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Excess costs of depression among a population-based older adults with chronic diseases in Singapore

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Abstract

Background There is limited evidence on the economic burden of depression among the older population in Singapore.

Objective We aim to evaluate the impact of depression on healthcare expenditure and productivity loss among older adults with chronic diseases in Singapore.

Methods Using the data from the Well-being of the Singapore Elderly study (WiSE), a 2011 national representative survey of older adults aged 60 years and above, 2510 respondents were included in this study. The sample comprised 44% male and 56% female respondents with 75% respondents aged between 60 and 74 years old. Healthcare utilisation data was obtained from respondents and healthcare cost was tabulated by multiplying each service unit by the unit cost price. These services include care from polyclinic doctors, private general practitioners (GP), outpatient specialists and inpatient care. We modelled the relationship of healthcare cost and depression using two-part models (probit & generalised linear model - loglink and gamma distribution).

Results For total healthcare expenditure, older adults with both depression and chronic diseases were associated with an average annual incremental cost of $7940 (95% CI 1490–14400; $p=0.016$), compared to those without these conditions. They were also associated with an average incremental cost of $257 (95% CI 38.7–475; $p=0.021$) for primary care. Likewise, in the case of specialist outpatient clinics, they had an average incremental cost of $970 (95% CI 163–1780; $p=0.018$). However, for inpatient setting, the average incremental cost of $6180 (95% CI 418–12800; $p=0.066$) was not significant. Additionally, older adults with depression and chronic diseases contribute to an annual productivity loss of $676 (95% CI 346–1010; $p<0.001$).

Discussion This study provides evidence that there are significant incremental costs associated with depression amongst the older adults with chronic diseases in Singapore's primary healthcare setting. The increased somatic presentations among the depressed older adults and the underdiagnosis of depression in primary care may contribute to higher utilisation of healthcare resources which entail higher expenditure. This is one of the first studies

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to look at the cost of depression using a representative sample of Singaporean older adults and taking into account the multi-ethnic nature of the population. Analyses were restricted to a cross-sectional design, and data relied heavily on the accuracy of self-report utilisation on health care services which was subjected to recall bias.

Conclusion Depression was found to inflate the total healthcare expenditure among older adults with chronic disease by two-fold. This study provides evidence that there are significant incremental costs associated with depression among the older adults with chronic diseases, demonstrating a need for more resources to improve systematic and clinical care for depressed older adults with chronic diseases.

Keywords Depression, Healthcare cost, Chronic diseases, Older adults

Introduction

Depression is a common mental disorder characterised by persistent sadness, decreased energy, and loss of interest or pleasure in activities that were previously enjoyable [1]. It is a significant public health issue that impacts 350 million people worldwide, predominantly older adults, with studies estimating that the prevalence ranges from 8 to 20% among the older adults living in the community [2–4]. Depression can lead to undesirable consequences such as functional decline and decreased quality of life which further increase the disability among the older population [2, 3]. In Singapore, the prevalence of depression among the older adults was 3.7% in 2016[2].

Depression is found to be associated with increased healthcare utilisation among older people [5–9]. Depression is also associated with high direct and indirect costs to society, leading to a significant economic burden to many countries [10]. Another study suggested that mental disorders were associated with higher healthcare cost and utilisation among patients with chronic diseases. The mean 3-year adjusted healthcare costs for those with both chronic diseases and mental disorders were estimated to be approximately 1.7 times more than patients with chronic diseases alone [11].

Depression incurs substantial indirect costs that are associated with decreased work functioning, absence from work, and impaired productivity [12]. According to the World Health Organisation (WHO), it was estimated that depression and anxiety cost the global economy US$ 1 trillion in productivity loss annually [13].

The magnitude of healthcare expenditure and productivity loss has been examined among people with depression and chronic medical conditions independently in many studies [5–8, 12, 14, 15], but few have examined the impact of depression on healthcare cost among the older adults with pre-existing chronic medical conditions. There is also a lack of evidence on the economic burden of depression in Singapore [16, 17]. Therefore, we aim to evaluate the association of depression on healthcare expenditure and productivity loss among the older adult population with chronic diseases in Singapore.

