



Disease burden and government spending on mental, neurological, and substance use disorders, and self-harm: cross-sectional, ecological study of health system response in the Americas

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Summary

Background Disorders affecting mental health are highly prevalent, can be disabling, and are associated with substantial premature mortality. Yet national health system responses are frequently under-resourced, inefficient, and ineffective, leading to an imbalance between disease burden and health expenditures. We estimated the disease burden in the Americas caused by disorders affecting mental health. This measure was adjusted to include mental, neurological, and behavioural disorders that are frequently not included in estimates of mental health burden. We propose a framework for assessing the imbalance between disease burden and health expenditures.

Methods In this cross-sectional, ecological study, we extracted disaggregated disease burden data from the Global Health Data Exchange to produce country-level estimates for the proportion of total disease burden attributable to mental disorders, neurological disorders, substance use disorders, and self-harm (MNSS) in the Americas. We collated data from the WHO Assessment Instrument for Mental Health Systems and the WHO Mental Health Atlas on country-level mental health spending as a proportion of total government health expenditures, and of psychiatric hospital spending as a proportion of mental health expenditures. We used a metric capturing the imbalance between disease burden and mental health expenditures, and modelled the association between this imbalance and real (ie, adjusted for purchasing power parity) gross domestic product (GDP).

Findings Data were collected from July 1, 2016, to March 1, 2017. MNSS comprised 19% of total disability-adjusted life-years in the Americas in 2015. Median spending on mental health was 2.4% (IQR 1.3–4.1) of government health spending, and median allocation to psychiatric hospitals was 80% (52–92). This spending represented an imbalance in the ratio between disease burden and efficiently allocated spending, ranging from 3:1 in Canada and the USA to 435:1 in Haiti, with a median of 32:1 (12–170). Mental health expenditure as a proportion of government health spending was positively associated with real GDP ($\beta=0.68$ [95% CI 0.24–1.13], $p=0.0036$), while the proportion allocated to psychiatric hospitals ($\beta=-0.5$ [–0.79 to –0.22], $p=0.0012$) and the imbalance in efficiently allocated spending ($\beta=-1.38$ [–1.97 to –0.78], $p=0.0001$) were both inversely associated with real GDP. All estimated coefficients were significantly different from zero at the 0.005 level.

Interpretation A striking imbalance exists between government spending on mental health and the related disease burden in the Americas, which disproportionately affects low-income countries and is likely to result in undertreatment, increased avoidable disability and mortality, decreased national economic output, and increased household-level health spending.

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Introduction

An epidemiological transition has largely shifted the global burden of disease from communicable, maternal, childhood, and nutritional disorders to non-communicable diseases (NCDs).^{1,2} Mental health disorders represent a particularly complex challenge given their high prevalence and disability burden, estimated as the highest among NCDs.^{3–6} Yet, pervasive stigma, outdated practices, and organisational fragmentation still result in woefully inadequate responses by health systems to mental illness.^{7,8} Further, traditional approaches to measuring the

disease burden of mental health problems have led to underestimates because of methodological constraints, including arbitrary separation between psychiatric and neurological disorders, consideration of self-harm as a category outside mental illness, conflation of painful somatisation disorders with musculoskeletal disorders, exclusion of personality disorders, and inadequate consideration of the contribution of mental illness to excess deaths.⁶

The aim of this study was to estimate the disease burden attributable to disorders affecting mental health

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Research in context

Evidence before this study

The WHO Mental Health Atlas project, launched in 2001, and the WHO Assessment Instrument for Mental Health Systems, introduced in 2007, collect mental health systems data for the Americas and other regions, including government expenditures on mental health and expenditures allocated to mental health hospitals. With respect to disease burden data, the Global Burden of Disease Study collaborators have published country-level annual estimates of years lived with disability, years of life lost, and disability-adjusted life-years starting in 1993. We searched PubMed and publicly available reports identified by the authors, and consulted with additional expert sources, for studies comparing country-level government spending on mental, substance use, and neurological disorders, and suicide (combined or separately) in the Americas, with the related disease burden, using the search terms "mental health", "mental disorders", "substance use disorders", "suicide", "neurological disorders", combined with "association", "correlation" "imbalance", OR "gap" and with "spending" OR "expenditures" AND "government" OR "public" AND "Americas" on July 1, 2016, for the past 10 years, without language or field restrictions. We identified a few publications addressing different partial aspects of this issue, but no comprehensive analysis of the issue as a whole.

