                    | 5    | N76      | 9298 (2.6)   | L08      | 10 811 (1.4) | I25      | 15 266 (0.7) | M13      | 6769 (0.4)   | I67/I69  | 1328 (0.2)       |
|                    | 6    | L30      | 8474 (2.4)   | M13      | 10 118 (1.3) | J40      | 14 173 (0.7) | J40      | 5292 (0.3)   | J40      | 1078 (0.2)       |
| Dyads              | 7    | N92      | 7307 (2.0)   | L30      | 9124 (1.2)   | K29      | 13 943 (0.6) | K29      | 4812 (0.3)   | K59      | 1014 (0.2)       |
|                    | 8    | I10      | 6945 (1.9)   | M54      | 8310 (1.1)   | L30      | 9203 (0.4)   | E78      | 3763 (0.2)   | G47      | 867 (0.1)        |
|                    | 9    | K52      | 6378 (1.8)   | N76      | 8249 (1.1)   | E78      | 8544 (0.4)   | E78      | 3763 (0.2)   | G47      | 867 (0.1)        |
|                    | 10   | M54      | 5764 (1.6)   | H10      | 7567 (1.0)   | H10      | 8142 (0.4)   | L30      | 3730 (0.2)   | L30      | 845 (0.1)        |
|                    |      |          |             |          |             |          |             |          |             |          |                  |
|                    | 1    | N76+N92  | 910 (0.3)    | E14+J40  | 3138 (0.4)   | E14+J40  | 16 023 (0.7) | I10+J40  | 3933 (0.2)   | I10+J40  | 847 (0.1)        |
|                    | 2    | J40+K29  | 604 (0.2)    | I10+K29  | 2855 (0.4)   | I10+K29  | 15 797 (0.7) | E14+I10  | 8770 (0.5)   | E14+I10  | 1647 (0.2)       |
|                    | 3    | K01/K02/K04/K05/K08+K29 | 521 (0.2) | I10+J40   | 2711 (0.3)   | I10+K01/K02/K04/K05/K08 | 12 238 (0.6) | I10+K01/K02/K04/K05/K08 | 5116 (0.3) | I10+I67/I69 | 1204 (0.2)       |
|                    | 4    | J40+K01/K02/K04/K05/K08 | 491 (0.1) | I10+K01/K02/K04/K05/K08 | 2139 (0.3) | I10+J40   | 7701 (0.4)   | I10+J40  | 3933 (0.2)   | I10+J40  | 847 (0.1)        |
|                    | 5    | L08+L30  | 486 (0.1)    | I10+K29  | 2002 (0.3)   | E78+I10  | 7203 (0.3)   | E78+I10  | 3626 (0.2)   | I10+M13  | 846 (0.1)        |
|                    | 6    | K29+K52  | 477 (0.1)    | E78+I10  | 1961 (0.3)   | I10+K29  | 6665 (0.3)   | I10+I67/I69 | 3535 (0.2) | I10+K59  | 693 (0.1)        |
|                    | 7    | J40+L30  | 372 (0.1)    | I10+M13  | 1226 (0.2)   | I10+M13  | 5389 (0.3)   | I10+M13  | 3319 (0.2)   | I10+K29  | 675 (0.1)        |
|                    | 8    | K29+L30  | 366 (0.1)    | I10+L30  | 1220 (0.2)   | I10+L30  | 4630 (0.2)   | I10+K29  | 3142 (0.2)   | E78+I10  | 580 (0.1)        |
|                    | 9    | I10+K29  | 350 (0.1)    | J40+K29  | 1103 (0.1)   | I10+I67/I69 | 4010 (0.2) | I10+L30  | 2335 (0.1)   | I25+I67/I69 | 561 (0.1)       |
|                    | 10   | I10+J40  | 322 (0.1)    | N76+N92  | 1047 (0.1)   | H10+I10  | 3773 (0.2)   | H10+I10  | 2278 (0.1)   | I10+L30  | 527 (0.1)        |
| Number of diseases Rank | 19–34 years | 35–49 years | 50–64 years | 65–79 years | More than 80 years |
|------------------------|-------------|-------------|-------------|-------------|-------------------|
|                        | ICD code    | n (%)       | ICD code    | n (%)       | ICD code          | n (%)         | ICD code          | n (%)         | ICD code          | n (%)         |
| Triads 1               | J40+K01/K02/K04/K05/K08+K29 | 71 (0.0) | E78+I10+I25 | 460 (0.1) | E78+I10+I25 | 3460 (0.2) | E78+I10+I25 | 2880 (0.2) | I10+I25+I67/I69 | 1184 (0.2) |
|                        | K01/K02/K04/K05/K08+K29+K52 | 50 (0.0) | E14+E78+I10 | 266 (0.0) | E14+I10+I25 | 3257 (0.2) | E14+I10+I25 | 2767 (0.2) | E14+I10+I25 | 839 (0.1) |
|                        | J40+K29+K52 | 50 (0.0) | E14+I10+I25 | 248 (0.0) | I10+I25+I67/I69 | 2349 (0.1) | I10+I25+I67/I69 | 2561 (0.1) | E78+I10+I25 | 721 (0.1) |
|                        | N76+N91+N92 | 47 (0.0) | I10+I25+J40 | 235 (0.0) | I10+I25+K29 | 1675 (0.1) | I10+I25+J40 | 1313 (0.1) | I10+I25+M13 | 498 (0.1) |
|                        | I10+J40+K29 | 46 (0.0) | I10+J40+K29 | 233 (0.0) | I10+I25+J40 | 1538 (0.1) | I10+I25+K29 | 1305 (0.1) | I10+I25+J40 | 463 (0.1) |
|                        | K01/K02/K04/K05/K08+K29+L30 | 43 (0.0) | I10+I25+K29 | 229 (0.0) | I10+I25+K01/K02/K04/K05/K08 | 1472 (0.1) | I10+I25+M13 | 1203 (0.1) | I10+I25+K59 | 397 (0.1) |
|                        | E78+I10+I25 | 43 (0.0) | I10+J40+K01/K02/K04/K05/K08 | 226 (0.0) | I10+I25+K01/K02/K04/K05/K08 | 1135 (0.1) | I10+I25+K01/K02/K04/K05/K08 | 348 (0.1) |
|                        | J40+K29+L30 | 42 (0.0) | E14+I10+K01/K02/K04/K05/K08 | 187 (0.0) | E14+I10+K01/K02/K04/K05/K08 | 1275 (0.1) | I10+I25+I49 | 830 (0.0) | I10+I25+I49 | 334 (0.1) |
|                        | K29+N76+N92 | 38 (0.0) | I10+I25+I67/I69 | 185 (0.0) | E14+I10+J40 | 1207 (0.1) | E14+E78+I10 | 813 (0.0) | G47+I10+I25 | 311 (0.1) |
|                        | K01/K02/K04/K05/K08+N76+N92 | 38 (0.0) | I10+K01/K02/K04/K05/K08+K29 | 164 (0.0) | I10+I25+M13 | 1122 (0.1) | I10+I25+L30 | 778 (0.0) | I10+I25+L30 | 297 (0.0) |

