

Prevalence of complexity in primary care and its associated factors: A Singapore experience

Jing Sheng Quek¹ FCFP(S), Jeremy Kaiwei Lew¹ MA (Biomedical Informatics), Eng Sing Lee^{1,2} PhD,
Helen Elizabeth Smith³ DM, Sabrina Kay Wye Wong^{1,2} PhD

ABSTRACT

Introduction: As the population ages, patient complexity is increasing, intensifying the demand for well-resourced, coordinated care. A deeper understanding of the factors contributing to this complexity is essential for optimising resource allocation. This study evaluates the prevalence of complex care needs in Singapore's primary care settings and identifies the factors associated with these needs.

Methods: Using a qualitative study design, we developed a patient complexity questionnaire to assess how Singapore family physicians recognise patient complexity. Sixty-nine experienced primary care physicians applied this tool to assess patient encounters, categorising each as "routine care" (RC), "medically challenging" (MC), or "complex care" (CC). We compared the care needs across these categories and used mixed-effects multinomial logistic regression to determine the independent predictors of complexity.

Results: Of the 4327 encounters evaluated, 15.0% were classified as CC, 18.5% as MC, and 66.4% as RC. In both CC and MC encounters, the most common medical challenges were polypharmacy (66.2% in CC, 44.9% in MC); poorly controlled chronic conditions (41.3% in CC, 24.5% in MC); and treatment interactions (34.4% in CC, 26.0% in MC). Non-medical issues frequently identified included low health literacy (32.6% in CC, 20.8% in MC); limited motivation for healthy lifestyle behaviours (27.2% in CC, 16.6% in MC); and the need for coordinated care with hospital specialists (24.7% in CC, 17.1% in MC). The top 3 independent predictors of complexity included mobility limitations requiring assistance (odds ratio [OR] for requiring wheelchair/trolley: 7.14 for CC vs RC, 95% confidence interval [CI] 4.74–10.74); longer consultation times with physicians (OR for taking >20 minutes for doctor's consultation: 3.96 for CC vs RC, 95% CI 2.86–5.48); and low socioeconomic status (OR for living in 1- or 2-room HDB flats: 2.98 for CC vs RC, 95% CI 1.74–5.13).

Conclusion: High care needs, encompassing both CC and MC encounters, were prevalent in primary

care interactions. These findings highlight that relying solely on chronic disease count is insufficient to capture the full spectrum of patient complexity.

Ann Acad Med Singap 2025;54:87-100

Keywords: complex care, epidemiology, family medicine, multimorbidity, public health, social science

CLINICAL IMPACT

What is New

- The prevalence of complexity in primary care was 15.0%, with another 18.5% of encounters deemed medically challenging.
- Complex care encounters were associated with longer doctor, nursing and allied health consultation time with higher overall cost of care.

Clinical Implications

- Patients with complex needs require adequate consultation time and an integrated, well-coordinated, team-based care approach.
- Medical education should incorporate complexity training.
- Imperative for a better way to systematically and accurately capture complexity.

INTRODUCTION

As Singapore's population ages, the incidence of non-communicable chronic diseases will rise in tandem.¹ There exists a subset of individuals, oftentimes elderly with multiple chronic conditions, whose care needs are particularly complex.² While

The Annals is an open access journal, allowing non-commercial use under CC BY-NC-SA 4.0.

¹ National Healthcare Group Polyclinics, Singapore

² Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore

³ School of Medicine, Keele University, United Kingdom

Correspondence: Dr Jing Sheng Quek, Woodlands Polyclinic, National Healthcare Group Polyclinics, 3 Fusionopolis Link, Nexus@one-north, South Tower, #05-10, Singapore 138543.

Email: jing_sheng_quek@nhgp.com.sg

Accepted: 09 December 2024

there is no universal definition of a person with complex needs, these individuals have been found to consume more healthcare resources, yet often have poorer health outcomes.³⁻⁵ There is a need to improve care for these individuals, but much is unknown about their prevalence, their needs and the ways to improve their outcomes, particularly in Asian settings.⁶

The prevalence of complexity in primary care varies greatly internationally, ranging from 3.98% to 42.5%.⁷⁻¹¹ These differences stem from discrepant healthcare contexts across localities, as well as varying definitions of complexity used.¹² For instance, a Spanish study¹¹ that found a complexity prevalence of 3.98% relied primarily on the clinical judgment of general practitioners among primary care patients over 14 years old with chronic conditions, while an English study¹⁰ that employed a model with a predetermined definition of complexity derived using a Delphi methodology arrived at a complexity prevalence of 41.6–42.5%.

In Singapore, polyclinics are large publicly-funded primary care clinics with a comprehensive suite of services including medical, nursing, allied health, laboratory and basic radiology. Many patients with chronic conditions choose polyclinics for their care due to low out-of-pocket costs and care accessibility.¹³ An estimated 6.9 million visits were made to polyclinics in 2023, and the top conditions were hyperlipidaemia, hypertension and diabetes mellitus.¹⁴ With the high volume of care for chronic conditions at polyclinics, we hypothesise that prevalence of complexity is also high.

In terms of definition of complexity, some studies and health systems equate complexity with multimorbidity.¹⁵ The Singapore Ministry of Health (MOH), for instance, uses number of chronic conditions to define complexity.¹⁶ However, most experts recognise that non-biomedical aspects like mental health, socioeconomic factors and patient preferences contribute to complexity and should be considered.¹² To better account for complexity, multiple frameworks¹⁷⁻¹⁹ and measurement tools have been developed. For example, a Canadian group developed a complexity framework with 5 health dimensions: demographics, mental health, social capital, medical/physical health, and health and social experiences, that considers a patient's sociopolitical and physical environmental contexts.¹⁹ While frameworks are helpful for understanding complexity conceptually, they are less useful for clinical implementation. Additionally, many frameworks highlight the influence of cultural, community and local healthcare system factors on patient

complexity.^{17,19} These factors differ from country to country, underscoring the importance of contextual evidence.²⁰ The paucity of Asian studies on this topic is a significant barrier to understanding and addressing these complex care (CC) needs in the local setting.^{12,20,21}

Some studies have developed various tools to quantify complexity, such as the Cumulative Illness Rating Scale (CIRS), INTERMED and Patient Centered Assessment Method (PCAM).²²⁻²⁴ However, these tools come with their own limitations, such as lack of contextual adaptation to the local setting, omission of key factors, and insufficient granularity.

