

Disability in Singapore's Elderly Population

Mithila Mahesh,¹*MSc*, Edimansyah Abidin,¹*PhD*, Janhavi Ajit Vaingankar,¹*MSc*, Louisa Picco,¹*MPH*, Anita Jeyagurunathan,¹*MSW, MPhil*, Saleha Binte Shafie,¹*BSc*, Shirlene Pang,¹*MSc*, Vathsala Sagayadevan,¹*BSc*, Esmond Seow,¹*BA*, Siow Ann Chong,¹*MBBS, MMed, MD*, Mythily Subramaniam,¹*MBBS, MHSM*

Abstract

Introduction: Disability increases an individual's dependence and negatively impacts their physical, mental, and social functioning. The current study aims to establish the prevalence and risk factors of disability in Singapore's population. **Materials and Methods:** Data was extracted from the Well-being of the Singapore Elderly (WiSE) study. This cross-sectional study recruited participants aged 60 years and above (n = 2421) who were representative of Singapore's multiethnic population. We used the World Health Organization Disability Assessment Schedule (WHODAS) 2.0 to assess the severity of disability in our sample while establishing its associations and correlations with cognitive levels, sociodemographic variables, and chronic illness. **Results:** Cognitive deficits, old age, female gender, Malay and Indian ethnicity, lack of education, retired or homemaker status, presence of chronic illness (specifically stroke, heart problems, depression, and dementia) were found to be significantly associated with disability in Singapore's elderly population. As hypothesised, participants with deficits in cognition were more likely to indicate higher WHODAS scores. **Conclusion:** The findings highlighted specific factors associated with disability in this multiethnic population. The identification of these factors would lead the way to the development of appropriate interventions.

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Key words: Chronic illness, Cognitive decline, Functioning, Old age

Introduction

The World Health Organization (WHO) endorses a balanced approach to defining disability which incorporates equal weight to the medical and the social aspects that influence the term.¹ Thus, disability is a multi-dimensional concept which encompasses impairment as well as the social or environmental barriers that limit the individual's participation in society^{1,2} and independence.³ Individuals with disability experience elements of impairment, activity limitations, and participation restrictions.² Longer life expectancies enhance risk of disability in elderly population due to declining health and vulnerability to chronic illness.^{3,4} Worldwide, the prevalence of moderate and severe disability in persons over the age of 60 years is estimated to be 46.1%.¹

Two-thirds of the elderly population with disability

have a comorbid chronic illness.⁵ Most cases of disability are predicted by dementia,^{5,6} stroke,⁵ limb impairment,^{5,7} arthritis,^{5,8} depression, eyesight problems,^{5,7} and gastrointestinal impairments.⁵ Previous population-based studies in elderly samples have also identified associations between disability and symptoms of mild cognitive impairment (MCI)^{8,9} or lacking of educational background.^{3,9,10} Developed cognitive ability or a "cognitive reserve" was found to be protective against MCI and its associated disability.^{11,12}

WHO defines an aged society as one whose population has 14% residents over the age of 65,¹³ thus it is predicted that Singapore will fall into this category within the next 5 years.¹³ Studies on Singapore's ageing population indicate that in 2005, 1 in every 12 residents was over the age of

¹Research Division, Institute of Mental Health, Singapore

Address for Correspondence: A/Prof Mythily Subramaniam, Research Division, Institute of Mental Health, Buangkok Green Medical Park, 10 Buangkok View, Singapore 539747.

Email: Mythily@imh.com.sg

65 years and by 2030, this will increase to 1 in every 5 residents who would be over the age of 65.¹⁴ Previous literature suggests that disability is prevalent among elderly Singaporeans.^{13,15} On assessing the activities of daily living (ADL) as a measure of disability, a recent report suggests that 6% of men over the age of 65 years reported 1 or more limitations in performing their daily activities, compared to 16% of older women who reported limitations.¹³

The aim of this study was to establish the prevalence and correlates of disability in a cross-sectional epidemiological study conducted on older adults i.e. those aged 60 years and above in Singapore. We explored associations of disability with regards to sociodemographic variables, cognitive ability, and diagnosis of chronic illnesses. Research in this field clarifies markers of disability and provides policymakers and clinicians with the necessary information to establish strategies which will enhance quality of life in elderly populations. Data for this study was extracted from the Well-being of the Singapore Elderly (WiSE) study – a population-based study to establish the prevalence of dementia among the elderly in Singapore.¹⁶

