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"Hold fast to dreams, for if dreams die, life is a broken-winged bird that cannot fly."

Langston Hughes (1902 – 1967)

American poet

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Braille and the Need to Innovate for the Blind

Clement WT Tan,^{1,2} MBBS, MMed (Ophth), FRCSEd

It's been almost 200 years since Louis Braille—who lost his vision as a child—invented the tactile writing system that is now used all over the world. This 6-cell dot system allows blind individuals to read (and write) by feeling symbols on a page. Braille is available for more than 120 languages and has become a powerful means by which the blind achieve independent living.

Recent estimates suggest that there are currently 217 million people worldwide who are visually disabled and 36 million who are blind. Thirty-three percent of the latter reside in South Asia, 17% in East Asia and about 10% in Southeast Asia; and 86% of them are over the age of 50.¹ About 33% of them suffer from cataract and 42% from uncorrected refractive error.² These are potentially easily reversible conditions and access to care seems to be the main limitation for these conditions. The main initiative of the World Health Organization (WHO) is the elimination of avoidable blindness (which makes up 80% of blindness). That leaves 8 million blind whose conditions are not easily reversed.

Contrary to popular belief, blindness is not about living in total darkness. The WHO defines blindness as vision worse than 3/60 or a visual field of less than 10 degrees.³ The United States' definition of legal blindness is vision worse than 6/60 and/or a visual field of less than 20 degrees.⁴ Whichever definition is applied, at least 2 things are certain. First, although there is a spectrum of disability within the definition of blindness, there is no doubting the severity of the disability. Second, helping the blind to achieve independence requires a multipronged and very often, an individualised approach.

A systematic approach to helping the blind and visually impaired achieve independence requires at least 3 elements: 1) tools and techniques; 2) policies and plans; and 3) social and psychological support.

Tools and Techniques

Louis Braille adapted a system of tactile writing that had been developed by Charles Barbier—who had devised

this at the instruction of Napoleon Bonaparte—as a means for soldiers to communicate silently in the dark. In like manner, inventors of the current day are adapting mobile phone and global positioning system (GPS) technology to enable the blind to navigate safely, and using camera and optical reading technology to help the blind to read. One must not neglect to mention traditional aids like the white cane and guide dogs that make it possible for the blind to achieve independence in mobility. In addition, many useful techniques have been developed and deployed by occupational therapists and others to help the blind adapt.

Policies and Plans

Some of the barriers facing the blind are not solved by tools and techniques. Advocacy, organisation and legislation go a long way. Good examples of these are: requiring documents and labels to be available in Braille; giving due consideration for the blind and other handicapped individuals when planning public spaces and building access; providing funding for the handicapped and to agencies that aid the handicapped; and policies to include the blind and visually handicapped in the workplace to prevent discrimination.

Social and Psychological Support

Despite the availability of tools, techniques, infrastructure and legislation, one major barrier to independent living for the blind is reluctance on the part of individuals and/or their immediate caregivers to avail themselves to the opportunities. Breaking down the social stigma, debunking myths, educating, providing counselling, befriending—all these are important.

Louis Braille and many other remarkable individuals demonstrate for us the amazing capacity for those with a handicap to rise above their disability. That they are able to achieve independence in daily activities and rise above limitations to contribute to society is an encouragement to all.

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Predictors of General Functioning and Correlates of Quality of Life: A Cross-Sectional Study among Psychiatric Outpatients

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Abstract

Introduction: Functioning and quality of life (QOL) are negatively impacted as a result of mental illness. This study aimed to determine the: i) socio-demographic and clinical correlates of functioning and; ii) associations between functioning and QOL in a multiethnic sample of psychiatric outpatients. **Materials and Methods:** This was a cross-sectional study of outpatients receiving treatment from a tertiary psychiatric hospital. Functioning was assessed using the Global Assessment of Functioning (GAF) scale, while QOL was measured using the World Health Organization Quality of Life-BREF (WHOQOL-BREF) which comprises 4 domains: physical health, psychological health, social relationships and environment. **Results:** Various socio-demographic and clinical correlates were associated with functioning including employment and marital status, education and diagnosis. Depression was the only clinical characteristic which negatively correlated with functioning ($P=0.035$). Amongst the whole sample, multiple linear regressions revealed that functioning was positively associated with all 4 QOL domains (physical health [$P<0.001$], psychological health [$P<0.001$], social relationships [$P<0.001$] and environment [$P<0.001$]). Further analysis of each diagnostic group revealed that functioning was positively associated with all 4 QOL domains in the anxiety, depression and obsessive compulsive disorder subsamples, while in the schizophrenia subsample, functioning was only significantly associated with the environment domain. **Conclusion:** Functional impairments were associated with different socio-demographic and clinical characteristics, which should be addressed when planning tailored treatment and interventions. Given that functioning is significantly associated with QOL, it is crucial to regularly assess and monitor them (in addition to symptomatic outcomes and adopting a more holistic and biopsychosocial approach).

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Key words: Anxiety, Depression, Obsessive compulsive disorder, Schizophrenia

Introduction

Having a mental illness or poor mental health can impede an individual's capacity to realise his/her potential, work productivity and ability to make meaningful contributions to society. The social and economic impact of poor mental health is both diverse and debilitating and can lead to homelessness, poor educational and health outcomes and high unemployment rates.¹ In order to improve outcomes for people with mental illness, it is important to understand what affects functioning and how functional impairments in areas such as social, occupational or role and psychological aspects may be associated with other outcomes such as quality of life (QOL). Until recently, there has been a focus

on targeting symptom severity in people with psychiatric disorders in an effort to minimise it. However, it is important to consider improvements in psychosocial outcomes such as functioning and QOL at the same time.² Moving away from a medical model to a more biopsychosocial model—which aims to understand the social and psychological underpinnings of health and illness³ and the interaction between biological, psychological and social factors—is now becoming common practice in psychiatry. As such, routine and systematic measurement of functional outcomes are needed.

When assessing patient outcomes, the terms 'functioning' and 'QOL' are sometimes used interchangeably. Whilst there

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is conceptual overlap, there are also distinct differences and it is important to distinguish these 2 constructs. Functioning is a complex concept, and whilst there is little consensus on how it should be best defined, it describes “the ability to perform the tasks of daily life and to engage in relationships with others in ways that are gratifying to the individual and others and that meet the needs of the community”.⁴ QOL on the other hand is broadly defined as an “individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”.⁵ Evans and Lam⁶ eloquently make the distinction between functioning and QOL by stating that functioning is related to a person’s actual behaviour which is assessed by how this behaviour is executed, performed or maintained, whilst QOL is a subjective measure based on self-perception in relation to satisfaction, contentment or enjoyment in facets of life.

Measures of functioning are key indicators that can be used to determine impairment across various domains as well as to evaluate the success of treatment. In addition, patients have reported that treatment outcomes such as functioning, QOL and well-being are more important than symptomatic relief,⁷ which further exemplifies the importance of routine assessment of such outcomes in people with psychiatric disorders. There is an array of global measures to assess functioning, including the Global Assessment of Functioning (GAF) scale, Social and Occupational Functioning Assessment Scale (SOFAS) and the Specific Levels of Functioning (SLOF) scale, as well as scales that measure specific aspects of functioning such as work/role or social functioning including the Sheehan Disability Scale (SDS), Work Limitation Questionnaire and the Social Functioning scale. The GAF is one of the most widely used measures of functioning among patients with psychiatric and/or substance use disorders⁸ and has been translated in several languages and used in both clinical assessment and research. It is a single-item scale which measures overall functioning in relation to impairments in psychological, social and occupational/school functioning as assessed by a clinician or trained rater.⁹ The GAF scale is quick and easy to use and allows for comparisons in scores to be made across multiple disorders. It is a useful measure for not only planning psychiatric treatment but also assessing treatment outcomes.¹⁰

Whilst substantial evidence supports the need to assess functioning outcomes in psychiatry, the majority of research pertains to specific disorders such as schizophrenia^{11,12} or depression^{13,14} and therefore less is known about disorders such as obsessive compulsive disorder (OCD) or anxiety disorders. Furthermore, there is also a lack of studies that explore and compare correlates of functioning across disorders;^{11,15} additionally, there is scarcity of data relating

to functioning in Asian populations and consequently less is known about whether socio-demographic factors such as ethnicity are correlated with functioning. Finally, whilst several studies have explored the relationship between functioning and QOL, results are inconsistent and inconclusive, with some studies showing a moderate to strong relationship,^{2,16,17} whilst others find there to be no or minimal correlation^{15,18,19} between self-reported and clinician or rater-assessed measures.

Therefore, the purpose of this study is to fill a gap in the existing literature by exploring functioning across mental disorders in a multiethnic Asian population. More specifically, among a sample of outpatients with schizophrenia, OCD, depression and anxiety spectrum disorders, this study aimed to determine the socio-demographic and clinical correlates of functioning, as assessed by the GAF scale. In addition, associations between functioning and QOL were investigated, amongst the whole sample and across the 4 diagnostic groups. We hypothesised that there would be differences in functioning across the different diagnostic groups, given that each psychiatric disorder has specific and different traits that would affect how people function on a daily basis, where there is some earlier evidence showing a significant inverse correlation between functioning and QOL specific to social relationship, among those with major depressive disorder.¹⁵ Furthermore, we hypothesised that the psychological health and social relationships QOL domains would be significantly associated with functioning, given that the GAF specifically asks questions relating to an individual’s psychological health and social relationships.

Materials and Methods

Participants and Recruitment

Prior to the commencement of the study, ethical approval was obtained from the Institutional Ethics Committee, the Domain Specific Review Board of the National Healthcare Group, Singapore. The current study adopted a cross-sectional design, using convenience sampling. Participants were seeking treatment and recruited from outpatient clinics at the Institute of Mental Health (IMH), the only tertiary psychiatric hospital in Singapore. Inclusion criteria comprised: i) Singapore citizens and permanent residents, ii) aged 21–65 years, iii) Chinese, Malay or Indian ethnicity, iv) capable of providing consent and; v) literate in English. In addition, participants were also required to have a clinical diagnosis of either schizophrenia, OCD, depression or anxiety spectrum disorders of at least 1 year duration, as determined by a psychiatrist, using International Classification of Disease version 9 (ICD-9) criteria. Patients with intellectual disabilities, patients who were not fluent in English and patients who had been seeking treatment at IMH

for less than 1 year were excluded. The study employed a convenience sampling strategy to recruit participants using multiple methods and referral sources. Firstly, patients could self-refer, whereby they were alerted to the study via posters in the clinics. Secondly, psychiatrists and other healthcare professionals were also informed of the study and assisted in referring eligible patients for the study. A quota-based method was adopted to ensure similar recruitment numbers across the 4 diagnostic groups.

This was a face-to-face, interviewer-administered interview, which took approximately 1 hour to complete. The interview commonly took place before or after a routine consultation at IMH, however, if this timing was not suitable, an alternative arrangement and location was made to best suit the participant. It was ensured that study team members who administered the interview were not involved in any form of care or treatment of the participants, in order to minimise any form of coercion. Upon completion of the interview, participants received an inconvenience fee of \$30 to compensate them for their time. Data was captured in real-time via online Computer Assisted Personal Interviewing via iPad, by trained researchers who were members of the study team. This method allowed interviewers to provide assistance or clarification to the participants where needed, whilst reducing the likelihood of pattern answers. Additional information on the study recruitment process and participants are published elsewhere.²⁰

Measures

Socio-demographic information including age, gender, ethnicity, education attainment, marital and employment status were provided by the participant. Clinical information pertaining to their diagnosis, age at diagnosis, duration of illness, comorbid psychiatric illnesses and hospitalisations were extracted from their medical records.

Global Assessment of Functioning (GAF)

The GAF scale⁹ is a scoring system for the severity of illness in psychiatry which assesses overall functioning, taking into account impairments in psychological, social and occupational/school functioning. The scale ranges from 0 (inadequate information) to 100 (superior functioning). The 100-point scale is divided into 10-point intervals, each of which has anchors describing symptoms and functioning pertaining to that interval. For example the interval from 51-60 corresponds to moderate symptoms which is described as flat affect and circumstantial speech, occasional panic attacks or moderate difficulty in social, occupational, or school functioning, which may include having only a few friends or conflicts with peers or co-workers. At the top end, a score from 91-100 indicates optimal mental health and coping capabilities, while a score in the 1-10 range may

indicate a danger to oneself or others and being incapable of maintaining minimal personal hygiene. The GAF was administered at the same time and incorporated as part of the survey interview.

Prior to the commencement of the study, all study team members involved in recruitment and administration of the survey underwent specific training relating to administration of the GAF, which was led by a senior psychiatrist and study team member (SAC). Raters were instructed to start at either the top or the bottom of the scale and to go up/down the list until the most accurate description of functioning for the individual is reached. Following the training, raters were required to independently rate dummy cases and online examples to ensure consistent scoring across rates. At the commencement of the survey data collection, all initial cases were rated by 2 raters, to ensure consistency in scoring. Where scores differed by greater than a 10-point interval, the trainer was consulted upon to assist in reaching a consensus for scoring individual cases. Once raters were consistently scoring within the same 10-point, all future cases were scored by just 1 rater.

World Health Organization Quality of Life-BREF

The 26-item World Health Organization Quality of Life-BREF (WHOQOL-BREF) measures self-reported overall QOL and general health. It also comprises 4 distinct QOL domains: physical health, psychological health, social relationships and environmental aspects.²¹ The physical health domain consists of items relating to activities of daily living, dependence on medicinal substances and medical aids, energy and fatigue, mobility, pain and discomfort, sleep and rest and work capacity. Psychological health items relate to bodily image and appearance, positive and negative feelings, self-esteem, spirituality/religion/personal beliefs and thinking, learning, memory and concentration, while the social relationships items ask about personal relationships, social support and sexual activity. Finally, the items about environmental aspects comprise statements relating to financial resources, freedom, physical safety and security, health and social care, home environment, opportunities for acquiring new information and skills, participation in and opportunities for recreation or leisure activities, physical environment and transport. Participants were instructed to indicate “how much”, “how completely”, “how often”, “how good” or “how satisfied” they felt during the 2-week period prior to the interview, using a 5-point Likert Scale from 1 to 5. Scores for the 4 domains were calculated by taking the mean of all items within each domain and multiplying by 4 and then linearly transforming it to a 0-100 scale. Items 3, 4 and 26 were reversed scored. For missing items, the mean of other items in the domain were substituted, however, if more than 2 items were missing from the domain, the

domain score was not calculated. Domain scores were scaled in a positive direction, with higher scores denoting higher QOL.²¹ The Cronbach's alpha in our sample for each of the 4 domains was: physical health, 0.81; psychological health, 0.84; social relationships, 0.63; environment, 0.78.

Sample Size

Power analysis to determine the relationship between the GAF scores and the WHOQOL-BREF domain scores was conducted using Pearson correlation formula implemented in the SAS software. The Type I error and power of this study was set at 5% and 80%, respectively. Earlier research has shown that a significant inverse correlation was observed between the GAF scores and the WHOQOL-BREF-social relationship domain scores in subject with major depressive disorder ($r = -0.41$).¹⁵ This estimation produced a total sample size of 44. Allowing for approximately 35% non-response rate, a required sample size of 59 is desirable for examining the relationship within this group. However, after taking into consideration subgroup analysis which requires an equivalent number of respondents under each subgroup (i.e. 4 diagnostic groups), a minimum sample size of 236 ($59 \times 4 = 236$) was required to achieve enough precision to detect differences in the current study.

Statistical Analysis

Analysis was performed using Statistical Package for Social Sciences (SPSS) version 21. Descriptive analyses were conducted for study sample characteristics. The socio-demographic and clinical correlates of functioning were determined by performing multiple linear regression analysis (using the SPSS General Linear Model [Univariate] function) with functioning as the dependent variable and the socio-demographic and clinical variables as the independent variables. To examine the association between functioning and QOL, multiple linear regression analysis (controlled for socio-demographic and clinical characteristics) was performed where the GAF score was treated as the independent variable, with the 4 QOL domains as the dependent variable in 4 separate models. We repeated this regression analysis for each of the diagnostic groups to investigate whether the relationship between functioning and QOL differs across diagnostic groups. Multi-collinearity between the variables was checked before running the regression analyses. All statistically significant results were reported at $P < 0.05$.

Results

A total of 280 outpatients with schizophrenia ($n = 74$), OCD ($n = 61$), depression ($n = 74$) and anxiety spectrum disorders ($n = 71$) were recruited. The mean age of the sample was 38.9 years, and the majority were male (54.6%), Chinese (53.6%), never married (63.1%) and employed (55.7%). The

mean GAF score amongst the overall sample was 53.4, and ranged from 18 to 95, while for those with schizophrenia, OCD, depression and anxiety, the mean scores were 54.3, 53.3, 50.0 and 55.9, respectively. The mean scores for the physical health, psychological health, social relationships and environment domains of the WHOQOL-BREF were 54.0, 49.8, 54.2 and 61.1 respectively, among the entire sample (Table 1).

Table 2 shows the socio-demographic and clinical correlates of functioning. Results revealed that those who were unemployed ($P < 0.001$) and had secondary or 'O'/'N' level (10-11 years of schooling) education ($P = 0.027$) had poorer functioning as compared to those who were employed and had diploma level education, respectively. Those who were married ($P = 0.038$), however, had a significant positive correlation with functioning. A depression diagnosis ($P = 0.035$) was the only clinical characteristic which negatively correlated with functioning.

Multiple linear regressions (controlled for socio-demographic and clinical characteristics) were conducted to examine the association between functioning and QOL (Table 3). In the whole sample, functioning was positively associated with all 4 QOL domains (physical health [$P < 0.001$], psychological health [$P < 0.001$], social relationships [$P < 0.001$] and environment [$P < 0.001$]). The repeated analysis for each diagnostic group revealed that functioning was positively associated with all 4 QOL domains in the anxiety, depression and OCD subsamples. In the schizophrenia subsample, however, functioning was only significantly associated with the environment domain.

Discussion

This is one of the few studies to explore the correlates of functioning across multiple psychiatric disorders, and to our knowledge, the only study which has done so in Asia. Significant functional impairment was observed among the patients in our sample. The mean GAF score in the current sample was 53.4. This score was higher than that of a local sample of first-episode psychosis patients (mean GAF score = 39.8),²² and it is comparable to scores amongst other studies of psychiatric outpatients conducted in Western settings,^{16,22-24} where mean scores commonly range from 51-60. A score within this range corresponds to moderate symptoms which is described as flat affect and circumstantial speech, occasional panic attacks or moderate difficulty in social, occupational, or school functioning, which may include having only a few friends or conflicts with peers or co-workers.⁹

Existing literature shows that the correlation between socio-demographic factors and functioning is inconclusive. Several studies have reported that such variables are not correlates of functioning,²⁵⁻²⁷ whilst others observe

Table 1. Socio-Demographic and Clinical Characteristics

Variable	n (%)	Mean (SD)				
		Global Assessment of Functioning	Physical Health	Psychological Health	Social Relationships	Environment
Overall	280	53.4 (16.0)	54.0 (13.2)	49.8 (16.0)	54.2 (22.3)	61.1 (16.7)
Gender						
Male	153 (54.6)	52.1 (16.4)	53.8 (13.9)	49.8 (15.9)	52.2 (22.4)	61.3 (16.8)
Female	127 (45.4)	54.9 (15.5)	54.3 (12.3)	49.8 (16.2)	56.5 (21.9)	60.9 (16.6)
Marital status						
Never married	176 (63.1)	52.8 (15.9)	53.7 (13.3)	49.1 (15.7)	53.4 (21.2)	61.6 (16.5)
Married	58 (20.8)	58.9 (15.7)	54.9 (12.7)	52.2 (16.1)	54.1 (25.7)	61.7 (17.1)
Separated, divorced, widowed	45 (16.1)	48.6 (15.2)	53.5 (13.0)	49.7 (17.2)	57.4 (22.0)	59.0 (17.4)
Ethnicity						
Chinese	150 (53.6)	55.0 (15.4)	52.1 (13.1)	48.2 (15.2)	52.4 (20.1)	61.0 (17.1)
Malay	65 (23.2)	51.3 (14.2)	56.2 (12.1)	50.8 (16.9)	59.1 (22.0)	60.8 (17.2)
Indian	65 (23.2)	51.8 (18.8)	56.3 (13.8)	52.5 (16.7)	53.2 (25.8)	61.7 (15.4)
Highest education						
Primary or below	19 (6.8)	45.9 (12.8)	55.8 (15.5)	47.4 (19.5)	53.9 (26.1)	51.2 (20.3)
Secondary or 'O'/'N' level	93 (33.3)	49.2 (14.7)	54.1 (14.2)	49.9 (16.6)	53.0 (23.0)	58.3 (17.5)
'A' level/diploma	124 (44.4)	55.1 (15.3)	54.2 (11.7)	49.9 (15.1)	55.0 (21.7)	62.6 (14.7)
University	43 (15.4)	60.8 (18.6)	53.2 (13.7)	50.8 (16.0)	54.9 (20.8)	68.2 (14.9)
Employment status						
Employed	156 (55.7)	57.5 (15.4)	55.1 (12.4)	50.7 (15.5)	53.7 (21.9)	63.7 (15.6)
Student/homemaker/retired	34 (12.1)	56.2 (16.3)	54.2 (11.5)	49.1 (14.0)	62.1 (19.4)	62.6 (15.2)
Unemployed	90 (32.2)	45.2 (11.6)	52.1 (14.9)	48.4 (17.4)	52.0 (23.4)	56.1 (18.1)
Diagnosis						
Schizophrenia	74 (26.4)	54.3 (16.0)	60.4 (11.5)	54.2 (16.1)	59.8 (18.8)	63.1 (15.1)
Anxiety	71 (25.4)	55.9 (15.9)	53.4 (13.3)	49.1 (15.0)	54.5 (22.6)	63.5 (16.9)
Depression	74 (26.4)	50.0 (17.6)	50.4 (11.8)	47.1 (16.4)	48.8 (24.6)	56.5 (17.9)
Obsessive compulsive disorder	61 (21.8)	53.3 (13.5)	51.4 (14.0)	48.6 (15.7)	53.6 (21.6)	61.6 (16.1)
Previous hospitalisation						
Yes	123 (45.7)	52.1 (16.3)	55.3 (14.0)	49.3 (16.5)	52.4 (22.5)	60.2 (16.5)
No	146 (54.3)	55.0 (15.8)	53.2 (12.2)	50.2 (15.4)	55.9 (21.6)	62.0 (16.7)
Comorbid mental disorder						
Yes	110 (39.3)	52.2 (15.3)	53.6 (13.4)	49.4 (16.1)	52.5 (23.2)	61.4 (16.8)
No	170 (60.7)	54.2 (16.5)	54.2 (13.0)	49.9 (15.8)	55.2 (21.6)	60.9 (16.6)
Mean (SD)						
Age			38.9 (11.6)			
Age at diagnosis			29.5 (10.4)			
Duration of illness			8.93 (8.80)			