Methods

The WiSE study was a cross-sectional study conducted among Singapore residents who are aged 60 years and above. A random representative sample was selected from a national registry that contains the names and socio-demographic details such as the age, gender, ethnicity, and addresses of all residents in Singapore. Respondents were approached at their residential address provided by the registry, and interviews were conducted using an online Computer Assisted Personal Interviewing (CAPI) application. The survey data was weighted to the 2011 resident population. For confidentiality, all personal identifiers were removed before analysis. Written informed consent was obtained from respondents. When respondents were unable to answer the questions or unsure of their answers, information may be collected from their nominated informant as proxy. Methodologies were described in detail elsewhere [2]. The study was approved by the National University of Singapore Institutional Review Board (IRB), National Healthcare Group Domain Specific Review Board and Singhealth Centralised IRB.

Assessment of depression

The Geriatric Mental State (GMS) examination was used in the assessment of depression and comprised a semi-structured interview with a rating section that assess psychopathology and cognition.The Automated Geriatric Examination for Computer Assisted Taxonomy (AGECAT) was used to diagnose depression. The validity of AGECAT has been established with an agreement of 0.88 (Kappa score) with the psychiatrist's diagnoses of depression. Details were explained in previous studies [2, 17].

Data collection

Socio-demographics data such as age, gender, ethnicity, marital status and education were collected. Data on common medical conditions including history of heart trouble (myocardial infarction, cardiac failure, and valvular heart disease), stroke and diabetes were also collected. Heart trouble, stroke, and diabetes were defined as a dichotomous variable for answering 'yes' to the question

of whether a doctor had ever told them that they had any of the conditions.

Healthcare utilisation data was obtained from respondents and their informants using an adapted version of the Client Service Receipt Inventory (CSRI) [2, 17]. The CSRI was shown to be a well-validated scale that has been widely adopted in 10/66 population-based studies among the older adult population [18]. Respondents were asked if they used specific services during the three months before the interview. Details on the number of visits, average time spent on visits, time spent on travelling and out-of-pocket expenses were collected. These services include care from polyclinic doctors, private general practitioners (GP), restructured hospital doctors/healthcare workers, and inpatient care.

Cost calculation

Healthcare cost was calculated by multiplying each service unit (i.e., consultations per minute, number of visits) by the unit cost price. The 3-month healthcare expenditure for each service was multiplied by four to obtain annualised cost. Due to sparse local data, extrapolation of United Kingdom (UK) unit cost was used to estimate the unit cost of selected health services in Singapore (primary care doctor, restructured hospital doctor, and healthcare workers). Ratios were generated using data from the World Health Organisation Choosing Interventions that are Cost-Effective (WHO-CHOICE) database [17, 19]. The ratios were then applied to the UK's unit cost of each selected services to generate Singapore unit costs. Reliable sources such as the Unit Cost of Health and Social Care 2013 [17, 20] and NHS Reference Costs [17, 21] were used. Unit cost per bed day was calculated for inpatient care. These calculations were based on the assumption that the unit costs for health services were fixed and had remained unchanged between both countries. Figures were converted to local currency. Average out-of-pocket expenses were used if UK unit cost data was not available. This method was adopted by previous population-based cost evaluation studies using the WiSE study [17, 18]. Appendix Table 1 presents the unit costs for health services in Singapore. Cost will be reported in Singapore Dollars in this paper.

Productivity loss was calculated using the human capital approach [22] by multiplying the total number of healthcare visits (absent from work) and time spent on visits by the hourly income. The median national gross income [23] and average national working hours [24] for 2013 published by the Ministry of Manpower (MOM) were used to estimate productivity loss. The median income in 2013 was $3700 (including Employer CPF contributions) [23], and the average national working hours for a week was 45.3 h [24]. We acknowledge that majority of the older population may not be in the workforce, hence labour participation rate was taken into account in the calculation of productivity loss among older adults. The labour participation rate was reported to be 67.1% for those aged between 55 and 64 and 23.8% for 65 years and above as published by MOM Research and Statistics Department's "Singapore Workforce 2013" report [25]. Primary care expenditure was derived from polyclinic doctors and GP services. Specialists' Outpatient Clinics (SOC) expenditure was derived from visits to specialists in restructured hospitals. Total health care expenditure was derived from the sum of primary health care, SOC and inpatient costs.

