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Title: The cost of inaction on physical inactivity to healthcare systems

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Abstract

Background

Physical inactivity (PI) is an important modifiable risk factor for noncommunicable diseases (NCDs) and mental health conditions. Estimating the health and economic costs associated with these diseases due to PI will help policymakers to prioritise investment in policy actions to promote and enable more people to be more active.

Methods

We updated and estimated incidence due to PI, and direct healthcare costs of NCDs and mental health conditions for a 11-year period (2020 to 2030). We used standardised methods and the most recent health and economic data evidence available for 194 countries.

Results

Almost 500 million new cases of *preventable* major NCDs would occur globally, with direct health care costs of INT$ 520 billion, by 2030 if the current prevalence of PI does not change. The global cost of inaction on PI would reach approximately INT$ 47·6 billion per year, an increase of more than 50% in costs compared to previous studies. Although 74% of new cases of NCDs would occur in LMICs, high-income countries would bear a larger proportion of the economic costs (63%). The cost of treatment and management of NCDs varied, such that, although dementia accounted for only 3% of these preventable NCDs, it corresponded to 22% of all costs; type 2 diabetes and cancers, accounted for 2% and 1% of these preventable cases, but 9% and 15% of all costs, respectively.

Findings

This health and economic burden of PI is avoidable. Further investments in and implementation of known and effective policy interventions will support countries to reach the Sustainable Development Goal of reduction of NCD mortality by 2030.

Funding

None.

Research in context

Evidence before this study

Physical inactivity (PI) reduces the risk of leading causes of death from noncommunicable diseases (NCDs). The only previous global study of the costs resulting from PI estimated an economic cost to society of INT$ 53·8 billion (2013 prices), of which 58% was paid by the public sector. This study covered five health outcomes for which scientific evidence on the relative risks (RRs) was available at the time.

Added value of this study

This study updates previous estimates of population attributable fractions (PAFs) and direct healthcare costs for five health endpoints (coronary heart disease, stroke, type 2 diabetes mellitus, breast cancer, and colon cancer) and provides new PAFs and healthcare cost estimates for additional health outcomes: hypertension, dementia, depression, and cancers (bladder, endometrial, gastric, oesophageal, and renal).

Implications of all the available evidence

This study, combining the assessment of the health and economic impact of NCDs and mental health conditions associated with PI, provides policymakers with empirical data on the cost of not acting to reduce PI. These data will equip them with evidence to inform and advocate for greater investment in policy interventions that increase physical activity levels. This study calls for urgent actions by countries to prioritise investments in interventions that reduce this modifiable risk factor. The Global Action Plan on Physical Activity provides clear guidance on evidence-based policy recommendations which if implemented by countries will improve health, reduce the burden on health systems and save money.

Introduction

Many countries are falling behind on their commitments to reduce by one-third the premature mortality from non-communicable diseases (NCDs), the leading cause of death and ill-health globally.[1] Also of concern, is the rising global burden of mental health conditions, exacerbated by the COVID-19 pandemic.[2] At this pace, countries are unlikely to achieve the 2030 United Nations' Sustainable Development Goal (SDG) 3 of ensuring healthy lives and promoting well-being for all at all ages.

Reducing the prevalence of modifiable risk factors, such as tobacco use, harmful use of alcohol, unhealthy diets, and physical inactivity, is a cost-effective strategy to reduce the burden of NCDs and mental health conditions. Every dollar invested in scaling up effective interventions to reduce risk factors and manage NCDs, for example, could generate a return of up to US$ 7 in low- and middle-income countries (LMICs), where almost 85% of all premature deaths due to NCDs occur every year.[3] Yet, slow progress has been observed over the years, especially in those settings.

Physical inactivity (PI) is a major modifiable risk factor for NCDs and mental health conditions including stroke, hypertension, type 2 diabetes mellitus, coronary heart diseases (CHD), several types of cancers, dementia, depression, and all-cause mortality, in particular, deaths due to cardiovascular diseases.[4,5] The global costs of PI to healthcare systems, based on only five health outcomes (CHD, stroke, type 2 diabetes mellitus, breast cancer, and colon cancer) were estimated at INT$ 53.8 billion (2013 prices), of which 58% was paid by the public sector.[6] Urgent actions are needed to improve the prevention and treatment of NCDs and mental health conditions by governments and the global health community.

