

**Estimating primary health care expenditures: trends and associations with
health outcomes and outputs in low- and middle-income countries**

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Abstract

Estimating primary health care expenditures: trends and associations with health outcomes and outputs in low- and middle-income countries

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As the world responds to the novel coronavirus and aims for the Sustainable Development Goals, the potential for primary health care (PHC) is substantial, although the trends and effectiveness of PHC expenditure are largely unknown. The first aim of this dissertation compiled all available National Health Accounts and used these data of country-reported health expenditures to estimate a complete set of health expenditures across 195 countries between 1995 and 2017. Aim 2 built upon the outputs of aim 1 to improve upon previous estimates of PHC expenditures and produce a complete set of PHC expenditures for low- and middle-income countries between 2000 and 2017. Lastly, aim 3 used regression analyses to test which health outputs and outcomes were associated with PHC expenditure. PHC expenditures in low- and middle-income countries increased between 2000 and 2017, from \$41 per capita (95% uncertainty interval \$33-\$49) to \$90 (\$73-\$105). Expenditures for low-income countries plateaued since 2014 at \$17 per capita (\$15-\$19). PHC expenditures were associated with maternal and child health outcomes and outputs, but were not associated with reduction in health burden for other key causes of disability, such as NCDs. Primary health care is touted as foundational to reaching the

global goal of universal health coverage and the health-related Sustainable Development Goals. Based upon this research, for PHC to reach these goals policy-makers and health professionals need to adapt PHC to ensure the impact is broader and not only associated with improvements in maternal and child health outcomes and outputs.

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Aim 1

Modeling health expenditures by services and providers for 195 countries,
1995 to 2017

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Introduction

Global health expenditures have risen dramatically in the past two decades, from \$700 USD per person in 2000 to nearly \$1,100 USD per person in 2017.(1) Understanding how these health expenditures are spent is an essential component for policy-makers, healthcare providers and payers to be able to maximize healthcare service provision and allocate personnel and other limited resources.(2–8) Since 2000, National Health Accounts (NHAs) have intended to be a key resource for national and international policy-makers and researchers to track health expenditures within and between countries over time.(4,7–12) Based upon the System of Health Accounts (SHA) frameworks, countries reporting NHAs focus on health expenditures related to three pillars: the types of goods and services that are delivered (health functions), which health care providers delivered these goods and services (health providers), and what financing schemes paid for these goods and services (financing schemes).(4,9)

Using NHA expenditures broken down into health functions (HC), health providers (HP), and financing schemes (FS), researchers and policy-makers have set overarching national and international health financing goals, such as reaching universal health coverage (UHC) and understanding expenditures for primary health care (PHC).(9,13–15) However, there is no single repository to easily access this information. Where data is available, it is plagued with inconsistent reporting, gaps, and challenges with extraction due to formatting, particularly in less developed countries and older reports.(11) These barriers have inhibited the ability to draw a complete understanding of past and current trends in health financing systems.(6,8,11,16,17)

There are currently two main repositories for NHA data and reports. The first is the Organization for Economic Cooperation and Development (OECD) which collects and makes available NHAs reported by member states and a select number of other countries, including Brazil, China, India, and South Africa.(18) The second repository is the World Health Organization's (WHO's) Global Health Expenditure Database (GHED).(19) The WHO's GHED collects member state NHA reports and makes them available for download. While these repositories focus on the reporting of all three breakdowns of health expenditures (functions, providers, and financing schemes), there has been a large amount of work estimating sources of financing and so this research focuses on health functions and providers.(17,20,21)

Within the OECD database, the majority of consistently reported health expenditure data by HC and HP categories are only from high-income countries. WHO's GHED has expenditures from low and middle income countries, however, it has only extracted and made available HC and HP spending for the last few years. Leaving the majority of low and middle income countries' data still housed in the original PDF format. Drawing upon the WHO and OECD databases, Bui et al assessed the completeness of 872 NHAs from the time period of 1996 to 2010 and found that out of 193 United Nations' Member States, 76 reported no NHAs and even where NHAs were reported, they had incomplete reporting of spending by HC and HP categories.(11)