Materials and Methods

Sample

The WiSE study¹⁶ adopted the 10/66 Dementia Research Group protocols^{17,18,19} to establish the prevalence of dementia in Singapore's elderly resident population. This cross-sectional study was conducted on Singapore citizens or permanent residents aged 60 years or above who were living in Singapore at the time of the survey. Participants in this age group were randomly selected from an administrative database. Respondents were approached in their homes as well as day care centres, nursing homes, and institutions. This study used a nationally representative sample which encompassed the 3 main ethnic groups in Singapore: Chinese, Malay, and Indians; 10/66 questionnaires were available in English, Chinese and Tamil while our research team translated the instruments into Malay. The questionnaires were also transcribed into 3 major dialects: Hokkien, Cantonese, and Teochew. Choice of administered language was based on the participant's preferences.

An informant, selected for each participant, was a "person who knew the older person best"; and were most commonly co-residents, family members, or caregivers of the participant.²⁰ A Computer Assisted Personal Interviewing (CAPI) mode was used for real-time data collection in the field. Sample sizes were estimated to be $n = 2500$ based on the previously estimated prevalence rate of 5.2% of dementia in Singapore's population.^{16,21} There were a total of 2565 respondents which yielded a response rate of 65.6%. Within this sample, only 2421 respondents were able to complete

cognitive tests and provide a suitable caregiver for informant reports. The sample consisted of Chinese (38.5%), Malay (30.1%), Indian (30.1%), and Others (1.4%).

The WiSE study was approved by the institutional ethics review boards (National Healthcare Group Domain Specific Review Board [DSRB] and the SingHealth Centralised Institutional Review Board [CIRB]). Written informed consent was obtained from all participants; in the event that the respondent was unable to understand or give consent, consent was obtained from a legally acceptable representative. Details of the WiSE study are described in an earlier article by Subramanian et al.¹⁶

Main Instruments

World Health Organization Disability Assessment Schedule (WHODAS) 2.0

The World Health Organization Disability Assessment Schedule (WHODAS) 2.0 was established as an international and cross-cultural method to comprehend severity of disability levels in patients.²² WHODAS was developed by the International Classification of Functioning, Disability, and Health (ICF) to identify symptoms of disorders that hindered everyday living. Disability levels measured by this assessment have good test-retest reliability with validation in 16 languages in 14 countries.²³ WHODAS measures functioning based on 6 domains: cognition, mobility, self-care, getting along, life activities, and participations.²² Items were measured and computed using a specific scale: "None" (0), "Mild" (1), "Moderate" (2), "Severe" (3), and "Extreme" (4). Items in each domain were summed and weighted, then all 6 weighted scores were converted into a summary score ranging from 0-100 (where 0 = no disability; 100 = full disability).

Community Screening Instrument for Dementia (CSI-D)

The Community Screening Instrument for Dementia (CSI-D) questionnaire is used to measure cognition and can be administered to both non-literate and literate populations.²⁰ CSI-D scores incorporate elements of memory, orientation, naming and language expression, and comprehension.²⁴ CSI-D establishes a cognitive score (COGSCORE) based on an item-weighted total score from each participant's cognitive test.^{18,25,26}

CSI-D Informant Interview (RELScore) 18,27

The CSI-D Informant Interview (RELScore) is an informant-based interview used to trace cognitive and functional decline in participants by enquiring about the participant's general health and daily functioning. RELSCOREs were measured by interviews and reports

by “informants” or individuals who knew the participant best.²⁷ Informant scores range from 0-16 (where 0 = no impairment, 16 = complete functional impairment) and have been used in various sites and populations.^{20,28}

Sociodemographic Questionnaire

The Sociodemographic Questionnaire included questions on age, gender, ethnicity, marital status, education, employment status, social support, and personal/family income. Participants were asked if they had been diagnosed with any chronic illnesses: hypertension, high blood pressure, any type of heart trouble, stroke, serious head injury, diabetes, tuberculosis, depression, dementia, arthritis, eye sight problems, hearing difficulty, persistent cough, difficulty breathing, stomach problems, faints, paralysis, and skin disorders. For difficult terms and complex medical terms such as transient ischaemic attack, the question asked: “Have you ever developed sudden weakness of a limb, loss of speech, or partial blindness which got better quickly, in less than one day? Doctors sometimes call these transient ischaemic attacks.” With regard to chronic illness, results that either showed significance or a trend towards significance ($P < 0.05$) are represented. The study used the 10/66 algorithm to diagnose dementia. For this particular study, cognition, as measured by the CSI-D COGSCOREs and RELSCOREs, was correlated with domains integrated within the WHODAS 2.0 measure.²²

