



# Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010

Harvey A Whiteford, Louisa Degenhardt, Jürgen Rehm, Amanda J Baxter, Alize J Ferrari, Holly E Erskine, Fiona J Charlson, Rosana E Norman, Abraham D Flaxman, Nicole Johns, Roy Burstein, Christopher J L Murray, Theo Vos

## Summary

**Background** We used data from the Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) to estimate the burden of disease attributable to mental and substance use disorders in terms of disability-adjusted life years (DALYs), years of life lost to premature mortality (YLLs), and years lived with disability (YLDs).

**Methods** For each of the 20 mental and substance use disorders included in GBD 2010, we systematically reviewed epidemiological data and used a Bayesian meta-regression tool, DisMod-MR, to model prevalence by age, sex, country, region, and year. We obtained disability weights from representative community surveys and an internet-based survey to calculate YLDs. We calculated premature mortality as YLLs from cause of death estimates for 1980–2010 for 20 age groups, both sexes, and 187 countries. We derived DALYs from the sum of YLDs and YLLs. We adjusted burden estimates for comorbidity and present them with 95% uncertainty intervals.

**Findings** In 2010, mental and substance use disorders accounted for 183·9 million DALYs (95% UI 153·5 million–216·7 million), or 7·4% (6·2–8·6) of all DALYs worldwide. Such disorders accounted for 8·6 million YLLs (6·5 million–12·1 million; 0·5% [0·4–0·7] of all YLLs) and 175·3 million YLDs (144·5 million–207·8 million; 22·9% [18·6–27·2] of all YLDs). Mental and substance use disorders were the leading cause of YLDs worldwide. Depressive disorders accounted for 40·5% (31·7–49·2) of DALYs caused by mental and substance use disorders, with anxiety disorders accounting for 14·6% (11·2–18·4), illicit drug use disorders for 10·9% (8·9–13·2), alcohol use disorders for 9·6% (7·7–11·8), schizophrenia for 7·4% (5·0–9·8), bipolar disorder for 7·0% (4·4–10·3), pervasive developmental disorders for 4·2% (3·2–5·3), childhood behavioural disorders for 3·4% (2·2–4·7), and eating disorders for 1·2% (0·9–1·5). DALYs varied by age and sex, with the highest proportion of total DALYs occurring in people aged 10–29 years. The burden of mental and substance use disorders increased by 37·6% between 1990 and 2010, which for most disorders was driven by population growth and ageing.

**Interpretation** Despite the apparently small contribution of YLLs—with deaths in people with mental disorders coded to the physical cause of death and suicide coded to the category of injuries under self-harm—our findings show the striking and growing challenge that these disorders pose for health systems in developed and developing regions. In view of the magnitude of their contribution, improvement in population health is only possible if countries make the prevention and treatment of mental and substance use disorders a public health priority.

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## Introduction

Historically, mental and substance use disorders were not a global health priority, especially when compared with communicable diseases and non-communicable diseases such as cancer or cardiovascular disease. Services for mental and substance use disorders have typically been neglected, and in many countries were segregated from mainstream health care with resourcing not commensurate with the burden.<sup>1,2</sup> Since the 1993 World Development Report<sup>3</sup> by the World Bank, global attention has been focused on the relative burden associated with disease morbidity, rather than mortality alone. The move to incorporate the effects of disease

morbidity has been key in emphasising the importance of mental and substance use disorders. An international effort to improve the mental health of populations around the world is now underway.<sup>4</sup>

The first Global Burden of Disease study in 1990 (GBD 1990), showed that neuropsychiatric disorders—a grouping that included neurological disorders and dementia as well as mental and substance use disorders—accounted for more than a quarter of all non-fatal burden, measured in years lived with disability (YLD).<sup>5</sup> Five of the top ten causes of disability were included in the neuropsychiatric disorder category. Depression was the most disabling disorder worldwide measured in YLDs, and the fourth

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School of Population Health (Prof H A Whiteford MD, A J Baxter MPH, A J Ferrari BPsySc, H E Erskine BPsySc, F J Charlson MPH, R E Norman PhD) and Queensland Children's Medical Research Institute (R E Norman), University of Queensland, Herston, QLD, Australia; Queensland Centre for Mental Health Research, Wacol, QLD, Australia (H A Whiteford, A J Baxter, A J Ferrari, H E Erskine, F J Charlson); University of New South Wales, National Drug and Alcohol Research Centre, Sydney, NSW, Australia (Prof L Degenhardt PhD); University of Melbourne, Melbourne School of Population and Global Health, Centre for Health Policy, Programs and Economics, Melbourne, VIC, Australia (L Degenhardt); Social and Epidemiological Research Department, Centre for Addiction and Mental Health, Toronto, Canada (Prof J Rehm PhD); Epidemiological Research Unit, Klinische Psychologie & Psychotherapie, Technische Universität Dresden, Dresden, Germany (J Rehm); and University of Washington, Institute for Health Metrics and Evaluation, Seattle, Washington, USA (A D Flaxman PhD, N Johns BA, R Burstein BA, Prof C J L Murray MD, Prof T Vos PhD)

Correspondence to:  
 Prof Harvey A Whiteford,  
 Queensland Centre for Mental  
 Health Research, University of  
 Queensland, The Park Centre for  
 Mental Health, Wacol, QLD 4076,  
 Australia  
[h.whiteford@uq.edu.au](mailto:h.whiteford@uq.edu.au)

leading cause of overall disease burden measured in disability-adjusted life years (DALYs), which combines premature mortality as years of life lost (YLLs) and disability as YLDs.<sup>6</sup> Estimates for selected disorders were revised in the early 2000s with updated epidemiological evidence and, for some disorders, modified health states and disability weights.<sup>7,8</sup> These selected disorders were mood disorders (depression and bipolar disorder), anxiety disorders (panic disorder, obsessive-compulsive disorder, and post-traumatic stress disorder), and schizophrenia.<sup>9</sup> Drug use disorders were shown as a combined estimate including harmful use and dependence of opioids and cocaine. A single estimate was also given for alcohol use disorders which encompassed alcohol-induced psychoses, alcohol dependence, and alcohol abuse.<sup>5</sup> A notable limitation was the failure to capture some common disorders (eg, cannabis dependence, generalised anxiety disorder, eating disorders, and most childhood onset disorders).