To address this need for action, WHO identified 20 evidence-based policy recommendations, outlined in the WHO Global Action Plan on Physical Activity 2018-2030 (GAPPA), to support national efforts to increase physical activity at the population level.[5] But progress on reducing levels of PI has been slow. Advocacy calling for stronger multisectoral action to promote and enable more physical activity through provision of supportive environments, accessible programmes and sustained communication campaigns in all communities is needed, and this can be supported by making the case for governments and non-governmental organisations to invest in physical activity.[7]

Making the investment case for physical activity is key to informing decision-making and prioritizing resources and generating political and societal support for policy implementation. Estimating the health and economic costs of "business as usual" i.e., no action to reduce levels of PI, is the first step in building a case for investment in physical activity.

Hence, the objective of this study is to estimate the cost to healthcare systems of inaction on PI, by updating previous estimates of direct healthcare costs and providing new cost estimates for additional health endpoints with strong association with PI, notably mental health disorders (dementia and depression) and five additional cancer sites (bladder, endometrial, oesophageal, gastric, and renal).

Methods

Overall approach

We assessed the total direct costs to the health system incurred by new cases of seven diseases strongly associated with PI to estimate the cost of inaction on PI. The disease endpoints included were CHD, stroke, type 2 diabetes mellitus, hypertension, cancer (breast, colon bladder, endometrial, oesophageal, gastric, and renal), dementia, and depression. Estimates of the economic costs of PI are presented by country, WHO Regions, and the World Bank income level classification. All costs are provided in 2020 market exchange prices (US$, U.S. Dollars) and international (INT$) U.S Dollars, using 2020 purchasing power parity (PPP) conversion factors, to allow for international comparison of estimates. PI was defined as not meeting the current WHO physical activity recommendations: for adults, namely at least 150 minutes of moderate-intensity aerobic physical activity or at least 75 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity throughout the week.[8] The methods used are briefly described below and detailed in the Supplementary Material.

Attributing incident cases to PI

The population attributable fraction (PAF) of incident cases due to PI, was estimated using established methods, and recently updated adjusted relative risks (RRs). [4, 6, 9, 10] These RRs were derived from the most recent meta-analysis or pooled data of systematic literature reviews, that provided strong evidence of association with the outcomes of interest, based on the magnitude and precision of the effect, quality of the studies included (including risk of bias), and the generalisability of the results Prevalence of PI for all countries was obtained from the most recent

global comparable national estimates from WHO for adults aged 18 years old and over, and by sex.[11, 12]

Annual incidence for each endpoint was obtained from various sources of data. [13–16] We used the most recent number of incident cases by disease as baseline (using 2020 as the reference year), and estimated the number of new cases, for each year, from 2020-2030. Where these data were only available before 2020, we used United Nations (UN) data on total population and applied population growth rates to the number of incident cases from the year of data availability until 2020. [17] For example, data on incidence of depression, coronary heart diseases, stroke and type 2 diabetes were obtained from the Institute for Health Metrics and Evaluation (IHME)'s Global Burden of Disease (GBD) study for the year of 2019, the most recent estimates available, and we applied one-year average UN population growth rate, by country, to bring these estimates to 2020.

We estimated the PAFs based on the adjusted RRs and the prevalence of PI using the formula below. [10] The total number of new cases was estimated by multiplying the PAFs by the total number of incident cases of diseases in the population, per year, from 2020 to 2030, and using population growth rates.

$$PAF = \frac{p_i(RR-1)}{[p_i(RR-1)]+1}$$

Where,
RR = relative risk comparing the risk of disease between those who are physically inactive with the risk of disease between those who are physically active.
p_i = prevalence of physical inactivity among adults aged 18 years and older.

Attributing direct medical costs to PI

Total direct costs to the health system attributed to PI for each health condition were collated from multiple sources. For cancer endpoints, we obtained country-specific costs of incident cases of cancers from the WHO Cancer Unit. These costs use an 'ingredient-based' approach where the use of each input (e.g., medical and non-medical time, medication, tests, overheads, etc.) was estimated - from diagnosis through the first year of treatment of the disease - and inputted as a price. For type 2 diabetes, we used the most recent estimates from the International Diabetes Federation (IDF). [18] Costs estimates by IDF include costs for complications of diabetes associated to coronary heart disease and stroke. To avoid double counting the costs of stroke and coronary heart diseases in

patients with diabetes, we deducted the direct healthcare costs per case of (i) diabetes and stroke, (ii) diabetes and coronary heart diseases, and (ii) the cost of diabetes, coronary heart disease and stroke, from the total estimates of costs attributed to PI, from the total global costs. Further details on this calculation are in the Supplementary Material.