Recognising the limitations of existing tools and acknowledging primary care physicians' knowledge of complexity—given their unique positions as first-line providers and coordinators of care for many individuals with complex needs,^{7,11} we undertook a foundational approach. We decided to first gain a deeper understanding of the nature of complexity in Singapore's primary care, rather than prematurely applying a measurement tool with limited scope. To this end, we previously undertook a qualitative study to understand how family physicians in Singapore recognise complexity.²⁵ Through this study involving physicians practising in both private and public primary care settings, we found 2 distinct groups of patients that required more clinical effort and resources (i.e. high care needs): patients with CC needs and those with medically challenging (MC) issues. In CC, 1 or more difficult medical issues were encountered, with concomitant issues in 1 or more of the following domains: psychological, socioeconomic and behavioural; and these factors adversely impacted medical care and outcomes. In contrast, with MC, issues were mainly limited to the medical domain. Patients not fitting the above characteristics were considered routine care (RC). The qualitative study findings suggested that while CC and MC patients could both be considered "complex", CC patients had higher level care needs than MC patients. We were interested to identify the complexity-related factors that may differ between MC and CC.

This study aimed to further characterise complexity by assessing the prevalence of CC needs and identifying factors associated with high care needs (i.e. CC and MC) in a real-world primary care population. Understanding the magnitude (i.e. prevalence) of complexity and its associated factors is a critical first step in guiding future research and informing efforts to effectively manage complexity in primary care.

METHOD

Study design, population and recruitment

Experienced primary care physicians (PCPs) with postgraduate Family Medicine (FM) qualifications—Graduate Diploma in FM (GDFM), Master of Medicine in FM (MMed[FM]) or Fellowship of the College of Family Physicians Singapore (FCFP[S])—from National Healthcare Group Polyclinics (NHGP) were invited to participate in this cross-sectional study, where PCPs code patients that they had seen. We included physicians with FM training and experience, to mitigate the perception of complexity that may stem from underdeveloped professional competencies.¹²

NHGP has 6 polyclinics in central and northwest Singapore, providing subsidised primary care to an estimated population of 1.5 million residents, ranging from acute care services to chronic disease management and women and child health services.²⁶ Each polyclinic is a publicly-funded “one-stop” facility that houses physicians, nurses and allied healthcare professionals, with laboratory and radiological capabilities.²⁷

To determine the prevalence of patient encounters with high care needs in a representative population from NHGP, weighted random sampling was carried out from 24 August 2022 to 30 November 2022. Physicians were recruited from all 6 polyclinics according to the proportion of patients in NHGP seen at each clinic. PCPs were randomly selected using a random number generator and invited via email. Informed consent was obtained.

Patient complexity questionnaire

Based on the findings of a local qualitative study²⁵ and triangulating with other studies,^{3,7,10,12,17–20,28–30} a questionnaire on CC needs in Singapore primary care was formulated with inputs from an expert panel of experienced PCPs over a few meetings. The questionnaire was pre-tested (n=8) and pilot-tested (n=13), with revisions done iteratively before study commencement.

Participating PCPs assigned a complexity rating for each patient encounter, based on 3 categories: RC, MC and CC. CC needs were also identified and were categorised according to the following domains: (1) medical (7 issues); (2) functional (3 issues); (3) mental health (9 issues); (4) social (4 issues); (5) behavioural (6 issues); as well as (6) resource utilisation (7 issues) (see Supplementary Material Annex A). An encounter was considered CC if there was 1 or more medical domain issues that interacted with a concomitant issue in another non-medical domain (2–6) impacting medical care and outcomes. MC encounters were mainly medical

domain issues with little interacting issues in other domains that affected medical care or outcomes. RC encounters were routine encounters that were not considered CC or MC.

PCP participants attended training sessions—each lasting an hour and held virtually over a video-conferencing platform—on questionnaire-filling to standardise the categorisation of CC, MC and RC, using case studies to illustrate each category of patient encounters.

Sample size

The estimated sample size was 3450 according to the following formula³¹: $n = [Z^2 P(1-P)] / d^2$, where Z is the statistic for level of confidence of 1.96, P is the expected prevalence of 42.5% (based on prior studies^{7–10}), d is precision of 2%,³² and after multiplying a variance inflation factor (VIF) of 1.47 to take into account the possible clustering of data within PCPs,³³ where $VIF = 1 + ICC(\text{cluster size} - 1)$, using a conservative intraclass correlation (ICC) of 0.01³⁴ and an estimated cluster size of 48 patients seen per PCP. Assuming each PCP would see 42–54 patients over 4 half-day sessions, 64–82 PCPs were required.

Data collection

Participating PCPs retrospectively assessed the complexity and care needs of patients they saw over 4 half-day sessions, referring to electronic case notes. To reduce recall bias, PCPs completed each questionnaire no later than 1 day after the clinic session. Questionnaires were hosted on REDCap.³⁵ To ensure the confidentiality of PCPs and their patients, participants entered a uniquely-assigned physician code and each patient's masked identity number into the questionnaires, without any other identifiers. Each PCP participant received reimbursement of SGD60 (USD44) in grocery vouchers for each half-day clinic session of case notes review and questionnaire filling.

We obtained patient characteristics based on routinely-collected data in the NHGP database, including clinical and resource utilisation data in the preceding year. Time of consultation was extracted electronically based on time spent between the successful “call” of the patient's queue number and the transfer of the patient's queue number to the next provider. The medical conditions included were selected based on clinical judgment, local practice guidelines (Chronic Disease Management Programme¹⁶) and evidence on multimorbidity,^{36,37} and extracted based on coding in electronic medical records (EMR). A member of the data analytics department who was not part of the study team extracted the data and clarified any missing

fields on questionnaire with individual participants to ensure data completeness. Only de-identified data were sent to the study team for analysis.

Data analysis

We analysed the prevalence of complex patient encounters and CC needs. We compared EMR-derived sociodemographic, disease status and resource utilisation characteristics between the 3 groups of patients (RC, MC and CC), applying Kruskal-Wallis test for comparison of continuous variables, and Pearson's chi-squared test or Fisher's Exact test for categorical variables. Similarly, we compared the frequency of questionnaire complex factors between RC, MC and CC using Pearson's chi-squared test or Fisher's Exact test. We developed a mixed-effects multinomial logistic regression model to identify independent predictors of complexity (that were derived from EMR data), comparing RC with MC and CC, while accounting for potential clustering effects at the PCP level, fitted using the Mclogit R package version 0.9.6 (Elff, 2022). We also compared physician-identified complexity with the MOH definition of complexity,¹⁶ which is based on the number of chronic conditions present: simple being 1 chronic condition, moderate being 2 or 3 chronic conditions and complex being 4 or more chronic conditions.