Statistical Analysis

Survey data analysis of 10/66 protocols were completed on Statistical Analysis Software (SAS) Version 9.3. Data were weighted to encompass findings that appropriately signify Singapore’s elderly population. Mean scores were compared of $n = 2421$ responses on cognitive tests (COGSCORE) and informant reports (RELSCORE) versus levels of disability (WHODAS). Descriptive statistics were used to compare differences in mean WHODAS scores among various sociodemographic subgroups: gender, age groups, ethnicity, marital status, education, and employment status. Other sociodemographic and risk factors pertinent to disability like education levels, physical and mental health, and comorbid chronic illness were also explored. Multiple linear regressions were used in order to form predictors based on effects of COGSCORE and RELSCORE on WHODAS scores. We used 5 models to explore effects of COGSCOREs/RELSCOREs on WHODAS scores: 1) effects of only COGSCOREs/RELSCOREs with no adjustments, 2) after adjusting for sociodemographic variables, 3) after adjusting for sociodemographic variables and presence of any chronic illness, 4) after adjusting for sociodemographic variables, and presence of either hypertension, heart problems, stroke,

diabetes, or transient ischaemic attack, 5) after adjusting for sociodemographic variables, and presence of either hypertension, heart problems, stroke, diabetes, transient ischaemic attack, depression, or dementia. Each model used R-squares and root mean square error (RMSE) tests for fit statistics. Significant variables were identified by P values (< 0.05) with a 95% confidence interval indicating effects on WHODAS scores.

Results

The WiSE study collected data from 2421 sets of residents and informants in Singapore. The mean age of respondents was 72.7 years. The proportion of males to females was 43% to 57%, respectively. The sample’s ethnic distribution was 38.5% Chinese ($n = 931$), 30.1% Malay ($n = 728$), 30.1% Indian ($n = 728$) with an additional component of 1.4% Other ethnicities ($n = 34$) (Table 1). As indicated in Table 2, the average disability for the entire sample as measured by WHODAS 2.0 was $11.2 (\pm 0.47)$. The average COGSCORE was $28.1 (\pm 0.12)$ while the average RELSCORE was $1.6 (\pm 0.08)$.

Comparison of Mean WHODAS Scores among Sociodemographic Groups

Table 1 indicates the mean WHODAS scores among various sociodemographic groups. Participants aged 85 years or more had a mean WHODAS of $44.0 (\pm 2.1)$. This was followed by those in the age group of 75 to 84 with average WHODAS scores of $19.6 (\pm 1.3)$, and age group of 60 to 74 attaining the least severe WHODAS scores of $6.5 (\pm 0.05)$. Females had significantly higher disability levels compared to males, WHODAS scores of $13.0 (\pm 0.65)$ and $8.8 (\pm 0.75)$, respectively. Malay and Indian participants had higher levels of disability compared to Chinese and those belonging to Other ethnicity group. The mean WHODAS score of widowed participants were significantly higher (21.7 ± 1.2) compared to married/ cohabitating (8.1 ± 0.57) or never married (7.6 ± 2.0) participants.

Disability measured by WHODAS 2.0 was associated with educational levels. Participants with no educational background had a mean WHODAS score of $21.0 (\pm 1.5)$; while those with some background without completing primary education had WHODAS scores of $12.3 (\pm 1.0)$. Results consistently indicated that as educational level increased, mean WHODAS scores decreased (Table 1). Participants who were homemakers (average WHODAS score of 14.6 ± 1.0) or retired (15.4 ± 0.94) had significantly higher WHODAS scores than participants who were employed (3.1 ± 0.33) and unemployed (3.8 ± 2.2) (Table 1).

Table 1. Sociodemographic Characteristics and Mean WHODAS Score

Variable	Sample			WHODAS Score	
	Unweighted (n)	Unweighted (%)	Weighted (%)	Mean	SE
Overall	2421	100	100	11.2	0.47
Age group					
60 – 74	1403	58.0	74.8	6.5	0.05
75 – 84	633	26.2	19.4	19.6	1.3
85+	385	15.9	5.7	44.0	2.1
Gender					
Men	1039	42.9	43.0	8.8	0.75
Women	1382	57.1	57.0	13.0	0.65
Ethnicity					
Chinese	931	38.5	82.6	10.9	0.56
Malay	728	30.1	9.8	13.8	0.78
Indian	728	30.1	6.1	13.1	0.70
Others	34	1.4	1.5	7.7	1.8
Marital status					
Never married	108	4.5	6.8	7.6	2.0
Married/cohabiting	1419	58.7	65.4	8.1	0.57
Widowed	798	33.0	22.8	21.7	1.2
Divorced/separated	94	3.9	5.0	8.5	2.4
Education					
None	502	20.9	17.1	21.0	1.5
Some, but did not complete primary	579	24.1	23.8	12.3	1.0
Completed primary	597	24.8	24.1	9.5	1.0
Completed secondary	488	20.3	22.5	7.0	0.9
Completed tertiary	241	10.0	12.5	6.1	1.3
Employment status					
Paid work (part- and full-time)	632	26.4	32.9	3.1	0.33
Unemployed	30	1.3	1.4	3.8	2.2
Homemaker	782	32.7	27.2	14.6	1.0
Retired	947	39.6	38.5	15.4	0.94