SD: Standard deviation

Table 2. Socio-Demographic and Clinical Correlates of Functioning

	95% Confidence Interval (CI)			P Value
	B	Lower CI	Upper CI	
Gender				
Female	2.348	-1.392	6.088	0.217
Male	Ref.			
Ethnicity				
Malay	-1.658	-6.612	3.296	0.510
Indian	0.130	-4.722	4.982	0.958
Chinese	Ref.			
Education				
Primary or below	-4.588	-12.739	3.563	0.269
Secondary or 'O'/'N' level	-5.052	-9.525	-0.579	0.027
University	5.157	-0.197	10.512	0.059
'A' level/ diploma	Ref.			
Employment status				
Student/homemaker/retired	-1.737	-7.745	4.271	0.570
Unemployed	-10.230	-14.464	-5.996	<0.001
Employed	Ref.			
Marital status				
Married	5.925	0.342	11.508	0.038
Separated/divorced/widowed	0.710	-5.321	6.740	0.817
Never married	Ref.			
Diagnosis				
Anxiety	-1.661	-8.716	5.393	0.643
Depression	-6.752	-13.033	-0.471	0.035
Obsessive compulsive disorder	-2.686	-9.385	4.013	0.430
Schizophrenia	Ref.			
Hospitalisation				
Yes	-1.469	-5.885	2.946	0.513
No	Ref.			
Age at diagnosis	0.071	-0.159	0.301	0.544
Duration of illness	0.238	-0.029	0.506	0.081
Comorbid mental disorder	-0.231	-3.777	4.238	0.910
Intercept	55.475	45.753	65.197	<0.001

an association between 1 or more socio-demographic characteristics and functioning. In the current study, significant differences in GAF scores were observed by education, marital and employment status. More specifically, when compared to those who were employed, unemployment was significantly correlated with poorer functioning, which corroborates with findings from a recent study which explored the interaction between depressive symptoms, functioning and QOL among outpatients with major depressive disorder seeking care in the United States² and outpatients with depressive disorders in the Netherlands.²⁴ Similarly, earlier studies found that higher

GAF scores were associated with not only employment, but also more hours worked and greater income earned.^{28,29}

With regard to education, those with secondary education had poorer functioning, compared to diploma holders. Mean GAF scores by education level (Table 1) increased with education and whilst university education ($P = 0.059$) was not significantly correlated with functioning, it showed a trend towards significance. These findings suggest that increased education may be linked or associated with better outcomes for people, where they have the necessary skills to overcome impairments in psychological, social and/or occupational functioning. It is also likely that education

Table 3. Associations between Functioning and Quality of Life

		Global Assessment of Functioning							
		95% CI				P Value	Adjusted R ²	B [†]	P Value
	Dependent Variable	Mean (SD)	B*	Lower CI	Upper CI				
Whole sample	Physical health	54.0 (13.2)	0.4356	0.260	0.452	<0.001	0.251	0.344	<0.001
	Psychological health	49.8 (16.0)	0.507	0.390	0.623	<0.001	0.262	0.461	<0.001
	Social relationship	54.2 (22.3)	0.702	0.546	0.859	<0.001	0.306	0.630	<0.001
	Environment	61.1 (16.7)	0.494	0.375	0.608	<0.001	0.309	0.518	<0.001
Anxiety	Physical health	53.4 (13.3)	0.465	0.265	0.665	<0.001	0.320	0.430	<0.001
	Psychological health	49.1 (15.0)	0.499	0.299	0.699	<0.001	0.457	0.508	<0.001
	Social relationship	54.5 (22.6)	0.615	0.267	0.962	0.001	0.279	0.677	<0.001
	Environment	63.5 (16.9)	0.464	0.205	0.724	0.001	0.254	0.494	<0.001
Depression	Physical health	50.4 (11.8)	0.314	0.152	0.477	<0.001	0.414	0.406	<0.001
	Psychological health	47.1 (16.4)	0.629	0.373	0.884	<0.001	0.320	0.572	<0.001
	Social relationship	48.8 (24.6)	1.036	0.678	1.394	<0.001	0.405	0.789	<0.001
	Environment	56.5 (17.9)	0.673	0.419	0.928	<0.001	0.418	0.603	<0.001
OCD	Physical health	51.4 (14.0)	0.749	0.466	1.033	<0.001	0.319	0.574	<0.001
	Psychological health	48.6 (15.7)	0.629	0.352	0.907	<0.001	0.467	0.689	<0.001
	Social relationship	53.6 (21.6)	0.860	0.453	1.266	<0.001	0.392	0.853	<0.001
	Environment	61.6 (16.1)	0.535	0.186	0.883	0.003	0.243	0.628	<0.001
Schizophrenia	Physical health	60.4 (11.5)	0.004	-0.274	0.281	0.979	-0.127	0.014	0.866
	Psychological health	54.2 (16.1)	0.252	-0.112	0.616	0.171	-0.013	0.139	0.239
	Social relationship	59.8 (18.8)	0.337	-0.054	0.728	0.090	0.020	0.214	0.122
	Environment	63.1 (15.1)	0.318	0.018	0.619	0.038	0.143	0.319	0.003

CI: Confidence interval; OCD: Obsessive compulsive disorder; SD: Standard deviation

*Beta coefficient was derived from multiple linear regression after adjusting for socio-demographic and clinical characteristics.

†Beta coefficient was derived from simple linear regression without any adjustments.

is related to employment, whereby better qualifications improve the chances of finding a job and may further explain these findings.

Those who were married had significantly higher functioning compared to those who were single—a finding which is not surprising given that research has repeatedly shown that those who are married have better physical and mental health compared to unmarried counterparts. More specifically, in relation to functioning, spouses can provide psychological and social support, which is assessed as part of the GAF, and is a likely explanation for this finding. It is also possible that those with better functioning were more likely to be married. However, due to the cross-sectional nature of the study, we were unable to determine this causal relationship. Interestingly, of the socio-demographic correlates that were significantly

associated with functioning (i.e. education, employment and marital status), these were largely characteristics that are actionable, unlike demographic characteristics such as age, gender or ethnicity which cannot be changed. Therefore, interventions such as occupational therapy and treatment which address modifiable characteristics including education and employment may further result in improved functioning.

In addition to investigating the socio-demographic correlates of functioning, clinical correlates were also explored. Functioning was significantly lower amongst those with depression (when compared to schizophrenia), a finding which is consistent with existing literature.^{25,28} These findings could be interpreted in several ways: firstly, this may be a result of the specific symptoms of each disorder. For depression, symptoms are commonly

grouped as affective (comprising symptoms such as sad or low mood, dysphoria, anhedonia, guilt); cognitive (e.g. lack of motivation, concentration difficulty, cognitive slowing) and somatic which includes symptoms such as changes in sleep or appetite.^{6,30} Symptoms of schizophrenia, however, commonly include hallucinations and delusions as well as withdrawal, lack of spontaneity and poor attention, judgement and insight.³¹ As a consequence of such symptoms, it is possible that those with schizophrenia do not always have the capacity or insight to understand the nature, significance and severity of their illness, where it is possible that these people had an unawareness of cognitive³² and functional deficits³³ and thus failed to report them. Furthermore, research has found that those with poorer neuropsychological performance tend to underestimate impairments³⁴ and this is another possible explanation for the current finding. Finally, it could also be in relation to the severity of these symptoms or comorbid conditions. Unfortunately, such information was not captured. Therefore this warrants further exploration into the impact of symptom severity and comorbidities on functioning across mental disorders, using structured measures such as the Positive and Negative Syndrome Scale (PANSS).

Besides depressive symptoms, maladaptive rumination has been shown to mediate the relationship between perceived identity, emotional representation of illness and negative emotions in Singaporeans suffering from depression.³⁵ Such ruminations cause distraction to patients and affect their functioning and productivity. Lam et al³⁶ highlight that additional factors aside from symptoms and side effects are also important in determining functional improvements. Given that clinical practice guidelines stipulate that the primary goal of depression treatment is to restore functioning,³⁷ it is important that this becomes routine practice, especially given that impairment was greatest amongst this diagnostic group. Furthermore, findings from a local study have highlighted the importance of psychological interventions which focus on improving symptom management ability and problem-focused coping skills in improving QOL and functioning in people with depression.³⁸

The association between functioning and QOL was also investigated, whereby a significant positive association between functioning and specific QOL domains was observed. Our findings are in line with existing research^{2,16,17} which also found a significant positive association between functioning and QOL, among those with depression. Contrary to this, others have not observed the same finding.^{15,18,19} Possible reasons for these inconsistencies may be explained by methodological differences including the use of different functioning and QOL measures which may be either self-rated or clinician-rated, different samples

with varying diagnoses and different study designs. In the present study, a strong association between functioning and QOL was observed which substantiates the importance of routinely measuring these outcomes in psychiatric assessment, treatment and programme evaluation.

To our knowledge, there has only been 1 other study that has explored functioning and QOL across multiple disorders. Caldirola et al¹⁵ in their study of Italian inpatients with major depressive disorder, bipolar disorder, OCD and anxiety disorders, also used the GAF and WHOQOL-BREF to explore the relationship between functioning and QOL. Surprisingly, no significant correlations were found between functioning and any of the 4 WHOQOL-BREF domains, amongst the whole sample or by diagnosis, with the exception of a significant inverse correlation between functioning and the social relationship domain, among those with major depressive disorder. Whilst the disorders of interest in the current study are quite similar to that studied by Caldirola et al,¹⁵ their sample was relatively small ($n = 117$) and comprised of inpatients enrolled in a psychiatric rehabilitation programme, and these contributing factors may explain the discrepancies observed in the findings between the studies.

When the sample was split into the 4 diagnostic groups, the same strong positive association between functioning and each of the QOL domains was observed, except in the schizophrenia group, where functioning was only significantly associated with the environment domain. We hypothesised that functioning would be associated with the social and psychological domains, given that the GAF specifically measures psychological and social impairments. It is difficult to postulate why amongst those with schizophrenia, functioning was only significantly associated with the environment domain of the WHOQOL-BREF. This domain comprises broad concepts such as physical environment, having enough money to meet one's needs, the opportunity for leisure activities and satisfaction with one's living place, access to health services and transport—many of which could affect psychological, social and or occupational/school functioning. This unique finding amongst those with schizophrenia therefore requires further exploration in order to better understand how these constructs are associated.

It is also important to highlight that for conditions such as schizophrenia, functioning does not appear to impact QOL that significantly after controlling for socio-demographic and clinical characteristics. It is possible that other factors such as symptom severity¹⁸ may have a greater influence on QOL than functioning. Studies have also revealed that self-reports of functioning amongst those with schizophrenia are often not replicated in objective evidence or the assessment of others,³⁹ which is often the result of lack of insight. It is

also plausible that impairments or deficits in functioning or QOL may differ according to individual characteristics such as their temperament, the quality of their social relationships or their personal value system¹⁵ and as such may explain the current finding.

The following limitations should be considered when interpreting these results. Information pertaining to functioning and QOL was self-reported and therefore may be subjected to social desirability bias. Whilst the GAF raters were trained and undertook various strategies to ensure consistency across scoring, subjective bias is possible, given they relied on the participant's self-report. Whilst inconsistencies in scoring were discussed with a senior psychiatrist and team members, formal documentation of the inter-rater reliability was not captured. In addition, it is also important to highlight that whilst at the time of recruitment, the GAF was the recommended measure of functioning within the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV), with updates in the later version, this has now been replaced. Other limitations relating to the study design such as the cross-sectional nature (which do not allow for changes in functioning to be measured over time) should also be acknowledged, while convenience sampling as well as restrictions concerning the inclusion criteria will affect the generalisability of the study findings and do not allow for a response rate to be calculated. It is also possible that those who participated had better QOL and functioning compared to those who didn't participate or those patients who have defaulted or currently not undergoing treatment. Finally, while this study was among people with mental illness, information on comorbid chronic physical conditions was not captured and is likely to impact functioning and QOL outcomes, as functional status explained all or most of the depression-chronic disease link in a sample of older Singaporeans.⁴⁰

Conclusion

Despite this, the current study is to our knowledge, the first to explore functioning across multiple psychiatric disorders in a multiethnic Asian population. It also examined the relationship between functioning and QOL. As various correlates of functioning were identified including education, marital status and employment, this highlights the importance of considering various socio-demographic factors when designing interventions to improve functioning. Given that such factors are largely modifiable, this further reinforces the importance of building the skills and capacity to support people with mental illness to pursue educational and employment opportunities, which will ultimately reduce functional impairments. Differences in functioning were also observed across different diagnostic groups, where depression was associated with poorer functioning.

Clinicians need to be mindful of the differences in functional impairments across disorders and given the cognitive, emotional and physical symptoms associated with depression, they should be cognisant of this when planning tailored treatment and interventions to monitor and improve functioning and recovery outcomes. Given that functioning is significantly associated with QOL life, it is crucial to regularly assess and monitor functioning and QOL in psychiatric outpatients, with the ultimate goal being to improve outcomes and recovery, which will then have an impact to the wider community and society. Functional impairment should be assessed in addition to symptomatic and QOL outcomes and adopting a more holistic and biopsychosocial approach.

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Projection of Eye Disease Burden in Singapore

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Abstract

Introduction: Singapore's ageing population is likely to see an increase in chronic eye conditions in the future. This study aimed to estimate the burden of eye diseases among resident Singaporeans stratified for age and ethnicity by 2040. **Materials and Methods:** Prevalence data on myopia, epiretinal membrane (ERM), retinal vein occlusion (RVO), age macular degeneration (AMD), diabetic retinopathy (DR), cataract, glaucoma and refractive error (RE) by age cohorts and educational attainment from the Singapore Epidemiology of Eye Diseases (SEED) study were applied to population estimates from the Singapore population model. **Results:** All eye conditions are projected to increase by 2040. Myopia and RE will remain the most prevalent condition, at 2.393 million (2.32 to 2.41 million) cases, representing a 58% increase from 2015. It is followed by cataract and ERM, with 1.33 million (1.31 to 1.35 million), representing an 81% increase, and 0.54 million (0.53 to 0.549 million) cases representing a 97% increase, respectively. Eye conditions that will see the greatest increase from 2015 to 2040 in the Chinese are: DR (112%), glaucoma (100%) and ERM (91.4%). For Malays, DR (154%), ERM (136%), and cataract (122%) cases are expected to increase the most while for Indians, ERM (112%), AMD (101%), and cataract (87%) are estimated to increase the most in the same period. **Conclusion:** Results indicate that the burden for all eye diseases is expected to increase significantly into the future, but at different rates. These projections can facilitate the planning efforts of both policymakers and healthcare providers in the development and provision of infrastructure and resources to adequately meet the eye care needs of the population. By stratifying for age and ethnicity, high risk groups may be identified and targeted interventions may be implemented.

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Key words: Ophthalmology, System dynamics

Introduction

Singapore, like many countries, has a rapidly ageing population. The proportion of residents aged 65 years and above is expected to increase by 207% from 2010 to 2050,¹ while those aged 40 years and above is projected to increase by 67% from 2010 to 2040. This has several repercussions on the healthcare system. For chronic eye conditions such as diabetic retinopathy (DR) and glaucoma, the main risk factor is age,² and this will therefore result in an inevitable increase in the demand for eye care services. Furthermore, the disproportionate increase in chronic eye conditions may

bring about an unprecedented demand for eye care needs. This rising trend in disease burden is further compounded by variations in the prevalence of eye diseases across ethnic groups. Even within a single Asian country like Singapore, for instance, the Chinese suffer higher prevalence of myopia and acute angle closure glaucoma than Malays or Indians.²

Several studies have examined the prevalence of key eye diseases in the local context comprehensively, such as the Singapore Epidemiology of Eye Diseases (SEED) study³⁻⁶ and the Tanjong Pagar Survey,⁷⁻⁹ both implemented by the Singapore Eye Research Institute (SERI). These studies,

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while helpful in presenting an overview of the current eye disease burden in Singapore and establishing ethnic differences in the prevalence of major eye diseases, provide less data that can inform pre-emptive eye care policies, such as ophthalmologist training numbers or eye care system design.

To do so, effective planning is key to providing adequate eye care services and the manpower required. This will require credible projections of the number of individuals with eye diseases and subsequently, the associated demand for eye care services in future. These estimates provide evidence for healthcare planners and policymakers to support any scaling up or down of eye care services in order not to under or overprovide services. To address this knowledge gap, this study projects—up to year 2040—the burden of eye and vision disease among resident Singaporeans—disaggregated by age and ethnicity—using inputs from the SEED study. This will help policymakers and healthcare providers to plan infrastructural and workforce requirements in order to meet future eye care needs.

Materials and Methods

To project the number of people with eye diseases in

Singapore, ethnic, education and age-specific prevalence estimates from the SEED study³⁻⁵ were used. The SEED study consisted of 3 population-based studies of Singapore residents – Chinese, Malays, and Indians – aged 40 years or older. The cross-sectional SEED study was conducted in southwestern Singapore between 2004 and 2011. Using an age-stratified random sampling strategy, 6752 Chinese, 5600 Malays, and 6350 Indians were selected from a registry of Singapore residents obtained from the Ministry of Home Affairs, of which 4605 Chinese, 4168 Malays, and 4497 Indians were deemed eligible to participate. Those who had moved from the residential address, had not lived there in the past 6 months, or were deceased or terminally ill were considered ineligible. A total of 3353 Chinese, 3280 Malays and 3400 Indians participated in the study, giving a response rate of 72.8%, 78.7% and 75.6%, respectively.

The eye conditions included in the model are myopia, epiretinal membrane (ERM), retinal vein occlusion (RVO), age-related macular degeneration (AMD), DR, cataract, glaucoma, and refractive error (RE). Table 1 shows the definition of all the eye conditions. Estimated prevalence of eye conditions by ethnicity, education and age from the study are shown in Figures 1 to 3.

Table 1. Definition of Eye Conditions

Condition	Definition
Myopia	Myopia was defined as spherical equivalent (SE) of less than -0.5 Diopter.
Refractive error	Refractive error (RE) was defined as the difference between presenting visual acuity and best corrected visual acuity that is no less than 0.2 logMAR.
Epiretinal membrane	Epiretinal membrane (ERM) was defined with either surface wrinkling retinopathy (preretinal fibrosis), with folds, tension lines or a patch, or cellophane reflex only (macular pucker).
Retinal vein occlusion	Retinal vein occlusion (RVO) included branch retinal vein occlusion or central retinal vein occlusion.
Age macular degeneration	Early age macular degeneration (AMD) was defined as the presence of either any soft drusen (distinct or indistinct) plus pigmentary abnormalities, reticular drusen, or large soft drusen >125 µm in diameter with drusen area >500 µm in diameter. Late AMD is defined as the presence of neovascular AMD or geographic atrophy (GA). Neovascular AMD included serous or haemorrhagic detachment of the retinal pigment epithelium (RPE) or sensory retina, and the presence of subretinal or sub-RPE haemorrhages or subretinal fibrous scar tissue. GA was characterised by sharply edged, roughly round or oval areas of RPE hypopigmentation, with clearly visible choroidal vessels. The minimum diameter of GA was 175 µm, or larger. All colour fundus photographs were graded initially in a masked manner and discrepancies were adjudicated by a senior retinal specialist.
Diabetic retinopathy	Diabetic retinopathy (DR) was considered present if characteristic lesions as defined by the Early Treatment Diabetic Retinopathy Study (ETDRS) (i.e. microaneurysms, haemorrhages, cotton wool spots, intraretinal microvascular abnormalities, hard exudates, venous beading, new vessels) were observed. DR severity was graded based on the modified Airlie House classification system, using the Blue Mountains Eye Study protocol. Individual DR status was defined based on the severity scores of the worse eye. Clinically significant macular oedema (CSMO) was considered present when the macular oedema involved was within 500 µm of the foveal centre or if focal photocoagulation scars were present in the macular area. Vision-threatening DR was defined as the presence of severe non-proliferative DR, proliferative DR or CSMO.
Cataract	Cataract was defined using the Wisconsin Cataract Grading System. In our previous study, using the Wisconsin cataract grading, we defined cortical and PSC cataract as $\pm 5\%$ and $>0\%$ of total lens area, respectively. In the current study, nuclear cataract was defined as grade 4 or more, cortical cataract was defined as $\pm 25\%$ of total lens area, and posterior subcapsular (PSC) cataract was defined as $\pm 5\%$ of total lens area. Any cataract was defined as nuclear, cortical, or PSC cataract in at least 1 eye.
Glaucoma	Glaucoma was defined according to the International Society of Geographical and Epidemiological Ophthalmology (ISGEO) criteria based on 3 categories. In brief, category 1 cases were defined as optic disc abnormality (vertical cup:disc ratio [VCDR] or VCDR asymmetry ≥ 97.5 percentile) with a corresponding glaucomatous visual field defect. Category 2 cases were defined as having a severely damaged optic disc (VCDR or VCDR asymmetry ≥ 99.5 percentile) in the absence of reliable visual field test results. Category 3 cases were defined for subjects who were blind (corrected visual acuity of $<3/60$), were without visual field or optic disc data, and had previous glaucoma surgery or intraocular pressure >99.5 percentile.