In 2007, a new GBD study was launched<sup>10</sup> and high level results for the Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) were reported in December, 2012.<sup>11–17</sup> GBD 2010 was a comprehensive reanalysis of burden for 291 causes, 20 age groups, both sexes, and 187 countries in 21 world regions for 1990 and 2010. The definition of world regions was based on geographical proximity and epidemiological similarity in terms of child and adult mortality.<sup>11</sup> These regions were further grouped into seven super-regions (based on cause of death patterns) to permit imputation of data for regions where no information was available

The number of specific mental and substance use disorders was expanded in GBD 2010 to include 20 disorders, consisting of all anxiety disorders (compared with three in the original study), eating disorders (anorexia nervosa and bulimia nervosa), childhood behavioural disorders (attention-deficit/hyperactivity disorder and conduct disorder), pervasive developmental disorders (autism and Asperger's syndrome), and idiopathic intellectual disability, a residual category capturing intellectual disability not attributed to any of the other diseases and injuries. Existing disorder categories were also expanded; for example, bipolar disorder captured cyclothymic disorder in 2010 and unipolar depression was modelled as major depressive disorder and dysthymia. Substance use disorders were expanded to include burden for alcohol use disorders (alcohol dependence and fetal alcohol syndrome) and illicit drug use disorders (opioid dependence, cannabis dependence, cocaine dependence, and amphetamine dependence). Two residual categories capturing other mental and substance use disorders were also estimated. Harmful use or abuse of drugs and alcohol were not included in GBD 2010. The burden estimation techniques changed substantially in GBD 2010: notably, prevalent rather than incident based YLDs were estimated without age weighting and discounting.

Because of changes in methodology, estimates for the years 1990 and 2010 were re-calculated for GBD 2010 to allow meaningful comparisons in burden across time.

In this report, we aimed to summarise fatal, non-fatal, and total burden for eleven classes of mental and substance use disorders for 2010 with reference to changes in burden since 1990.

## Methods

### Definitions of mental and substance use disorders

To be included, specific mental and substance use disorders had to meet the threshold for a case according to criteria described in the Diagnostic and Statistical Manual of Mental Disorders (DSM)<sup>18</sup> or the International Classification of Diseases (ICD).<sup>19</sup> To obtain the most comprehensive dataset possible, we included all clinically relevant case definitions that would map to DSM or ICD diagnostic criteria. We tested for differential case-finding properties of different diagnostic criteria in a meta-regression and reported no significant differences between either DSM or ICD classificatory systems, or between versions within the same system. This finding might show a lack of true difference between the diagnostic criteria used or that we had insufficient data to detect a significant effect. To capture variability within a diagnostic category, we apportioned prevalent cases in some disorders into disorder-specific health states that showed different levels of disability, for example mild, moderate, or severe cases.<sup>14,20</sup> Although 20 mental and substance use disorders were included in GBD 2010, some major disorders (eg, personality disorders) were not specifically shown because of insufficient epidemiological data to generate defensible global estimates. When only sparse data were available, we estimated attributable burden within residual categories of other mental and behavioural disorders or other drug disorders. Appendix p 2 contains more detail about the mental and substance use disorders in GBD 2010.

### YLDs

#### *Systematic reviews for empirical data*

We conducted systematic reviews in line with PRISMA guidelines<sup>21</sup> for every specific disorder to identify studies that provided epidemiological data. We used a three-stage search strategy involving electronic database searches of Medline, Embase, and, PsycINFO, and searches for unpublished data and consultation with experts. We contacted study authors for further estimates or clarification of methods. We included community representative studies that used diagnostic techniques that could be mapped to DSM or ICD criteria (appendix p 3). We restricted the electronic search to reports published in any language between Jan 1, 1980, and Dec 31, 2008, but periodic assessment of the literature and consultation with experts in the specialty captured additional studies up to 2011. We extracted estimates of prevalence, incidence, remission and duration, and excess all-cause mortality together with details on study methods. Detailed infor-

For region definitions see [http://www.healthmetricsandevaluation.org/sites/default/files/publication\\_summary/GBD2010\\_Regions\\_countries.pdf](http://www.healthmetricsandevaluation.org/sites/default/files/publication_summary/GBD2010_Regions_countries.pdf)

See Online for appendix

mation about the reviews for specific disorders has been published elsewhere.<sup>22–35</sup>

Appendix pp 4–28 summarises the number of studies and estimates reported for every parameter within each disorder group and region. For mental disorders, data were available for 85 countries in 19 world regions. The greatest proportion of prevalence data was for anxiety and depressive disorders, whereas fewer studies related to low prevalence disorders (such as schizophrenia, bipolar disorder, and eating disorders). Disorders with onset in childhood (childhood behavioural disorders and pervasive developmental disorders) were under-represented. For illicit drug use disorders, we identified studies for populations in 98 countries in 18 GBD regions. For alcohol dependence and fetal alcohol syndrome, we identified 58 studies from 17 GBD regions. For most disorders, we identified only sparse data for sub-Saharan Africa, parts of Asia, and central and eastern Europe. In most regions, data were available for prevalence, but for other parameters (incidence, remission and duration, and mortality) studies were largely restricted to populations from western Europe, North America, and Australasia.<sup>27,35,36</sup>

#### *Disease modelling*

Our eligibility criteria for exclusion did not account for all sources of between-study variability and data were unequally distributed between specific disorders, age groups, regions, and epidemiological parameters. These limitations were addressed and adjusted for wherever possible by use of DisMod-MR, a Bayesian meta-regression tool that makes use of the generic association between incidence, prevalence, remission, and mortality parameters to derive a consistent epidemiological assessment for a given disorder.<sup>16,37</sup> We calculated a generalised negative binomial model for all epidemiological data using two sets of covariates (the first of which estimates variability in the distribution of a given disorder due to ecological variables such as conflict or economic status and the second of which aims to minimise artificial variability due to measurement bias) as well as super-region, region, and country random effects (appendix pp 29–30). Uncertainty around the epidemiological input data was propagated to the final output that (for the purposes of calculation of prevalence-based YLDs) were point prevalence estimates stratified by age and sex for countries and regions in 1990 and 2010.<sup>16,37</sup> Appendix p 31 summarises the total number of prevalent cases estimated for each disorder.

