Impact of mental disorders and chronic physical conditions on quality-adjusted life years in Singapore

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The current study aims to evaluate the burden of disease in Singapore by estimating the quality-adjusted life years (QALYs) lost due to mental disorders and chronic physical conditions. The second Singapore Mental Health Study (SMHS-2016) was conducted in 2016 among 6126 respondents aged 18 years and above. The World Health Organization Composite International Diagnostic interview version 3.0 (WHO-CIDI 3.0) and a modified version of the CIDI chronic medical disorders checklist were used to assess the 12-month diagnoses of mental and chronic physical disorders while the SF-6D scores derived from the 12-item Short Form Health Survey instrument was used to estimate the QALYs lost. The mean SF-6D score in this population was 0.87. The largest reduction in SF-6D scores among people with mental disorders was observed in Generalized Anxiety Disorder (GAD), followed by Major Depressive Disorder (MDD), alcohol abuse, bipolar disorder and Obsessive Compulsive Disorder (OCD) while the largest reduction in SF-6D score among people with chronic physical conditions was observed in ulcer, followed by lung disease, chronic pain and cardiovascular disease. At the population level, chronic pain was associated with the greatest QALY loss followed by MDD (14,204 and 6,889 respectively). Lung disease was associated with the smallest QALY loss (376). These findings highlight chronic pain, MDD, OCD, cardiovascular disease and GAD as the five leading contributors of QALYs lost in the general population which deserve prioritisation in public health prevention programmes.

Between 1990 and 2017, the decline in mortality rates has been associated globally with increasing life span, and an ageing population which has translated into an increase in the magnitude of the non-fatal disease burden1. The Global Burden of Disease Study (GBD)1,2 has reported that the leading contributors of years lived with disability (YLDs) are related to pain - low back pain, headache disorders, mental - depressive disorders, and metabolic disorders - diabetes1. In parallel with the transformation of the healthcare model towards a holistic person-centred approach3–5 and transition of focus from infectious diseases to non-communicable diseases6,7, quality-adjusted life years (QALYs)8 has increasingly become a valuable tool to estimate the burden of disease in the general population9–11. A QALY is a summary measure that combines the length of survival of an individual and the health-related quality of life8 by placing a value on time spent in different health states12. The value is reflective of the preference weight that society gives for different health states based on their own health preference12. For example, a person with full health has a utility score value of 1 while a health state equivalent to being dead is given a value of 012,13.

Several studies have been conducted to estimate QALY losses attributed to chronic medical conditions which includes both physical and psychiatric disorders9,14,15. The QALY losses in the population can be calculated as a product of the marginal effect of each disorder, i.e., change in the health-related quality of life associated with a disorder multiplied with its prevalence in the general population15,16. The value is interpreted as the annual loss in QALYs resulting from the disorder, without considering mortality9,14,15. This method is commonly used to

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measure the burden of disease in the general population so that health services and initiatives can be planned to target the relevant chronic disorder that has a higher impact on the individual and the society.

Singapore, a country in South-East Asia has a total population of about six million. The Chinese (74.4%) form the majority of the population, followed by Malays (13.4%), Indians (9.0%) and those from other ethnic groups (3.2%)17. As the population in Singapore is rapidly ageing with a growing chronic disease burden, data on current disease burden in terms of QALY losses due to chronic physical and mental disorders are important tools for monitoring the burden of these conditions on the population9. An epidemiological study conducted in 2010 - the Singapore Mental Health Study (hereafter referred to as SMHS-2010) had shown that chronic pain conditions, hypertension, and major depressive disorders (MDD) were the largest contributor to QALY losses in Singapore9. It was also found that the impact of the two mood disorders - MDD and bipolar disorder, as well as one of the anxiety disorders - obsessive compulsive disorder (OCD), examined in the study were associated with significantly larger QALY losses than the impact of any chronic physical condition at an individual level9. Recently, the second SMHS was carried out in 2016 (hereafter referred to as SMHS-2016)18. Although previous studies have investigated the impact of mental and physical disorders on QALY in the general population9, little is known about the change in the prevalence of these conditions over the years and its impact on QALYS. Hence, the current study aims to estimate QALY's lost due to mental disorders and chronic physical conditions in Singapore using the recent data from the second SMHS-2016.