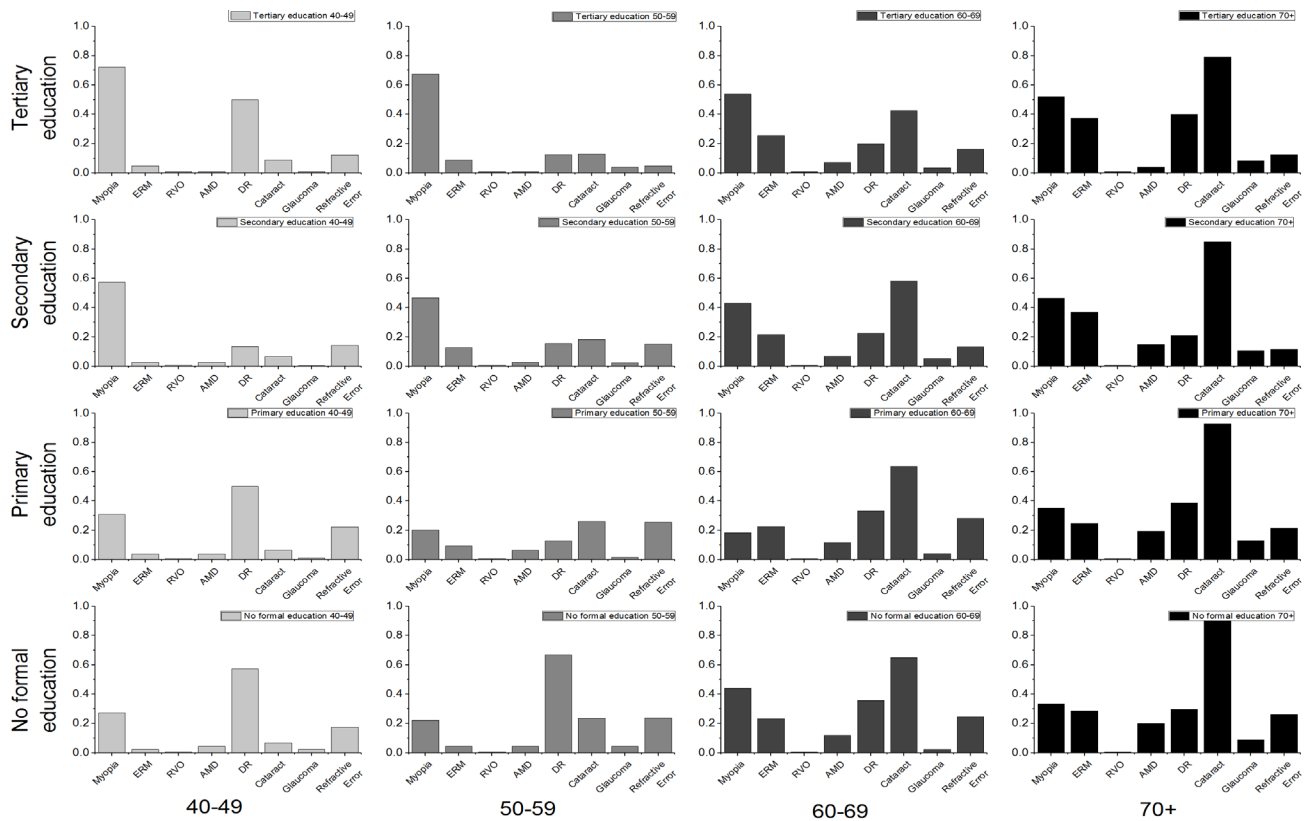


Fig. 1. Prevalence of eye conditions by educational attainment for the Chinese. AMD: Age-related macular degeneration; DR: Diabetic retinopathy; ERM: Epiretinal membrane; RVO: Retinal vein occlusion.

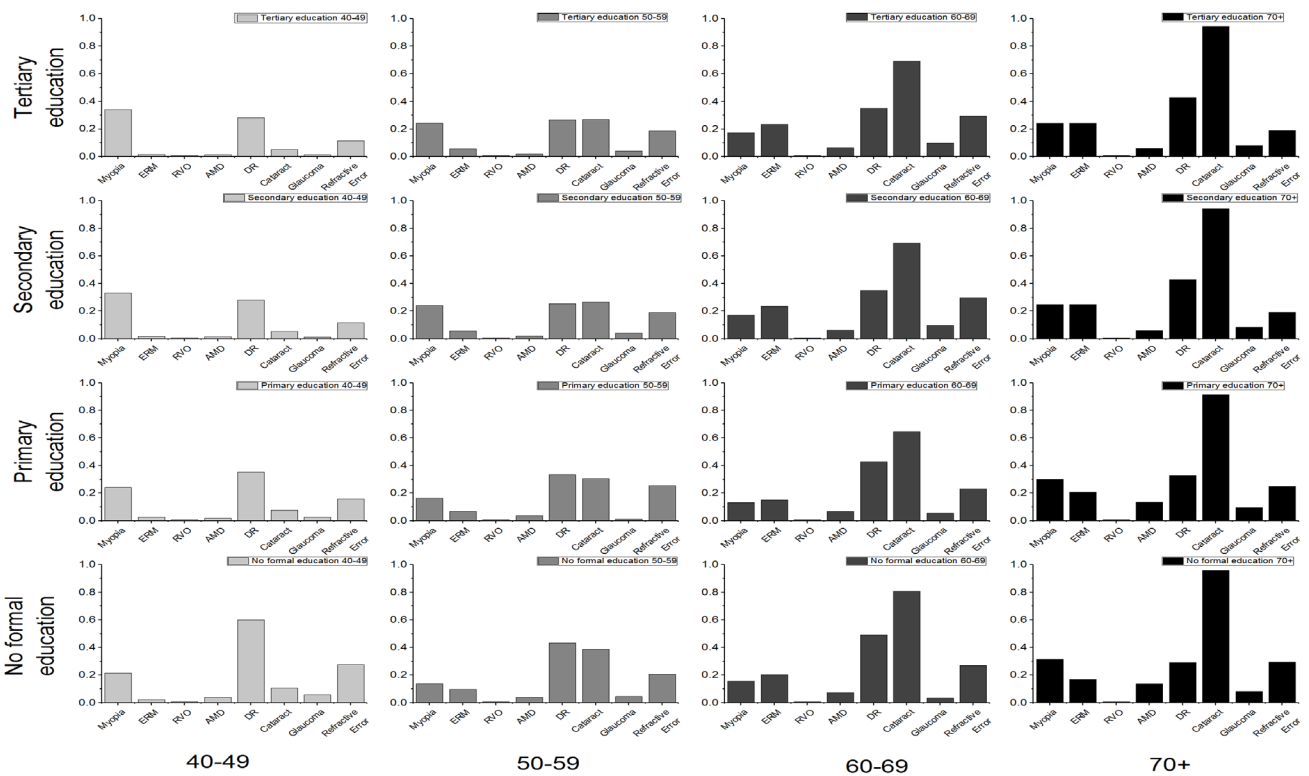


Fig. 2. Prevalence of eye conditions by educational attainment for Malays. AMD: Age-related macular degeneration; DR: Diabetic retinopathy; ERM: Epiretinal membrane; RVO: Retinal vein occlusion.

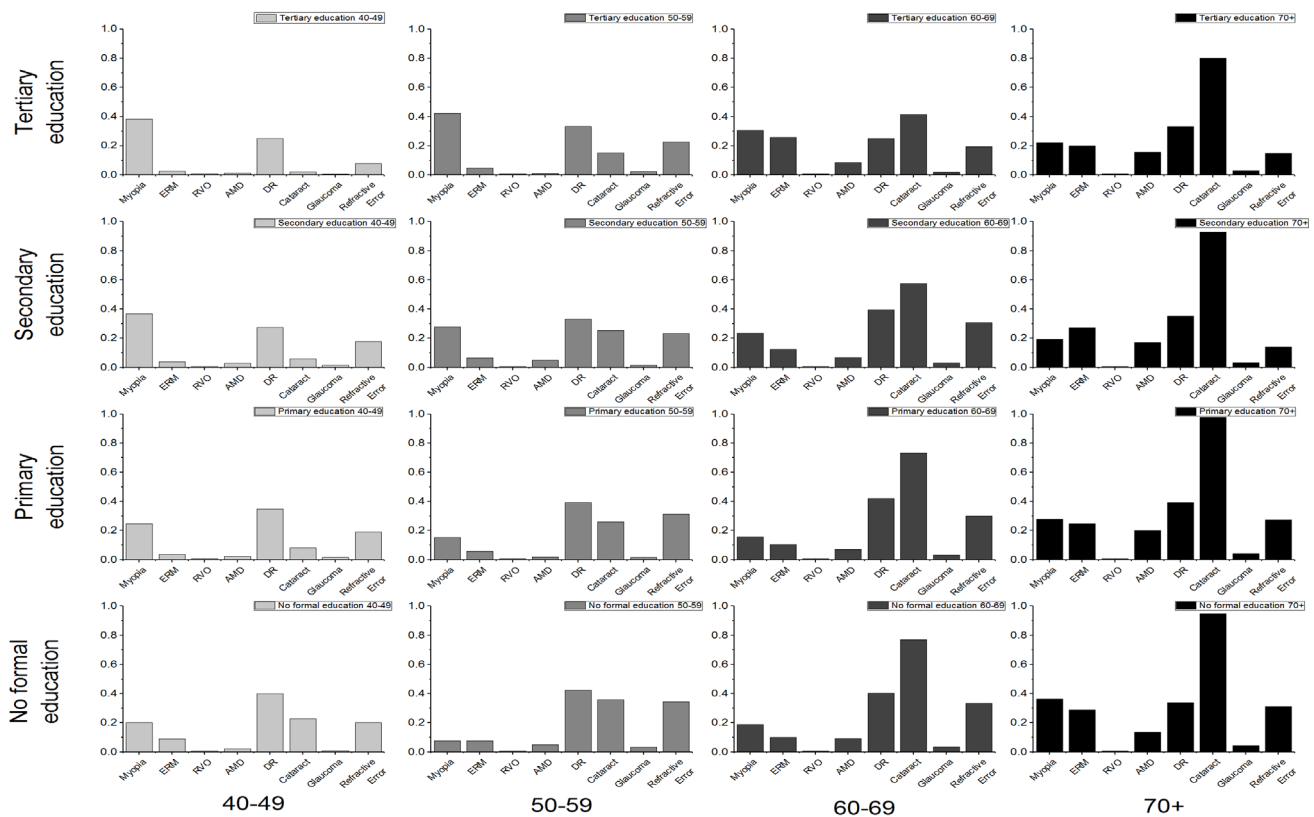


Fig.3. Prevalence of eye conditions by educational attainment for Indians. AMD: Age-related macular degeneration; DR: Diabetic retinopathy; ERM: Epiretinal membrane; RVO: Retinal vein occlusion.

To estimate the future number of people with eye and vision diseases, the ethnic, education and age-specific prevalence estimates from the SEED study were applied to a Singapore population model. The Singapore population model was developed using systems dynamics methodology and has been described elsewhere.^{10,11} The model represents resident population—citizens, permanent residents and foreigners—disaggregated by ethnicity (Chinese, Malays, Indians and Others); age (0 to 100 and older); and educational attainment (no formal, primary, secondary and tertiary education). Because the SEED study includes only the 3 major ethnic groups, prevalence of eye diseases for minority ethnic groups classified as others was assumed to be similar to that of Indians. In addition, a sensitivity analysis was performed by varying all the ethnic, education and age-specific prevalence estimates $\pm 20\%$. The model was run 200 times, and the estimated average, as well as the minimum and maximum values at 95% confidence level for each run, were used to show the credible interval.

Results

Projected prevalence rates of specific eye conditions for resident Singaporeans 40 years and older up to the year 2040 are shown in Table 2. All eye conditions are projected to

increase from 2015 to 2040. In 2015, the 3 most prevalent conditions were myopia and RE, cataract and ERM, with a total of 1.5 million (sensitivity analysis at 95% confidence range: 1.48 to 1.51 million), 0.73 million (0.72 to 0.74 million) and 0.274 million (0.27 to 0.279 million) cases, respectively. In 2040, myopia and RE will still be the most prevalent condition, with a total of 2.393 million (2.34 to 2.41 million) cases, representing an increase of 58% compared with 2015. This is followed by cataract, with 1.33 million (1.31 to 1.35 million) cases, representing an increase of 81%; and ERM, with 0.54 million (0.53 to 0.549 million) cases, representing a 97% increase by the year 2040. The next conditions are in decreasing order of prevalence—DR, AMD, glaucoma and RVO. The prevalence of DR and AMD are expected to be 0.248 million (0.24 to 0.256 million) (113%) and 0.193 million (0.19 to 0.196 million) (54%), respectively. Similarly, glaucoma and RVO are projected to reach 0.15 million (0.148 to 0.153 million) (101%), and 0.0208 million (0.02 to 0.021 million) (46%), respectively.

The projected prevalence of the various eye diseases disaggregated by age and ethnicity are shown in Tables 3 to 7. Prevalence of myopia and refractive error are reported separately in Table 7.

Table 2. Prevalence of Eye Conditions in Singapore Residents by Age and Ethnicity

Eye Condition	Base Year		Projected					Change from 2015 – 2040
	2010	2015	2020	2025	2030	2035	2040	
Myopia and refractive error	1,275,997	1,501,032	1,694,639	1,876,270	2,058,553	2,231,651	2,376,320	58%
	(1,262,764 – 1,289,230)	(1,483,659 – 1,518,405)	(1,673,532 – 1,715,746)	(1,851,490 – 1,901,050)	(2,029,945 – 2,087,161)	(2,199,241 – 2,264,061)	(2,340,518 – 2,412,122)	
Epiretinal membrane	216,205	274,806	338,984	402,359	458,325	504,409	540,689	97%
	(212,695 – 219,714)	(270,346 – 279,267)	(333,482 – 344,486)	(395,829 – 408,890)	(450,886 – 465,764)	(496,222 – 512,596)	(531,912 – 549,465)	
Retinal vein occlusion	12,523	14,276	15,810	17,236	18,634	19,902	20,888	46%
	(12,320 – 12,726)	(14,044 – 14,508)	(15,553 – 16,066)	(16,956 – 17,516)	(18,331 – 18,936)	(19,579 – 20,225)	(20,549 – 21,227)	
Age macular degeneration	106,172	125,274	144,940	163,650	179,162	189,404	193,435	54%
	(104,449 – 107,896)	(123,241 – 127,307)	(142,587 – 147,292)	(160,993 – 166,306)	(176,254 – 182,070)	(186,329 – 192,478)	(190,295 – 196,575)	
Diabetic retinopathy	92,135	116,584	144,054	172,602	200,084	225,397	248,145	113%
	(89,160 – 95,110)	(112,820 – 120,348)	(139,403 – 148,705)	(167,029 – 178,175)	(193,624 – 206,545)	(218,119 – 232,674)	(240,133 – 256,157)	
Cataract	587,780	736,183	895,334	1,048,058	1,177,797	1,274,104	1,335,051	81%
	(578,240 – 597,322)	(724,234 – 748,132)	(880,802 – 909,867)	(1,031,046 – 1,065,060)	(1,158,680 – 1,196,914)	(1,253,423 – 1,294,784)	(1,313,381 – 1,356,720)	
Glaucoma	59,030	75,043	93,273	111,967	128,980	142,313	150,965	101%
	(58,071 – 59,988)	(73,825 – 76,261)	(91,759 – 94,787)	(110,149 – 113,784)	(126,887 – 131,074)	(140,003 – 144,623)	(148,515 – 153,415)	

Table 3. Prevalence of Age-Related Macular Degeneration and Diabetic Retinopathy of Singapore Residents by Age and Ethnicity

Year	Ethnicity	Age-Related Macular Degeneration						Diabetic Retinopathy					
		40 – 49	50 – 59	60 – 69	70 – 79	80+		40 – 49	50 – 59	60 – 69	70 – 79	80+	
2010	Chinese	12,775 (12,568 – 12,983)	15,670 (15,415 – 15,924)	24,831 (24,428 – 25,234)	23,534 (23,152 – 23,916)	11,430 (11,244 – 11,616)		9933 (9612 – 10,253)	14,701 (14,227 – 15,176)	17,107 (16,555 – 17,660)	10,159 (9831 – 10,487)	4901 (4743 – 5059)	
	Malay	1595 (1569 – 1621)	1873 (1842 – 1903)	2100 (2066 – 2134)	2147 (2112 – 2181)	1053 (1036 – 1070)		3559 (3444 – 3673)	5691 (5507 – 5875)	5242 (5073 – 5412)	2008 (1943 – 2073)	575 (556 – 593)	
	Indian	1265 (1244 – 1285)	1668 (1641 – 1695)	1710 (1683 – 1738)	1956 (1925 – 1988)	984 (968 – 1000)		2937 (2842 – 3032)	5146 (4980 – 5312)	4050 (3919 – 4180)	2297 (2223 – 2371)	1002 (970 – 1035)	
	Others	216 (213 – 220)	291 (286 – 296)	336 (330 – 341)	366 (360 – 372)	196 (193 – 199)		526 (509 – 543)	954 (923 – 985)	741 (717 – 765)	414 (401 – 428)	192 (186 – 198)	
2015	Chinese	11,166 (10,985 – 11,347)	15,865 (15,608 – 16,123)	32,200 (31,677 – 32,722)	29,225 (28,751 – 29,700)	15,071 (14,826 – 15,315)		11,447 (11077 – 11816)	15,943 (15,428 – 16,458)	23,804 (23,036 – 24,573)	13,547 (13,110 – 13,985)	6781 (6562 – 7000)	
	Malay	1414 (1392 – 1437)	2230 (2194 – 2266)	3172 (3121 – 3224)	2362 (2324 – 2401)	1438 (1414 – 1461)		3577 (3461 – 3692)	7310 (7074 – 7547)	8056 (7796 – 8316)	2716 (2629 – 2804)	938 (907 – 968)	
	Indian	1131 (1113 – 1150)	1927 (1896 – 1958)	2438 (2399 – 2478)	2360 (2322 – 2399)	2360 (2322 – 2399)		2771 (2682 – 2861)	6270 (6067 – 6472)	5850 (5661 – 6039)	2726 (2638 – 2814)	1348 (1304 – 1391)	
	Others	193 (190 – 196)	332 (327 – 338)	483 (475 – 491)	457 (446 – 468)	249 (245 – 253)		493 (477 – 509)	1172 (1135 – 1210)	1071 (1037 – 1106)	515 (498 – 531)	248 (240 – 256)	
2020	Chinese	8965 (8820 – 9111)	14,681 (14,442 – 14,919)	37,924 (37,308 – 38,539)	38,093 (37,475 – 38,712)	19,188 (18,877 – 19,499)		14,212 (13,754 – 14,671)	16,269 (15,743 – 16,794)	29,894 (28,928 – 30,859)	19,075 (18,459 – 19,691)	9120 (8825 – 9414)	

Table 3. Prevalence of Age-Related Macular Degeneration and Diabetic Retinopathy of Singapore Residents by Age and Ethnicity (Cont'd)