#### *Disability weights*

We derived new disability weights for GBD 2010.<sup>14</sup> To establish these disability weights, surveys were administered via face-to-face interviews (in Bangladesh, Indonesia, Peru, and Tanzania), telephone interviews (USA) and online (an open-access web-based survey).<sup>14</sup> More than 30 000 participants provided responses to

random pair-wise comparison questions, in which participants were asked to nominate the disorder phrase they deemed healthier than the comparator. Responses were converted into discrete values and anchored between 0 (perfect health) and 1 (death). In the online survey, additional information was elicited on population health equivalence for a small number of health states to help anchor results on the 0–1 scale. For some disorders, we estimated disability weights for several health states to capture the difference in severity of symptoms associated with the disorder (appendix p 32). We aggregated the health state specific disability weights into an overall disability weight taking into account the proportion of cases in every health state.

#### *Severity distributions*

We obtained information about the severity of schizophrenia, bipolar disorder, and childhood behavioural disorders from existing studies reporting the proportion of cases in each disorder-specific health state.<sup>20,38</sup> Because this information was not available for the other disorders, we used three national surveys: the US Medical Expenditure Panel Survey (MEPS) 2000–09,<sup>39</sup> the US National Epidemiological Survey on Alcohol and Related Conditions 2000–01 and 2004–05,<sup>40</sup> and the Australian National Survey of Mental Health and Wellbeing of Adults, 1997,<sup>41</sup> with diagnostic information about various mental and physical disorders and 12-item short-form (SF-12) summary scores. Data from these surveys allowed us to derive severity distributions for every disorder while adjusting for any comorbid conditions and also those with a diagnosis but no disability at the time of measurement of health status. We developed a mathematical relationship between GBD 2010 disability weights and the SF-12 summary scores using data from a small study on a convenience sample of 60 respondents who were asked to complete the SF-12 for 62 lay descriptions of diverse severity that had been used in the GBD 2010 disability surveys. We mapped the scores for each individual survey respondent into a corresponding GBD 2010 disability weight and did a regression on these disability weights along with dummies for all comorbid disorders to parse out the amount of disability for each individual health state. For disorders with one disability weight, we classified disability into categories of no disability and individuals with disability. For disorders with several disability weights, we allocated disability to every health state as well as a category of no disability on the basis of the midpoint values between the disability weights for every successive health state.

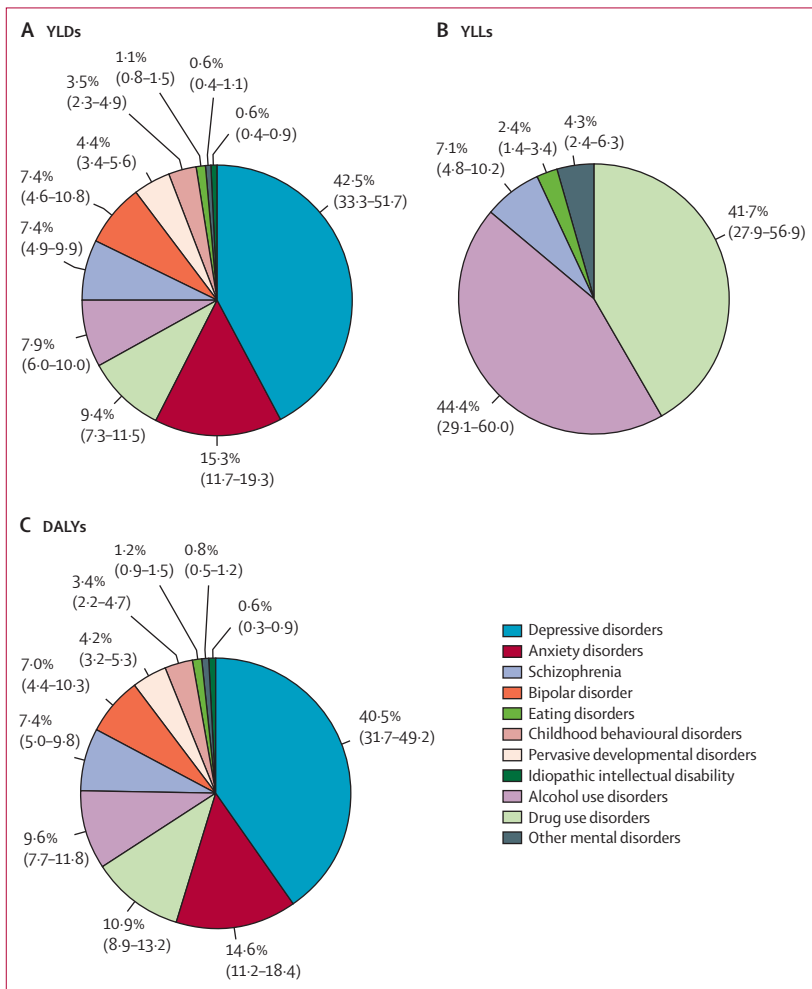
#### *Comorbidity*

In GBD 2010, adjustments were made for independent comorbidity by treating the prevalence estimates for all 1120 sequelae as independent probabilities and through microsimulation methods creating hypothetical populations for each age group, by sex, year, and country. The

	Proportion of total DALYs (95% UI)	Proportion of total YLDs (95% UI)	Proportion of total YLLs (95% UI)
Cardiovascular and circulatory diseases	11.9% (11.0–12.6)	2.8% (2.4–3.4)	15.9% (15.0–16.8)
Diarrhoea, lower respiratory infections, meningitis, and other common infectious diseases	11.4% (10.3–12.7)	2.6% (2.0–3.2)	15.4% (14.0–17.1)
Neonatal disorders	8.1% (7.3–9.0)	1.2% (1.0–1.5)	11.2% (10.2–12.4)
Cancer	7.6% (7.0–8.2)	0.6% (0.5–0.7)	10.7% (10.0–11.4)
Mental and substance use disorders	7.4% (6.2–8.6)	22.9% (18.6–27.2)	0.5% (0.4–0.7)
Musculoskeletal disorders	6.8% (5.4–8.2)	21.3% (17.7–24.9)	0.2% (0.2–0.3)
HIV/AIDS and tuberculosis	5.3% (4.8–5.7)	1.4% (1.0–1.9)	7.0% (6.4–7.5)
Other non-communicable diseases	5.1% (4.1–6.6)	11.1% (8.2–15.2)	2.4% (2.0–2.8)
Diabetes, urogenital, blood, and endocrine diseases	4.9% (4.4–5.5)	7.3% (6.1–8.7)	3.8% (3.4–4.3)
Unintentional injuries other than transport injuries	4.8% (4.4–5.3)	3.4% (2.5–4.4)	5.5% (4.9–5.9)

DALYs=disability-adjusted life-years. YLDs=years lived with disability. YLLs=years of life lost.

