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# Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016

GBD 2016 Healthcare Access and Quality Collaborators

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## Summary

### Background

To bring universal health coverage (UHC) within reach of all populations, it is crucial to identify where gains in personal healthcare access and quality have occurred and where progress has faltered. Examining inequalities across and within countries, as well as key health service areas, can help identify priorities for improving personal healthcare access and quality across the development spectrum. In the present study, we use the Global Burden of Diseases, Injuries, and Risk Factors Study 2016 (GBD 2016) to assess personal healthcare access and quality with the Healthcare Access and Quality (HAQ) Index for 195 countries and territories, as well as subnational locations in seven countries, from 1990 to 2016.

### Methods

Drawing from established methods, we generated updated estimates of the HAQ Index based on risk-standardised death rates due to 32 causes that should not result in death in the presence of high-quality healthcare. In addition to improved cause of death and risk estimates from GBD 2016, we implemented three main updates for the present study. First, we measured subnational HAQ Index performance for seven countries: China, India, the USA, Brazil, Japan, Mexico, and England. Second, supported by the expansion of cancer registry data in GBD 2016, we used mortality-to-incidence ratios instead of risk-standardised death rates to provide a stronger signal on the effects of personal healthcare and access on cancer survival. Third, to provide greater stability in measurement, we transformed each cause on a scale of 0 to 100, with 0 as the 1st percentile estimated between 1990 and 2016, and 100 as the 99<sup>th</sup> percentile, rather than the minimum and maximum values observed. We used principal components analysis to construct the Healthcare Access and Quality (HAQ) Index, and compared HAQ Index levels and trends by quintiles on the Socio-demographic Index (SDI), a summary measure of overall development. As derived from the broader GBD study and other data sources, we then conducted an exploratory analysis of the relationships between national HAQ Index levels and potential determinants of performance such as health spending and utilisation of care.

### Results

In 2016, the global HAQ Index was 50.8 (95% uncertainty interval, 49.9–51.7), yet massive inequalities persisted worldwide, with scores ranging from greater than 95 in Iceland to less than 20 in the Central African Republic and Somalia in 2016. The pace of progress achieved from 1990 to 2016 substantially varied, with markedly faster improvements occurring from 2000 to 2016 for many countries in sub-Saharan Africa and Southeast Asia, whereas some places in Latin America and the Caribbean, as well as higher-SDI countries like the USA, saw progress stagnate after experiencing considerable advances in

personal healthcare access and quality from 1990 to 2000. Striking subnational disparities on the HAQ Index emerged, with China and India experiencing particularly large gaps between locations with the highest and lowest scores in 2016 (45.4 and 30.3 points, respectively). Japan recorded the smallest range in subnational HAQ performance in 2016, a 5.5-point difference spanning from 94.1 (92.7–95.2) in Tokyo to 88.4 (86.5–90.2) in Okinawa. In contrast, England saw a wider gap (19.5) between the lowest and highest levels achieved, which ranged from 96.3 (94.8–97.8) in Kensington and Chelsea to 76.8 (73.6–80.1) in Blackpool, as did the USA (ie, a 13.1-point difference between Massachusetts and Mississippi, at 90.4 [88.9–91.7] and 77.3 [74.3–80.2], correspondingly). Performance on the HAQ Index showed strong linkages to overall development, as high- and high-middle SDI countries generally had higher scores and faster gains on cancers, non-communicable diseases (NCDs) like stroke, and conditions addressed by routine surgery. Nonetheless, countries across the development spectrum saw dramatic gains on some key health service areas from 2000 to 2016, most notably vaccine-preventable diseases. In general, national performance on the HAQ Index was positively associated with higher levels of total health spending per capita, as well as health system inputs, but these relationships were quite heterogeneous, particularly among low-middle to middle SDI countries.

### **Interpretation**

GBD 2016 provides a more detailed understanding of past success and current challenges in improving personal healthcare access and quality. Despite achieving substantial gains from 2000 to 2016, many lower-SDI countries still remain at risk of falling behind in the SDG era unless heightened policy action and investments are directed toward advancing both access to and quality of healthcare across key health services. Accelerating progress for cancers, NCDs, and conditions amenable to surgery is especially critical to strengthening health systems for the next generation. Stagnating or minimal improvements experienced by several low-middle to high-middle SDI countries likely reflect the complexities of re-orienting healthcare beyond the more limited foci of the Millennium Development Goals. The pursuit of UHC hinges upon improving both access and quality worldwide, and thus requires adopting a more comprehensive view – and subsequent provision – of high-priority, effective healthcare for all populations.

### **Funding**

Bill & Melinda Gates Foundation

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## Research in Context

### Evidence before this study

85 Improving – and subsequently measuring – healthcare access and quality has emerged as an increasing  
priority alongside a heightened emphasis on making progress toward universal health coverage (UHC) in  
the Sustainable Development Goal (SDG) era. Nevertheless, few studies have sought to assess personal  
healthcare access and quality across a wide range of key health service dimensions and the  
development spectrum. Past work by the European Union, the Organisation for Economic Co-operation  
and Development (OCED), and other high-income countries has used amenable mortality – deaths from  
90 causes that should not occur in the presence of high-quality health care – to provide a strong signal on  
national levels of personal healthcare access and quality. Drawing from the Global Burden of Diseases,  
Injuries, and Risk Factors Study 2015 (GBD 2015), the GBD collaboration offered the first-ever  
application of this amenable mortality framework across a wide range of countries and over time. In its  
development of the Healthcare Access and Quality (HAQ) Index, GBD 2015 offered several major  
95 improvements from previous studies on measuring personal healthcare access and quality. First, the  
extensive cause of death standardisation processes that occurred as part of the GBD study enabled  
comparison across locations and over time. Second, risk-standardising death rates for environmental  
and behavioural risk factors helped isolate differences in healthcare access and quality from variations in  
death rates due to background risk exposure. Third, estimating the HAQ Index for 195 countries and  
100 territories from 1990 to 2015 allowed for a broader investigation of trends in personal healthcare access  
and quality. Despite these methodological strengths, additional areas for improvement were identified,  
including the consideration of health outcomes that more directly reflect the progression of disease  
onset to mortality for amenable causes, and examining subnational inequalities in personal healthcare  
access and quality.