Added value of this study

We collated all country-level spending data available from these sources, identified the most recent datapoint for each country, and reviewed the peer-reviewed and grey literature to fill gaps in the data. With respect to burden, we extracted the raw Global Burden of Disease Study data (published in 2016), and we re-estimated the aggregate disease burden of mental, neurological, substance use disorders, and self-harm for the Americas. We present metrics to assess the imbalance between disease burden and spending on mental health, factoring in allocative efficiency. We used a log-log regression model to correlate the imbalance in efficiently allocated spending with real gross domestic product (GDP) per capita, identifying a significant and large negative association.

Implications of all the available evidence

In the Americas, the share of government mental health expenditure and allocative efficiency of spending rises as country-level, real GDP per-capita increases, compounding the scarcity of general health expenditure that affects lower-income countries. Better allocation of mental health expenditures is a priority in lower-income countries, given the high human and economic costs of untreated mental illness, including disability affecting working-age populations, out-of-pocket health spending, and decreased economic output.

in the 35 countries in the WHO Region of the Americas, accounting for biases affecting previous estimates, and to analyse how expenditures in mental health services vary in relation to national economic output, as measured by real (ie, adjusted for purchasing power parity) gross domestic product (GDP) per capita.

Methods

Study design and data sources

In this cross-sectional, ecological study, we extracted 2015 data published in October, 2016, and accessed online on Jan 1, 2017, for the WHO Region of the Americas on years lived with disability (YLD) and disability-adjusted life-years (DALYs), including country-age-sex-specific numbers, from the Global Health Data Exchange.⁹ We then re-estimated the burden following the framework described by Vigo et al,⁶ in 2016, which partially rectifies current underestimates by aggregating the burden of mental, neurological, and substance use disorders, and self-harm (MNSS). We included specific neurological conditions, self-harm and suicide, and an estimation for somatic symptom disorder with prominent pain, as described elsewhere.⁶ For the included neurological disorders (Alzheimer's disease, epilepsy, tension-type headache, and migraine), we followed the approach of WHO, systematically adding specific neurological disorders to mental burden aggregations,^{10,11} the Disease Control Priorities Group,¹²

and some Global Burden of Disease Study (GBD) publications,^{13,14} among others. The resulting estimates have advantages and limitations that are highlighted in the discussion.^{2,5,6,9}

We obtained a set of spending and allocation estimates by collating the latest data available through the Pan American Health Organization and published in the Mental Health Atlas¹⁵ and the WHO Assessment Instrument for Mental Health Systems.¹⁶ When data were missing, we supplemented with additional available country-level data (resulting in a range of expenditure data from 2009 to 2015).¹⁷⁻²² For countries with unavailable data for either spending on mental health or on psychiatric hospitals, we imputed the median regional value. Four countries were missing both expenditure datapoints (Colombia, Cuba, Bahamas, and Grenada), and one country had no burden of disease data (St Kitts and Nevis). We treated them as missing at random and dropped them from the analysis. We also obtained 2015 real GDP per capita from the International Monetary Fund's World Economic Outlook Database.²³

Statistical analysis

Based on data for 30 countries we obtained *a*, proportion of total DALYs attributable to MNSS; *b*, proportion of total DALYs attributable to schizophrenia; *c*, proportion of DALYs attributable to schizophrenia corresponding to

acute schizophrenia in the GBD severity distribution; *d*, proportion of government health spending allocated to mental health services; and *e*, proportion of government mental health spending allocated to psychiatric hospitals.