Our research builds upon the work by the WHO, the OECD, and Bui et al, updating the systematic search, compilation, and extraction of NHAs expenditures by health functions (HC) and health providers (HP) from 1995 to 2017. We further use these data to develop, for the first time, a methodology to estimate a complete time-series of health expenditures for all countries by the cross-tabulation of HC and HP categories. This effort accomplishes two key goals: Creating a single repository of NHA data that

is easily accessible, and providing complete estimates of health expenditures by functions and providers for policy-makers and researchers to better inform the allocation of limited resources.

Methods

Systematic search for NHAs

To identify all available National Health Accounts (NHAs), a systematic approach was taken. Firstly, all NHAs previously collected for the work by Bui et al were reviewed and categorized.(11) Secondly, the OECD and WHO website repositories were searched for any and all available NHA data or reports.(18,19) Thirdly, country government websites were reviewed for any additional national health accounts not identified or collected in the first two steps. Lastly, keyword searches on the world-wide-web were used to identify any additional account reports or data not previously identified. All collected NHAs were placed on the Global Health Data Exchange at healthdata.org.

Extraction process

As previously discussed, the data of focus for this research were health expenditures reported in categories of health functions (HC), health providers (HP), or the cross-tabulation of HC and HP as defined by the SHAs. All NHAs identified in the systematic search were reviewed for these expenditures. Three approaches were taken to extract these identified tables: 1) Download in current format, 2) Automatically convert to Excel, and 3) Extract by hand. If the data were already assessable via an excel table or similar format, they were simply compiled and vetted for consistent reporting with their respective SHA guide, 2000 or 2011.(4,9) Those NHA data that were only found in their report form, were either extracted using PDFtoExcel or by hand. If the same country-year of reported health expenditures were identified from two different reports, the most recently reported data was taken unless issues of completeness or accuracy were identified.

Where the extracted data category names did not match the SHA guidance, a three step approach was taken to categorize these health expenditures into SHA HC or HP categories. Two research team members independently reviewed the NHA to categorize these expenditures into the most appropriate SHA category. If no category was deemed appropriate, these expenditures were placed into a *Not Elsewhere Classified* (n.e.c.) category. A third researcher reviewed the two team members' categorization. If the two recommended categories aligned, this was approved. If the categories did not align, the third researcher re-reviewed the NHA to decide which category was most appropriate and consistent.

Reconciling versions of health function and health provider categories

NHAs were reported by countries following either the SHA 2000 or 2011 guidelines for categorizing expenditures into functions and providers. Between these two guidelines, many categories remain the same, however, some did change. To be able to have a consistent time-series of raw reported health expenditure data from the collected NHAs, reconciling differences between the two guidelines was conducted using recommendations provided by the SHA and all categories were brought to the SHA 2011 standards.(4) For certain HC categories, a category in the SHA 2000 framework was split into multiple SHA 2011 categories, however, the exact proportioning was undefined. An example, is SHA 2011 Immunization programs (HC 6.2) is part of HC 6.3 from SHA 2000. Without knowing how this breakdown should be implemented, these were treated as missing values and allowed to be estimated

using the statistical methods. For the complete table of all mapping between SHA version please see the appendix.

Limiting complexity of health expenditure HC and HP matrix

The SHA 2011 HC and HP categories have 51 and 70 hierarchical categories, respectively. When considering these two sets of categories in a cross tabulated format, this produces over 3,500 unique combinations for 4,480 country-years of health expenditure data. The need to estimate over 15 million data-points is not a feasible goal given the amount of missing information, the computational power needed, and the fact that not every combination of health function and health provider exist in a health system. For these reasons, we focused on estimating 861 unique HC and HP combinations for each of the 4,480 country-years. The final list of categories estimated by this work can be found in Table 1. It should be noted that all capital formation identified in country reporting was removed from total health expenditures to align with the SHA 2011 framework.