Costs to treat dementia were obtained from a WHO publication on public health response to dementia.[19] These costs, however, were only available, and thus presented by WHO Regions and World Bank country income levels, and not by country.

For stroke, hypertension, coronary heart disease, and depression there were no global data sets on the direct healthcare costs, thus we adopted the same approach used by Ding and colleagues, the Economist Intelligence Unit and the World Economic Forum.[6,20,21] Following this approach, we obtained data on the national disease-specific healthcare costs from 28 European Union countries (EU-28), and for hypertension, from the National Health Service, England, and extrapolated these costs to other countries by using a country weighting factor. The country weighting factor was constructed as the country health expenditure for a specific year divided by the average of healthcare expenditure for the EU-28 (and National Health Services (NHS) England, for hypertension) for the same year, at PPP. This weighting factor was then applied to the average healthcare costs, per type of disease, for the EU-28's and NHS England's costs. The healthcare expenditure, per country, was obtained from the WHO Global Health Expenditure Database.[22]

For each disease, we calculated the total annual direct costs to the health system, per country, by multiplying the estimated total number of new cases of diseases attributed to PI by the estimated average annual costs per new case; annual costs in subsequent years for the treatment of prevalent cases were not included in the analysis. Total costs were extrapolated, annually, from 2020 to 2030 by using country-specific inflation rates as informed by the World Bank.[23] The Supplementary Material provides further details on these methods.

Sensitivity analysis

We presented all estimates as the mean, lower- and upper-bounds of the confidence intervals for the RRs. As costs estimates were derived from European Countries to all other countries, uncertainty around the true costs to LMICs were accounted for by applying a reduction in costs of 30% and 50%.

Results

Almost 500 million (499·2 million) new cases of *preventable* NCDs and mental health conditions would occur globally, from 2020 to 2030, if the current prevalence of physical inactivity does not change. Nearly half of these new cases (234·6 million) would be hypertension and over 200 million would be due to depression (see Figure 1). Approximately three-quarters (74%) of these new cases would occur in LMICs, and 25% and 21% of the total number of new cases of NCDs and mental health conditions due to PI would occur in the Western Pacific and Southeast Asia Regions, respectively (see Figure 2).

The global cost of the almost 500 million preventable cases is estimated to reach more than INT$ 520 billion (INT$ 523·8; US$ 301·8 billion), for the period 2020 to 2030, approximately INT$ 47·6 billion (US$ 27·4 billion) per year (see Table 1 and Supplementary Material). The costs of treatment and management of NCDs and mental health conditions varied such that although dementia accounted for only 3% of the preventable new cases, it accounted for 22% of total direct health care costs. Furthermore, type 2 diabetes and cancers accounted for 2% and 1%, respectively, of the preventable cases, but 9% and 15%, of all costs, respectively (see Figure 3).

Although the majority (74%) of all new cases would occur in LMICs, high-income countries (HIC) would bear a larger proportion of the economic costs (63%) (Figure 4). The economic burden attributable to PI was highest in the European Region (31%), followed by the Americas (26%), Western Pacific (24%), Eastern Mediterranean (11%), Southeast Asia (6%) and Africa (2%), as shown in Figure 5.

New cases of preventable diseases would vary from 154 to 860 million cases, when assessing the lower- and upper-bound of RRs, with costs varying from INT$ 182 to 900 billion for these RRs (see Table 1). When dealing with uncertainties around costs estimates, a variation of -50% and -30% would reduce the cost of inaction to INT$ 344 billion (US$ 164 billion) and INT$ 499 billion (US$ 219 billion), respectively (see the Supplementary Material for the results of the sensitivity analysis).

Discussion

Health systems around the world continue to face heavy health and economic burden associated with noncommunicable diseases and this has been exacerbated by COVID pandemic. [3, 24] Reducing physical inactivity can contribute to significantly reducing the burden of NCDs through improved physical and mental health and thereby contribute to lowering the demand for health services and national health care costs. [3,5]

We estimated, globally, the total cost of PI will be approximately INT$ 520 billion over an 11-year period (2020-2030) if global levels of participation are not increased. Of particular concern is the high burden of PI seen in preventable cases of dementia and cancers, because despite the relatively lower incidence of these conditions they incur a high cost due to requirements of diagnosis, treatment and long-term management. Furthermore, while most of the predicted new cases of NCDs would occur in LMICs, high-income countries will bear a larger proportion of the economic burden. This reflects the increased coverage and higher healthcare expenditure in wealthy countries, while in lower-income settings coverage and healthcare expenditure are comparatively lower. Our findings also call for attention to the high number of cases of depression and anxiety, whose rates steadily increased during the COVID-19 pandemic.[2] Incidence and prevalence of those mental disorders can also be effectively reduced by increasing physical activity levels, which would also help to reduce costs to healthcare systems and increase wellbeing.[5]