CHC, community health centre; ICD, International Classification of Diseases.
These results are consistent with the relevant literature across the world. For example, a survey conducted in Nanjing, Jiangsu Province, showed that hypertension, diabetes, coronary heart disease and other diseases were common coexisting diseases among urban residents. A study of 1480 adults aged more than 60 years in rural China also showed the same disease pairs. Studies in developed countries such as the USA and the UK also show that metabolic diseases and cardiovascular and cerebrovascular diseases were common disease combinations. These results may be related to economic development and changes in people's lifestyles. At the same time, it is also related to the Chinese government's policy emphasis on the prevention and treatment of chronic diseases. Hypertension and diabetes are currently important contents of chronic disease management in the community. Our findings also provide evidence for the need of multitargeted prevention and management strategies for chronic diseases.

However, we also found that the most prominent combination of arthritis or rheumatism and other diseases in the survey of Chinese community residents is relatively low in CHCs. Compared with primary care in developed countries, mental illness, tumours, tobacco and alcohol dependencies are very rare in CHCs in China. This finding hints at the limitations of Chinese GPs' scope disease treatment. Most of these diseases are treated in large general hospitals, which highlights the need to strengthen the diagnosis and treatment capabilities of Chinese GPs.

Our research also found that among young patients aged 19–34, gynaecological diseases and oral diseases are the main types of diseases. For example, vaginitis and irregular menstruation rank first in the combination of diseases, followed by dental diseases such as pulpitis, periodontal disease and dental caries. Studies have reported that dental disease is a risk factor for many chronic diseases. GPs need to pay attention to the challenge of oral diseases.

There are also some limitations in our study. First, our study is based on the retrospective review of EMRs. Therefore, as other studies conducted with EMRs, only the diagnoses recorded in CHCs were included, excluding health problems seen elsewhere, which likely underestimated the scope multimorbidity. Second, due to the limitation of statistical power, analyses were mostly descriptive and no control group was included. Socioeconomic data like family income cannot be obtained from EMRs, and thus we could not compare the differences in socioeconomic groups in this study.