Year	Ethnicity	Age-Related Macular Degeneration					Diabetic Retinopathy				
		40–49	50–59	60–69	70–79	80+	40–49	50–59	60–69	70–79	80+
2025	Malay	1320 (1298–1341)	2248 (2211–2284)	4456 (4383–4528)	2984 (2936–3033)	1732 (1704–1760)	3730 (3609–3850)	7974 (7716–8231)	11,371 (11,004–11,738)	4403 (4261–4545)	1380 (1335–1424)
	Indian	930 (915–945)	1957 (1925–1989)	3224 (3172–3277)	3329 (3274–3383)	1579 (1553–1604)	2536 (2454–2617)	6744 (6527–6962)	7747 (7497–7997)	3784 (3661–3906)	1651 (1598–1705)
	Others	162 (159–164)	337 (331–342)	635 (625–645)	654 (643–664)	303 (298–308)	452 (438–467)	1265 (1224–1306)	1408 (1363–1454)	733 (710–757)	306 (296–316)
	Chinese	7146 (7030–7262)	12,805 (12,597–13,012)	40,504 (39,847–41,162)	48,093 (47,313–48,874)	24,323 (23,928–24,718)	18,108 (17,523–18,692)	16,017 (15,500–16,534)	33,818 (32,726–34,910)	26,194 (25,349–27,040)	12,326 (11,928–12,724)
2030	Malay	1411 (1388–1434)	2063 (2030–2097)	5472 (5383–5560)	4025 (3960–4091)	2031 (1998–2064)	4434 (4291–4577)	7933 (7677–8189)	14,025 (13,572–14,478)	7156 (6925–7387)	2087 (2020–2154)
	Indian	815 (802–829)	1748 (1720–1777)	3845 (3782–3907)	4724 (4648–4801)	1996 (1964–2028)	2566 (2484–2649)	6555 (6343–6767)	9151 (8855–9446)	5331 (5159–5503)	2103 (2035–2171)
	Others	150 (147–152)	304 (299–309)	756 (744–768)	917 (902–932)	389 (383–395)	476 (461–491)	1224 (1184–1263)	1670 (1616–1723)	1030 (996–1063)	399 (386–412)
	Chinese	6539 (6433–6645)	10,620 (10,448–107,92)	40,540 (39,882–41,198)	54,970 (54,078–55,862)	31,189 (30,683–31,695)	22,368 (21,646–23,090)	15,565 (15,062–16,067)	35,603 (34,454–36,753)	32,886 (31,825–33,948)	16,963 (16,415–17,511)
2035	Malay	1621 (1595–1647)	1958 (1926–1989)	5864 (5769–5959)	5135 (5051–5218)	2543 (2502–2584)	5610 (5429–5792)	8188 (7923–8452)	15,165 (14,675–15,654)	10,304 (9972–10,637)	3437 (3326–3547)
	Indian	833 (819–846)	1410 (1387–1433)	4117 (4050–4183)	6145 (6045–6245)	2737 (2692–2781)	2894 (2800–2987)	6264 (6061–6466)	9620 (9309–9931)	6919 (6695–7142)	2902 (2808–2996)
	Others	163 (161–166)	254 (250–258)	803 (790–816)	1179 (1160–1198)	535 (527–544)	565 (547–583)	1177 (1139–1215)	1768 (1711–1825)	1327 (1285–1370)	559 (541–577)
	Chinese	6659 (6551–6767)	8925 (8780–9070)	39,339 (38,700–39,977)	56,746 (55,825–57,667)	38,596 (37,970–39,223)	26,359 (25,508–27,211)	1177 (1139–1215)	35,984 (34,822–37,146)	37,903 (36,679–39,127)	22629 (21,899–23,360)
2040	Malay	1815 (1785–1844)	2052 (2019–2086)	5802 (5708–5896)	5834 (5739–5929)	3298 (3244–3351)	6843 (6622–7063)	9284 (8984–9584)	15,364 (14,868–15,860)	12,894 (12,477–13,310)	5576 (5396–5756)
	Indian	897 (882–911)	1147 (1128–1166)	4090 (4023–4156)	7168 (7052–7285)	3764 (3702–3825)	3274 (3168–3380)	6429 (6222–6637)	9207 (8910–9505)	8073 (7813–8334)	4035 (3905–4165)
	Others	183 (180–186)	220 (217–224)	789 (776–801)	1370 (1347–1392)	731 (720–743)	662 (641–684)	1245 (1204–1285)	1710 (1655–17650)	1546 (1497–1596)	779 (754–804)
	Chinese	6797 (6687–6907)	8254 (8120–8388)	38,094 (37,475–38,712)	53,953 (53,077–54,829)	44,300 (43,581–45,019)	29,321 (28,375–30,268)	16,582 (16,046–17,117)	35,904 (34,745–37,064)	41,451 (40,113–42,789)	28,236 (27,325–29,148)
2045	Malay	1916 (1885–1947)	2280 (2243–2317)	5808 (5714–5902)	5884 (5789–5980)	4115 (4049–4182)	7801 (7549–8053)	10,973 (10,619–11,328)	15,997 (15,480–16,513)	14,412 (13,947–14,877)	8218 (7953–8484)
	Indian	925 (910–940)	1057 (1040–1074)	4056 (3990–4122)	7532 (7410–7654)	4854 (4775–4933)	3482 (3370–3595)	10,973 (10,619–11,328)	8525 (8250–8801)	8495 (8220–8769)	5282 (5111–5452)
	Others	192 (189–195)	216 (213–220)	783 (770–795)	1435 (1411–1458)	939 (924–954)	717 (694–741)	1419 (1373–1465)	1619 (1567–1672)	1624 (1571–1676)	1020 (987–1053)

Table 4. Prevalence of Cataract and Glaucoma of Singapore Residents by Age and Ethnicity

Year	Ethnicity	Cataract						Glaucoma					
		40–49	50–59	60–69	70–79	80+		40–49	50–59	60–69	70–79	80+	
2010	Chinese	35,000 (34,432–35,568)	90,986 (89,509–92,463)	160,813 (158,202–163,423)	118,293 (116,373–120,213)	55,433 (54,533–56,333)		4130 (4197–4063)	13,026 (12,815–13,238)	11,099 (10,918–11,279)	12,885 (12,676–13,094)	5692 (5600–5784)	
	Malay	5357 (5270–5444)	20,983 (20,643–21,324)	23,910 (23,522–24,298)	16,395 (16,129–16,662)	7642 (7518–7766)		1714 (1686–1742)	2660 (2618–2704)	2314 (2277–2352)	1478 (1454–1502)	678 (667–689)	
	Indian	3266 (3213–3319)	10,748 (10,573–10,922)	13,954 (13,727–14,180)	11,243 (11,061–11,426)	5811 (5717–5905)		630 (629–640)	782 (769–794)	701 (690–713)	476 (468–484)	252 (248–256)	
	Others	552 (543–561)	1869 (1839–1900)	2440 (2400–2479)	1993 (1960–2025)	1095 (1077–1113)		107 (106–109)	152 (150–155)	127 (125–129)	79 (78–80)	45 (44–46)	
2015	Chinese	35,050 (34,481–35,619)	96,631 (95,062–98,199)	215,893 (212,389–219,397)	152,457 (149,983–154,932)	74,030 (72,828–75,231)		3982 (3917–4046)	14,537 (14,302–14,774)	16,072 (15,812–16,333)	17,263 (16,982–17,543)	7780 (7653–7906)	
	Malay	4741 (4664–4818)	25,377 (24,965–25,789)	36,116 (35,529–36,702)	19,705 (19,385–20,025)	10,597 (10,425–10,769)		1453 (1430–1477)	3266 (3213–3319)	3965 (3901–4030)	1787 (1758–1816)	946 (931–962)	
	Indian	2774 (2729–2819)	12,503 (12,300–12,706)	19,410 (19,095–19,725)	13,279 (13,064–13,495)	7621 (7497–7744)		561 (552–570)	949 (933–964)	988 (972–1004)	551 (542–560)	327 (322–333)	
	Others	498 (490–506)	2210 (2175–2246)	3454 (3398–3510)	2459 (2419–2499)	1377 (1355–1399)		96 (94–98)	188 (185–191)	180 (177–183)	96 (95–98)	55 (54–56)	
2020	Chinese	35,207 (34,635–35,778)	94,982 (93,440–96,524)	259,309 (255,100–263,518)	207,949 (204,574–211,324)	96,439 (94,873–98,004)		3997 (3932–4062)	15,339 (15,090–15,588)	20,177 (19,850–20,505)	24,348 (23,953–33,246)	10,468 (10,298–10,638)	
	Malay	4436 (4364–4508)	26,243 (25,817–26,669)	49,557 (48,753–50,361)	28,236 (27,778–28,695)	13,271 (13,055–13,486)		1332 (1311–1354)	3480 (3423–3536)	5763 (5670–5857)	2562 (2520–2604)	1193 (1174–1212)	
	Indian	2164 (2129–2199)	12,835 (12,627–13,043)	24,980 (24,575–25,386)	18,294 (17,998–18,591)	9101 (8954–9249)		462 (454–469)	1028 (1011–1045)	1279 (1258–1300)	741 (729–753)	386 (380–392)	
	Others	402 (395–409)	2307 (2269–2344)	4478 (4405–4550)	3488 (3432–3545)	1656 (1629–1683)		81 (79–82)	203 (200–206)	232 (228–236)	135 (133–137)	66 (65–67)	
2025	Chinese	36,365 (35,775–36,955)	89,117 (87,671–90,564)	280,026 (275,481–284,571)	274,132 (269,683–278,582)	126,632 (124,577–128,687)		4201 (4133–4269)	15,813 (15,556–16,069)	22,457 (22,092–22,821)	32,715 (32,184–33,246)	14,261 (14,030–14,492)	
	Malay	4765 (4688–4842)	25,046 (24,639–25,452)	59,225 (58,264–60,186)	41,845 (41,166–42,525)	16,912 (16,637–17,186)		1433 (1410–1456)	34,512 (33,96–35,08)	7103 (6988–7219)	3973 (3731–3854)	1529 (1504–1553)	
	Indian	1786 (1757–1815)	11,817 (11,625–12,009)	28,828 (28,360–29,296)	25,572 (25,157–25,987)	11,268 (11,085–11,450)		407 (400–413)	1023 (1007–1010)	1481 (1457–1505)	1018 (1001–1034)	469 (461–476)	
	Others	348 (342–353)	2153 (2118–2188)	5249 (5164–5334)	4872 (4793–4951)	2099 (2065–2133)		75 (74–76)	198 (195–201)	270 (266–274)	188 (185–191)	82 (81–84)	
2030	Chinese	38,950 (38,318–39,582)	81,405 (80,084–82,726)	280,967 (276,407–285,528)	327,758 (322,438–333,078)	169,346 (166,598–172,095)		4552 (4478–4625)	16,405 (16,139–16,671)	23,029 (23,403–22,655)	39,373 (38,734–40,012)	19,688 (19,368–20,007)	
	Malay	5487 (5398–5576)	24,863 (24,459–25,266)	62,273 (61,263–63,284)	56,269 (55,355–57,182)	23,628 (23,244–24,011)		1654 (1628–1681)	3540 (3483–3598)	7701 (7576–7826)	5096 (5013–5178)	2140 (2106–2175)	

Table 4. Prevalence of Cataract and Glaucoma of Singapore Residents by Age and Ethnicity (Cont'd)

Year	Ethnicity	Cataract					Glaucoma				
		40 – 49	50 – 59	60 – 69	70 – 79	80+	40 – 49	50 – 59	60 – 69	70 – 79	80+
	Indian	1749 (1721 – 1777)	10,402 (10,233 – 10,570)	29,714 (29,232 – 30,196)	32,961 (32,426 – 33,496)	15,112 (14,866 – 15,357)	417 (410 – 423)	1032 (1016 – 1049)	1528 (1504 – 1553)	1297 (1276 – 1318)	615 (605 – 625)
	Others	358 (353 – 364)	1941 (1909 – 1972)	5497 (5408 – 5587)	6253 (6151 – 6354)	2864 (2818 – 2911)	82 (80 – 83)	197 (194 – 200)	281 (276 – 286)	241 (237 – 245)	111 (109 – 113)
	Chinese	41,730 (41,053 – 42,408)	76,116 (74,881 – 77,352)	268,792 (264,429 – 273,155)	357,218 (351,420 – 363,016)	218,604 (215,055 – 222,152)	4892 (4812 – 4971)	17,354 (17,072 – 17,636)	22,297 (21,935 – 22,659)	42,817 (42,122 – 43,512)	25,920 (25,499 – 26,341)
2035	Malay	6147 (6047 – 6246)	27,036 (26,597 – 27,475)	61,590 (60,591 – 62,590)	66,409 (65,331 – 67,487)	33,498 (32,954 – 34,041)	1853 (1823 – 1883)	3927 (3863 – 3991)	7889 (7761 – 8017)	5999 (5902 – 6097)	3035 (2986 – 3085)
	Indian	1851 (1821 – 1881)	9706 (9549 – 9864)	28,040 (27,585 – 28,495)	38,222 (37,602 – 38,842)	20,454 (20,122 – 20,785)	449 (442 – 457)	1124 (1106 – 1142)	1437 (1414 – 1460)	1493 (1468 – 1517)	818 (804 – 831)
	Others	391 (385 – 398)	1889 (1859 – 1920)	5264 (5178 – 5349)	7255 (7137 – 7372)	3894 (3831 – 3957)	92 (90 – 93)	219 (215 – 222)	267 (263 – 271)	280 (276 – 285)	151 (148 – 153)
2040	Chinese	42,999 (42,301 – 43,697)	75,842 (74,611 – 77,073)	251,345 (247,265 – 255,424)	364,734 (358,814 – 370,654)	262,251 (257,994 – 266,507)	5045 (4963 – 5127)	18,610 (18,308 – 18,912)	20,874 (20,536 – 21,213)	43,320 (42,616 – 44,023)	31,363 (30,854 – 31,872)
	Malay	6491 (6386 – 6597)	30,614 (30,117 – 31,111)	62,647 (61,630 – 63,664)	70,114 (68,976 – 71,252)	44,287 (43,568 – 45,006)	1957 (1925 – 1988)	4489 (4416 – 4561)	8291 (8156 – 8426)	6300 (6197 – 6402)	4010 (3945 – 4075)
	Indian	1904 (1873 – 1935)	9969 (9807 – 10,131)	25,813 (25,394 – 26,232)	39,971 (39,322 – 40,620)	26,111 (25,687 – 26,534)	463 (456 – 471)	1269 (1248 – 1289)	1307 (1286 – 1329)	1551 (1526 – 1576)	1031 (1015 – 1048)
	Others	409 (402 – 415)	2026 (1993 – 2059)	4952 (4871 – 5032)	7589 (7466 – 7712)	4986 (4905 – 5067)	96 (95 – 98)	254 (250 – 258)	249 (245 – 253)	294 (289 – 298)	193 (189 – 196)

Table 5. Prevalence of Myopia and Refractive Error of Singapore Residents by Age and Ethnicity

Year	Ethnicity	Myopia						Refractive Error					
		40 – 49	50 – 59	60 – 69	70 – 79	80+		40 – 49	50 – 59	60 – 69	70 – 79	80+	
2010	Chinese	345,778 (340,741 – 350,814)	234,343 (233,846 – 234,840)	101,968 (101,967 – 101,969)	41,023 (41,023 – 41,023)	21,371 (21,371 – 21,371)	72,719 (71,539 – 73,899)	77,320 (76,065 – 78,575)	52,265 (51,417 – 53,114)	27,530 (27,083 – 27,977)	13,989 (13,762 – 14,216)		
	Malay	59,204 (58,299 – 60,109)	21,951 (21,859 – 22,013)	6172 (6172 – 6172)	2826 (2826 – 2826)	2255 (2255 – 2255)	12,074 (11,878 – 12,270)	14,595 (14,359 – 14,832)	9100 (8952 – 9247)	4652 (4576 – 4727)	2256 (2219 – 2293)		
	Indian	36,045 (35,492 – 36,597)	14,242 (14,188 – 14,295)	4930 (4930 – 4930)	2472 (2472 – 2472)	1749 (1749 – 1749)	8014 (7884 – 8144)	11,059 (10,879 – 11,238)	6654 (6546 – 6762)	2798 (2752 – 2843)	1546 (1521 – 1571)		
	Others	6494 (6394 – 6593)	2642 (2632 – 2652)	962 (962 – 962)	445 (445 – 445)	338 (338 – 338)	1356 (1334 – 1378)	1995 (1963 – 2028)	1217 (1197 – 1236)	396 (389 – 402)	238 (234 – 242)		
2015	Chinese	358,254 (352,497 – 364,010)	289,116 (286,579 – 291,654)	160,583 (160,515 – 160,650)	58,415 (58,415 – 58,415)	26,346 (26,346 – 26,346)	68,159 (67,053 – 69,266)	78,977 (77,695 – 80,259)	67,478 (66,383 – 68,574)	32,872 (32,338 – 33,405)	18,149 (17,855 – 18,444)		
	Malay	60,424 (59,449 – 613,999)	40,548 (40,081 – 41,014)	11,545 (11,533 – 11,558)	3566 (3566 – 3566)	2376 (2376 – 2376)	10,658 (10,485 – 10,831)	17,769 (17,481 – 18,058)	14,200 (13,970 – 14,431)	5298 (5212 – 5384)	3089 (3038 – 3139)		
	Indian	37,481 (36,875 – 38,086)	24,339 (25,601 – 24,616)	8570 (8563 – 8578)	2824 (2824 – 2824)	2002 (2002 – 2002)	7050 (6936 – 7165)	13,087 (12,874 – 13,299)	9397 (9244 – 9549)	3107 (3056 – 3157)	1546 (1521 – 1571)		
	Others	6533 (6428 – 6639)	4461 (4410 – 4511)	1631 (1630 – 1633)	537 (537 – 537)	370 (370 – 370)	1210 (1191 – 1230)	2406 (2367 – 2445)	1723 (1695 – 1751)	466 (459 – 474)	290 (285 – 294)		
2020	Chinese	342,518 (336,96 – 348,075)	331,855 (327,231 – 336,479)	270,909 (268,438 – 273,379)	91,741 (91,733 – 91,749)	34,494 (34,494 – 34,494)	62,561 (61,546 – 63,577)	73,972 (72,772 – 75,173)	79,269 (77,983 – 80,556)	41,125 (40,458 – 41,793)	22,491 (22,126 – 22,856)		
	Malay	58,525 (57,576 – 59,475)	55,027 (54,206 – 55,849)	22,358 (22,218 – 22,499)	5828 (5827 – 5830)	2539 (2539 – 2539)	9977 (9815 – 10,139)	18,385 (18,086 – 18,683)	19,796 (19,474 – 20,117)	7087 (6972 – 7202)	3766 (3704 – 3827)		
	Indian	34,084 (33,531 – 34,637)	33,549 (33,047 – 34,052)	14,339 (14,257 – 14,422)	4552 (4551 – 4553)	2107 (2107 – 2107)	5682 (5590 – 5774)	13,694 (13,472 – 13,916)	12,195 (11,997 – 12,393)	3965 (3901 – 4030)	2280 (2243 – 2317)		
	Others	5838 (5743 – 5932)	6025 (5935 – 6115)	2663 (2648 – 2678)	879 (879 – 879)	391 (391 – 391)	999 (983 – 1015)	2549 (2508 – 2591)	2223 (2187 – 2259)	641 (630 – 651)	334 (328 – 339)		
2025	Chinese	330,828 (325,458 – 336,197)	344,436 (338,997 – 349,874)	270,909 (268,438 – 273,379)	138,950 (138,795 – 139,105)	49,244 (49,243 – 49,245)	59,246 (58,285 – 60,208)	64,979 (63,924 – 66,034)	84,524 (83,153 – 85,896)	50,658 (49,836 – 51,480)	27,492 (27,045 – 27,938)		
	Malay	63,971 (62,933 – 65,010)	58,160 (57,231 – 59,090)	38,003 (37,553 – 38,452)	10,928 (10,899 – 10,957)	3197 (3196 – 3197)	10,741 (10,567 – 10,916)	17,503 (17,219 – 17,787)	23,871 (23,484 – 24,259)	10,013 (9850 – 10,175)	4562 (4488 – 4636)		
	Indian	33,564 (33,020 – 34,109)	35,573 (35,004 – 36,142)	23,060 (22,791 – 23,329)	7759 (7743 – 7776)	2555 (2555 – 2555)	4856 (4777 – 4935)	12,989 (12,778 – 13,200)	14,143 (13,913 – 14,372)	5231 (5146 – 5316)	2660 (2617 – 2703)		
	Others	5940 (5844 – 6037)	6220 (6121 – 6320)	4220 (4171 – 4270)	1469 (1466 – 1472)	486 (486 – 486)	903 (888 – 918)	2425 (2386 – 2465)	2587 (2545 – 2629)	889 (875 – 903)	404 (397 – 410)		
2030	Chinese	340,814 (335,282 – 346,346)	334,570 (329,159 – 339,982)	307,567 (303,395 – 311,740)	187,255 (186,397 – 188,113)	74,834 (74,811 – 74,856)	60,657 (59,672 – 61,641)	53,640 (52,769 – 54,511)	84,656 (83,282 – 86,030)	57,707 (56,771 – 58,644)	33,983 (33,431 – 34,535)		
	Malay	75,309 (74,087 – 76,531)	58,367 (57,422 – 59,313)	49,981 (49,245 – 50,717)	20,362 (20,204 – 20,519)	5066 (5061 – 5070)	12,386 (12,185 – 12,587)	17,292 (17,011 – 17,572)	25,345 (24,934 – 25,756)	13,120 (12,907 – 13,333)	5994 (5897 – 6092)		

Table 5. Prevalence of Myopia and Refractive Error of Singapore Residents by Age and Ethnicity (Cont'd)