For patients with 2 or more visits recorded, we only considered the first visit to eliminate multiple levels of clustering. We did not detect significant collinearity using VIF. All analyses were performed using R version 4.4.1 (R Core Team, 2021). The National Healthcare Group Domain Specific Review Board approved our study (2022/00226).

RESULTS

Sociodemographic characteristics

Seventy-two PCPs consented to participate (80.2% response rate). Eventually, 69 PCPs (95.8% completion rate) from 6 polyclinics assessed the complexity of 4327 unique patients, after excluding 24 second-visit encounters (see Supplementary Material Annex B). The mean age of patients was 61.2 years (standard deviation [SD] 17.4) with approximately equal proportion of genders. Among them, 73.7% were Chinese, 11.8% Malay, 8.8% Indian and 5.7% others. Socioeconomic status was represented by housing type: 3.6% lived in 1- or 2-room Housing & Development Board (HDB) government-subsidised flats,³⁹ 49.2% lived in 3- or 4-room HDB flats, and the remaining 47.2% in 5-room HDB, private housing and others (Table 1).

Prevalence of patient complexity

In terms of prevalence, 15.0% of patient encounters were CC, 18.5% deemed MC and 66.4% RC (Table 1).

Demographic, medical and resource factors

Demographic and encounter-related factors

Table 1 describes the demographic- and encounter-related factors between CC, MC and RC. Patients with CC encounters were more likely to be older (67.5 years for CC, 65.3 years for MC and 58.7 years for RC, $P<0.001$), residing in 1- or 2-room HDB flats (7.8% in CC, 2.2% in MC, 3.0% in RC, $P<0.001$), and require assistance for ambulation (27.7% in CC, 12.6% in MC and 4.4% in MC, $P<0.001$). Patients with CC encounters had statistically significantly more issues managed (4.06 for CC, 3.51 for MC, 2.19 for RC, $P<0.001$) and more medications dispensed at the encounter (5.32 for CC, 4.45 for MC, 2.87 for RC, $P<0.001$).

Medical conditions

The top 5 medical conditions experienced by patients with high care needs were: hyperlipidaemia (81.4% in CC, 80.3% in MC), hypertension (75.9% in CC, 70.7% in MC), diabetes (60.7% in CC, 51.8% in MC), chronic kidney disease (23.2% in CC, 17.4% in MC) and ischaemic heart disease (19.8% in CC, 17.0% in MC) (Table 2).

Resource utilisation data

Patients with CC encounters utilised significantly more resources across all types of resources studied, including number of medications, cost of care, number and duration of visits to doctors, nurses, medical social workers, psychologists and financial counsellors (Table 2). Doctors spent a mean duration of 17.8 (SD 13.5) minutes attending to CC patients per consultation, compared to 14.9 (SD 9.8) minutes for MC patients, and 12.7 (SD 11.8) minutes for RC patients.

Prevalence of complex care needs

CC needs in CC and MC encounters were categorised as medical, functional, mental health, social, behavioural and related to resource utilisation, and are described in Table 3.

Medical care needs

The most common medical domain issues among CC and MC patients were polypharmacy (66.2% in CC, 44.9% in MC), poor control of chronic conditions (41.3% in CC, 24.5% in MC) and treatment interactions (34.4% in CC, 26.0% in MC).

Table 1. Sociodemographic and encounter-related information of patients.

	Total	Routine care (RC)	Medically challenging (MC)	Complex care (CC)	P value
Prevalence, no. (%)	4327 (100.0%)	2875 (66.4%)	801 (18.5%)	651 (15.0%)	NA
Age, mean (SD)	61.2 (17.4)	58.7 (17.7)	65.3 (16.0)	67.5 (14.9)	<0.001
Gender, no. (%)					0.081
Female	2243 (51.8%)	1511 (52.6%)	421 (52.6%)	311 (47.8%)	
Male	2084 (48.2%)	1364 (47.4%)	380 (47.4%)	340 (52.2%)	
Ethnicity, no. (%)					0.079
Chinese	3191 (73.7%)	2132 (74.2%)	592 (73.9%)	467 (71.7%)	
Malay	509 (11.8%)	316 (11.0%)	101 (12.6%)	92 (14.1%)	
Indian	380 (8.8%)	256 (8.9%)	74 (9.2%)	50 (7.7%)	
Others	247 (5.7%)	171 (5.9%)	34 (4.2%)	42 (6.5%)	
Housing type, no. (%)					<0.001
1- and 2-room HDB	155 (3.6%)	86 (3.0%)	18 (2.2%)	51 (7.8%)	
3- and 4-room HDB	2128 (49.2%)	1389 (48.3%)	393 (49.1%)	346 (53.1%)	
5-room HDB ¹ , private housing and others	2044 (47.2%)	1400 (48.7%)	390 (48.7%)	254 (39.0%)	
Ambulation status, no. (%)					<0.001
Ambulant	3917 (90.5%)	2746 (95.5%)	700 (87.4%)	471 (72.4%)	
Ambulant with aid	147 (3.4%)	53 (1.8%)	37 (4.6%)	57 (8.8%)	
Wheelchair / Trolley / Others	263 (6.1%)	75 (2.6%)	64 (8.0%)	123 (18.9%)	
No. of issues managed, mean (SD)	2.72 (1.72)	2.19 (1.35)	3.51 (1.83)	4.06 (1.94)	<0.001
No. of medications dispensed, mean (SD)	3.53 (3.46)	2.87 (2.81)	4.45 (3.91)	5.32 (4.48)	<0.001

P values in bold are statistically significant. Kruskal-Wallis test applied for comparison of continuous variables; Pearson's chi-squared test or Fisher's Exact test applied for categorical variables.

HDB: Housing & Development Board flat; NA: not applicable; SD: standard deviation

Non-medical care needs

The most common non-medical domain issues faced by CC and MC patients were largely from the behavioural and resource utilisation domains. They were poor health literacy (32.6% in CC, 20.8% in MC); poor motivation for healthy lifestyle behaviours (27.2% in CC, 16.6% in MC); required coordination of care with hospitalists (24.7% in CC, 17.1% in MC); refused or non-adherent to medications (22.4% in CC, 10.4% in MC); and required multidisciplinary team intervention (19.2% in CC, 9.7% in MC).