Importantly, if a specific value of HC, HP, or any combination of the two categories was not reported by a country, this analysis assumed it was missing, not zero. Data points collected that were reported as zero's were removed due to their influence on the estimation methods causing systematic under-estimation. All expenditures were converted from reported currencies to 2017 US dollars.

Estimation of complete time-series

After extraction, cleaning, compiling, and reconciling differences of all identified NHA health expenditures reported by HC and HP categories, missing cross-tabulations of these data and countries with no data were estimated using multiple statistical approaches. These include a linear mixed effects model, Bayesian multivariate model, and spatial temporal Gaussian process regression (ST-GPR).(22–24) All three estimation methods use the same dependent variable – the reported health expenditure for each cross-tabulation of HC and HP as a share of total health expenditure for that given country-year. The dependent variable is then logit transformed to remain bound between 0 and 1. The linear mixed effects and Bayesian multivariate models allow all data to be estimated within one model specification represented in Equation 1 below.

$$\text{Equation 1: } y_{c,t,i,j} = X_{c,t} + s_t + \alpha_i + \alpha_j + \tilde{\alpha}_c + \tilde{\alpha}_{i,j} + \tilde{\alpha}_{c,i,j} + \varepsilon_{c,t,i,j}$$

Where c = country, t = years, i = NHA health functions categories, j = NHA health provider categories. $y_{c,t,i,j}$ are country-year reported health spending by NHA categories (i,j) as a share of total health expenditures. $X_{c,t}$ are country and year varying covariates (fraction of total health expenditures that is from government, health access and quality index, GDP per capita, urbanicity, total fertility rate, years of maternal education, female HIV prevalence), s_t is a penalized spline over time, α_i are health function random-slopes (fixed effects), α_j are health provider random-slopes (fixed effects), $\tilde{\alpha}_c$ are country random intercepts (random effects), $\tilde{\alpha}_{i,j}$ are health function and provider category interaction random intercepts (random effects), and $\tilde{\alpha}_{c,i,j}$ are random intercepts (random effects) of the interaction between country and health function and provider interactions.

However, ST-GPR cannot allow for random or fixed effects by HC and HP categories and thus is unable to differentiate between the hierarchical complexity of the cross tabulation of function and provider categorization. Thus the model had to be fit for each cross-tabulation of HC and HP categories.

Across the three analytical methods, the independent variables were chosen based upon data availability, literature review, and statistical significance found through a step-wise analysis.(25) While these covariates remained the same between the three statistical approaches, the underlying methodology of these approaches lead to different predictions of HC and HP health expenditures. Briefly, the linear mixed effects and Bayesian multivariate models utilize nearly the exact formulation, with the exception of the Bayesian method contains a semi-parametric relationship between time and our outcome variable using penalized splines, instead of a linear relationship. While the model specifications between the linear mixed effects and Bayesian models remain similar, the difference between the maximum likelihood estimation versus the Bayesian incorporation of weakly informative priors and Hamiltonian Monte Carlo sampler to estimate the posterior distribution of our parameters leads to differences in estimates, specifically for cross-tabulations without many observations. For a review of these models, refer to their source publications and additional summary in the statistical appendix.(22,23)

ST-GPR consists of three parts, the first is a linear mixed effects model which produces first-stage predictions. These first stage predictions are then used in the second step to estimate spatiotemporal patterns using weights to average the residuals producing spatiotemporally smoothed predictions. The final step uses a Gaussian process regression with the raw data and the smoothed predictions as the mean function to produce final ST-GPR predictions.(24) Again, ST-GPR was estimated for each cross-tabulation of HC and HP categories across countries and years. This allows us to test if individual models per cell of the HC and HP matrix produce better estimates than a single model across all collected data.