Year	Ethnicity	Myopia						Refractive Error					
		40 – 49	50 – 59	60 – 69	70 – 79	80+		40 – 49	50 – 59	60 – 69	70 – 79	80+	
	Indian	37,111 (36,508 – 37,713)	33,672 (33,126 – 34,217)	30,461 (30,012 – 30,911)	7759 (7743 – 7776)	3860 (3857 – 3862)		4875 (4796 – 4954)	12,139 (11,942 – 12,336)	14,618 (14,381 – 14,856)	6499 (6394 – 6605)	3326 (3272 – 3380)	
	Others	6977 (6863 – 7090)	5826 (5731 – 5920)	5508 (5456 – 5640)	2404 (2387 – 2421)	738 (738 – 739)		965 (949 – 981)	2290 (2253 – 2327)	2691 (2648 – 2735)	1151 (1133 – 1170)	533 (524 – 542)	
	Chinese	363,392 (357,493 – 369,290)	326,876 (321,572 – 332,180)	319,690 (314,725 – 311,740)	229,053 (226,888 – 231,248)	109,755 (109,56 – 110,994)		64,119 (63,078 – 65,160)	44,438 (43,717 – 45,159)	82,753 (81,410 – 84,096)	60,569 (59,586 – 61,552)	41,070 (40,404 – 41,737)	
	Malay	86,273 (84,873 – 87,673)	63,698 (62,664 – 64,731)	49,981 (49,245 – 50,717)	32,419 (32,024 – 32,815)	9166 (9130 – 9201)		12,386 (12,185 – 12,587)	18,714 (18,410 – 19,018)	25,360 (24,948 – 25,772)	15,220 (14,973 – 15,467)	8111 (7979 – 8242)	
	Indian	41,629 (40,953 – 42,305)	33,545 (33,001 – 34,089)	32,657 (32,140 – 33,175)	12,927 (12,834 – 13,020)	6347 (6326 – 6368)		4875 (4796 – 4954)	12,204 (12,006 – 12,402)	13,768 (13,545 – 13,992)	7351 (7232 – 7471)	4252 (4183 – 4321)	
	Others	8189 (8056 – 8322)	5984 (5887 – 6081)	5740 (5649 – 5831)	3628 (3584 – 3671)	1202 (1198 – 1206)		1072 (1055 – 1089)	2373 (2334 – 2411)	2559 (2518 – 2601)	1355 (1333 – 1377)	717 (705 – 729)	
2040	Chinese	377,656 (371,526 – 383,786)	335,649 (330,201 – 341,096)	314,270 (309,210 – 319,329)	257,487 (254,023 – 260,951)	147,872 (147,132 – 148,611)		65,908 (64,838 – 66,978)	40,562 (39,904 – 41,221)	81,389 (80,068 – 82,710)	60,083 (59,108 – 61,059)	46,846 (46,085 – 47,606)	
	Malay	92,624 (91,121 – 94,128)	73,717 (72,21 – 74,914)	55,687 (54,787 – 56,587)	41,450 (40,842 – 42,059)	16,213 (16,078 – 16,348)		14,657 (14,419 – 14,894)	21,138 (20,795 – 21,481)	26,083 (25,659 – 26,506)	15,768 (15,512 – 16,024)	10,419 (10,250 – 10,588)	
	Indian	43,921 (43,208 – 44,634)	36,537 (35,944 – 37,130)	31,843 (31,328 – 32,357)	25,200 (24,830 – 25,570)	10,338 (10,258 – 10,418)		5375 (5288 – 5462)	13,163 (12,950 – 13,377)	12,551 (12,347 – 12,754)	7558 (7435 – 7681)	5217 (5133 – 5302)	
	Others	8848 (8703 – 8991)	6876 (6764 – 6987)	5566 (5476 – 5656)	4549 (4483 – 4616)	1939 (1924 – 1954)		1124 (1106 – 1142)	2654 (2611 – 2697)	2385 (2346 – 2423)	1438 (1415 – 1461)	922 (908 – 937)	

Table 6. Prevalence of Epiretinal Membrane and Retinal Vein Occlusion of Singapore Residents by Age and Ethnicity

Year	Ethnicity	Epiretinal Membrane					Retinal Vein Occlusion				
		40–49	50–59	60–69	70–79	80+	40–49	50–59	60–69	70–79	80+
2010	Chinese	16,203 (15,940–16,466)	49,449 (48,646–50,252)	60,516 (59,534–61,499)	39,347 (38,708–39,986)	17,548 (17,263–17,833)	3421 (3366–3477)	3247 (3195–3300)	1881 (1850–1911)	906 (891–920)	417 (410–424)
	Malay	1686 (1659–1714)	4724 (4647–4801)	6914 (6801–7026)	3308 (3255–3362)	1457 (1434–1481)	604 (594–614)	501 (493–509)	233 (229–237)	121 (119–123)	56 (55–57)
	Indian	2074 (2040–2108)	2664 (2621–2707)	2933 (2885–2980)	3245 (3192–3297)	1457 (1434–1481)	370 (364–376)	303 (298–308)	156 (154–159)	84 (82–85)	43 (42–44)
	Others	366 (360–372)	486 (478–494)	709 (698–721)	569 (559–578)	316 (311–321)	67 (66–68)	58 (57–59)	31 (30–31)	15 (15–15)	8 (8–8)
2015	Chinese	16,631 (16,361–16,901)	55,354 (54,455–56,252)	82,811 (81,467–84,155)	53,217 (52,353–54,080)	23,854 (23,467–24,241)	3321 (3267–3375)	3578 (3520–3636)	2578 (2536–2620)	1185 (1166–1205)	561 (552–570)
	Malay	1528 (1503–1553)	5681 (5589–5774)	10,883 (10,706–11,059)	4230 (4162–4299)	2060 (2026–2093)	560 (551–569)	613 (604–623)	358 (352–364)	146 (144–149)	78 (77–80)
	Indian	1865 (1835–1895)	3155 (3104–3206)	4479 (4406–4552)	3807 (3745–3869)	2209 (2173–2245)	345 (339–350)	366 (360–371)	226 (222–229)	100 (98–101)	57 (56–58)
	Others	331 (326–336)	578 (569–587)	1044 (1027–1061)	695 (684–706)	396 (389–402)	61 (60–62)	69 (68–71)	44 (44–45)	19 (19–19)	10 (10–11)
2020	Chinese	17,478 (17,194–17,762)	56,890 (55,966–57,813)	101,670 (100,020–103,320)	76,449 (75,208–77,690)	32,084 (31,563–32,605)	3169 (3118–3221)	3668 (3608–3727)	3157 (3106–3209)	1644 (1617–1671)	738 (726–750)
	Malay	1473 (1449–1496)	5842 (5747–5937)	15,229 (14,982–15,477)	6483 (6378–6589)	2673 (2630–2717)	552 (543–561)	642 (632–653)	495 (487–503)	210 (207–214)	98 (97–100)
	Indian	1595 (1569–1621)	3298 (3244–3351)	6250 (6148–6351)	5204 (5119–5288)	2628 (2586–2671)	315 (310–320)	389 (383–395)	299 (294–304)	138 (136–141)	68 (67–69)
	Others	286 (282–291)	605 (595–615)	1396 (1373–1418)	979 (963–995)	473 (465–480)	56 (55–57)	73 (72–74)	58 (57–59)	27 (27–28)	13 (12–13)
2025	Chinese	18,848 (18,542–19,154)	55,060 (54,166–55,953)	112,921 (111,088–114,753)	104,867 (103,165–106,569)	44,087 (43,371–44,803)	3110 (3059–3160)	3612 (3553–3671)	3486 (3430–3543)	2196 (2160–2231)	983 (968–999)
	Malay	1620 (1594–1647)	5534 (5444–5623)	18,417 (18,118–18,716)	10,010 (9847–10,172)	3613 (3554–3672)	616 (606–626)	622 (612–632)	594 (584–604)	312 (307–317)	126 (123–128)
	Indian	1493 (1469–1518)	3101 (3051–3152)	7835 (7708–7962)	7230 (7113–7348)	3233 (3180–3285)	320 (315–325)	375 (369–381)	355 (349–361)	195 (192–198)	84 (83–86)
	Others	279 (275–284)	569 (560–578)	1688 (1660–1715)	1361 (1339–1383)	594 (585–604)	59 (58–60)	70 (68–71)	68 (67–70)	38 (38–39)	16 (16–16)
2030	Chinese	20,620 (20,285–20,955)	51,025 (50,197–51,853)	117,470 (115,563–119,377)	129,310 (127,211–131,409)	61,826 (60,823–62,830)	3243 (3190–3295)	3507 (3450–3563)	3592 (3534–3650)	2653 (2610–2696)	1336 (1314–1357)
	Malay	1887 (1856–1917)	5448 (5360–5537)	19,643 (19,325–19,962)	13,734 (13,511–13,957)	5368 (5281–5455)	722 (710–734)	626 (615–636)	626 (615–636)	420 (413–426)	176 (173–179)
	Indian	1591 (1565–1617)	2824 (2778–2870)	8808 (8665–8951)	9269 (9119–9420)	4304 (4234–4374)	357 (351–363)	355 (349–361)	377 (371–383)	253 (249–257)	114 (112–116)

Table 6. Prevalence of Epiretinal Membrane and Retinal Vein Occlusion of Singapore Residents by Age and Ethnicity (Cont'd)

Year	Ethnicity	Epiretinal Membrane					Retinal Vein Occlusion				
		40 – 49	50 – 59	60 – 69	70 – 79	80+	40 – 49	50 – 59	60 – 69	70 – 79	80+
2035	Others	314 (309 – 319)	526 (517 – 534)	1816 (1786 – 1845)	1738 (1709 – 1766)	805 (792 – 819)	69 (68 – 70)	66 (65 – 67)	72 (71 – 73)	49 (48 – 50)	22 (22 – 23)
	Chinese	22,226 (21,866 – 22,587)	47,848 (47,071 – 48,625)	118,253 (116,334 – 120,173)	144,954 (142,602 – 147,307)	82,984 (81,637 – 84,331)	3447 (3391 – 3503)	3480 (3424 – 3537)	3559 (3502 – 3617)	2920 (2873 – 2968)	1746 (1718 – 1775)
	Malay	2121 (2086 – 2155)	5887 (5792 – 5983)	19,773 (19,452 – 20,094)	16,398 (16,132 – 16,664)	7931 (7803 – 8060)	813 (800 – 826)	686 (675 – 697)	620 (610 – 630)	495 (487 – 503)	250 (245 – 254)
	Indian	1736 (1708 – 1764)	3101 (3051 – 3152)	9268 (9118 – 9418)	10,689 (10,516 – 10,863)	5788 (5694 – 5882)	395 (389 – 401)	362 (356 – 368)	369 (363 – 375)	297 (292 – 301)	156 (153 – 158)
	Others	354 (349 – 360)	531 (522 – 539)	1829 (1799 – 1859)	2005 (1973 – 2038)	1089 (1071 – 1107)	79 (78 – 81)	70 (69 – 71)	70 (69 – 71)	57 (56 – 58)	31 (30 – 31)
2040	Chinese	22,928 (22,556 – 23,300)	47,652 (46,879 – 48,426)	118,405 (116,483 – 120,327)	152,023 (149,555 – 154,490)	102,758 (101,090 – 104,426)	3547 (3489 – 3604)	3597 (3539 – 3656)	3485 (3428 – 3541)	3013 (2964 – 3062)	2118 (2083 – 2152)
	Malay	2241 (2205 – 2278)	6645 (6537 – 6753)	20,451 (20,119 – 20,783)	17,490 (17,206 – 17,774)	10,730 (10,556 – 10,905)	860 (846 – 874)	780 (768 – 793)	631 (621 – 641)	523 (514 – 531)	330 (325 – 335)
	Indian	1796 (1767 – 1825)	2896 (2849 – 2943)	9885 (9724 – 10045)	11,101 (10,920 – 11,281)	7348 (7229 – 7467)	410 (403 – 417)	393 (387 – 399)	357 (351 – 362)	313 (308 – 319)	200 (197 – 204)
	Others	373 (367 – 379)	584 (574 – 593)	1911 (188 – 1942)	2086 (2052 – 2120)	1387 (1364 – 1409)	84 (83 – 85)	79 (77 – 80)	68 (67 – 69)	60 (59 – 61)	39 (39 – 40)

Table 7. Prevalence of Myopia and Refractive Error (Combined) of Singapore Residents by Age and Ethnicity

Year	Ethnicity	Myopia and Refractive Error				
		40 – 49	50 – 59	60 – 69	70 – 79	80+
2010	Chinese	418,473 (413,377 – 423,569)	311,663 (308,122 – 315,203)	154,234 (153,385 – 155,083)	68,553 (68,106 – 68,999)	35,360 (35,132 – 35,587)
	Malay	71,278 (68,492 – 74,063)	36,546 (34,371 – 38,722)	15,272 (15,124 – 15,420)	7477 (7402 – 7553)	4511 (4474 – 4547)
	Indian	44,059 (39,196 – 48,921)	25,300 (22,690 – 27,911)	11,584 (11,476 – 11,692)	5270 (5224 – 5315)	3295 (3270 – 3320)
	Others	7850 (6427 – 9273)	4637 (3969 – 5305)	2179 (2159 – 2199)	841 (834 – 847)	576 (572 – 579)
2015	Chinese	426,390 (420,601 – 432,179)	368,093 (358,427 – 377,759)	228,061 (226,898 – 229,224)	91,287 (90,754 – 91,821)	44,495 (44,201 – 44,790)
	Malay	71,082 (67,592 – 74,573)	58,317 (52,940 – 63,694)	25,745 (25,502 – 25,988)	8864 (8778 – 8950)	5464 (5414 – 5514)
	Indian	44,531 (39,039 – 50,023)	37,425 (31,691 – 43,159)	17,967 (17,808 – 18,127)	5931 (5881 – 5982)	3981 (3949 – 4014)
	Others	7744 (6214 – 9273)	6867 (5403 – 8331)	3354 (3325 – 3384)	1003 (996 – 1011)	659 (655 – 664)
2020	Chinese	405,059 (399,478 – 410,640)	405,827 (388,115 – 423,539)	298,985 (296,940 – 301,031)	132,867 (132,191 – 133,542)	56,986 (56,621 – 57,351)
	Malay	68,502 (64,555 – 72,449)	73,412 (64,865 – 81,959)	42,154 (41,692 – 42,616)	12,915 (12,799 – 13,032)	6305 (6243 – 6366)
	Indian	39,766 (34,512 – 45,020)	47,243 (38,387 – 56,100)	26,534 (26,254 – 26,814)	8517 (8452 – 8582)	4387 (4350 – 4424)
	Others	6837 (5424 – 8249)	8574 (6364 – 10783)	4886 (4834 – 4937)	1520 (1509 – 1530)	725 (719 – 730)
2025	Chinese	390,054 (384,663 – 395,446)	409,415 (386,356 – 432,473)	355,433 (351,591 – 359,276)	189,608 (188,631 – 190,585)	76,736 (76,289 – 77,183)
	Malay	74,713 (69,788 – 79,638)	75,663 (65,783 – 85,543)	61,874 (61,037 – 62,711)	20,941 (20,750 – 21,132)	7758 (7684 – 7833)
	Indian	38,420 (33,024 – 43,817)	48,561 (38,633 – 58,490)	37,203 (36,704 – 37,701)	12,991 (12,889 – 13,092)	5215 (5172 – 5258)
	Others	6843 (5372 – 8314)	8646 (6241 – 11050)	6808 (6716 – 6899)	2358 (2340 – 2375)	889 (883 – 896)
2030	Chinese	401,451 (395,897 – 407,004)	388,210 (362,695 – 413,725)	392,223 (386,677 – 397,769)	244,962 (243,168 – 246,757)	108,817 (108,242 – 109,391)
	Malay	87,695 (81,188 – 94,202)	75,659 (65,049 – 86,270)	75,326 (74,178 – 76,473)	33,482 (33,111 – 33,852)	11,060 (10,958 – 11,161)
	Indian	41,986 (35,741 – 48,230)	45,811 (35,976 – 55,645)	45,080 (44,393 – 45,766)	19,426 (19,228 – 19,625)	7186 (7129 – 7242)
	Others	7942 (6169 – 9715)	8116 (5770 – 10462)	8161 (8037 – 8285)	3556 (3520 – 3591)	1271 (1262 – 1281)
2035	Chinese	427,489 (421,569 – 433,409)	371,314 (343,769 – 398,858)	402,443 (396,135 – 408,751)	289,622 (286,444 – 292,800)	150,825 (149,965 – 151,685)
	Malay	100,151 (91,891 – 108,412)	82,412 (70,156 – 94,667)	79,370 (78,103 – 80,637)	47,639 (46,996 – 48,282)	17,276 (17,109 – 17,444)
	Indian	46,847 (39,491 – 54,202)	45,749 (35,536 – 55,961)	46,425 (45,684 – 47,166)	27,113 (26,755 – 27,470)	10,599 (10,509 – 10,689)
	Others	9261 (7116 – 11405)	8357 (5869 – 10,845)	8299 (8167 – 8432)	4983 (4917 – 5048)	1919 (1903 – 1934)
2040	Chinese	443,542 (437,391 – 449,694)	376,211 (345,181 – 407,241)	395,659 (389,278 – 402,039)	317,570 (313,131 – 322,009)	194,717 (193,217 – 196,217)

Table 7. Prevalence of Myopia and Refractive Error (Combined) of Singapore Residents by Age and Ethnicity (Cont'd)

Year	Ethnicity	Myopia and Refractive Error				
		40 – 49	50 – 59	60 – 69	70 – 79	80+
	Malay	107,281 (97,544 – 117,018)	94,855 (79,962 – 109,748)	81,769 (80,446 – 83,093)	57,218 (56,354 – 58,083)	26,632 (26,328 – 26,936)
	Indian	49,296 (41,148 – 57,444)	49,700 (38,193 – 61,208)	44,393 (43,675 – 45,112)	32,758 (32,265 – 33,250)	15,555 (15,391 – 15,720)
	Others	9971 (7580 – 12,362)	9530 (6613 – 12,446)	7951 (7822 – 8079)	5987 (5897 – 6077)	2861 (2832 – 2891)

Comparing across ethnicity, the 3 most prevalent eye conditions in the Chinese population are myopia and RE (1.72 million), cataract (0.997 million) and ERM (0.44 million). In the Malay population, myopia and RE (0.36 million), cataract (0.21 million) and ERM (0.057 million) are the 3 most prevalent conditions. Similarly, in the Indian population, myopia and RE (0.191 million), cataract (0.10 million), and ERM (0.033 million) are the most prevalent. Eye conditions with the greatest increase in cases from 2015 to 2040 in the Chinese population are DR (112% increase), glaucoma (100%) and ERM (91.4%). For the Malays, DR (154%), ERM (136%), and cataract (122%) cases are expected to increase the most within the same timeframe. On the other hand, in the Indian population, ERM (112%), AMD (101%) and cataract (87%) cases are expected to increase the most from 2015 to 2040.

Discussion

Our projections suggest that the number of Singapore residents aged 40 years and older with eye conditions will increase greatly by 2040 but differential prevalence of eye conditions are also noted. Consequently, this phenomenon is likely to result in an increased demand for eye care services and perhaps a change in the skill mix of the healthcare workforce required to provide adequate care.

The anticipated increase in the prevalence of eye conditions is largely due to changing population dynamics. Singapore's population—both residents and non-residents—is expected to increase gradually, reaching an estimated 6.9 million by year 2040.¹² This is coupled with a demographic shift towards a larger proportion of elderly as a result of increasing life expectancy. Since the prevalence of eye conditions increases with age,² the growing and ageing Singapore population will inevitably see a rise in individuals afflicted with eye conditions.

To the best of our knowledge, this is the first study that attempts to project the future burden of eye diseases in Singapore with such level of granularity. Thus, directly comparable data is not yet available in the literature.

The projected increasing trend in all eye diseases has implications on the demand for eye services. Apart from an increased disease burden, eye care utilisation is dependent on a myriad of factors. Socioeconomic factors have been found to influence the utilisation patterns of eye care services.^{13,14} Strict education policies in Singapore, such as the Compulsory Education Act passed in 2000,¹⁵ have resulted in a burgeoning proportion of the educated population. For instance, 74% of Singapore resident non-students aged 25 to 34 years received tertiary education in 2012, up from 50% in 2002.¹⁶ The prevalence of some eye diseases has also been found to increase positively with educational attainment.¹⁷⁻²¹ Moreover, rising educational status is expected to increase expectations of one's visual acuity, resulting in an increased use of eye care services. It has also been shown that those with higher educational attainment have a higher consumption of preventive eye care and specialist care utilisation.²² Furthermore, educational attainment and affluence are positively correlated. Singapore residents with a higher education profile tend to earn higher monthly gross income than their less educated counterparts.²³ Thus, this change in demographics is likely to see an increase in the affluence of the general population. Consequently, the utilisation of eye care services is expected to increase.^{14,24-27}

In addition, there has been increasing governmental efforts to enhance the accessibility, affordability and quality of healthcare in Singapore through the Healthcare 2020 Masterplan by expanding healthcare capacity and increasing subsidies.²⁸ Subsidies introduced under this masterplan has proven to be effective in increasing healthcare utilisation.²⁹ Increased frequency of screening for various conditions, such as eye diseases, will also be implemented. Eye screening has been proven to be effective in the detection of many asymptomatic eye conditions in the initial stages. In the case of eye screenings, the resultant diagnosis would compel patients to seek treatment, thereby increasing the utilisation of eye care services. The main implication for the projection of prevalence by ethnic groups is to facilitate targeted screening and implementation of interventions among high-risk ethnic and age groups for specific eye diseases.

The strength of our study includes the use of a large representative sample, as well as credible estimates of age-, education- and ethnic-specific prevalence in the projection of eye disease burden. The study has many limitations; first, the use of prevalence instead of incidence to estimate future disease burden may over or underestimate projected disease burden. Second, since the projection focused on individuals 40 years and older, any pathological condition with higher or lower prevalence among the population 40 years or younger may under or overestimate the projected future disease burden. Lastly, the projection did not subdivide eye diseases by severity, which may impact the management and planning of services.

