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Cohort profile: Chinese elderly with multimorbidity in primary care in Hong Kong

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Patient consent Obtained

Ethics approval Compliance with Ethical Standards. Ethics approval was obtained from the Joint Chinese University of Hong Kong – New Territories East Cluster Clinical Research Ethics Committee (The Joint CUHK-NTEC CREC).

Conflict of Interest None declared

Contributors SYSW conceived and supervised the study and revised the manuscript. DXZ contributed to study design, analysed the data, prepared the draft and revised the manuscript. SRWS and CW contributed to the study design and implementation, and manuscript revisions. DZ contributed in data collection and manuscript revisions. SWM and MJ contributed in manuscript revisions.

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Abstract

Purpose

This cohort aims to examine health profile of primary care patients with multimorbidity longitudinally, and the potential impact of multimorbidity on health service utilization, quality of life and mortality among elderly patients in primary care in Hong Kong. This paper aims to describe the cohort design and baseline characteristics.

Participants

A total of 1080 patients aged 60 years or above with at least two chronic diseases were recruited in 4 public primary care clinics in the New Territories East Region of Hong Kong.

Findings to date

The study sample comprised 70% women with a mean age of 70.0 years (SD=6.8); 61% were overweight or obese; the mean number of chronic conditions was 4.1 (1.8); the mean medication in use was 2.4 (1.9); more than 70% rated their health as fair or poor; 18% were frail; three quarters reported the presence of one (11%) or two or more (64%) body pain areas; 12% had mild cognitive impairment; 19% had mild depression or above; 16% had mild anxiety or above; 49% had insomnia at sub-threshold level or above; 28% indicated being lonely; the EQ-5D-5L index score was -0.6 (0.2) and its visual analogue scale (VAS) score was 67.0 (14.8) out of 100; in the past 12 months, 17% admitted to hospital, 91% attended general out-patient clinic (GOPC), 70% attended specialist out-patient clinic (SOPC), and 10% used elderly day care center services; and the median out-of-pocket health cost was 1000 HK$ (US$150).

Future plans

Future plans will be longitudinally studying health profiles of patients with multimorbidity, the longitudinal association of psychosocial factors and multimorbidity, as well as influence of multimorbidity on quality of life and mortality. Health service utilization in primary and secondary care will also be studied.

Key Words:

Multimorbidity; Prospective Cohort; Older Adults; Primary Care; Physical, Psychological and Social Factors

Strengths and limitations of this study

- This cohort specifically looks into the health profile of Hong Kong Chinese elderly with multimorbidity in primary care. As far as we are aware, very few prospective cohorts specifically cover this population in primary care, and no such cohort among Chinese.
- The study includes questionnaires and physical health assessments to identify physical and psychosocial problems commonly encountered in the elderly. The data are linked with health electronic records which allow follow up and examination of long-term outcomes associated with multimorbidity.
- The limitation was that older adult patients who were disabled, very ill, institutionalized, or home-bounded were unlikely to have been included in this study.

INTRODUCTION

Multimorbidity, defined as patients living with two or more chronic health conditions, is common in primary care. The prevalence is increasing over the last decades as a result of an aging population and changes in lifestyles e.g. more sedentary lifestyle.[1 2] A recent systematic review suggests that the prevalence of multimorbidity is high among the elderly.[3] Increasing age, being female and having a lower socioeconomic status are positively associated with multimorbidity.[3 4] Multimorbidity is associated with increased disability and depression, reduced quality of life, and higher rates of adverse drug consequences. Multimorbidity leads to increased primary and secondary health service utilization, especially unplanned health care, as well as reduced life-expectancy.[5]

The management of multimorbidity is challenging to healthcare systems globally due to its heavy disease burden in multiple aspects. The common problems experienced by patients with multimorbidity include fragmentation and poor coordination of care, polypharmacy, treatment burden, mental health problems, functional disability, and increased healthcare expenditures.[6 7] The direct and indirect economic burden associated with multimorbidity is huge.[8] The annual healthcare costs were €4,096.86 among patients with 5 or more chronic conditions, which was almost 5 times more than those who were healthy in a study in the West of Ireland.[9] The economic burden highlights an urgent need to search for cost-effective ways to manage patients with multimorbidity, given that treatment of diseases in isolation can be inefficient, leading to duplication of care and poorer health outcomes.[10]

Studies on multimorbidity have increased in recent years; however, important knowledge gaps still exist.[11] Although a guideline on clinical assessment and management of multimorbidity was developed by the NICE in 2016,[12] questions on the epidemiology and profiles of patients with multimorbidity to inform policy making are unanswered.[3 13] For example, there is insufficient information on clustering of different conditions and limited research has been conducted on physical, psychological and social factors longitudinally associated with chronic conditions. In addition, the impact of multimorbidity on various patient outcomes such as loneliness, fatigue, use of different kinds of healthcare services is less studied.[3 12-15] Therefore, cohort studies with multiple repeat measures of both exposures and outcomes are needed to advance our understanding of potential causality. [1416-20]

In Hong Kong, although there is a large private primary care sector, around 85% of people with chronic conditions are managed in the public primary care setting. Given that Hong Kong people have the longest life expectancy in the world: (81.7 for men and 87.7 for women in 2017),[21] the ageing population and multimorbidity have brought much burden and challenge to the local healthcare system. The present cohort aims to study the health profiles of patients with multimorbidity who present to primary care in Hong Kong. The specific objectives are to examine: 1) health profiles of elderly patients in primary care; 2) the longitudinal association between psychosocial factors and multimorbidity; and 3) the potential impact of multimorbidity on healthcare utilization, quality of life and mortality. The findings of this study will inform healthcare providers and policymakers in providing suitable health services for people with multimorbidity in primary care. This paper aims to introduce the cohort methods and baseline measures and results, with comparisons to two other population-based studies on the older adults with two or more chronic conditions in Hong Kong.

COHORT DESCRIPTION

Study setting and participants

Hong Kong has a population of 7.34 million according to the 2016 census data,[22] with 23.7% aged 60 years or above, which was higher than the rates of 16.5% and 19.5% in 2006 and 2011, respectively. This cohort contains primary care patients from four general out-patient clinics (GOPCs) (Lek Yuen, Ma On Shan, Shatin (Tai Wai) and Yuen Chau Kok), which were available as indicated by administrative staffs for patient recruitment during the study period, out of the ten general out-patient clinics (GOPCs) in the New Territory East Cluster (NTEC), Hong Kong. Each GOPC sees about 450 patients each day. The working hours are generally from 9:00 am to 5:00 pm from Monday to Friday with some additional night and weekend sessions. In the most recent Hospital Authority Annual Report 2016-2017, the ten GOPCs in NTEC provided 972,454 consultations in total in the year of 2015/2016, which consisted of one third of total GOPC consultations in Hong Kong public health system.[23]

The inclusion criteria of participants were: 1) aged 60 years or above; 2) with two or more chronic diseases confirmed by physicians; and 3) could speak and understand Chinese. No specific exclusion criteria were adopted. However, as participants need to respond to questionnaire surveys

and health checks, they required to be able to access the clinic, sign informed consent by themselves, and understand and answer the research questions.

Patients were first consecutively screened for eligibility by trained research assistants in the out-patient waiting areas of the GOPCs. For those who were eligible, they were asked to provide a contact phone number and then be scheduled to visit the study nurse for further assessments. From April 2016 to October 2017, 1080 eligible patients were recruited and completed the baseline assessments. All patients provided informed consent before participation in the study. The flowchart of recruitment is shown in **Figure 1**. The baseline assessments were conducted through face-to-face interviews by nurses or a social worker at a university affiliated primary care clinic.

Measures

The assessments covered a range of measures that are postulated to be potential physical, psychological and social factors associated with multimorbidity. All the measures were validated and have been widely used or have been used in our previous studies. Information was collected through face-to-face interviews by trained nurses and social workers, and additional information of the disease entities, medication use and health service utilization were confirmed through the review of electronic medical records by nurses. Each complete assessment lasted for about 45 to 60 minutes.

The measures in the questionnaires included: 1) the number and type of chronic diseases in fifteen categories (a total of 43 chronic conditions); 2) depression (screened by the 2-item Patient Health Questionnaire (PHQ-2)[24] and those with a score of 3 or more which suggests depression were further measured by the 9-item Patient Health Questionnaire (PHQ-9);[25] 3) anxiety (screened by the 2-item Generalised Anxiety Disorder (GAD-2) and those with a score of 3 or more which suggests anxiety were further measured by the 7-item Generalised Anxiety Disorder (GAD-7);[26] 4)loneliness (measured by the 6-item De Jong Gierveld Loneliness Scale,[27] as well as one loneliness question; 5) insomnia (measured by the 7-item Insomnia Severity Index (ISI)[28] among those who answered yes to the screening question); 6) pain (measured by the Brief Pain Inventory among those who were screened positive in pain); 7) physical activity (measured by Physical Activity Scale for the Elderly (PASE)[29] among those who were screened positive in pain); 8) frailty (measured by the Edmonton Frail Scale[30] which was translated and back-translated by experienced

bilingual translators); 9) meaning of existence (measured by one question extracted from the validated Chinese Purpose in Life test (CPIL) which was used in a previous study);[31] 10) sarcopenia (measured by the 5-item Sarcopenia Assessment (SARC-F)[32 33]; 11) cognition (measured by the Hong Kong Montreal Cognitive Assessment (HK-MoCA) with a score of 22 or above being with normal cognition);[34] 12) alcohol use (screened by one question and then measured by the 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who screened positive); 13) smoking (non-smoker, current smoker, ex-smoker); 14) medication use (number and duration (0-1 year/2-5 years/>5 years) of antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics was checked in electronic medical system, and compliance of medication use was measured by "At times, do you forget to take your prescription medications?" (no/yes)); 15) self-rated health; 16) community network; 17) use of social media (measured by a screening question, and for those who answered yes to any of the social media, they were further assessed with importance and comfort of using internet); 17) oral health; 18) incontinence; 19) caregiving to somebody; 20) quality of life was measured by the EuroQol EQ-5D-5L (EQ5D);[35] 21) daily function (ability to use telephone, mode of transportation, shopping, food preparation, ability to handle finances were measured); 22) health service utilization was recorded by visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare cost which was not covered by public health system or insurance both in private and public in the past year. In addition, physical examinations included blood pressure, weight, height and Body Mass Index (BMI), waist circumference and handgrip strength (kg). Social economical status such as age, gender, marriage, living status, employment, receiving of social welfare scheme was also included. Due to a change of data collection plan, some measures were only collected among part of the patients in a later stage. Summaries of the measures at baseline are described in **Table 1**.

The questionnaire was set up in password protected EpiData files in a password protected computer with quality control, e.g., for scale question with answers of a Likert scale of 1 to 5, a range of 1-5 and one digit was set up so no other results were allowed during data entry; and for most data variables, a must enter was set up, so that it could not be missed unless answered or purposely move to next question. Checking for missing data was done regularly by experienced researchers and missing data was further collected by nurses through face-to-face interviews, telephone or by checking of the electronic medical record system.

Patient and Public Involvement

The research questions and outcome measures were developed based on some most common problems that are widely recognized among elder patients. Patients or the public did not involve in the design of the study, recruitment or conduction of the study. The results of the study would be disseminated to patients once he or she requests so and aggregated data would be reported in project reports and research publications.

Findings to date

Baseline characteristics of the patients in the cohort are shown in **Table 2**. The mean age of patients was 70 (SD=6.8) years with 70% being females, 67% married, 14% living alone, 92% retired or housewives, 49% had 6 years of education or above, 10% on Comprehensive Social Security Assistance (CSSA) scheme, about half used social media in last 2 weeks, and about 18% provided care to another one such as their spouse or children/grandchildren; the mean BMI was 24.2 (SD=3.6): 61% were overweight or obese; 12% had ever drunk alcohol in the past year and3% were current smoker.

Overall, the mean number of chronic diseases was 4.1 (SD=1.8) and about one in five of patients had 6 or more chronic diseases. The top three chronic conditions were hypertension (73%), dyslipidemia (46%), and skeletal and connective tissue inflammation (e.g. arthritis) (37%). The prevalence of co-morbidities of the 15 disease categories among the patients is shown in **Figure 2**. The most prevalent co-morbidities out of the 43 specific chronic conditions under the 15 categories are shown in **Figure 3**, with the combination of hypertension and dyslipidemia being the most common (38% of the patients), followed by hypertension and skeletal and connective tissue inflammation (e.g. arthritis) (27%), hypertension and diabetes mellitus (26%), chronic pain and diabetes mellitus (21%), and hypertension and chronic pain (19%). On average, patients took 2.4 (SD=1.9) medications, with 27% taking 5 or more medications regularly.

There were 17.5% frail based on Edmonton Frail Scale. Eight percent had sarcopenia, 24% reported chewing difficulty, 20% reported incontinence, 35% had stage one or two hypertension according to the physical check, the average handgrip strength (best outcomes of the two trials of both hands) were 21.9 (SD=6.7) kg; 10% needed help or being dependent in at least one out of the 5 daily functions (using telephone, transportation, shopping, preparing meals, or financial

management). Overall, 28%, 59% and 12% of patients rated their health being 'excellent/very good/good', 'fair', or 'poor' respectively. Seventy-five percent reported the presence of one (11%) or two or more (64%) body pain areas, 12% scored the HK-MoCA <22 suggesting at least mild cognitive impairment, 19% had PHQ-2 ≥3 and 19% had PHQ-9 ≥5 suggesting mild depression or above, 17% had GAD-2 ≥3 and 16%had GAD-7 ≥5 suggesting mild anxiety or above, 28% reported feeling lonely, 49% had insomnia at subthreshold level or above, the mean score of meaning of existence was 4.8 (SD=1.2) out of 7; the EQ-5D-5L index score was -0.6 (0.2) and its visual analogue scale (VAS) score was 67.0 (14.8) out of 100.

Seventeen percent were admitted to hospital in the previous year, 91% attended GOPC, 70% attended SOPC, 10% used elderly day care center services and the median out-of-pocket health cost was 1000 HK$ (US$150) for any health expenditures not covered by the public health system or insurance. Details of the findings can be seen in **Table 2**.

Comparison of participant characteristics with two other population-based surveys

Comparison was made with the data from the two population-based surveys: the Elderly Telephone Survey (ETS) and Thematic Household Survey (THS) 2011 with participants age ≥ 60 and having two or more chronic diseases in these two surveys included. The Elderly Telephone Survey was a population-based survey conducted in 2016 on older adults aged 60 or above. The ETS was a random population-based telephone survey on 1000 older adults who could speak Cantonese in the households.[36] It included items focusing on primary care, health service utilization, and access to care were extracted from the 2014 Commonwealth Fund International Health Policy Survey of Older Adults. In ETS, 414 people aged 60 or above had two or more chronic conditions. The THS was a population-based household survey which collected data on different social and health topics since 1999. The data used for comparison in this study was collected from October 2011 to January 2012.[37] This THS included topics on health and healthcare utilization besides socio-demographic data on 10,065 out of a total of 13,411 sampled households with a response rate of 75% using face to face interviews. In total, 29,187 persons were interviewed. The survey did not include institutionalized residents, persons living on board vessels, foreign domestic helpers and hotel transients. It included 2301 people aged 60 or above with two or more chronic conditions.

The available data for comparisons between the current cohort and the two surveys are shown in Table 2. Chi-square tests were used for comparisons. It shows that the current cohort has

more females, relatively younger age, higher education level, fewer recipients of social security schemes, more chronic conditions, relatively better self-rated health, less smokers, and more out-patient clinic visits in the past year, while their marital, employment status, and number of hospitalisation in the past year were similar.

Follow-up

The patients will be followed-up regularly (interval of 2 years) to monitor changes in health status and outcomes by both questionnaire and physical assessments. The first follow-up (i.e., wave 2 assessment) started in early 2018. Additional information on mobility by the 30 second chair-stand test, visual acuity by Amsler Grid test and hearing by Weber's test and Rinne Test were added. Information on electronic medical records will also be updated to provide information on health outcomes including health service utilization, changes in medication use, and new onset of diseases and death.

Analysis plan

Based on the cohort aims, the analyses will include the following: 1) Longitudinal biopsychosocial health profiles of primary care patients with multimorbidity: 2) longitudinal association of multimorbidity (or common diseases or common disease combinations) and psychosocial factors such as pain, sarcopenia, cognition, depression, anxiety, insomnia, meaning of existence, loneliness and social network; 3) the longitudinal impact of multimorbidity on healthcare use, quality of life and mortality. In addition, further analyses would include but not limit to polypharmacy (health conditions and factors associated with polypharmacy); and associated factors of quality of life, mortality or a specific problem over time such as depression, anxiety, insomnia, loneliness, perceived meaning of existence, self-rated health, frailty, pain, sarcopenia, cognitive impairment, incontinence, oral health, social support.

Discussion

This is one of the few etiological cohorts on older adults being conducted in Asian primary care settings to examine physical, psychological and social factors associated with multimorbidity. It has been estimated that by 2030, 66% of the global disease burden will be due to non-communicable disease, with most of the burden occurring in the most populous area – Asia.[38 39]

Previous studies[40-43] examined factors associated with multimorbidity in primary care and found that poor mental well-being (depression, anxiety, insomnia, loneliness) were associated with the presence of multimorbidity and it was also found that depression, anxiety, insomnia and loneliness was also prevalent as shown in our findings.

In the present study, we found that those who suffered from multimorbidity had the psychological problems are common, including more than 10% suffering from mild cognitive impairment, more than half suffering from chronic physical pain involving two body parts and with almost 20% with either depressive or anxiety symptoms. Moreover, sleep disturbance appears to be common with almost half being assessed reported significant sleep related symptoms.

It is well established that people with multimorbidity have reduced quality of life. Previous studies[44-46] showed that people with multimorbidity have significantly reduced quality of life. In the current cohort, the majority of patients rated their quality of life as being low comparing to the general public.[35] Self-reported quality of life has been shown to be a good predictor of mortality.[47] Our findings suggest that people with multimorbidity have complex health needs in physical, mental and social aspects such as multiple body pain, depression, anxiety, insomnia and loneliness.

We show that in additional to their physical chronic conditions, older adults with multimorbidity are also affected by significant psychological and social problems. A holistic approach that addresses general physical and functional domain of health, at the same time assessing and managing psychological and social problems may be needed to look after older adults with multimorbidity.

Strengths and Limitations

This cohort has several strengths. First, it covers a lot of biopsychosocial factors which are not included in other previous large-scale cohorts only with extracted medical or insurance records. Second, the sample size is relatively large allowing exploration of associated factors and changes in common health problems among elderly populations with multimorbidity. Third, this is one of the very few cohorts based on primary care patients with multimorbidity and to our knowledge is a unique one among Chinese populations. Fourth, as this is relatively stable cohort, it will allow us to follow-up them in the very long term with the support from doctors and nurses, as well as the use of clinical management system information.

Since only those who agreed to participate in the current study were recruited, the limitation is that the prevalence of various health issues may not be representative of the general older adult population with multimorbidity. However, we have compared the demographics of this cohort to those of the older adults in two population-based surveys and found that the distribution of age, socio-economic status and lifestyle factors such as smoking suggesting that people in the current cohort were more females, younger, with higher education level, higher social status, more number of chronic conditions, relatively better self-rated health and less smokers, which might be a result of voluntary participation in the study. The sample size may then have been too small to examine factors associated with multimorbidity in some subgroups such as older men and people with lower educational levels. Second, only ambulatory adults were included in this study and our findings are therefore only be applicable in ambulatory old adults in primary care.

Collaboration

The authors warmly welcome collaborations. For those who would like to request for the data or propose new assessments into the follow-up assessments, they can email to: [yeungshanwong@cuhk.edu.hk]. For more information please see the website: http://cpcp.sphpc.cuhk.edu.hk/chi/.

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Table 1 Core topic areas in questionnaires and examinations in the

Assessment	Description
Questionnaire	
Use of medication	number and duration (0-1 year/2-5 years/>5 years) for antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics
Compliance of medication use	"At times, do you forget to take your prescription medications?" (no/yes)
Depression	The 2-item Patient Health Questionnaire (PHQ-2) for depression; The 9-item Patient Health Questionnaire (PHQ-9) for those with PHQ-2 ≥ 3
Anxiety	The 2-item Genralised Anxiety Disorder (GAD-2); The 7-item Generalised Anxiety Disorder (GAD-7) for those with GAD-2 ≥ 3
Loneliness*	De Jong Gierveld Loneliness Scale; and one question asking "Do you feel lonely? (Yes/No)" (added at a later stage)
Insomnia	The 7-item Insomnia Severity Index (ISI) for those answered yes to the screening question "In the past two weeks, do you have insomnia? (Yes/No)"
Pain	A screening question of "In the past year, do you have musculoskeletal pain for at least 3 months", for those who answered 'yes, one pain area or 'yes, two or more pain areas', Brief Pain Inventory (BPI) was measured.
Physical activity	For those were screened positive in pain, Physical Activity Scale for the Elderly (PASE) was measured
Self-rated health	"In general, how will you describe your health? (extremely good, very good or good/fair/poor)
Community network	"When you need help, do you have someone who is willing to and able to meet your needs?" (always/sometimes/never)
Meaning of existence*	One item extracted from the validated reliable Chinese Purpose in Life test (CPIL)
Use of social media	A screening question of "In the past two weeks, have you ever used the following social media", for those who answered yes to any of the social media, they were further assessed with importance and comfort of using internet.
Oral health*	"Do you have any difficulty when biting or chewing foods (even with the use of denture)" (yes/no)
Incontinence*	"Do you have incontinence?" (yes/occasionally/no)
Frailty*	The Edmonton Frail Scale

Sarcopenia*	The 5-item Sarcopenia Assessment (SARC-F)
Cognition	Mainly assessed with Montreal Cognitive Assessment Hong Kong version (HK-MoCA) but in an earlier stage, Abbreviated Memory Inventory for Chinese (AMIC) was used.
Quality of life	The EuroQol EQ-5D-5L (EQ5D)
Daily Function	Instrumental Activities of Daily Living (IADL) including ability to use telephone, mode of transportation, shopping, food preparation, ability to handle finances
Use of health services	Visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare cost both in private and public in the past year
Alcohol use	The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who drank alcohol in the past year
Tobacco use	One question asking for current, ex- and non-smoking behavior
Caregiving to somebody else	"Are you taking care of somebody?" (Yes/No)
Social economical status	Age, gender, marriage, living status, employment, receiving of social welfare scheme
Physical examination	
Blood pressure	Measured twice in 15 minutes after rest
Weight, height and BMI	
Waist circumference	
Handgrip strength	Each hand was measured twice
Electronic health record and self-report data	
Chronic diseases	43 common chronic conditions in fifteen categories including diseases of metabolic system, cancer, heart, respiratory system, liver and gallbladder, stomach and intestine, musculoskeletal and connective tissue, kidney and reproductive system, ear nose and throat (ENT), eye, blood, nervous system, mental disorders and others
Use of medication	Medication use number and duration (0-1 year/2-5 years/>5 years) for antihypertensive drugs, cardiovascular drugs, cholesterol-lowering drugs, antidiabetics, antipsychotics and analgesics

* Measures were added at later stages: about 712 to 995 patients received these measures.