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### Added value of this study

Based on updated cause of death and risk factor estimates from the GBD 2016 study, the present  
analysis provides an improved assessment of national levels of personal healthcare access and quality  
from 1990 to 2016. For the first time, we quantify subnational levels and trends on the HAQ Index for  
110 seven countries: China, India, the USA, Brazil, Japan, Mexico, and England. Due to major improvements  
in cancer estimation since 2015, we use mortality-to-incidence ratios (MIRs) rather than risk-  
standardised death rates due to cancer to provide a more robust approximation of cancer detection and  
treatment effects across countries. To improve index stability, we utilise percentiles (ie, 1st and 99th  
percentile) for transforming HAQ Index components to a scale of 0 to 100 rather than taking the  
115 absolute minimum and maximum values to set these thresholds. Finally, we conduct an exploratory  
analysis of national HAQ Index levels and potential determinants of performance, examining  
relationships between the HAQ Index and indicators focused on health financing (eg, total health  
spending per capita and government health spending) and health system workforce or use (eg,  
physicians per 1,000 and inpatient utilisation rates).

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### Implications of all the available evidence

Globally, personal healthcare access and quality improved substantially since 1990, with many countries accelerating their pace of progress between 2000 and 2016. Such gains in the more recent time period may reflect the catalytic effects of the Millennium Development Goals and their focus on a subset of health service areas (ie, vaccine-preventable diseases, infectious diseases, and maternal and child health). Nonetheless, inequalities increased in some parts of the world, particularly as many low-to-middle income countries saw much slower gains for cancers, other non-communicable diseases, and conditions targeted by routine surgery. Large disparities in subnational levels of personal healthcare access and quality emerged for several countries, especially China and India. These results emphasise the urgent need to improve both access to and quality of healthcare across service areas and for all populations within countries. Otherwise, gains toward UHC may be short-lived, and health systems could face widening gaps between the health services they provide and disease burden experienced by local communities. Going forward, the HAQ Index can provide a robust measure for monitoring the effects of policy action on personal healthcare access and quality, a vital component of achieving overall UHC. To deliver health systems for the next generation and hasten progress in the SDG era, now is the time to align investments for improving access and quality across the full range of healthcare needs.

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## Introduction

165 Providing access to high-quality personal healthcare is among the foremost objectives of a health system, as the receipt of effective personal healthcare can substantially improve many health outcomes and avert premature mortality. Advancing population health was elevated to global policy agendas with the Alma Ata Declaration of 1978, wherein WHO called for achieving “Health for All” by 2000.<sup>1</sup> Such aspiration has garnered new momentum in the Sustainable Development Goal (SDG) era,<sup>2</sup> with a heightened emphasis on attaining universal health coverage (UHC) and ensuring that “no one is left behind” in this pursuit. Foundational to UHC is access to high-quality personal healthcare for all populations, as UHC cannot be considered achieved if individuals lack access to care, or if populations can only access poor-quality health services. To deliver on this ambition, it is crucial to monitor where advances have occurred – and where progress must be accelerated – in improving personal healthcare access and quality across the development spectrum.

175 Measuring healthcare access and quality has become an increasingly important priority alongside its ascent in global health policy. In particular, the use of “amenable mortality” – deaths from causes that should not occur in the presence of timely, effective medical care – to approximate national levels of personal healthcare access and quality has gained greater traction in both research and policy-focused assessments.<sup>3–13</sup> As part of the Global Burden of Diseases, Injuries, and Risk Factors Study 2015 (GBD 180 2015), the GBD collaboration offered the first systematic application of the amenable mortality framework to measure personal healthcare access and quality across 195 countries and territories from 1990 to 2015.<sup>14</sup> By generating comparable cause-of-death estimates and accounting for variations in risk factor exposure beyond the health system,<sup>15,16</sup> the GBD study supported the development of a novel 185 measure – the Healthcare Access and Quality (HAQ) Index – to track gains and gaps on national levels of personal healthcare access and quality.<sup>14</sup>

The use of GBD to measure personal healthcare access and quality with the HAQ Index offered several strengths and insights, all of which have prompted engagement around further advances. First, the HAQ 190 Index is based on 32 causes considered amenable to healthcare, representing a range of key health service areas: vaccine-preventable diseases; infectious diseases and maternal and child health, cancers, a broader set of non-communicable diseases (NCDs); and conditions from which routine surgery can easily avert death (eg, appendicitis and hernia). Outside of higher-income countries, past work rarely encompasses this wide array of healthcare services,<sup>17</sup> even though highly effective medical technologies, 195 diagnostics, and treatment exist; instead, they often limit their focus to infectious diseases and maternal and child health and thus fail to fully account for potential challenges in healthcare access and quality across service areas. Second, because the GBD study quantifies risk exposure and risk-attributable deaths for each location over time, we can account for local variations in risk exposure and better isolate differences in death rates related to personal healthcare access and quality. Even with the advantages of 200 this risk-standardisation approach, challenges can still exist in ensuring that measures of cause-specific fatal outcomes provide a strong signal on healthcare access and quality. For instance, in the absence of stronger monitoring systems, low rates of cancer mortality may more directly reflect inadequate detection and treatment of cancer rather than good access to high-quality cancer care.<sup>18</sup> Third, while

205 some insights into the relationship between the HAQ Index and sociodemographic development were explored in GBD 2015, further examination of how health financing and health system measures such as workforce and utilisation are related to the HAQ Index has yet to occur. For instance, much debate exists concerning the relative contribution of supply- and demand-side factors to personal healthcare as they relate to access (eg, proximity of health facilities to communities and reduction of financial barriers to accessing care), as well as macro-level influences that ultimately affect the ease with which  
210 individuals can receive the care they need (eg, government health spending, human resources for health, insurance coverage).<sup>19–21</sup> Last, GBD 2015 highlighted marked inequalities in personal healthcare access and quality across countries, with the gap between the lowest and highest HAQ Index levels achieved growing from 1990 to 2015.<sup>14</sup> At the same time, given the magnitude by which health outcomes can vary within countries,<sup>22–28</sup> measuring subnational differences in healthcare access and  
215 quality was viewed as an important next step for the GBD study.

In the present study, we provide updated estimates from 1990 to 2016 for the HAQ Index in 195 countries and territories, as well as global and regional levels. For the first time, we produce subnational estimates of the HAQ Index for seven countries, allowing for a more in-depth examination of inequalities  
220 in personal healthcare access and quality. With the improved estimation of cancers in GBD 2016, we use mortality-to-incidence ratios (MIRs) for cancers to better reflect potential differences in cancer diagnostic and treatment capacity across locations. Last, we conduct an exploratory analysis of the associations between the HAQ Index and potential determinants of performance, including total health spending and health system indicators such as utilisation of care.