Methods
Sample. Data were obtained from the SMHS-2016 survey18 - a nationally representative cross-sectional survey conducted among resident adults aged 18 years and above in Singapore. The study design and characteristics of the sample of this survey have been described in detail elsewhere18. In brief, the study applied a disproportionate stratified random sampling design. Over a period of 1-year, face-to-face interviews were conducted with the participants. The respondents received an inconvenience fee of $60 for their participation in the survey.

SF-6D. We used the SF-1219, a multidimensional health classification system assessing the six health domains of physical functioning, role limitation, social functioning, pain, mental health, and vitality, across 4-6 levels for each domain19,20. This instrument is based on 11 items from the 36-item Short Form Health Survey (SF-36) or 7 of the 12-item Short Form Health Survey (SF-12)13,19. This instrument has been widely used to generate utility values and is psychometrically sound in measuring health-related quality of life outcomes in both general and specific populations13,21. The SF-6D health state is defined by selecting 1 level from each domain, which results in a total of 18,000 possible health states19,21. The SF-6D scoring algorithm was developed using the standard gamble (SG) method from a sample of 249 SF-6D health states from a representative sample of the UK population19,21. Utility scores generated by the SF-6D range from 0.29 to 1.00, with 1.00 representing full health and 0.29 representing the worst possible health state defined by the SF-6D (i.e., all domains being at the worst level)19,21. The utility scores derived from English and Chinese versions of the SF-6D have been demonstrated to be equivalent in Singapore's multi-ethnic general population22 and the instrument performs well in patients with mental illnesses23.

Mental disorder. Mental disorders were assessed using the World Health Organization Composite International Diagnostic Interview (WHO-CIDI), a fully structured diagnostic interview to assess mental disorders and their treatment44. Only selected diagnostic modules for 12-month prevalence of mood disorders (major depressive disorder (MDD), dysthymia and bipolar disorder), anxiety disorders (generalized anxiety disorder (GAD) and obsessive-compulsive disorder (OCD)), and alcohol abuse and dependence were included18. Diagnoses of mental disorders were based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria25. CIDI hierarchy rules were applied to all diagnoses18.

Chronic physical disorders. Information on chronic physical disorders was obtained using a modified version of the CIDI checklist of chronic medical disorders26. The question was read as ‘I’m going to read to you a list of health problems some people have. Has a doctor ever told you that you have any of the following…’. This was followed by a list of chronic physical disorders which were considered prevalent in Singapore’s population26. Eighteen individual disorders included in the current survey were re-classified into 11 types of common chronic physical conditions: (1) asthma, (2) diabetes, (3) hypertension and high blood pressure, (4) chronic pain (arthritis or rheumatism, back problems including disk or spine, migraine headaches), (5) cancer, (6) cardiovascular disease (stroke or major paralysis, heart attack, coronary heart disease, angina, congestive heart failure or other heart disease), (7) ulcer and chronic inflamed bowel disease (stomach ulcer, chronic inflamed bowel, enteritis, or colitis), (8) thyroid disease, (9) neurological condition (epilepsy, convulsions, fainting spells, or Parkinson's disease), (10) chronic lung disease (chronic bronchitis or emphysema (excluding asthma)), and, (11) hyperlipidaemia. Those who gave a positive answer to the list of chronic physical disorders were routed to the following question “Did you receive any treatment for it at any time during the past 12-month.” Those who answered positively to both the questions were then identified as having a chronic physical condition for the past 12-months in this study26.

Socio-demographic data. Data on gender, age group (18–34 years, 35–49 years, 50–64 years, and 65 years old and above), ethnicity (Chinese, Malay, Indian, and Others), marital status (never married, married, divorced/separated or widowed), educational level (primary and below, secondary, vocational /ITE, pre-university/junior college/diploma, and university), employment status (employed, unemployed and economically inactive i.e., students, homemakers and retirees) and average household income per month (below Singapore Dollar (SGD)2000,
Table 3 shows the annual QALY losses for the entire population that could be explained by each condition that reached statistical significance in the multivariate regression analyses. We found that chronic pain was associated with the greatest QALY loss at population level, followed by MDD (14,204 and 6,889 respectively). Lung disease was associated with the smallest QALY loss (376). We found chronic pain was also the leading cause of QALY loss among those aged 35 years and above, while MDD had the greatest impact among those aged 18–34 years.