SE: Standard error; WHODAS: World Health Organization Disability Assessment Schedule

Table 2. Comparison of Cognitive Ability, Informant Reports, and Disability Score of Sample Population

Variable	Label	n	Mean	Standard Error	95% CI for Mean		Minimum Score	Maximum Score
COGSCORE	Cognitive ability	2421	28.1	0.1	27.8	28.3	0.0 (full impairment)	32.2 (no impairment)
RELScore	Informant report	2421	1.6	0.1	1.4	1.8	0.0 (no impairment)	30.0 (full impairment)
WHODAS-12	Levels of disability	2421	11.2	0.5	10.3	12.2	0.0 (no disability)	100.0 (full disability)

COGSCORE: CSI-D cognitive test; RELSCORE: CSI-D informant interview; WHODAS: World Health Organization Disability Assessment Schedule

Correlates of Cognition, Sociodemographic Factors, and Chronic Illness on Disability

Analyses of data from regressions were compared based on 5 sets of models. The first model in Table 3 indicated that participants with deficits in cognition (low COGSCORE, $\beta = 2.9$) were more likely to have higher levels of disability (high WHODAS score). Model 2, adjusting for sociodemographic variables, found that those aged 60 to 74 years ($\beta = -11.76$) and 75 to 84 years ($\beta = -7.45$) were less likely to have higher WHODAS scores compared to those aged 85 years and older. Males ($\beta = -1.7$) were less likely than females to express high levels of disability. Participants who were widowed ($\beta = 3.5$) were more likely to have higher WHODAS scores versus those who were never married (Table 3). Those who were retired ($\beta = 2.6$) and homemakers ($\beta = 2.3$) were more likely to have higher WHODAS scores compared to those who were working part- and full-time.

Participants with comorbid diagnosis of a chronic illness ($\beta = 2.8$) were more likely to have higher WHODAS scores. Chronic illnesses that were significantly associated with disability were heart problems ($\beta = 4.12$), stroke ($\beta = 10.4$), and transient ischaemic attack ($\beta = 6.7$) (Model 4, Table 3). In Model 5, depression ($\beta = 4.25$) and dementia ($\beta = 14.6$) were strongly associated with disability. Despite adjusting for sociodemographic factors and chronic illnesses in all 5 models, COGSCORE consistently had significant effects on WHODAS scores indicating that participants with deficits in cognitive ability had greater levels of disability (Table 3).

Correlates of Informant Reports, Sociodemographic Factors and Chronic Illness on Disability

In Model 1 of Table 4, impairment indicated by RELSCOREs or informant reports ($\beta = 3.8$) were associated with higher levels of disability. Consistent with COGSCOREs, participants aged 85 years or more had greater disability as compared to those aged 60 to 74 ($\beta = 15.70$) and 75 to 84 ($\beta = 10.78$). Participants with no education ($\beta = 4.95$) were more likely to indicate higher levels of disability as compared to those with tertiary education. RELSCOREs of participants who were retired ($\beta = 4.19$) and had homemaker status ($\beta = 3.41$) were more likely to indicate higher disability as compared to participants with full- or part-time paid work (Model 2, Table 4).

Model 5 using RELSCOREs found that depression ($\beta = 3.12$) and dementia ($\beta = 19.29$) were also significant predictors of disability. Similar to COGSCOREs, RELSCOREs in all 5 models was significantly associated with higher WHODAS scores despite adjusting for various factors (Table 4).

Discussion

This study aimed to establish risk factors and the extent of disability in Singapore's elderly population. With a mean WHODAS score of 11.2, Singapore's elderly population falls within the range of 8.0 to 16.5 that was reported from previous 10/66 studies in the urbanised centres of Cuba, Dominican Republic, Peru, Venezuela, Mexico, China, and India.⁵ Our results suggest that disability is associated with older age, female gender, Malay or Indian ethnicity, being widowed, poor educational background, being retired or a homemaker, deficits in cognitive ability and comorbidity with at least 1 chronic illness (physical and/or mental).