Statistical analysis

All estimates were analysed using survey weights to adjust for oversampling, non-response and post-stratification according to age and ethnicity of the Singapore older adult population to ensure a better representation of the population. The dependent variables were healthcare expenditure (total healthcare, primary care, SOC and inpatient) and productivity loss. The primary independent variable of interest was depression with chronic diseases. Categorical variables were expressed in frequencies and percentages, by depression status. Continuous variables were expressed in mean ± SD. Pearson's Chi-Square test was used to compare categorical variables. Age was categorised into three groups: 60–74, 74–85 and 85 years and above with 60–74 years old being the reference group. Ethnicity was categorised into four groups: Chinese (reference group), Malay, Indian and Others. Marital status was categorised into three groups: married (reference group), single and divorced/separated/widowed. Education level was categorised into four groups: no education (reference group), up to primary level, completed secondary level and completed tertiary level. Income was categorised into four groups: paid work, unemployed, homemaker and retired. Gender and medical condition were dichotomised. Participants who reported yes to any of the following conditions – heart trouble, stroke and diabetes were considered to have chronic diseases in the analysis. Incomplete data on demographics and medical conditions was not included in the analysis.

We used two-part models to estimate annual health care expenditure and productivity loss associated with depression and chronic medical conditions, controlling for individual characteristics as well as accounting for sampling design. The two-part models are widely used in health economics and health services research when the outcome of interest has a large number of zero outcomes and a group of nonzero outcomes that are discrete or highly skewed [26, 27]. Before deciding on the two-part models, histograms were plotted to show the sample distribution of cost data (Appendix Fig. 1).

Given that the distribution of costs in the dataset was skewed with many zeros, and both assumptions of normality and homoscedasticity of residuals were violated, we applied a probit model for the first part of the model to predict the probability of incurring any healthcare expenditure. For the second part, we modelled the positive cost using a generalised linear model (GLM) with the log link and gamma distribution. Individual components of the total healthcare expenditure were modelled to look at the cost of depression in the older adult population with chronic diseases in different sectors of the healthcare system in Singapore: primary care, SOC, inpatient. Socio-demographic factors were adjusted in the multivariable regression.

Statistical analysis was performed with STATA ver16 (STATA Corp, College Station, Tx, USA). The 'twopm' command was used to execute the two-part models in Stata [28]. Two-sided p-values less than 0.05 were considered statistically significant.

Results

2510 respondents were included in this study. The sample comprised 44% male and 56% female respondents, with 75% respondents aged between 60 and 74 years old. The prevalence of depression was 3.7%, and the prevalence of chronic diseases was 35.5%. Table 1 shows the descriptive statistics of the sample stratified into four groups – no depression and no chronic diseases (reference group); no depression and has chronic diseases; has depression and no chronic diseases; has both depression and chronic diseases. Age group, gender, ethnicity and employment status were shown to be statistically different between the four groups. For age, a higher proportion of respondents aged 60–74 was in the reference group ($p<0.0001$). A higher proportion of respondents aged 75–84 was shown more likely to be depressed. There was a higher proportion of females in both the depression group with and without chronic diseases ($p=0.0027$). The weighted percentages for each variable are presented in Table 1. Table 2 presents the incremental effects of annual

Table 1 Distribution of socio-demographic characteristics by chronic disease and depression, $n=2510$

Characteristic	No depression and no chronic diseases ($n=1,364$)		No depression and has chronic diseases ($n=975$)		Depression and no chronic diseases ($n=74$)		Depression and chronic diseases ($n=97$)		
	n	Weighted %	n	Weighted %	n	Weighted %	n	Weighted %	P
Age group									
60–74	846	78.9	530	70.0	42	60.3	53	62.1	< 0.0001
75–84	309	16.1	295	24.0	23	34.2	28	31.3	
85+	209	4.98	150	6.08	9	5.49	16	6.62	
Gender									
Male	573	41.1	468	50.4	18	29.0	31	37.4	0.0027
Female	791	58.9	507	49.6	56	71.0	66	62.6	
Ethnicity									
Chinese	623	86.4	332	79.5	17	67.8	14	55.2	< 0.0001
Malay	406	8.38	273	10.3	28	20.1	29	18.8	
Indian	318	4.05	353	8.28	29	12.1	52	21.5	
Others	17	1.15	17	1.99	0	0	2	4.54	
Marital status									
Single	87	9.12	35	5.87	3	2.32	4	6.34	0.309
Married	808	64.1	573	64.5	34	65.0	47	64.2	
Divorced/Separated/Widowed	469	26.8	367	29.6	37	32.7	46	29.4	
Education									
None	255	15.0	193	18.2	24	21.5	27	32.7	0.0968
Up to Primary	662	47.5	502	51.1	33	50.8	44	40.4	
Completed Secondary	296	24.6	187	19.5	9	13.0	18	15.6	
Completed Tertiary	151	13.0	93	11.2	8	14.6	8	11.2	
Employment									
Paid Work	451	39.3	208	25.9	13	19.0	14	23.5	< 0.0001
Unemployed	18	1.75	10.0	1.20	2	1.53	2	1.07	
Homemaker	418	25.7	318	26.7	31	40.1	39	33.4	
Retired	477	33.3	439	46.2	28	39.4	42	42.1	