Discussion

This study has revealed that a number of mental and chronic physical conditions in Singapore were significantly associated with substantial QALY loss at the societal level and a significant decrease in health utility scores at an individual level. GAD had a greater impact on utility scores at the individual level as compared to other mental disorders and chronic physical conditions. It is possibly due to the fact that in our population, the proportion of those with GAD who reported 'severe' impact on functioning was highest among those with mental disorders. 7% of GAD cases were assessed to have had a severe disorder in the past one year using the Sheehan's Disability Scale criteria, while only 1% of bipolar cases were assessed to be severe. None of the alcohol abuse cases had severe disorder. Moreover, the marginal effect of GAD on utility scores was considered to have met clinically important different (CID) criterion. The CID can be defined as the smallest difference in the score that patients perceive as important that could lead a clinician to consider the change in the patient's management. In the current study, we adopted CID as additional information beyond the p-value in order to interpret the meaningfulness of the marginal effect of each disorder on utility scores from the patient's perspective. Previous studies have reported that the CID values for SF-6D as 0.051 using an anchor-based method and the range as 0.01 to 0.48 using a distribution-based method. It seems that different methods used can lead to different findings. Thus, if we use the anchor-based method to define CID, it seems that all mental disorders and only three chronic physical
conditions can be considered as clinically important. However, if the lower range (0.01) of the distribution-based method is used, a number of physical conditions can be considered as achieving CID.

The finding that GAD had the highest impact on utility scores in the SMHS-2016 came as a surprise in light of the fact that GAD was associated with a smaller and insignificant reduction in health utility scores in the SMHS 20109. The changes in the magnitude of the impact of GAD on utility scores between 2010 and 2016 are not easy to explain, because many factors may have played a significant role between these two time-points. It is possible that a significant increase in the lifetime (0.9% to 1.6%, p = 0.005) and 12-month (0.4% vs. 0.8%, p = 0.033) prevalence of GAD between SMHS 2010 and SMHS 201618 may be associated with a substantial impact of GAD on the person’s physical and mental health30,31. It is also possible that the changes are due to the different instruments employed in the two surveys as the utility scores were measured based on EQ-5D in the SMHS-2010.

MDD was the second largest contributor to the reduction in utility scores at an individual-level after GAD. It was also the second largest contributor to the loss of QALY at the population level after chronic pain and the leading cause of QALY loss among younger age groups. This finding is partly consistent with our previous study which reported MDD as the largest contributor to the reduction of HRQoL at individual-level in SMHS 20109. Higher prevalence of MDD in the general population18,32 with significantly impaired role functioning as well as increased days out of role could explain the significant impact of MDD on health utilities and QALYs32.

When we multiplied the marginal effects of each condition on utility scores with the prevalence, chronic pain was associated with the largest loss of QALYs in our population. Although the impact of GAD and MDD on