This study updates and expands previous global economic estimates for the burden of PI to health systems.[6,25] Ding and colleagues estimated that PI cost health systems INT$ 31·2 billion for the year of 2013, compared with INT$ 47·6 estimated by our study (in 2020 prices). The increase of about 52% in the economic burden of PI reflects the inclusion of additional health endpoints in our analyses (namely hypertension, depression, dementia and more cancers), and inflation related to the health sector (e.g., increases in the price of technologies, drugs and personnel costs).

Our results are however likely to underestimate the total cost of physical inactivity as we only considered expenditures related to the initial treatment of new cases of NCDs (usually costs related to the first year of treatment), per year, not the accumulated costs of the treatment, complications, and management of these new cases over the years, nor did we include the costs associated with mortality. Chronic conditions, and particularly multiple chronic conditions per patient, accrue a disproportionate burden to health systems. In addition, our analysis used 2016 estimates of

prevalence of PI and if the prevalence of PI were to increase, these results underestimate the impact on health systems.

It is important to note that the results of this study should not be interpreted as the total cost that would be avoided if PI were reduced. Estimating the total avoidable costs of PI requires calculating the *net* cost of interventions implemented to increase physical activity that is, the total benefits of PA interventions *less* the costs of physical inactivity.[26] Future work should undertake net cost analyses once the necessary data on an agreed set of interventions are available. In addition, future analyses should adopt a wider societal perspective, taking into consideration the costs associated with loss in productivity and mortality due to PI. We found only one such study has been undertaken at global level and it reported the potential global benefits to society, including productivity gains and deaths averted, was between US$ 314 to 446 billion per year (in 2019 prices), depending on the levels of physical activity.[25]

Assessing the total societal costs and benefits of increased population levels of physical activity is complex as changing population levels of participation requires multiple policy interventions undertaken as part of a comprehensive 'whole-system' approach as outlined by WHO in GAPPA.[5] Policy interventions by different government departments and sectors are needed to provide the public awareness, supportive environments and community programmes that can effectively increase PA. For example, this includes policy interventions to improve urban infrastructure to enable more safe walking and cycling for transport; and to ensure adequate access to convenient facilities and programmes to engage more people in community sport and active recreation. Implementing a 'whole system' approach comprising multiple policy actions led by different government departments is not only necessary, it is also desirable because it can provide multiple benefits to different sectors, not only in health.[7] Thus, while estimates of the direct impact of PI on health systems is important, future development of methods and modelling of a cost benefit analysis using a whole system perspective is urgently required. [7]

To extrapolate costs from EU-28 to other countries, we assumed, as in Ding and colleagues, that the cross-country differences in disease-specific costs per case are solely driven by the differences in overall health care expenditure per capita.[6] Given the lack of costing data, especially in LMICs, the methodology of using weighting factor to extrapolate EU-28 costs is, arguably, the best available approach to proxy healthcare costs in lower income settings.[18, 20, 21] However better data and further methodological development are needed to produce more robust and contextualised evidence in lower income settings.

Despite limitations in the availability of some data, this study provides new insights and understanding on the global health and economic burden of PI to health systems in all countries. All government policy decision-makers are faced with competing demands on limited financial and human resources and consequently they require information on the cost of not acting to increase physical activity. These data can also support the development and strengthening of national investment cases and resource mobilisation to support the implementation of policy and programmes that enable more people to be more active, more often.

Modelling cost of inaction and return on investment analyses have been important contributors to national and global progress on other NCD risk factors such as tobacco control.[27] Yet to date, there remains relatively few economic analyses undertaken on PI despite recognition of the urgent need for such research.[6] This study shows that if governments fail to take effective action to increase levels of physical activity by 2030, countries will incur substantial costs in terms of preventable new cases of NCDs. In addition, countries will miss the opportunities to reap the associated benefits that increasing physical activity can have on other important national agendas, such as reducing air pollution and fossil fuel consumption through more walking and cycling and the wider impacts of increasing sports participation on social and economic development.[5]