Weighted row percentages included

Table 2 Incremental effects of annual healthcare expenditure and productivity loss by chronic disease and depression using two-part regression model

	Total	Primary care	Inpatient care	Outpatient care	Productivity loss
No depression & no chronic diseases	Ref	Ref	Ref	Ref	Ref
No depression and has chronic diseases	3780***	107**	3240***	597***	394***
Depression and no chronic diseases	1480	188	30.3	1030	343*
Depression and chronic diseases	7940*	257*	6180	970*	676***

All outcomes for healthcare expenditures and productivity loss were adjusted for age, gender, ethnicity, marital status, education and employment

(* $p<0.05$, ** $p<0.01$, *** $p<0.001$)

healthcare expenditure and productivity loss by chronic disease and depression using two-part regression model.

Total healthcare care expenditure

Appendix table 2 presents the predictors of annual total healthcare expenditure based on the two-part models. After adjusting for socio-demographic factors, the average incremental cost of chronic diseases alone was $3780 (95% CI 1820–5370; $p<0.001$), followed by depression only ($1480,95% CI -853–3810; $p=0.214$), though not statistically significant. Having both chronic diseases and depression was associated with an average annual incremental cost of $7940 (95% CI 1490–14400; $p=0.016$).

Primary care expenditure

Appendix table 3 presents the predictors of annual primary care expenditure. After adjusting for socio-demographics, chronic diseases were associated with an average incremental cost of $107 (95% CI: 34.3–179, $p=0.004$), followed by depression only ($188, 95% CI: -52.1– 429; $p=0.125$), and having both depression and chronic diseases ($257, 95% CI: 38.7–475; $p=0.021$).

Tertiary expenditure

Appendix table 4 presents the predictors of annual tertiary expenditure.The average increment cost of chronic diseases for annual inpatient expenditure was $3240 (95% CI 1370–5110, $p=0.001$) after adjusting for socio-demographics (table 2).Though not statistically significant, having depression and chronic diseases contributed to an average incremental cost of $6180 (95% CI -418–12800; $p=0.066$). The adjusted average incremental cost of chronic diseases on annual SOC expenditures was $597 (95% CI 355–839, $p<0.001$) (table 2). The average increment cost of depression alone was $1030 (95% CI -445–2510; $p=0.171$). Having both depression and chronic diseases had an average incremental cost of $970 (95% CI 163–1780; $p=0.018$) in SOC which is statistically significant.

Productivity loss

Appendix table 5 presents the predictors of annual productivity loss. Having chronic diseases alone was associated with an average incremental annual productivity loss of $394 (95% CI 216–571, $p<0.001$) after adjusting for socio-demographics and comorbidities. In the multivariable regression model, depression alone contributed to an annual productivity loss of $343 (95% CI 9.91–676, $p=0.044$). Having both depression and chronic diseases contributed to an annual productivity loss of $676 (95% CI 346–1010; $p<0.001$).

Discussion

Our study shows that depression significantly impacts healthcare expenditure among the older adults with chronic diseases in Singapore. The prevalence of older adults aged 65 years and above was 13.7% in Singapore in 2018. This is a 5% increase over the last decade, and the numbers are expected to double by 2030[29]. Additionally, patients with chronic conditions are more likely to develop psychiatric disorders such as depression or anxiety [30]. This finding was consistent with current literature that chronic diseases lead to increased medical costs around the world [31, 32]. In our study, older adults with both chronic diseases and depression were associated with an average incremental cost of $7940 compared to those without these conditions. Having depression alone increases healthcare costs by $1480 while having chronic diseases alone increases healthcare costs by $3780. Of note, having depression and chronic diseases double the total healthcare cost ($7940) which is more than the combined effect of having chronic disease alone and having depression alone ($5260). This suggests the possibility of depression acting as a moderator in the relationship between chronic diseases and healthcare expenditure. While depression impacts healthcare cost, regression analysis revealed that depression does not significantly moderate this relationship. However the lack of statistical significance could be due to a small sample size. The incremental effect of depression on healthcare cost was 2.4 times of older adults with chronic diseases ($257 vs. $107) in the primary care setting and 1.7 times in the outpatient setting ($1030 vs. $597). These findings were statistically significant. Excess cost with depression and chronic diseases in the inpatient setting was not found to be statistically significant which was consistent with previous studies in the United States, where depression had

no significant effect on the frequency of hospital admission or length of stay [5, 33].