**Table: Proportion of YLDs, YLLs, and DALYs explained by the ten leading causes of total burden in 2010**



**Figure 1: Proportion of YLDs (A), YLLs (B), and DALYs (C) explained by each mental and substance use disorder group in 2010**  
 Data are % (95% UI). DALYs=disability-adjusted life-years. YLDs=years lived with disability. YLLs=years of life lost.

microsimulation exposed simulated individuals in each age, sex, time and country category to no, one, and two or more sequelae concurrently. For individuals with two or more sequelae, we applied a multiplicative function to the disability weights and scaled the weights for every health state down accordingly. The average reduction in disability weight for any given sequelae in each age, sex, time and country category was used as a downward comorbidity adjustment of YLDs. We noted in the MEPS dataset in the USA that, after correction for independent comorbidity, inclusion of dependent comorbidity did not notably affect the results. In view of the enormous data requirements and computational complexity to take these dependent associations into account, we decided to adjust for independent comorbidity only.<sup>16</sup> This approach is supported by findings presented at the recent Global Health Metrics and Evaluation conference from the New Zealand burden of disease study that used linked health databases in which researchers concluded that after accounting for independent comorbidity, dependent comorbidity had little additional effect.<sup>42</sup>

**YLLs**

We computed premature mortality attributable to mental and substance use disorders as YLLs based on cause of death estimates from 1980 to 2010 for 20 age groups, both sexes, and 187 countries. Mortality was explicitly modelled for schizophrenia, alcohol use disorders, drug use disorders, anorexia nervosa, and the residual group of other mental and substance use disorder categories. Cause of death data available for the remaining disorders were insufficient to allow attributions to specific disorders. We developed the cause of death estimates from a comprehensive database of vital registration, verbal autopsy, surveillance, and other sources. Ultimately, we used 17258 country-years of data from 126 countries for the estimation of mental and substance use disorder mortality. We assessed the quality of each

observation, and mapped various revisions of ICD disorder classifications. We reassigned deaths with standardised algorithms when the recorded cause of death was not likely to be the underlying cause of death. Several mental and substance use disorders posed unique cause attribution challenges; the miscoding of alcohol poisonings as cardiovascular disease death has been studied in the former Soviet Union, for example, but the published work on this misattribution is too restrictive to generate a generalisable redistribution scheme.<sup>43</sup> Future iterations of the GBD will take into account additional surveys validating causes of death to improve capture of these and other miscoded deaths. Substance use deaths are also often mischaracterised as accidental poisonings. Deaths coded as accidental poisonings attributable to drugs that fall under the drug-use disorder category (including narcotics, hallucinogens, sedative-hypnotic, or psychotropic drugs) were recoded to be drug use disorder deaths (unless they occurred in children) and accidental poisonings by exposure to alcohol were recoded as alcohol use deaths. We used an ensemble modelling strategy for estimation of deaths, employing mixed effects linear models and spatio-temporal Gaussian process regression models weighted by out-of-sample predictive validity.<sup>13,17</sup> If data were sparse or missing, the models were informed by data sources close in geography or time, and by use of relevant country-level covariates. All mental and substance use disease models included a transformed measure of average income per head, education level, and an aggregate measure of health system access, which takes into account indicators such as hospital beds per head, in-facility deliveries, and vaccination coverage rates. Specific models used additional covariates; we informed drug use disorders, for example, both by indicators of use, such as opium production, and by risk factors of cardiovascular disease that would make death attributable to overdose more likely, such as blood pressure. To attribute drug use disorders to specific categories of use, we extracted the fraction attributable to each specific category from vital registration and verbal autopsy data, pooled by year, and region, and rescaled to sum to 1. We applied the resulting year-region specific fractions to the estimates of overall drug use mortality to derive estimates for opioid, cocaine, amphetamine, and other drug related deaths. We captured uncertainty in cause of death model predictions by use of standard simulation methods, taking 1000 draws for each age, sex, country, year, and cause. To create consistency between the sum of cause-specific mortality and all-cause mortality, the models of mental and substance use disorders and all other causes included in the GBD 2010 were rescaled according to the uncertainty around the cause-specific rate. We converted the resulting predicted numbers of deaths to the measure YLLs by multiplying deaths by the reference standard life expectancy at the age of death as derived from the GBD 2010 standard model life table.<sup>13</sup>

When we report comparisons of prevalence and DALYs, we used the direct standardisation method and the standard population proposed by WHO in 2001.<sup>44</sup>

## Results

Worldwide, mental and substance use disorders accounted for 183.9 million DALYs (95% UI 153.5 million–216.7 million), or 7.4% (6.2–8.6) of total disease burden in 2010 (table). Overall, mental and substance use disorders were the fifth leading disorder category of global DALYs (table).

Within the mental and substance use disorders group, depressive disorders accounted for most DALYs, followed by anxiety disorders, drug use disorders, and alcohol use disorders (figure 1). Eating disorders, childhood behavioural disorders, and pervasive developmental disorders (which were assessed for the first time in GBD 2010 estimates) contributed about 9% of DALYs accounted for by mental and substance use disorders.

Mental and substance use disorders were the leading global cause of all non-fatal burden of disease (YLDs). In 2010 they accounted for 175.3 million (95% UI 144.5 million–207.8 million) YLDs, or 22.9% (18.6–27.2) of all non-fatal burden (figure 1). Depressive disorders contributed most of the non-fatal burden of mental and substance use disorders followed up by anxiety disorders, drug use disorders, and schizophrenia (figure 1).