As expected, age was positively correlated with severity in disability scores, with participants aged 85 years and above reporting higher levels of disability compared to those in the age groups of 60 to 74 and 75 to 84 years. These results were consistent with WHO findings stating that within those with some type of disability, 20% were older than 70 years and 50% were older than 85 years.³ In examining disability scores between genders, our results suggest that females are more likely than males to have higher WHODAS scores. In line with this, a report by the International Longevity Centre found 29% of elderly females as compared to 8% of elderly males in Singapore report at least 1 limitation in executing their daily activities.¹³ Likewise, another study that used 10/66 protocols measuring cognition in Latin America, India, and China found that men had higher cognitive ability (based on COGSCOREs) compared to women.²⁴ In Singapore, 71% of elderly females were diagnosed with cognitive impairment as compared to 29% of elderly males.¹³ Gender differences in disability could potentially be due to the fact that in Singapore, females have a longer life expectancy and thus may be susceptible to chronic diseases and disability as compared to men.^{3,8}

Our results indicate that disability scores of Indians and Malay participants were significantly higher than that of Chinese participants. A study by Ng et al,⁸ consistent with our results on ethnic differences in disability, suggests that the higher prevalence of health-related factors such as chronic medical illness could result in Malays having higher levels of functional disability compared to the Chinese. Their study suggests that Indians also had higher levels of functional disability compared to the Chinese, but this association remains persistent despite adjusting for both sociodemographic and health-related variables.⁸ Though our study is consistent with previous literature stating that Indians have higher levels of disability compared to the Chinese, the reason behind this finding is yet to be determined. Another study pertaining to Singapore's ethnic differences suggested that Indians and Malays have significantly lower health-related quality of life (incorporating both physical and mental health conditions) as compared to the Chinese.²⁹ Ethnic

Table 3. Associations between COGSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
COGSCORE	-2.99	(-3.18, -2.79)	<0.0001*	-2.69	(-2.95, -2.44)	<0.0001*	-2.69	(-2.94, -2.44)	<0.0001*	-2.49	(-2.74, -2.25)	<0.0001*	-1.88	(-2.16, -1.59)	<0.0001*
Age groups															
60 – 74	-11.76	(-15.64, -7.88)	<0.0001*	-11.81	(-15.66, -7.96)	<0.0001*	-12.15	(-15.83, -8.47)	<0.0001*	-12.15	(-15.83, -8.47)	<0.0001*	-9.71	(-13.35, -6.07)	<0.0001*
75 – 84	-7.45	(-11.36, -3.54)	0.00*	-7.73	(-11.63, -3.84)	0.00*	-8.23	(-11.97, -4.49)	<0.0001*	-8.23	(-11.97, -4.49)	<0.0001*	-6.73	(-10.34, -3.12)	0.00*
85+	REF			REF			REF			REF			REF		
Gender															
Males	-1.70	(-3.35, -0.05)	0.04*	-2.02	(-3.68, -0.37)	0.02*	-2.62	(-4.27, -0.97)	0.00*	-2.62	(-4.27, -0.97)	0.00*	-2.22	(-3.81, -0.63)	0.01*
Females	REF			REF			REF			REF			REF		
Ethnicity															
Others	1.46	(-2.12, 5.05)	0.42	1.36	(-2.24, 4.97)	0.46	-1.10	(-5.24, 3.04)	0.6	-1.10	(-5.24, 3.04)	0.6	-0.49	(-4.60, 3.62)	0.82
Indian	2.99	(1.57, 4.41)	<0.0001*	2.80	(1.38, 4.22)	0.00*	2.19	(0.79, 3.58)	0.00*	2.19	(0.79, 3.58)	0.00*	2.36	(0.97, 3.75)	0.00*
Malay	2.66	(1.11, 4.20)	0.00*	2.73	(1.20, 4.26)	0.00*	2.96	(1.50, 4.42)	<0.0001*	2.96	(1.50, 4.42)	<0.0001*	3.26	(1.83, 4.68)	<0.0001*
Chinese	REF			REF			REF			REF			REF		
Marital status															
Divorced/separated	3.03	(-0.02, 6.08)	0.05	3.06	(-0.03, 6.15)	0.05	2.50	(-0.68, 5.68)	0.12	2.50	(-0.68, 5.68)	0.12	1.80	(-1.40, 5.00)	0.27
Widowed	3.53	(0.73, 6.34)	0.01*	3.22	(0.42, 6.02)	0.02*	2.92	(0.29, 5.55)	0.03*	2.92	(0.29, 5.55)	0.03*	1.79	(-0.78, 4.36)	0.17
Married	2.41	(0.04, 4.77)	0.05	2.29	(-0.07, 4.64)	0.06	2.07	(-0.11, 4.25)	0.06	2.07	(-0.11, 4.25)	0.06	1.22	(-0.93, 3.38)	0.26
Never married	REF			REF			REF			REF			REF		
Educational background															
No education	-2.42	(-5.28, 0.43)	0.1	-2.59	(-5.42, 0.24)	0.07	-2.67	(-5.23, -0.10)	0.04*	-2.67	(-5.23, -0.10)	0.04*	-1.72	(-4.25, 0.81)	0.18
Some but did not complete primary education	-2.45	(-4.66, -0.24)	0.03*	-2.47	(-4.68, -0.26)	0.03*	-2.43	(-4.50, -0.36)	0.02*	-2.43	(-4.50, -0.36)	0.02*	-1.65	(-3.73, 0.43)	0.12