Despite GAPPA providing countries with clear guidance on a set of effective and adaptable physical activity interventions, national progress on implementing relevant policy has been slow and global levels of physical activity in adults remain little changed in over a decade.[5, 11] The first WHO Global Status Report on Physical Activity reveals that whilst most countries report having a national policy on NCDs which includes physical activity, there is a profound gap in relevant policy implementation.[28] This gap perpetuates inequalities in levels of physical activity and inequities in opportunities and access to PA services and programmes across communities. Given there is only eight years remaining to achieve the global target set to for 2020 to reduce PI by a relative 15% from 2010 baseline, the findings of this study should be used by advocates and decision makers as a catalyst to mobilise resources and accelerate implementation of national policy commitments to reducing physical inactivity.[5] In addition, global initiatives such as HEARTS[29], Diabetes Compact (https://www.who.int/initiatives/the-who-global-diabetes-compact), Resolve to Save Lives (https://resolvetosavelives.org/), Decade of Healthy Ageing (https://www.who.int/initiatives/decade-of-healthy-ageing), Mental Health Action Plan 2013-2030[30] and Second decade of action on road safety (https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/decade-of-action-for-road-safety-2021-2030) should strengthen

alignment and implementation of interventions on physical activity. The scientific community is encouraged to further advance the evidence on economic impact and returns from increasing physical activity.

The first step in advocating for investment is understanding what are the associated costs of inaction, not only in terms of population health and wellbeing, but also importantly in direct costs to the healthcare system. This study provides estimates of the economic burden to the health systems of each country and at the global level.

Coordinated and accelerated action to reduce the prevalence of physical inactivity will make a significant impact and further investments and scaling up of multisectoral actions are needed to achieve this.[7]

Contributions

ACS and FCB designed the study and interpreted the data. ACS obtained and managed the data and conducted the data analysis. ACS, FCB and JW, wrote the manuscript. FM and AE estimated the incident costs of cancers. All authors critically reviewed the document.

Declaration of interests

We declare no competing interests.

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Table 1. Direct healthcare costs attributable to physical inactivity, by health endpoints, and by WHO Regions and World Bank income classification (in INT$), 2020-2030

WHO Regions/World Bank income levels	Cancers	Coronary Heart Disease	Dementia	Depression	Hypertension	Stroke	Type 2 Diabetes
African Region (AFR)	375 (80 to 755)	141 (98 to 191)	389 (203 to 642)	6598 (247 to 13781)	3128 (1573 to 4667)	314 (152 to 456)	1151 (753 to 1541)
Region of the Americas (AMR)	9465 (1899 to 18323)	1400 (977 to 1873)	55560 (29804 to 88239)	37536 (1466 to 75007)	21018 (10618 to 31207)	2601 (1274 to 3723)	32479 (21439 to 43090)
Eastern Mediterranean Region (EMR)	6969 (1131 to 14273)	2733 (1912 to 3647)	862 (459 to 1382)	42283 (1670 to 83567)	21546 (10899 to 31951)	3066 (1507 to 4374)	3847 (2546 to 5092)
European Region (EUR)	30325 (5804 to 60120)	4696 (3268 to 6304)	27889 (14719 to 45236)	70224 (2706 to 142348)	51111 (25779 to 76008)	6168 (3005 to 8867)	10269 (6758 to 13664)
South-East Asia Region (SEAR)	1633 (305 to 3351)	1166 (808 to 1572)	10441 (5521 to 16895)	18668 (706 to 38605)	15360 (7731 to 22890)	1663 (805 to 2405)	1622 (1063 to 2167)
Western Pacific Region (WPR)	19536 (3035 to 40141)	1913 (1332 to 2567)	24382 (12628 to 40562)	30852 (1192 to 62357)	29387 (14827 to 43688)	6991 (3410 to 10041)	10207 (6722 to 13574)
Low	136 (24 to 290)	33 (23 to 45)	140 (72 to 234)	1606 (60 to 3377)	759 (381 to 1133)	79 (38 to 115)	125 (81 to 167)
Lower-middle	2338 (401 to 4850)	1619 (1127 to 2172)	6238 (3295 to 10104)	28873 (1114 to 58434)	19244 (9708 to 28613)	2297 (1120 to 3301)	3944 (2596 to 5246)
Upper-middle	8033 (1291 to 16843)	2435 (1688 to 3283)	24732 (12896 to 40767)	41517 (1572 to 85784)	30656 (15430 to 45680)	6511 (3152 to 9413)	14489 (9498 to 19352)
High	60730 (11497 to 119174)	4538 (3171 to 6064)	80067 (42778 to 127816)	80755 (3170 to 160598)	66535 (33631 to 98736)	7227 (3545 to 10331)	28255 (18671 to 37450)
Total by health endpoint and income level	**71238 (13212 to 141156)**	**8626 (6008 to 11565)**	**111176 (59042 to 178921)**	**152751 (5916 to 308193)**	**117193 (59150 to 174162)**	**16114 (7855 to 23160)**	**46813 (30847 to 62215)**
Global Total (by income level)*	**523894 (182030 to 899372)**						

*Excludes double counting (see Supplementary Material).