We then created two metrics of imbalance in mental health expenditures (*f* and *g*):

$$f = \frac{a}{d}$$

$$g = (a - b \times c) / (d - d \times e)$$

Metric *f* is a ratio of the proportion of disease burden to the proportion of health spending. Metric *g* includes in the denominator the fraction of spending available for community-based services after subtracting the fraction allocated to psychiatric hospitals to measure efficiently allocated spending. Additionally, we subtracted the burden of disease that cannot be directly and fully treated in the community from the numerator. Subtracting the disease burden of patients currently treated in psychiatric hospitals would produce an overestimate because most of them could and should be treated in the community. We therefore subtracted the disease burden due to acute schizophrenia, which captures the fraction of the burden that arguably cannot be dealt with through community-based resources. The GBD framework includes a modelled distribution of health states by severity.²⁴ For schizophrenia, it estimates that 63% of cases correspond to acute schizophrenia, with a disability weight of 0.778 (ranging from 0 [representing health] to 1 [representing death]), and 37% of cases correspond to residual schizophrenia, carrying a disability weight of 0.588. Because years of life lost (YLLs) for schizophrenia captured by the GBD model are negligible, and because YLDs result from multiplying prevalence by disability weight, we estimated that 69% of the disease burden of schizophrenia is attributable to the acute state.^{25,26}

With these data, we considered three linear regression models, all in log-log form: (1) a regression of the proportion of total government health spending allocated to mental health services (metric *d*) on real GDP per capita (where *c* is country):

$$\text{Ln}(\% \text{ of government health spending allocated to mental health services}_c) = a_1 + \beta_1 \text{Ln}(\text{GDP}_c) + \epsilon_1$$

(2) A regression of the proportion of mental health spending allocated to psychiatric hospitals (metric *e*) on real GDP per capita:

$$\text{Ln}(\% \text{ of mental health spending allocated to psychiatric hospitals}_c) = a_2 + \beta_2 \text{Ln}(\text{GDP}_c) + \epsilon_2$$

(3) A regression of imbalance in efficiently allocated spending (metric *g*) on real GDP per capita:

$$\text{Ln}(\frac{(\% \text{MNSS DALYs} - 0.69 \times \text{schizophrenia DALYs})}{(\% \text{ mental health spending} - [\% \text{ mental health spending} \times \% \text{ psychiatric hospital spending}])}_c) = a_3 + \beta_3 \text{Ln}(\text{GDP}_c) + \epsilon_3$$

In these bivariate log-log regressions, variables on both sides are transformed by the natural logarithm function, implying that we can interpret the estimated slope coefficients (eg, β_1) as an estimate of elasticity.^{27,28} In particular, in a log-log regression, the slope coefficient gives the approximate percentage point change in the left-hand side variable associated with a 1% change in the right-hand side variable. The approximation is exact for small changes in the right-hand side variable.

We also produced ranked bar-charts for both imbalance ratios:

$$\frac{\% \text{ of MNSS burden}}{\% \text{ spent on mental health services}}$$

$$\frac{\% \text{ of MNSS burden to be treated in the community}}{\% \text{ of resources available for community services}}$$