Independent indicators of complexity and care needs

Based on our mixed-effects multinomial logistic regression model (Table 4), factors that indepen-

dently predicted for high care needs (both CC and MC) included: requiring aid for ambulation and/or requiring wheelchair/trolley (odds ratio [OR] 2.63 for MC versus [vs] RC, 95% confidence interval [CI] 1.77–3.91; OR 7.14 for CC vs RC, 95% CI 4.74–10.74); a greater number of issues managed during the encounter (OR 1.64 for MC vs RC, 95% CI 1.52–1.77; OR 2.16 for CC vs RC, 95% CI 1.96–2.38); longer duration of doctor consultation (OR for taking >20 minutes for doctor's consultation was 2.03 for MC vs RC, 95% CI 1.56–2.66; OR for taking >20minutes for doctor's consultation was 3.96 for CC vs RC, 95% CI 2.86–5.48); and higher cost of care over the past 1 year. Factors that independently predicted for CC (but not MC) included living in 1- or 2-room HDB flats (OR 2.98 for CC vs RC, 95% CI 1.74–

Table 2. Disease status and resource utilisation data of patients.

	Total	Routine care (RC)	Medically challenging (MC)	Complex care (CC)	P value
Prevalence, no. (%)	4327 (100.0)	2875 (66.4)	801 (18.5)	651 (15.0)	NA
Medical diagnosis, no. (%)					
Hypertension	2608 (60.3)	1548 (53.8)	566 (70.7)	494 (75.9)	<0.001
Hyperlipidaemia	3001 (69.4)	1828 (63.6)	643 (80.3)	530 (81.4)	<0.001
Type 2 diabetes	1695 (39.2)	885 (30.8)	415 (51.8)	395 (60.7)	<0.001
Stroke/TIA	361 (8.3)	151 (5.3)	95 (11.9)	115 (17.7)	<0.001
Ischaemic heart disease	516 (11.9)	251 (8.7)	136 (17.0)	129 (19.8)	<0.001
Congestive cardiac failure	55 (1.3)	13 (0.5)	13 (1.6)	29 (4.5)	<0.001
Atrial fibrillation	166 (3.8)	55 (1.9)	60 (7.5)	51 (7.8)	<0.001
Peripheral vascular disease	30 (0.7)	9 (0.3)	8 (1.0)	13 (2.0)	<0.001
Chronic kidney disease	471 (10.9)	181 (6.3)	139 (17.4)	151 (23.2)	<0.001
Asthma and/or COPD	263 (6.1)	154 (5.4)	60 (7.5)	49 (7.5)	0.022
Chronic liver disease	406 (9.4)	238 (8.3)	92 (11.5)	76 (11.7)	0.003
Dementia and/or cognitive impairment	82 (1.9)	24 (0.8)	22 (2.7)	36 (5.5)	<0.001
Rheumatoid arthritis	22 (0.5)	12 (0.4)	8 (1.0)	2 (0.3)	0.129
Peptic ulcer disease/gastritis/GERD	410 (9.5)	277 (9.6)	74 (9.2)	59 (9.1)	0.875
Malignant neoplasm	148 (3.4)	74 (2.6)	38 (4.8)	36 (5.5)	<0.001
Osteoporosis	235 (5.4)	122 (4.2)	60 (7.5)	53 (8.1)	<0.001
Disorder of thyroid	343 (7.9)	217 (7.5)	71 (8.9)	55 (8.4)	0.412
Depression	111 (2.6)	48 (1.7)	25 (3.1)	38 (5.8)	<0.001
Anxiety disorder	84 (1.9)	33 (1.1)	19 (2.4)	32 (4.9)	<0.001
Hyperplasia of prostate	211 (4.9)	107 (3.7)	52 (6.5)	52 (8.0)	<0.001

Table 2. Disease status and resource utilisation data of patients. (Cont'd)

	Total	Routine care (RC)	Medically challenging (MC)	Complex care (CC)	P value
No. of chronic conditions, mean (SD)	3.0 (2.1)	2.5 (1.9)	3.7 (2.0)	4.1 (2.0)	<0.001
MOH definition, no. (%)					<0.001
No chronic condition (0 condition)	689 (15.9)	591 (20.6)	61 (7.6)	37 (5.7)	
Simple (1 condition)	444 (10.3)	363 (12.6)	48 (6.0)	33 (5.1)	
Moderate (2-3 conditions)	1428 (33.0)	1011 (35.2)	243 (30.3)	174 (26.7)	
Complex (≥4 conditions)	1766 (40.8)	909 (31.7)	449 (56.1)	407 (62.5)	
Resource utilisation in last 1 year, mean (SD)					
Unique medications dispensed	7.80 (5.71)	6.80 (5.27)	9.13 (5.72)	10.56 (6.32)	<0.001
Doctor visits	3.36 (2.54)	2.99 (2.36)	3.90 (2.61)	4.30 (2.88)	<0.001
Nurse visits	0.33 (0.66)	0.30 (0.59)	0.40 (0.78)	0.41 (0.76)	<0.001
MSW visits	0.01 (0.15)	0.01 (0.09)	0.01 (0.12)	0.05 (0.30)	<0.001
Psychologist visits	0.02 (0.24)	0.01 (0.18)	0.02 (0.22)	0.04 (0.42)	0.036
Financial counsellor visits	0.06 (0.31)	0.04 (0.25)	0.06 (0.30)	0.15 (0.51)	<0.001
Consult time per doctor visit (min)	13.9 (11.9)	12.7 (11.8)	14.9 (9.8)	17.8 (13.5)	<0.001
Total doctor consult time (min)	62.2 (68.6)	54.3 (65.1)	68.0 (60.6)	89.6 (83.3)	<0.001
Total nursing consult time (min)	32.3 (67.0)	25.6 (41.9)	38.1 (53.1)	55.1 (133.6)	<0.001
Total allied health consult time (min)	9.0 (33.5)	7.3 (30.5)	9.3 (31.4)	16.2 (45.6)	<0.001
Total cost of care (SGD)	851.8 (684.6)	705.2 (561.8)	1050.8 (705.3)	1254.4 (897.2)	<0.001

P values in bold are statistically significant. Kruskal-Wallis test applied for comparison of continuous variables; Pearson's chi-squared test or Fisher's Exact test applied for categorical variables.

COPD: chronic obstructive pulmonary disease; GERD: gastroesophageal reflux disease; HDB: Housing & Development Board flat; min: minutes; MOH: Ministry of Health, Singapore; MSW: medical social worker; NA: not applicable; SD: standard deviation; SGD: Singapore dollar; TIA: transient ischaemic attack

5.13); a greater number of medications dispensed during the encounter (OR 1.05 for CC vs RC, 95% CI 1.01–1.09); longer total nursing time; and total allied health time. The number of chronic conditions did not independently predict for complexity or high care needs.