We attributed mortality to a mental or substance use disorder only when that disorder was regarded as the direct cause of death following the ICD-10 guidelines.<sup>19</sup> Most excess deaths in individuals with a mental disorder were coded to the direct physical cause of death

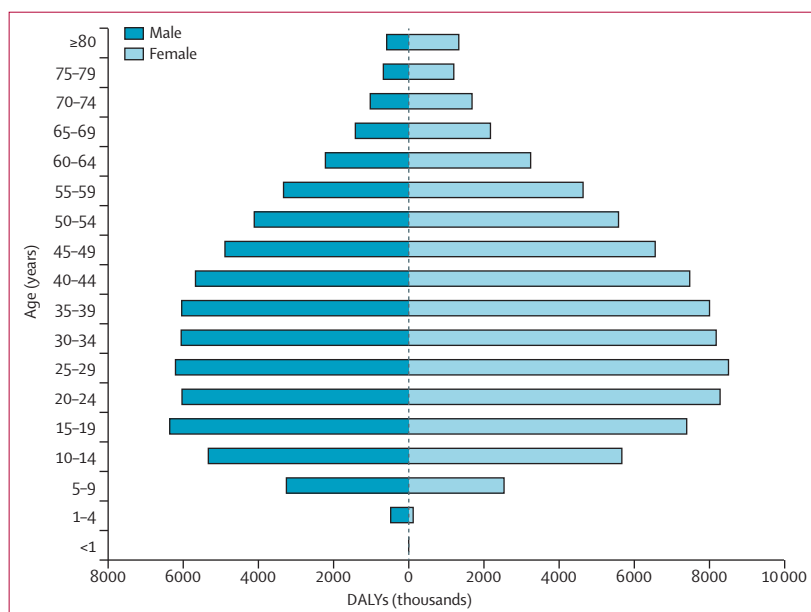


Figure 2: Disability-adjusted life years (DALYs) for all mental and substance use disorders in 2010, by age and sex

(eg, suicide deaths were coded under injuries as self-harm). In 2010 mental and substance use disorders were directly responsible for 8.6 million YLLs (95% UI 6.5 million–12.1 million), equivalent to 232 000 deaths. Almost all of these deaths were attributable to substance use disorders (81.1% [95% UI 74.8–87.3]). Appendix p 33 shows YLDs, YLLs, and DALYs attributable to mental and substance use disorders in 2010.

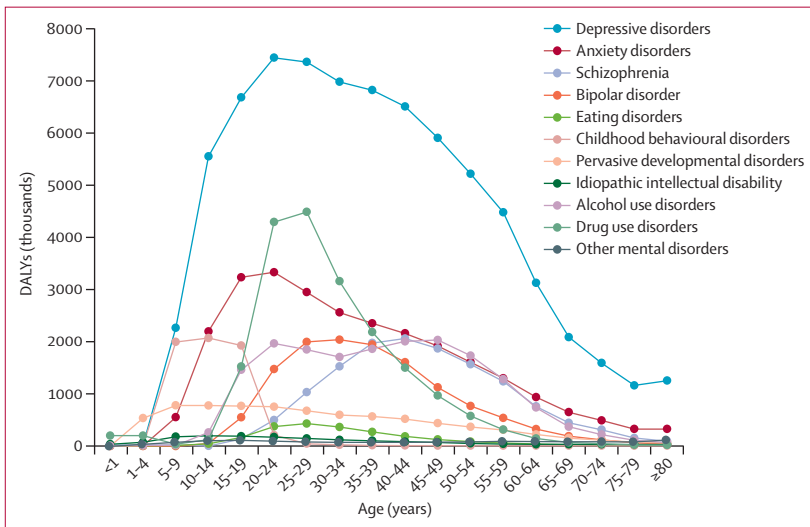


Figure 3: Disability-adjusted life years (DALYs) for each mental and substance use disorder in 2010, by age