| Sample | SF-6D | Multiple linear regression |
|--------|-------|--------------------------|
|        | N     | %           | Mean  | SD     | Beta coefficient | 95% CI         | P value       |
| Age group |       |             |       |        |                 |                |               |
| 18–34  | 1706  | 30.5        | 0.862 | 0.095  | Ref.             |                |               |
| 35–49  | 1494  | 29.6        | 0.879 | 0.088  | 0.013 (0.0005,0.025) | 0.042       |
| 50–64  | 1623  | 26.9        | 0.877 | 0.101  | 0.015 (0.002,0.029) | 0.029       |
| 65+    | 1290  | 13.1        | 0.856 | 0.147  | 0.007 (−0.011,0.025) | 0.420       |
| Gender |       |             |       |        |                 |                |               |
| Female | 3050  | 50.5        | 0.865 | 0.104  |                 |                |               |
| Male   | 3063  | 49.5        | 0.875 | 0.100  | 0.01 (0.002,0.019) | 0.111       |
| Ethnicity |      |             |       |        |                 |                |               |
| Chinese | 1780  | 75.7        | 0.869 | 0.062  | Ref.             |                |               |
| Malay  | 1982  | 12.4        | 0.870 | 0.174  | 0.002 (−0.006,0.01) | 0.621       |
| Indian | 1842  | 8.7         | 0.870 | 0.202  | 0.001 (−0.007,0.008) | 0.817       |
| Others | 509   | 3.1         | 0.886 | 0.167  | 0.016 (0.005,0.027) | 0.005       |
| Education |      |             |       |        |                 |                |               |
| Primary and below | 1183  | 16.3        | 0.864 | 0.120  | 0.001 (−0.014,0.016) | 0.886       |
| Secondary | 1641  | 23          | 0.867 | 0.120  | −0.005 (−0.018,0.009) | 0.492       |
| Pre-U/Junior college | 304   | 4.1         | 0.862 | 0.093  | −0.01 (−0.029,0.009) | 0.313       |
| Vocational institute/ITE | 508   | 6.3         | 0.875 | 0.118  | 0.0004 (−0.016,0.017) | 0.968       |
| Diploma | 1023  | 14.9        | 0.872 | 0.092  | −0.003 (−0.014,0.009) | 0.650       |
| University | 1454  | 20.4        | 0.875 | 0.082  | Ref.             |                |               |
| Employment |      |             |       |        |                 |                |               |
| Employed | 4052  | 72          | 0.878 | 0.090  | Ref.             |                |               |
| Economically inactive | 1710  | 22.8        | 0.859 | 0.122  | −0.007 (−0.018,0.004) | 0.211       |
| Unemployed | 350   | 5.2         | 0.813 | 0.149  | −0.055 (−0.081,−0.03) <0.001 | 0.201       |
| Marital status |      |             |       |        |                 |                |               |
| Never married | 1542  | 31          | 0.860 | 0.090  | −0.007 (−0.019,0.004) | 0.210       |
| Married | 3836  | 59.8        | 0.878 | 0.101  | Ref.             |                |               |
| Divorced/separated | 342   | 5.2         | 0.858 | 0.121  | −0.016 (−0.036,0.003) | 0.107       |
| Widowed | 393   | 4.1         | 0.844 | 0.153  | −0.014 (−0.036,0.008) | 0.201       |
| Household income per month (SGD) |      |             |       |        |                 |                |               |
| <2000  | 1140  | 16.4        | 0.848 | 0.137  | Ref.             |                |               |
| 2000–3999 | 1328  | 20          | 0.871 | 0.110  | 0.018 (0.004,0.031) | 0.009       |
| 4000–5999 | 1112  | 16.4        | 0.878 | 0.092  | 0.024 (0.010,0.037) | 0.001       |
| 6000–9999 | 1003  | 15.3        | 0.868 | 0.093  | 0.012 (−0.003,0.027) | 0.111       |
| 10000 and above | 860   | 20.4        | 0.879 | 0.080  | 0.021 (0.005,0.036) | 0.009       |