COGSCORE: CSI-D cognitive test; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

Table 3. Associations between COGSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores (Cont'd)

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
Completed primary education	-1.20	(-3.30, 0.91)	0.27	-1.16	(-3.25, 0.93)	0.28	-1.34	(-3.30, 0.62)	0.18	-1.31	(-3.25, 0.64)	0.19	-1.31	(-3.25, 0.64)	0.19
Completed secondary education	0.14	(-1.84, 2.11)	0.89	0.18	(-1.78, 2.14)	0.86	-0.11	(-1.97, 1.74)	0.9	-0.39	(-2.20, 1.42)	0.67	-0.39	(-2.20, 1.42)	0.67
Completed tertiary education	REF			REF			REF			REF			REF		
Employment status															
Retired	2.62	(1.11, 4.13)	0.00*	2.21	(0.69, 3.73)	0.00*	1.54	(0.03, 3.04)	0.05	1.29	(-0.19, 2.78)	0.09	1.29	(-0.19, 2.78)	0.09
Homemaker	2.35	(0.43, 4.27)	0.02*	2.01	(0.08, 3.94)	0.04*	1.42	(-0.47, 3.31)	0.14	1.02	(-0.73, 2.77)	0.25	1.02	(-0.73, 2.77)	0.25
Unemployed	0.79	(-2.18, 3.75)	0.6	0.55	(-2.36, 3.46)	0.71	1.17	(-1.99, 4.34)	0.47	1.28	(-2.08, 4.63)	0.46	1.28	(-2.08, 4.63)	0.46
Paid work	REF			REF			REF			REF			REF		
Diagnosis of any chronic illness															
Yes				2.83	(1.49, 4.16)	<0.0001*									
No				REF											
Hypertension															
Yes							1.03	(-0.22, 2.28)	0.1	1.16	(-0.03, 2.35)	0.06	1.16	(-0.03, 2.35)	0.06
No							REF			REF			REF		
Heart problems															
Yes							4.12	(1.87, 6.37)	0.00*	3.67	(1.51, 5.83)	0.00*	3.67	(1.51, 5.83)	0.00*
No							REF			REF			REF		
Stroke															
Yes							10.42	(6.19, 14.66)	<0.0001*	10.00	(6.06, 13.94)	<0.0001*	10.00	(6.06, 13.94)	<0.0001*
No							REF			REF			REF		
Diabetes															
Yes							1.39	(-0.27, 3.05)	0.1	1.59	(-0.01, 3.18)	0.05	1.59	(-0.01, 3.18)	0.05
No							REF			REF			REF		

COGSCORE: CSI-D cognitive test; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

Table 3. Associations between COGSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores (Con't)

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
Transient ischaemic attack															
Yes							6.69	(1.86, 11.53)	0.01*	6.28	(1.17, 11.39)	0.02*			
No							REF			REF					
Depression															
Yes										4.25	(1.47, 7.02)	0.00*			
No										REF					
Dementia															
Yes										14.60	(9.62, 19.57)	<0.0001*			
No										REF					

COGSCORE: CSI-D cognitive test; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