The best performing of these approaches was chosen based upon in- and out-of-sample cross validations. As these methods do not constrain the estimates of the HC and HP categories to sum to their respective aggregates, a process of “raking” the modeled estimates to each component’s higher level was undertaken. For example, at the highest level, the sum of the categories of health functions must equal the total health expenditure for that given country year. This is the same for health provider categories. An example of lower levels would be that health function curative care (HC 1) is broken down into inpatient (HC 1.1), day (HC 1.2), outpatient (HC 1.3), home-based (HC 1.4), and not elsewhere classified (HC 1.nec) curative care. The sum of these subcomponents must sum to HC 1. For reference, Table 1 lists all HC and HP categories used in this analysis and their respective level label. This process is followed down to the lowest levels of the cross tabulation of HC and HP categories and utilizes an iterative proportional fitting method to be sure that the original proportions from the models are retained while the totals sum correctly in this multidimensional space.(26) Uncertainty intervals for the raked estimates were calculated using the 97.5th and 2.5th percentile of a 1000 raked samples for each country-year of the data.

All statistical estimations were conducted using R Version 5.3.3. The linear mixed effects method was performed using the package lmer4, while the Bayesian multivariate model was performed using Bayesian Regression Models using Stan (BRMS).(23,27) ST-GPR is created and maintained at the Institute for Health Metrics and Evaluation.(24)

Total health expenditure and covariate data

As the health expenditures are modeled as a share of total health expenditure, the value of total health expenditure is sourced from annual work published by Global Burden of Disease Health Financing Collaborator Network.(16) These estimates of total health expenditure are a complete time-series for all countries with uncertainty intervals. This same source is used for estimates of GDP and the share of total health expenditures from government sources. Other independent variables used for this analysis were sourced from the Global Burden of Disease and can be found on the Global Health Data Exchange website.(28) These covariates are the Health Access and Quality Index, the average number of years of maternal education, the total fertility rate, age-standardized female HIV prevalence, and proportion of population living in urban areas.(29–31)

Results

Raw national health account data collected

Through the systematic search and review of national health accounts, 1,626 country-years-worth of health expenditure data were identified, extracted, cleaned and cross-walked. Of the 1,626 country-years of data, 1,256 break expenditures down by health functions (HC), 1,113 by health providers (HP), and 840 contained the cross tabulation of both. These expenditure data span 148 countries and contain health expenditures for years between 1995 and 2017. Health expenditures reported since 2000 make up the majority of the collected data (86% or 1,391 country-years). Just under 50 percent, or 799 country-years, of health expenditure data are from high-income countries, while middle- and low-income countries account for the remaining 663 and 164, respectively. Figure 1 presents the number of country-years reported over time by World Bank income groups.

Figure 1 also displays the trend that over time more low- and middle-income countries reported HC and HP data. Of the 148 countries with collected health expenditure data between 1995 and 2017, 28 countries have data for all years; of which, all but one (Turkey) are high income countries. The median number of years a country reported data for is 19. Of the 195 countries this analysis searched for NHA expenditure data by HC and HP categories, 55 countries were found to have no data for any years.

Data by health functions and health providers

After cleaning the extracted NHA data and cross walking HC and HP categories between SHA version, there were 91 HC categories and 74 HP unique categories identified (6,734 unique combinations of HC and HP categories). For utility of this research and applicability to policy topics, these categories were paired down to 41 HC categories and 21 HP categories. The categories kept are the most reported by countries, while those dropped are only sub-components of retained categories. Even with these paired down categories the most complete matrix of health expenditures still have 861 unique HC and HP cross tabulations. Of all the 1,626 country-years of data collected, Figure 2 shows the proportion of HC and HP reported tables completeness. The most complete HC by HP matrix had 52% of these 861 cells complete, while on average only 8% of all 861 cells were complete when reported by countries. For a complete list of country-year completeness please see appendix. While overall completeness of the cross-tabulation of categories in reported tables was relatively limited, completeness of the totals of first, second, and third levels of HC and HP categories is significantly better than the overall average. Figure 3, panel A shows that over time reporting improved of all HC level totals with over 60% of all 1st level totals being reported in 2014, 2016, and 2017. Panel B shows that similarly over time HP totals

improved but due to reliance on WHO GHED data in 2016 and 2017 and not raw extracted NHA reports there was a dip in completeness. Panel C of Figure 3, shows how the reported expenditures of the cross-tabulation of HC and HP categories improved slightly over time, however, this is where the majority of missing data is found.