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## Methods

### Overview

Drawing from the methods established in GBD 2015, our analysis involved four main steps: (1) mapping  
230 the Nolte and McKee cause list to GBD causes; (2) constructing MIRs for cancers and risk-standardising non-cancer death rates to remove variations in mortality not directly amenable to personal healthcare; (3) calculating the HAQ Index based on principal components analysis (PCA); and (4) examining associations between national HAQ Index scores and potential determinants of performance. More detail is provided below, as well as in the appendix (pp 9–13).

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For the first time, we report HAQ Index results for 195 countries and territories, as well as the subnational level for China (33 provinces), India (31 states and union territories), the USA (50 states and the District of Columbia), Brazil (26 states and the Distrito Federal), Japan (47 prefectures), Mexico (32 states), and England (150 local government areas). We also provide aggregated estimates at the global,  
240 GBD super-region, and GBD region levels from 1990 to 2016.

Our study draws from GBD 2016 results,<sup>29,30</sup> which entailed a number of improvements since GBD 2015; such advances include an increase of 169 new country-years of vital registration data, 528 new cancer-registry country years with a total of 92 country cancer registries,<sup>29</sup> five new risk factors and 93

245 additional risk-outcome pairs,<sup>30</sup> and substantial improvements in cause-specific mortality modelling (eg, cancers, tuberculosis).<sup>29</sup> Further information on these updates is found in the appendix (pp 9-89) and the GBD 2016 capstone series.<sup>29,30</sup> As with all revisions of the GBD study, GBD 2016 estimates for the full time series on the HAQ Index published here supersede previous iterations. This analysis complies with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER);<sup>31</sup> additional information is included in the appendix (pp 6-8).

### **Mapping the Nolte and McKee amenable cause list to GBD causes**

Based on the Nolte and McKee list of causes considered amenable to personal healthcare,<sup>5-8</sup> we mapped 32 out of 33 causes to the GBD cause list as they corresponded with International Classification of Diseases codes (appendix p 134). The GBD cause list includes thyroid diseases within a larger residual category, and only nonfatal outcomes are estimated for benign prostatic hyperplasia; subsequently, these causes were not included. GBD provides separate estimates for diphtheria and tetanus, so we disaggregated these causes from the original Nolte and McKee list.

### **260 Mortality-to-incidence ratios for cancers**

For GBD, cancer mortality estimates are informed by MIRs derived from incidence data recorded in cancer registries; more detail on MIR estimation can be found in the appendix (pp 41-49).<sup>29</sup> MIRs provide an approximation of cancer survival and have been used to determine whether countries have higher or lower rates of cancer mortality relative to incidence.<sup>18,32</sup> Due to the quantity and quality of cancer registry data included in GBD, we tested the use of cancer-specific MIRs instead of risk-standardised death rates in the present analysis. As detailed in the appendix (p 11), the relationship between cancer-specific MIRs and the Socio-demographic index (SDI), a measure of overall development, was significantly stronger than risk-standardised death rates (eg,  $r = -0.94$  for colon and rectum cancer MIRs and SDI, as compared with  $r = 0.38$  for risk-standardised death rates). This result, and the distribution of MIRs by SDI quintile (appendix pp 91-106), demonstrated that cancer MIRs provided a more robust signal on personal access to and quality of cancer services than the risk-standardised death rates.

### **Risk-standardisation of death rates for non-cancer causes**

275 To better isolate potential differences in cause-specific mortality associated with healthcare access and quality from differences associated with underlying risk exposure, we risk-standardised cause-specific deaths to the global level of exposure for risk factors measured in GBD 2016.<sup>30</sup> We did not risk-standardise differences in exposure to three metabolic risk factors – high systolic blood pressure, total cholesterol, and fasting plasma glucose – given these risks' amenability to personal healthcare access and quality. For non-cancer causes (24 causes) we risk-standardised death rates by removing the joint effects of location-specific behavioural and environmental risk exposure, and replaced these estimates with the global level of joint risk exposure (appendix p 10).

285 Joint PAF estimation accounts for effects of multiple risks combined, including the mediation of different risk factors through each other. More detail on the calculation of joint PAFs is provided in the appendix (p 10). Since GBD 2015,<sup>16</sup> 89 risk-outcome pairs and five risk factors were added; most notable was the



inclusion of low birth weight and short gestation as a risk factor for GBD 2016, which enabled the risk-standardisation of deaths due to neonatal disorders. Mortality attributable to unsafe water and sanitation was estimated for higher-income locations in GBD 2016, also supporting the appropriate risk-standardisation of diarrhoeal disease deaths across locations. PAFs were not calculated for seven causes included in this analysis (ie, diphtheria, tetanus, whooping cough, appendicitis, hernia, congenital heart anomalies, and adverse effects of medical treatment); subsequently, risk-standardised death rates due to these causes equalled observed death rates.

### 295 **Age-standardisation**

Based on the GBD world population,<sup>33</sup> we age-standardised risk-standardised death rates, as well as cancer mortality and incidence estimates, prior to producing MIRs. We rescaled age weights to equal 1 by cause, a necessary step since the age groups for which cause-specific deaths are considered amenable to healthcare represented a subset of the age groups comprising the world population standard.

### **Constructing the Healthcare Access and Quality Index**

By cause, we first transformed log age-standardised risk-standardised death rates (or age-standardised MIRs for cancers) to a scale of 0 to 100 across countries and territories from 1990 to 2016. Zero was determined by the 1<sup>st</sup> percentile observed (ie, highest death rates or MIRs), while 100 was applied to the 99<sup>th</sup> percentile. This scaling approach differs somewhat from that of GBD 2015,<sup>14</sup> wherein maximum and minimum values set the 0 and 100 bounds, respectively. Using a percentile-based approach more closely aligns with other index construction methods used in GBD and elsewhere,<sup>34</sup> and is less sensitive to outliers or fluctuations in estimates over time. Cause-specific scaling thresholds derived from the 195 countries and territories were applied to all subnational locations.

We used PCA to construct the HAQ Index; all rescaled PCA weights are reported in the appendix (p 135). The PCA-derived HAQ Index in this analysis differed in two main ways from the GBD 2015 HAQ Index. First, no cause had negative PCA weights (ie, implying that higher death rates were associated with better access to and quality of healthcare), and thus all causes were included in the overall index. In GBD 2015, colon and breast cancers had negative PCA weights in the first PCA iteration, which led to their weights being set to zero in the final PCA-derived HAQ Index. Second, a number of cancers had similar PCA weights to several communicable, maternal, and neonatal causes, which meant these causes comparably contributed to the overall index. We view this more equal weighting as a substantial improvement in approximating personal healthcare access and quality across a wider range of key health service areas.