DISCUSSION

Our study categorised complexity in 4327 primary care encounters. The prevalence of complexity in our polyclinic sample was 15.0%, with another 18.5% deemed medically challenging. Different demographics, biopsychosocial characteristics and resource utilisation patterns were associated with each group. The independent indicators of complexity included lower socioeconomic status (by housing type)³⁸; requiring assistance for mobility; a greater number of issues managed and medications dispensed during the encounter;

longer duration of doctor; nursing and allied health consultation time; and higher cost of care over the past year.

Sociodemographic data of the sample population were reasonably representative of the general population in Singapore. In terms of ethnicity, 73.7% of study sample vs 74.1% of the general population were Chinese; 11.8% of study sample vs 13.6% of the general population were Malay; 8.8% of study sample vs 9.0% of the general population were Indian; and 5.7% of the study sample vs 3.3% of the general population were "others" in 2022.³⁹ For housing status, 3.6% of the study sample vs 6.7% of the general population lived in 1- or 2-room HDB flats; 49.2% of the study sample vs 48.6% of the general population lived in 3- or 4-room HDB flats; and 47.2% of the study sample vs 44.4% of the general population lived in 5-room HDB flats or private housing in 2022.³⁹

Table 3. Frequency of questionnaire complexity factors.

	Total	Routine care (RC)	Medically challenging (MC)	Complex care (CC)	P value
	(%)	(%)	(%)	(%)	
Prevalence	100.0	66.4	18.5	15.0	
Medical issues					
Polypharmacy	28.5	15.4	44.9	66.2	<0.001
Treatment for 1 condition affects another	13.5	5.2	26	34.4	<0.001
Poor disease control at risk of complications/deterioration	13.2	3.7	24.5	41.3	<0.001
Declined specialist referral or follow-up	3.8	0.7	7.5	13.4	<0.001
Diagnostic uncertainty/ambiguous diagnosis	6	1.8	16.9	11.1	<0.001
Somatisation disorders	0.7	0.2	0.9	2.9	<0.001
Chronic pain	2.4	1.7	2.2	5.8	<0.001
Functional issues					
Recent worsening of function	3.7	1.3	6.5	11.2	<0.001
Poor function that affects work	1.8	0.8	2.6	4.9	<0.001
Poor function requiring caregiver/bADL assistance	2.2	0.6	3	8.4	<0.001
Mental health issues					
Major depressive disorder	1	0.4	1.1	3.7	<0.001
Anxiety disorders	1.9	0.6	2.9	6.5	<0.001
Obsessive compulsive disorders	0.1	0	0.2	0.2	0.038
Schizophrenia	0.6	0.5	0.4	1.8	<0.001
Bipolar disorder	0	0	0	0	1
Personality disorder	0.1	0	0.1	0.2	0.262
Addictions/substance abuse	0.3	0.2	0.5	0.8	<0.043
Bereavement	0.3	0.1	0.2	1.1	<0.001

Legend	
Prevalence:	
	<5.0%
	5.0-9.9%
	10.0-14.9%
	15.0-19.9%
	20-24.9%
	25.0-29.9%
	30-34.9%
	35.0-39.9%
	40.0-44.9%
	45.0-49.9%
	50.0-54.9%
	55.0-59.9%
	60.0-64.9%

Table 3. Frequency of questionnaire complexity factors. (Cont'd)

	Total	Routine care (RC)	Medically challenging (MC)	Complex care (CC)	P value
Intellectual disability	0.2	0.1	0.2	0.5	0.038
Dementia	1.4	0.3	2.5	4.5	<0.001
Other psychiatric disorders	0.8	0.1	1.4	3.2	<0.001
Social issues					
Family or relationship difficulties	1.4	0.3	2	5.7	<0.001
Caregiver issues or stress	2.1	0.4	1.9	10	<0.001
Financial issues	2.1	0.6	2.6	8.4	<0.001
Social isolation	1.4	0.3	1.6	6	<0.001
Behavioural issues					
Poor health literacy	11.6	4.3	20.8	32.6	<0.001
Poor motivation for healthy lifestyle behaviours	10.4	4.9	16.6	27.2	<0.001
Refused or not adherent to medications	7.5	3.4	10.4	22.4	<0.001
Difficulty with healthcare system navigation	2.9	0.9	5.1	9.2	<0.001
Lack of trust in medical providers	1.8	0.5	2.7	6.6	5.2
Misaligned/unusual health beliefs	3.9	1.4	6.4	11.8	<0.001
Resource utilisation issues					
Frequent polyclinic attendances	2.9	1.3	4.4	8.4	<0.001
Requires multidisciplinary team intervention	5.5	1.2	9.7	19.2	<0.001
Frequent ED attendances or hospitalisations	0.6	0.1	0.5	3.4	<0.001
Recent admission to hospital	3.6	1.2	4.4	12.9	<0.001
Coordination with hospital specialist(s)	9.8	4.5	17.1	24.7	<0.001
Coordination with community partner(s)/agencies	1.3	0.4	1.1	5.2	<0.001

P values in bold are statistically significant. Pearson's chi-squared test/Fisher's Exact test applied for categorical variables. bADL: basic activities of daily living; ED: emergency department

Legend	
Prevalence:	
	<5.0%
	5.0-9.9%
	10.0-14.9%
	15.0-19.9%
	20-24.9%
	25.0-29.9%
	30-34.9%
	35.0-39.9%
	40.0-44.9%
	45.0-49.9%
	50.0-54.9%
	55.0-59.9%
	60.0-64.9%

Table 4. Multinomial logistic regression for predictors of complexity.

	Routine care (RC)			Medically challenging (MC)			Complex care (CC)		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Demographics									
Age	Ref	1.00	0.99-1.01	0.78	0.99-1.01	0.24			
Housing type									
• 5-room HDB & others	Ref			Ref					
• 3 & 4-room HDB	Ref	0.94	0.78-1.12	0.49	0.97-1.53	0.10			
• 1 & 2-room HDB	Ref	0.65	0.37-1.16	0.14	1.74-5.13	<0.001			
Encounter-related									
Ambulation status									
• Ambulant	Ref			Ref					
• Ambulant with aid	Ref	1.94	1.17-3.20	0.01	2.18-6.48	<0.001			
• Wheelchair/trolley/others	Ref	2.63	1.77-3.91	<0.001	4.74-10.74	<0.001			
No. of issues managed	Ref	1.64	1.52-1.77	<0.001	1.96-2.38	<0.001			
No. of chronic conditions	Ref	1.06	0.99-1.13	0.11	0.92-1.09	0.98			
No. of medications dispensed	Ref	1.03	0.99-1.06	0.10	1.01-1.09	0.01			
Database resource utilisation									
Mean doctor visit time									
• ≤10min	Ref			Ref					
• 10 to ≤15min	Ref	1.61	1.29-2.02	<0.001	1.57-2.84	<0.001			
• 15 to ≤20min	Ref	2.08	1.59-2.72	<0.001	2.12-4.24	<0.001			
• >20min	Ref	2.03	1.56-2.66	<0.001	2.86-5.48	<0.001			
Nursing time in last 1 year (min)	Ref	1.00	1.00-1.00	0.07	1.00-1.01	0.002			
Allied health time in last 1 year (min)	Ref	1.00	1.00-1.00	0.83	1.00-1.01	0.03			
Cost of care over last 1 year (SGD)	Ref	1.00	1.00-1.00	0.007	1.00-1.00	<0.001			