Figure 1. Number (in million) and distribution of new cases of noncommunicable diseases and mental conditions attributed to physical inactivity, total global, 2020-2030

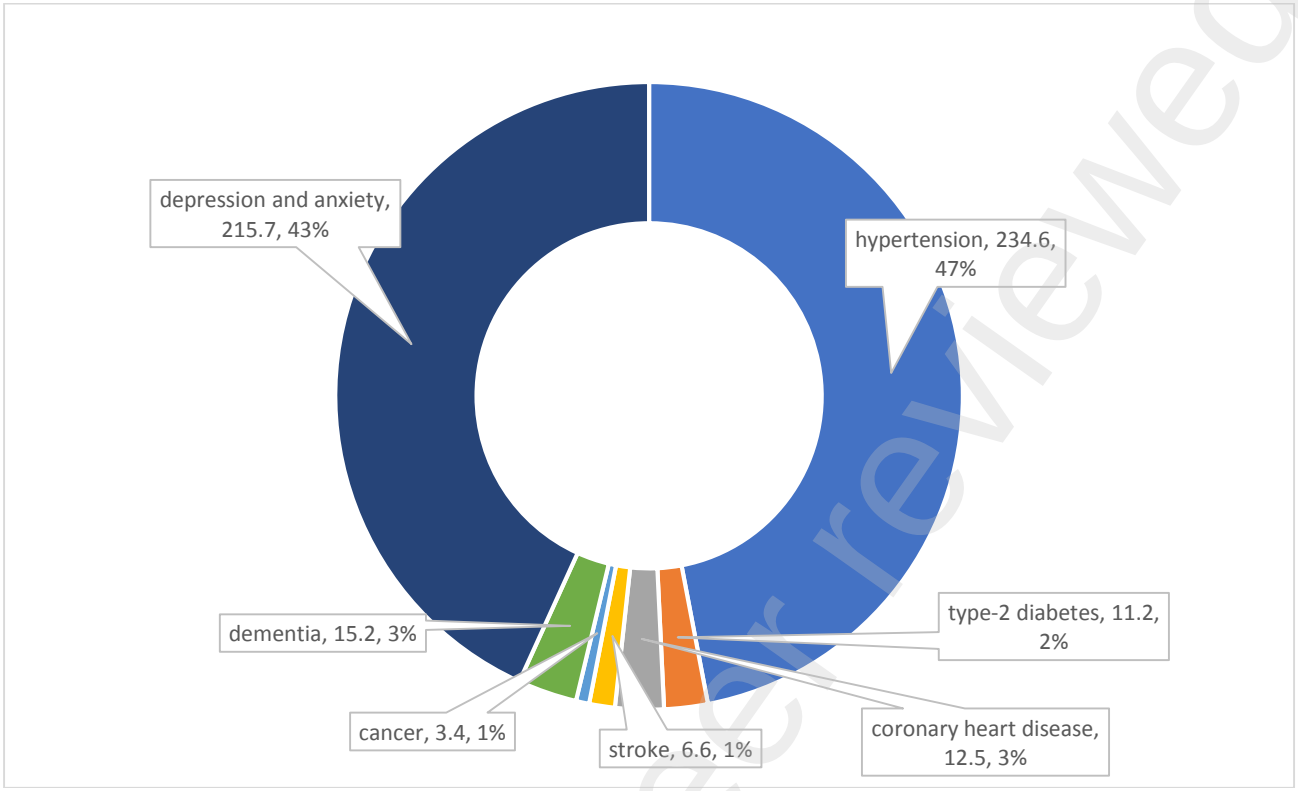

Figure 2. Number (in million) and distribution of new cases of noncommunicable diseases and mental conditions attributed to physical inactivity by WHO Regions and the World Bank country income level, 2020-2030