### **Examining potential determinants of HAQ Index performance**

The HAQ Index reflects the culmination of factors that affect personal healthcare access and quality across levels of care and therapeutic areas; subsequently, it is challenging to distinguish the relative contribution of personal healthcare access versus quality or other potential determinants for a given location or point in time. Nonetheless, it is important to consider how different factors may relate to overall HAQ Index performance, as their appropriate redress will likely necessitate policy actions.<sup>19</sup> To

330 provide an initial examination of how national HAQ Index scores may be associated with potential  
determinants of performance, we compared location-specific HAQ Index values with three financial  
measures<sup>35</sup> (total health spending per capita, government spending as a fraction of total health  
spending, and out-of-pocket spending as a fraction of total health spending) and three health system  
indicators (physicians per 1,000,<sup>36</sup> hospital beds per 1,000, and inpatient utilisation rates, as defined by  
annual admissions to a health facility for one night or longer per capita<sup>37</sup>).

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### **Comparing performance on the HAQ Index across the development spectrum**

In addition to examining global patterns, we report on differences on the HAQ Index across levels of  
development. To do this, we use SDI, a summary measure of overall development that was originally  
introduced as part of GBD 2015.<sup>15</sup> SDI is based on income per capita, mean years of education among  
340 populations 15 years and older, and total fertility rates, on a scale of 0 to 1. We use the SDI quintiles  
established in the GBD study to compare performance and progress on the HAQ Index. More details on  
the estimation of SDI can be found elsewhere.<sup>29</sup>

### **Uncertainty analysis**

345 GBD aims to propagate all sources of uncertainty through its estimation process, which results in  
uncertainty intervals (UIs) accompanying each point estimate reported. We estimated the HAQ Index for  
each location-year based on 1000 draws from the posterior distribution for each included cause of  
death. 95% UIs were based on the ordinal 25th and 975th draws for each measure.

### **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.

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## **Results**

### **National and subnational patterns in personal healthcare access and quality**

The global HAQ Index reached 50.8 (49.9–51.7) in 2016, yet levels varied substantially across countries  
(figure 1). Iceland, Canada, Australia, New Zealand, Japan, and several western European countries  
360 including Norway, Switzerland, and the Netherlands composed the highest decile of HAQ Index  
performance in 2016. A more geographically diverse set of countries were in the ninth decile, including  
Singapore, Taiwan (Province of China), South Korea, Greece, Malta, Israel, Lebanon, the UK, and the  
USA. Both smaller states and populous countries comprised the eighth and seventh deciles, spanning  
from Cuba, Costa Rica, and Sri Lanka to China and Russia. Several countries in Latin America and the  
365 Caribbean, including Mexico, Brazil, Nicaragua, and Panama, improved to the sixth and fifth deciles by  
2016. Southeast Asian countries ranged from the seventh decile with Thailand to the third decile  
(Cambodia, Indonesia, Laos, Myanmar) in 2016, while South Asian countries were in the fourth  
(Bangladesh and Nepal) and third deciles (Bhutan, India, and Pakistan). By 2016, sub-Saharan African  
countries occupied the first to fourth deciles, reflecting substantive gains over time (figure 1; appendix

370 pp 107-108): South Africa, Botswana, and Equatorial Guinea rose to the fourth decile, and several  
countries improved to the third decile (eg, Kenya, Namibia, Nigeria, Ghana). Nonetheless, many African  
countries remained in the first decile over time, particularly in areas of central and eastern sub-Saharan  
Africa (eg, the Central African Republic, Chad, South Sudan, Somalia), as well as southern sub-Saharan  
Africa (Lesotho and Zimbabwe). Outside of Africa, two countries – Afghanistan and Papua New Guinea –  
375 were in the lowest decile of HAQ Index performance in 2016.

Sizeable subnational inequalities on the HAQ Index emerged for several countries in 2016 (figure 2). For  
China, scores on the HAQ Index differed by more than 40, ranging from 88.7 (86.4–90.9) in Beijing to  
43.6 (39.0–49.7) in Tibet. Hong Kong and several eastern provinces equaled or exceeded 80 in 2016,  
380 whereas western provinces were generally closer to or less than 60. Across states in India, Goa and  
Kerala ranked the highest, each surpassing 60, followed by Delhi (52.1 [47.6–56.5]) in 2016. Assam,  
Odisha, Uttar Pradesh, and Chhattisgarh occupied India’s first decile, while other northern and  
northeastern areas of India also had comparatively lower HAQ Index scores in 2016. Brazil and Mexico  
also experienced relatively large subnational disparities, with states ranging from 71.1 (67.9–74.0) in  
385 Distrito Federal to 50.6 (47.4–54.2) in Maranhão for Brazil, and 68.4 (65.3–71.4) in Nuevo León to 51.2  
(48.1–54.7) in Chiapas for Mexico. In Brazil, higher HAQ Index performance was primarily concentrated  
among southern states, while the country’s first and second deciles were mainly composed of northern  
states and Acre. For Mexico, states in the tenth and ninth deciles included those bordering the USA and  
Mexico City, whereas the lowest scores were largely found in southern states, including Oaxaca and  
390 Guerrero. State-level HAQ Index scores in the USA spanned from a high of 90.4 (88.9–91.7) in  
Massachusetts to a low of 77.3 (74.3–80.0) in Mississippi. Northeastern states, as well as those on the  
west coast, Minnesota, and Colorado, recorded the highest HAQ Index values for the USA, while  
southeastern states and those located in Appalachia (eg, Alabama, Arkansas, and West Virginia)  
generally had the lowest scores in 2016. In contrast, Japan experienced far fewer subnational  
395 differences, with prefectures only ranging from 94.1 (92.7–95.2) in Tokyo to 88.4 (86.5–90.2) in  
Okinawa. For England, HAQ Index performance spanned from a high of 96.3 (94.8–97.8) in Kensington  
and Chelsea – a level rivaled only by Iceland in 2016 – to a low of 76.8 (73.6–80.1) in Blackpool. Higher  
HAQ Index scores were generally found in southeastern England, whereas lower performance was more  
dispersed across northern England and metropolitan areas near Birmingham and Manchester and the  
400 eastern boroughs of London. Subnational maps for each country comparing 1990 and 2000 HAQ Index  
values to levels achieved in 2016 are found in the appendix (pp 109-115).