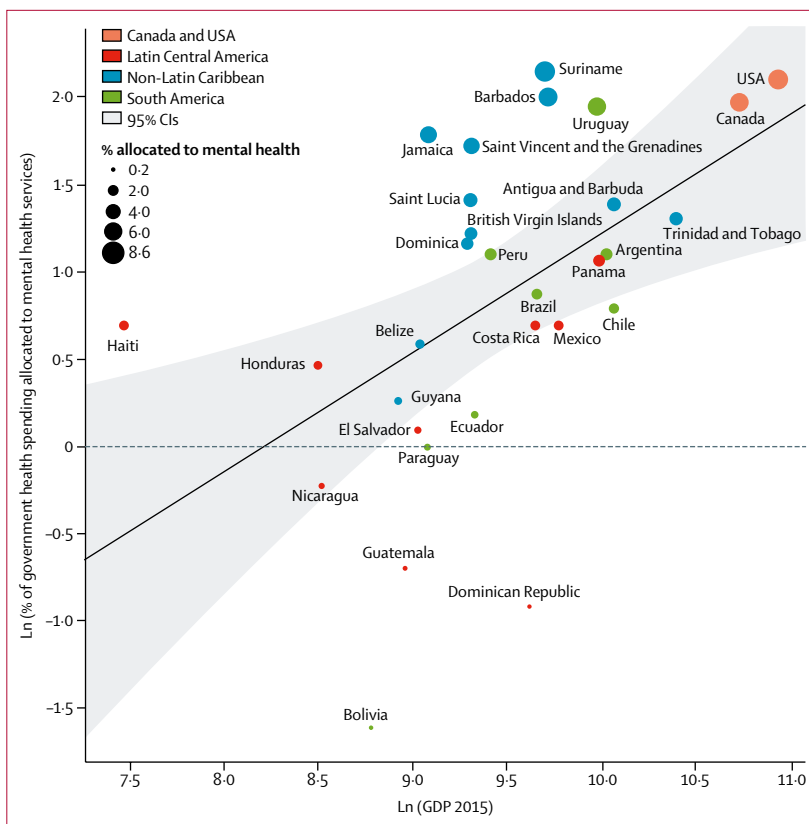


Figure 1: Mental health spending vs GDP per capita
 $\beta_2=0.68$ (95% CI 0.24–1.13). Linear model: $\text{Ln}(\% \text{ of government health expenditures spent on MNSS}) = 0.68 \times \text{Ln}(\text{GDP}) + -5.6$; $R^2=0.26$; $p=0.0036$. MNSS=mental, neurological, and substance use disorders, and self-harm. GDP=gross domestic product.

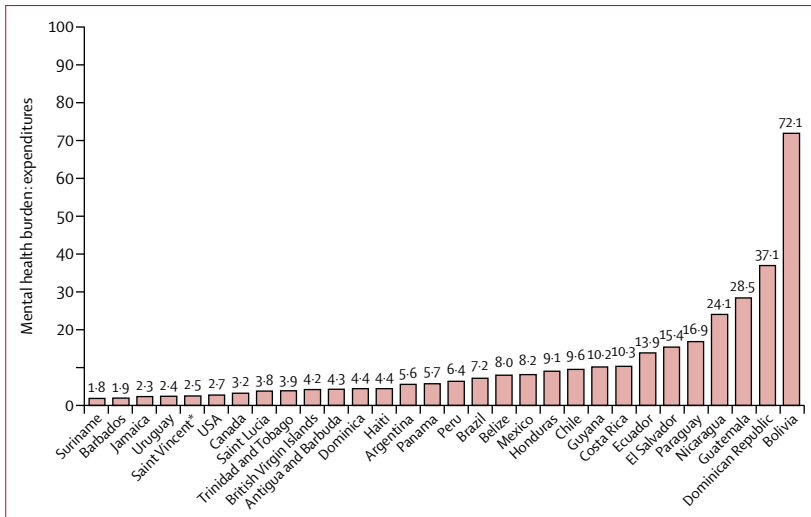


Figure 2: Ratio of proportion of total DALYs attributable to MNSS to proportion of health spending allocated to mental health
 DALYs=disability-adjusted life-years. MNSS=mental, neurological, and substance use disorders, and self-harm.
 *Saint Vincent and the Grenadines.