Table 1. Descriptive statistics of the sample and socio-demographic correlates of the SF-6D. ITE = Institute Technology of Education; Pre-U = Pre University; SGD = Singapore Dollar.
|                                | Beta coefficient | 95% CI         | P value   |
|--------------------------------|------------------|----------------|-----------|
| **Mental disorders***          |                  |                |           |
| GAD                            | −0.136           | (−0.188, −0.084) | <0.001    |
| MDD                            | −0.097           | (−0.125, −0.069) | <0.001    |
| Alcohol abuse                  | −0.07            | (−0.12, −0.02)  | 0.006     |
| Bipolar                        | −0.06            | (−0.11, −0.009) | 0.02      |
| OCD                            | −0.058           | (−0.083, −0.034) | <0.001    |
| Dysthymia                      | −0.053           | (−0.117, 0.01)  | 0.101     |
| Alcohol dependence             | 0.061            | (−0.001, 0.123) | 0.051     |
| **Chronic physical conditions***|                  |                |           |
| Ulcer                          | −0.09            | (−0.133, −0.046) | <0.001    |
| Lung disease                   | −0.076           | (−0.12, −0.033) | 0.001     |
| Chronic pain                   | −0.06            | (−0.076, −0.044) | <0.001    |
| Cardiovascular                 | −0.042           | (−0.065, −0.02)  | <0.001    |
| Cancer                         | −0.03            | (−0.074, 0.014) | 0.186     |
| Neurological conditions        | −0.021           | (−0.079, 0.037) | 0.485     |
| Diabetes                       | −0.013           | (−0.029, 0.003) | 0.101     |
| Hyperlipidaemia                | −0.01            | (−0.023, 0.004) | 0.166     |
| Asthma                         | −0.005           | (−0.025, 0.016) | 0.670     |
| Hypertension                   | −0.002           | (−0.014, 0.01)  | 0.714     |
| Thyroid                        | 0.006            | (−0.021, 0.033) | 0.640     |
| **Age group**                  |                  |                |           |
| 18–34                          |                  |                |           |
| 35–49                          | 0.010            | (−0.001, 0.022) | 0.076     |
| 50–64                          | 0.015            | (0.002, 0.028)  | 0.024     |
| 65+                            | 0.014            | (−0.004, 0.032) | 0.136     |
| **Gender**                     |                  |                |           |
| Female vs. Male                | −0.009           | (−0.016, −0.001) | 0.023     |
| **Ethnicity**                  |                  |                |           |
| Chinese                        |                  |                |           |
| Malay                          | 0.006            | (−0.002, 0.013) | 0.154     |
| Indian                         | 0.007            | (−0.001, 0.014) | 0.069     |
| Others                         | 0.017            | (0.006, 0.027)  | 0.002     |
| **Marital status**             |                  |                |           |
| Married                        |                  |                |           |
| Never married                  | −0.006           | (−0.016, 0.005) | 0.291     |
| Divorced/separated             | −0.008           | (−0.026, 0.009) | 0.337     |
| Widowed                        | −0.014           | (−0.035, 0.007) | 0.197     |
| **Education**                  |                  |                |           |
| University                     |                  |                |           |
| Primary and below              | 0.006            | (−0.008, 0.021) | 0.398     |
| Secondary                      | −0.003           | (−0.016, 0.01)  | 0.604     |
| Pre-U/Junior college           | −0.004           | (−0.022, 0.013) | 0.623     |
| Vocational institute/ITE       | 0.002            | (−0.013, 0.018) | 0.777     |
| Diploma                        | −0.001           | (−0.011, 0.01)  | 0.915     |
| **Employment**                 |                  |                |           |
| Employed                       |                  |                |           |
| Economically inactive          | −0.008           | (−0.019, 0.002) | 0.131     |
| Unemployed                     | −0.044           | (−0.066, −0.021) | <0.001    |
| **Household income per month (SGD)**|                  |                |           |
| <2000                          |                  |                |           |
| 2000–3999                      | 0.014            | (0.001, 0.026)  | 0.033     |
| 4000–5999                      | 0.020            | (0.008, 0.033)  | 0.002     |
| 6000–9999                      | 0.011            | (−0.003, 0.025) | 0.120     |
| 10000 and above                | 0.021            | (0.006, 0.035)  | 0.005     |

Table 2. Impact of type of mental disorders and chronic physical conditions on SF-6D scores. *The mental disorders and chronic physical conditions are rank ordered by the size of the beta coefficient.
utility scores was much higher than chronic pain at an individual level, chronic pain remained associated with the largest QALY loss at the societal level. This finding could be explained due to the higher prevalence of chronic pain in our population, which was almost 9 and 3 times higher than GAD and MDD, respectively. In this study, the prevalence of chronic pain was 7.6%, while the prevalence of GAD and MDD was 0.8% and 2.3%, respectively. To ensure comparability with previous studies, the current study defined chronic pain as those who experienced migraine, arthritis or rheumatism and back problems including “disc or spine problems”. The greater impact of chronic pain on QALYs at societal level was in line with recent epidemiological data that has shown that low back pain was the strongest contributor of non-fatal loss in terms of YLD globally.

After controlling for sociodemographic factors, mental disorders and chronic physical conditions in multiple linear regression model, we found younger age, female gender, unemployment, and lower income were significantly associated with lower utility scores. Our findings are consistent with local data which found that the prevalence of mental disorders was higher among those of younger age and mental disorders represented the largest single contributor to the disease burden of disability-adjusted life years for Singaporeans between the ages of 10 and 34 years. In Australia too mental disorders were found to be the leading cause of burden among those belonging to the younger age group followed by neonatal causes and unintentional injuries. These evidence support the finding that the burden of mental disorders among those belonging to the younger age group is significant. Hence, initiatives to promote mental wellbeing and development of effective treatment strategies to improve young people’s mental health are needed.