Conclusion

The projected prevalence disaggregated by ethnicity in this study can serve to better inform eye care industry stakeholders regarding the future eye disease burden and proportion of different diseases in the Singapore population. Further, care providers such as hospitals and eye centres can use this information to project the likely eye care service demand as well as an appropriate workforce staffing levels to meet this demand. Policymakers may also find the disaggregation according to ethnicity useful in policy planning, such as providing screening for high-risk ethnic groups.

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Can Robots Accelerate the Learning Curve for Surgical Training? An Analysis of Residents and Medical Students

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Abstract

Surgical traineeship has traditionally been based on a master apprentice model where learning takes place in the operating theatre. This approach has changed over the past few years with greater emphasis on surgical training taking place within the surgical skills laboratory. We developed a high fidelity simulator, the Image-guided Robotic Assisted Surgical simulator (IRAS) with an incorporated robotic guidance feature. The robot system is developed to mimic the process of an experienced surgeon physically holding a trainee's hands to demonstrate manoeuvring of the laparoscopic instruments. We aimed to assess the efficacy of incorporating robotic guidance into this high fidelity surgical simulator. Forty-two participants (13 surgical residents and 29 medical students) were recruited. Participants had one practice run for familiarisation and subsequently performed the virtual laparoscopic cholecystectomy (LC) once. Among the medical students, they were randomised to either a control or intervention group. They were tasked to perform a second- and third-timed LC assessment. Participants were asked to rate the simulator using a 5-point Likert scale questionnaire. IRAS rated favourably in hand-eye coordination and training bimanual dexterity (mean score: 4.1 and 4.0 among students, 3.4 and 3.4 among residents) though it fared suboptimally in realism. At baseline, residents were statistically faster compared to students (overall time: 418.9 vs 586.8 seconds, $P = 0.001$). Participants randomised to the intervention group consistently scored better. However, their overall time were not statistically significant from the control group. The robotic guidance capability of the IRAS is a key advantage of this simulator platform over the conventional platform.

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Key words: Cholecystectomy, Laparoscopy, Simulation training, Virtual reality

Introduction

Surgical traineeship has traditionally been based on a master apprentice model where learning takes place in the operating theatre. This approach has changed significantly with greater emphasis on surgical training taking place within the surgical skills laboratory. Basic laparoscopic handling skills are being taught to surgical trainees using the fundamentals of laparoscopic skills box trainer.^{1,2} Virtual reality laparoscopic simulators or cadaveric dissections can further enhance training by allowing users to undertake partial or full surgical procedures.

Virtual reality simulators are currently excellent tools in teaching basic psychomotor and visual-spatial laparoscopic skills.³ These simulators have improved with increasing

realistic anatomy, tactile feedback and software that allows for training on complete laparoscopic procedures.⁴ Virtual simulator utilises guidance concerning software involving digital lines or arrows to direct the user to the next step.⁵ These teaching adjuncts have been validated to decrease operating time, increase accuracy and improve economy of movement in individuals.⁶

Experienced surgeons have better dexterity. They are able to complete a laparoscopic task faster and with better economy of movement.⁷ The manoeuvring of laparoscopic instruments is a difficult aspect for more experienced surgeons to teach surgical trainees. Trainees traditionally learn these manoeuvres through observation and trial and error. Subsequently, the manoeuvring of the laparoscopic

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instrument is left to the discretion of the trainee. We have sought to address this deficiency with the incorporation of a robotic guidance feature into a high fidelity simulator.^{8,9} The robotic guidance feature is functioned to “hand-hold” the user to move in a predetermined route. It is hypothesised that transfer of surgical skills can be further improved with this added capability.

Materials and Methods

Participant Selections

Thirteen surgical residents were recruited from a single institution; 29 medical students who were rotating through the surgical department at the time of the study were also recruited. At recruitment, the 29 medical students were randomised into a control or intervention group. Fifteen were in the control group and 14 were in the intervention group.

Instrument – Image-guided Robotic Assisted Surgical Simulator (IRAS)

The IRAS training system is developed to mimic the process of an experienced surgeon physically holding a trainee's hands to demonstrate movement of the laparoscopic instruments. IRAS consists of 3 major components: medical image processing and model reconstruction module,^{10,11} surgical simulation platform,^{12,13} and the robotic laparoscopic surgical trainer.^{8,9} A simulated surgical procedure can be reproduced for training and demonstration. Motion of the robotic handle and tool-tissue interaction can be replayed on the robot and the surgical simulation platform simultaneously. The user can hold the handles of the moving robotic instruments while watching the simulated surgical procedure to appreciate the manoeuvres performed by an experienced surgeon. Motor skills training is conducted through such a record and replay procedure.

For this study, IRAS was designed to allow participants to perform a virtual laparoscopic cholecystectomy (LC). The procedure involved the ablation of the connective tissue to expose the cystic duct, deployment of clips on the cystic duct, cutting of the cystic duct and ablation of the connective tissue to free the gallbladder from the liver bed (Fig. 1). The time taken and trajectory distance of each subtask was recorded and generated as an assessment report at the end of the procedure. Two different virtual anatomical setups were made. One setup was used for familiarisation with IRAS and the other setup was used for assessment. Additional details of the design and construct of the simulator is described elsewhere.^{8,9}

Experimental Task and Protocol

The study was conducted in 2 phases. The first phase involved surgical residents and the second phase involved medical students. Amongst surgical residents, they were given an introduction and allowed one practice run to

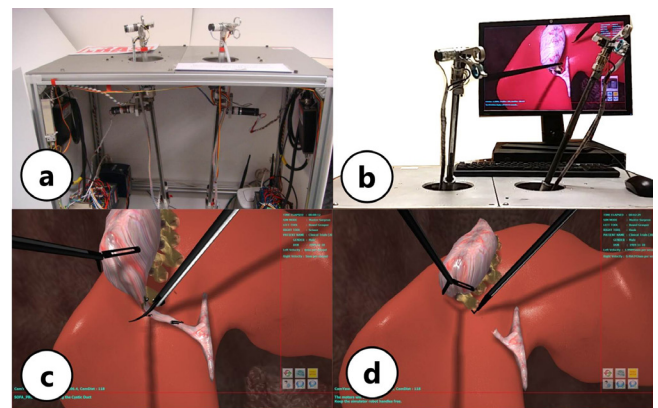


Fig. 1. Image-guided robotic assisted surgical simulator (IRAS). A) Interior setup of the IRAS simulator. B) IRAS setup with external monitor. C) Division of the cystic duct. D) Ablation of connective tissues to free the gallbladder from the liver bed.

familiarise themselves to IRAS. Subsequently, they were tasked to perform the virtual LC once. Upon completion, they were showed how the robotic guidance functioned before filling up a questionnaire.

In the second phase, medical students were first given a video introduction to the steps involved in performing a LC. They were then introduced to IRAS and allowed one practice run for familiarisation. Subsequently, they performed an assessment run on the virtual LC which was assigned as their baseline performance.

Participants were randomly allocated to either control or intervention group in a 1:1 ratio using a block randomisation technique. The allocation of intervention options to each numbered envelope was computer generated based on a block randomisation with block size of 10. Control participants were given 10 minutes of self-practice followed by a second-timed assessment. Participants in the intervention group underwent training only via the robotic guidance mode for 10 minutes followed by a second-timed assessment. This cycle of training and assessment was performed till all the participants completed a total of 3 timed assessments. The robotic guidance playback was based on the recording from a surgical consultant. A 5-point Likert questionnaire was then administered (Table 1).

Statistical Analysis

Sample size calculation was based on a priori power analysis. As incorporation of robotic guidance is novel, we looked at previous studies that compared deliberate practice training against routine training. The improvement effects in such studies ranged from 20%-35%.^{14,15} We calculated our sample size based on detecting at least a 20% difference in surgical performance with alpha of 0.05 and beta of 0.8.

In phase 1, we needed a minimum of 10 surgical residents and 10 medical students. In phase 2, we needed

Table 1. Questions of the 5-Point Likert Scoring Questionnaire

Questions	Responses
Preliminary questions	
Age & gender	
Dominant hand	1) Right 2) Left
Past experience with training with low fidelity surgical trainer (i.e. surgical box trainer)?	1) Limited experience (used for days to weeks) – attended laparoscopic course 2) No previous experience 3) Vast experience (used for weeks to months) – repeated usage of a surgical box-trainer
Past experience with training with high fidelity surgical trainer (i.e. surgical simulators)?	1) Limited experience (used for days to weeks) – attended laparoscopic course 2) No previous experience 3) Vast experience (used for weeks to months) – repeated usage of a surgical simulator
Current level of training? (residents)	
Which year of medical school are you currently in? (medical students)	
How many years of training/rotating through general surgery?	
Past experience with laparoscopic surgery? (residents)	
I have watched laparoscopic surgeries in the operating theatre before? (medical students)	
Past experience with laparoscopic cholecystectomy? (residents)	
I have watched laparoscopic cholecystectomy in the operating theatre before? (medical students)	
I feel that surgical simulators should be incorporated into my training?	1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree
Design & functionality	
I like the appearance and design of the simulator setup?	1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree
I like the appearance and design of the virtual reality environment?	
I feel that IRAS is user friendly?	
The movement of the laparoscopic instruments was well reflected in the virtual reality environment?	
The virtual reality environment/graphics look similar to real-life operation?	
The movement of the laparoscopic instruments in the virtual reality environment feels similar to real-life operation?	
The application of clips in the virtual reality environment feels similar to real-life operation?	
The cutting function in the virtual reality environment feels similar to real-life operation?	
The dissection of the gallbladder from the bed of the liver feels similar to real-life operation?	
Training capabilities	
IRAS is a useful instrument to train basic laparoscopic skills to residents?	1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree
IRAS is a useful instrument to train laparoscopic procedures (i.e. laparoscopic cholecystectomy) to residents?	
IRAS is a useful instrument to train hand-eye coordination?	
IRAS is a useful instrument to train depth perception in laparoscopic surgery?	
IRAS is a useful instrument to train bimanual dexterity in laparoscopic procedures?	
The addition of the robotic guidance mode will enhance the training capability of the simulator?	
Surgical simulators are superior to basic laparoscopic box trainer in training laparoscopic skills?	
Surgical simulators should be incorporated into surgical education?	
I will benefit from using the IRAS simulator?	
I feel that the overall experience of performing a virtual laparoscopic cholecystectomy is realistic?	
IRAS: Image-guided Robotic Assisted Surgical Simulator	

IRAS: Image-guided Robotic Assisted Surgical Simulator

a minimum of 10 medical students in each of the study arm. We aimed to recruit up to 15 surgical residents and 30 medical students (15 in each arm) to account for potential exclusion of participants. We were aware that technical errors within the IRAS system exist which could lead to missing data. Analyses between the various groups of participants were compared using non-parametric analysis (Mann-Whitney U test). We presented time and trajectory distances as medians. An exact significance (2-tailed) P value of ≤ 0.05 was considered significant. All statistical analyses were performed using the SPSS version 20.0 (SPSS, Inc., Chicago, IL).

Results

Assessment between Surgical Residents and Medical Students

Owing to missing or incomplete data capture, the final analysis included 9 surgical residents and 24 medical students. At baseline, surgical residents were statistically faster compared to medical students (dissection time: 73.5 vs 163.4, $P = 0.01$ and overall time: 418.9 vs 586.8 seconds, $P = 0.001$). Surgical residents were faster in all the other domains of exposure time, clipping time, cutting time and performed the procedure with a shorter trajectory distance. However, the results did not reach statistical significance (Table 2).

Assessment of Robotic Guidance

The final analysis included 12 participants in the control group and 11 in the intervention group. We presented data on dissection time, overall time and overall trajectory distance. At baseline, there were no significant differences in the control and intervention group (Table 3). In the subsequent second and third assessments, participants in both groups had improvement in time taken as well as the trajectory distance. Participants randomised to the intervention group had statistically significant improvement in dissection time (second run) and trajectory distance (right instrument, third run) (Table 3).

Subjective Feedback on IRAS

A 5-point Likert scoring questionnaire was used to assess the realism of IRAS and its usefulness as a teaching modality (Table 1). The questions related to realism of IRAS were assigned only to the surgical residents as they had prior operating theatre experience with laparoscopic surgery. For realism, IRAS was rated suboptimally with scores less than 3. As a teaching adjunct, IRAS rated favourable in hand-eye coordination as well as training bimanual dexterity. Medical students rated IRAS more favourably as compared to surgical residents (Table 4).

Discussion

The technique of manoeuvring laparoscopic instrument in performing a procedure is difficult to learn without feedback.¹⁶ The concept of teaching laparoscopic surgery via robotic guidance playback is novel and not previously validated in the literature. Our study is a pilot project in evaluation of robotic guidance in surgical training. From our analysis, we have 2 key findings. First, IRAS is able to discriminate between users of varying surgical experience level. Secondly, transfer of laparoscopic skills can be achieved through robots.

Evaluation of IRAS between Surgical Residents and Medical Students

In the first phase of our study, we determined that IRAS could discern between users of varying surgical experience. When compared based on dissection time and overall time, surgical residents achieved a significant difference compared to medical students (Table 2). IRAS's inability to discriminate the time difference in the other domains could be attributed to the simulator's lack of realism. In real-life laparoscopic cholecystectomy, the challenge involves the complete skeletonisation of the cystic duct. The grasper is used for manipulation of the infundibular junction while the hook cautery performs the dissection. In contrast, IRAS lacks bleeding, has poorly deformable organ structure

Table 2. Baseline Performance between Surgical Residents and Medical Students

Baseline	Surgical Residents	Medical Students	P Value (Residents vs Medical Students)
Exposure time (s)	60.2 (27.0), n = 11	85.3 (66.1), n = 28	0.078
Clip time (s)	125.4 (89.6), n = 11	173.6 (179.0), n = 28	0.149
Cut time (s)	28.0 (21.1), n = 11	44.5 (30.9), n = 28	0.078
Dissection time (s)	73.5 (67.0), n = 9	163.4 (106.9), n = 25	0.010*
Overall time (s)	418.9 (111.9), n = 9	586.8 (225.6), n = 24	0.001*
Overall trajectory (right)	3385.9 (1628.4), n = 9	4486.6 (2582.9), n = 23	0.246
Overall trajectory (left)	3837.8 (1204.4), n = 9	4289.3 (1961.2), n = 23	0.133

*Statistically significant results.

Table 3. Performance between Medical Students who Trained Without and With Robotic Guidance

	Control Group (Conventional Simulator Training)	Intervention Group (Robotic Guidance Training)	P Value (Control vs Intervention)
Baseline Run			
Dissection time (s)	168.6 (118.3), n = 13	139.0 (77.5), n = 11	0.303
Overall time (s)	618.1 (251.0), n = 13	510.5 (181.3), n = 11	0.303
Overall trajectory (right) mm	4497.7 (3012.2), n = 12	4273.6 (2004.6), n = 11	0.487
Overall trajectory (left) mm	4567.9 (2178.7), n = 12	4486.6 (1586.7), n = 11	0.211
Second Run			
Dissection time (s)	152.9 (96.0), n = 14	115.4 (78.1), n = 13	0.038*
Overall time (s)	486.9 (223.5), n = 14	372.2 (211.9), n = 13	0.458
Overall trajectory (right) mm	3848.4 (3739.4), n = 14	2875.3 (1908.3), n = 14	0.114
Overall trajectory (left) mm	4014.3 (2334.6), n = 14	3162.2 (1759.8), n = 14	0.427
Third Run			
Dissection time (s)	115.8 (43.2), n = 12	88.6 (75.2), n = 11	0.059
Overall time (s)	357.5 (117.5), n = 13	261.0 (160.3), n = 11	0.063
Overall trajectory (right) mm	3617.1 (1289.1), n = 12	2186.3 (2153.2), n = 11	0.032*
Overall trajectory (left) mm	3382.8 (1218.0), n = 12	2906.0 (1602.6), n = 11	0.260

*Statistically significant results.

Table 4. Subjective Assessment of IRAS

Domains	Residents n = 14	Students n = 29
Hardware appearance	3.1 (1.0)	3.7 (0.9)
Software appearance	2.8 (1.0)	3.3 (1.1)
User-friendliness	2.9 (1.0)	3.1 (1.0)
Movement of virtual laparoscopic instruments	2.3 (1.0)	2.9 (1.0)
Graphic realism	2.4 (0.8)	NA
Movement realism	2.5 (1.2)	NA
Realism of clipping	2.6 (1.2)	NA
Realism of cutting	2.6 (1.2)	NA
Realism of dissection	2.4 (1.0)	NA
Teaching basic laparoscopic skills	3.1 (1.2)	3.8 (0.9)
Teaching laparoscopic procedures	3.1 (1.2)	3.7 (0.8)
Training hand-eye coordination	3.4 (1.2)	4.1 (0.8)
Training depth perception	3.2 (1.2)	3.1 (1.2)
Training bimanual dexterity	3.4 (1.1)	4.0 (0.8)
Benefit of robotic guidance	2.9 (1.1)	3.6 (0.8)
Recommend to trainees	3.9 (0.9)	NA
Incorporating surgical simulators into surgical education	3.7 (1.0)	4.1 (0.6)
Interest in general surgery (before)	NA	3.1 (1.4)
Interest in general surgery (after)	NA	3.7 (0.9)

IRAS: Image-guided Robotic Assisted Surgical Simulator; NA: Not applicable

and rudimentary Calot's dissection. Due to technical limitations, the cystic artery was also not included in the current simulator design. The IRAS simplifies ablation of a portion of connective tissues to a touch by the hook cautery

instead of plane identification. Additionally, the movement of the instruments felt crude in the hands of the surgical residents. This would have interfered with the assessment.

Transfer of Laparoscopic Skills

Nevertheless, we have shown that surgical laparoscopic skills can be taught via robotic guidance. The robotic guidance that the participants had was based on a recorded version of an experienced surgeon's performance on the IRAS. They were trained repeatedly with that recorded version during their 10 minutes of allocated training time. While robotic guidance training trended towards improved overall timing, we currently do not observe a statistical difference in overall time (Table 3 and Fig. 2).

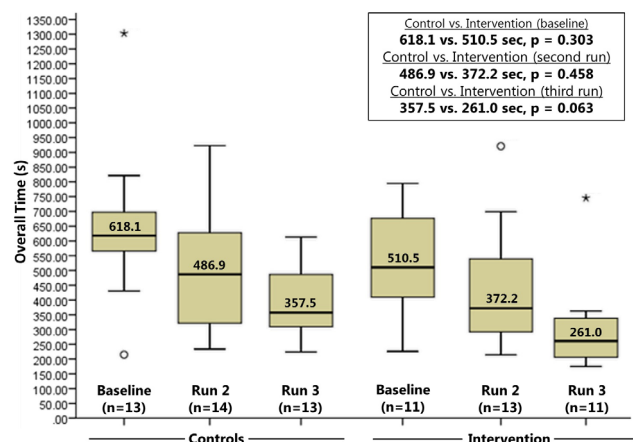


Fig. 2. Graph showing the overall time between the control and intervention group for baseline, run 2 and run 3 assessments.

The most complex subtask in the current model would be the dissection of the gallbladder away from the liver bed. Participants were required to use one instrument to control the position of the gallbladder with the second instrument positioned to ablate the connective tissue. This subtask did achieve statistical significance in the intervention group compared to the control group (Table 3). Additionally, overall trajectory distance also achieved statistical significance by the third (3617.1 mm vs 2186.3 mm, $P = 0.032$). With robotic guidance, participants could have learned how to rightly manoeuvre both the instruments to achieve quicker dissection and more precise movements compared to a trial-and-error approach.

Benefits and Limitations of Robotic Guidance

The robotic guidance function may inadvertently put forth the misconception that there is only one right way to perform a surgical procedure. In real-life, many different surgical techniques exist. The type of technique also differs based on the anatomy encountered. With increased surgical experience, most surgeons do develop their own technique in dealing with a challenging anatomy. At present, the lack of realism in IRAS impedes the potential benefits of the robotic guidance. We anticipate that with a highly realistic simulator model, the robotic guidance would be best used to teach specific aspects of a surgery (i.e. bowel wall suturing, Calot's dissection).

Study Limitations

The current study is limited by the low number of training cycles (2 x 10 minutes block). Increased training cycles might help to further differentiate between the control and the intervention group. Additionally, we have yet to investigate if the learning effects of robotic guidance training can be retained. The incorporation of simulator-based training with assessment on a cadaveric porcine model would have given a better indicator on the usefulness of the robotic guidance in terms of skill transfer.

Nevertheless, the results of this study suggest that incorporation of robotic guidance is a useful adjunct for next-generation laparoscopic simulators. It is likely that with a more realistic simulator platform, the capabilities of the robotic guidance function will be more evident.

Conclusion

Virtual reality simulation training will continue to be an important adjunct for training surgical residents in laparoscopic surgery. Next-generation simulators can consider the incorporation of robotic guidance to their setup to enhance the user's learning experience.