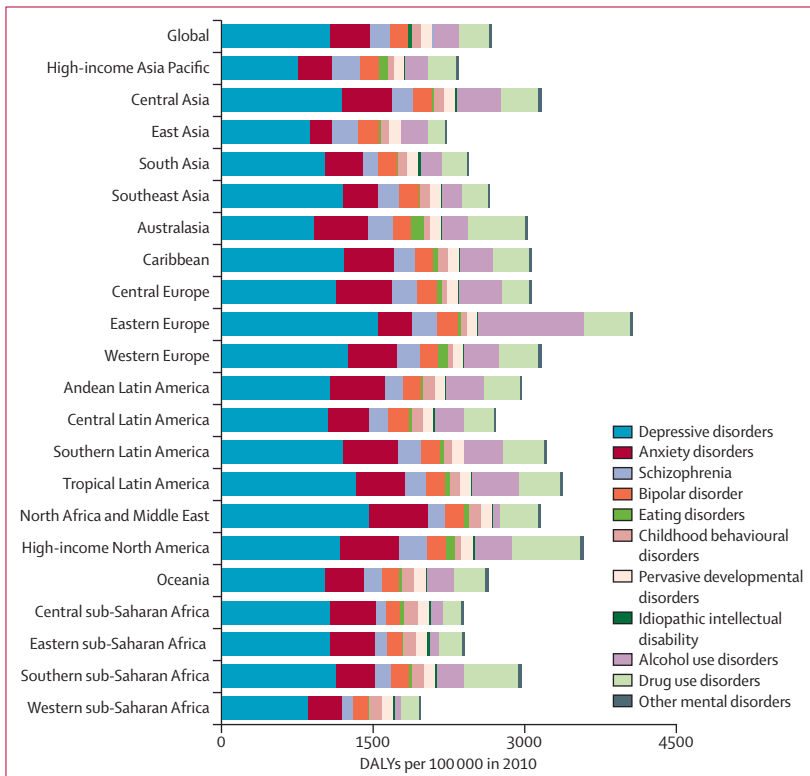


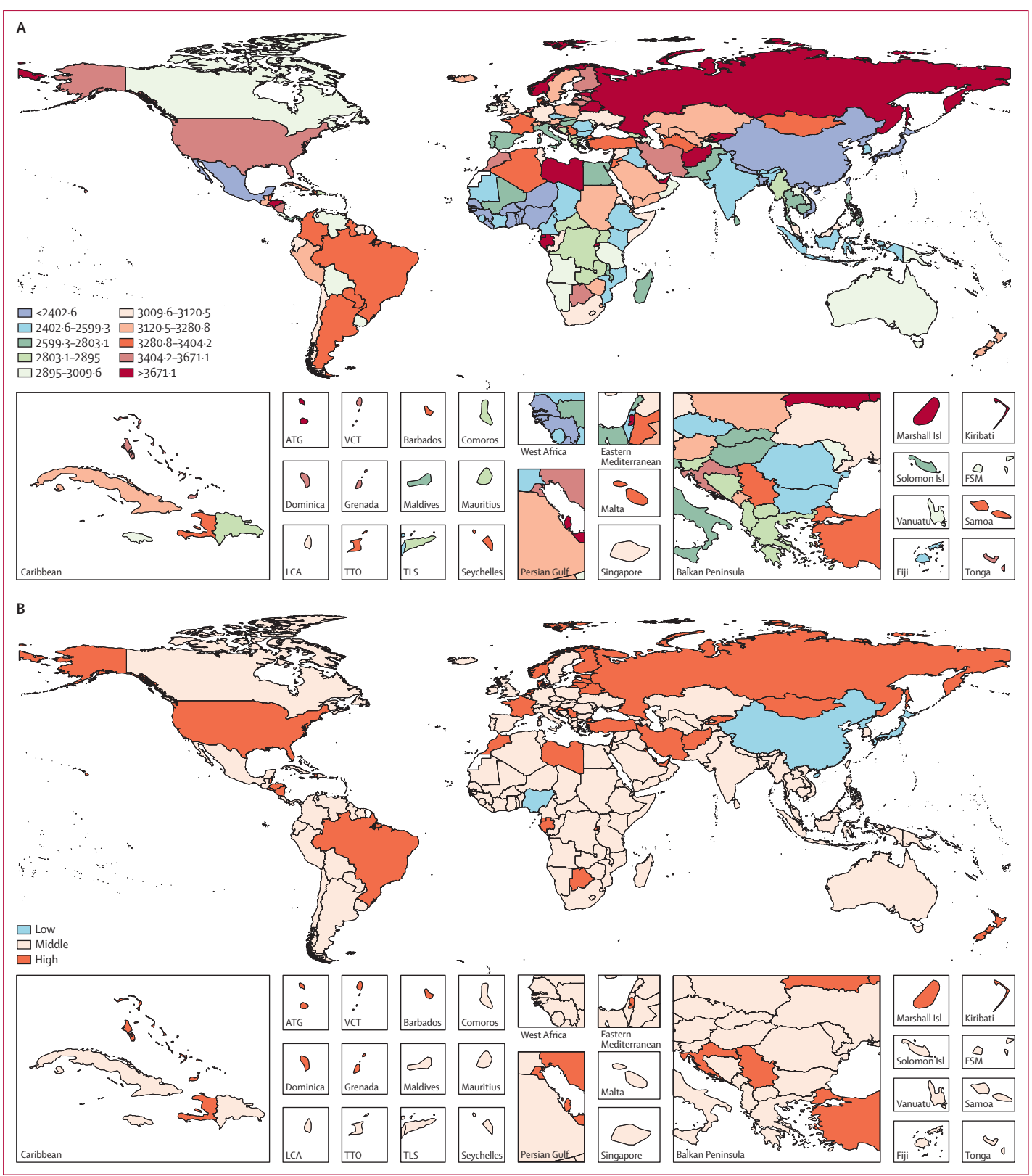
Figure 4: Rates of disability-adjusted life years (DALYs) per 100 000 individuals for mental and substance use disorders in 2010, by region

Mental and substance use disorders led to 91.0 million (95% UI 75.7 million–108.5 million) DALYs in male individuals, accounting for 49.5% (47.0–51.9) of the burden. Male individuals accounted for 84.6 million (69.0 million–101.5 million) YLDs (48.2% [45.7–50.5]) and 6.5 million (4.4 million–10.0 million) YLLs (75.1% [65.2–83.9]). Figure 2 shows that boys (aged <10 years) had a greater proportion of burden than did girls of equivalent age. This difference was especially apparent in the case of childhood behavioural disorders, for which the burden in boys was more than 2.5 times higher than it was for girls. From the 10–14 year age group onwards, girls and women had a greater burden from mental disorders than did boys and men. Men had a greater burden than women for substance use disorders in all age groups.

The burden of mental and substance use disorders spanned all age groups. The highest proportion of DALYs occurred in adolescents and young to middle-aged adults (aged 10–29 years; figure 3). The burden associated with common mental disorders (depressive disorders and anxiety disorders) rose abruptly in childhood (ages 1–10 years) and peaked in adolescence and early to middle age (ages 10–29 years). The burden associated with less common but chronic disorders, such as schizophrenia and bipolar disorder, rose more gradually into early adulthood, peaking between 25–50 years of age. The burden from drug use disorders was greatest among young adults (ages 15–29 years). For alcohol use disorders, the largest burden occurred at age 25–50 years, followed by a gradual decline.

Figure 4 shows the burden attributable to mental and substance use disorders as a proportion of all disease burden, globally and by region. Depressive disorder had the highest proportion of total burden across all regions. Eating disorders had the greatest regional variation; the proportion of DALYs attributable to eating disorders was more than 40 times higher in Australasia than it was in western sub-Saharan Africa. Alcohol use disorder DALYs varied more than ten-times between regions. By contrast, childhood behavioural disorders, and pervasive developmental disorders were stable in terms of their proportion of DALYs (less than four-times variation between regions).

Although substantial variability existed in age standardised DALY rates between countries, most differences did not differ significantly from the global mean (figure 5). Countries with significantly increased mental and substance use disorder DALY rates compared with the global mean were dispersed across various developed and developing regions. Only China, North Korea, Japan, and Nigeria produced DALYs that were statistically lower than the global mean. The effect of conflict can be clearly noted in countries such as Afghanistan, which is consistent with findings from disease modelling of anxiety and depressive disorders in which conflict status has a significant effect on prevalence of disease.<sup>22,45</sup> The absence of raw data available for many countries means that



**Figure 5: DALY rates per 100 000 individuals for mental and substance use disorders in 2010**  
(A) Age-standardised DALY rates per 100 000 individuals. (B) Age-standardised DALY rates compared with the global mean. DALYs=disability-adjusted life years. Low=significantly lower than the global mean. Middle=not significantly different from the global mean. High=higher than the global mean. ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. Isl=Islands. FSM=Federated States of Micronesia. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste.

country and regional differences are made up of both true differences in burden and differences arising from uncertainty in the estimates because of a scarcity of data.