P values in bold are statistically significant.
CI: confidence interval; HDB: Housing & Development Board flat; min: minutes; OR: odds ratio; Ref: reference; SD: standard deviation; SGD: Singapore dollar

Unsurprisingly, the sample population had more chronic conditions than that of the general population—with 69.4% of the study sample vs 31.9% of the general population with hyperlipidaemia; 60.3% of the study sample vs 37.0% of the general population having hypertension; and 39.2% of the study sample vs 8.5% of the general population diagnosed with diabetes.⁴⁰

The combined prevalence of high care needs (CC and MC) of 33.6% in our study more closely mirrored the midpoint of prevalence of complexity reported in other western studies, which ranged from 3.98% to 42.5%.^{5,10-12} The differences likely stemmed from different definitions used for complexity. Our study is the first to differentiate complex care from medically challenging encounters. We did so because our qualitative study with PCPs had previously differentiated CC from MC, identifying that persons with CC required a multidisciplinary approach with longer time for consultation.²⁵ The requirement for increased consultation time and resource utilisation was elucidated in our study, with CC encounters requiring a mean duration of 17.8 minutes for their doctor's consultation, compared to 14.9 minutes for MC patients and 12.7 minutes for RC patients. It is uncertain if the consultation time in our study truly reflected the ideal time required, as the time pressures of a busy polyclinic could have constrained the time that doctors could dedicate to CC and MC encounters. Additionally, longer nursing and allied health consultation times were independent predictors for complexity, highlighting the importance of a multidisciplinary approach in managing complexity.

Asian studies on complexity were limited. They had largely focused on inpatients,⁴¹⁻⁴³ specific conditions (e.g. alcohol misuse),⁴⁴ validation of specific complexity tools⁴⁵ or equated multimorbidity with complexity.^{21,46} Among Asian studies that studied complexity in primary care contexts, 2 were qualitative studies regarding primary care physicians' perceptions of complexity.^{25,47} There was only 1 study⁴⁸ that showed a medium positive relationship between patient complexity (identified via PCAM) and healthcare costs. Our study adds to the literature describing how the use of an intuitive questionnaire could identify individuals with complex needs—who were more likely to have incurred higher cost and consumed more resources. This questionnaire could be easily administered in a form suited to any resource setting—integrated seamlessly with electronic medical records systems, or filled manually via pen and paper. On top of higher resource utilisation, our study further identified other independent indicators of complexity, including lower socioeconomic status, requiring

assistance for mobility and a greater number of issues managed during the encounter, providing an opportunity for the pre-emptive identification of these individuals for earlier intervention and prior to resource consumption.

Our study found that while 62.5% of CC and 56.1% of MC patients had 4 or more conditions, using multimorbidity alone to identify complexity would miss a large proportion of patients who required additional care. Rather than the number of chronic conditions, we discovered that complexity was better predicted by the number of issues addressed during the encounter,²⁵ many of which were non-medical in nature. This echoed other studies showing that chronic disease count did not equate to complexity or medical difficulty.^{3,7,29,49} Even among RC patients, two-thirds had 2 or more chronic conditions. It appeared that many PCPs considered the management of multimorbidity as routine, reflecting the high prevalence of multimorbidity.^{50,51} Policymakers in Singapore tend to identify complexity through multimorbidity, which could lead to inaccurate projections of resource requirements. Our findings suggest that funding models for primary care can be adjusted to account for complexity rather than focusing solely on multimorbidity. Such adjustments would better reflect resource utilisation, including appropriately capturing doctor time required for effective management and funding for multidisciplinary teams. This is particularly relevant in the era of population health and national enrolment with primary care providers under the nationwide Healthier SG initiative.⁵² Our study further identified common complex care needs in CC and MC encounters, yet these needs are often not coded in routine clinical care. More efficient and precise methods of identifying CC and MC encounters using electronic medical records are required to support accurate resource projections and provider reimbursements.

We found that living in 1- or 2-room HDB flats independently predicted for physician-defined complexity, agreeing with previous studies showing similar associations with lower socioeconomic status.^{7,19,29} Requirement of assistance for mobility was an independent indicator of physician-defined complexity, perhaps because these individuals require functional support in the form of caregivers or community resources such as day care/rehabilitation centres. The mobility aids could have also served as visual cues for PCPs to explore the impact of their patients' functional status on their medical care.

The most common non-medical domain issues in CC encounters included poor health literacy, low motivation for healthy behaviours, the need

for coordination with hospitalists, medication non-adherence and requiring multidisciplinary intervention. Given the high prevalence of complexity in primary care, family medicine education, particularly at the postgraduate level, must emphasise skill development for managing CC needs. Findings from our study can inform the identification of specific knowledge, skills, attitudes and partnerships essential for complexity management in the local context, thereby guiding curriculum design with the explicit aim of building learners' confidence in caring for individuals with complex needs.⁵³ This curriculum should involve broad-based transdisciplinary training, such as enhancing communication skills to tackle health literacy issues, practising motivational interviewing, and adopting team-based care approaches.

Our study corroborated the findings of numerous studies, affirming that complexity is a multidomain concept.^{12,18–20} The complexity questionnaire data clearly demonstrated that the issues faced by patients with high care needs are highly heterogeneous, highlighting the necessity of an individualised, rather than one-size-fits-all, approach. This underscores the importance of a holistic, multidisciplinary team-based care approach,²⁶ as well as the necessity of allocating sufficient resources to primary care practices. Such team-based care may need to extend beyond traditional team members, such as nurses, medical social workers and psychologists, to include community partners and social service agencies. For instance, scheduled physical or virtual multidisciplinary case discussions could be organised for patients with particularly complex psychosocial needs, allowing for a more holistic and coordinated approach to care. These resources and collaborations are essential for delivering the comprehensive and customised care required to effectively manage individuals with high care needs.