Acknowledgement

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Clinical and Reproductive Outcomes Following Hysteroscopic Adhesiolysis for Asherman Syndrome in an Asian Population

Dear Editor,

Women with Asherman syndrome present with menstrual abnormalities, subfertility or recurrent pregnancy loss, as a result of intrauterine adhesions.¹ There may be a geographical variation in the prevalence of Asherman syndrome due to varying incidence of genital infections and the different laws with regard to therapeutic and illegal abortions across the world.² The pathophysiology of Asherman syndrome is linked to the disruption of the basalis layer during intrauterine injury, in turn leading to endometrial sclerosis and adhesion formation.³ It is now recognised that Asherman syndrome may result from causes other than trauma to a gravid uterine cavity.⁴ The aims of our study were to elucidate the possible predisposing risk factors for Asherman syndrome in our population and to describe the clinical, reproductive and obstetrical outcomes following hysteroscopic adhesiolysis in our centre.

Materials and Methods

This is a retrospective case series analysis carried out in a tertiary women's hospital in Singapore. Approval from Institutional Review Board was obtained. Symptomatic women with hysteroscopically diagnosed intrauterine adhesions aged 45 years and below were included in our study. The demographics, predisposing factors and menstrual symptoms and reproductive outcomes following hysteroscopic adhesiolysis were recorded for 76 patients over a 2-year period. Hysteroscopic grading of intrauterine adhesions in our centre was done using a modified classification proposed by Yu et al based on that by the European Society of Gynaecological Endoscopy.⁵

Results

Table 1 shows the demographics of the 76 patients in our study. Seventy-one procedures classified as trauma to the gravid uterus were performed on 62 patients (Table 2), of which 23/71 (32.4%) were elective terminations of pregnancy (TOP) by suction curettage, 2/71 (2.81%) were curettage with blunt curette after medical mid-trimester TOP, 39/71 (54.9%) were dilatation and suction curettage secondary to missed or incomplete miscarriage and 7/71 (9.9%) were dilatation and curettage post-delivery secondary to retained products of conception. Fifty-one patients had only trauma to the gravid uterus while 11

Table 1. Patient Demographics

Patient Demographics (n = 76)	
Age	
Median age (years)	35 (24 – 45)
Ethnicity (n, [%])	
Chinese	54 (71.0)
Malay	10 (13.1)
Indian	6 (7.9)
Others	6 (7.9)
Parity (n, [%])	
Nulliparous	45 (59.2)
Multiparous	31 (40.7)

had an episode of trauma to the gravid uterus, in addition to other procedures at a different time. None of these 11 patients had a prior hysteroscopy and dilatation and curettage for endometrial pathology and 2 underwent transcervical resection of polyp; 16/62 (25.8%) patients were classified as having severe adhesions after trauma to the gravid uterus while only 1/10 (10%) patient presented with severe adhesions after predisposing factors that affected the non-gravid uterus. The 4 patients with no documented risk factors were all nulliparous and presented with primary subfertility. Only mild adhesions were found in them.

A total of 65.8% (56/76) of patients in our study had presented with subfertility, of which 4 had recurrent pregnancy loss (Table 3). Fifty-percent of patients presenting with subfertility had mild adhesions. In contrast, 60.8% of patients who presented with menstrual abnormalities had moderate to severe adhesions. Following treatment, there was a return of normal menses in 20/23 (87%) of patients presenting with menstrual abnormalities. Of the 56 patients who presented with subfertility, 9 were lost to follow-up for the 2-year period. Of the remaining 47 patients with intrauterine adhesions who presented with subfertility, 3 patients had other gynaecological conditions affecting fertility (adenomyosis, fibroids distorting the endometrial cavity and septate uterus) and were excluded from analysis of reproductive outcomes following hysteroscopic adhesiolysis (n = 44). Clinical pregnancy was achieved in 56.8% of patients (Table 4). However, while 83.8% in the

Table 2. Possible Aetiologies for the Development of Asherman Syndrome

Severity of Intrauterine Adhesions	Trauma to Gravid Uterus	Trauma to Gravid and Non-Gravid Uterus	Trauma to Non-Gravid Uterus	Uterine Mobiliser	Endometritis	No Obvious Cause Found
Mild, n = 35, (n [%])	22 (62.9)	4 (11.4)	2 (5.7)	1 (2.9)	2 (5.7)	4 (11.4)
Moderate, n = 24, (n [%])	17 (70.8)	3 (12.5)	3 (12.5)	1 (4.2)	0	0
Severe, n = 17, (n [%])	12 (70.6)	4 (23.5)	1 (5.9)	0	0	0
All stages, n = 76, (n [%])	51 (67.1)	11 (14.5)	6 (7.9)	2 (2.6)	2 (2.6)	4 (5.3)

Table 3. Presenting Symptoms of Patients with Asherman Syndrome

	Subfertility	Menstrual Abnormality	Subfertility & Menstrual Abnormality
Mild adhesions, n (%)	25/50 (50.0)	9/23 (39.1)	1/3 (33.3)
Moderate adhesions, n (%)	21/50 (42.0)	3/23 (13.0)	0/3 (0)
Severe adhesions, n (%)	4/50 (8.0)	11/23 (47.8)	2/3 (66.7)
All grades, n (%)	50 (65.8)	23 (30.2)	3 (3.9%)

Table 4. Severity of Intrauterine Adhesions and Reproductive Outcomes

Severity of Adhesions	Number of Patients	Clinical Pregnancy	Live Birth in Patients who Achieved Clinical Pregnancy
Mild	22	12/22 (54.5%)	10/12 (83.3%)
Moderate	17	9/17 (52.9%)	7/9 (77.8%)
Severe	5	4/5 (80%)	1/4 (25%)
Total	44	25/44 (56.8%)	18/25 (72%)

mild adhesions group with clinical pregnancies went on to have live births, only 25% achieved live births in the severe adhesions group. Rate of miscarriage was higher in the group with severe adhesions compared to the group with mild adhesions, odds ratio 15.00 (95% confidence interval 0.98 to 228.91, $P = 0.05$). For the 19 patients who achieved live births in our study population, 21% (4/19) had preterm deliveries while 5.3% (1/19) had abnormal placentation (placenta praevia major). Caesarean section rate was 63.2% (12/19) and there was intrauterine growth restriction in 5.3% (1/19).

Discussion

Trauma to the gravid uterus (81.6%) was the main predisposing factor for the development of Asherman syndrome in our study population. In 1982, Schenker and Margalioth reviewed 1856 cases of intrauterine adhesions and found that pregnancy was the dominating predisposing

factor in 90.8% of patients.⁴ More recent data, including 3 retrospective studies that included a total of 239 patients, found trauma to the gravid uterus to be the predisposing cause in 57.7% to 76.9% of patients with Asherman syndrome.¹ The endometrium is dependent on oestrogen for regeneration, and it is hypothesised that a low oestrogen status at the time of operation and postoperative period is a reason why the basal layer of the endometrium is more vulnerable after pregnancy to trauma.¹ Tan WH et al performed a randomised controlled trial on 82 women who had been treated with conservative management, medical evacuation, or surgical evacuation of retained products of conception after spontaneous abortion and found no cases of intrauterine adhesions in patients managed conservatively or by medical evacuation, whereas 2 cases (7.7%) of filmy intrauterine adhesions were detected in those managed by surgical evacuation.⁶

In our study population, 65.8% presented with subfertility and 30.3% presented with menstrual abnormalities. We found that the percentage of moderate to severe adhesions in the group presenting with menstrual abnormalities was higher than that in the group presenting with subfertility. Mild adhesions could possibly affect the microenvironment of the endometrium and lead to disruption in the maternal-fetal crosstalk in the complicated process of embryo implantation. Defective vascularisation of the regenerating endometrium in turn could lead to recurrent pregnancy loss.⁷ Amenorrhoea or hypomenorrhoea may be explained by more severe adhesions such as cervical adhesions blocking menstrual flow or fibrosis leading to destruction of the entire basal layer of the endometrium or that the small pockets of endometrium present have atrophied because of limited local exposure to sex steroids.⁸

There is a lack of prospective, randomised controlled trials on the treatment of Asherman's syndrome.⁹ Sharp dissection of adhesions minimises destruction of the endometrium.¹⁰ The use of electrosurgery is reserved for moderate to severe adhesions. Electrosurgery used in the lysis of adhesions include monopolar energy, bipolar (Versapoint), or Nd:YAG laser ablation. Zikopoulos et al found no difference with respect to reproductive outcome after adhesiolysis comparing monopolar to bipolar

electrosurgery.¹¹ In cases of severe adhesions, hysteroscopic lysis of adhesions was performed under ultrasonographic or laparoscopic guidance. Different methods of adhesiolysis for severe adhesions have been studied. McComb and Wagner described a simplified therapy of inserting a Pratt cervical dilator towards each cornua under laparoscopic guidance, converting the obliterated cavity into a uterine septum, which is then divided with hysteroscopic scissors.¹² The myometrial scoring technique in the management of severe Asherman syndrome was proposed by Protopapas A et al, and it involved making 4 mm deep longitudinal incisions on the myometrium with a resectoscope fitted with a knife electrode.¹³ Laparotomy as a last resort was offered only after 3–4 hysteroscopic failures in well counselled patients¹⁴ and was not utilised in any of the patients in our study. Ancillary treatment postprocedure has often been used, but varies according to surgeon preference. Insertion of a physical barrier between the uterine walls creating a separation between the endometrial layers after adhesiolysis, is hypothesised to prevent adhesion formation after surgery. Physical barriers include the loop intrauterine device and foley catheter. However to date, there have been no class I studies investigating the use of intrauterine device after hysteroscopic intrauterine adhesiolysis.¹⁰ Hormone therapy is another form of ancillary therapy. In 1964, Wood and Pena described regeneration of the endometrium with oestrogen therapy after surgical treatment of intrauterine adhesions. A new ancillary treatment recently introduced is adhesion barriers in the form of film or gel. A prospective, randomised, controlled study found that following hysteroscopic adhesiolysis, auto-cross link hyaluronic acid gel significantly reduced the development of intrauterine adhesions postoperatively.¹⁵

In a review of 36 articles that reported fertility and obstetric outcomes after hysteroscopic management, the pregnancy rate was approximately 63% and of women who conceived, the live birth rate was 75%.¹⁰ Our study reports a pregnancy rate of 56.8% and for those with a clinical pregnancy, 72% achieved live births. The group that had mild adhesions by hysteroscopic diagnosis achieved a higher live birth rate of 83.3% while those in the severe adhesions group achieved a live birth rate of 25%, despite pregnancy rates being more than 50% in each group. It is expected that with greater severity of the adhesions, there would be more endometrial fibrosis hindering successful implantation and even after adhesiolysis, there is a high rate of reformation of adhesions (20 to 65%).^{16,17} Patients with severe adhesions should be counselled regarding the prognosis and high miscarriage rates.

The obstetric complications rate reported in the group which achieved live birth was also high. Deans R and Abbott J reported 17 pregnancies out of 696 births complicated by

placental accreta and increta.¹⁰ Abnormal placentation is possible as the basalis layer of the endometrium has been disrupted in these women.⁹ They also reported an increased risk of premature delivery and uterine rupture.¹⁰ In our small group of 19 pregnancies posthysteroscopic adhesiolysis, 4 pregnancies (21%) were complicated by preterm delivery compared to the rate of preterm delivery of 13.6% in our centre.¹⁸ The caesarean section rate was 63.2% in our study group, which was higher than the caesarean section rates of our centre during that period (32.2% in 2010 and 33.8% in 2011).

We acknowledge the limitations of our study. It is retrospective in nature and consists of small numbers, with significant numbers lost to follow-up. No second look hysteroscopy was done to assess recurrence after treatment. The lack of a standardised pathway for the operative procedure also reduces the strength of our study.

Conclusion

The most common predisposing factor for developing Asherman syndrome in our population was trauma to the gravid uterus. The severity of adhesions has an impact on the prognosis of pregnancy outcomes. The importance of minimising, if not avoiding, the occurrence of endometrial injury post-TOP or post miscarriage, remains paramount. Efforts to reduce the number of unwanted pregnancies through effective contraception counselling, limiting instrumentation to the gravid uterus and the use of intrauterine adhesion barriers may help to prevent this rare but serious condition.

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Preschool Teachers' and Parents' Understanding of Early Childhood Temperament in an Asian Culture – Implications on Child Health and Development

Dear Editor,

Temperament refers to constitutionally-based individual differences in emotional and attentional reactivity and self-regulation, influenced by genetics and experience.¹ It represents one's own style that determines how an individual behaves and interacts with others and defines how an individual would approach and react to a situation or a person. Distinct cultural and population differences in temperament exist, which are influenced by both genetic factors and cultural differences in values and methods of child-rearing.^{2,3} Individual temperament differences can explain the ease or difficulties of daily parenting around common childhood issues, for example: sleep, feeding, toileting, disobedience, tantrums, over-activity, shyness, excessive crying and school refusal.⁴ Thomas and Chess described 9 temperament traits which form the basis of our understanding of childhood temperament.⁵ Temperament is an integral factor influencing childhood emotional development, which in turn contributes to adult emotional and mental health.⁶ Little is known about temperament understanding in Asia.

Caregivers' understanding of temperament is crucial. Firstly, it reduces the likelihood of assigning pathology to behaviour variations. Secondly, caregivers can modify expectations and reactions to a child's behaviour, therefore reducing stress.² Finally, greater synchrony between a caregiver's parenting style and child's behavioural style, a concept termed 'parenting to the fit', positively impacts a child's development, learning and achievement.⁷ Within classrooms, goodness-of-fit between educator's teaching style and child's temperament improves social-emotional outcomes in younger children and educational achievement in older children.⁷

In Singapore, behavioural and emotional problems are estimated to occur in about 7% and 10% of children, respectively.^{4,8} Shaped by principles of Confucianism, "sound moral and social values" is one of the key aims in Singapore's Kindergarten Curriculum Framework (KCF). Given this context that emphasises discipline and teaching to collective benefit rather than individual differences, we hypothesised that the temperament model may be under-utilised in understanding children's behaviours locally.

The study aimed to: 1) assess parents' and teachers' beliefs and knowledge with regard to early childhood

temperament and to find out which traits were perceived as "difficult", 2) compare temperament scores of Singapore children with the originally normed Carey Temperament Scale (CTS),⁹ and 3) explore teachers' perceptions of their exposure to temperament teaching within the preschool teachers' curriculum.

Materials and Methods

This was a cross-sectional study. Data was collected over a year (2013-2014) using self-administered questionnaires after obtaining consent. Ethics approval was obtained.

English literate caregivers of children aged 3 to 6 years from 2 major public preschool organisations in Singapore were recruited.

Measures

Parents (pertaining to their own child) and teachers (without pertaining to any specific child), were asked to rate their perceived ease or difficulty in handling children using descriptions of behaviours based on each of the 9 temperament constructs.

Teachers were asked about their exposure to temperament teaching within the preschool teachers' curriculum and parents completed the Behavioural Style Questionnaire (BSQ) of the CTS.

Analysis

Chi-squared test was used to compare outcomes between parents and teachers. Descriptions of means and standard deviations of the CTS were examined, relative to published norms.

Results

Demographic Profiles

A total of 268 parents' and 104 teachers' responses were included (Table 1).

Knowledge and Understanding of Temperament

Parents and teachers had similar understanding of temperament. Most believed children have different temperaments and that a child's temperament affects how he or she is disciplined. Both groups had the perception that temperament is affected by gender and can be changed by discipline and environment. More parents than teachers

Table 1. Demographic Data of Parents and Teachers

Variable	No. (%)	
	Parents (n = 268)	Teachers (n = 104)
Gender		
Female	182 (67.9)	103 (99.0)
Male	86 (32.1)	
Age (yrs)		
21 – 30	39 (14.6)	54 (51.9)
31 – 40	171 (64.0)	21 (20.2)
41 – 50	52 (19.5)	18 (17.3)
51 and above	5 (1.9)	11 (10.6)
Highest academic qualification		
Primary School Leaving Exam	20 (7.5)	-
'O' Levels	53 (20.0)	-
'A' Levels	3 (1.1)	6 (5.8)
Diploma	76 (28.7)	56 (53.8)
Graduate	67 (25.3)	29 (27.9)
Others	46 (17.4)	13 (12.5)
Household income (Singapore \$)		
<1500	24 (9.1)	-
1500 – 4999	133 (50.6)	-
5000 – 10,000	85 (32.3)	-
>10,000	21 (8.0)	-
Time spent with child per day (hrs)		
<5	141 (52.6)	-
5 – 6	70 (26.1)	-
7 – 8	28 (10.4)	-
9 – 10	13 (4.9)	-
>10	16 (6.0)	-
Experience in teaching preschool (yrs)		
0 – 5	-	61 (58.7)
6 – 10	-	25 (24.0)
11 – 15	-	8 (7.7)
>15	-	10 (9.6)

Children (n = 268)

Age	
2 yrs 0 mths – 2 yrs 11 mths	1 (0.4)
3 yrs 0 mths – 3 yrs 11 mths	25 (9.5)
4 yrs 0 mths – 4 yrs 11 mths	71 (27.0)
5 yrs 0 mths – 5 yrs 11 mths	113 (43.0)
6 yrs 0 mths – 6 yrs 11 mths	53 (20.2)
Gender	
Female	129 (48.3)
Male	138 (51.7)

Table 1. Demographic Data of Parents and Teachers (Cont'd)

Table 1: Demographic Data of Parents and Teachers (Continued)	
Variable	No. (%)
	Children (n = 268)
Order of child in family	
1	136 (54.0)
2	82 (32.5)
3	26 (10.3)
4	6 (2.4)
5	2 (0.8)

believed that temperament remains largely constant in spite of age (Fig. 1).

Few (11.5%) teachers reported receiving adequate training on temperament. Only 13.5% indicated they were taught specific methods to deal with children of different temperaments.

Manageability of Different Temperament Traits

Teachers generally perceived more difficulties managing children. Compared to parents, teachers found traits of high activity (28.6% vs 40.4%, $P = 0.002$), low mood (19.4% vs 31.0%, $P = 0.031$), and low sensory threshold (19.4% vs 34.6%, $P = 0.001$) more difficult to handle. Parents reported non-persistence (19.4% vs 29.2%, $P = 0.040$) more difficult to handle than teachers.

Overall Manageability of Child

Most parents (70.2%) and teachers (72.1%) rated that they were coping well with managing a child's behaviour. This correlated to the manageability score on the BSQ where 75.9% of the parents reported scores of 1-3 (ie. very easy to somewhat easy to manage the child).

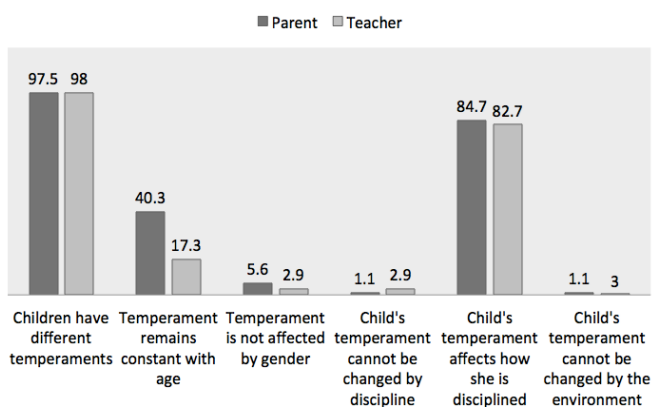


Fig 1. Chart showing comparison between parents' and teachers' understanding of temperament.

Temperament of Children Scored with the Carey Temperament Scales

Children studied mostly fell within 2 standard deviations (SD) of the mean for activity, approach, distractibility and threshold as per United States (US) norms. They appeared to be more arrhythmic, less adaptable, less intense, less persistent and having more negative mood (Table 2).

Discussion

This is one of the few Asian studies that highlights gaps in knowledge about temperament amongst carers, as well as differences in temperament of children in Singapore. It reveals that parents and teachers have limited understanding of temperament. This is of concern because teachers contribute significantly to the care of children in Singapore with over 90% of preschool children enrolled in

full-day programmes in childcare centres.¹⁰ Preschools in Singapore focus on an academic-driven curriculum, are more teacher-directed than child-centred and less customised for individual differences.¹¹ Our preschool teachers are diploma graduates with 1–3 years of training. Their training includes general aspects of socio-emotional development in children but does not address specific strategies in dealing with individual variations and styles. Since most teachers reported inadequate training in temperament, the temperament framework should be included within early childhood educators' curriculum—to equip preschool educators with classroom strategies for behavioural understanding and support.

For parents, enhancing this understanding potentially reduces blame and guilt on child and parent, especially if temperament is challenging and parents do not feel competent about parenting. By using the goodness-of-fit model in their parenting, they will be able to better appreciate their child's temperament as potential strengths, draw on the child's unique characteristics to impart skills, and enhance the parent-child relationship.

Distinctions between parents and teachers on traits perceived to be “difficult” can be attributed to the high (1:20) teacher-to-student ratio in Singapore, in comparison to the ratio in the top 10 countries in the Starting Well Index (1:5–11). The child with high activity, low mood (unfriendliness in words and behaviours) and low sensory threshold (easily disturbed by sensory stimulation) will require increased attention from the teacher in a packed classroom. Distinctions between parents and teachers on traits perceived to be “difficult” informs us that it would be helpful to customise management strategies for the classroom or home setting.

Interestingly, children in our study appeared less rhythmic (less regular in their basic functions), less adaptable (less adjustable to change or new situations), less persistent (easily distracted from a task), milder in intensity and slightly more negative in mood compared to children in the US. This may reflect an actual difference in the temperament of children of Asian ethnicity or a cultural difference where certain behaviours are more accepted hence encouraged.¹² Studies comparing school-aged children living in China, South Korea and India to those in the US showed that parents from all 3 Asian countries perceived specific temperament styles to be more desirable in comparison to those from the US.¹³

Limitations

The study was limited to mainly low to middle income families and English literate participants. Differences in understanding and management of temperament might exist between different income groups. Response to the survey was voluntary, creating a possible selection bias.