Table 2 Baseline characteristics of the elderly with multimorbidity in the cohort (n=1080) and comparison with another two population-based surveys

	Multimorbidity Cohort	Elderly Telephone Survey		Thematic Household Survey 2011	
Characteristics	**N=1080**	**N=414**	**p**	**N=2301**	**p**
Female	69.9%	67.4%	0.3483	55.7%	<0.001
Age (mean, sd)	70.0 (6.8)				
60-64	21.8%	15.5%	<0.001	18.4%	<0.001
65-69	32.8%	18.8%		16.8%	
70-74	22.7%	20.5%			
75-79	11.7%	12.6%		64.8%	
80 or above	11.0%	32.6%			
Marriage					
married	67.4%	74.2%	<0.001	61.1%	<0.001
single/divorced/separated	9.6%	2.2%		7.4%	
widowed	23.1%	23.4%		31.4%	
No. of children (mean, sd)	2.52 (1.47)				
Living alone	14.1%			18.9%	<0.001
Employment					
Retired/ Housewife	91.9%			92.4%	0.629
Employed	8.1%			7.6%	
Education (year, mean, sd)	7.7 (4.6)				
Year of education ≥ 6 years	49.3%	30.7%	<0.001	31.6%	<0001
Social security receipient	58.6%	75.8%	<0.001		
Comprehensive Social Security Assistance (CSSA) Scheme	10.2%	5.3%	0.003	10.7	0.628
Fruit Voucher	46.4%				
Disability allowance	3.5%	2.9%	0.551	2.4%	0.062
Other	0.5%				
Caregiving to somebody	17.5%				
Number of chronic conditions (mean, sd)	4.1 (1.8)				
2 diseases	19.5%	64.5%	<0.001	47.4%	<0.001
3 diseases	26.4%	25.8%		29.7%	
4 diseases	19.8%	6.8%		13.1%	
5 disease	14.4%	2.2%		6.1%	
6+ disease	19.8%	0.7%		5.4%	
Chronic conditions by category					
Metabolic diseases	83.6%				
Cancer	9.0%				
Cardiovascular diseases (CVD)	16.9%				
Respiratory disease	7.2%				
Liver disease	9.5%				
Gastrointestinal disorders	26.8%				
Musculoskeletal disorders (MSK)	60.4%				
Thyroid disease	7.3%				
Renal disease	11.7%				
ENT	9.0%				
Eye	26.3%				
Skin	9.5%				
Anemia	3.0%				
Neurological disease	0.8%				
Mental illness	14.9%				
Self-rated health					
Excellent/very good/good	28.4%	25.8%	<0.001	29.2%	<0.001
Fair	59.2%	52.7%		52.7%	
Poor	12.4%	21.5%		18.2%	

Use of medication	
Antihypertensive drugs (mean, sd)	1.1 (0.9)
Percentage of patients who use	71.0%
Cardiovascular drugs(mean, sd)	0.2 (0.5)
Percentage of patients who use	15.3%
Antidiabetics(mean, sd)	0.4 (0.8)
Percentage of patients who use	25.3%
Cholesterol-lowering drugs(mean, sd)	0.4 (0.5)
Percentage of patients who use	41.6%
Antipsychotics (mean, sd)	0.2 (0.7)
Percentage of patients who use	10.6%
Analgesics (mean, sd)	0.1 (0.5)
Percentage of patients who use	10.8%
Total number of medication (mean, sd)	2.4 (1.9)
% forgetting taking medication (n=995)	37.1%
Quality of life (EQ5D-5L)	
Index score (range: -0.864 to 1)	-0.6 (0.2)
visual analogue scale (VAS) (0-100)	67.0 (14.8)
Depression	
PHQ-2	1.2 (1.5)
Screen (-) (<3)	80.9%
Screen (+) (≥3)	19.1%
PHQ-9 (mean, sd) [a]	11.3 (4.4)
Normal (0-4)	81.2%
Mild (5-9)	7.4%
Moderate (10-14)	6.8%
Moderately severe (15-19)	3.4%
Severe (20+)	1.2%
Anxiety	
GAD-2 (≥3) (mean, sd)	1.2 (1.5)
Screen (-) (<3)	83.0%
Screen (+) (≥3)	17.0%
GAD-7 (mean, sd) [b]	10.7 (3.9)
Very mild (0-4)	0.7%
Mild (5-9)	6.3%
Moderate (10-14)	7.7%
Severe (15+)	2.3%
Loneliness (n=741)	
One question (yes/no)	
No	72.3%
Yes	27.7%
De Jong Gierveld Loneliness Scale	
Total loneliness score (mean, sd)	1.64 (1.76)
Emotional loneliness score (mean, sd)	0.90 (1.02)
Social loneliness score (mean, sd)	0.74 (1.25)
Insomnia	
Insomnia in the past 2 weeks	
No	33.4%
Yes	66.6%
ISI (n=719) (mean, sd) [c]	11.5 (5.0)
No clinically significant insomnia (0-7)	48.4%
Subthrehold insomnia (8-14)	30.4%
Clinical insomnia, moderate severity (15-21)	20.0%
Clinical insomnia, severe (22-28)	1.2%
Social Support (can count on someone willing and able to meet your needs)	
Always	62.6%
Sometimes	30.7 %
Never	6.7%
Oral Health Problem (n=995)	24.1%
Incontinence (n=995)	

No	79.6%				
Occasionally	18.9%				
Yes	1.5%				
Pain					
Muscle-skeletal pain for at least 3 months in the past year					
No	24.8%				
Yes, one pain area	10.8%				
Yes, two or more pain areas	64.4%				
Brief Pain Inventory (BPI) [c]					
Interference (n=812)	4.5 (1.9)				
Severity (n=813)	2.7 (2.1)				
Physical Activity Scale for the Elderly (PASE) (n=812) [d]					
Mean (SD)	80.3 (43.3)				
Use of social media in last 2 weeks					
Yes	52.5%				
Web	24.6%				
Whatsapp	50.8%				
Facebook	17.2%				
Blog	2.2%				
E-literacy (n=566) [e]	25.0 (12.0)				
Importance of social media (total score: 6-24)	11.1 (4.8)				
Comfort of using social media (total score: 3-18)	8.2 (4.5)				
Frailty					
Edmonton Frail Scale (EFS) (mean, sd) (n=992) [f]	3.4 (2.2)				
No frailty (0-5)	82.5%				
Apparently vulnerable (6-7)	12.3%				
Mild frailty (8-9)	4.1%				
Moderate frailty (10-11)	1.0%				
Severe frailty (12-18)	0.1%				
Sarcopenia (mean, sd) (n=719) [f]	1.2 (1.5)				
Positive (≥4)	7.9%				
Negative (0-3)	92.1%				
Daily function (Percentage of patients needing help or being dependent)					
Using telephone	0.8%				
Transportation	4.3%				
Shopping	5.5%				
Preparing meals	6.8%				
Financial management	3.5%				
Total	10.3%				
Alcohol use					
Yes, in last 12 months	12.6%				
AUDIT-C [g]					
AUDIT-C positive (>=3)	4.4%				
Smoke					
Never smoke	86.1%			79.6%	<0.001
Smoke	2.7%			7.2%	
Quit smoke	11.2%			13.3%	
Meaning (0-7)	4.8 (1.2)				
Cognition [h]					
AMIC (mean, sd) (n=338)	2.1 (1.7)				
AMIC Positive % (>=3)	37.3%				
HK-MOCA (n=787)	24.9 (4.0)				
HK-MOCA Abnormal % (<22)	15.9%				
Health care utilization in the past year					
Hopitalisation fequency					
0	83.0%	82.2%	0.702	82.4%	<0.001

1	15.3%	17.8%	11.4%	
2+	1.8%		6.2%	
Hospitalisation Length (days, mean, sd)	1.2 (6.2)			
Specialist Out-patient Clinics (SOPC)	69.6%		84.2%	
General Out-patient Clinics (GOPC)	91.0%			<0.001
Elderly day care service	9.6%			
Cost (out of pocket) (HKD) median (interquartile range, IQR)	1000 (0, 3000)			
Physical examinations				
Blood pressure (BP)				
Systolic (mean, sd)	133.5 (15.7)			
Diastolic (mean, sd)	75.9 (9.9)			
Normal (SBP <120 & DBP <80)	17.9%			
Pre-hypertension (SBP: 120-139 or DBP: 80-89)	46.5%			
Stage I hypertension (SBP: 140-159 or DBP: 90-99)	30.3%			
Stage II hypertension (SBP ≥ 160 or DBP ≥ 100)	5.3%			
Pulse (per minute)	72.7 (22.4)			
Weight (kg, mean, sd)	60.2 (10.4)			
Height (cm, mean, sd)	157.4 (8.2)			
Waist circumference (cm, mean, sd)	90.2 (9.9)			
Body mass Index (BMI) (mean, sd)	24.2 (3.6)			
Underweight (<18.5)	3.7%			
Normal (18.5-22.9)	35.6%			
Overweight (23-24.9)	22.1%			
Obese (≥ 25)	38.6%			
Handgrip strength (kg) [i]				
Left hand (mean, sd)	20.1 (6.6)			
Right hand (mean, sd)	21.1 (6.8)			
Both hand (mean, sd)	21.9 (6.7)			

Inclusion Criteria of participants in the Elderly Telephone Survey and Thematic Household Survey 2011): 1) age ≥ 60; 2) number of chronic conditions ≥ 2. Chi-square tests were used for comparisons between the current cohort and the two surveys.

Abbreviations: GAD-2: the two-item General Anxiety Disorder scale; HK-MoCA: Montreal Cognitive Assessment Hong Kong version (HK-MoCA); ISI: the 7-item Insomnia Severity Index; EQ5D: the EuroQol EQ-5D-5L; PHQ-2: The two item Patient Health Questionnaire for depression; The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C); SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Notes:

[a] Mean (SD) was for 206 patients who did PHQ-9. The % was for all the 1080 patients with the rest 874 patients who screened negative in PHQ-2 regarded as having normal scores in PHQ-9.

[b] Mean (SD) was for 184 patients who did GAD-7. The % was for all the 1080 patients with the rest 896 patients who screened negative in GAD-2 regarded as having normal scores in GAD-7.

[c] 719 patients were assessed with ISI. 361 patients who were screened negative in the screening question, was regarded as having no clinically significant insomnia.

[d] Only those who had one or more pain areas in the past 3 months were assessed with BPI or PASE-C.

[e] Only those who had social media use in the past 2 weeks were assessed.

[f] Measured by the 5-item Sarcopenia Assessment (SARC-F) which were added at a later stage.

[g] N=136, those who did not drink alcohol the past 12 months were regarded as 0 in AUDIT-C.

[h] HK-MOCA replaced AMIC in a later stage.

[i] Better result of two series for left or right hand, or best result of both hands.

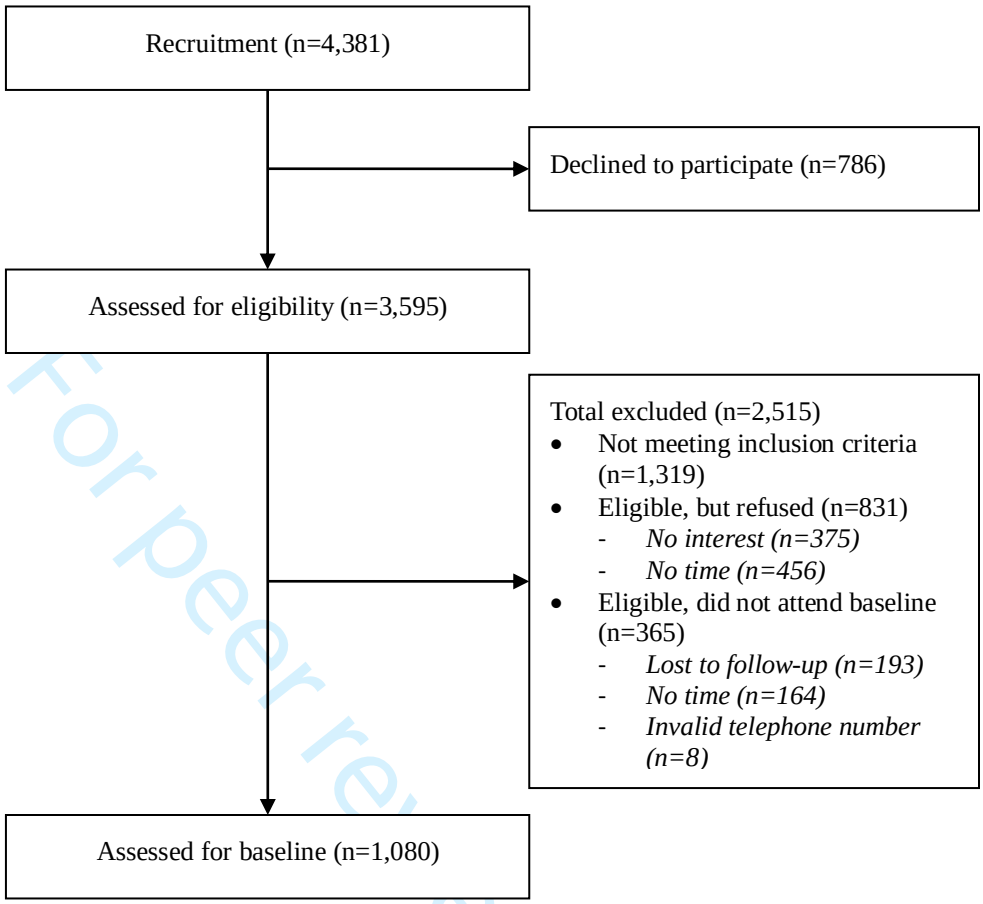

Figure 1 Flowchart of recruitment

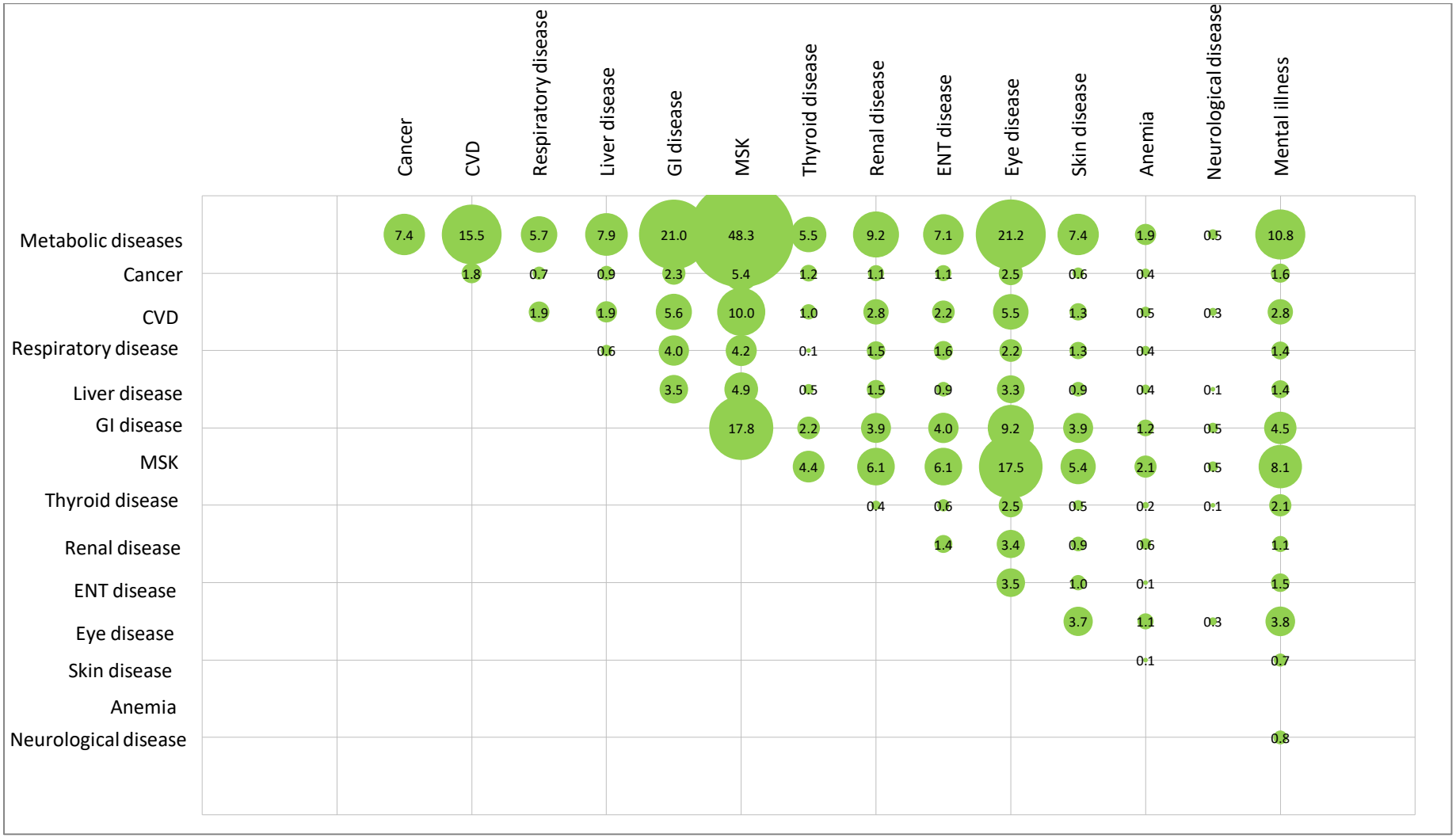

Figure 2 Prevalence of co-morbidities (by 15 disease categories) among the 1080 elderly with multimorbidity

(Figures are prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

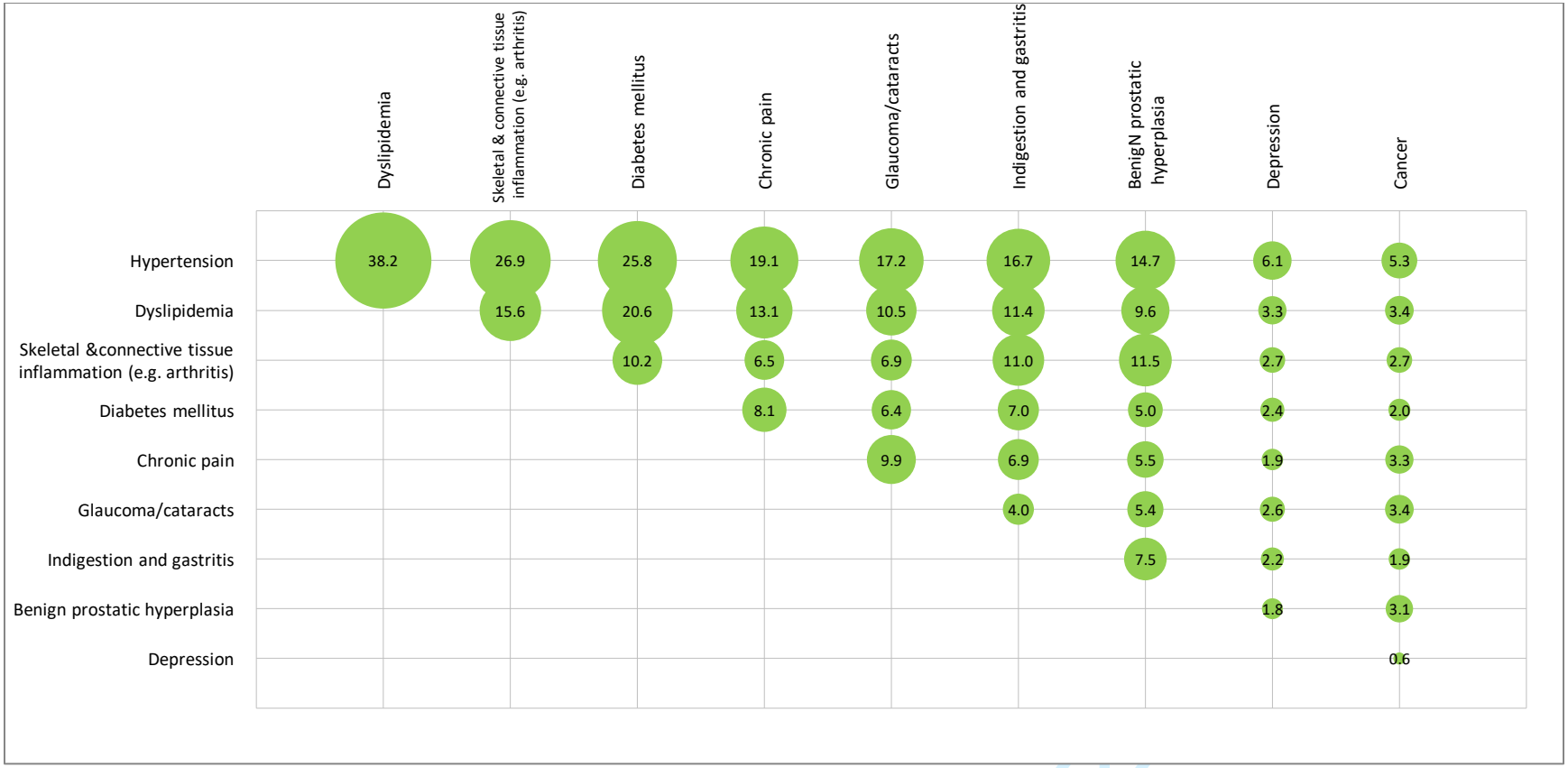

Figure 3 Prevalence of the top 10 co-morbidities (out of 43 specific chronic conditions) among the 1080 elderly with multimorbidity

(Figures are prevalence (%))

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4–5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7, 10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5-6, 10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7, Table 1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7, Table 1
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	5-6, Figure 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	NA
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7, Table 2
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	Table 2
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1

Descriptive data		14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-10, Table 2
			(b) Indicate number of participants with missing data for each variable of interest	Table 2
			(c) Summarise follow-up time (eg, average and total amount)	10
Outcome data		15*	Report numbers of outcome events or summary measures over time	8-10, Table 1
Main results	16		(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
			(*b*) Report category boundaries when continuous variables were categorized	Table 2
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion				
Key results	18		Summarise key results with reference to study objectives	10-11
Limitations	19		Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20		Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-12
Generalisability	21		Discuss the generalisability (external validity) of the study results	12
Other information				
Funding	22		Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Secondary Subject Heading:	Epidemiology, Evidence based practice, General practice / Family practice, Geriatric medicine, Health services research
Keywords:	Chronic conditions, Comorbidities, Older Adults, General practice, Physical, Psychological and Social Factors, PRIMARY CARE

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Biopsychosocial health profile of Chinese elderly with multimorbidity in Hong Kong

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Patient consent Obtained

Ethics approval Compliance with Ethical Standards. Ethics approval was obtained from the Joint Chinese University of Hong Kong – New Territories East Cluster Clinical Research Ethics Committee (The Joint CUHK-NTEC CREC).