Aside from the total health expenditure reported for a given country-year, the top 5 most reported HC and HP categories (all with more than 900 country-years of data) are the totals of the health functions preventative care (HC 6), governance, and health system and financing administration (HC 7), providers of preventative care (HP 6), medical goods (HC 5), hospitals (HP 1). The most reported cross tabulation of HC and HP categories was preventative care (HC 6) given by providers of preventative care (HP 6), with 735 data points, followed by medical goods (HC 5) provided by retailers and other providers of medical goods (HP 5), with 698 data points. A complete list of HC and HP categories and the number of data points collected can be found in the appendix. In total, 110,070 data points of health expenditures reported by the 41 health function and 21 health provider categories were identified and collected from national health accounts.

Global expenditures reported by first level HC and HP categories (meaning these sum to total health expenditure) are displayed in Figure 4. In Panel A, we can see that within these incomplete reported data, curative care (HC1) and medical goods (HC5) make up the largest share of global health expenditures. Followed by long-term care (HC3) and governance and admin (HC7). The observed fluctuations over time are due to different countries reporting and the amount of detail provided. Panel B, provides the breakdown of HP categories and show that hospitals (HP1), providers of ambulatory care (HP3), and retailers of medical goods (HP5) make up over three-quarters of total health expenditures.

Estimation of health expenditures

Method comparison

Table 2 presents the root mean squared errors (RMSE) for both in- and out-of-sample cross validations. The RMSEs were calculated in both per capita and as a share of total health expenditures. The lower the RMSE the better the predictions relative to the data. Using the three estimation methods (linear mixed effects regression, Bayesian regression models in Stan (BRMS), and ST-GPR) in-sample validity tests showed that the BRMS and mixed effects methods had comparable results (showing that the estimates were on average 3.3 percent from the data), while ST-GPR performed significantly worse (12.8 percent from the data). Based upon an out-of-sample validity test where 20% of the collected data was randomly dropped, the models were fit to the remaining 80% of the data, predictions were made for all country-years and HC and HP categories, and the RMSEs were calculated between the predictions and the randomly dropped 20% of data, it was found that the mixed effects slightly outperformed BRMS, while ST-GPR again was significantly worse than the other two. Another out-of-sample validity test conducted was dropping complete data for certain countries (examples provided in Table 2 for Australia and Thailand) to mimic the lack of all data for a country. In this last out-of-sample validity test, it was found that BRMS outperformed the other two methods. In addition to these statistical cross-validation differences, it was observed that BRMS estimated less erratic trends over time within health function and provider categories that lacked data, as compared to the mixed effects model and ST-GPR.

ST-GPR would not allow for the complete dataset to be estimated in one model as it does not differentiate different categories for the same country-year. As such ST-GPR instead estimated 759

independent model runs, one for each cross tabulation of HC and HP with data. The inability to borrow strength from values of related HP and HC categories meant that some of these models attempted to fit with very few data points and were unable to converge. As such, ST-GPR is unable to produce a complete time-series for all HC and HP cross tabulations of interest. Of the 759 models with collected data, only 606 categories of HC and HP cross tabulations were able to converge.

The final method used to estimate the complete time-series of health expenditures by HC and HP categories was BRMS. It outperformed ST-GPR using all cross-validation processes and as it was able to borrow strength from all HC and HP totals and cross-tabulations it was able to produce estimates for all cells. While the in- and out-of-sample validity tests showed little statistical difference between BRMS and the mixed effects model, the more consistent (exhibiting smaller annual changes) estimates of cells with little data gave BRMS an advantage and thus was chosen.