CONCLUSIONS
Multimorbidity is an unexplored but urgent need to understand in primary care in China. This study provides information on the patterns of multimorbidity among the patients in CHCs in Shanghai. The proportion of multimorbidity in adult patients with chronic diseases visiting CHCs is as high as 81.1%, and it increases with age. Distribution of multimorbidity is higher in female patients than that in male patients. Vascular and metabolic diseases are most frequent patterns in patients over 45 years old, but among the young patients, gynaecological diseases and oral diseases are the main disease combinations. Multimorbidity has brought huge challenges and burdens to GPs in primary care practice in Shanghai. China should strengthen its support for the prevention of chronic diseases and the improvement of GPs’ chronic disease management capabilities.

Author affiliations
1Department of General Practice, Clinical Research Center for General Practice, Yangpu Hospital, School of Medicine, Tongji University, Shanghai, China
2Shanghai General Practice and Community Health Development Research Center, Shanghai, China
3Department of Social Medicine and Health Management, School of Public Health, Shanghai Jiaotong University School of Medicine, Shanghai, China
4School of Management, Hainan Medical University, Haikou, China
5Huangpu District Dapuqiao Community Health Center, Shanghai, China
6Department of Emergency, Yangpu Hospital, School of Medicine, Tongji University, Shanghai, China
7Jing’an District Daming Community Health Center, Shanghai, China

Acknowledgements We sincerely acknowledge and appreciate the assistance of Shanghai Information Center of Health and Family Planning Commission for their help in collecting data.

Contributors Conceptualisation: HJ, JwS, DY. Data curation: ZW, HZ. Formal analysis: HJ, JwS. Funding acquisition: HJ, JwS, DY. Methodology: YZ, JJS. Validation: AG, MH. Visualisation: WL. Writing—original draft: HJ. Writing—review and editing: JwS. Guarantor: DY. All authors have read and approved the manuscript.

Funding The design of this study was supported by the National Natural Science Foundation of China (72104183, 71603182) and the Shanghai Leading Talents Program (YDH-20170627). Data extraction was funded by Shanghai Education Science Research Project (C2021039) and the Soft Science Project of Shanghai Science and Technology Commission (22692107200). Analysis and interpretation of data guided by statisticians were funded by Project of Shanghai Health Committee (201840132). The writing and revision, including language improvement, were sponsored by Shanghai Medicine and Health Development Foundation (Se1201931, Se1202137).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval All research activities were conducted in accordance with the recognised ethical principles and were approved by the Ethics Committee of Tongji University (reference: LL-2016-ZWX-017). Informed consent was given by all study participants. This study has the lowest risk of harm to participants, and the data were collected anonymously. Descriptive analysis was authorised. None of the patients’ personal information included in the database was available to individuals outside the research team.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available.

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.
REFERENCES

1. Dugravoit A, Faysosse A, Durnurgier 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.

2. Nguyen TN, Ngangue P, Haggerty J, et al. Multimorbidity, polypharmacy and primary care in community-dwelling adults in Quebec: a cross-sectional study. *Fam Pract* 2019;36:706–12.

3. Fried TR, O’Leary J, Towle V, et al. Health outcomes associated with polypharmacy in community-dwelling older adults: a systematic review. *J Am Geriatr Soc* 2014;62:2261–72.

4. Cheung JTK, Yu R, Wu Z, et al. Geriatric syndromes, multimorbidity, and disability overlap and increase healthcare use among older Chinese. *BMJ Geriatr* 2018;18:147.

5. Su P, Ding H, Zhang W, et al. The association of multimorbidity and disability in a community-based sample of elderly aged 80 or older in Shanghai, China. *BMJ Geriatr* 2016;16:178.

6. Dérivaz-Luyet A, N’Goran AA, Senn N, et al. Multimorbidity and patterns of chronic conditions in a primary care population in Switzerland: a cross-sectional study. *BMJ Open* 2017;7:e013664.

7. Seo S. Multimorbidity development in working people. *Int J Environ Res Public Health* 2019;16:4749.

8. Damarell RA, Morgan DD, Tieman JJ. General practitioner strategies for managing patients with multimorbidity: a systematic review and thematic synthesis of qualitative research. *BMCFam Pract* 2020;21:131.

9. Uslu A, Stausburg J. Value of the electronic medical record for hospital care: update from the literature. *J Med Internet Res* 2021;23:e26323.