Conflict of Interest None declared

Contributors SYSW conceived and supervised the study and revised the manuscript. DXZ contributed to study design, analyzed the data, prepared the draft and revised the manuscript. SRWS and CW contributed to the study design and implementation, and manuscript revisions. DZ contributed to data collection and manuscript revisions. SWM and MJ contributed to manuscript revisions.

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ABSTRACT

Objectives

To examine the biopsychosocial health profile of elder patients with multimorbidity in Hong Kong.

Design

Cross-sectional study, with results weighted according to the census.

Setting

Four public primary care clinics in Hong Kong.

Participants

A total of 1077 patients aged 60 years or above with at least two chronic diseases.

Primary and secondary outcome measures

Biopsychosocial health indicators (primary), healthcare utilization and quality of life (secondary).

Results

After weighting, they had 4.1 (1.8) chronic conditions and 2.5 (1.9) medications on average; 37% forgot taking medication sometimes; 71% rated their health as fair or poor; 17% were frail; 73% reported one (21%) or two or more (52%) body pain areas; 62% were overweight/obese; 23% reported chewing difficulty, 18% reported incontinence; 36% had current Stage 1/2 hypertension; 38% had handgrip strength below the cut-off; 18% screened positive in sarcopenia; 12% had mild cognitive impairment; 17% had mild depression or severer; 17% had mild anxiety or severer; 50% had sub-threshold insomnia or severer; 28% indicated being lonely; the EQ-5D-5L index score was 0.81 (0.20) and visual analogue scale (VAS) score was 67.6 (14.6); 12% needed help in at least one out of the five daily functions. In the past 12 months, 17% were hospitalized, 92% attended general out-patient clinics (GOPC), 70% attended specialist out-patient clinics (SOPC), and 10% used elderly daycare center services, the median out-of-pocket health cost was 1000 HK$ (US$150). Female and male patients showed significant differences in many biopsychosocial health aspects.

Conclusions

The weighted results might have underestimated the situation in elder primary care patients and be close to the situation of the general elderly. In addition to physical problems, elder primary care patients with multimorbidity are also affected by significant psychological and social problems. A holistic approach addressing physical, psychological and social health problems is greatly needed.

Study Registration ChiCTR-OIC-16008477

Key Words:

Chronic conditions; Comorbidities; Older Adults; General practice; Physical, Psychological and Social Factors; Primary Care

Strengths and limitations of this study

- The study examines biopsychosocial health problems encountered by Chinese elderly with multimorbidity in a primary care program in Hong Kong. The results were weighted according to the census data. The information could be helpful to healthcare providers, policy makers and researchers.
- The data could be linked with health electronic records to allow follow up and examination of long-term outcomes associated with multimorbidity.
- The limitation was that older adult patients who were male, disabled, very ill, institutionalized, or house-bounded were less likely to have participated in this study; and a few assessments were only conducted within subgroups or added at a later stage. The weighted rates might be an underestimation of the rates among the primary care patients and be close to the rates of the general population.

INTRODUCTION

Multimorbidity, defined as having two or more chronic health conditions, is common in primary care. The prevalence has increased in recent decades as a result of an aging population and changes in lifestyles e.g. more sedentary lifestyles which have increased the risk of obesity, resulting in a higher risk of developing chronic conditions.[1 2] A recent systematic review suggests that the prevalence of multimorbidity is high among the elderly ranging from 12.9% to 95.1% in different studies.[3] Multimorbidity is associated with increased disability and depression, reduced quality of life, and higher rates of adverse drug consequences.[4] Multimorbidity also leads to increased primary and secondary health service utilization, especially unplanned health care, as well as reduced life-expectancy.[5] The direct and indirect economic burden associated with multimorbidity is huge.[6] The annual healthcare costs were €4,096.86 among patients with 5 or more chronic conditions, which was almost 5 times more than those who were healthy in a study in the West of Ireland.[7] It has been estimated that by 2030, 66% of the global disease burden will be due to chronic diseases, with most of the burden occurring in the most populous area – Asia.[8 9] The economic burden highlights an urgent need to search for cost-effective ways to manage patients with multimorbidity, given that treatment of diseases in isolation can be inefficient, leading to duplication of care and poorer health outcomes.[10]

Studies of multimorbidity have increased in recent years,[11-20] and a clinical guideline on clinical assessment and management of multimorbidity was developed by the National Institute for Health and Care Excellence (NICE) in the UK in 2016.[21] However, studies are still needed for the epidemiology and profiles of patients with multimorbidity and their longitudinal outcomes to inform policy making in different populations including Chinese primary care patients.[3 22] Most studies on primary care patients with multimorbidity are conducted in western countries such as UK, USA, Australia, Spain and Belgium,[14 15 23-29] and limited research has been conducted on psychological and social problems accompanying with multimorbidity.[3 21 22 30 31] Several longitudinal studies of multimorbidity have been conducted in Asian populations,[32-34] but none of these are of primary care patients. Important knowledge gaps still exist regarding the biopsychosocial health profiles of elderly people with multimorbidity in primary care in Asian Chinese elderly.[35] Therefore, more studies among Chinese elderly with multimorbidity in primary care are needed to advance our understanding for services. [14 36-40]

This study focuses on the elderly in Hong Kong, where the population is ageing rapidly. Hong Kong has a population of 7.34 million according to the 2016 census data, with 23.7% aged 60 years or above. This was higher than the proportions in 2006 (16.5%) and 2011 (19.5%).[41] In Hong Kong, although there is a large private primary care sector, around 85% of people with chronic conditions are managed in the public primary care setting. Given that the Hong Kong population has the longest life expectancy in the world: (81.7 for men and 87.7 for women in 2017),[42] the ageing population and multimorbidity have brought much burden and challenge to the local healthcare system. To inform healthcare providers and policymakers in providing suitable health services for people with multimorbidity in primary care, the present study aimed to study the biopsychosocial health profiles of Chinese patients with multimorbidity who present to public primary care in Hong Kong.

METHODS

Study design

This cross-sectional study reports the baseline data of a primary care programme for multimorbidity in Hong Kong.

Study setting and participants

This study contains primary care patients from four general out-patient clinics (GOPCs) out of the ten general out-patient clinics (GOPCs) in the New Territory East Cluster (NTEC), Hong Kong, as permission to recruit from these four was given by the local regulator (the Hospital Authority). Each GOPC sees about 450 patients each day. The working hours are generally from 9:00 am to 5:00 pm from Monday to Friday with some additional night and weekend sessions. In the most recent Hospital Authority Annual Report 2016-2017, the ten GOPCs in NTEC provided 972,454 consultations in total in the year of 2015/2016, which consisted of one third of total GOPC consultations in Hong Kong public health system.[43]

The inclusion criteria of participants were: 1) aged 60 years or above; 2) with two or more chronic diseases confirmed by the medical information in the public Clinical Management System (CMS) and patients' self-report; and 3) could speak and understand Chinese. No specific exclusion criteria were adopted. However, as participants needed to respond to questionnaire surveys and

health checks, they should be able to access the clinic, sign informed consent by themselves, and understand and answer the research questions.

Patients were first consecutively screened for eligibility by trained research assistants in the waiting areas of the GOPCs. For those who were eligible, they were asked to provide a contact phone number and then were scheduled to visit the study nurse for further assessments. All patients provided informed consent before participation in the study. From April 2016 to October 2017, 1077 eligible patients were recruited and completed the baseline assessments. The sample size allowed a margin of error at 3% with a confidence interval of 95%. The flowchart of recruitment is shown in **Figure 1**. The baseline assessments were conducted through face-to-face interviews by nurses or a social worker at a university affiliated primary care clinic.

Measurements

The assessments covered a range of measures that are postulated to be potential physical, psychological and social factors associated with multimorbidity. Each complete assessment lasted for about 45 to 60 minutes. All the measures were validated and have been widely used or have been used in our previous studies. Information was collected through face-to-face interviews by trained nurses and social workers, and additional information of the disease entities, medication use and health service utilization was confirmed through the review of electronic medical records by nurses. The electronic medical records include patient information and diagnosis, health examinations, medication prescription, and health visits to the public health system. The records cover all patients who seek medical services in public health system. It is a medical record system of routine clinical practices with quality ensured by all healthcare professionals including trained doctors, nurses and allied health professionals under Hospital Authority in Hong Kong.

The measures in the questionnaires included: 1) the number and type of chronic diseases in fifteen categories (a total of 43 chronic conditionals) adapted slightly by a group of family physicians and researchers based on chronic conditions in previous studies[44 45] and the International Statistical Classification of Diseases 11 (ICD-11). Details can be seen in Table 1; 2) depression (screened by the 2-item Patient Health Questionnaire (PHQ-2)).[46] Those with a score of 3 or more (which suggests depression) were further measured by the 9-item Patient Health Questionnaire (PHQ-9);[47] 3) anxiety (screened by the 2-item Generalised Anxiety Disorder (GAD-2)). Those with a score of 3 or more (which suggests anxiety) were further measured by the 7-item

Generalised Anxiety Disorder (GAD-7);[48] 4) loneliness (measured by the 6-item De Jong Gierveld Loneliness Scale),[49] as well as one loneliness question; 5) insomnia (measured by the 7-item Insomnia Severity Index (ISI))[50] among those who answered yes to a screening question); 6) pain (measured by the Brief Pain Inventory among those who were screened positive in pain); 7) physical activity (measured by Physical Activity Scale for the Elderly (PASE)[51] among those who were screened positive in pain); 8) frailty (measured by the Edmonton Frail Scale[52] which was translated and back-translated by experienced bilingual translators); 9) meaning of existence (measured by one question extracted from the validated Chinese Purpose in Life test (CPIL) which was used in a previous study);[53] 10) sarcopenia (measured by the 5-item Sarcopenia Assessment (SARC-F));[54 55] 11) cognition (measured by the Hong Kong Montreal Cognitive Assessment (HK-MoCA) with a score of 22 or above being with normal cognition);[56] 12) alcohol use (screened by one question and then measured by the 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who screened positive); 13) smoking (non-smoker, current smoker, ex-smoker); 14) medication use (number and duration (0-1 year/2-5 years/>5 years) of antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics was checked in electronic medical system, and compliance of medication use was measured by "At times, do you forget to take your prescription medications?" (no/yes)); 15) self-rated health; 16) community network; 17) use of social media (measured by a screening question, and for those who answered yes to any of the social media, they were further assessed on the importance and comfort of using the internet); 17) oral health; 18) incontinence; 19) caregiving to somebody; 20) quality of life was measured by the EuroQol EQ-5D-5L (EQ5D);[57] 21) daily function (ability to use the telephone, mode of transportation, shopping, food preparation, ability to handle finances were measured); 22) health service utilization was based on visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare costs which were not covered by public health system or insurance both in private and public in the past year. In addition, physical examinations included blood pressure, Body Mass Index (BMI), waist circumference and handgrip strength (kg). For blood pressure, two assessments were taken by the nurses. Patients sat for at least 5 minutes before the first assessment, and they were assessed again 15 minutes later. Handgrip strength was also assessed twice for each hand. Social economic status such as age, gender, marriage, living status, employment, receiving of social welfare scheme was also included. Due to the data collection plan

amendments, some measures were only collected in a sub-group of the patients at a later stage. Summaries of the baseline measures are described in **Table 1**.

The questionnaire was set up in password protected EpiData files in a password protected computer with quality control. For example, for scale questions with answers on a Likert scale of 1 to 5, a range of 1-5 and one digit was set up so no other results were allowed during data entry. Additionally, for most data variables, a "must enter" was set up, so that the question could not be missed unless answered or an individual purposely moves to the next question. Checking for missing data was done regularly by experienced researchers and missing data was further collected by nurses through face-to-face interviews, telephone or by checking the electronic medical record system.

Data analysis

Data was described using mean (standard deviation), median (interquartile range) and percentages. Differences between male and female patients were analyzed. Chi square tests were used for analyzing categorical variables. T tests and non-parameter tests were used for analyzing continuous variables with normal and non-normal distributions, respectively. The results were further weighted according to age, gender, and marital status of the elderly aged 60 or above based on the Hong Kong 2016 Population By-census data from the Census and Statistics Department of Hong Kong government.[58] Linear regression and logistic or ordinal regression was used for analyzing gender differences with the weighted data for the continuous and categorical results, respectively. Stata 12 and SPSS 20 were used for data analysis. P values $\leq$ 0.05 (two sides) were regarded as statistically significant.

Patient and Public Involvement

The research questions and outcome measures were developed based on health and social problems which are widely regarded as common in older people. Patients or the public were not involved in the design of the study, recruitment or conduction of the study. The results of the study will be disseminated to patients if he or she requests so, and aggregated data will be reported in project reports, research publications and conferences.

RESULTS

Participants

Baseline characteristics of the patients in the study are shown in **Table 2**. The weighted data are shown in the bracket beside the unweighted data. The mean age of the study patients was 70 (SD=6.8) (70.5, SD=7.9) years, 70% (52.8%) were female, 67% (68%) were married, 14% (15%) lived alone, 92% (87%) were retired or housewives, 49% (52%) had 6 years of education or above, 10% (10%) were on the Comprehensive Social Security Assistance (CSSA) scheme which is open for those with a low income, about half used social media in the last 2 weeks, about 18% (15%) provided care to another (such as their spouse or children/grandchildren), 12% (17%) had drank alcohol in the past year and 3% (4%) were current smokers. More female patients lived alone, were retired/housewives, had lower education, and had more social security support than male patients (p values < 0.05).

Chronic conditions

After weighting, overall, the mean number of chronic diseases was 4.1 (SD=1.8) and about one in five patients had 6 or more chronic diseases. The top three chronic conditions were hypertension 75%, dyslipidemia (46%), and skeletal and connective tissue inflammation (e.g. arthritis) (36%). The unweighted and weighted prevalence of co-morbidities of the 15 disease categories among the patients is shown in **Figure 2a** and **Figure 2b**, respectively. The unweighted and weighted co-morbidities of top 10 prevalent conditions out of the 43 conditions are shown in **Figure 3a** and **Figure 3b**, respectively, with the combination of hypertension and dyslipidemia being the most common (39% of the patients), followed by hypertension and diabetes mellitus (27%), hypertension and skeletal and connective tissue inflammation (e.g. arthritis) (26%), dyslipidemia and diabetes mellitus (21%), hypertension and chronic pain (20%). Information of the rest co-morbidities is shown in the figures. Female patients had fewer number of chronic conditions, fewer number of medications in use but poorer self-rated health than male patients (p values < 0.05).

Biopsychosocial profile and quality of life

After weighting, the mean BMI was 24.3 (SD=3.4) with 61% being overweight or obese. Based on the Edmonton Frail Scale, 17% were frail. Eight percent had sarcopenia, 23% reported chewing difficulty, 18% reported incontinence, 36% had stage one or two hypertension currently according

to the physical examination, 38% had their handgrip strength (based on the best outcome of two trials of both hands) below the cut-off point, 12% needed help or were dependent in at least one out of the 5 daily functions (using telephone, transportation, shopping, preparing meals, or financial management). Overall, 30%, 59% and 11% of patients rated their health being 'excellent/very good/good', 'fair', or 'poor' respectively. Seventy-three percent reported the presence of one (21%) or two or more (52%) body pain areas, 17% scored the HK-MoCA <22 suggesting at least mild cognitive impairment;18% had PHQ-2 ≥3, while 17% had PHQ-9 ≥5 suggesting mild depression or more severe; 15% had GAD-2 ≥3, while 16% had GAD-7 ≥5 suggesting mild anxiety or more severe; 50% had insomnia at subthreshold level or above, the mean score of the meaning of existence was 4.9 (SD=1.2) out of 7, 28% reported feeling lonely; the EQ-5D-5L index score was 0.81 (0.20) and its visual analogue scale (VAS) score was 67.6 (14.6) out of 100. More finding details can be seen in **Table 2**. More female patients had incontinence, pain, sarcopenia and cognitive impairment than male patients. Female patients were more likely to be screened positive in depression and anxiety, reported severer level of insomnia and reported lower perceived existence of meaning than male patients (p values < 0.05). More male patients used social media. The loneliness level and perceived social support were not significantly different between female and male patients. Female patients were more likely to be frail and have poorer quality of life.

Health service utilization

On average, patients took 2.5 (SD=1.9) medications, with 30% taking 5 or more medications regularly, 36% reported forgot taking medication sometimes. In the last year, 17% were admitted to hospital, 92% attended GOPC, 70% attended SOPC, 10% used elderly day care center services and the median out-of-pocket health cost was 1000 HK$ (US$150) for any health expenditures not covered by the public health system or insurance. Male patients reported more GOPC visits than female patients in the past year (p=0.007).

DISCUSSIONS

Key results

This is one of the few etiological studies on older adults being conducted in Asian primary care settings to examine physical, psychological and social problems accompanying with multimorbidity. The weighted results were in general similar to the unweighted results. The study results were overall in consistency with results reported in the western populations, that biopsychosocial health problems are prominent among the elder adults with multimorbidity in primary care clinics in Hong Kong. Depression, anxiety, insomnia and loneliness were prevalent. Almost one fifth had either depressive or anxiety symptoms, and one quarter reported feeling lonely. Moreover, sleep disturbance appears to be common with almost half reporting significant sleep related symptoms. Some also showed cognition decline with more than one fifth suffered from mild cognitive impairment. In addition, we found that about one quarter of the patients were overweight and another one third were obese, about two thirds of the participants suffered from chronic physical pain involving two body parts, one quarter used 5 or more medications regularly and one third forgot using medications sometimes, one quarter had chewing difficulty, one fifth self-reported incontinence, more than one in ten reported being frail, and some had reduced handgrip strength and signs of sarcopenia. At least one in ten needed help in daily function. Our findings suggest that people with multimorbidity have complex health needs in physical, mental and social aspects such as obesity, multiple body pain, polypharmacy, depression, anxiety, insomnia and loneliness. We showed that in addition to their physical chronic conditions, older adults with multimorbidity were also affected by significant psychological and social problems.

Interpretation

The results suggested that a holistic approach that addresses general physical and functional domain of health, at the same time assessing and managing psychological and social problems is therefore needed in the care of older adults with multimorbidity. The biopsychosocial health problems may interact with each other in determining prognoses. For example, those with depression are less likely to continue with medical treatments for physical problems like diabetes.[59] [60] While good social support is a mediator buffering the effects of depression, social isolation and loneliness may lead to worse outcomes both mentally and physically.[61] Existing health services often focus on physical health but neglect the psychosocial aspects of patients. Given the high rates of psychosocial problems reported by patients, services which are designed to cater for the complex needs of elder patients with multimorbidity from biopsychosocial perspectives are

urgently needed. These models should also be adapted and tested in local circumstances to maximize its efficacy. Based on these findings, we have been designing and testing a model for tackling biopsychosocial health problems in Hong Kong. In addition, the patients in this study will be followed-up regularly to monitor changes in health status and outcomes by both questionnaire and physical assessments. The first follow-up started in early 2018. The longitudinal biopsychosocial health profiles of these primary care patients will be evaluated, as well as the longitudinal associations of psychosocial factors and multimorbidity, and the impact of biopsychosocial health status on different health outcomes, healthcare use, quality of life and mortality. Furthermore, given the significant differences found between male and female patients in biopsychosocial aspects, future interventions need also to take gender differences into account.

Strengths and Limitations

This study has several strengths. First, it covers a range of biopsychosocial factors which are not included in other previous large-scale studies since plenty of them are derived from extracted medical or insurance records. Second, this is one of the very few studies based on Chinese primary care patients with multimorbidity. Third, because it contains linked electronic medical records, it will allow us to follow them up for mortality and public medical service use. Fourth, the results were weighted according to the census data to make the sample more representative of the general population.

There are also several limitations. First, self-selection bias might still exist which was consistent with other similar studies,[62] although we used weighting for adjustment, as not all variables were available for weighting such as education. Since only ambulatory adults who agreed to join were recruited and these usually are more likely to be female and those with higher educational level and higher self-motivation, and those who were house-bound or institutionalized are less likely to have been included, we might have resulted in a relatively healthier and higher-functioning patients in primary care, and the real health status might be worse than what are reported in our study. Future studies may need to take measures to increase participation from male and vulnerable patients. Second, the sample size may limit examinations of potential interactions and factors associated with multimorbidity in some subgroups such as older men and people with lower educational levels, or uncommon health problems among these patients. Third, we used a two-step assessment for some health indicators. While false negative reported rates of

pain, insomnia and alcohol use were unlikely, there might be false negative rates for depression and anxiety as the specificity and sensitivity of PHQ-2 and GAD-2 were not 100% (although results from meta-analytic reviews suggest they are reasonable to use in initial screening).[63 64] In addition, as PHQ-2 and GAD-2 are often used for screening with results in dichotomies (negative/positive), this might limit application of some statistical analysis such as using growth models in future longitudinal data. Fourth, for a few assessments, we only conducted them among a subgroup of participants, e.g. PASE for physical activity among those patients with pain. Furthermore, some additional assessments such as meaning, sarcopenia, oral health were added at a later stage. So only subgroup data could be reported in this paper or analyzed in the future when using these data.

Generalizability

We might have resulted in a relatively healthier sample. After weighting according to age, gender and marital status based on the most recent census data in Hong Kong, the weighted results might be an underestimation of the real situation among elder primary care patients and be more representative of the situation of the older adults of the general population. The rates of health problems reported in our study might be an underestimation of the real situation among the elder primary care patients with multimorbidity in Hong Kong. Future analysis will need to consider this in the interpretation of findings.

Data availability statement

Data will be available upon reasonable request. The authors warmly welcome collaborations for future research based on this study. For those who would like to request for the data or propose new assessments into the follow-up assessments, they can email to: [yeungshanwong@cuhk.edu.hk].