Patterns of performance on the overall HAQ Index and health areas varied considerably across countries  
in 2016 (figure 3). Locations that scored approximately 90 or above on the HAQ Index – the leading 20  
405 countries – generally had high scores across broader causes, including vaccine-preventable diseases,  
infectious diseases and maternal and child health, and causes associated with routine surgeries and  
more complex case management (eg, epilepsy, diabetes, and chronic kidney disease). Nonetheless,  
many of these high performers experienced lower scores on cancers and some NCDs. Greater  
heterogeneity surfaced across cause groups for countries that scored below 90 on the HAQ Index,  
410 though many locations achieved greater consistency – and high scores – for vaccine-preventable  
diseases and causes for which routine surgeries could easily avert death (eg, appendicitis and hernias).

For these countries, a mixture of relatively low values on cancers and some NCDs and then comparably better performance on other health areas was commonplace. Among countries with the lowest HAQ Index levels in 2016, most fared poorly across health areas and recorded particularly low scores on  
415 cancers, some infectious causes like tuberculosis, and maternal and child health. Nonetheless, many of these countries still exceeded 90 for some vaccine-preventable diseases, such as diphtheria, tetanus, and measles.

### **Progress on personal healthcare access and quality**

420 While 186 out of 195 countries and territories recorded significant increases on their HAQ Index between 1990 and 2016, disparities between the highest and lowest scores grew (76.5 in 1990 and 80.9 in 2016) (figure 4A). Low-middle SDI countries saw the largest widening of inequalities since 1990, with HAQ Index scores ranging from 24.9 to 64.9 in 2016 – the equivalent of the first to sixth deciles of global performance. Conversely, the gap between the highest and lowest HAQ Index levels narrowed among  
425 middle SDI countries from 1990 (45.4) to 2016 (34.8). High-SDI countries also experienced a reduction in absolute inequality over time, decreasing from a difference of 32.3 in 1990 to 26.4 in 2016.

Within countries, improvements on the HAQ Index and changes in absolute inequalities over time varied markedly (figure 4B). For example, in the USA, the gap between the highest and lowest HAQ Index levels  
430 decreased considerably since 1990, but little overall progress occurred between 2000 and 2016. Japan, on the other hand, both narrowed absolute differences between prefectures and accelerated progress from 2000 to 2016. For England, disparities increased since 1990, with some UTLAs surpassing Japan's highest levels, while others fell below or equaled the lowest HAQ Index scores in the USA for 2016. China's notable advances on the HAQ Index were hastened by gains since 2000. Although absolute  
435 differences across Chinese provinces remained quite large in 2016 (a 45.1-point difference), the lowest provincial estimate improved by 17.4 (12.7–22.0) from 2000 to 2016. Notably, China's wide range in HAQ Index performance led to Beijing and Hong Kong achieving levels comparable to many states in the USA; at the same time, Tibet remained well below the lowest HAQ Index scores observed in Brazil and Mexico in 2016. Mexico's progress on the HAQ Index was much faster from 1990 to 2000 than 2000 to  
440 2016. In Brazil, state-level disparities also somewhat widened since 2000, rising from an absolute difference of 17.1 to 20.5 in 2016. India's improvements on the HAQ Index hastened between 2000 and 2016, though the gap between the country's highest and lowest scores grew over time.

Several middle SDI countries, including China, the Maldives, Peru, and Equatorial Guinea, achieved some  
445 of the most pronounced gains on the HAQ Index between 1990 and 2016 (appendix p 116). South Korea, Taiwan, Singapore, and Poland recorded the largest improvements among high SDI countries, while Lebanon, Turkey, and Saudi Arabia documented the fastest progress among middle SDI countries during this time. For many low-middle and low SDI countries, their advances on the HAQ Index either primarily took place or accelerated between 2000 and 2016 (figure 5). Bangladesh, Myanmar, Bhutan, and  
450 Cambodia (low-middle SDI), and Rwanda and Ethiopia (low SDI), exemplified this trend. A number of countries, such as Bolivia and Guatemala, recorded more similar absolute levels of change during each time period, while others, including several Caribbean islands, experienced stalling progress after making considerable gains from 1990 to 2000. Table 2 provides estimates of absolute change and

455 annualised rates of change for 1990–2000, 2000–2016, and 1990–2016 for each location, as well as HAQ Index values for each year.

Focusing on 2000 to 2016, examining patterns in how places improved across broader health categories highlights a mixture of progress and potential for worsening performance if past trends are not addressed (appendix pp 123-128). Across locations, the most pronounced improvements since 2000 were primarily found for vaccine-preventable diseases; some infectious diseases (eg, diarrhoea); conditions targeted by routine surgeries; and a subset of cancers (eg, leukaemia). Such gains were especially striking among countries that recorded the largest increases in their HAQ Index performance between 2000 and 2016 (eg, China, Turkey, Rwanda). For high and high-middle SDI countries, considerable improvements also were found more consistently across cancers and cardiovascular diseases. At the same time, for most low-to-middle SDI countries, progress was far less pronounced on cancers, conditions amenable to routine surgery, and a range of NCDs, including cardiovascular diseases and causes that can require more complex case management. Further, countries that experienced relatively minimal progress on the overall HAQ Index since 2000 also saw comparatively small advances, even for health areas where improvements have been more widespread. The main exception was vaccine-preventable diseases, especially measles, for lower-SDI countries.

### **Examining potential determinants of HAQ Index performance**

In comparing national HAQ Index scores with potential determinants of performance (figure 6; appendix pp 129-131), we found that total health spending per capita was positively related to the HAQ Index ( $r=0.93$ ), but massive variation existed at similar levels of health spending. For countries with an HAQ Index of 30 to 60, total health spending per capita spanned at least a five times difference in spending with similar levels of performance. For government health spending and out-of-pocket spending as a fraction of total health spending (appendix pp 129-130), patterns differed by SDI quintile. Among high and high-middle SDI countries, higher HAQ Index scores were generally associated with a higher proportion of total health spending from government and a lower fraction from out-of-pocket spending. However, among low-to-middle SDI countries, the relationships between government and out-of-pocket spending as a fraction of total health spending were far from consistent. For instance, countries with an HAQ Index of 50 or lower ranged from having less than 5% to nearly 75% of total health spending per capita as out-of-pocket. Hospital beds and physicians per 1,000 population had moderately positive associations with the HAQ Index across SDI quintiles ( $r=0.63$  and  $r=0.78$ , respectively), and inpatient utilisation rates were also moderately related to country-level HAQ Index performance ( $r=0.65$ ). However, sizeable heterogeneity emerged across these health system measures and their relationships to the HAQ Index, particularly among middle-to-high SDI countries.