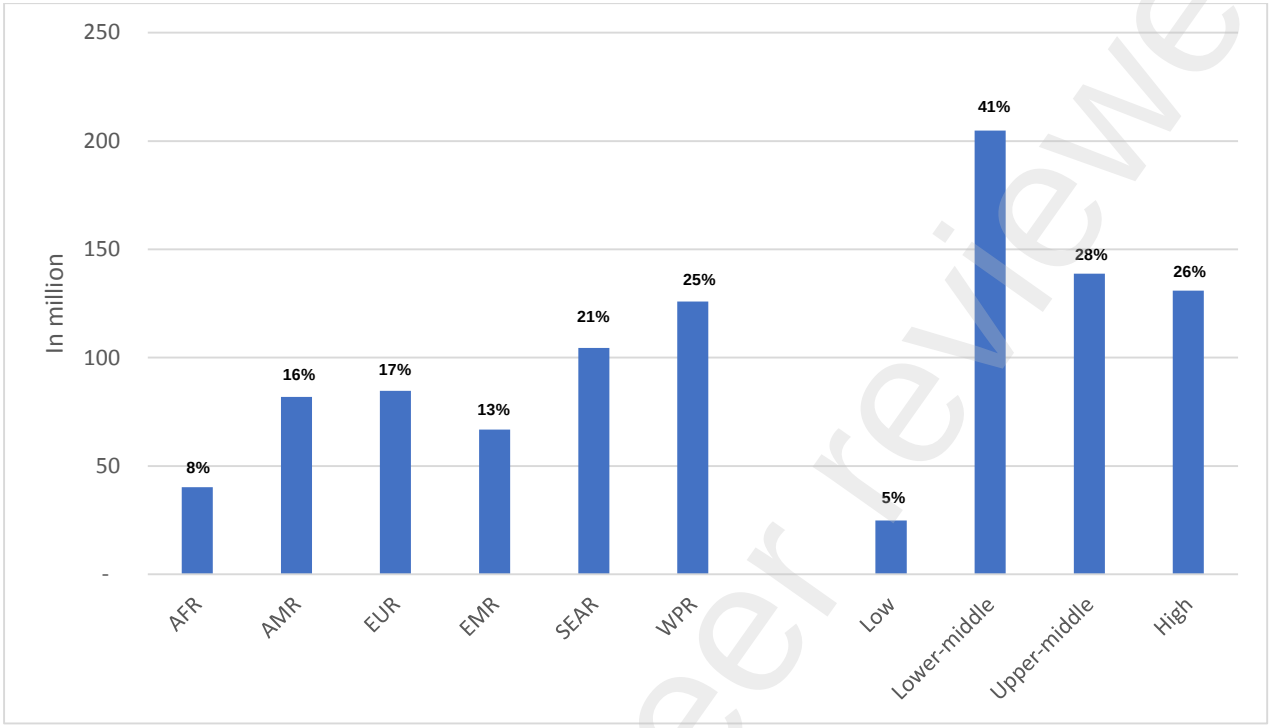

Figure 3. Distribution of new cases and direct healthcare costs of noncommunicable diseases and mental conditions attributed to physical inactivity, total global, 2020-2030