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Table 1 Core topic areas in questionnaires and examinations of the study

Assessment	Description
Questionnaire	
Use of medication	number and duration (0-1 year/2-5 years/>5 years) for antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics
Compliance of medication use	"At times, do you forget to take your prescription medications?" (no/yes)
Depression	The 2-item Patient Health Questionnaire (PHQ-2) for depression; The 9-item Patient Health Questionnaire (PHQ-9) for those with PHQ-2 ≥ 3
Anxiety	The 2-item Genralised Anxiety Disorder (GAD-2); The 7-item Generalised Anxiety Disorder (GAD-7) for those with GAD-2 ≥ 3
Loneliness*	De Jong Gierveld Loneliness Scale; and one question asking "Do you feel lonely? (Yes/No)" (added at a later stage)
Insomnia	The 7-item Insomnia Severity Index (ISI) for those answered yes to the screening question "In the past two weeks, do you have insomnia? (Yes/No)"
Pain	A screening question of "In the past year, do you have musculoskeletal pain for at least 3 months", for those who answered 'yes, one pain area or 'yes, two or more pain areas', Brief Pain Inventory (BPI) was measured.
Physical activity	For those were screened positive in pain, Physical Activity Scale for the Elderly (PASE) was measured
Self-rated health	"In general, how will you describe your health? (extremely good, very good or good/fair/poor)
Community network	"When you need help, do you have someone who is willing to and able to meet your needs?" (always/sometimes/never)
Meaning of existence*	One item extracted from the validated reliable Chinese Purpose in Life test (CPIL)
Use of social media	A screening question of "In the past two weeks, have you ever used the following social media", for those who answered yes to any of the social media, they were further assessed with importance and comfort of using internet.
Oral health*	"Do you have any difficulty when biting or chewing foods (even with the use of denture)" (yes/no)
Incontinence*	"Do you have incontinence?" (yes/occasionally/no)
Frailty*	The Edmonton Frail Scale

Sarcopenia*	The 5-item Sarcopenia Assessment (SARC-F)
Cognition	Mainly assessed with Montreal Cognitive Assessment Hong Kong version (HK-MoCA) but in an earlier stage, Abbreviated Memory Inventory for Chinese (AMIC) was used.
Quality of life	The EuroQol EQ-5D-5L (EQ5D)
Daily Function	Instrumental Activities of Daily Living (IADL) including ability to use telephone, mode of transportation, shopping, food preparation, ability to handle finances
Use of health services	Visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare cost both in private and public in the past year
Alcohol use	The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who drank alcohol in the past year
Tobacco use	One question asking for current, ex- and non-smoking behavior
Caregiving to somebody else	"Are you taking care of somebody?" (Yes/No)
Social economic status	Age, gender, marriage, living status, employment, receiving of social welfare scheme
Physical examination	
Blood pressure	Measured twice in 15 minutes after rest
Body Mass Index (BMI)	
Waist circumference	
Handgrip strength	Each hand was measured twice
Electronic health record and self-report data	
Chronic diseases	43 common chronic conditions in 15 categories including: 1. Metabolic diseases (hypertension, lipid disorder, diabetes) 2. Cancer 3. Disease of the cardiovascular system (coronary heart disease, stroke/cerebrovascular disease, peripheral vascular disease) 4. Disease of the respiratory system (COPD, bronchiectasis, asthma, chronic pharyngitis /laryngitis) 5. Disease of the liver, spleen and gallbladder (gallbladder/spleen disease, viral hepatitis, chronic liver disease) 6. Disease of the stomach and intestines (dyspepsia and gastritis, diverticular disease of intestine, chronic enteritis; irritable bowel syndrome; constipation)

	7. Disease of the musculoskeletal and connective tissue (chronic pain needing medication control, skeletal and connective tissue inflammation (such as arthritis, gout)) 8. Disease of the genitourinary system (chronic kidney disease (nephritis), prostatitis, benign prostatic hyperplasia) 9. Disease of the ear, nose and throat (ENT) (chronic rhinitis, deafness/tinnitus) 10. Disease of the visual system (glaucoma/cataracts, blindness/amblyopia, diabetic eyes, retinal detachment) 11. Disease of the skin (eczema, psoriasis) 12. Disease of the blood (anemia) 13. Disease of the nervous system (multiple sclerosis, migraine, epilepsy, Parkinson's disease) 14. Mental disorders (schizophrenia/bipolar disorder, depression, anxiety & other stress related disorders, dementia) 15. Others
Use of medication	Medication use number and duration (0-1 year/2-5 years/>5 years) for antihypertensive drugs, cardiovascular drugs, cholesterol-lowering drugs, antidiabetics, antipsychotics and analgesics

* Measures were added at later stages: about 712 to 995 patients received these measures.

Table 2 Basic characteristics and biopsychosocial health profile of the elderly with multimorbidity in primary care in Hong Kong

	Un-weighted rates and analyses				Weighted rates and analyses			
Characteristics	**Female (n = 753)**	**Male (n = 324)**	**P values**	**Crude total %**	**Female (n = 568)**	**Male (n = 508)**	**P values**	**Weighted total %**
Female				69.9%				52.8%
Age (mean, sd)	69.6 (6.6)	71.1 (7.1)	<0.001	70.0 (6.8)	71.3 (8.4)	70.2 (7.9)	0.097	70.5 (7.9)
60-64	22.8%	19.8%	0.002	22.0%	28.8%	31.4%		30.2%
65-69	35.6%	26.5%		32.9%	22.9%	25.3%		24.0%
70-74	21.8%	24.4%		22.5%	12.5%	14.5%		13.4%
75-79	9.7%	16.4%		11.6%	12.1%	13.0%		12.5%
80 or above	10.1%	13.0%		11.0%	23.8%	15.7%		20.0%
Marriage			<0.001				<0.001	
married	57.9%	89.2%		67.3%	54.7%	82.9%		68.1%
single/divorced/separated	11.8%	4.3%		9.6%	10.9%	9.6%		10.3%
widowed	30.2%	6.5%		23.1%	34.4%	7.5%		21.7%
No. of children (mean, sd)	2.5 (1.6)	2.5 (1.2)	0.409	2.52 (1.47)	2.7 (1.9)	2.4 (1.3)	0.013	2.53 (1.6)
Living alone	16.5%	8.3%	<0.001	14.0%	18.4%	11.9%	0.004	14.6%
Employment								
Retired/ Housewife	96.0%	82.4%	<0.001	91.9%	95.8%	77.5%	0.000	86.9%
Employed	4.0%	17.6%		8.1%	4.2%	22.5%		13.1%
Education (year, mean, sd)	7.2 (4.7)	8.7 (4.1)	<0.001	7.7 (4.6)	6.5 (4.6)	8.9 (4.1)	<0.001	7.7 (4.5)
Year of education ≥ 6 years	46.8%	59.5%	0.001	49.3%	40.7%	63.2%	<0.001	51.8%
Social security recipient	58.1%	59.3%	0.726	58.6%	59.8%	50.5%	0.002	55.4%
Comprehensive Social Security Assistance (CSSA) Scheme	11.4%	7.1%	0.031	10.1%	12.3%	7.6%	0.011	10.1%
Fruit Voucher	44.7%	50.3%	0.089	46.4%	45.5%	41.5%	0.190	43.6%
Disability allowance	3.7%	3.1%	0.604	3.5%	3.9%	3.0%	0.426	3.5%
Other	0.5%	0,3%	0.621	0.5%	0.4%	0.3%	0.803	0.3%
Caregiving to somebody	18.9%	14.5%	0.118	17.6%	16.8%	13.0%	0.126	15.0%
Alcohol use								
Yes, in last 12 months	5.4%	29.3%	<0.001	12.6%	5.2%	29.8%	<0.001	16.8%
AUDIT-C [g]								
AUDIT-C positive (>=3)	1.4%	11.1%	<0.001	4.4%	1.5%	11.2%	<0.001	6.1%
Smoke			<0.001				<0.001	
Never smoke	97.1%	60.5%		86.1%	96.9%	60.3%		79.6%
Smoke	0.8%	7.1%		2.7%	0.8%	7.2%		3.8%
Quit smoke	2.1%	32.4%		11.2%	2.4%	32.5%		16.6%
Self-rated health							0.001	

Excellent/very good/good	26.0%	34.7%	<0.001	28.5%	26.8%	32.7%		29.5%
Fair	59.5%	58.4%		59.2%	58.6%	60.1%		59.3%
Poor	14.6%	6.9%		12.3%	14.7%	7.2%		11.2%
Number of chronic conditions (mean, sd)	4.0 (1.7)	4.3 (1.9)	0.004	4.1 (1.8)	4.0 (1.7)	4.3 (1.9)	0.026	4.1 (1.8)
2 diseases	21.4%	15.4%	0.003	19.6%	22.6%	16.0%	0.019	19.4%
3 diseases	25.5%	28.7%		26.5%	25.1%	29.8%		27.3%
4 diseases	21.0%	17.0%		19.8%	19.5%	16.1%		17.9%
5 disease	15.0%	13.0%		14.4%	14.8%	12.7%		13.8%
6+ disease	17.1%	25.9%		19.8%	18.1%	25.4%		21.5%
Chronic conditions by category								
Metabolic diseases	82.%	86.7%	0.066	83.6%	83.8%	85.5%	0.449	84.6%
Cancer	7.3%	13.0%	0.003	9.0%	7.0%	11.6%	0.009	9.2%
Cardiovascular diseases (CVD)	13.4%	24.7%	<0.001	16.9%	14.5%	24.1%	<0.001	19.0%
Respiratory disease	6.1%	9.6%	0.043	7.2%	6.4%	9.9%	0.039	8.1%
Liver disease	9.3%	10.2%	0.649	9.6%	9.3%	10.8%	0.439	10.0%
Gastrointestinal disorders	28.0%	23.8%	0.148	26.7%	27.7%	23.2%	0.093	25.5%
Musculoskeletal disorders (MSK)	65.2%	48.8%	<0.001	60.3%	65.5%	49.8%	<0.001	58.1%
Thyroid disease	9.7%	1.9%	<0.001	7.3%	9.2%	1.9%	<0.001	5.7%
Renal disease	2.3%	33.3%	<0.000	11.6%	2.1%	31.7%	<0.001	16.1%
ENT	8.9%	9.3%	0.849	9.0%	8.8%	9.6%	0.645	9.2%
Eye	27.9%	22.5%	0.067	26.3%	29.1%	20.5%	0.001	25.0%
Skin	9.3%	9.9%	0.765	9.5%	9.0%	10.5%	0.401	9.7%
Anemia	3.1%	2.8%	0.806	3.0%	3.0%	2.8%	0.867	2.9%
Neurological disease	0.7%	1.2%	0.346	0.8%	0.5%	1.3%	0.175	0.9%
Mental disorders	16.7%	10.2%	0.005	14.8%	16.4%	11.2%	0.015	14.0%
Use of medication								
Antihypertensive drugs (mean, sd)	1.0 (0.9)	1.2 (0.9)	0.082	1.1 (0.9)	1.1 (0.9)	1.1 (0.9)	0.431	1.1 (0.9)
Percentage of patients who use	69.1%	75.3%	0.038	70.9%	71.3%	74.0%	0.326	72.5%
Cardiovascular drugs (mean, sd)	0.2 (0.5)	0.3 (0.6)	<0.001	0.2 (0.5)	0.2 (0.5)	0.3 (0.7)	0.024	0.24 (0.6)
Percentage of patients who use	11.8%	22.8%	<0.001	15.1%	12.7%	21.8%	<0.001	17.0%
Antidiabetics (mean, sd)	0.4 (0.7)	0.5 (0.8)	0.0195	0.4 (0.8)	0.3 (0.7)	0.5 (0.8)	0.029	0.4 (0.7)
Percentage of patients who use	22.6%	31.8%	0.001	25.4%	22.1%	31.9%	<0.001	26.7%
Cholesterol-lowering drugs (mean, sd)	0.4 (0.5)	0.5 (0.5)	0.005	0.4 (0.5)	0.4 (0.5)	0.5 (0.5)	0.004	0.4 (0.5)
Percentage of patients who use	38.8%	48.2%	0.004	41.6%	37.5%	48.4%	<0.001	42.7%
Antipsychotics (mean, sd)	0.2 (0.8)	0.1 (0.5)	0.038	0.2 (0.7)	0.2 (0.8)	0.1 (0.5)	0.035	0.2 (0.7)
Percentage of patients who use	11.7%	7.4%	0.035	10.4%	11.1%	7.7%	0.055	9.5%
Analgesics (mean, sd)	0.1 (0.5)	0.1(0.4)	0.875	0.1 (0.5)	0.1 (0.5)	0.1 (0.4)	0.929	0.1 (0.4)
Percentage of patients who use	10.5%	10.8%	0.879	10.6%	9.8%	10.2%	0.833	10.0%
Total number of medication (mean, sd)	2.3 (1.9)	2.7 (1.9)	0.001	2.4 (1.9)	2.3 (1.9)	2.6 (1.9)	0.025	2.5 (1.9)
% forgetting taking medication (n=995)	38.4%	34.0%	0.196	37.1%	36.3%	34.8%	0.640	35.6%
Oral Health Problem (n=992)	25.3%	20.6%	0.119	23.9%	24/8%	20.5%	0.104	22.8%
Incontinence (n=992)			0.004				<0.001	
No	77.0%	86.3%		79.7%	76.9%	86.6%		81.5%
Occasionally	21.3%	12.7%		18.8%	20.3%	12.7%		16.7%
Yes	1.7%	1.0%		1.5%	2.8%	0.7%		1.8%

Pain								
Muscle-skeletal pain for at least 3 months in the past year			0.000				<0.001	
No	19.1%	37.7%		24.9%	18.7%	37.4%		27.5%
Yes, one pain area	19.7%	23.8%		10.9%	18.7%	23.6%		21.0%
Yes, two or more pain areas	61.2%	38.6%		64.3%	62.7%	39.0%		51.5%
Brief Pain Inventory (BPI) [c]								
Interference (n=809)	4.6 (1.9)	4.1 (1.9)	<0.001	4.5 (1.9)	4.7 (2.0)	4.1 (1.9)	<0.001	4.4 (2.0)
Severity (n=810)	2.9 (2.2)	2.2 (1.8)	<0.001	2.7 (2.1)	2.9 (2.2)	2.2 (1.8)	<0.001	2.6 (2.1)
Physical Activity Scale for the Elderly (PASE) (n=809) [d]								
Mean (SD)	77.4 (34.9)	89.1 (61.5)	<0.001	80.3 (43.4)	74.7 (36.1)	95.7 (67.3)	<0.001	83.3 (52.2)
Sarcopenia (mean, sd) (n=719) [f]	1.5 (1.6)	0.7 (1.3)	<0.001	1.2 (1.5)	1.7 (1.8)	0.7 (1.2)	<0.001	1.2 (1.6)
Positive (≥4)	11.0%	5.7%	0.019	9.3%	15.5%	5.1%	<0.001	10.4%
Negative (0-3)	89.0%	94.3%		90.7%	84.5%	94.9%		89.6%
Cognition [h]								
AMIC (mean, sd) (n=337)	2.2 (1.7)	1.7 (1.6)	0.035	2.1 (1.7)	2.1 (1.7)	1.6 (1.6)	0.038	1.9 (1.7)
AMIC Positive % (>=3)	40.6%	27.3%	0.027	37.1%	39.3%	24.7%	0.007	33.3%
HK-MOCA (n=785)	24.7 (4.3)	25.4 (3.2)	0.026	24.9 (4.0)	24.0 (4.8)	25.5 (3.1)	<0.001	24.7 (4.1)
HK-MOCA Abnormal % (<22)	17.5%	12.6%	0.080	15.9%	23.0%	10.5%	<0.001	16.9%
Depression								
PHQ-2	1.3 (1.6)	0.8 (1.2)	<0.001	1.2 (1.5)	1.3 (1.6)	0.8 (1.3)	<0.001	1.1 (1.5)
Screen (-) (<3)	78.1%	88.3%	<0.001	81.2%	77.8%	87.6%	<0.001	82.4%
Screen (+) (≥3)	21.9%	11.7%		18.9%	22.2%	12.4%		17.6%
PHQ-9 (mean, sd) [a]	11.4 (4.3)	10.5 (4.5)	0.274	11.2 (4.4)	11.4 (4.2)	10.4 (4.3)	0.179	11.0 (4.3)
Mild (5-9)	8.8%	4.3%		7.4%	8.6%	4.8%		6.8%
Moderate (10-14)	7.3%	4.9%		6.6%	8.2%	5.4%		6.9%
Moderately severe (15-19)	4.2%	1.2%		3.3%	4.0%	1.2%		2.7%
Severe (20+)	1.3%	0.9%		1.2%	1.2%	0.8%		1.0%
Anxiety								
GAD-2 (≥3) (mean, sd)	1.4 (1.5)	0.8 (1.1)	<0.001	1.2 (1.5)	1.4 (1.6)	0.8 (1.1)	<0.001	1.1 (1.4)
Screen (-) (<3)	79.7%	91.1%	<0.001	83.0%	79.5%	90.9%	<0.001	84.9%
Screen (+) (≥3)	20.3%	9.0%		17.0%	20.5%	9.1%		15.1%
GAD-7 (mean, sd) [b]	10.8 (3.9)	9.8 (3.7)	0.182	10.7 (3.9)	10.9 (3.9)	10.1 (3.6)	0.294	10.7 (3.8)
Mild (5-9)	0.9%	0.3%		0.7%	0.7%	0.2%		0.5%
Moderate (10-14)	6.9%	4.6%		6.2%	8.5%	5.0%		6.8%
Moderately Severe (15-19)	9.6%	3.4%		7.7%	10.1%	4.4%		7.4%
Severe (20+)	2.9%	0.6%		2.2%	3.6%	0.6%		2.2%
Insomnia								
Insomnia in the past 2 weeks			0.030				0.086	
No	31.5%	28.3%		33.5%	32.2%	37.2%		34.6%
Yes	68.5%	61.7%		66.5%	67.8%	62.8%		65.4%

ISI (n=716) (mean, sd) [c]	12.0 (5.1)	10.2 (4.6)	<0.001	11.5 (5.0)	11.9 (5.1)	10.1 (4.5)	<0.001	11.1 (4.9)
No clinically significant insomnia (0-7)	13.7%	18.2%		15.0%	14.2%	18.8%		16.4%
Subthrehold insomnia (8-14)	31.1%	29.0%		30.5%	31.0%	29.7%		30.4%
Clinical insomnia, moderate severity (15-21)	22.2%	14.2%		19.8%	22.1%	15.0%		18.8%
Clinical insomnia, severe (22-28)	1.6%	0.3%		1.2%	1.5%	0.3%		0.9%
Meaning (0-7) (n=544)	4.8 (1.2)	5.0 (1.1)	0.098	4.8 (1.2)	4.7 (1.3)	5.0 (1.1)	0.022	4.9 (1.2)
Loneliness (n=741)								
One question (yes/no)			0.009				0.128	
No	68.0%	77.1%		72.5%	69.8%	74.6%		72.2%
Yes	32.1%	22.9%		27.5%	30.2%	25.4%		27.9%
De Jong Gierveld Loneliness Scale								
Total loneliness score (mean, sd)	1.8 (1.9)	1.6 (1.7)	0.121	0.7 (1.2)	1.8 (1.8)	1.6 (1.7)	0.309	1.7 (1.8)
Emotional loneliness score (mean, sd)	1.0 (1.1)	0.9 (1.0)	0.156	1.6 (1.8)	0.9 (1.0)	0.9 (1.0)	0.566	0.9 (1.0)
Social loneliness score (mean, sd)	0.8 (1.3)	0.7 (1.2)	0.121	0.9 (1.0)	0.8 (1.3)	0.7 (1.3)	0.350	0.8 (1.3)
Social Support (can count on someone willing and able to meet your needs)			0.083				0.146	
Always	61.2%	66.3%		62.7%	61.6%	65.8%		63.5%
Sometimes	31.1%	30.0%		30.7 %	31.2%	28.6%		30.0%
Never	7.7%	4.1%		6.7%	7.3%	5.6%		6.5%
Use of social media in last 2 weeks								
Yes	52.5%	52.1%	0.849	52.6%	46.6%	55.8%	0.003	51.0%
Web	20.9%	33.6%	<0.001	24.7%	18.5%	36.5%	<0.001	27.0%
WhatsApp	51.4%	50.0%	0.675	51.0%	45.9%	52.6%	0.028	49/0%
Facebook	15.9%	20.4%	0.077	17.3%	14.5%	20.7%	0.006	17.4%
Blog	1.7%	3.4%	0.089	2.2%	1.3%	3.0%	0.065	2.1%
E-literacy (n=566) [e]	25.0 (11.7)	24.9 (12.6)	0.931	25.0 (12.0)	25.5 (11.6)	25.4 (12.7)	0.953	25.4 (12.2)
Importance of social media (total score: 6-24)	11.3 (4.8)	10.8 (4.7)	0.218	11.1 (4.8)	11.5 (4.7)	10.8 (4.8)	0.171	11.1 (4.8)
Comfort of using social media (total score: 3-18)	8.2 (4.5)	8.2 (4.7)	0.975	8.2 (4.5)	8.3 (4.4)	8.3 (4.7)	0.878	8.3 (4.5)
Daily function (Percentage of patients needing help or being dependent)								
Total	8.4%	14.8%	0.001	10.3%	10.%	14.3%	0.056	12.3%
Using telephone	0.7%	1.2%		0.8%	1%	1%		1%
Transportation	4.7%	5.6%		4.3%	5.9%	5.4%		5.7%
Shopping	5.7%	5.0%		5.5%	7.5%	4.8%		6.2%
Preparing meals	4.3%	12.7%		6.8%	5.5%	12.7%		8.9%
Financial management	2.9%	4.9%		3.5%	4.1%	0.9%		2.6%
Frailty								
Edmonton Frail Scale (EFS) (mean, sd) (n=989) [f]	3.5 (2.3)	3.1 (2.0)	0.003	3.4 (2.2)	3.7 (2.4)	3.1 (2.0)	<0.001	3.4 (2.2)
No frailty (0-5)	80.3%	88.3%	0.012	82.6%	77.6%	88.7%	<0.001	82.8%
Apparently vulnerable (6-7)	13.7%	8.6%		12.2%	13.8%	8.7%		11.4%
Mild frailty (8-9)	4.7%	2.4%		4.0%	6.8%	2.0%		4.6%
Moderate frailty (10-11)	1.3%	0.3%		1.0%	1.8%	0.2%		1.1%

Severe frailty (12-18)	0%	0.33%		0.1%	0%	0.4%		0.2%
Quality of life (EQ5D-5L)								
Index score (range: -0.864 to 1)	0.8 (0.2)	0.9 (0.2)	0.001	0.81 (0.20)	0.8 (0.2)	0.9 (0.2)	<0.001	0.81 (0.2)
visual analogue scale (VAS) (0-100)	66.0 (15.3)	69.6 (13.4)	<0.001	67.1 (14.8)	66.0 (15.4)	69.4 (13.3)	0.001	67.6 (14.6)
Health care utilization in the past year								
Hospitalization frequency			0.453				0.557	
0	83.8%	81.2%		83.0%	83.6%	82.0%		82.9%
1-2	14.4%	17.3%		15.2%	14.0%	16.7%		15.3%
2+	1.9%	1.5%		1.8%	2.4%	1.3%		1.9%
Hospitalization Length (days, mean, sd) (n=1073)	1.1 (5.1)	1.5 (8.2)	0.424	1.2 (6.2)	1.1 (5.1)	1.4 (8.3)	0.535	1.2 (6.8)
Specialist Out-patient Clinics (SOPC)	69.0%	70.7%	0.587	69.5%	68.8%	70.2%	0.636	69.5%
General Out-patient Clinics (GOPC)	89.6%	94.1%	0.018	91.0%	89.8%	94.3%	0.007	92.0%
Elderly day care service	9.4%	9.9%	0.824	9.6%	10.2%	9.1%	0.554	9.6%
Cost (out of pocket) (HKD) median (interquartile range, IQR) (n=1063)	1000 (0, 3000)	1000 (0, 2000)	0.141	1000 (0, 3000)	1000 (0, 3000)	1000 (0, 2000)	0.488	1000 (0, 3000)
<u>Physical examinations</u>								
Blood pressure (BP)								
Systolic (mean, sd)	133.2 (15.6)	134.2 (15.9)	0.337	133.5 (15.7)	133.5 (16.3)	133.3 (15.2)	0.848	133.4 (15.8)
Diastolic (mean, sd)	74.9 (9.6)	78.4 (10.0)	<0.001	75.9 (9.9)	74.1 (10.0)	78.6 (9.9)	<0.001	76.2 (10.2)
Normal (SBP <120 & DBP <80)	19.2%	14.8%	0.272	17.9%	19.9%	15.8%	0.070	17.9%
Pre-hypertension (SBP: 120-139 or DBP: 80-89)	45.8%	48.2%		46.5%	44.6%	48.4%		46.4%
Stage I hypertension (SBP: 140-159 or DBP: 90-99)	30.2%	30.6%		30.3%	29.9%	29.8%		29.8%
Stage II hypertension (SBP ≥ 160 or DBP ≥ 100)	4.8%	6.5%		5.3%	5.6%	6.0%		5.8%
Pulse (per minute)	71.5 (19.5)	75.2 (28.0)	0.016	72.7 (22.5)	71.7 (22.0)	74.9 (24.8)	0.041	73.2 (23.4)
Weight (kg, mean, sd)	57.5 (56.8)	66.5 (9.6)	<0.001	60.2 (10.4)	56.9 (9.3)	66.9 (9.7)	<0.001	61.6 (10.7)
Height (cm, mean, sd)	154.0 (6.2)	165.5 (6.7)	<0.001	157.4 (8.2)	153.4 (6.2)	165.6 (6.7)	<0.001	159.2 (8.8)
Waist circumference (cm, mean, sd)	88.8 (9.7)	93.2 (9.5)	<0.001	90.2 (9.9)	89.1 (9.9)	93.2 (9.2)	<0.001	91.1 (9.8)
Body mass Index (BMI) (mean, sd)	24.2 (3.8)	24.2 (2.0)	0.963	24.2 (3.6)	24.2 (3.7)	24.4 (3.1)	0.398	24.3 (3.4)
Underweight (<18.5)	4.1%	2.8%	0.067	3.7%	3.6%	2.7%	0.013	3.1%
Normal (18.5-22.9)	37.6%	31.3%		35.7%	38.9%	31.5%		35.4%
Overweight (23-24.9)	20.4%	26.0%		22.1%	20.5%	23.6%		22.0%
Obese (≥ 25)	37.9%	39.9%		38.5%	37.0%	42.2%		39.5%
Handgrip strength (kg) [i]								
< cutoff score (<26 for male, <18 for female)	36.3%	36.1%	0.964	36.2%	40.2%	34.7%	0.061	37.6%

Left hand (mean, sd)	17.4 (4.2)	26.4 (7.0)	20.1 (6.6)	17.0 (4.2)	26.7 (7.0)	21.5 (7.5)
Right hand (mean, sd)	18.5 (4.3)	27.4 (7.5)	21.1 (6.8)	18.0 (4.3)	27.5 (7.7)	22.5 (7.7)
Both hand (mean, sd)	19.1 (4.1)	28.5 (7.1)	21.9 (6.7)	18.6 (4.0)	28.8 (7.2)	23.4 (7.6)

Abbreviations: GAD-2: the two-item General Anxiety Disorder scale; HK-MoCA: Montreal Cognitive Assessment Hong Kong version (HK-MoCA); ISI: the 7-item Insomnia Severity Index; EQ5D: the EuroQol EQ-5D-5L; PHQ-2: The two item Patient Health Questionnaire for depression; The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C); SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Notes:

[a] Mean (SD) was for 203 patients who did PHQ-9. The % was for all the 1077 patients with the rest 874 patients who screened negative in PHQ-2 regarded as having normal scores in PHQ-9.