Estimated health spending by health functions

As with the underlying, collected, NHA health expenditures, Figure 5, panel A, and Figure 6 (the right most column) show that the estimated expenditures by health functions show that curative care and medical goods make up the two largest shares of average total health expenditures, representing 51.3% (UIs between 21.1% to 63.8%) and 17.6% (UIs between 9.1% to 31.1%) of total health expenditures in 2017, respectively. During this same time period, curative care further can be broken down into inpatient, outpatient, day, and home-based care which make up 22.0% (UIs between 5.6% to 31.6%), 22.7% (UIs between 5.1% to 33.0%), 1.9% (UIs 0.4% to 5.0%), and 0.6% (UIs between 0.2% to 0.4%) of total health expenditures, respectively. The category of medical goods breakdowns into pharmaceuticals and other medical non-durable goods, therapeutic appliances and prosthetics, and not elsewhere classified goods which represent 13.5% (UIs between 4.7% to 25.1%), 2.3% (UIs between 0.8% to 5.5%), and 1.8% (UIs between 0.1% to 7.6%) of total health expenditures, respectively.

As can be seen in Figure 7, across World Bank income groups, high income countries spent 9% of total health expenditures on long-term care, which is far more than the next closest group, which was upper-middle income countries at just 1.5%. Low income countries spent more on preventive care (11.1%) as a share of total health expenditures than any other income group, with lower-middle, upper-middle, and high income countries spending 9.8%, 8%, and 3.7%, respectively. Fairly consistently, country income groups spent between 15.8% and 17.8% of all health expenditures on medical goods. Interestingly, low income countries spent more than any other income group on governance and administrative services (HC.7) at 11.1% of total expenditures.

Estimated health spending by health providers

Figure 5, panel B, and Figure 6, in the bottom row of the matrix, show health spending by providers over time and in 2017. Over three quarters of the average estimated global health expenditures by health providers fall into hospitals providers (35.5%, UIs 22.5%-43.4%), providers of ambulatory care (25.6%, UIs 16.4%-32.7%), and retailers of medical good (14.7%, UIs 9.1%-19.5%). Within hospital providers, general hospitals make up the largest component of health expenditures, with 24.0% (UIs 8.7%-34.4%) of global total health expenditures. Within providers of ambulatory care, medical practices and ambulatory health care centers make up 8.0% (UIs 2.7%-13.8%) and 6.1% (UIs 2.5%-10.4%) of total health expenditures, respectively.

Across income groups, as seen in the bottom rows of matrixes in Figure 7, low and high income countries spent a similar proportion of total health expenditures in hospitals, 32.8% and 33.6%, respectively. Lower-middle countries spent 39.1% and upper-middle income countries spent 44.5% of total health expenditures in hospitals. High income countries spent the most of any income group within providers of ambulatory care at 27% of total health expenditures, while upper-middle and low income countries spent just over 19% in the same settings. Similar to health functions, low income countries spent more of their health expenditures than any other country income group within providers of preventive care, at 10.8%.

Estimated health spending by cross-tabulation of health functions and health providers

Figure 6, presents the share that each cross-tabulation of health function and health provider, at the highest level, makes up of global total health expenditures in 2017. Curative care in hospital settings makes up the largest share of total health expenditures at 27.7% (UIs 9.2%-37.8%), followed by curative care from providers of ambulatory care with 18.6% (UIs 5.4%-27.1%) and medical goods provided by retailers of medical goods with 12.4% (UIs 5.6%-17.1%).