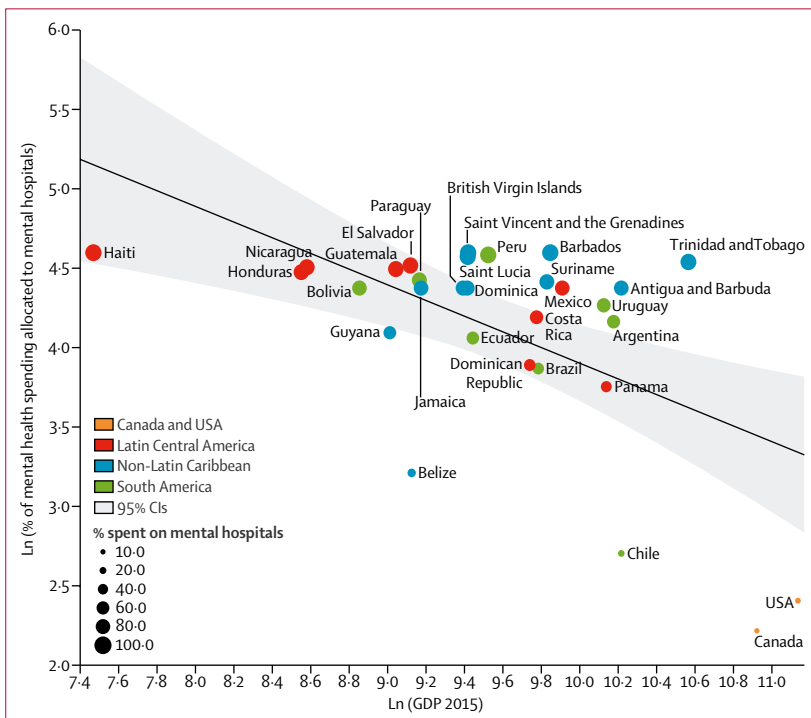


Figure 3: MNSS spending allocated to psychiatric hospitals vs GDP (purchasing power parity)
 $\beta_2 = -0.50$ (95% CI -0.79 to -0.22). Linear model: $\text{Ln}(\% \text{ MNSS expenditures spent on psychiatric hospitals}) = -0.50 \times \text{Ln}(\text{GDP}) + 8.9$; $R^2 = 0.32$; $p = 0.0012$. MNSS=mental, neurological, and substance use disorders and self-harm. GDP=gross domestic product.

See Online for appendix

Models and figures were computed with Stata 14.2 and Tableau 10.1.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of

the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Globally, in 2015, NCDs accounted for 60% of total DALYs, of which 12% corresponded to MNSS, whereas in the Americas they accounted for 78% of total DALYs, of which 19% corresponded to MNSS. The fraction of DALYs attributable to MNSS varied among countries, ranging from 9% in Haiti to 23% in Canada (figure 1; appendix).

Globally, median spending on mental health stands at around 2% of total government health spending, while mental disorders account for 12% of total DALYs and 35% of total YLDs as per our estimates updated to 2015.^{2,5,6} Low-income countries spend around 0.5% of their health budget on mental health services, lower-middle-income countries around 1.9%, upper-middle-income countries 2.4%, and high-income countries 5.1%.²¹ The median in the Americas is 2.4% ranging from 0.2% to 8.6%, while the regional disease burden attributable to MNSS comprises 19% of total DALYs and 34% of total YLDs.

We calculated the natural log of mental health spending as a proportion of government health spending (metric *d*) and the natural log of real GDP per capita (figure 1) and found a positive association. We estimated regression model (1) and plotted its predicted values and 95% CIs (appendix). The estimated value of β_1 in this regression is 0.68 ([95% CI 0.24–1.13], $p = 0.0036$), which is significantly different from zero at the 0.5% level (ie, if the true value of the slope parameter β were zero, the probability of seeing an estimated coefficient as large [in absolute value] as our estimate is smaller than 0.5%). Our model, however, does not establish the causal links that generate this association. The estimated value indicates that within the Americas, a country with a 10% increase in real GDP per capita would allocate approximately a 6.8% larger proportion of its health expenditures to mental health. Note that this estimate is a percent increase in a fraction; for example, considering two countries, if the first country had a real GDP per capita of US\$10 000 and the second of \$11 000, if the first country allocated 10% of health expenditures to mental health, we would predict that the second country would allocate approximately 10.7%.

We ordered all countries by how disproportionate the burden of MNSS (DALYs) was in relation to expenditures (figure 2). Regional variation was high, with DALY burden ranging from 1.8 to 72.1 times expenditure. The median imbalance for American countries was 6.1 (IQR 3.8–10.3)—ie, the proportion of total disease burden attributable to MNSS is six times the proportion of health funds allocated to mental health.

We next considered allocative efficiency of spending, defined as the distribution of resources to achieve the

desirable combination of services and maximise societal health outcomes.²⁹ Evidence indicates that MNSS services should aim to care for people in the community, providing services in primary care and general hospitals for common mental illnesses and community care for severely affected individuals.³⁰ The proportion of spending that is not allocated to psychiatric hospitals can be considered a proxy for allocative efficiency, given the lack of evidence of effectiveness and reported association with iatrogenic practices.^{31–34} The median allocation to psychiatric hospitals in the Americas was 80% (52–92).

We calculated the log of the proportion of mental health spending allocated to psychiatric hospitals (metric *e*) and the log of real GDP per capita (figure 3) and found a negative association. Regression analysis reinforced this view. We estimated regression model (2) and found a significant negative estimate of -0.50 for β_2 ([95% CI -0.79 to -0.22], $p=0.0012$; appendix). We calculated the predicted values from the regression and 95% CIs. This estimate indicates that a country with a 10% increase in GDP would allocate approximately a 5% lower proportion of mental health expenditures to psychiatric hospitals. Hence, countries with more developed economies not only spend a larger proportion of their health budget on mental health, but also allocate that increased proportion better than countries with less developed economies, where the lower proportion of mental health spending is compounded by lower overall health budgets to begin with and inefficient allocation, with psychiatric hospitals capturing most funds.