[b] Mean (SD) was for 182 patients who did GAD-7. The % was for all the 1077 patients with the rest 895 patients who screened negative in GAD-2 regarded as having normal scores in GAD-7.

[c] 719 patients were assessed with ISI.

[d] Only those who had one or more pain areas in the past 3 months were assessed with BPI or PASE-C.

[e] Only those who had social media use in the past 2 weeks were assessed.

[f] Measured by the 5-item Sarcopenia Assessment (SARC-F) which were added at a later stage.

[g] N=136, those who did not drink alcohol the past 12 months were regarded as 0 in AUDIT-C.

[h] HK-MOCA replaced AMIC in a later stage.

[i] Better result of two series for left or right hand, or best result of both hands.

Figure 1 Flowchart of recruitment

Figure 2a Unweighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

Figure 2b Weighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

Figure 3a Unweighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%))

Figure 3b Weighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%))

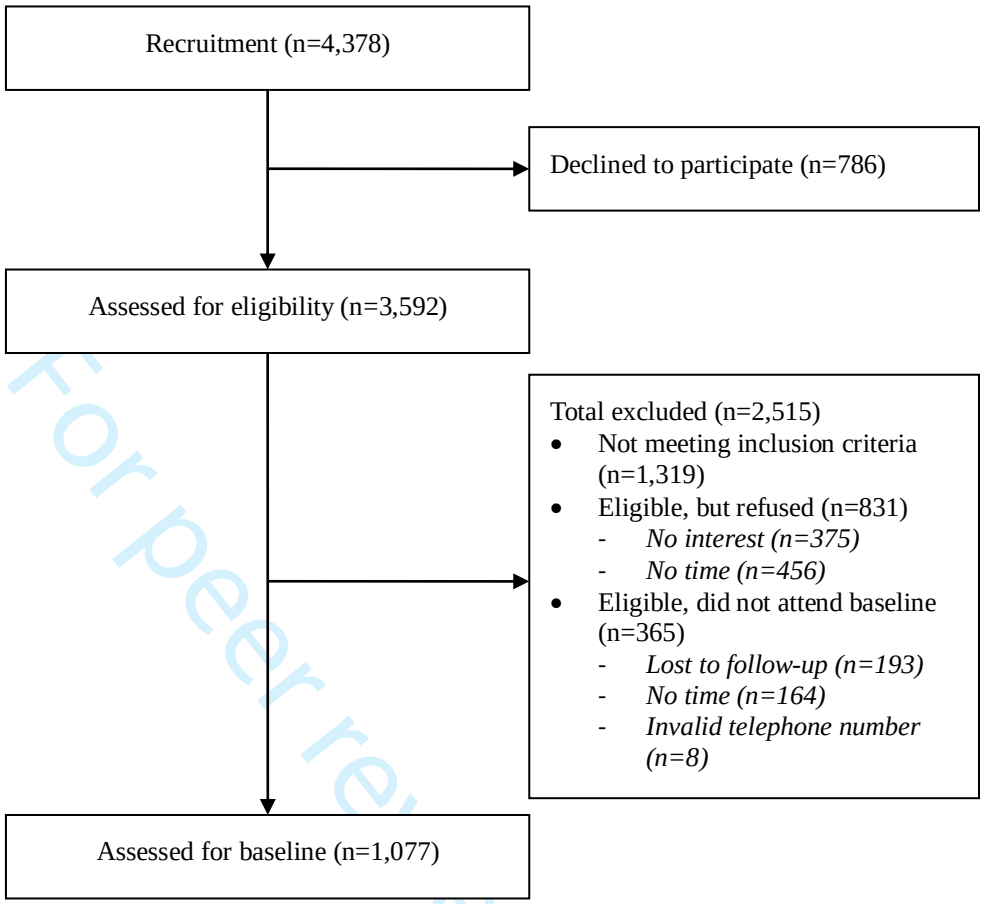
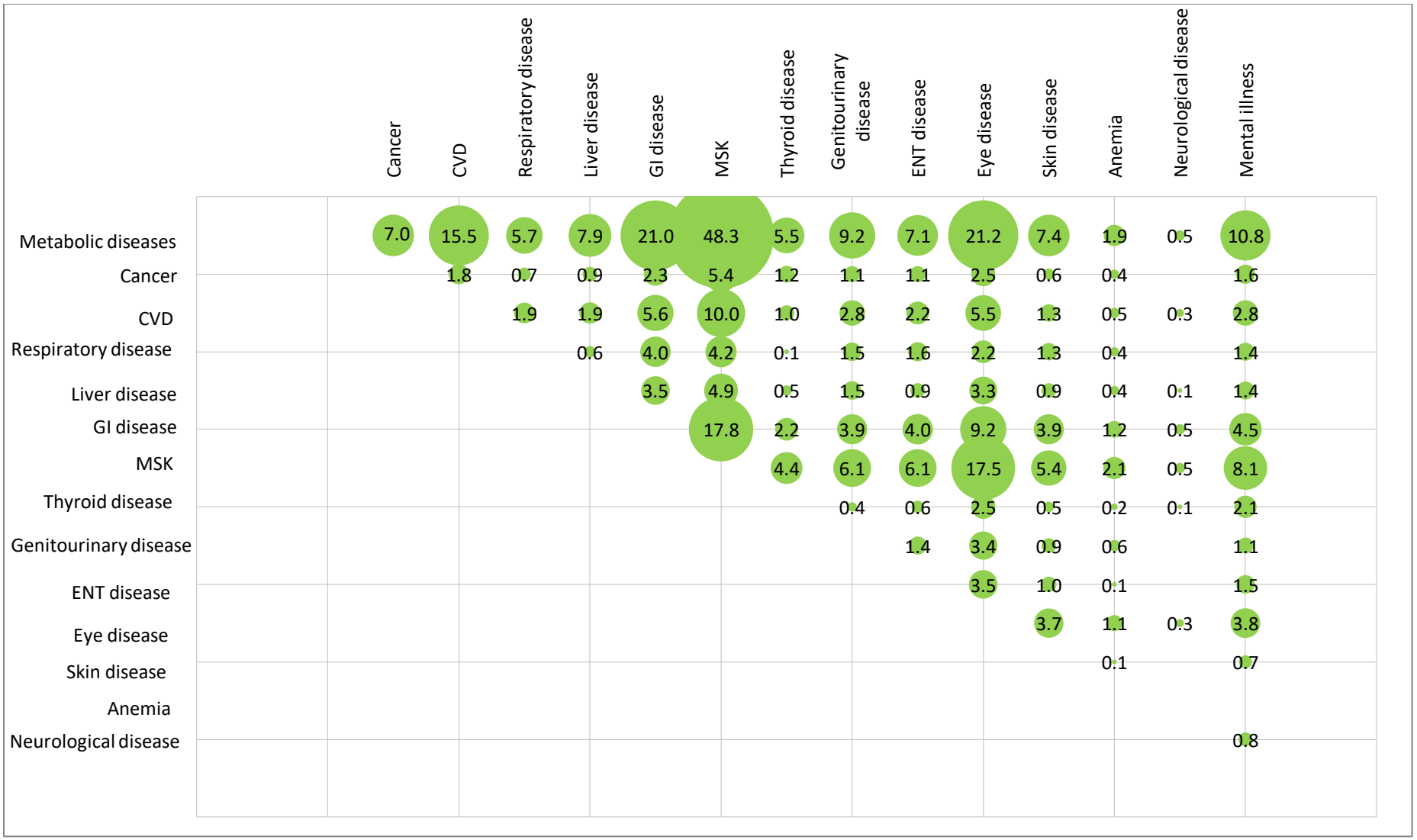


Figure 1 Flowchart of recruitment



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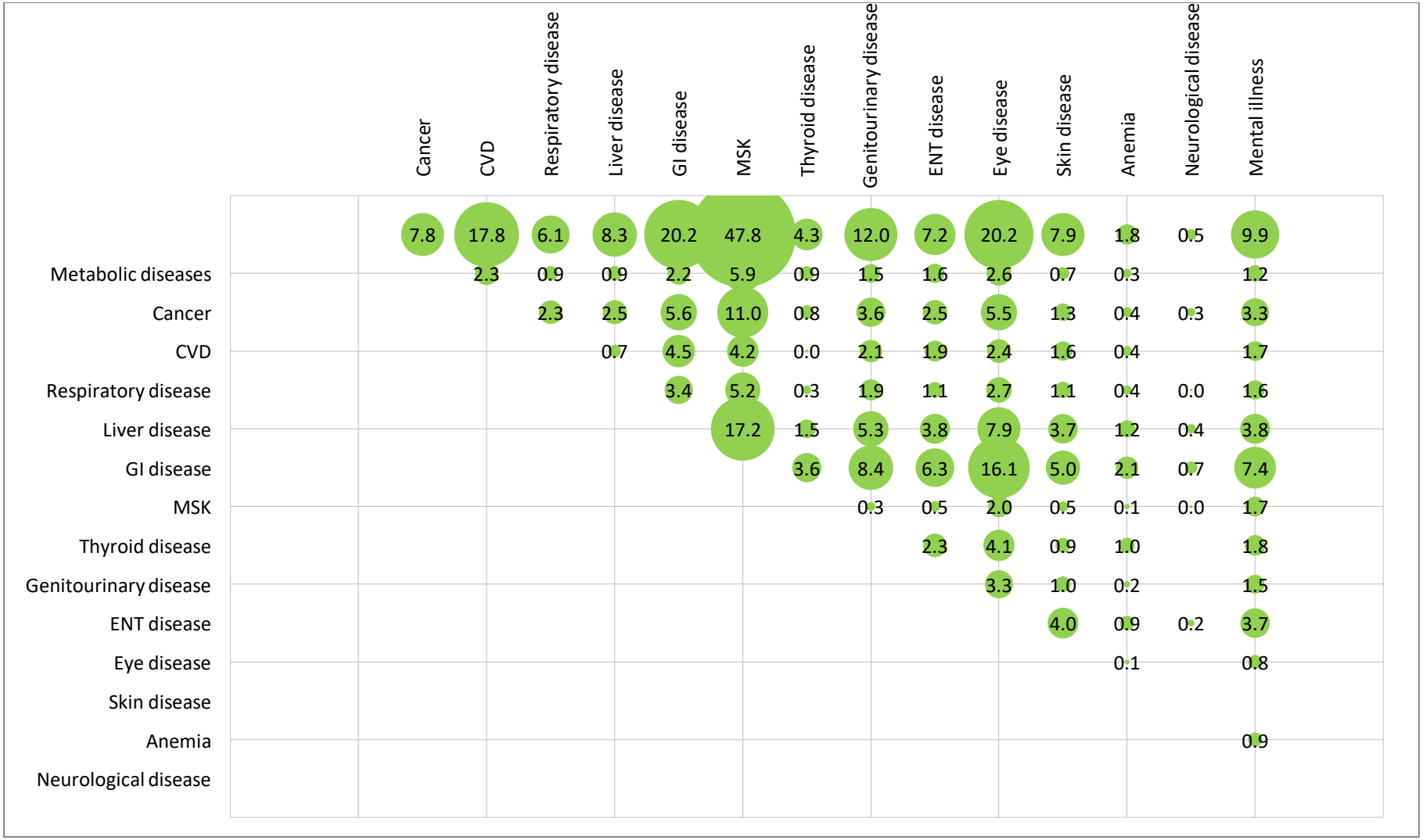

Figure 2b Weighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

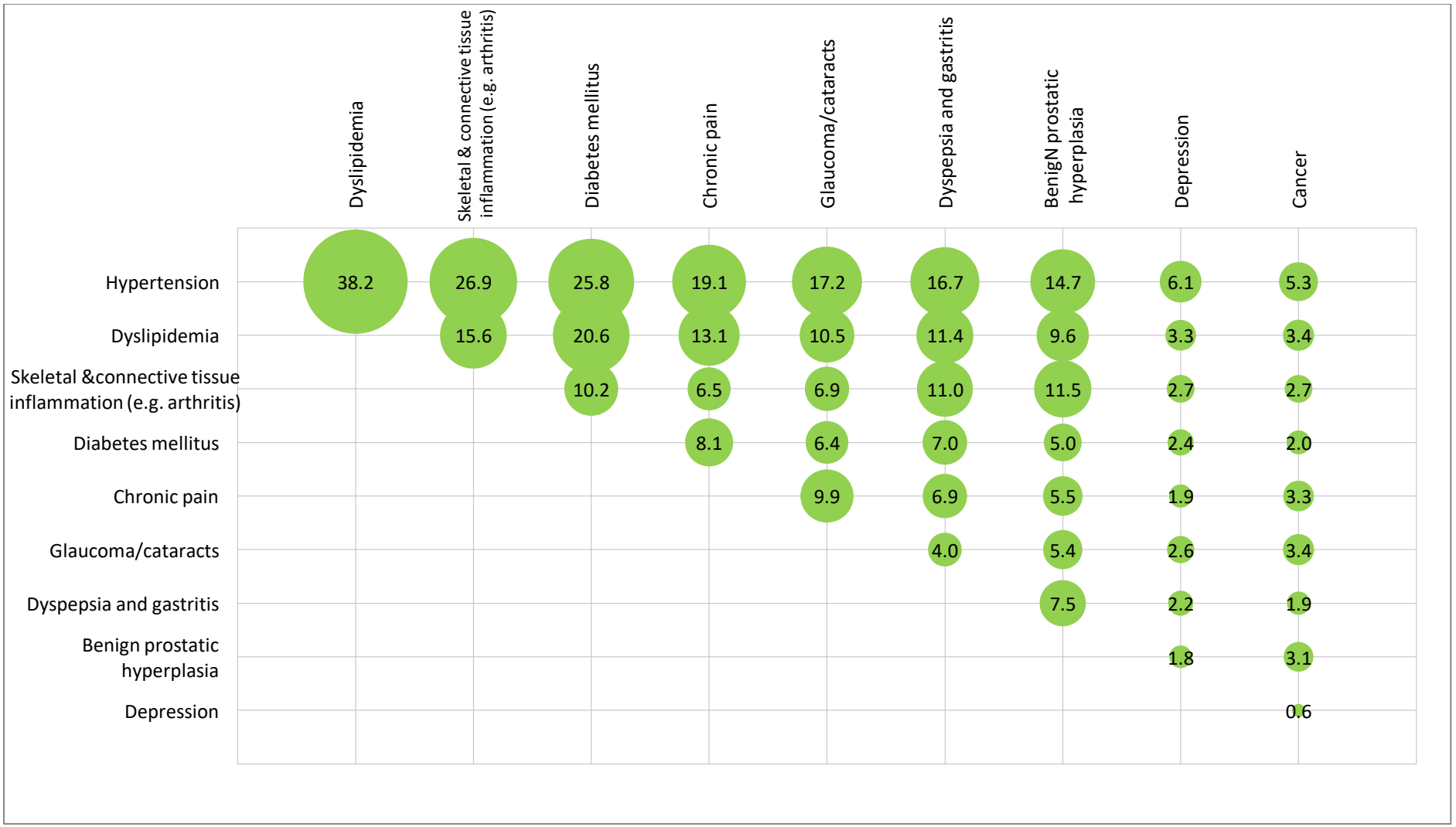

Figure 3a Unweighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%))

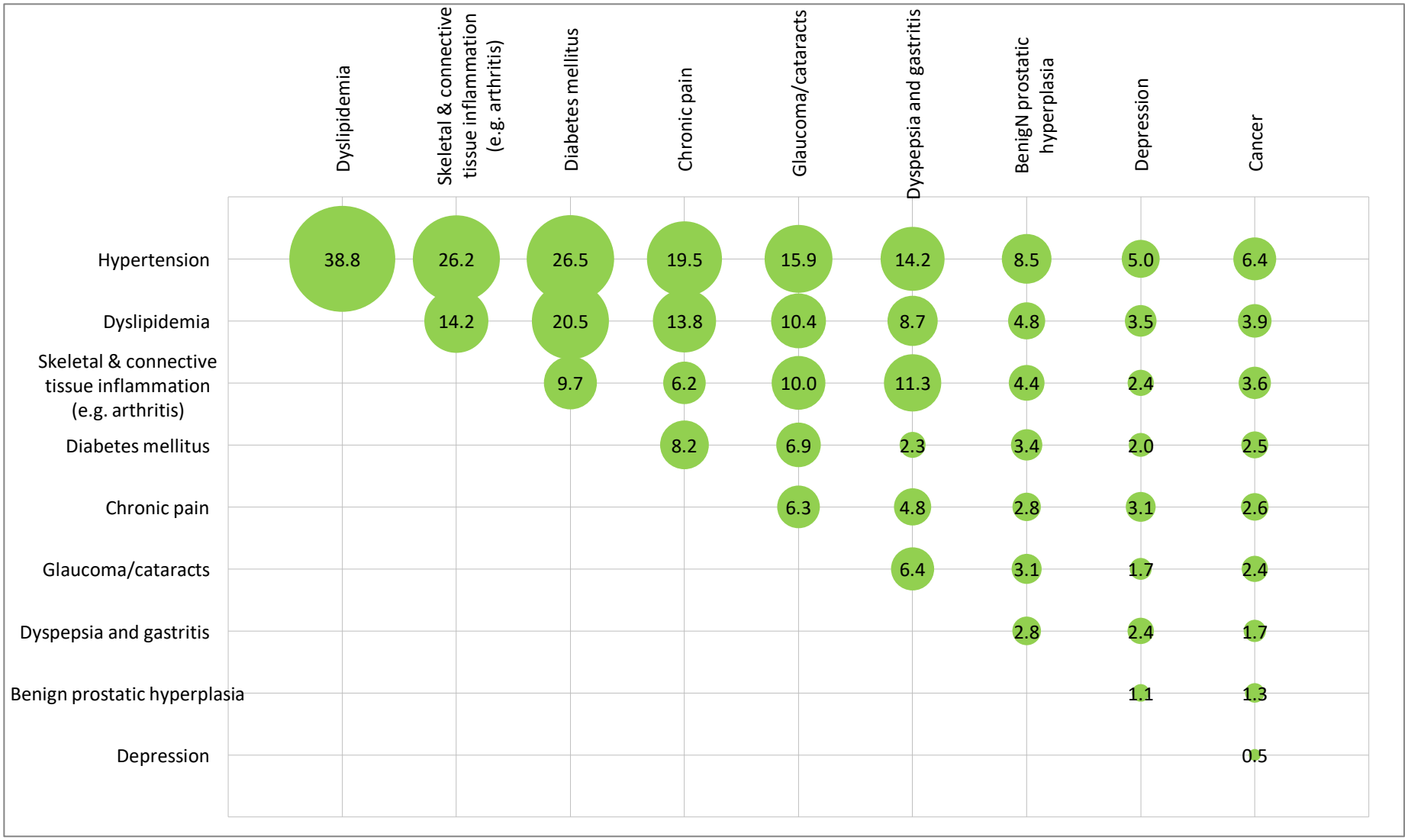

Figure 3b Weighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%))

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p2	Cross-sectional study, with results weighted according to the census.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p5−6	
Objectives	3	State specific objectives, including any prespecified hypotheses	p6	
Methods				
Study design	4	Present key elements of study design early in the paper	p6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p6-9	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	p6-7	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p7-9, p19-21 (Table 1)	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*p7-9， p19-21 (Table 1)*	
Bias	9	Describe any efforts to address potential sources of bias	p9	

Study size	10	Explain how the study size was arrived at	p7

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p9
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	p9
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p10-11
		(b) Indicate number of participants with missing data for each variable of interest	p10-11, p23-27 (Table 2), Figure 2, Figure 3
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	p10-11 and p23-27 (Table 2), Figure 2, Figure 3
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were	NA

	included	
	(*b*) Report category boundaries when continuous variables were categorized	p23-27 (Table 2)
	(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	p11	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p13-14	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	p14	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p1	Funding The work was supported by The Hong Kong Jockey Club Charities Trust.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Cohort profile: The prospective study on Chinese elderly with multimorbidity in primary care in Hong Kong

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Cohort profile: The prospective study on Chinese elderly with multimorbidity in primary care in Hong Kong

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Patient consent Obtained

Ethics approval Compliance with Ethical Standards. Ethics approval was obtained from the Joint Chinese University of Hong Kong – New Territories East Cluster Clinical Research Ethics Committee (The Joint CUHK-NTEC CREC).