10. Guisado-Clavero M, Roso-Llorach A, López-Jiménez T, et al. Multimorbidity patterns in the elderly: a prospective cohort study with cluster analysis. *BMJ Geriatr* 2018;18:16.

11. Wang R, Li F, He Z. Disease profile of inpatients in general practice department of a grade a tertiary hospital. *Chin J Gen Pract* 2016;15:845–9.

12. Zhao R. Investigation and Analysis on the coexistence of multiple diseases among inpatients in a hospital [D]. Shanxi Medical University, 2016.

13. Yu D, Shi J, Zhang H, et al. Identifying patterns of non-communicable diseases in developed eastern coastal China: a longitudinal study of electronic health records from 12 public hospitals. *BMJ Open* 2017;7:e016007.

14. Shi J, Chi C, Gong X, et al. Examining health disparities and characteristics in general practice utilization: based on outpatient data from 2014 - 2018 in Shanghai. *BMFam Pract* 2020;21:74.

15. Abad-Diez JM, Calderón-Larrañaga A, Poncel-Falcó A, et al. Age and gender differences in the prevalence and patterns of multimorbidity in the older population. *BMJ Geriatr* 2014;14:75.

16. Xu X, Mishra GD, Jones M. Evidence on multimorbidity from depletion to intervention: an overview of systematic reviews. *Ageing Res Rev* 2017;37:53–68.

17. He Z, Bian J, Carretta HJ, et al. Prevalence of multiple chronic conditions among older adults in Florida and the United States: comparative analysis of the OneFlorida data trust and national inpatient sample. *J Med Internet Res* 2018;20:e137.

18. O’Halloran J, Miller GC, Britt H. Defining chronic conditions for primary care with ICPC-2. *Fam Pract* 2004;21:381–6.

19. Nicholson K, Terry AL, Fortin M, et al. Prevalence, characteristics, and patterns of patients with multimorbidity in primary care: a retrospective cohort analysis in Canada. *Br J Gen Pract* 2019;69:e647–56.

20. Excoffier S, Herzig L, N’Goran AA, et al. Prevalence of multimorbidity in general practice: a cross-sectional study within the Swiss sentinel surveillance system (Sentinella). *BMJ Open* 2018;8:e019616.

21. Swain S, Chandra Mishra R. Multimorbidity and frailty in primary care patients aged 40 years or more in Odisha, India. *Clin Epidemiol Glob Health* 2019;7:331–6.

22. Boeckxstaens P, Peersman W, Goubin S, et al. A practice-based analysis of combinations of diseases in patients aged 65 or older in primary care. *BMJ Fam Pract* 2014;15:159.

23. Violán C, Fiquet-Boreu Q, Fernández-Bertolin S, et al. Soft clustering using real-world data for the identification of multimorbidity patterns in an elderly population: cross-sectional study in a Mediterranean population. *BMJ Open* 2019;9:e029594.

24. Wang SB, D’Arco C, Yu YQ, et al. Prevalence and patterns of multimorbidity in northeastern China: a cross-sectional study. *Public Health* 2015;129:1539–46.

25. Fu S, Huang N, Chou Y-J. Trends in the prevalence of multiple chronic conditions in the UK between 2000 and 2014: a population-based study. *Prev Chronic Dis* 2014;11:E187.

26. Khanam MA, Streetfield 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.

27. Gu J, Chao J, Chen W, et al. Multimorbidity in the community-dwelling elderly in urban China. *Arch Gerontol Geriatr* 2017;68:62–7.

28. Wang R, Yan Z, Liang Y, et al. Prevalence and patterns of chronic disease pairs and multimorbidity among older Chinese adults living in a rural area. *PLoS One* 2015;10:e0138521.

29. Adams ML. Differences between younger and older us adults with multiple chronic conditions. *Prev Chronic Dis* 2017;14:E76.

30. Tran J, Norton R, Conrad N, et al. Patterns and temporal trends of comorbidity among adult patients with incident cardiovascular disease in the UK between 2000 and 2014: a population-based cohort study. *PLoS Med* 2018;15:e1002513.

31. 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.

32. Gill B, Harris A, Tredwin C, et al. Multimorbidity and oral health: need for new models of care. *Fam Med Community Health* 2020;8:e003837.

33. Islas-Granillo H, Borges-Yañez SA, Navarrete-Hernández JdeJ, et al. Indicators of oral health in older adults with and without the presence of multimorbidity: a cross-sectional study. *Clin Interv Aging* 2019;14:219–24.

34. Salisbury C, Johnson L, Purdy S, et al. Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. *Br J Gen Pract* 2011;61:e12–21.