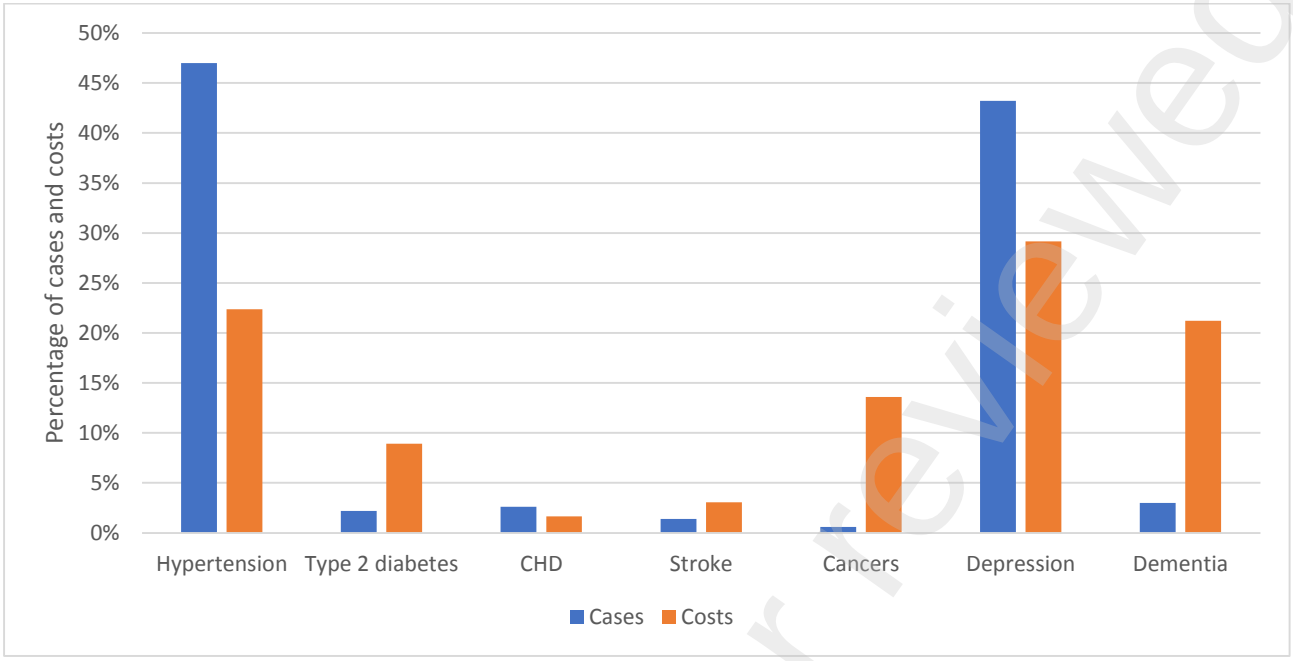

Figure 4. Costs (in INT$ billion) and distribution of direct healthcare costs of new cases of noncommunicable diseases and mental illnesses attributed to physical inactivity by the World Bank country income level, 2020-2030

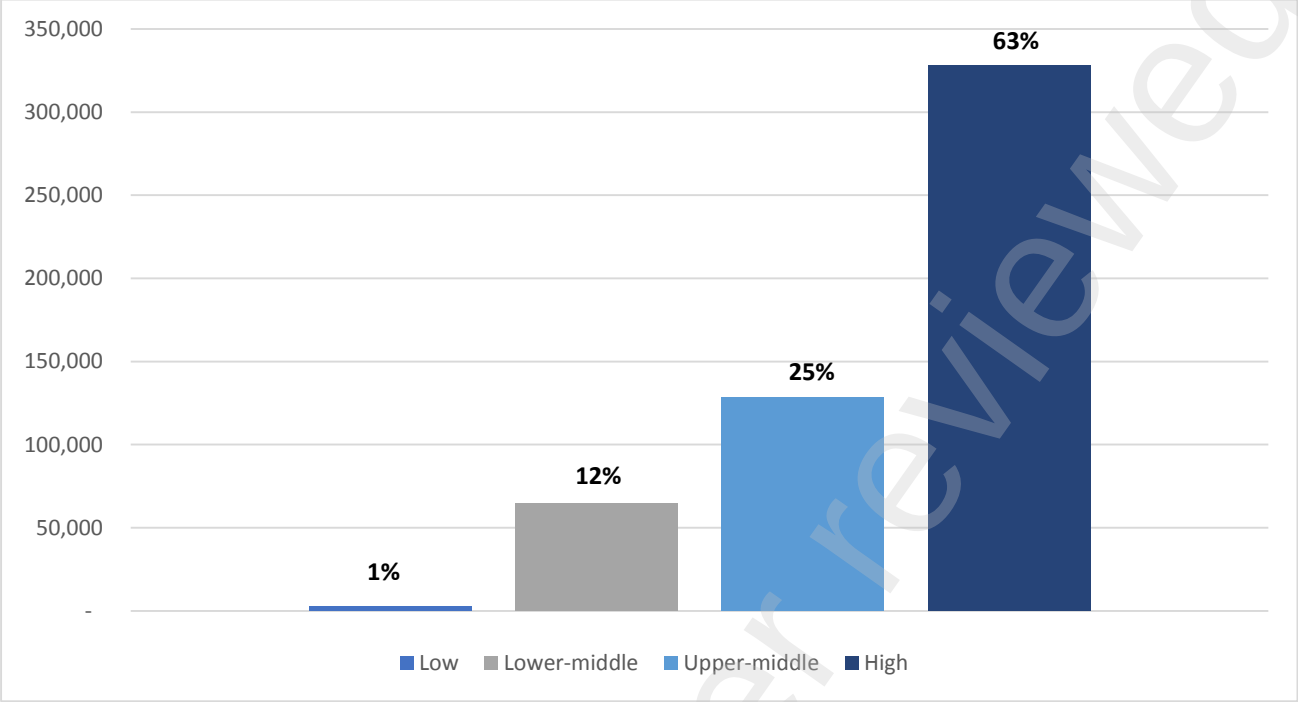

Figure 5. Total direct healthcare costs (in INT$ billion) and distribution of costs of new cases of noncommunicable diseases and mental conditions attributed to physical inactivity by WHO Regions and the World Bank country income level, 2020-2030