Considering the fraction of MNSS burden that should be cared for in the community divided by the spending not absorbed by psychiatric hospitals (metric *g*), we obtained a very different picture of the imbalance in spending, we ordered countries from the lowest ratio of burden over efficiently allocated spending (figure 4). The imbalance ratio varied by two orders of magnitude, from the burden being three times spending in the USA and Canada to 435 times spending in Haiti, and more than 100 times in a third of American countries.

We calculated the log of the imbalance ratio and the log of real GDP per capita (figure 5). A negative association was shown and was corroborated by the estimation of regression (3). The estimated value of β_3 was -1.38 ([95% CI -1.97 to -0.78], $p=0.0001$) and was significantly different from zero (appendix). The estimated coefficient suggests that a country with a 10% increase in GDP will have approximately a 14% lower imbalance ratio for mental health expenditures.

Given the limitations of the available data, we did additional analyses to check that our results were not unduly influenced by potential outliers or methodological assumptions, or contingent on the functional form chosen for the variables. First, inspection of figure 5 raised the possibility that Haiti, Canada, and the USA might be outliers unduly influencing our results. Hence,

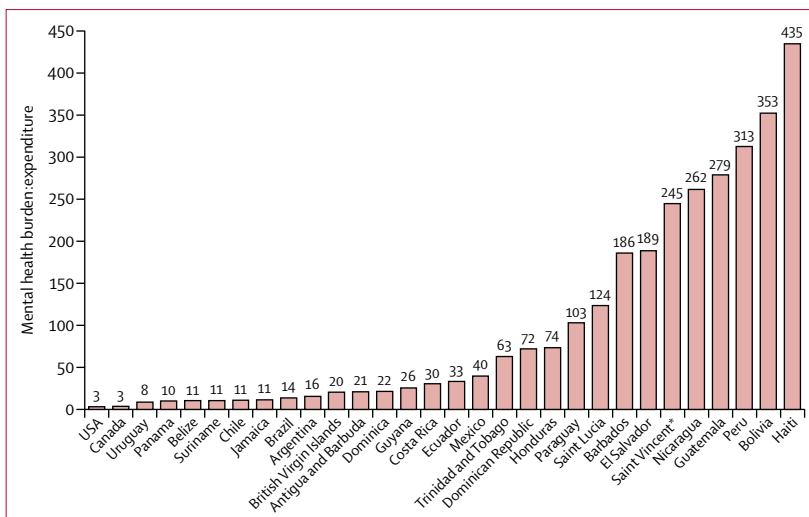


Figure 4: Imbalance in spending vs GDP
Ratio of MNSS burden to efficiently allocated spending. MNSS=mental, neurological, and substance use disorders, and self-harm. GDP=gross domestic product. *Saint Vincent and the Grenadines.