Strengths and limitations

To our knowledge, this is the first local study investigating the prevalence and associated factors of complexity in primary care. It builds on previous work and provides rich data on an important but previously unidentified group of patients in Singapore. We ensured the robustness of the estimate of prevalence via sample size calculation and undertook measures to standardise the definition of complexity through compulsory briefing sessions for participants. The study was adequately powered and the study sample was fairly representative of the general population sociodemographically. PCPs were randomly selected to mitigate potential biases—at the level

of individual physician in recognising complexity, and systemic biases arising from variations in the patient profiles seen by different doctors. We also performed mixed-effects multinomial logistic regression to further account for PCP-level clustering due to variability in the training and experience of individual PCPs.

There are several limitations. First, this is a cross-sectional study and causation cannot be determined. We were unable to investigate patients' progression and longer-term outcomes. Second, this study involved only PCPs from a public healthcare organisation in Singapore, precluding the generalisability of our findings to other primary care contexts like private general practices in Singapore or primary care practices in other countries. Different settings might have different resources, styles of practice, patient profiles, cultural norms and healthcare infrastructure that would affect the perception of complexity. Third, the identification of issues was limited to what the PCP was aware of or had time to ask about. Fourth, we were unable to obtain the perspectives of patients or other healthcare providers. Fifth, we acknowledge that some of the independent variables used in our multinomial logistic regression model (e.g. ambulation status, housing type, number of chronic conditions) may be closely related to the definition of our outcome measures (i.e. MC/CC, which were based on medical, functional, social and resource utilisation domains being affected). This overlap introduces complexity in fully disentangling the relationships between predictors and outcomes using the current regression framework.

Future research

To better model the complex interplay between predictors and the definition of complexity (MC/CC), a follow-up study that employs advanced analytical techniques, such as Structural Equation Modelling (SEM) can be undertaken. In addition to validating this questionnaire and replicating this study in other family medicine settings, other potential areas of future research could also include cohort studies that examine the relationship between complexity factors and clinical or resource utilisation outcomes prospectively. This questionnaire could also be utilised in interventional studies to identify patients with complex needs and demonstrate effectiveness of clinical programmes.

CONCLUSION

The prevalence of complexity in Singapore primary care was 15.0%, and an additional 18.5% was medically challenging. Our study identified key

areas for improving care for patients with complex care needs: adequate consultation time, multidisciplinary teamwork, complexity training in medical education, and refined methods for identifying complexity.

Acknowledgements

This research was supported by seedcorn fund from the Centre for Primary Health Care and Innovation (CPHCRI), a joint initiative between the Lee Kong Chian School of Medicine and the National Healthcare Group (Reference Code: CPHCRI 8.1/009). Funding source was not applied in study design, participant recruitment, data collection, data analysis or data interpretation. We would like to acknowledge Mr Lim Hai Thian's support in data anonymisation and extraction, as well as Mr Ng Xinyao and Ms Koh Hui Li for assisting with the administrative aspects of the study.

Ethics statement

This study was approved by the National Healthcare Group Domain Specific Review Board (2022/00226).

Declaration

The authors have no affiliations or financial involvement with any commercial organisation with a direct financial interest in the subject or materials discussed in the manuscript.

REFERENCES

- Malhotra R, Bautista MAC, Müller AM, et al. The Aging of a Young Nation: Population Aging in Singapore. *Gerontologist* 2019;59:401-10.
- Upshur RE, Tracy S. Chronicity and complexity: is what's good for the diseases always good for the patients? *Can Fam Physician* 2008;54:1655-8.
- Peek CJ, Baird MA, Coleman E. Primary care for patient complexity, not only disease. *Fam Syst Health* 2009;27:287-302.
- Maciejewski ML, Powers BJ, Sanders LL, et al. The intersection of patient complexity, prescriber continuity and acute care utilization. *J Gen Intern Med* 2014;29:594-601.
- Hong CS, Atlas SJ, Ashburner JM, et al. Evaluating a Model to Predict Primary Care Physician-Defined Complexity in a Large Academic Primary Care Practice-Based Research Network. *J Gen Intern Med* 2015;30:1741-7.
- Upshur RE. Understanding Clinical Complexity the Hard Way: A Primary Care Journey. *Healthc Q* 2016;19:24-8.
- Grant RW, Ashburner JM, Hong CS, et al. Defining patient complexity from the primary care physician's perspective: a cohort study. *Ann Intern Med* 2011;155:797-804.
- Barcones MF, Amatriain E, Lobo E, et al. Complex patients. *J Psychosom Res* 2019;121:140.
- Oliveira CA, Weber B, Dos Santos JLF, et al. Health complexity assessment in primary care: A validity and feasibility study of the INTERMED tool. *PLoS One* 2022;17:e0263702.
- Salisbury C, Lay-Flurrie S, Bankhead CR, et al. Measuring the complexity of general practice consultations: a Delphi and cross-sectional study in English primary care. *Br J Gen Pract* 2021;71:e423-e431.
- Hernansanz Iglesias F, Martori Cañas JC, Limón Ramírez E, et al. Clustering Complex Chronic Patients: A Cross-Sectional Community Study From the General Practitioner's Perspective. *Int J Integr Care* 2021;21:4.
- Nicolaus S, Crelier B, Donzé JD, et al. Definition of patient complexity in adults: A narrative review. *J Multimorb Comorb* 2022;12:26335565221081288.
- Tan CC, Lam CSP, Matchar DB, et al. Singapore's health-care system: key features, challenges, and shifts. *Lancet* 2021;398:1091-104.
- Healthhub.sg. Polyclinic Attendance (Top 4 Conditions). <https://www.healthhub.sg/a-z/health-statistics/top-4-conditions-of-polyclinic-attendances>. Accessed 8 October 2024.
- Holzhausen M, Fuchs J, Busch M, et al. Operationalizing multimorbidity and autonomy for health services research in aging populations--the OMAHA study. *BMC Health Serv Res* 2011;11:47.
- Ministry of Health, Singapore. Chronic Disease Management Programme Handbook for Healthcare Professionals (Singapore; Ministry of Health, 2022).
- Grembowski D, Schaefer J, Johnson KE, et al. A conceptual model of the role of complexity in the care of patients with multiple chronic conditions. *Med Care* 2014;52:S7-S14.
- Safford MM, Allison JJ, Kiefe CI. Patient complexity: more than comorbidity. the vector model of complexity. *J Gen Intern Med* 2007;22:382-90.
- Schaink AK, Kuluski K, Lyons RF, et al. A scoping review and thematic classification of patient complexity: offering a unifying framework. *J Comorb* 2012;2:1-9.
- Zullig LL, Whitson HE, Hastings SN, et al. A Systematic Review of Conceptual Frameworks of Medical Complexity and New Model Development. *J Gen Intern Med* 2016;31:329-37.
- Kaneko H, Hanamoto A, Yamamoto-Kataoka S, et al. Evaluation of Complexity Measurement Tools for Correlations with Health-Related Outcomes, Health Care Costs and Impacts on Healthcare Providers: A Scoping Review. *Int J Environ Res Public Health* 2022;19:16113.
- Linn BS, Linn MW, Gurel L. Cumulative illness rating scale. *J Am Geriatr Soc* 1968;16:622-6.
- de Jonge P, Huyse FJ, Stiefel FC, et al. INTERMED -a clinical instrument for biopsychosocial assessment. *Psychosomatics* 2001;42:106-9.
- Pratt R, Hibberd C, Cameron IM, et al. The Patient Centered Assessment Method (PCAM): integrating the social dimensions of health into primary care. *J Comorb* 2015;5:110-9.
- Quek JS, Lee ES, Low LL, et al. How family physicians in Singapore recognise complexity during consultations: a qualitative study. *BMC Prim Care* 2024;25:134.
- Chong PN, Tang WE. Transforming primary care-the way forward with the TEAMS2 approach. *Fam Pract* 2019;36:369-70.
- Mun VL, Chuan TN, Hong CM. Chronic Disease Management In Singapore Polyclinics. *Malays Fam Physician* 2006;1:94-6.
- Manning E, Gagnon M. The complex patient: A concept clarification. *Nurs Health Sci* 2017;19:13-21.
- Mount JK, Massanari RM, Teachman J. Patient care complexity as perceived by primary care physicians. *Fam Syst Health* 2015;33:137-45.
- Loeb DF, Binswanger IA, Candrian C, Bayliss EA. Primary care physician insights into a typology of the complex patient in primary care. *Ann Fam Med* 2015;13:451-5.