490

## **Discussion**

### **Summary of findings**

Amid overall global gains on personal healthcare access and quality, striking disparities remained in terms of levels achieved by 2016 and how quickly locations improved over time. In 2016, HAQ Index

495 performance diverged along the development spectrum, ranging from more than 94 in Iceland, Norway, Australia, Luxembourg, and the Netherlands to less than 20 in the Central African Republic and Somalia. Subnational inequalities on the HAQ Index were particularly pronounced in China and India, though higher-income countries such as England the USA also saw considerable gaps between the highest and lowest levels reached in 2016. The global pace of progress accelerated from 2000 to 2016, a trend  
500 fueled by many lower-SDI countries in sub-Saharan Africa and Southeast Asia. In contrast, several countries, particularly in Latin America and the Caribbean, saw slowed or minimal improvement from 2000 to 2016 after recording larger gains from 1990 to 2000. Examining patterns in broader health services unveiled large differences in how countries improved performance on key healthcare needs – vaccine-preventable diseases, infectious and maternal and child health, cancers, NCDs, and conditions  
505 amenable to surgical interventions – over time. These findings, coupled with the variable relationships between national HAQ Index scores and potential determinants of performance, emphasise both the complexity and urgent need for reorienting health systems toward providing access to high-quality care across all priority health service areas.

#### 510 **Inequalities in personal healthcare access and quality within countries**

Our first-ever subnational assessment of personal healthcare access and quality stresses the importance of monitoring healthcare gaps and gains at more local levels. Further, because some factors related to personal healthcare access and quality could be more uniform within countries due to country-level policy or healthcare characteristics (eg, national health insurance schemes, federally maintained hospital  
515 or referral systems), this analysis can offer more nuanced insights into where challenges in access to personal healthcare – versus or in addition to quality – may be most prevalent. For instance, subnational differences on the HAQ Index in Mexico could be more related to state-level variations in quality of care than widespread barriers to accessing care in relation to insurance coverage.<sup>38,39</sup> Similar factors may underlie disparities found in England, where the UK’s National Health Service (NHS) ought to minimise  
520 financial barriers to accessing healthcare across the country.<sup>40</sup> Nonetheless, other obstacles to accessing personal healthcare in both Mexico and England, such as inadequate utilisation of care across Mexican states<sup>41</sup> and human resource constraints in many UK localities,<sup>40</sup> may contribute to or exacerbate potential HAQ Index inequalities. The dramatic disparities found in China and India likely represent a culmination of factors, including large subnational variations in physical access to health facilities, health  
525 system infrastructure and adoption of medical technologies, and provision of effective care. Past work in Brazil suggests that the expansion of community-based health programmes and governance functions reduced amenable mortality across municipalities from 2000 to 2012,<sup>13</sup> which corresponds with state-level improvements on the HAQ Index. However, state-level progress on the HAQ Index was generally faster from 1990 to 2000 than from 2000 to 2016, pointing to potential challenges in improving quality  
530 of care across health service areas – especially NCDs – alongside Brazil’s likely advances in access.

The relatively minimal differences observed across prefectures in Japan, as well as narrowing of disparities since 1990, may reflect the country’s longstanding commitment to UHC.<sup>42</sup> In contrast, despite its high health spending per capita, the USA saw relatively large state differences on the HAQ Index.  
535 These results may be associated with the widely acknowledged challenges that the USA faces in providing good access to healthcare for all populations,<sup>12,43</sup> as well as potential disparities in quality of

care available in poorer regions of the country. Notably, three places in the USA – California, New York, and the District of Columbia (DC) – had the largest gains during both time periods, with the District of Columbia having the lowest HAQ Index performance in the USA in 1990. Reforms that began in the late 1990s to improve access to healthcare in DC may be related to its marked progress,<sup>44</sup> whereas the negligible advances found in states such as West Virginia and Kentucky from 2000 to 2016 may reflect the challenges – or complacency – in improving personal healthcare access and quality in much of Appalachia.<sup>45</sup> As future iterations of the GBD study endeavour to support subnational burden of disease assessments for more countries, we aim to expand more locally focused monitoring of personal healthcare access and quality in tandem.

### **Pace of past progress and strengthening health systems for the next generation**

Current analyses of the HAQ Index represent the culmination of past investments and policy actions on personal healthcare access and quality, and subsequently offer an important entry point for strengthening health systems for the future. Recent demographic and epidemiologic trends point to populations living longer and with higher disease burden worldwide,<sup>46</sup> which portends an escalation of healthcare challenges across the development spectrum in the absence of immediate, deliberate intervention.

Historically, focus areas of the global health community centred around primary health care facilities and first-level hospitals, directing political and financial attention to a narrower set of health service areas (ie, vaccine-preventable diseases, infectious diseases, and maternal and child health). The world's successes in scaling up vaccine coverage, early diagnosis and treatment of infectious disease (eg, antibiotics for lower respiratory infections), and improving access to and quality of maternal care and delivery are illustrated by the acceleration of HAQ Index performance in many low-to-middle SDI countries during the Millennium Development Goal (MDG) era. Such rapid advances were particularly pronounced in Southeast Asia (eg, Bangladesh, Myanmar, Cambodia, and Timor-Leste) and some sub-Saharan African countries like Rwanda and Ethiopia. The exact drivers of these improvements vary by country and context (eg, Timor-Leste emerged from years of conflict in the late 1990s; political strife and the HIV/AIDS epidemic devastated health systems in many sub-Saharan African countries during the 1990s and early 2000s), but it is likely that a combination of domestic policy action and an influx of international development assistance for health (DAH) fueled accelerated progress since 2000.<sup>47</sup>

In parallel, the poor availability and/or slow adoption of healthcare technologies and advances to treat cancers, NCDs, and operable conditions may explain many countries' relatively slower gains or minimal advances for these key service areas – a warning sign for how these countries' health systems are evolving alongside changes in population health needs. Performance on cancers and causes targeted by routine surgeries showed a strong divide among high-SDI countries and low-to-middle SDI locations, likely reflecting inadequate prioritisation of and investments in improving referral and specialty health services alongside advancing primary care initiatives in the past. The gains made against vaccine-preventable diseases and other causes in the MDG era must be sustained in the future, but not at the expense of preparing health systems for the next generation. The HAQ Index and performance on broader health service areas can provide signals on both strengths and weaknesses across healthcare

580 levels and platforms of care (eg, primary care versus referral hospitals for oncology), as well as insights into where along the continuum of healthcare services greater investment is needed.