In line with this, Sagayadevan et al. also found younger age and unemployment to be significantly associated with lower quality of life among local psychiatric outpatients. Similar findings were also reported among patients with mental disorders as well as in population-based studies conducted in other countries. However, findings on the relationship between age and quality of life between SMHS 2010 and SMHS 2016 were mixed. In the SMHS 2010, those belonging to the younger age group were significantly associated with a higher quality of life while these findings were reversed in 2016. Those in the younger age group in the current cohort may have been more vulnerable to economic and psychological stresses as compared to the previous cohort; however this needs further research.

The study has some limitations that need to be acknowledged. Firstly, the study used self-report to assess chronic physical conditions, and administrative data were not used for confirmation. A study by Knight et al. has shown that the chronic physical conditions checklist provides useful and accurate information about both treated and untreated chronic conditions. Ye et al. have similarly reported that the self-reporting of chronic physical conditions provided information similar to that available from medical records. Secondly, cross-sectional studies cannot ascertain causality, so longitudinal research is warranted. These limitations notwithstanding, this study was conducted on a nationally representative multi-ethnic population. The study had a good response rate, making the estimates highly generalizable to the multi-ethnic local population. All field interviewers were trained and stringent quality control was implemented throughout the study to ensure the data is reliable and valid. In all, 66 field interviewers were recruited for the study. All field interviewers underwent a structured training programme over a three-week period and were evaluated individually on all study-related procedures before being allowed to conduct the interviews in the field. The core research team members underwent training and were certified by the WMH-CIDI Training and Research Centre at the University of Michigan, USA. Stringent quality control measures were implemented throughout the study. For example, the number of completed interviews and time taken for each interview by each interviewer was closely tracked, on average two direct observation of each interviewer’s actual interviews at respondent’s household was conducted by core research team members, as well
### Table 3. Annual QALY losses for the entire population and at different age groups.

| Condition          | All | Marginal effect | QALY* | % | Marginal effect | QALY | % | Marginal effect | QALY | % | Marginal effect | QALY | % |
|--------------------|-----|-----------------|-------|---|-----------------|------|---|-----------------|------|---|-----------------|------|---|
| Chronic pain       | 7.6 | −0.060          | −14204| 5.3 | −0.059          | −2974| 7.3 | −0.040          | −2655| 8.1 | −0.074          | −4977| 12.4 | −0.067          | −336| 3.6 |
| MDD                | 2.3 | −0.097          | −6889 | 4.4 | −0.083          | −3481| 1.8 | −0.118          | −1927| 1.3 | −0.132          | −1402| 0.5 | −0.005          | −1   | 11 |
| OCD                | 2.9 | −0.058          | −5282 | 5.7 | −0.042          | −2267| 3.1 | −0.083          | −2351| 0.8 | −0.074          | −486 | 0.5 | −0.044          | −90  | 0  |
| Cardiovascular     | 3.1 | −0.042          | −4122 | 0.3 | −0.147          | −481 | 1.1 | −0.106          | −1094| 4.7 | −0.020          | −784 | 10.9 | −0.012          | −521 | 0  |
| GAD                | 0.8 | −0.136          | −3561 | 1.1 | −0.114          | −1159| 1.3 | −0.160          | −1853| 0.5 | −0.101          | −436 | 0.0 | −0.315          | −57  | 0  |
| Bipolar            | 0.9 | −0.060          | −1616 | 2.1 | −0.073          | −1439| 0.4 | 0.040           | 164  | 0.4 | −0.141          | −451 | 0.0 | −0.100          | −12  | 0  |
| Alcohol abuse      | 0.6 | −0.070          | −1224 | 1.1 | −0.082          | −863 | 0.5 | −0.088          | −429  | 0.2 | 0.020           | 39   | 0.0 | 0.000           | 0    | 0  |
| Ulcer              | 0.4 | −0.090          | −1002 | 0.1 | −0.066          | −67  | 0.1 | −0.166          | −103  | 0.6 | −0.115          | −576 | 1.1 | 0.015           | 69   | 0  |
| Lung               | 0.2 | −0.076          | −376  | 0.1 | −0.093          | −80  | —  | —              | —    | 0.4 | −0.072          | −234 | 0.2 | −0.046          | −38  | 0  |

As 20% of completed interviews were randomly selected for verification via telephone calls/home visits to detect any falsification of the data.