Table 4. Associations between RELSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
RELSCORE	3.80	(3.48, 4.12)	<0.0001*	3.17	(2.83, 3.50)	<0.0001*	3.16	(2.83, 3.49)	<0.0001*	2.87	(2.56, 3.18)	<0.0001*	1.83	(1.46, 2.19)	<0.0001*
Age groups															
60 – 74	-15.70	(-19.73, -11.68)	<0.0001*	-15.79	(-19.80, -11.78)	<0.0001*	-16.00	(-19.73, -12.27)	<0.0001*	-16.00	(-19.73, -12.27)	<0.0001*	-12.12	(-15.98, -8.27)	<0.0001*
75 – 84	-10.78	(-14.77, -6.80)	<0.0001*	-11.04	(-15.01, -7.07)	<0.0001*	-11.31	(-15.03, -7.58)	<0.0001*	-11.31	(-15.03, -7.58)	<0.0001*	-8.73	(-12.44, -5.03)	<0.0001*
85+	REF			REF			REF			REF			REF		
Gender															
Male	-0.37	(-2.30, 1.55)	0.7036	-0.62	(-2.57, 1.32)	0.5298	-1.45	(-3.30, 0.41)	0.1274	-1.45	(-3.30, 0.41)	0.1274	-1.40	(-3.12, 0.31)	0.108
Female	REF			REF			REF			REF			REF		
Ethnicity															
Others	-0.13	(-3.80, 3.52)	0.9432	-0.21	(-3.91, 3.49)	0.91	-2.67	(-7.16, 1.83)	0.2445	-2.67	(-7.16, 1.83)	0.2445	-1.40	(-5.78, 2.98)	0.5308
Indian	3.25	(1.76, 4.74)	<0.0001*	3.11	(1.60, 4.61)	<0.0001*	2.84	(1.30, 4.37)	0.0003*	2.84	(1.30, 4.37)	0.0003*	2.94	(1.44, 4.43)	0.0001*
Malay	3.35	(1.74, 4.96)	<0.0001*	3.41	(1.82, 5.00)	<0.0001*	3.86	(2.37, 5.36)	<0.0001*	3.86	(2.37, 5.36)	<0.0001*	3.88	(2.42, 5.34)	<0.0001*
Chinese	REF			REF			REF			REF			REF		
Marital status															
Divorced/separated	0.27	(-4.48, 5.03)	0.91	0.30	(-4.52, 5.12)	0.9037	-0.06	(-4.75, 4.64)	0.9806	-0.06	(-4.75, 4.64)	0.9806	0.15	(-4.20, 4.50)	0.9465
Widowed	0.12	(-3.58, 3.82)	0.948	-0.12	(-3.83, 3.60)	0.9514	-0.04	(-3.70, 3.62)	0.9825	-0.04	(-3.70, 3.62)	0.9825	-0.27	(-3.63, 3.10)	0.8754
Married	-1.95	(-5.33, 1.42)	0.2561	-2.04	(-5.46, 1.37)	0.2407	-1.77	(-5.15, 1.61)	0.3046	-1.77	(-5.15, 1.61)	0.3046	-1.53	(-4.58, 1.52)	0.3252
Never married	REF			REF			REF			REF			REF		
Educational background															
No education	4.95	(1.62, 8.28)	0.0036*	4.82	(1.49, 8.16)	0.0046*	4.09	(1.12, 7.07)	0.007*	4.09	(1.12, 7.07)	0.007*	3.01	(0.09, 5.93)	0.0432*
Some but did not complete primary education	1.81	(-1.06, 4.68)	0.2162	1.80	(-1.08, 4.67)	0.2198	1.16	(-1.31, 3.63)	0.358	1.16	(-1.31, 3.63)	0.358	0.86	(-1.56, 3.27)	0.4844

RELSCORE: CSI-D informant interview; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

Table 4. Associations between RELSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores (Cont'd)

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
Completed primary education	0.59	(-2.02, 3.19)	0.6592	0.61	(-1.99, 3.22)	0.6442	0.23	(-2.11, 2.58)	0.8452	-0.27	(-2.52, 1.98)	0.8118			
Completed secondary education	0.19	(-2.38, 2.76)	0.8857	0.22	(-2.36, 2.80)	0.8656	-0.14	(-2.47, 2.20)	0.9072	-0.50	(-2.67, 1.67)	0.6507			
Completed tertiary education	REF			REF			REF			REF					
Employment status															
Retired	4.19	(2.36, 6.00)	<0.0001*	3.88	(2.04, 5.71)	<0.0001*	2.86	(1.14, 4.58)	0.0011*	2.25	(0.64, 3.86)	0.0063			
Homemaker	3.41	(1.19, 5.62)	0.0026*	3.15	(0.91, 5.39)	0.0058*	2.35	(0.25, 4.46)	0.0285*	1.66	(-0.22, 3.53)	0.0833			
Unemployed	-0.04	(-3.62, 3.54)	0.9819	-0.23	(-3.80, 3.34)	0.9017	0.75	(-3.04, 4.55)	0.6969	0.98	(-2.86, 4.82)	0.6176			
Paid work	REF			REF			REF			REF					
Diagnosis of any chronic illness															
Yes				2.17	(0.69, 3.66)	0.0042*									
No				REF											
Hypertension															
Yes							0.20	(-1.19, 1.58)	0.7826	0.60	(-0.68, 1.87)	0.3571			
No							REF			REF					
Heart problems															
Yes							2.41	(-0.25, 5.07)	0.0757	2.34	(-0.09, 4.77)	0.0592			
No							REF			REF					
Stroke															
Yes							14.79	(9.89, 19.69)	<0.0001*	13.02	(8.64, 17.41)	<0.0001*			
No							REF			REF					
Diabetes															
Yes							0.38	(-1.40, 2.15)	0.6764	0.93	(-0.74, 2.60)	0.2733			
No							REF			REF					