Last, a number of countries failed to experience such catalytic effects during the MDGs and are currently at risk for falling further behind in the SDG era without heightened international attention. These locations included the Central African Republic, South Sudan, and Somalia, all of which experienced  
585 among the lowest levels of HAQ Index performance over time, as well as Zimbabwe and Lesotho, countries that have struggled to recover from faltering HAQ Index levels during the 1990s and early 2000s. Again, the precise factors underlying these countries' challenges in improving personal healthcare access and quality are multifaceted, but commonalities include prolonged conflict, widespread poverty, and comparatively lower levels of DAH from development partners.

590

### **Benchmarking progress on UHC**

Providing access to high-quality healthcare is a cornerstone of UHC, and the bold SDG aim of achieving UHC by 2030 will require extraordinary advances in both healthcare access and quality worldwide. The HAQ Index serves as an important metric for monitoring aspects of progress in UHC, as its current  
595 formulation gives a more comprehensive measure across key health service areas (ie, NCDs and injuries) than past indicators solely focused on infectious diseases, reproductive health, and maternal and child health. This is particularly important since achieving UHC is meant to be an objective for countries across the development spectrum, and thus comparable, meaningful measures of UHC are needed for benchmarking progress and identifying specific health areas for policy action.<sup>48</sup> For instance, gains in performance on maternal disorders generally lagged behind those of neonatal disorders in many low-to-  
600 middle SDI countries, which suggests that a greater investment in neonatal intensive care units and related medical technologies may be required to support faster progress. Good access to high-quality personal healthcare is necessary but is far from sufficient in the pursuit of UHC, which also demands provision of care without incurring financial hardship and may encompass services or interventions  
605 delivered through public health programmes (eg, community screening for diabetes). Substantial debate exists around the impact of national health insurance schemes and government health spending on improving healthcare access and quality, as well as overall progress toward UHC. Our exploratory analyses point to a positive, albeit heterogeneous, relationship between total health spending per capita and government spending as a fraction of total health spending. These results highlight the importance  
610 of dedicated financing for improving healthcare access and quality, and suggest that how domestic resources are dispersed across health service areas and subnationally, as well as their overall composition (eg, government and pre-paid insurance),<sup>49</sup> may contribute to the sizeable differences observed across countries.

### **615 Future directions for measuring healthcare access and quality**

With its annual cycle, the GBD study enables opportunities to improve methods and corresponding estimates of personal healthcare access and quality. One priority area is determining the strategy for refining the amenable cause list that comprises the HAQ Index. How exactly to expand the current cause list, which is meant to represent a range of causes for which personal healthcare can significantly  
620 improve outcomes, comes with considerable debate. One approach would entail a systematic review of



the full GBD cause list, for both fatal and nonfatal outcomes, to identify the effects of current medical technologies by cause and then empirically derive thresholds at which personal healthcare access and quality significantly improve defined outcomes. Beyond the resource demands of this strategy, other conceptual challenges remain, such as determining inclusion criteria for what constitutes a given cause-  
625 intervention set and ultimately translating the final index into a meaningful, actionable measure of personal healthcare access and quality. Another approach would involve establishing a framework from which key health service areas are identified and a parsimonious set of tracer indicators are then selected to characterise each health area.<sup>48</sup> The Nolte and McKee cause list offers an adequate  
630 representation of many key health service areas – vaccine-preventable diseases, infectious diseases and maternal and child health, cancers, other NCDs, and conditions targeted by routine surgery – but how well performance on these high-priority areas provides a signal on others (eg, vision and hearing, trauma services) is not clear.

The use of MIRs for cancers instead of risk-standardised death rates provided a much improved signal  
635 on country-level differences in access to effective cancer care. The quantity and quality of cancer-registry data used in GBD 2016 supported our use of MIRs for cancers; however, few other causes in the GBD currently have such levels of data quantity and quality. Broader use of MIRs may be further complicated for causes with long lag times between disease detection and death (eg, diabetes), as well as causes present at birth (eg, congenital heart anomalies). Future iterations of this work should  
640 consider whether and how to expand the application of MIRs for more GBD causes, particularly those where disease-specific registries or surveillance exist (eg, renal registries).

Further consideration of the age-specific dimensions for personal healthcare access and quality is warranted. Previous updates to what constitutes the “amenable age group” for each cause were fairly  
645 arbitrary; for instance, the current limit of 74 years for the majority of causes was increased from 64 years in 2004 on the basis of improved life expectancy among higher-income countries.<sup>5</sup> Whether the lower and upper bounds for amenable age groups should be determined by changes in life expectancy or age-specific improvements in survival, or demarcated by cause-specific advances in reducing mortality by age group is not easily answered. Relatedly, analyses wherein age-specific HAQ Index values  
650 are estimated also could provide a more in-depth understanding of how personal healthcare access and quality may vary across the lifespan, from birth to older age. Such work could shed light on how well health systems are responding to broader demographic shifts and population ageing, which necessitates ensuring access to high-quality care for older people and their specific health needs.<sup>50,51</sup>

655 Future work should aim to better disentangle the effects of personal healthcare access and quality on HAQ Index performance. In the present analysis, we found that the HAQ Index was strongly correlated with total health spending per capita, but it was not clear how higher levels of health spending at the national level culminate in improved access (eg, larger investments in healthcare infrastructure, dedicated financing to national insurance schemes) versus quality (eg, funding of extensive training in  
660 proper medical care, purchasing and maintenance of specialised medical equipment). In addition, the relative impact of improved access to, as compared with quality of, personal healthcare is likely to vary by therapeutic area and the optimal levels of care at which healthcare can have its greatest effects. For

instance, good access to primary care without corresponding access to hospitals with functional operating rooms and surgical equipment would likely have fewer negative ramifications for vaccine-preventable diseases than conditions that require surgery.