In conclusion, the current study provides important evidence of the reduction of quality-adjusted life years in people with mental disorders and chronic physical conditions in Singapore. These findings highlight chronic pain, MDD, OCD, cardiovascular disease and GAD as five leading contributors of QALYs lost in the general population, which deserve prioritisation in public health prevention programmes.

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### References

1. James, S. L. et al. Global, regional, and national incidence, prevalence, and years lived with disability for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* **392**, 1789–1838 (2018).

2. Institute for Health Metrics and Evaluation. Findings from the Global Burden of Disease Study 2017. *Seattle, WA* (2018).

3. Davis, E. L. et al. The relationship between patient-centered care and outcomes in specialist drug and alcohol treatment: A systematic literature review. *Subst Abus* 1–16 (2019).

4. Rathert, C., Wyrwich, M. D. & Boren, S. A. The estimation of a preference-based measure of health from the SF-12. *Med. Care Res. Rev* **70**, 351–379 (2013).

5. Fiorio, C. V., Gorli, M. & Verzillo, S. Evaluating organizational change in health care: the patient-centered hospital model. *BMC Health Serv. Res* **18**, 95 (2018).

6. Ock, M., Han, J. W., Lee, J. Y., Kim, S. H. & Jo, M. W. Estimating quality-adjusted life-year loss due to noncommunicable diseases in Korean adults through to the year 2040. *Value Health* **18**, 61–66 (2015).

7. Murray, C. J. et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380**, 2197–2223 (2012).

8. Sassi, F. Calculating QALYs, comparing QALY and DALY calculations. *Health Policy Plan* **21**, 402–408 (2006).

9. Subramaniam, M. et al. Impact of psychiatric disorders and chronic physical conditions on health-related quality of life: Singapore Mental Health Study. *J. Affect. Disord.* **190**, 326–332 (2013).

10. Fernández, A. et al. Burden of chronic physical conditions and mental disorders in primary care. *Br. J. Psychiatry* **196**, 302–309 (2010).

11. Penner-Goeke, K. et al. Reductions in quality of life associated with common mental disorders: results from a nationally representative sample. *J. Clin. Psychiatry* **76**, 1506–1512 (2015).

12. Kind, P., Lafata, E., Matuszewski, K. & Raisch, D. The use of QALYs in clinical and patient decision-making: Issues and prospects. *Value Health* 5, S27–S30 (2009).

13. Brazier, J. et al. A systematic review, psychometric analysis and qualitative assessment of generic preference-based measures of health in mental health populations and the estimation of mapping functions from widely used specific measures. *Health Technol Assess* 18, iii–vii, iii–xxv, i–188 (2014).

14. Fernández, A. et al. Burden of chronic physical conditions and mental disorders in primary care. *Br. J. Psychiatry* **196**, 302–309 (2010).

15. Saarni, S. I. et al. Impact of psychiatric disorders on health-related quality of life: general population survey. *Br. J. Psychiatry* **190**, 326–332 (2007).

16. Saarni, S. I. et al. The health-related quality-of-life impact of chronic conditions varied with age in general population. *J. Clin. Epidemiol.* **60**, 1288–1297 (2007).

17. Department of Statistics. Population Trends, 2019. *Department of Statistics, Ministry of Trade & Industry, Republic of Singapore* (2019).

18. Subramaniam, M. et al. Tracking the mental health of a nation: prevalence and correlates of mental disorders in the second Singapore mental health study. *Epidemiol. Psychiatr. Sci.* **29**, e29 (2019).

19. Brazier, J. E. & Roberts, J. The estimation of a preference-based measure of health from the SF-12. *Qual. Life Res.* **21**, 177–186 (2019).

20. Subramaniam, M. et al. Mapping the Positive and Negative Syndrome Scale scores to EQ-5D-5L and SF-6D utility scores in patients with schizophrenia. *Qual. Life Res.* **28**, 177–186 (2019).

21. Subramaniam, M. et al. The estimation of a preference-based measure of health from the SF-36. *J. health Econ.* **21**, 271–292 (2002).