The GBD 2010 results for 1990 and 2010 show the total burden of mental and substance use disorders increased by 37.6%, from 133.6 million (95% UI 111.5 million–158.0 million) DALYs in 1990 to 183.9 million (153.5 million–216.7 million) in 2010. Moreover, the burden of mental and substance use disorders as a proportion of all-cause DALYs increased from 5.4% (4.5–6.2) in 1990 to 7.4% (6.2–8.6%) in 2010. Drawing on methods presented in the GBD 2010 capstone papers,<sup>11,16</sup> we disaggregated this increase into changes in burden from demography and disease epidemiology and found that this change was largely due to population growth and changing age structure (appendix p 34). Investigation of time differences in burden at this aggregated level (ie, mental and substance use disorders combined) masked some disorder-specific differences across time. The prevalence of alcohol, opioid, and cocaine dependence increased notably between 1990 and 2010, whereas the prevalence of most mental disorders did not.<sup>46</sup>

## Discussion

Mental and substance use disorders are notable contributors to the global burden of disease, directly accounting for about 7.4% of disease burden worldwide (panel). These disorders were responsible for more of the global burden than were HIV/AIDS and tuberculosis, diabetes, or transport injuries. GBD 2010 provides a comprehensive picture of burden compared with previous estimates in view of the wide range of disorders included, improved definitions, data, and methods used. The inclusion of childhood disorders was especially important in regions such as Africa, where up to 40% of the population are children.<sup>47</sup>

Although the burden of mental and substance use disorders increased by 37.6% between 1990 and 2010, for mental disorders this change was almost entirely attributable to population growth and ageing. Little change in the absolute number of DALYs was attributable to increases in the prevalence of mental disorders. Our inclusion criteria for epidemiological data imposed a minimum quality on the data, ensuring that prevalence was based on community-representative samples rather than clinical samples. The modelling strategy also allowed us to adjust for differing diagnostic criteria and screening techniques in population surveys. Our conclusions have substantial implications for setting of public health agendas, for which the rise in life expectancy will result in more people living with mental and substance use disorders for a longer period of time. However, we noted striking variation in these time trends for specific disorders. For example, not much evidence existed to suggest an increase in the prevalence of mental disorders over time,<sup>48</sup> whereas the increased burden of alcohol, opioid, and cocaine dependence between 1990 and 2010

was largely driven by an increasing prevalence of these disorders and less so by demographic transitions.<sup>46</sup>

Some disorders do not feature prominently in the YLD ranking because of their low prevalence but are very disabling for the individual. For example, acute schizophrenia had the highest disability weight of all disorders in GBD 2010 (0.756), but did not rank highly in terms of YLDs because of its low prevalence compared with anxiety, depressive, and substance use disorders.

GBD 2010 made striking improvements to the burden estimation compared with previous studies.<sup>9,49</sup> Rather than reliance on selected epidemiological datapoints to calculate YLDs, we systematically reviewed the literature to capture all available data. We quantified disability for a large number of disorder-specific health states from community-representative data rather than expert-based data.<sup>14</sup> We used an updated strategy for disease modelling to propagate uncertainty to final burden estimates, which were also adjusted for comorbidity with other diseases. Some of the changes in methodology had a large effect on the estimates from mental and substance use disorders. GBD 2010 results are reported without discounting and age-weighting, which had been applied to the GBD estimates made in 1990 and 2000. Age-weighting assigns maximum value to young and middle-aged adults, for whom prevalence of mental and substance use disorders is highest. Had age-weighting and discounting not been used in the GBD 1990, DALY estimates for these disorders would have been more than a third lower than they were.<sup>50</sup>

Our burden estimates emphasise the notable challenge mental and substance use disorders pose to health systems in developed and developing regions. A study<sup>51</sup> undertaken for the World Economic Forum estimated that the cumulative global effect of mental disorders in terms of lost economic output could amount to US \$16 trillion in the next 20 years, equivalent to 25% of global GDP in 2010. Despite the personal and economic costs, treatment rates for people with mental and substance use disorders are low,<sup>52,53</sup> with treatment gaps of more than 90% in developing countries. Even in developed countries, treatment is typically provided many years after the disorder begins.<sup>54,55</sup> Three main reasons for this are the scarcity of available human and financial resources, inequities in their distribution, and inefficiencies in their use.<sup>56</sup> In all countries, stigma about mental and substance use disorders constrain the use of available resources as do inefficiencies in the distribution of funding and interventions.<sup>56</sup> The combination of stigma and the very large treatment gaps contributes to social exclusion and breaches of basic human rights of individuals with mental disorders.<sup>57</sup>

Problems associated with the burden of mental and substance use disorders are especially severe in many developing countries, which spend less than 2% of their health budgets on mental health.<sup>58</sup> However, knowledge about how to respond to the challenge posed by the GBD



2010 findings exists. Treatment and prevention packages for developing countries have been developed.<sup>59–62</sup> A fully scaled-up package of mental health care in sub-Saharan Africa and south Asia, based on a comparative cost-effectiveness analysis of 44 individual or combined interventions, was estimated to cost \$3–4 per person.<sup>63</sup> Primary care interventions for depression, modelled for 14 subregions of the world, could reduce the present burden of depression between 10% and 30%.<sup>64</sup> Nevertheless, numerous challenges to implementation exist, especially in developing countries. The commitment of governments and international agencies to provide adequate funding, especially to increase the capacity in human resources,<sup>65</sup> so that proven treatment and prevention packages can be implemented is crucial. Research is needed to identify the most effective ways to deliver sustainable mental health services.<sup>66</sup> Furthermore, because mental and substance use disorders have substantial comorbidity with other diseases that are also increasing in burden (eg, cardiovascular disease and diabetes<sup>67,68</sup>), screening and interventions for mental and substance use disorders will need to be included in all aspects of the health-care system.<sup>69</sup> However, even with optimum treatment and population coverage, much of the burden of mental and substance use disorders is not avertable at present,<sup>70</sup> emphasising the need for more research so we can better understand causes of the burden and develop better treatments.