Conflict of Interest None declared.

Contributors SYSW conceived and supervised the study and revised the manuscript. DXZ contributed to study design, analysed the data, prepared the draft and revised the manuscript. SRWS and CW contributed to the study design and implementation, and manuscript revisions. DZ contributed in data collection and manuscript revisions. SWM and MJ contributed in manuscript revisions.

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Abstract

Purpose

This is an ongoing prospective cohort aiming to examine the biopsychosocial health profiles and predictors of health outcomes of older patients with multimorbidity in primary care in Hong Kong.

Participants

From April 2016 to October 2017, 1077 patients aged 60+ years with at least two chronic diseases were recruited in 4 public primary care clinics in the New Territories East Region of Hong Kong.

Findings to date

After weighting, the patients had 4.1 (1.8) chronic conditions and 2.5 (1.9) medications on average; 37% forgot taking medication sometimes; 71% rated their health as fair or poor; 17% were frail; 73% reported one (21%) or two or more (52%) body pain areas; 62% were overweight/obese; 23% reported chewing difficulty, 18% reported incontinence; 36% had current Stage 1/2 hypertension; 38% had handgrip strength below the cut-off; 18% screened positive in sarcopenia; 12% had mild cognitive impairment; 17% had mild to severe depression; 17% had mild to severe anxiety; 50% had sub-threshold to severe insomnia; 28% indicated being lonely; 12% needed help in at least one out of the five daily functions; and the EQ-5D-5L index score was 0.81 (0.20) and its visual analogue scale (VAS) score was 67.6 (14.6). In the past 12 months, 17% were hospitalized, 92% attended general out-patient clinics (GOPC), 70% attended specialist out-patient clinics (SOPC), and 10% used elderly daycare center services, the median out-of-pocket health cost was 1000 HK$ (US$150). Female and male patients showed significant differences in many biopsychosocial health aspects.

Future plans

With assessments and clinical data, the cohort can be used for understanding longitudinal trajectories of biopsychosocial health profiles of Chinese older patients with multimorbidity in primary care. We are also initially planning cohort studies on factors associated with various health outcomes, as well as quality of life and healthcare use.

Cohort Registration: ChiCTR-OIC-16008477

Key Words:

Multimorbidity; Prospective Cohort; Older Adults; Primary Care; Physical, Psychological and Social Risk Factors

Strengths and limitations of this study

- This prospective cohort comprehensively examines biopsychosocial health problems encountered by Chinese older patients with multimorbidity in a primary care program in Hong Kong. As far as we are aware of, very few prospective cohorts specifically cover this population in primary care, and no such prospective cohort exists among Chinese.
- The data could be linked with electronic health records to allow follow up and examination of long-term outcomes associated with multimorbidity, and predictors of those outcomes.
- The limitation was that older adult patients who were male, disabled, very ill, institutionalized, or house-bounded were less likely to have participated in this study; a few assessments were only conducted within subgroups or added at a later stage; the sample size may limit examinations of potential interactions and factors associated with multimorbidity in some subgroups.
- The baseline health results had been weighted according to the census data. The weighted rates might be an underestimation of the rates among the primary care patients and be close to the rates of the general population.

INTRODUCTION

Multimorbidity, defined as patients living with two or more chronic health conditions, is common in primary care. The prevalence is increasing over the last decades as a result of an aging population and changes in lifestyles e.g. more sedentary lifestyle which have increased the risk of obesity, resulting in a higher risk of developing chronic conditions.[1 2] A recent systematic review suggests that the prevalence of multimorbidity is high among the elderly ranging from 12.9% to 95.1% in different studies.[3] Multimorbidity is associated with increased disability and depression, reduced quality of life, and higher rates of adverse drug consequences.[4] Multimorbidity also leads to increased primary and secondary health service utilization, especially unplanned health care, as well as reduced life-expectancy.[5] The direct and indirect economic burden associated with multimorbidity is huge.[6] The annual healthcare costs were €4,096.86 among patients with 5 or more chronic conditions, which was almost 5 times more than those who were healthy in a study in the West of Ireland.[7] It has been estimated that by 2030, 66% of the global disease burden will be due to chronic diseases, with most of the burden occurring in the most populous area – Asia.[8 9] The economic burden highlights an urgent need for holistic understanding of patients with multimorbidity when searching for cost-effective ways to manage these patients, given that treatment of diseases in isolation can be inefficient, leading to duplication of care and poorer health outcomes.[10]

Studies on multimorbidity have increased in recent years,[11-20] and a clinical guideline on clinical assessment and management of multimorbidity was developed by the National Institute for Health and Care Excellence (NICE) in the UK in 2016.[21] However, studies are still needed for the epidemiology and profiles of patients with multimorbidity and their longitudinal outcomes to inform policy making in different populations including Chinese primary care patients.[3 22] Most studies on primary care patients with multimorbidity are conducted in western countries such as UK, USA, Australia, Spain and Belgium,[14 15 23-29] and limited research has been conducted on psychological and social problems accompanying with multimorbidity.[3 21 22 30 31] Several longitudinal studies of multimorbidity have been conducted in Asian populations,[32-34] but none of these are of primary care patients. Important knowledge gaps still exist regarding the biopsychosocial health profiles of patients with multimorbidity in primary care among Asian

Chinese.[35] Therefore, more studies among Chinese patients with multimorbidity in primary care are needed to advance our understanding for services.[14 36-40]

This study focuses on the elderly in Hong Kong, where the population is ageing rapidly. Hong Kong has a population of 7.34 million according to the 2016 census data, with 23.7% aged 60 years or above. The rate was higher than the proportions in 2006 (16.5%) and 2011 (19.5%).[41] In Hong Kong, although there is a large private primary care sector, around 85% of people with chronic conditions are managed in the public primary care setting. Given that the Hong Kong population has the longest life expectancy in the world: (81.7 for men and 87.7 for women in 2017),[42] the ageing population and multimorbidity have brought much burden and challenge to the local healthcare system. To inform healthcare providers and policymakers in allocating suitable health services for people with multimorbidity in primary care, the present study aimed to study the longitudinal biopsychosocial health profiles and also predictors of health outcomes of Chinese patients with multimorbidity who present to public primary care in Hong Kong.

COHORT DESCRIPTION

Study setting and participants

This study contains primary care patients from four general out-patient clinics (GOPCs) out of the ten general out-patient clinics (GOPCs) in the New Territory East Cluster (NTEC), Hong Kong, as permission to recruit from these four clinics was given by the local regulator (the Hospital Authority) during the study period. Each GOPC receives about 450 patients each day. The working hours are generally from 9:00 am to 5:00 pm from Monday to Friday with some additional night and weekend sessions. In the most recent Hospital Authority Annual Report 2016-2017, the ten GOPCs in NTEC provided 972,454 consultations in total in the year of 2015/2016, which consisted of one third of total GOPC consultations in Hong Kong public health system.[43]

The inclusion criteria of participants were: 1) aged 60 years or above; 2) with two or more chronic diseases confirmed by the medical information in the public Clinical Management System (CMS) and patients' self-report; and 3) could speak and understand Chinese. No specific exclusion criteria were adopted. However, as participants needed to respond to questionnaire surveys and health checks, they should be able to access the clinic, sign informed consent by themselves, and understand and answer the research questions.

Patients were first consecutively screened for eligibility by trained research assistants in the waiting areas of the GOPCs. For those who were eligible, they were asked to provide a contact phone number and then were scheduled to visit the study nurse for further assessments. All patients provided informed consent before participation in the study. From April 2016 to October 2017, 1077 eligible patients were recruited and completed the baseline assessments. The baseline assessments were conducted through face-to-face interviews by nurses or a social worker at a university affiliated primary care clinic. The flowchart of recruitment is shown in **Figure 1**. The sample size allows a margin of error at 3% with a confidence interval of 95%. It is also 100% powered to detect a mean difference of 0.5 (assuming standard deviation is 1.0) and 90% powered to detect a difference of 8% of different rates, with a follow-up rate of 50% (α=0.05).[44 45]

Measures

The assessments covered a range of measures that are postulated to be potential physical, psychological and social factors associated with multimorbidity. Each complete assessment lasted for about 45 to 60 minutes. All the measures were validated and have been widely used or have been used in our previous studies. Information was collected through face-to-face interviews by trained nurses, social workers and research assistants, and additional information of the disease entities, medication use and health service utilization was confirmed through the review of electronic medical records by nurses. The electronic medical records include patient information and diagnosis, health examinations, medication prescription, and health visits to the public health system. The records cover all patients who seek medical services in public health system. It is a medical record system of routine clinical practices with quality ensured by all healthcare professionals including trained doctors, nurses and allied health professionals under Hospital Authority in Hong Kong.

The measures in the questionnaires included: 1) the number and type of chronic diseases in fifteen categories (a total of 43 chronic conditionals) adapted slightly by a group of family physicians and researchers based on chronic conditions employed in previous studies[46 47] and the International Statistical Classification of Diseases 11 (ICD-11). Details can be seen in Table 1; 2) depression (screened by the 2-item Patient Health Questionnaire (PHQ-2)).[48] Those with a score of 3 or more (which suggests depression) were further measured by the 9-item Patient Health Questionnaire (PHQ-9);[49] 3) anxiety (screened by the 2-item Generalised Anxiety Disorder (GAD-

2)). Those with a score of 3 or more (which suggests anxiety) were further measured by the 7-item Generalised Anxiety Disorder (GAD-7);[50] 4) loneliness (measured by the 6-item De Jong Gierveld Loneliness Scale),[51] as well as one loneliness question; 5) insomnia (measured by the 7-item Insomnia Severity Index (ISI))[52] among those who answered yes to a screening question); 6) pain (measured by the Brief Pain Inventory among those who were screened positive in pain); 7) physical activity (measured by Physical Activity Scale for the Elderly (PASE)[53] among those who were screened positive in pain); 8) frailty (measured by the Edmonton Frail Scale[54] which was translated and back-translated by experienced bilingual translators); 9) meaning of existence (measured by one question extracted from the validated Chinese Purpose in Life test (CPIL) which was used in a previous study);[55] 10) sarcopenia (measured by the 5-item Sarcopenia Assessment (SARC-F));[56 57] 11) cognition (measured by the Hong Kong Montreal Cognitive Assessment (HK-MoCA) with a score of 22 or above being with normal cognition);[58] 12) alcohol use (screened by one question and then measured by the 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who screened positive); 13) smoking (non-smoker, current smoker, ex-smoker); 14) medication use (number and duration (0-1 year/2-5 years/>5 years) of antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics was checked in electronic medical system, and compliance of medication use was measured by "At times, do you forget to take your prescription medications?" (no/yes)); 15) self-rated health; 16) community network; 17) use of social media (measured by a screening question, and for those who answered yes to any of the social media, they were further assessed on the importance and comfort of using the internet); 17) oral health; 18) incontinence; 19) caregiving to somebody; 20) quality of life (measured by the EuroQol EQ-5D-5L (EQ5D));[59] 21) daily function (ability to use the telephone, mode of transportation, shopping, food preparation, ability to handle finances were measured); 22) health service utilization (visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare costs which were not covered by public health system or insurance both in private and public in the past year). In addition, physical examinations included blood pressure, Body Mass Index (BMI), waist circumference and handgrip strength (kg). For blood pressure, two assessments were taken by the nurses. Patients sat for at least 5 minutes before the first assessment, and they were assessed again 15 minutes later. Handgrip strength was also assessed twice for each hand. Social economic status such as age, gender, marriage, living status, employment, receiving

of social welfare scheme was also included. Due to the data collection plan amendments, a few measures were only collected in a sub-group of the patients at a later stage. Summaries of the baseline measures are described in **Table 1**.

The questionnaire was set up in password protected EpiData files in a password protected computer with quality control. For example, for scale questions with answers on a Likert scale of 1 to 5, a range of 1-5 and one digit was set up so no other results were allowed during data entry. Additionally, for most data variables, a "must enter" was set up, so that the question could not be missed unless answered or an individual purposely moves to the next question. Checking for missing data was done regularly by experienced researchers and missing data was further collected by nurses through face-to-face interviews, telephone or by checking the electronic medical record system.

Patient and Public Involvement

The research questions and outcome measures were developed based on some most common problems that are widely recognized among elder patients. Patients or the public did not involve in the design of the study, recruitment or conduction of the study. The results of the study would be disseminated to patients once he or she requests so and aggregated data would be reported in project reports and research publications and conferences.

Findings to date

Baseline characteristics of the patients in the study are shown in **Table 2**. The weighted data are shown in the bracket beside the unweighted data. The mean age of the study patients was 70 (SD=6.8) (70.5, SD=7.9) years, 70% (52.8%) were female, 67% (68%) were married, 14% (15%) lived alone, 92% (87%) were retired or housewives, 49% (52%) had 6 years of education or above, 10% (10%) were on the Comprehensive Social Security Assistance (CSSA) scheme which is open for those with a low income, about half used social media in the last 2 weeks, about 18% (15%) provided care to another (such as their spouse or children/grandchildren), 12% (17%) had drank alcohol in the past year and 3% (4%) were current smokers. More female patients lived alone, were retired/housewives, had lower education, and had more social security support than male patients (p values < 0.05).

After weighting, overall, the mean number of chronic diseases was 4.1 (SD=1.8) and about one in five patients had 6 or more chronic diseases. The top three chronic conditions were hypertension (75%), dyslipidemia (46%), and skeletal and connective tissue inflammation (e.g. arthritis) (36%). The unweighted and weighted prevalence of co-morbidities of the 15 disease categories among the patients is shown in **Figure 2** and **Figure 3**, respectively. The unweighted and weighted co-morbidities of top 10 prevalent conditions out of the 43 conditions are shown in **Figure 4** and **Figure 5**, respectively, with the combination of hypertension and dyslipidemia being the most common (39%), followed by hypertension and diabetes mellitus (27%), hypertension and skeletal and connective tissue inflammation (e.g. arthritis) (26%), dyslipidemia and diabetes mellitus (21%), hypertension and chronic pain (20%). Information of the rest co-morbidities is shown in the figures. Female patients had fewer number of chronic conditions, fewer number of medications in use but poorer self-rated health than male patients (p values < 0.05). On average, patients took 2.5 (SD=1.9) medications, with 30% taking 5 or more medications regularly, 36% reported forgot taking medication sometimes.

After weighting, the mean BMI was 24.3 (SD=3.4) with 61% being overweight or obese. Based on the Edmonton Frail Scale, 17% were frail. Eight percent had sarcopenia, 23% reported chewing difficulty, 18% reported incontinence, 36% had stage one or two hypertension currently according to the physical examination, 38% had their handgrip strength (based on the best outcome of two trials of both hands) below the cut-off point, 12% needed help or were dependent in at least one out of the 5 daily functions (using telephone, transportation, shopping, preparing meals, or financial management). Overall, 30%, 59% and 11% of patients rated their health being 'excellent/very good/good', 'fair', or 'poor' respectively. Seventy-three percent reported the presence of one (21%) or two or more (52%) body pain areas, 17% scored the HK-MoCA <22 suggesting at least mild cognitive impairment; 18% had PHQ-2 ≥3, while 17% had PHQ-9 ≥5 suggesting mild depression or more severe; 15% had GAD-2 ≥3, while 16% had GAD-7 ≥5 suggesting mild anxiety or more severe; 50% had insomnia at subthreshold level or above, the mean score of the meaning of existence was 4.9 (SD=1.2) out of 7, 28% reported feeling lonely. More finding details can be seen in **Table 2**. More female patients had incontinence, pain, sarcopenia and cognitive impairment than male patients. Female patients were more likely to be screened positive in depression and anxiety, reported severer level of insomnia and reported lower perceived existence of meaning than male patients. Female patients were more likely to be frail.

More male patients used social media (p values < 0.05). The loneliness level and perceived social support were not significantly different between female and male patients.

In addition, after weighting, the EQ-5D-5L index score was 0.81 (0.20) and its visual analogue scale (VAS) score was 67.6 (14.6) out of 100. Female patients showed poorer quality of life. In the last year, 17% were admitted to hospital, 92% attended GOPC, 70% attended SOPC, 10% used elderly day care center services and the median out-of-pocket health cost was 1000 HK$ (US$150) for any health expenditures not covered by the public health system or insurance. Male patients reported more GOPC visits than female patients in the past year (p=0.007).

Future plans

The patients will be followed-up regularly (interval of ~2 years) to monitor changes in health status and outcomes through data collected from questionnaires, physical assessments and clinical records. Key biopsychosocial assessments such as depression, anxiety, loneliness, pain, frailty, as well as quality of life would be included in the follow-up assessments, but each follow-up might be added with some additional assessments with specific research interests. The first follow-up (i.e., wave 2 assessment) had started in early 2018. Additional information on mobility by the 30 second chair-stand test, visual acuity by Amsler Grid test and hearing by Weber's test and Rinne Test were added. Information on electronic medical records will also be updated to provide information on health service utilization, changes in medication use, and new onset of diseases and death.

The longitudinal trajectories of biopsychosocial health profiles of these primary care patients will be described. For example, changes and occurrence of different physical, mental and social problems among all the study participants as well as some subgroups (e.g. different age, gender, co-morbidities). We are also initially planning cohort studies on factors associated with various health outcomes as well as quality of life and healthcare use. In addition, more explorations will be made to answer many other research questions based on hypotheses.

Strengths and limitations

This study has several strengths. First, this is one of the few etiological studies on older adults being conducted in Asian primary care settings to examine physical, psychological and social problems accompanying with multimorbidity. Second, it prospectively covers a range of

biopsychosocial factors which are not included in other previous large-scale studies since plenty of them are derived from extracted medical or insurance records. Our findings suggest that people with multimorbidity have significant complex healthcare needs in physical, mental and social aspects such as obesity, multiple body pain, polypharmacy, depression, anxiety, insomnia and loneliness. The results suggested that a holistic approach that addresses general physical and functional domain of health, at the same time assessing and managing psychological and social problems is therefore needed in the care of older adults with multimorbidity. Services which are designed to cater for the complex needs of elder patients with multimorbidity from biopsychosocial perspectives are urgently needed. These service models should also be adapted and tested in local circumstances to maximize its efficacy. Furthermore, given the significant differences found between male and female patients in biopsychosocial aspects, future interventions may also need to take gender differences into account. Third, the results were weighted according to the census data to make the sample more representative of the general population. In general, the weighted results were similar to the unweighted results, and in consistency with results reported in the western populations. Fourth, because it contains linked electronic medical records, it will allow us to follow them up for public medical service use and mortality.

There are also several limitations. First, self-selection bias might still exist which was consistent with other similar studies,[60] although we used weighting for adjustment, as not all variables were available for weighting such as education. Since only ambulatory adults who agreed to join were recruited and these usually are more likely to be female and those with higher educational level and higher self-motivation, and those who were house-bound or institutionalized are less likely to have been included, we might have resulted in a relatively healthier and higher-functioning patients in primary care, and the real health status might be worse than what are reported in our study. Future studies may need to take measures to increase participation from male and vulnerable patients. Second, the sample size may limit examinations of potential interactions and factors associated with multimorbidity in some subgroups such as older men and people with lower educational levels, or uncommon health problems among these patients. Third, we used a two-step assessment for some health indicators. While false negative reported rates of pain, insomnia and alcohol use were unlikely, there might be false negative rates for depression and anxiety as the specificity and sensitivity of PHQ-2 and GAD-2 were not 100% (although results from meta-analytic reviews suggest they are reasonable to use in initial screening).[61 62] In

addition, as PHQ-2 and GAD-2 are often used for screening with results in dichotomies (negative/positive), this might limit application of some statistical analysis such as using growth models in future longitudinal data. Fourth, for a few assessments, we only conducted them among a subgroup of participants, e.g. PASE for physical activity among those patients with pain. Furthermore, some additional assessments such as meaning, sarcopenia, oral health were added at a later stage. So only subgroup data could be reported in this paper or analyzed in the future when using these data.

Data Sharing

Data will be available upon reasonable request. The authors warmly welcome collaborations for future research based on this study. For those who would like to request for the data or propose new assessments into the follow-up assessments, they can email to: [yeungshanwong@cuhk.edu.hk]. For more information please see the website: http://cpcp.sphpc.cuhk.edu.hk/chi/.