Table 2. Comparison of Carey's Score between Singapore and the Originally Normed Nine Domains of Temperament in the Carey's Questionnaire

Domains	Definition	Outside (-) 2SD (%)	Outside (+) 2 SD (%)
Activity	Motor component in a child's functioning	0.4 (low activity)	1.5 (high activity)
Approach	Initial response to novelty	0 (approachable)	1.1 (withdrawn)
Distractibility	Effectiveness of extraneous stimuli in altering the direction of ongoing behaviour	0 (non-distractible)	0 (distractible)
Threshold	The intensity level of stimulation that is necessary to evoke a discernible response	2.2 (high)	0.4 (low)
Rhythmicity	Regularity; predictability in daily functions	0 (very rhythmic)	7.8 (arrhythmic)
Adaptability	Behavioural flexibility in changing context	0 (adaptable)	5.2 (non-adaptable)
Intensity	Energy level of an emotional response	4.1 (mild)	0 (intense)
Mood	Tone of overall affect (positive or negative)	1.5 (positive)	3.0 (negative)
Persistence	Continuation of activity in face of obstacles	0 (persistent)	4.5 (non-persistent)

SD: Standard deviation

Locally, where up to 76% are dual-income families and at least 1 in 5 households employ foreign domestic workers (FDWs),¹⁴ FDWs are increasingly assuming the role of the main caregivers of our preschoolers. At least a quarter of our children grow up in a multicultural household and the majority spend most of their time with teachers or FDWs. It is unclear how this unique myriad of caregivers affects childhood temperament perception, although it raises the importance of identifying the key caregivers when seeking information on a child's temperament.

Recommendations and Implications for Future Research

It is encouraged that physicians use the temperament approach to explain behavioural differences among children. Physicians can address challenging temperaments that tip the parent-child dyadic relationship unfavourably.³

We hope to have a culturally-adapted version of the BSQ that would better reflect the distribution of temperament characteristics in our population.

This study serves as a platform for advocating greater awareness of temperament in caregivers to foster more nurturing relationships. There is a need for explanations of children's behaviours using a temperament framework, for better educational and mental health outcomes.

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Birth Outcomes and Successive Pregnancy Rates in Adolescents Attending a Specialised Antenatal Clinic

Dear Editor,

Adolescent pregnancies are associated with negative health and social consequences. Pregnant adolescents are prone to poorer birth outcomes that are attributed to biological and socioeconomic differences.^{1,2} A study in New Jersey³ reported 1 in 5 repeat pregnancies while still in their adolescence. Short pregnancy intervals drain the already limited resources that adolescents have, and their children, in turn, could be at risk of adolescent pregnancies themselves.

Azevado et al's systematic review⁴ reported improvements when there was adequate prenatal care. Age-specific antenatal clinics have been described in the literature. A study involving 731 patients by Quinlivan et al⁵ comparing teenage antenatal clinics versus general clinics showed a reduction in preterm births and an increase in contraception uptake when adolescents visited the former. Such clinics provide multidisciplinary care and screening for infectious and social pathologies. However, these adolescents may constitute a self-selected group with greater empowerment while others may not have access to these clinics due to emotional or financial insecurities.

This study retrospectively compared pregnancy complications, outcomes, contraception uptake and repeat pregnancy rates in adolescents with good attendance at a dedicated teenage pregnancy clinic in our centre versus those with poorer attendance (worse results were expected).

Materials and Methods

The specialised Clinic for Adolescent Pregnancy (CARE) was established in our centre in 2008. It has a multidisciplinary team of doctors, nurses, counsellors and social workers working with community agencies. Unmarried adolescents are booked with the clinic and the cutoff age is 21 at the expected date of delivery. Screening for chlamydia and gonorrhoea is emphasised. A formal psychosocial assessment of the involvement of the putative father and family, plans for marriage, homelessness, domestic violence, education and financial plans are conducted by medical social workers. High risk cases are followed-up by a mental wellness team including nurses, psychologists and psychiatrists. Designated trained nurse counsellors reinforce contraception use postpartum at follow-up. The clinic runs twice weekly at different time sessions to

allow scheduling flexibility. Monthly multidisciplinary meetings are conducted to discuss the management of adolescents with more complex social or medical issues.

Cases booked with CARE from 2008 to 2012 and delivered before the end of 2013 were reviewed. The study was extended for 2 years to follow-up on successive pregnancies. Access to prenatal care was categorised according to the Kessner Index criteria of the National Institute of Medicine,⁶ based on booking gestation and number of antenatal visits, adjusted for gestation length of that pregnancy. Good attendance was considered met if the booking had occurred before 28 weeks' gestation, with the number of prenatal visits within an adequate range as per the Kessner Index.

Demographic data for maternal profiling, pregnancy complications and outcomes, postpartum contraception use and successive pregnancies in the subsequent 1 to 2 years were analysed. Level of social support was measured using the newborn's discharge destination as a surrogate marker. Assessment and provisions were made to safeguard the interests of the newborn before discharge. The ability to discharge a newborn back to the care of the adolescent mother reflected at least the lack of psychosocial stressors such as homelessness, drug abuse and domestic violence. On the other hand, giving up for adoption reflected deficiencies in social structural supports.

Statistical significance was calculated by categorical chi-square test, Fisher's exact test and Student t-test analysis, where relevant, on SPSS Statistics 20. Difference was considered significant if *P* value was <0.05.

Results

A total of 630 cases were booked with CARE; 143 records were unavailable for review, 12 cases were lost to follow-up, 3 had terminated their pregnancies and 2 cases miscarried early after booking. The remaining 470 cases (74.6%) were reviewed.

Two hundred and sixty-five cases (56.4%) had adequate attendance while 205 cases (43.6%) had poor attendance. As shown in Table 1, poor attendees were younger (17.7 ± 1.5 vs 18.1 ± 1.4 , $P < 0.001$). Given that Malays in Singapore constitute 13.8% of the population,⁷ the Malay ethnic group was disproportionately larger (63.4%) in our study especially among the poor attendees (76.1%, $P < 0.001$).

Table 1. Maternal Profiles among Pregnant Adolescents Attending CARE

	At Least Minimal Standard of Care Obtained n (%)	Poor Access of Care n (%)	Overall n (%)	P Values*
Overall	265	205	470	
Age	18.1 ± 1.4	17.7 ± 1.5	17.9 ± 1.5	<0.001
Age below 16	12 (4.5)	15 (7.3)	27 (5.7)	
Race				
Chinese	95 (35.8)	36 (17.6)	131 (27.9)	<0.001
Malay	142 (53.6)	156 (76.1)	298 (63.4)	
Others	28 (10.6)	13 (6.3)	41 (8.7)	
Parity				
1	260 (98.1)	199 (97.0)	459 (97.7)	
2	5 (1.9)	6 (2.9)	11 (2.3)	
Substance abuse				
Alcohol	7 (5.7)	2 (1.0)	9 (1.9)	
Continued cigarette smoking	30 (11.3)	24 (11.7)	54 (11.5)	
Stopped smoking in pregnancy	12 (4.5)	7 (3.4)	19 (4.0)	
Recreational drugs	0 (0.0)	0 (0.0)	0 (0.0)	
Remained single	127 (46.8)	119 (58.0)	246 (52.3)	0.029
Newborn's discharge destination				
Self	253 (95.5)	187 (91.2)	440 (93.6)	0.041
Adoption	10 (3.8)	18 (8.7)	31 (6.6)	

CARE: Clinic for Adolescent Pregnancy

*Are indicated where significant.

Notably, more poor attendees remained single throughout the pregnancy (58.0% vs 46.8%, $P = 0.029$). A larger proportion of newborns required adoption among the poor attendees (8.7% vs 3.8%, $P = 0.041$).

Overall, 24.0% of adolescent pregnancies were complicated by anaemia. As shown in Table 2, this was significantly lower among the adequate attendees (20.4% vs 28.3%, $P = 0.046$). A total of 91.7% of adolescents received screening for chlamydia and gonorrhoea infections.

Table 2. Pregnancy Complications and Birth Outcomes among Pregnant Adolescents Attending CARE

	At Least Minimal Standard of Care Obtained n (%)	Poor Access of Care n (%)	Overall n (%)	P Values*
Overall	265	205	470	
Hypertension	4 (1.5)	7 (3.4)	11 (2.3)	
Diabetes	3 (1.1)	3 (1.5)	6 (1.3)	
Clinical depression	0 (0.0)	0 (0.0)	0 (0.0)	
Anaemia	54 (20.4)	58 (28.3)	112 (24.0)	0.046
Infections				
Not screened	14 (5.3)	25 (12.2)	39 (8.3)	0.002
Screened	251 (94.7)	180 (87.8)	431 (91.7)	
Chlamydia	67 (26.7)	44 (24.4)	111 (23.6)	
Gonorrhoea	6 (2.4)	3 (1.7)	9 (1.9)	
Intrauterine growth restriction	12 (4.5)	6 (2.9)	18 (3.8)	
Fetal anomalies (major and minor)	12 (4.5)	7 (3.4)	19 (4.0)	
Caesarean sections	15 (5.7)	14 (6.8)	29 (6.2)	
Preterm births	14 (5.3)	38 (18.5)	52 (11.1)	<0.001
Preterm births less than 34 weeks	2 (0.8)	6 (2.9)	8 (1.7)	
Mean birth weight	2861 ± 478	2922 ± 400	2895 ± 437	
Admission to high-level neonatal unit (SCN/NICU)	33 (12.5)	25 (12.2)	58 (12.3)	
Stillbirth/perinatal death	2 (0.8)	0 (0.0)	2 (0.4)	

CARE: Clinic for Adolescent Pregnancy

*Are indicated where significant.

The number of poor attendees who were not screened for chlamydia and gonorrhoea infections was twice that of adequate attendees (12.2% vs 5.3%, $P = 0.002$). The incidence of chlamydia (26.7% vs 24.4%) and gonorrhoea infections (2.4% vs 1.7%) were similar in both groups.

Significantly, 18.5% of births among the poor attendees were preterm compared to 5.3% ($P < 0.001$). However, the percentage of severely preterm births, mean birth weights and admissions to high level neonatal units were comparable.

Table 3. Postpartum Contraception and Successive Pregnancies among Pregnant Adolescents Attending CARE

	At Least Minimal Standard of Care Obtained n (%)	Poor Access of Care n (%)	Overall n (%)	<i>P</i> Values*
Overall	265	205	470	
Defaulted postpartum review	119 (44.9)	101 (49.3)	220 (46.8)	
Known postpartum contraception	30 (20.5)	15 (14.4)	45 (18.0)	0.056
Subsequent pregnancies in 1 year	47 (17.7)	43 (21.0)	90 (19.1)	0.364
Subsequent pregnancies in 2 years	116 (43.8)	89 (43.4)	205 (43.6)	0.62
Subsequent pregnancy still within adolescence	90 (34.0)	64 (31.2)	154 (32.8)	

CARE: Clinic for Adolescent Pregnancy

*Are indicated where significant.

As shown in Table 3, almost half defaulted on postnatal follow-up. Overall postpartum contraceptive use was low (20.5% vs 14.4%, $P = 0.056$), and rate of successive pregnancies were high (17.7% vs 21.0% in 1 year, $P = 0.364$; 43.8% vs 43.4% in 2 years, $P = 0.62$); 75.1% of these pregnancies occurred while still in adolescence.

Discussion

Our study highlighted a subgroup who were younger and predominantly of Malay ethnicity with poorer access to care. Anaemia and preterm births were more prevalent in this subgroup. The tendency to remain single also continued to put them at risk of further unintended pregnancies and sexually transmitted infections (STIs). Efforts are required to empower them to seek early triage care and to comply with interventions such as consumption of iron, antibiotics and usage of birth control.

Innovative ways to improve outreach could be explored. Group adolescent prenatal care was associated with higher satisfaction, less defaulted appointments, fewer emergency department visits, increased initiation of breastfeeding and improved perinatal outcomes.⁸⁻¹⁰ The efficacy of such a method in our reserved Asian culture remains to be evaluated.

School-based clinics may be effective in promoting sexual and reproductive health. A Canadian study¹¹ showed a 1.5 times increase in relative rate of pregnancy and 2 times increase in relative rate of STI in adolescents from schools without such clinics. A study by National University Hospital, Singapore¹² also highlighted the need for school-based sexual education programmes and suggested emphasising abstinence in Malay adolescents if contraception contradicts religious beliefs.

Despite a dedicated counselling service, contraception uptake was low in our study. Contraception counselling in the third trimester or postpartum may leave insufficient time for due consideration.¹³ Adolescent mothers discharged without initiating contraception have a significantly increased risk of repeat pregnancy.¹⁴ Hence, contraception counselling could be initiated earlier and administered prior to discharge. In particular, long-acting reversible contraception (LARC) should be emphasised. The Contraceptive CHOICE study found that these methods resulted in fewer unwanted pregnancies.¹⁵ A study on the use of motivational interviewing within an adolescent-focused prenatal care environment showed a 3 times higher rate of LARC uptake.¹⁶

Conclusion

Healthcare resources should be dedicated to improving accessibility and acceptability of care for the pregnant adolescent. Strategies such as group care and school-based clinics could be explored. Attendance at CARE was associated with less preterm births and anaemia, but was unable to prevent quick successive pregnancies. An early discussion on contraception, emphasising the use of LARC through motivational interviewing and initiating contraception before hospital discharge could be helpful.

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Recurrent Wheeze in a Young Patient

A 22-year-old Malay lady was admitted to the respiratory service for asthma exacerbation. She had a history of asthma since childhood and was treated with a combination of inhaled corticosteroid (ICS) and long acting beta-2-agonist (LABA) with suboptimal control of her symptoms. Notably, she had 5 admissions for asthma exacerbations over a 1-year period between 2015 and 2016. She was a lifelong non-smoker and further history did not reveal any specific allergens that could have triggered her asthma. She did not complain of any nasal or gastro-oesophageal reflux symptoms. She worked as a personal assistant at an insurance company. There was no family history of chronic lung disease. There were bilateral rhonchi on examination of her chest. Vital signs and the rest of her physical examination were unremarkable. Her chest X-ray (CXR) is shown in Figure 1. Her full blood count was normal and did not reveal any eosinophilia.



Fig. 1. Chest X-ray showed hyper-inflated lungs.

A recent lung function test demonstrated evidence of obstructive airway disease with a forced expiratory volume during the 1st second/forced vital capacity (FEV1/FVC) ratio of 45%. The FVC was normal at 2.26L (84% predicted) with a reduced FEV1 of 1.03L (40% predicted). There was also air trapping with grossly elevated residual volume (RV) at 2.5L (241% predicted) and a residual volume/total lung capacity (RV/TLC) ratio of 53% (204% predicted). The diffusion capacity of carbon monoxide (DLCO) was normal indicating that it was predominantly an intrinsic airway abnormality.

Given her CXR and lung function findings, a high resolution computed tomography (HRCT) of the chest was performed (Figs. 2A and 2B). Further questioning revealed

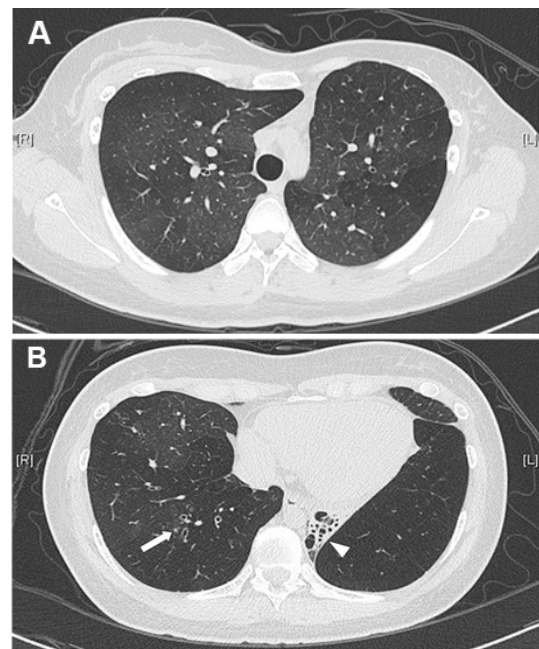


Fig. 2. High resolution computed tomography of the chest revealed: A) Mosaic attenuation in both upper lobes suggestive of small airway disease, and air-trapping was confirmed on expiratory images. B) Near-complete collapse of the left lower lobe (arrowheads) and bronchiectasis of the right lower lobe (arrows) associated with mosaic attenuation. There was reduction of vascularity and hyperlucency of the left lower zone which represents the hyper-inflated lingula.

that she was admitted to the intensive care unit at 2 years of age with severe pneumonia, and had frequent admissions for chest infections in the following year.

What is the diagnosis?

- A. Heart failure
- B. Eosinophilic granulomatosis with polyangiitis
- C. Vanishing lung syndrome
- D. Swyer-James-Macleod syndrome
- E. Emphysema from alpha-1 antitrypsin deficiency

Discussion

The combination of clinical and imaging features is suggestive of Swyer-James-Macleod syndrome (SJMS). SJMS, also known as unilateral hyperlucent lung syndrome, is a rare form of obliterative bronchiolitis with airflow obstruction accompanied by a decrease in the number and diameter of the ipsilateral peripheral pulmonary vessels. It is caused by injury to the developing lung before the age of 8 and usually follows viral aetiologies such as *Paramyxovirus morbillivirus*, *Influenza A*, and *Adenovirus*, and non-viral causes such as *Bordetella pertussis*, *Mycobacterium tuberculosis* and *Mycoplasma pneumoniae*.¹ The lung injury prevents the normal development of the alveolar buds² but they remain inflated due to collateral air drift.

Obliterative bronchiolitis (OB) encompasses a spectrum of disease that is associated with small airway injury caused by certain inhalational agents, infections, drug exposures, autoimmune causes and also as a complication of lung or hematopoietic stem cell transplantation.³ It is therefore also important to exclude other causes of OB in the workup of SJMS. CXR often provides a clue as it can show hyperlucency of one lung. The preferred imaging modality involves the use of HRCT imaging of the chest with thin collimation sections taken in both inspiratory and expiratory phases. In a review of 8 computed tomography (CT) images,⁴ unilateral lucency was seen in 7 cases and bilateral lucency in 1 case. Air trapping was found in all cases where inspiratory and expiratory scans were obtained. Other imaging features include atelectasis in the ipsilateral lower lobe (4 out of 8 cases) with accompanying bronchiectasis. Small foci opacities were also seen, which most likely represent residual scarring or chronic infections from previous pneumonia. CT chest also aids in excluding other differential diagnoses such as congenital hypoplastic lung, bullae or vascular abnormalities such as proximal interruption of the pulmonary arteries or pulmonary artery hypoplasia.

Patients with SJMS are usually young and can be asymptomatic or present with productive cough,

haemoptysis, shortness of breath, exertional dyspnoea or recurrent infections. Clinically, they can mimic asthma, and hence diagnosis requires a high index of suspicion.

There is airflow obstruction seen on the lung function test, and ventilation/perfusion scanning of the lungs often shows decreased perfusion of the affected lung.⁵

There is no consensus on how best to treat SJMS. General measures such as airway clearance and postural drainage with chest physiotherapy should be performed. Timely administration of appropriate vaccinations is essential to prevent pulmonary infections. Most patients receive bronchodilators and ICS. Pulmonary infections need to be treated early and aggressively, and if recurrent infections remain a problem, long-term antibiotic prophylaxis may be considered. In rare cases, such as those with recurrent pneumonias, recurrent pneumothoraces or worsening lung function, patients with SJMS are treated by surgical lung resection (lobectomy or pneumonectomy).⁶

In our patient, she had a history of childhood pneumonia and subsequent recurrent admissions for chest infections which could account for the complete collapse of the left lower lobe and the bronchiectatic changes. The imaging findings were not suggestive of heart failure where one would see smooth interlobular septal thickening, ground glass opacities or consolidation in dependent parts of the lung and pleural effusion. In eosinophilic granulomatosis with polyangiitis, one would expect eosinophilia on the full blood count, with CT imaging commonly showing ground-glass attenuation, consolidation, nodules or masses and pleural effusion.⁷ Emphysema would result in a reduction of DLCO, and the imaging findings were not suggestive of emphysema. Vanishing lung syndrome results from giant bullae in one or both upper lobes that are at least one-third of the hemithorax and compressing the surrounding lung parenchyma, which was not seen in the imaging of our patient.

Conclusion

SJMS can be erroneously diagnosed as asthma and the presence of a unilateral hyperlucent lung should raise the suspicion of this interesting but rare condition.

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Answer: D

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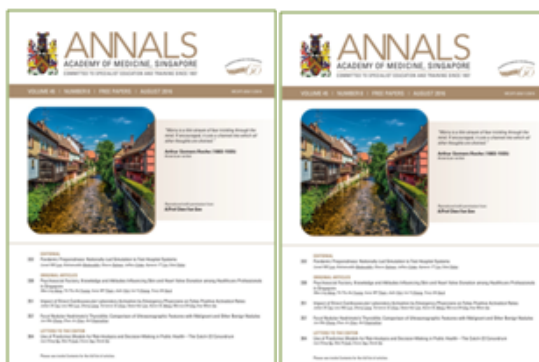
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