Our study had some limitations. The ICD categories of harmful use of alcohol and illicit drugs (defined in DSM as abuse) were not included in GBD 2010, which led to an underestimation of burden for substance use disorders, particularly for alcohol because of the more common diagnosis of harmful alcohol use.<sup>71</sup> Further updating of the GBD 2010 estimates will need to take this discrepancy into consideration, along with the ongoing debate around the validity of these diagnostic categories and changes in DSM-5, which defines substance use disorder with three levels of severity and no longer distinguishes between abuse and dependence.

If epidemiological data were not available for a country or region, the GBD protocol was for an estimate (using DisMod-MR) to be generated on the basis of data available from surrounding countries in that region or, if no data were available for the entire region, from surrounding regions. In the absence of high quality data, imputation was the only way to include all countries and regions in GBD's global health applications. Most GBD 2010 estimates have been presented at the regional and global level.<sup>11–17</sup> Limitations in data availability need to be taken into account when interpretations are made about specific countries; however, this accounting is partly captured in the estimates of uncertainty. The burden estimates we present show the state of the published work into mental and substance use at the time of our data collection, which ended in 2011. The ongoing updating of GBD 2010 aims to increase the amount of epidemiological data

### Panel: Research in context

#### Systematic review

The Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) provides new estimates of years of life lost to premature mortality, years lived with disability, and disability-adjusted life years. It builds on methods and findings from the Global Burden of Disease Study 1990 and the subsequent WHO global burden of disease updates. GBD 2010 is the most comprehensive assessment of the burden for mental and substance use disorders, incorporating an expanded number of disorders as well as improved definitions, data collection and methodology.

#### Interpretation

Mental and substance use disorders are major contributors to the global burden of disease and their contribution is rising, especially in developing countries. Cost-effective interventions are available for most disorders but adequate financial and human resources are needed to deliver these interventions. Mental health policy and services research is necessary to identify more effective ways to provide sustainable mental health services, especially in resource constrained environments, if the burden of mental and substance use disorders is to be reduced.

acquired from new surveys and promote data collection, allowing more definitive conclusions to be made about global differences in the burden of mental and substance use disorders than are possible at present.

Within GBD, disability intentionally aims to reflect any short-term or long-term health loss and does not attempt to capture welfare loss. Thus, it does not show effects on families or social and economic consequences of mental and substance use disorders. In GBD 1990, disability weights were derived from the views of health professionals on the basis that they would have knowledge of a diverse set of health states, and would be able to make comparative judgments.<sup>9</sup> In GBD 2010, new disability weights were derived from surveys of the general population attempting to capture a societal view of the health loss associated with a disorder.<sup>14</sup> Capturing the complexity of health states that describe mental and substance use disorders in lay descriptions (used for the disability weight survey) was difficult. The extent to which the loss of health attributable to these disorders was communicated in these descriptions and understood by respondents was one source of imprecision.

Because an outcome could only be counted once in the GBD cause list, deaths that were causally linked to mental and substance use disorders were largely captured under other causes. Mental disorders are rarely listed as the primary cause of death in vital registrations. Moreover, when several factors contribute to a death, understanding the different contributions of those factors is difficult. An alternative approach is to quantify the proportion of death attributable to mental and substance use disorders as risk factors for other health outcomes from comparative risk assessment methods. With as many as 80% of suicide deaths attributable to mental and substance use disorders,<sup>72–74</sup> we expect that quantification of the additional burden due to mental and substance use disorders as risk factors for suicide and other outcomes such as blood borne

viruses and ischaemic heart disease will attribute to them a substantial additional proportion of fatal burden.<sup>46,75</sup>

Individuals in some cultures interpret and express symptoms of mental disorders differently from the descriptions used in DSM/ICD diagnostic criteria. For instance, prevalence surveys show that major depressive disorder can be misdiagnosed as depression not otherwise specified in China.<sup>76</sup> Somatic manifestations of mental disorders that are attributed by the individual to physical illness is also evident in non-European or non-American cultures.<sup>77</sup> To help respond to this challenge, somatoform disorders have been identified as a group of disorders that need to be included in future iterations of GBD. DSM and ICD diagnostic criteria might not be sensitive to all crosscultural presentations of mental and substance use disorders and this discrepancy might have biased the burden of mental and substance use disorders in GBD 2010.

Global disease burden has continued to shift from communicable to non-communicable diseases and from premature death to YLDs.<sup>11</sup> Mental and substance use disorders make up a substantial component of this changing global picture. Our estimates need to be regularly updated, and do not represent the complete burden picture. Although GBD 2010 is a major advance compared with previous burden estimates, future research will allow the refinement of the estimates with increasing precision.

#### Contributors

HAW, LD, AJB, AJF, HEE, FJC, and REN worked with the members of the Global Burden of Diseases (GBD) core group (ADF, CJLM, and TV) to undertake the systematic reviews, the epidemiological modelling, and prepare the burden estimates for mental and drug use disorders. JR did the equivalent for alcohol use disorders. RB provided the analyses on severity distributions and NJ analysed mortality data for alcohol and drug use disorders and schizophrenia. HAW prepared the first draft of the paper with assistance from AJB, AJF, HEE, and FJC. All other authors contributed to subsequent drafts and approved the final report.

#### Conflicts of interest

HAW, AJB, AJF, HEE, and FJC are affiliated with the Queensland Centre for Mental Health Research, which receives its core funding from the Queensland Department of Health and is also supported by the National Health and Medical Research Council of Australia. LD is supported by an Australian National Health and Medical Research Council Principal Research Fellowship. The National Drug and Alcohol Research Centre at the University of New South Wales is supported by funding from the Australian Government under the Substance Misuse Prevention and Service Improvements Grants Fund. REN, ADF, NJ, RB, CJLM, and TV received funding for their work on the Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) from the Bill & Melinda Gates Foundation. JR is associated with the University of Toronto, Canada and the Centre for Addiction and Mental Health at Technische Universität, Dresden, Germany and received part of his salary and infrastructure from the Ontario Ministry of Health and Long Term Care. He also received funding from Contract number HHSN267200700041C of the US National Institute of Alcohol Abuse and Alcoholism, Bethesda, MD, USA.

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