22. Wee, H. L. et al. Are English- and Chinese-language versions of the SF-6D equivalent? A comparison from a population-based study. *Clin. therapeutics* **26**, 1137–1148 (2004).
23. Abdin, E. et al. A comparison of the reliability and validity of SF-6D, EQ-5D and HUI3 utility measures in patients with schizophrenia and patients with depression in Singapore. Psychiatry Res. 274, 400–408 (2019).
24. Kessler, R. C. & Ustun, T. B. The World Mental Health (WMH) Survey Initiative Version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). Int. J. Methods Psychiatr. Res. 13, 93–121 (2004).
25. American Psychiatric Association. Diagnostic and Statistical manual of mental disorders. Washington, DC: American Psychiatric Association (2000).
26. Chong, S. A., Abdin, E., Nan, L., Vaingankar, J. A. & Subramaniam, M. Prevalence and impact of mental and physical comorbidity in the adult Singapore population. Ann. Acad. Med. Singap. 41, 105–114 (2012).
27. Chang, S. et al. Prevalence and correlates of generalized anxiety disorder in Singapore: Results from the second Singapore Mental Health Study. J. Anxiety Disorder. 66, 102106 (2019).
28. Guyatt, G. H. et al. Methods to Explain the Clinical Significance of Health Status Measures. Mayo Clin. Proc. 77, 371–383 (2002).
29. Jayadevappa, R., Cook, R. & Chhatri, S. Minimal important difference to infer changes in health-related quality of life - a systematic review. J. Clin. Epidemiol. 89, 188–198 (2017).
30. Hoffman, D. L., Dukes, E. M. & Wittchen, H. U. Human and economic burden of generalized anxiety disorder. Depression anxiety 25, 72–90 (2008).
31. Yu, W. et al. Generalized anxiety disorder in urban China: Prevalence, awareness, and disease burden. J. Affect. Disord. 234, 89–96 (2018).
32. Chong, S. A., Vaingankar, J., Abdin, E. & Subramaniam, M. The prevalence and impact of major depressive disorder among Chinese, Malays and Indians in an Asian multi-racial population. J. Affect. Disord. 138, 128–136 (2012).
33. Epidemiology & Disease Control Division, Ministry of Health, Singapore; Institute for Health Metrics and Evaluation.. The Burden of Disease in Singapore, 1990–2017: An overview of the Global Burden of Disease Study 2017 results. Seattle, WA: IHME, 2019.
34. Queensland Health. The burden of disease and injury in Queensland’s Aboriginal and Torres Strait Islander people, 2014. The State of Queensland (Queensland Health) (2014).
35. Sagayadevan, V. et al. Quality of Life across Mental Disorders in Psychiatric Outpatients. Ann. Acad. Med. Singap. 47, 243–252 (2018).
36. Priebe, S. et al. Factors influencing subjective quality of life in patients with schizophrenia and other mental disorders: a pooled analysis. Schizophr. Res. 121, 251–258 (2010).
37. Sun, S. et al. Population health status in China: EQ-5D results, by age, sex and socio-economic status, from the National Health Services Survey 2008. Qual. Life Res. 20, 309–320 (2011).
38. Kind, P., Dolan, P., Gudex, C. & Williams, A. Variations in population health status: results from a United Kingdom national questionnaire survey. BMJ 316, 736–741 (1998).
39. Bjorklund, A. & Eriksson, T. Unemployment and mental health: evidence from research in the Nordic countries. Int. J. Soc. Welf. 7, 219–235 (1998).
40. Knight, M. et al. Estimating health needs: the impact of a checklist of conditions and quality of life measurement on health information derived from community surveys. J. Public Health Med. 23, 179–186 (2001).
41. Ye, F. et al. Comparison of patient report and medical records of comorbidities: Results from a population-based cohort of patients with prostate cancer. JAMA Oncol. 3, 1035–1042 (2017).

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Author contributions
The study was conceived and designed by S.A.C., M.S., J.A.V., S.V., L.J. and D.H. The initial draft of the manuscript was written up by E.A. Data were gathered and analyzed by E.A., J.A.V., and S.S.; the accuracy of the interpretation of the results was assured by J.A.V., N.L., K.B.T., S.S. and M.S. E.A., S.A.C., J.A.V., S.S., S.V., N.L., K.B.T., L.J., D.H. and M.S. participated in the preparation of the manuscript and approved the final version of the manuscript.

Competing interests
The authors declare no competing interests.

Additional information
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