Figure 7, highlights differences between the cross-tabulation of health functions and health providers expenditures in 2017 across World Bank income groups. We can see that not only do low income countries spend more on preventive care, but that more is provided in the hospital setting than any other income group. Also, low income countries did not spend a disproportionate share of expenditures on medical goods than other income groups, however, they spent less in the hospital settings and more in retailers of medical goods and providers of ambulatory care. In general, Figure 7 highlights that the higher the income country the more was spent on curative care in ambulatory settings (outside of hospitals).

Discussion

National Health Accounts (NHAs) are intended to be a systematic, comprehensive, and consistent source for monitoring the resources of a country's health system which can be used to inform health policy design and implementation.(10) NHAs leverage the System of Health Accounts' (SHA) standardized classification of health functions (HC) and health providers (HP), allowing for insights into the prioritization of national programs through the tracking of expenditures for different health services and goods, and by who is providing them.(4,9) However, as this and past research as shown, the number of missing years for which countries have no data is high. This work identified 55 countries that have no NHA data by HC and HP for any year between 1995 and 2017. We found that only 28 have NHAs with HC and HPs reported for every year in the study period. For those country-years that do have a NHA reported with HC and HP details, the details provided by the breakdown of expenditures into health functions and providers is often incomplete and worsens the more detailed the HC and HP categorization become. These gaps in national health accounts limit the ability of policy makers and researchers to conduct the intended analyses within and across countries. This research collected, extracted, synthesized, and published all available NHA expenditures by HC and HP categories in a single repository (GHDx) for the first time. It then leveraged these data within multiple statistical analysis methodologies to identify the most predictive model and specification to estimate the missing data with uncertainty.

Policy-makers and researchers can now access these estimates of all countries' health expenditures broken down by health functions and providers to gain insights into past allocations. While there are many insights that can be gleaned from this work, some key findings are that lower income countries spent more, as a share of total health expenditures, on governance and administration. This finding may be due to economies of scale within countries that have more access to care and integration of administrative services. Across income groups, countries spent a relative similar proportion of the expenditures on medical goods, however, low income countries spent the least in hospital settings.

In this time of focus on epidemic preparedness due to the novel coronavirus pandemic, we see that higher income countries spent a smaller percentage of their health expenditures on preventive care than lower income countries. According to SHA guidelines, preventive care includes *early disease detection programs* (HC 6.3), *epidemiological surveillance and risk and disease control programs* (HC 6.5), and *preparing for disaster and emergency response programs* (HC 6.6).⁽⁴⁾ In fact, it is estimated that high income countries spent only 0.6% of health expenditures on these three categories in 2017, while lower-middle and low income countries spent an estimated 2.0% and 2.2%, respectively.

While the SHA frameworks provides the best attempt at capturing consistently reported health expenditures across countries, they are limited by underlying data differences and availability. A few significant reason for these differences are countries' inability to disentangle expenditures to map directly to the SHA categories, differences or a complete lack of sources for certain categories of health expenditures, and actual differences in country-specific health systems.^(10,32) This research attempts to model across countries, time, and categories of spending to continue to push forward the comparability of these health expenditures, however, the underlying differences may still affect the interpretation of these numbers and necessitates additional details to more accurately use estimates when comparing across countries. For example, Nigeria has 19 years of NHA data reported. However, from 2006-2009 the majority of medical goods were reported within HC5.1, however, due to what seems to be a change in reporting, the later years of NHA data keeps those medical goods provided within other functions such as curative care and rehabilitative care. Due to this difference it would be inappropriate to interpret that Nigeria does not have expenditures for medical goods, just that medical goods are not necessarily reported with the function of medical goods (HC5). While the majority of raw data do not show significant annual increases or decreases, there are some example where significant annual changes in the underlying data were not able to be followed by the estimation methods.

As noted above, high income countries made up the majority of the collected health expenditures with health function and provider details. While low- and middle-income countries have increased their reporting of these expenditures in recent years, the estimates produced, especially in earlier years, are potentially biased toward observed trends from high income countries. For this reason, the estimates incorporate differences in demographics, development, and healthcare access, and uncertainty intervals are presented for every estimate of this research. The need for continued improvements in health expenditure reporting, especially in low- and middle-income countries, is required to allow policy-makers and researchers the ability to properly allocate limited resources to maximize health in their populations. However, until this is the norm, we hope these estimates will help to fill this knowledge gap.