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Table 1 Core topic areas in questionnaires and examinations of the study

Assessment	Description
Questionnaire	
Use of medication	number and duration (0-1 year/2-5 years/>5 years) for antihypertensive, cardiovascular and hypolipidemic drugs, antidiabetics, antipsychotics and analgesics
Compliance of medication use	"At times, do you forget to take your prescription medications?" (no/yes)
Depression	The 2-item Patient Health Questionnaire (PHQ-2) for depression; The 9-item Patient Health Questionnaire (PHQ-9) for those with PHQ-2 ≥ 3
Anxiety	The 2-item Genralised Anxiety Disorder (GAD-2); The 7-item Generalised Anxiety Disorder (GAD-7) for those with GAD-2 ≥ 3
Loneliness*	De Jong Gierveld Loneliness Scale; and one question asking "Do you feel lonely? (Yes/No)" (added at a later stage)
Insomnia	The 7-item Insomnia Severity Index (ISI) for those answered yes to the screening question "In the past two weeks, do you have insomnia? (Yes/No)"
Pain	A screening question of "In the past year, do you have musculoskeletal pain for at least 3 months", for those who answered 'yes, one pain area or 'yes, two or more pain areas', Brief Pain Inventory (BPI) was measured.
Physical activity	For those were screened positive in pain, Physical Activity Scale for the Elderly (PASE) was measured
Self-rated health	"In general, how will you describe your health? (extremely good, very good or good/fair/poor)
Community network	"When you need help, do you have someone who is willing to and able to meet your needs?" (always/sometimes/never)
Meaning of existence*	One item extracted from the validated reliable Chinese Purpose in Life test (CPIL)
Use of social media	A screening question of "In the past two weeks, have you ever used the following social media", for those who answered yes to any of the social media, they were further assessed with importance and comfort of using internet.
Oral health*	"Do you have any difficulty when biting or chewing foods (even with the use of denture)" (yes/no)
Incontinence*	"Do you have incontinence?" (yes/occasionally/no)
Frailty*	The Edmonton Frail Scale

Sarcopenia*	The 5-item Sarcopenia Assessment (SARC-F)
Cognition	Mainly assessed with Montreal Cognitive Assessment Hong Kong version (HK-MoCA) but in an earlier stage, Abbreviated Memory Inventory for Chinese (AMIC) was used.
Quality of life	The EuroQol EQ-5D-5L (EQ5D)
Daily Function	Instrumental Activities of Daily Living (IADL) including ability to use telephone, mode of transportation, shopping, food preparation, ability to handle finances
Use of health services	Visits to primary care doctors, specialist outpatient clinics, admission to hospital, use of services in elderly daycare centers and out-of-pocket healthcare cost both in private and public in the past year
Alcohol use	The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C) for those who drank alcohol in the past year
Tobacco use	One question asking for current, ex- and non-smoking behavior
Caregiving to somebody else	"Are you taking care of somebody?" (Yes/No)
Social economic status	Age, gender, marriage, living status, employment, receiving of social welfare scheme
Physical examination	
Blood pressure	Measured twice in 15 minutes after rest
Body Mass Index (BMI)	
Waist circumference	
Handgrip strength	Each hand was measured twice
Electronic health record and self-report data	
Chronic diseases	43 common chronic conditions in 15 categories including: 1. Metabolic diseases (hypertension, lipid disorder, diabetes) 2. Cancer 3. Disease of the cardiovascular system (coronary heart disease, stroke/cerebrovascular disease, peripheral vascular disease) 4. Disease of the respiratory system (COPD, bronchiectasis, asthma, chronic pharyngitis /laryngitis) 5. Disease of the liver, spleen and gallbladder (gallbladder/spleen disease, viral hepatitis, chronic liver disease) 6. Disease of the stomach and intestines (dyspepsia and gastritis, diverticular disease of intestine, chronic enteritis; irritable bowel syndrome; constipation)

	7. Disease of the musculoskeletal and connective tissue (chronic pain needing medication control, skeletal and connective tissue inflammation (such as arthritis, gout)) 8. Disease of the genitourinary system (chronic kidney disease (nephritis), prostatitis, benign prostatic hyperplasia) 9. Disease of the ear, nose and throat (ENT) (chronic rhinitis, deafness/tinnitus) 10. Disease of the visual system (glaucoma/cataracts, blindness/amblyopia, diabetic eyes, retinal detachment) 11. Disease of the skin (eczema, psoriasis) 12. Disease of the blood (anemia) 13. Disease of the nervous system (multiple sclerosis, migraine, epilepsy, Parkinson's disease) 14. Mental disorders (schizophrenia/bipolar disorder, depression, anxiety & other stress related disorders, dementia) 15. Others
Use of medication	Medication use number and duration (0-1 year/2-5 years/>5 years) for antihypertensive drugs, cardiovascular drugs, cholesterol-lowering drugs, antidiabetics, antipsychotics and analgesics

* Measures were added at later stages: about 712 to 995 patients received these measures.

Table 2 Basic characteristics and biopsychosocial health profiles of the elderly with multimorbidity in primary care in Hong Kong

	Un-weighted rates and analyses				Weighted rates and analyses			
Characteristics	**Female (n = 753)**	**Male (n = 324)**	**P values**	**Crude total %**	**Female (n = 568)**	**Male (n = 508)**	**P values**	**Weighted total %**
Female				69.9%				52.8%
Age (mean, sd)	69.6 (6.6)	71.1 (7.1)	<0.001	70.0 (6.8)	71.3 (8.4)	70.2 (7.9)	0.097	70.5 (7.9)
60-64	22.8%	19.8%	0.002	22.0%	28.8%	31.4%		30.2%
65-69	35.6%	26.5%		32.9%	22.9%	25.3%		24.0%
70-74	21.8%	24.4%		22.5%	12.5%	14.5%		13.4%
75-79	9.7%	16.4%		11.6%	12.1%	13.0%		12.5%
80 or above	10.1%	13.0%		11.0%	23.8%	15.7%		20.0%
Marriage			<0.001				<0.001	
married	57.9%	89.2%		67.3%	54.7%	82.9%		68.1%
single/divorced/separated	11.8%	4.3%		9.6%	10.9%	9.6%		10.3%
widowed	30.2%	6.5%		23.1%	34.4%	7.5%		21.7%
No. of children (mean, sd)	2.5 (1.6)	2.5 (1.2)	0.409	2.52 (1.47)	2.7 (1.9)	2.4 (1.3)	0.013	2.53 (1.6)
Living alone	16.5%	8.3%	<0.001	14.0%	18.4%	11.9%	0.004	14.6%
Employment								
Retired/ Housewife	96.0%	82.4%	<0.001	91.9%	95.8%	77.5%	0.000	86.9%
Employed	4.0%	17.6%		8.1%	4.2%	22.5%		13.1%
Education (year, mean, sd)	7.2 (4.7)	8.7 (4.1)	<0.001	7.7 (4.6)	6.5 (4.6)	8.9 (4.1)	<0.001	7.7 (4.5)
Year of education ≥ 6 years	46.8%	59.5%	0.001	49.3%	40.7%	63.2%	<0.001	51.8%
Social security recipient	58.1%	59.3%	0.726	58.6%	59.8%	50.5%	0.002	55.4%
Comprehensive Social Security Assistance (CSSA) Scheme	11.4%	7.1%	0.031	10.1%	12.3%	7.6%	0.011	10.1%
Fruit Voucher	44.7%	50.3%	0.089	46.4%	45.5%	41.5%	0.190	43.6%
Disability allowance	3.7%	3.1%	0.604	3.5%	3.9%	3.0%	0.426	3.5%
Other	0.5%	0,3%	0.621	0.5%	0.4%	0.3%	0.803	0.3%
Caregiving to somebody	18.9%	14.5%	0.118	17.6%	16.8%	13.0%	0.126	15.0%
Alcohol use								
Yes, in last 12 months	5.4%	29.3%	<0.001	12.6%	5.2%	29.8%	<0.001	16.8%
AUDIT-C [g]								
AUDIT-C positive (>=3)	1.4%	11.1%	<0.001	4.4%	1.5%	11.2%	<0.001	6.1%
Smoke			<0.001				<0.001	
Never smoke	97.1%	60.5%		86.1%	96.9%	60.3%		79.6%
Smoke	0.8%	7.1%		2.7%	0.8%	7.2%		3.8%
Quit smoke	2.1%	32.4%		11.2%	2.4%	32.5%		16.6%
Self-rated health							0.001	

Excellent/very good/good	26.0%	34.7%	<0.001	28.5%	26.8%	32.7%		29.5%
Fair	59.5%	58.4%		59.2%	58.6%	60.1%		59.3%
Poor	14.6%	6.9%		12.3%	14.7%	7.2%		11.2%
Number of chronic conditions (mean, sd)	4.0 (1.7)	4.3 (1.9)	0.004	4.1 (1.8)	4.0 (1.7)	4.3 (1.9)	0.026	4.1 (1.8)
2 diseases	21.4%	15.4%	0.003	19.6%	22.6%	16.0%	0.019	19.4%
3 diseases	25.5%	28.7%		26.5%	25.1%	29.8%		27.3%
4 diseases	21.0%	17.0%		19.8%	19.5%	16.1%		17.9%
5 disease	15.0%	13.0%		14.4%	14.8%	12.7%		13.8%
6+ disease	17.1%	25.9%		19.8%	18.1%	25.4%		21.5%
Chronic conditions by category								
Metabolic diseases	82.%	86.7%	0.066	83.6%	83.8%	85.5%	0.449	84.6%
Cancer	7.3%	13.0%	0.003	9.0%	7.0%	11.6%	0.009	9.2%
Cardiovascular diseases (CVD)	13.4%	24.7%	<0.001	16.9%	14.5%	24.1%	<0.001	19.0%
Respiratory disease	6.1%	9.6%	0.043	7.2%	6.4%	9.9%	0.039	8.1%
Liver disease	9.3%	10.2%	0.649	9.6%	9.3%	10.8%	0.439	10.0%
Gastrointestinal disorders	28.0%	23.8%	0.148	26.7%	27.7%	23.2%	0.093	25.5%
Musculoskeletal disorders (MSK)	65.2%	48.8%	<0.001	60.3%	65.5%	49.8%	<0.001	58.1%
Thyroid disease	9.7%	1.9%	<0.001	7.3%	9.2%	1.9%	<0.001	5.7%
Renal disease	2.3%	33.3%	<0.000	11.6%	2.1%	31.7%	<0.001	16.1%
ENT	8.9%	9.3%	0.849	9.0%	8.8%	9.6%	0.645	9.2%
Eye	27.9%	22.5%	0.067	26.3%	29.1%	20.5%	0.001	25.0%
Skin	9.3%	9.9%	0.765	9.5%	9.0%	10.5%	0.401	9.7%
Anemia	3.1%	2.8%	0.806	3.0%	3.0%	2.8%	0.867	2.9%
Neurological disease	0.7%	1.2%	0.346	0.8%	0.5%	1.3%	0.175	0.9%
Mental disorders	16.7%	10.2%	0.005	14.8%	16.4%	11.2%	0.015	14.0%
Use of medication								
Antihypertensive drugs (mean, sd)	1.0 (0.9)	1.2 (0.9)	0.082	1.1 (0.9)	1.1 (0.9)	1.1 (0.9)	0.431	1.1 (0.9)
Percentage of patients who use	69.1%	75.3%	0.038	70.9%	71.3%	74.0%	0.326	72.5%
Cardiovascular drugs (mean, sd)	0.2 (0.5)	0.3 (0.6)	<0.001	0.2 (0.5)	0.2 (0.5)	0.3 (0.7)	0.024	0.24 (0.6)
Percentage of patients who use	11.8%	22.8%	<0.001	15.1%	12.7%	21.8%	<0.001	17.0%
Antidiabetics (mean, sd)	0.4 (0.7)	0.5 (0.8)	0.0195	0.4 (0.8)	0.3 (0.7)	0.5 (0.8)	0.029	0.4 (0.7)
Percentage of patients who use	22.6%	31.8%	0.001	25.4%	22.1%	31.9%	<0.001	26.7%
Cholesterol-lowering drugs (mean, sd)	0.4 (0.5)	0.5 (0.5)	0.005	0.4 (0.5)	0.4 (0.5)	0.5 (0.5)	0.004	0.4 (0.5)
Percentage of patients who use	38.8%	48.2%	0.004	41.6%	37.5%	48.4%	<0.001	42.7%
Antipsychotics (mean, sd)	0.2 (0.8)	0.1 (0.5)	0.038	0.2 (0.7)	0.2 (0.8)	0.1 (0.5)	0.035	0.2 (0.7)
Percentage of patients who use	11.7%	7.4%	0.035	10.4%	11.1%	7.7%	0.055	9.5%
Analgesics (mean, sd)	0.1 (0.5)	0.1(0.4)	0.875	0.1 (0.5)	0.1 (0.5)	0.1 (0.4)	0.929	0.1 (0.4)
Percentage of patients who use	10.5%	10.8%	0.879	10.6%	9.8%	10.2%	0.833	10.0%
Total number of medication (mean, sd)	2.3 (1.9)	2.7 (1.9)	0.001	2.4 (1.9)	2.3 (1.9)	2.6 (1.9)	0.025	2.5 (1.9)
% forgetting taking medication (n=995)	38.4%	34.0%	0.196	37.1%	36.3%	34.8%	0.640	35.6%
Oral Health Problem (n=992)	25.3%	20.6%	0.119	23.9%	24/8%	20.5%	0.104	22.8%
Incontinence (n=992)			0.004				<0.001	
No	77.0%	86.3%		79.7%	76.9%	86.6%		81.5%
Occasionally	21.3%	12.7%		18.8%	20.3%	12.7%		16.7%
Yes	1.7%	1.0%		1.5%	2.8%	0.7%		1.8%

Pain							
Muscle-skeletal pain for at least 3 months in the past year			0.000			<0.001	
No	19.1%	37.7%		24.9%	18.7%	37.4%	27.5%
Yes, one pain area	19.7%	23.8%		10.9%	18.7%	23.6%	21.0%
Yes, two or more pain areas	61.2%	38.6%		64.3%	62.7%	39.0%	51.5%
Brief Pain Inventory (BPI) [c]							
Interference (n=809)	4.6 (1.9)	4.1 (1.9)	<0.001	4.5 (1.9)	4.7 (2.0)	4.1 (1.9)	<0.001	4.4 (2.0)
Severity (n=810)	2.9 (2.2)	2.2 (1.8)	<0.001	2.7 (2.1)	2.9 (2.2)	2.2 (1.8)	<0.001	2.6 (2.1)
Physical Activity Scale for the Elderly (PASE) (n=809) [d]							
Mean (SD)	77.4 (34.9)	89.1 (61.5)	<0.001	80.3 (43.4)	74.7 (36.1)	95.7 (67.3)	<0.001	83.3 (52.2)
Sarcopenia (mean, sd) (n=719) [f]	1.5 (1.6)	0.7 (1.3)	<0.001	1.2 (1.5)	1.7 (1.8)	0.7 (1.2)	<0.001	1.2 (1.6)
Positive (≥4)	11.0%	5.7%	0.019	9.3%	15.5%	5.1%	<0.001	10.4%
Negative (0-3)	89.0%	94.3%		90.7%	84.5%	94.9%		89.6%
Cognition [h]							
AMIC (mean, sd) (n=337)	2.2 (1.7)	1.7 (1.6)	0.035	2.1 (1.7)	2.1 (1.7)	1.6 (1.6)	0.038	1.9 (1.7)
AMIC Positive % (>=3)	40.6%	27.3%	0.027	37.1%	39.3%	24.7%	0.007	33.3%
HK-MOCA (n=785)	24.7 (4.3)	25.4 (3.2)	0.026	24.9 (4.0)	24.0 (4.8)	25.5 (3.1)	<0.001	24.7 (4.1)
HK-MOCA Abnormal % (<22)	17.5%	12.6%	0.080	15.9%	23.0%	10.5%	<0.001	16.9%
Depression							
PHQ-2	1.3 (1.6)	0.8 (1.2)	<0.001	1.2 (1.5)	1.3 (1.6)	0.8 (1.3)	<0.001	1.1 (1.5)
Screen (-) (<3)	78.1%	88.3%	<0.001	81.2%	77.8%	87.6%	<0.001	82.4%
Screen (+) (≥3)	21.9%	11.7%		18.9%	22.2%	12.4%		17.6%
PHQ-9 (mean, sd) [a]	11.4 (4.3)	10.5 (4.5)	0.274	11.2 (4.4)	11.4 (4.2)	10.4 (4.3)	0.179	11.0 (4.3)
Mild (5-9)	8.8%	4.3%		7.4%	8.6%	4.8%		6.8%
Moderate (10-14)	7.3%	4.9%		6.6%	8.2%	5.4%		6.9%
Moderately severe (15-19)	4.2%	1.2%		3.3%	4.0%	1.2%		2.7%
Severe (20+)	1.3%	0.9%		1.2%	1.2%	0.8%		1.0%
Anxiety							
GAD-2 (≥3) (mean, sd)	1.4 (1.5)	0.8 (1.1)	<0.001	1.2 (1.5)	1.4 (1.6)	0.8 (1.1)	<0.001	1.1 (1.4)
Screen (-) (<3)	79.7%	91.1%	<0.001	83.0%	79.5%	90.9%	<0.001	84.9%
Screen (+) (≥3)	20.3%	9.0%		17.0%	20.5%	9.1%		15.1%
GAD-7 (mean, sd) [b]	10.8 (3.9)	9.8 (3.7)	0.182	10.7 (3.9)	10.9 (3.9)	10.1 (3.6)	0.294	10.7 (3.8)
Mild (5-9)	0.9%	0.3%		0.7%	0.7%	0.2%		0.5%
Moderate (10-14)	6.9%	4.6%		6.2%	8.5%	5.0%		6.8%
Moderately Severe (15-19)	9.6%	3.4%		7.7%	10.1%	4.4%		7.4%
Severe (20+)	2.9%	0.6%		2.2%	3.6%	0.6%		2.2%
Insomnia							
Insomnia in the past 2 weeks			0.030			0.086	
No	31.5%	28.3%		33.5%	32.2%	37.2%		34.6%
Yes	68.5%	61.7%		66.5%	67.8%	62.8%		65.4%

ISI (n=716) (mean, sd) [c]	12.0 (5.1)	10.2 (4.6)	<0.001	11.5 (5.0)	11.9 (5.1)	10.1 (4.5)	<0.001	11.1 (4.9)
No clinically significant insomnia (0-7)	13.7%	18.2%		15.0%	14.2%	18.8%		16.4%
Subthrehold insomnia (8-14)	31.1%	29.0%		30.5%	31.0%	29.7%		30.4%
Clinical insomnia, moderate severity (15-21)	22.2%	14.2%		19.8%	22.1%	15.0%		18.8%
Clinical insomnia, severe (22-28)	1.6%	0.3%		1.2%	1.5%	0.3%		0.9%
Meaning (0-7) (n=544)	4.8 (1.2)	5.0 (1.1)	0.098	4.8 (1.2)	4.7 (1.3)	5.0 (1.1)	0.022	4.9 (1.2)
Loneliness (n=741)								
One question (yes/no)			0.009				0.128	
No	68.0%	77.1%		72.5%	69.8%	74.6%		72.2%
Yes	32.1%	22.9%		27.5%	30.2%	25.4%		27.9%
De Jong Gierveld Loneliness Scale								
Total loneliness score (mean, sd)	1.8 (1.9)	1.6 (1.7)	0.121	0.7 (1.2)	1.8 (1.8)	1.6 (1.7)	0.309	1.7 (1.8)
Emotional loneliness score (mean, sd)	1.0 (1.1)	0.9 (1.0)	0.156	1.6 (1.8)	0.9 (1.0)	0.9 (1.0)	0.566	0.9 (1.0)
Social loneliness score (mean, sd)	0.8 (1.3)	0.7 (1.2)	0.121	0.9 (1.0)	0.8 (1.3)	0.7 (1.3)	0.350	0.8 (1.3)
Social Support (can count on someone willing and able to meet your needs)			0.083				0.146	
Always	61.2%	66.3%		62.7%	61.6%	65.8%		63.5%
Sometimes	31.1%	30.0%		30.7 %	31.2%	28.6%		30.0%
Never	7.7%	4.1%		6.7%	7.3%	5.6%		6.5%
Use of social media in last 2 weeks								
Yes	52.5%	52.1%	0.849	52.6%	46.6%	55.8%	0.003	51.0%
Web	20.9%	33.6%	<0.001	24.7%	18.5%	36.5%	<0.001	27.0%
WhatsApp	51.4%	50.0%	0.675	51.0%	45.9%	52.6%	0.028	49/0%
Facebook	15.9%	20.4%	0.077	17.3%	14.5%	20.7%	0.006	17.4%
Blog	1.7%	3.4%	0.089	2.2%	1.3%	3.0%	0.065	2.1%
E-literacy (n=566) [e]	25.0 (11.7)	24.9 (12.6)	0.931	25.0 (12.0)	25.5 (11.6)	25.4 (12.7)	0.953	25.4 (12.2)
Importance of social media (total score: 6-24)	11.3 (4.8)	10.8 (4.7)	0.218	11.1 (4.8)	11.5 (4.7)	10.8 (4.8)	0.171	11.1 (4.8)
Comfort of using social media (total score: 3-18)	8.2 (4.5)	8.2 (4.7)	0.975	8.2 (4.5)	8.3 (4.4)	8.3 (4.7)	0.878	8.3 (4.5)
Daily function (Percentage of patients needing help or being dependent)								
Total	8.4%	14.8%	0.001	10.3%	10.%	14.3%	0.056	12.3%
Using telephone	0.7%	1.2%		0.8%	1%	1%		1%
Transportation	4.7%	5.6%		4.3%	5.9%	5.4%		5.7%
Shopping	5.7%	5.0%		5.5%	7.5%	4.8%		6.2%
Preparing meals	4.3%	12.7%		6.8%	5.5%	12.7%		8.9%
Financial management	2.9%	4.9%		3.5%	4.1%	0.9%		2.6%
Frailty								
Edmonton Frail Scale (EFS) (mean, sd) (n=989) [f]	3.5 (2.3)	3.1 (2.0)	0.003	3.4 (2.2)	3.7 (2.4)	3.1 (2.0)	<0.001	3.4 (2.2)
No frailty (0-5)	80.3%	88.3%	0.012	82.6%	77.6%	88.7%	<0.001	82.8%
Apparently vulnerable (6-7)	13.7%	8.6%		12.2%	13.8%	8.7%		11.4%
Mild frailty (8-9)	4.7%	2.4%		4.0%	6.8%	2.0%		4.6%
Moderate frailty (10-11)	1.3%	0.3%		1.0%	1.8%	0.2%		1.1%

Severe frailty (12-18)	0%	0.33%		0.1%	0%	0.4%		0.2%
Quality of life (EQ5D-5L)								
Index score (range: -0.864 to 1)	0.8 (0.2)	0.9 (0.2)	0.001	0.81 (0.20)	0.8 (0.2)	0.9 (0.2)	<0.001	0.81 (0.2)
visual analogue scale (VAS) (0-100)	66.0 (15.3)	69.6 (13.4)	<0.001	67.1 (14.8)	66.0 (15.4)	69.4 (13.3)	0.001	67.6 (14.6)
Health care utilization in the past year								
Hospitalization frequency			0.453				0.557	
0	83.8%	81.2%		83.0%	83.6%	82.0%		82.9%
1-2	14.4%	17.3%		15.2%	14.0%	16.7%		15.3%
2+	1.9%	1.5%		1.8%	2.4%	1.3%		1.9%
Hospitalization Length (days, mean, sd) (n=1073)	1.1 (5.1)	1.5 (8.2)	0.424	1.2 (6.2)	1.1 (5.1)	1.4 (8.3)	0.535	1.2 (6.8)
Specialist Out-patient Clinics (SOPC)	69.0%	70.7%	0.587	69.5%	68.8%	70.2%	0.636	69.5%
General Out-patient Clinics (GOPC)	89.6%	94.1%	0.018	91.0%	89.8%	94.3%	0.007	92.0%
Elderly day care service	9.4%	9.9%	0.824	9.6%	10.2%	9.1%	0.554	9.6%
Cost (out of pocket) (HKD) median (interquartile range, IQR) (n=1063)	1000 (0, 3000)	1000 (0, 2000)	0.141	1000 (0, 3000)	1000 (0, 3000)	1000 (0, 2000)	0.488	1000 (0, 3000)
<u>Physical examinations</u>								
Blood pressure (BP)								
Systolic (mean, sd)	133.2 (15.6)	134.2 (15.9)	0.337	133.5 (15.7)	133.5 (16.3)	133.3 (15.2)	0.848	133.4 (15.8)
Diastolic (mean, sd)	74.9 (9.6)	78.4 (10.0)	<0.001	75.9 (9.9)	74.1 (10.0)	78.6 (9.9)	<0.001	76.2 (10.2)
Normal (SBP <120 & DBP <80)	19.2%	14.8%	0.272	17.9%	19.9%	15.8%	0.070	17.9%
Pre-hypertension (SBP: 120-139 or DBP: 80-89)	45.8%	48.2%		46.5%	44.6%	48.4%		46.4%
Stage I hypertension (SBP: 140-159 or DBP: 90-99)	30.2%	30.6%		30.3%	29.9%	29.8%		29.8%
Stage II hypertension (SBP ≥ 160 or DBP ≥ 100)	4.8%	6.5%		5.3%	5.6%	6.0%		5.8%
Pulse (per minute)	71.5 (19.5)	75.2 (28.0)	0.016	72.7 (22.5)	71.7 (22.0)	74.9 (24.8)	0.041	73.2 (23.4)
Weight (kg, mean, sd)	57.5 (56.8)	66.5 (9.6)	<0.001	60.2 (10.4)	56.9 (9.3)	66.9 (9.7)	<0.001	61.6 (10.7)
Height (cm, mean, sd)	154.0 (6.2)	165.5 (6.7)	<0.001	157.4 (8.2)	153.4 (6.2)	165.6 (6.7)	<0.001	159.2 (8.8)
Waist circumference (cm, mean, sd)	88.8 (9.7)	93.2 (9.5)	<0.001	90.2 (9.9)	89.1 (9.9)	93.2 (9.2)	<0.001	91.1 (9.8)
Body mass Index (BMI) (mean, sd)	24.2 (3.8)	24.2 (2.0)	0.963	24.2 (3.6)	24.2 (3.7)	24.4 (3.1)	0.398	24.3 (3.4)
Underweight (<18.5)	4.1%	2.8%	0.067	3.7%	3.6%	2.7%	0.013	3.1%
Normal (18.5-22.9)	37.6%	31.3%		35.7%	38.9%	31.5%		35.4%
Overweight (23-24.9)	20.4%	26.0%		22.1%	20.5%	23.6%		22.0%
Obese (≥ 25)	37.9%	39.9%		38.5%	37.0%	42.2%		39.5%
Handgrip strength (kg) [i]								
< cutoff score (<26 for male, <18 for female)	36.3%	36.1%	0.964	36.2%	40.2%	34.7%	0.061	37.6%

Left hand (mean, sd)	17.4 (4.2)	26.4 (7.0)	20.1 (6.6)	17.0 (4.2)	26.7 (7.0)	21.5 (7.5)
Right hand (mean, sd)	18.5 (4.3)	27.4 (7.5)	21.1 (6.8)	18.0 (4.3)	27.5 (7.7)	22.5 (7.7)
Both hand (mean, sd)	19.1 (4.1)	28.5 (7.1)	21.9 (6.7)	18.6 (4.0)	28.8 (7.2)	23.4 (7.6)

Abbreviations: GAD-2: the two-item General Anxiety Disorder scale; HK-MoCA: Montreal Cognitive Assessment Hong Kong version (HK-MoCA); ISI: the 7-item Insomnia Severity Index; EQ5D: the EuroQol EQ-5D-5L; PHQ-2: The two item Patient Health Questionnaire for depression; The 3-item Alcohol Use Disorders Identification Test-consumption (AUDIT-C); SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Statistical methods: Chi square tests were used for categorical data; paired t tests were used for continuous data.