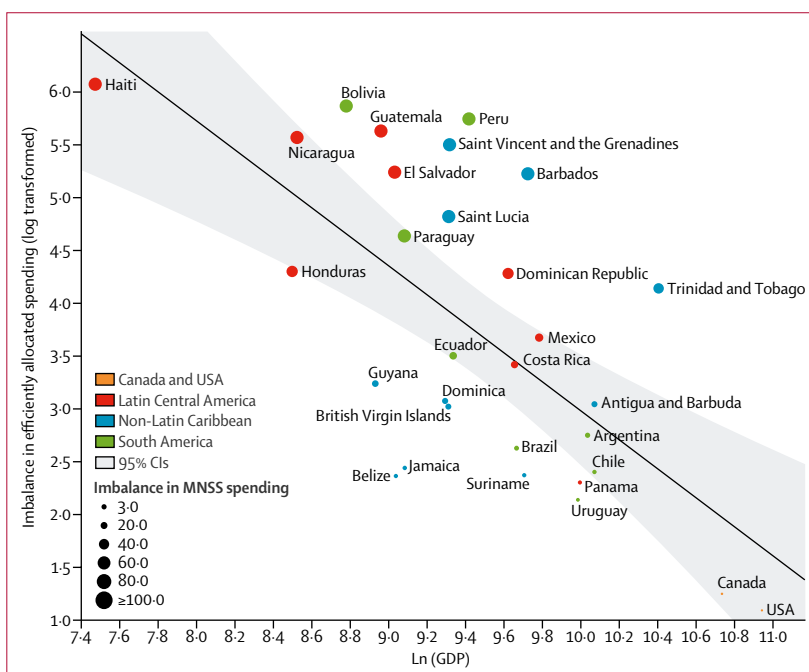


Figure 5: Imbalance in efficiently allocated spending vs GDP
 $\beta_3 = -1.38$ (-1.97 to -0.78). Linear model: $\ln(\% \text{ MNSS DALYs} - 69\% \times \text{schizophrenia DALYs}) / (\% \text{ mental health spending} - [\% \text{ mental health spending} \times \% \text{ psychiatric hospital spending}]) = -1.38 \times \ln(\text{GDP}2015) + 16.1883$; $R^2=0.44$; $p=0.0001$. MNSS=mental, neurological, and substance use disorders, and self-harm. GDP=gross domestic product.

we re-ran the analyses excluding these three countries for all three models (appendix). The results are quantitatively similar to those presented above. However, the estimated coefficient β_2 in the new regression (2) was not significant, though it was still negative.

Second, we used the natural log transformed variables to facilitate interpretation of the results in terms of

elasticities—ie, proportionate changes in response variables (metrics *d*, *e*, and *g*) to proportionate changes in real GDP per capita. To confirm that these results were not contingent on variable transformation, we also ran our three models on the non-transformed variables (appendix). The results were qualitatively identical to those reported above.

Finally, we ran our model regressing imbalance on GDP, but excluded dementia, suicide, and our estimation for somatic pain syndrome from the burden calculations—ie, we used the standard GBD estimates. The results were quantitatively similar to figure 5: the estimated coefficient was similar and significantly different from zero ($\beta_3 -1.5$; $r^2 0.53$; $p=0.0001$).

Discussion

MNSS spending in the Americas is low compared with the associated disease burden and is mostly captured by psychiatric hospitals; the resulting imbalance in efficiently allocated spending is negatively associated with real GDP per capita.

WHO recommends that health spending should be proportionate to burden as a general rule for all health conditions, and that there should be parity between physical and mental aspects of health care.^{30,35} To measure the burden of mental health disorders, we used DALYs with an expanded definition of MNSS taking into account specific neurological conditions, self-harm, and a fraction of painful syndromes.⁶ In a Comment³⁶ regarding our model, the GBD collaborators agreed on the need to include excess death due to mental illness and burden resulting from neurological disorders, personality disorders, and somatoform disorders. However, they found the existing evidence insufficient and, therefore, attributed 0% of the burden resulting from painful syndromes and self-harm to MNSS and 0% of total YLLs to mental disorders. These attributions lack face validity and might have deleterious policy consequences, so we find our approach preferable. However, we acknowledge its limitations: the non-zero fraction of pain disorders imputed to MNSS is based on our review of the evidence and not on primary data, which is unavailable;^{6,37} further, our approach does not distinguish the small fraction of suicide that should not be included in MNSS (eg, euthanasia).

Selection and information bias are important concerns in ecological studies. Selection bias affects ecological studies with a poorly defined population of interest or sampling method. The 35 countries in the WHO Region of the Americas constituted our population of interest. Our aim was to achieve a full population sample, but we were unable to obtain sufficient data for five countries; therefore, our sample covers 87% of the population of interest, which might limit generalisability to the full set of countries. A limitation to our conclusions emerges from the nature of the expenditure data, which are self-reported by ministries to WHO and are susceptible to

errors and inconsistencies leading to information bias. For example, potentially a substantial amount of resources allocated to dementia care or suicide prevention, and MNSS services delivered through primary care or non-health sectors, might be reported by some countries but not others. However, no alternative source of comparable comprehensiveness and quality is available.^{38,39} Further, if we assume that these channels of spending are expected to be higher in countries with higher GDP per capita, the result would be a more pronounced negative association between GDP and imbalance, making our findings conservative. Another caveat should be highlighted: our estimations do not account for private spending, which is a substantial source of mental health funding. We will address this issue and its potential consequences on health inequalities below. A final caveat results from treating countries for which key datapoints were not available as missing at random and therefore dropping them from the analysis. Considering the culture, population, economic arrangements, and health systems of the five countries dropped, we see that Colombia and Cuba are quite different within themselves and compared with the other three countries, so we posit that our missing at random assumption holds for them. Bahamas, Grenada, and St Kitts and Nevis are all small Caribbean island nations with more homogeneous characteristics (English or Creole-speaking smaller populations, tourism and agriculture-based economies), so our conclusions might not be applicable to this type of American country.