RELSCORE: CSI-D informant interview; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

Table 4. Associations between RELSCORE, Sociodemographic Factors, and Chronic Illness on WHODAS 2.0 Scores (Con't)

Variable	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value	β	(95% CI)	P Value
Transient ischaemic attack															
Yes				11.34	(3.47, 19.22)	0.0048*	9.73	(2.19, 17.28)	0.0115						
No				REF			REF								
Depression															
Yes							3.12	(0.34, 5.90)	0.028*						
No							REF								
Dementia															
Yes							19.29	(13.37, 25.22)	<0.0001*						
No							REF								

RELSCORE: CSI-D informant interview; WHODAS: World Health Organization Disability Assessment Schedule

*Significant variables were identified by P values (<0.05) with a 95% confidence interval.

Note: Beta coefficient was derived from multiple linear regression analysis.

differences in health-related quality of life may be explained by studies indicating that Malays and Indians have lower plasma folate concentrations compared to Chinese.³⁰ This contributes to cognitive impairment, behavioural disorders, weakness, fatigue, and shortness of breath.³¹ This and other such dietary or cultural factors may be responsible for the observed differences.

We found that higher educational backgrounds act as a protective measure against disability. Previous studies have linked a lack of educational background to deficits in cognitive abilities which lead to disability in elderly populations.^{2,8,9,24,26,32} Dotchin et al (2014), for instance, found a lack of educational background in an elderly Tanzanian population to be an accurate predictor of cognitive impairment and dementia which in turn predicted disability.⁹ Links between education, cognition, and disability could be explained by the cognitive reserve theory which posits that brain networks formed from intellectual experiences related to education or occupation avert incidence of dementia and thus disability by increasing cognition.¹¹ Consistent with previous literature,^{8,12} low educational background and cognitive impairment were found to be strongly associated with disability in the current study.

Significantly, association of low COGSCOREs with WHODAS scores in all 5 models indicate that impaired cognition strongly influences disability. Studies suggest that deficits in various domains of cognition (attention, memory, language, and visuo-spatial performances) directly reduce an individual's ability to perform everyday tasks; thereby, impacting disability and increasing dependence in elderly populations.^{33,34,35}

Presence of any chronic illness was strongly associated with disability in this elderly population. Other studies have also found that comorbid physical illnesses such as heart problems, stroke^{5,7,36,37} and transient ischaemic attacks were significantly correlated with disability. As in other studies, depression was associated with higher levels of disability.^{5,33,36-38} Depression is one of the most important causes for disability worldwide³⁹ as untreated depression has been reported to increase disability by making the individual vulnerable to cognitive decline,³³ personal suffering and additional health risks.⁴⁰ Similar to our study, numerous other studies suggest associated risk factors between dementia and disability.^{5,6-8,10,12,36,37}

Strengths and Limitations of the Study

As most participants were recruited from their homes, information from residents of nursing homes is somewhat limited in this study. Another limitation in terms of recruitment was that some participants were not able to provide a suitable informant; hence they were excluded

from the analyses. The cross-sectional design of the study did not permit us to determine any causal relationships. The strengths of the study include a large sample with a good response rate which makes it representative of the elderly population in Singapore. The study was also a single phase study that ensured that detailed data was collected from all individuals.

Conclusion

This study has identified a number of putative risk factors of disability among the elderly in this particular population. With a rapidly ageing population, it is crucial to further elucidate the relative contributions of these risk factors so that the appropriate strategies and interventions can be implemented. These might include screening for depression among the elderly, better management of chronic medical illnesses, and encouraging activities that could increase and preserve cognition.

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