Going forward, we plan to harness continued improvements in measuring personal healthcare access and quality, and apply these results to inform a more comprehensive assessment of health system performance. The expansion of HAQ Index estimation to subnational locations directly supports this aim, and ongoing efforts to systematically measure human resources for health and financial risk protection across locations and over time within the broader GBD study support the assessment of other health system domains. Quantifying inequalities in responsiveness remains an area of health system performance assessment that requires additional attention if the World Health Report 2000 framework is to be replicated.<sup>52</sup> In this sense, it is important to continue exploring in greater depth the effects of improving the quality of care and improving access to personal health care services, separately. Further, there is substantial interest in determining how to translate HAQ Index performance into the percentage of populations and counts of individuals that have good access to high-quality healthcare. Multiplying the HAQ Index, which is on a scale of 0 to 100, by populations could give an approximation of coverage of high-quality healthcare. However, additional analysis and methodological testing may be required to ensure that any estimates of coverage or populations with access to high-quality healthcare are not under- or overestimated due to the nature of HAQ Index construction.

#### **Comparison with GBD 2015 assessment of personal healthcare access and quality**

In comparison with the GBD 2015 HAQ Index results, the GBD 2016 update resulted in slightly higher overall levels for most high-SDI countries and lower scores for low-to-middle SDI countries (appendix p 132). Changes in overall rankings were less pronounced than HAQ Index values, but they followed less consistent patterns by SDI quintile (appendix p 133). While individual country-level changes between iterations of GBD may represent a confluence of factors (eg, availability of new vital registration [VR] data, improved cause-specific modelling), the main reasons for these shifts are due to the use of MIRs for cancers and thus increased PCA-derived weights for cancers relative to other causes in the HAQ Index. Many low-to-middle SDI countries received relatively high scores for cancers in GBD 2015, whereas scaled scores on MIRs show much a stronger SDI gradient in GBD 2016 (appendix p 99-106). We view these results as substantially improved since GBD 2015, particularly with respect to performance on cancers.

#### **Limitations**

The present analysis is subject to limitations beyond those already described. First, limitations experienced in GBD cause-of-death estimation are also applicable to this study.<sup>29</sup> For GBD 2016, we sought to better account for the quality of cause-of-death data, developing a metric for well-certified deaths captured by VR systems and applying this measure to inform data standardisation and correction processes within the broader GBD framework. Nonetheless, more investment is needed to both establish and maintain high-quality VR systems in order to further improve cause-of-death measurement. Second, continued updates to the GBD comparative risk assessment have supported risk-standardisation of more amenable causes in GBD 2016, but it is likely that we are not accounting for all

705 possible differences in mortality related to varied risk exposure. Third, our scaling approach for each  
amenable cause (ie, transforming each cause to a scale of 0 to 100 based on worst and best levels of  
mortality observed from 1990 to 2016) does not fully account for the potential for additional  
improvements in reducing cause-specific mortality. Establishing empirically derived lower bounds for  
each cause poses several scientific and conceptual challenges, but future iterations of this study should  
710 consider how to apply alternative scaling methods for each cause.

### **Conclusion**

The global ambition to achieve UHC by 2030 hinges upon ensuring that all populations have good access  
to high-quality care across key health service areas. Our findings show that progress is possible, as  
715 demonstrated by the accelerated gains in many lower-SDI countries during the MDG era. However, such  
advances are far from inevitable, as underscored by the slowing – if not minimal – improvements in  
many countries’ performance on conditions that require more complex care or surgical intervention.  
Massive geographic inequalities in personal healthcare access and quality persist across and within  
countries, highlighting an urgent need for policy attention focused on places that were left behind  
720 during the MDGs. Current measures of personal healthcare access and quality represent the results of  
investments and action in the past, and it is possible that the pace of progress may quicken as more  
health technologies and specialised types of care become more available among middle-to-low SDI  
countries. To strengthen – and deliver – health systems for the next generation, national and  
international health agencies alike must focus on improving healthcare access and quality across key  
725 health service areas and reaffirm their commitment to accelerating progress for the world’s poorest  
populations.

730

## Figures and tables

735 **Figure 1. Map of HAQ Index values, by decile, in 2016.** Deciles were based on the distribution of HAQ Index values in 2016. HAQ Index=Healthcare Access and Quality Index. ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

740 **Figure 2. Map of subnational HAQ Index values in 2016 for Japan (A), England (B), the United States (C), China (D), Mexico (E), Brazil (F), and India (G).** Deciles were based on the distribution of HAQ Index values in 2016 for each country. HAQ Index=Healthcare Access and Quality Index.

745 **Figure 3. Performance of the HAQ Index and 32 individual causes, by country or territory, in 2016.** Countries are ranked by their HAQ Index score from highest to lowest in 2016. The HAQ Index and individual causes are reported on a scale of 0 to 100, with 0 representing the worst levels observed from 1990 to 2016 and 100 reflecting the best during that time. HAQ Index=Healthcare Access and Quality Index.

750 **Figure 4. Median, interquartile range, and range of the HAQ Index globally and by SDI quintile (A), and for seven countries with subnational estimates (B), in 1990, 2000, and 2016.** The black lines represent the median, the darker coloured boxes represent the interquartile range, and the lighter coloured boxes represent the full range of values within a given group. HAQ Index=Healthcare Access and Quality Index. SDI=Socio-demographic Index.

755 **Figure 5. Absolute change on the HAQ Index, by SDI quintile, from 1990 to 2000 (A), and 2000 to 2016 (B).** Countries and territories are colour-coded by their SDI quintile, and are abbreviated according to the ISO3 code. HAQ Index = Healthcare Access and Quality Index. SDI = Socio-demographic Index.

760 **Figure 6. Comparing the HAQ Index in 2016 to the log of total health spending per capita (A), physicians per 1,000 (B), and inpatient utilisation rates (C).** Total health spending per capita is based on the cumulative per capita spending from 2010 to 2015 in purchasing power parity (PPP) for 2017. Physicians per 1,000 is based on the most recent location-year of data between 2010 and 2015 from the WHO Global Health Observatory database. Inpatient utilisation rates are annual number of admissions for one night or more to a health facility per capita in 2016. Countries and territories are colour-coded by their SDI quintile, and are abbreviated according to the ISO3 code. HAQ Index=Healthcare Access and Quality Index. SDI=Socio-demographic Index.

765 **Table 1. Causes for which mortality is amenable to healthcare mapped to GBD causes.** GBD=Global Burden of Disease.

770 **Table 2. Global, regional, national or territory, and subnational estimates for seven countries on the HAQ Index, 1990–2016, and absolute change and annualised rates of change for 1990–2016, 1990–2000, and 2000–2016.** Starred estimates of change represent statistically significant changes during a given time period. HAQ Index=Healthcare Access and Quality Index.

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