An important discussion is what the adequate ratio of burden to spending should be. A ratio of one would imply the assumption of equivalent cost-effectiveness of interventions across health sectors, which would not be grounded on evidence despite the well established cost-effectiveness of a broad range of mental health interventions.⁴⁰ To provide a benchmark, the National Health Service (NHS) in England can function as a real-world comparator of efficiently allocated mental health spending. Despite recent decreases in funding,⁴¹ NHS England has achieved notable outcomes in terms of providing evidence-based interventions, universal coverage, integration in primary care, and community rehabilitation—all leading to comparatively high user satisfaction.⁴² Additionally, because private spending is minimal, the ratio actually reflects the imbalance. The disease burden of MNSS in England represents 20% of total DALYs, and spending was estimated at 13% of health expenditures; therefore, our real-world comparator of imbalance would be 1.5:1.⁴¹ Our first metric of the imbalance in the Americas yielded a range from 1.8:1 to 72.1:1, but fails to capture the compounding effect of misallocation. Our second metric provides a more accurate picture of the imbalance in spending by factoring in allocative efficiency: we found that the regional median imbalance between mental health burden and spending was 32:1, with a range of between 3:1 and 435:1. The gap in spending is significantly and

inversely associated with real GDP per capita, disproportionately affecting lower-income countries (appendix).

This observed imbalance potentially results in an increasing treatment gap in poorer countries and increased private spending on mental health services, out-of-pocket spending in particular. For example, the 3:1 imbalance between disease burden and efficiently allocated spending affecting Canada and the USA is consistent with findings that establish the treatment gap for major depressive disorder in high-income countries to be 5:1; only 22.4% of patients received minimally adequate treatment in high-income countries (the remainder did not receive treatment), 26.6% (4:1) specifically in the USA.⁴³ In low-income or lower-middle-income countries, the gap was estimated at 27:1; only 4.7% of people in need received minimally adequate services. In Peru, less than one person received minimally adequate treatment for every 100 people with a valid diagnosis of major depressive disorder.⁴³ These data are in line with our findings, which indicate that the USA and Canada have the lowest imbalance at 3:1, Peru has one of the largest gaps in the continent with a 312:1 imbalance in burden relative to efficiently allocated spending, and the 27:1 gap⁴³ in low-income and lower-middle-income countries is consistent with our American median of 32:1. Our results merit further study as to whether the imbalance in government funding in poorer countries is being covered by increased out-of-pocket spending by people living in these countries, therefore, further compounding the burden on the poor.

Mental health is increasingly acknowledged as a global health and economic development priority, as articulated in the Sustainable Development Goals referring to mental health and wellbeing.^{44–49} However, the proportion of funds spent on mental health tends to be low and inefficiently allocated, with the least effective and cost-effective interventions receiving the largest share, particularly in low-income and middle-income countries. In the Americas, MNSS are the largest subgroup cause of disease burden, both when considering disability alone and combined with mortality; they comprise a third of total YLDs and a fifth of total DALYs. Governments of low-income and middle-income countries, in particular, must adjust the allocation of their mental health expenditures. Instead of allocating most funds to specialised hospitals, countries should prioritise mental health services integrated into primary care and delivered in the community—a strategy that would target not only the direct burden resulting from MNSS but also the excess mortality due to treatable causes, which are ineffectively cared for because of stigma, insufficient community support, and poorly integrated health services.^{50,51}

Contributors

DVV conceived the study and the first draft with RA, DK, and GT. RA, DK, and GT provided extensive comments on all aspects of the study.

KP provided extensive comments on the first draft and all subsequent drafts, with a specific focus on statistical models including figures and tables.

Declaration of interests

We declare no competing interests.

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