There are several reasons to explain the impact of depression on healthcare expenditure among older adults with chronic diseases in the primary care setting. Studies have shown that depressed older patients had a significantly higher frequency of "non-specific" medical complaints such as fatigue, dizziness, headache and pain compared to the non-depressed older patients [5, 34, 35]. These complaints are three to four times more than the non-depressed group [5]. Furthermore, the diagnosis of depression was infrequent among primary care setting, with studies suggesting that half of all depressed patients was undiagnosed in primary care [5, 36, 37]. Depressed patients are also more likely to continue seeking medical attention. The increased somatic presentations among the depressed older adults and the underdiagnosis of depression in primary care may contribute to higher utilisation of healthcare resources which entail higher expenditure.

Depression was associated with an average incremental annual productivity loss of $676 among older adults with chronic diseases. Productivity loss was estimated to be 1.7 times higher ($676 vs. $394) in older adults with both depression and chronic diseases. This finding is consistent with current literature that shows positive productivity loss associated with depression [12, 16, 38]. However, compared to a local study that reported a productivity loss of USD $3063 ($11,763) due to medical leave related to depressive disorder [16]; the findings are likely to be underestimated. Firstly, our study did not account for productivity losses from presenteeism (reduced productivity at paid work) – this is a huge component of productivity loss. Secondly, absenteeism was calculated based on respondents seeking healthcare and did not account for those who were absent but did not seek healthcare nor could we estimate the productivity loss from presenteeism. It is recommended in the literature to use a measurement instrument including questions about both paid and unpaid productivity [39].

Strengths and limitations

This study is the first to look at additional costs of depression among older adults using a representative Singapore epidemiological study adjusting for the multi-ethnic nature of the population. Validated instruments were used in the diagnosis of depression (AGECAT) and the measurement of healthcare utilisation (CSRI). The advantage of the bottom-up approach to estimate the cost of depression in this study provided greater details about how cost differs in different health sectors in Singapore. Future studies could look at quantifying the cost of depression from the top down using individual cost data from Mediclaim through the Ministry of Health. This method would mitigate recall bias but would be limited to services and medications from Medisave claims. Medisave is a national savings scheme that helps individuals set aside some part of their income to pay for their medical expenses.

One of the study's limitations was that the cost data relied heavily on the accuracy of self-reported utilisation of health care services, which is subject to recall bias. Furthermore, the study's cross-sectional design did not allow us to establish the temporal relation of depression. Hence, no conclusions on causal interference of the variables considered can be drawn. The 66% non-response rate with little medical information on the non-respondents further limits the generalisability of results to the population. Extrapolating from a 3-month healthcare utilisation period can also lead to imprecise estimation of the annual healthcare expenditure. Likewise, several assumptions were made while calculating the unit costs of healthcare due to the lack of information available in Singapore. However, this practice has been widely accepted and adopted in the estimation of economic cost [17, 18, 40]. The annual healthcare expenditure was likely to be an underestimation as this study did not include utilisation from private specialists, healthcare workers, and pharmaceuticals. Previous studies [29, 41] have shown that medication made up one of the largest components in the higher cost of depression.

Conclusion

As Singapore's population ages, the incremental cost associated with depression among the older adults with chronic diseases will begin to impose increasing pressure on the healthcare system, thereby inflating healthcare costs. Thus, there is a pressing need to prioritise the capabilities of the healthcare system to manage depression among older adults in Singapore. The findings of this study also provided insights that could impact the clinical practices of primary care physicians. As the first point of contact in our healthcare system, it is recommended that physicians actively look out for non-specific complaints associated with depression, especially among older adults with multiple comorbidities so appropriate treatment can be introduced promptly, abating the rising costs.

Supplementary Information

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Supplementary Material 1

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Author contributions
JWN wrote the paper, JWN and CC conceived and designed the study, NJW, CC and XYG performed the statistical analysis. MS, SAC, JA and EA collected the data. The authors read and approved the final manuscript.

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Data availability
Available from corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the National University of Singapore Institutional Review Board (IRB), National Healthcare Group Domain Specific Review Board and Singhealth Centralised IRB. Written informed consent was obtained from respondents in the WiSE study. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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