Notes:

[a] Mean (SD) was for 203 patients who did PHQ-9. The % was for all the 1077 patients with the rest 874 patients who screened negative in PHQ-2 regarded as having normal scores in PHQ-9.

[b] Mean (SD) was for 182 patients who did GAD-7. The % was for all the 1077 patients with the rest 895 patients who screened negative in GAD-2 regarded as having normal scores in GAD-7.

[c] 719 patients were assessed with ISI.

[d] Only those who had one or more pain areas in the past 3 months were assessed with BPI or PASE-C.

[e] Only those who had social media use in the past 2 weeks were assessed.

[f] Measured by the 5-item Sarcopenia Assessment (SARC-F) which were added at a later stage.

[g] N=136, those who did not drink alcohol the past 12 months were regarded as 0 in AUDIT-C.

[h] HK-MOCA replaced AMIC in a later stage.

[i] Better result of two series for left or right hand, or best result of both hands.

Figure 1 Flowchart of recruitment

Figure 2 Unweighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are unweighted (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

Figure 3 Weighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

Figure 4 Unweighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%))

Figure 5 Weighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%))

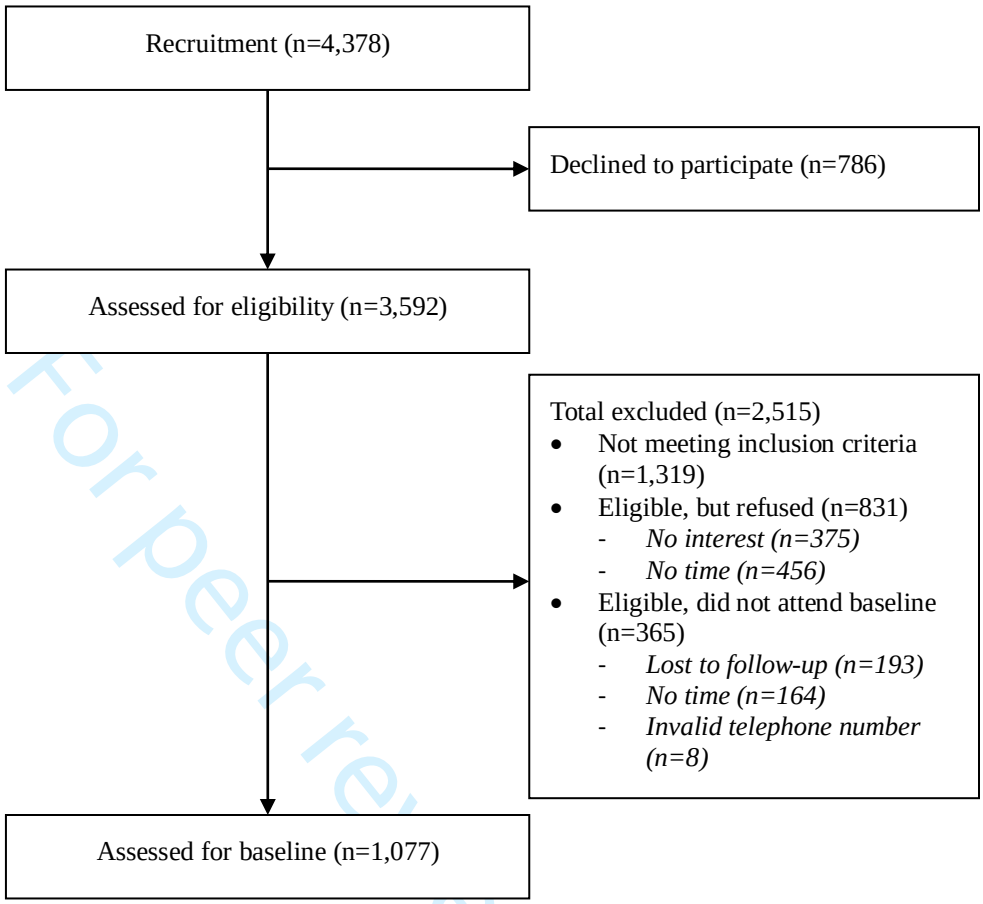

Figure 1 Flowchart of recruitment

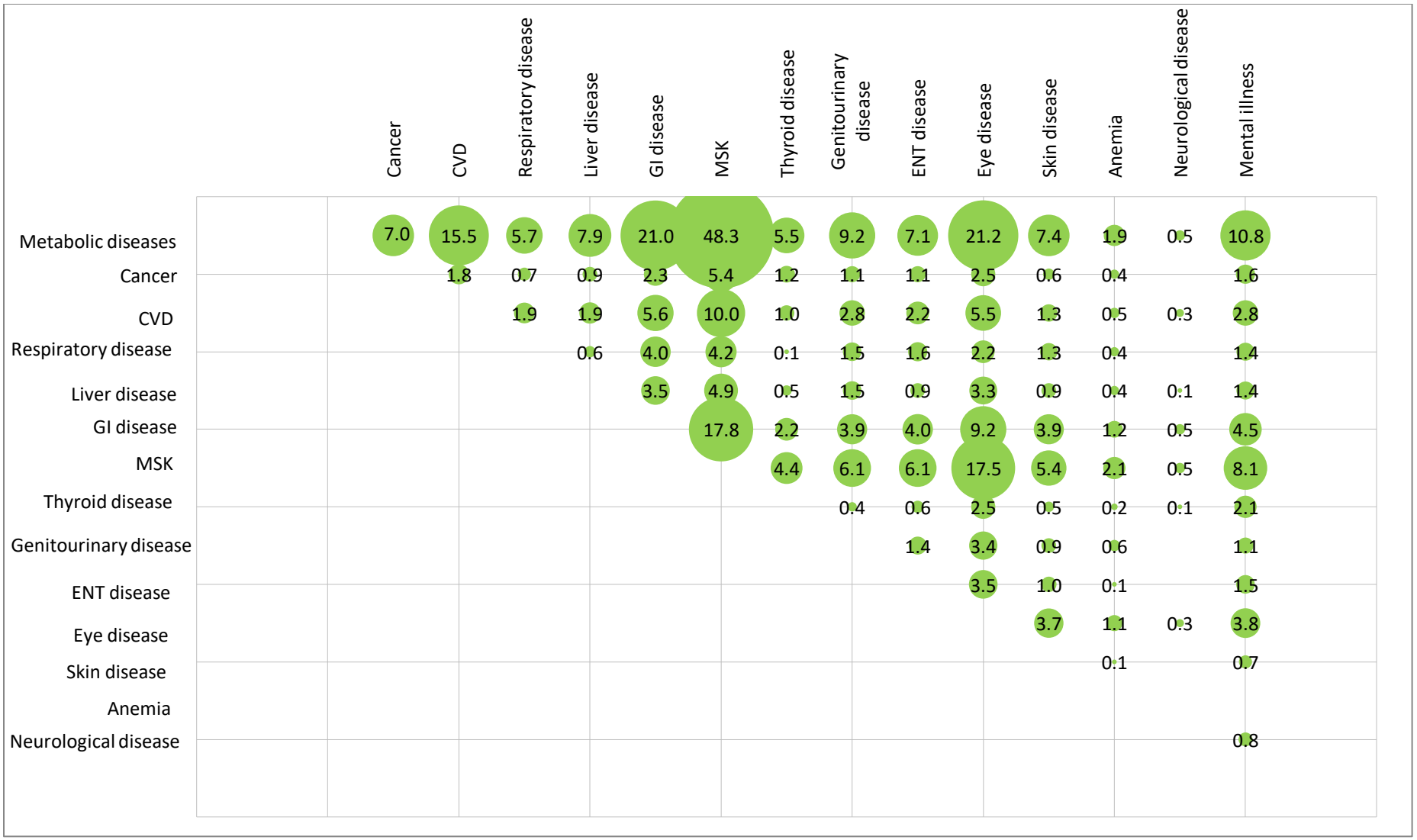

Figure 2 Unweighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

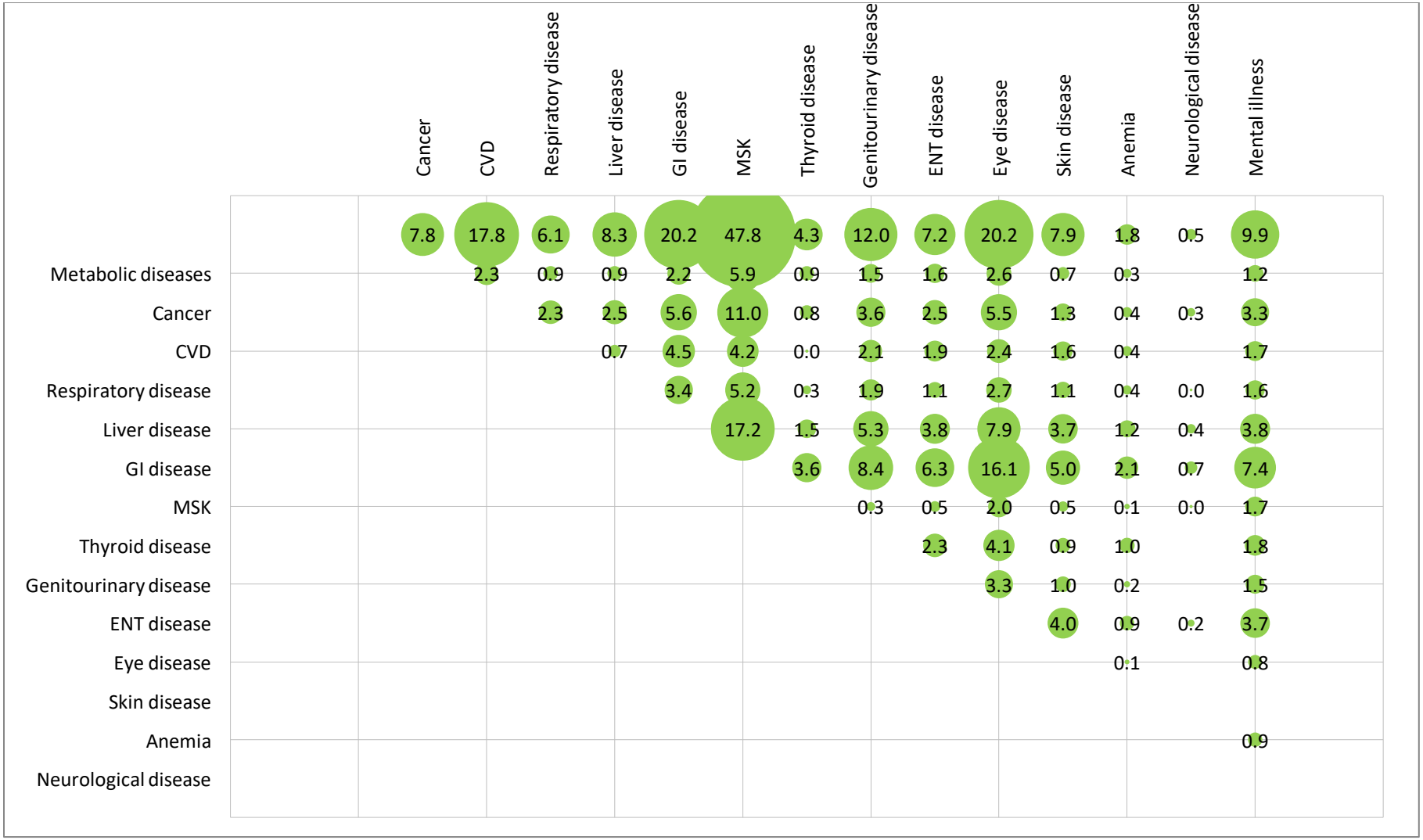

Figure 3 Weighted prevalence of co-morbidities (by 15 disease categories) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%); CVD: cardiovascular disease; GI disease: gastrointestinal disease; MSK: Musculoskeletal Disorders; ENT: eye, nose and throat)

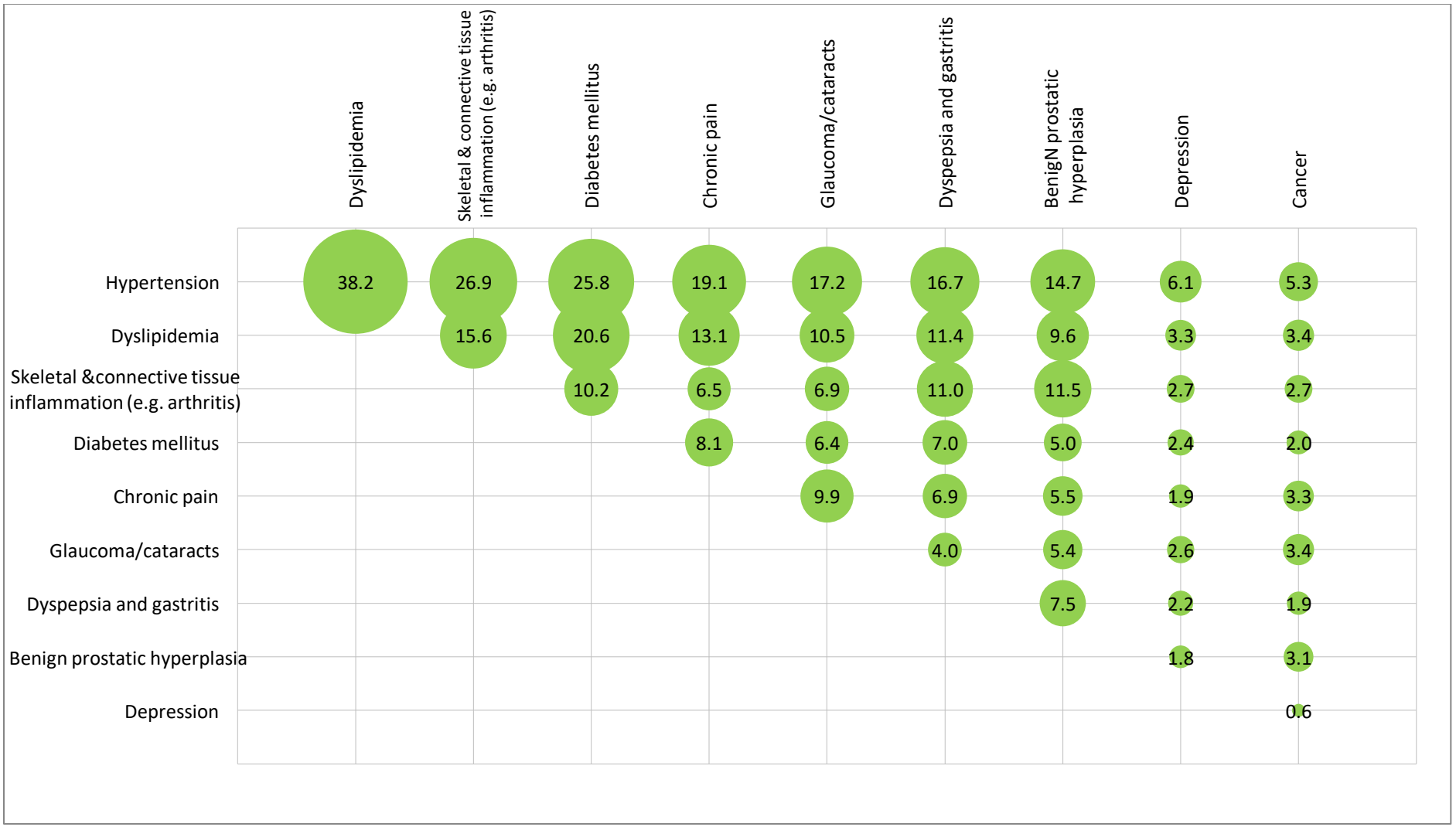

Figure 4 Unweighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are unweighted prevalence (%))

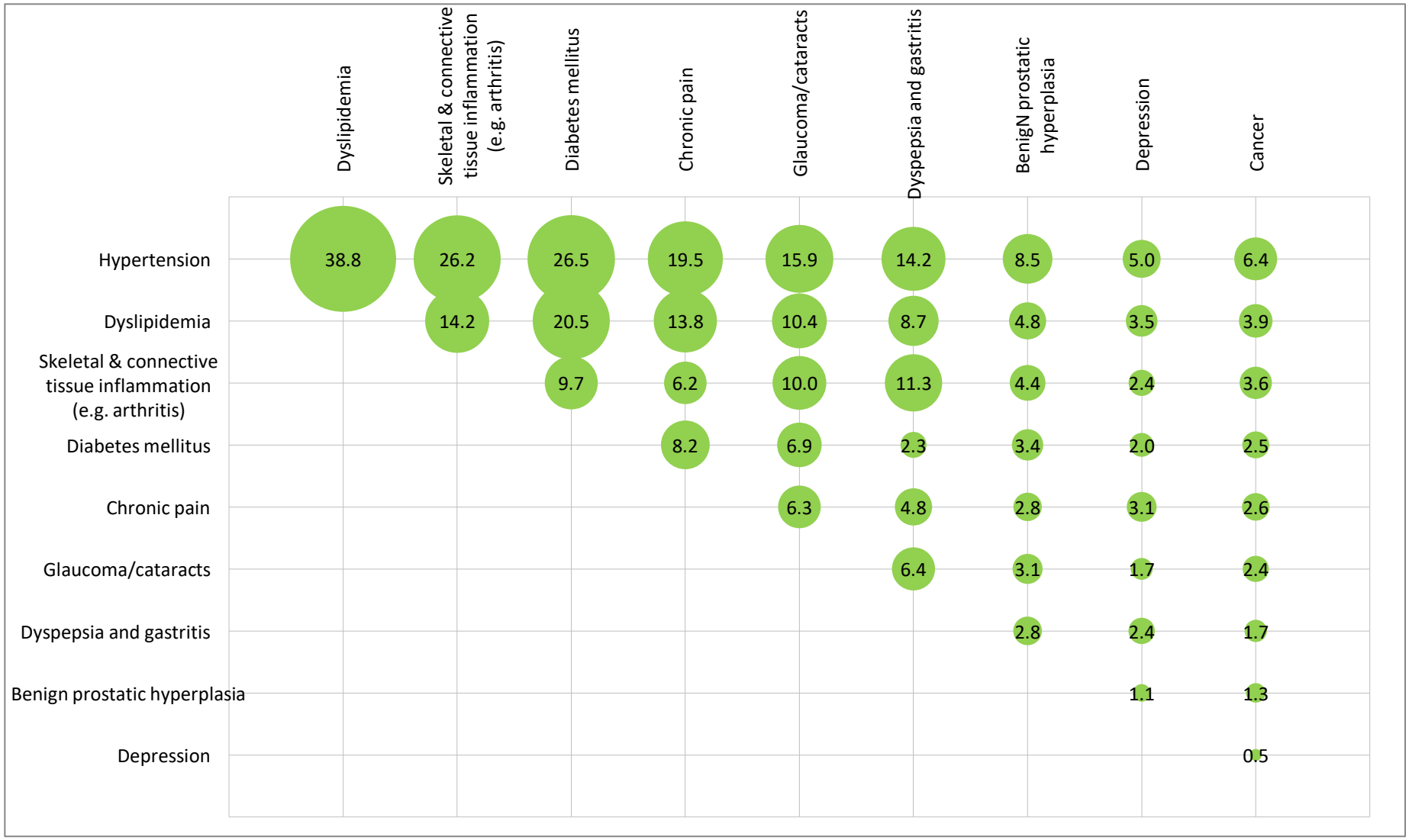

Figure 5 Weighted prevalence of the co-morbidities of top 10 chronic conditions (out of 43 specific chronic conditions) among the 1077 elderly with multimorbidity

(Figures are weighted prevalence (%))

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P1-2	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P4–5	
Objectives	3	State specific objectives, including any prespecified hypotheses	P5	
Methods				
Study design	4	Present key elements of study design early in the paper	P5	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5-8	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	P5-8	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P6-8, Table 1	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P6-8, Table 1	
Bias	9	Describe any efforts to address potential sources of bias	P8-9	
Study size	10	Explain how the study size was arrived at	P6	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P9-10, Table 2
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P8-10
		(b) Indicate number of participants with missing data for each variable of interest	P8-10, Table 2, Figure 2, Figure 3
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	P9-10, Table 2, Figure 2, Figure 3
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	Table 2

	(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	p11	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p13-14	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	p14	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p1	Funding The work was supported by The Hong Kong Jockey Club Charities Trust.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.