31. Hajian-Tilaki K. Sample size estimation in epidemiologic studies. *Caspian J Intern Med* 2011;2:289-98.
32. Naing L, Nordin RB, Abdul Rahman H, et al. Sample size calculation for prevalence studies using Scalex and ScalaR calculators. *BMC Med Res Methodol* 2022;22:209.
33. Rutterford C, Copas A, Eldridge S. Methods for sample size determination in cluster randomized trials. *Int J Epidemiol* 2015;44:1051-67.
34. Adams G, Gulliford MC, Ukoumunne OC, et al. Patterns of intra-cluster correlation from primary care research to inform study design and analysis. *J Clin Epidemiol* 2004;57:785-94.
35. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: Building an international community of software platform partners. *J Biomed Inform* 2019;95:103208.
36. Tyagi S, Koh V, Koh GC, et al. Defining and measuring multimorbidity in primary care in Singapore: Results of an online Delphi study. *PLoS One* 2022;17:e0278559.
37. Fortin M, Almirall J, Nicholson K. Development of a research tool to document self-reported chronic conditions in primary care. *J Comorb* 2017;7:117-123.
38. Housing & Development Board (HDB). Types of Flats, 2023. <https://www.hdb.gov.sg/residential/buying-a-flat/finding-a-flat/types-of-flats>. Accessed 3 December 2024.
39. Department of Statistics, Singapore. SingStat Table Builder. <https://tablebuilder.singstat.gov.sg/>. Accessed 3 December 2024.
40. Ministry of Health, Singapore. National Population Health Survey (NPHS) 2022 Report. <https://www.moh.gov.sg/others/resources-and-statistics/nphs-2022>. Accessed 3 December 2024.
41. Yoshida S, Matsushima M, Wakabayashi H, et al. Validity and reliability of the Patient Centred Assessment Method for patient complexity and relationship with hospital length of stay: a prospective cohort study. *BMJ Open* 2017;7:e016175.
42. Yoshida S, Matsushima M, Wakabayashi H, et al. Correlation of patient complexity with the burden for health-related professions, and differences in the burden between the professions at a Japanese regional hospital: a prospective cohort study. *BMJ Open* 2019;9:e025176.
43. Yokokawa D, Shikino K, Kishi Y, et al. Does scoring patient complexity using COMPRI predict the length of hospital stay? A multicentre case-control study in Japan. *BMJ Open* 2022;12:e051891.
44. Sugiyama Y, Matsushima M, Yoshimoto H. Association between alcohol consumption/alcohol use disorders and patient complexity: a cross-sectional study. *BMJ Open* 2020;10:e034665.
45. Aoki T, Inoue M, Nakayama T. Development and validation of the Japanese version of Primary Care Assessment Tool. *Fam Pract* 2016;33:112-7.
46. Sugiyama Y, Mutai R, Aoki T, et al. Multimorbidity and complex multimorbidity, their prevalence, and associated factors on a remote island in Japan: a cross-sectional study. *BMC Prim Care* 2022;23:258.
47. Wong PYA, Chan FYS, Ong L, et al. A qualitative study of challenges and enablers faced by private general practitioners providing primary care to patients with complex needs in Singapore. *BMC Prim Care* 2022;23:14.
48. Sugiyama Y, Mutai R, Matsushima M. Association between patient complexity and healthcare costs in primary care on a Japanese island: a cross-sectional study. *BMJ Open* 2023;13:e068497.
49. Weiner SJ, Schwartz A, Sharma G, et al. Patient-centered decision making and health care outcomes: an observational study. *Ann Intern Med* 2013;158:573-9.
50. Lee ES, Lee PSS, Xie Y, et al. The prevalence of multimorbidity in primary care: a comparison of two definitions of multimorbidity with two different lists of chronic conditions in Singapore. *BMC Public Health* 2021;21:1409.
51. Low LL, Kwan YH, Ko MSM, et al. Epidemiologic Characteristics of Multimorbidity and Sociodemographic Factors Associated With Multimorbidity in a Rapidly Aging Asian Country. *JAMA Netw Open* 2019;2:e1915245.
52. Foo C, Chia HX, Teo KW, et al. Healthier SG: Singapore's multi-year strategy to transform primary healthcare. *Lancet Reg Health West Pac* 2023;37:100861.
53. Osborn J, Raetz J, Huntington J, et al. A Curriculum on Care for Complex Patients: Resident Perspectives. *Fam Med* 2016;48:35-43.