Tables and figures

Table 1. Health functions and health provider categories with level label

Health Functions	Hierarchy Level
1. Curative care	1
1.1 Curative care - Inpatient	2
1.2 Curative care - Day	2
1.3 Curative care - Outpatient	2
1.3.1 Curative care - Outpatient - General	3
1.3.2 Curative care - Outpatient - Dental	3
1.3.3 Curative care – Outpatient - Specialized	3
1.3.nec Curative care - Outpatient - NEC	3
1.4 Curative care - Home-based	2
1.nec Curative care - NEC	2
2. Rehabilitative care	1
2.1 Rehabilitative care - Inpatient	2
2.2 Rehabilitative care - Day	2
2.3 Rehabilitative care - Outpatient	2
2.4 Rehabilitative care - Home-based	2
2.nec Rehabilitative care - NEC	2
3. Long-term care	1
3.1 Long-term care - Inpatient	2
3.2 Long-term care - Day	2
3.3 Long-term care - Outpatient	2
3.4 Long-term care - Home-based	2
3.nec Long-term care - NEC	2
4. Ancillary care	1
5. Medical goods	1
5.1 Medical goods - Pharms & other medical non-durable goods	2
5.1.1 Medical goods - Prescribed meds	3
5.1.2 Medical goods - Over the counter meds	3
5.1.3 Medical goods - Other medical non-durables	3
5.2 Medical goods - Therapeutic appliances & prosthetics	2
5.nec Medical goods - NEC	2
6. Preventative care	1
6.1 Prevention care - IEC programs	2
6.2 Prevention care - Immunization programs	2
6.3 Prevention care - Early disease detection	2
6.4 Prevention care - Healthy condition monitoring programs	2
6.5 Prevention care - Epi surveillance and risk and disease control programs	2
6.6 Prevention care - Preparing for disaster and emergency response programs	2

6.nec Prevention care - NEC	2
7. Governance & admin	1
9. Other health care services	1
Total	0
Health Providers	Hierarchy Levels
1. Hospitals	1
1.1 Hospitals - General	2
1.2 Hospitals - Mental health	2
1.3 Hospitals - Specialized	2
1.nec Hospitals - Other	2
2. Resid. long-term care fac.	1
3. Providers of ambulatory care	1
3.1 Providers of ambulatory care - Medical practices	2
3.2 Providers of ambulatory care - Dental practices	2
3.3 Providers of ambulatory care - Other practices	2
3.4 Providers of ambulatory care - Ambulatory health care centers	2
3.5 Providers of home health care services	2
3.nec Providers of ambulatory care - NEC	1
4. Providers of ancillary services	1
5. Retailers and other providers of medical goods	1
6. Providers of preventative care	1
7. Health care system admin.	1
8. Rest of economy	1
9. Rest of world	1
N.E.C	1
HP Total	0

Note: N.E.C is not elsewhere classified

Table 2. Estimation method validity tests, root mean squared errors

Model	RMSE of All Data (In-sample)		RMSE of Dropped 20% of Data (Out-of-sample)		RMSE when Australia Is Dropped (Out-of-sample)		RMSE when Thailand Is Dropped (Out-of-sample)	
	Per capita space	Share space	Per capita space	Share space	Per capita space	Share space	Per capita space	Share space
BRMS	43.63	0.0333	55.17	0.0588	114.71	0.0266	12.02	0.0568
Mixed Effects	43.37	0.0338	53.93	0.0556	122.53	0.0287	12.16	0.0574
ST-GPR	380.69	0.128	73.69	0.0674	373.85	0.0787	59.46	0.2783

Figure 1. Collected national health accounts by World Bank income groups

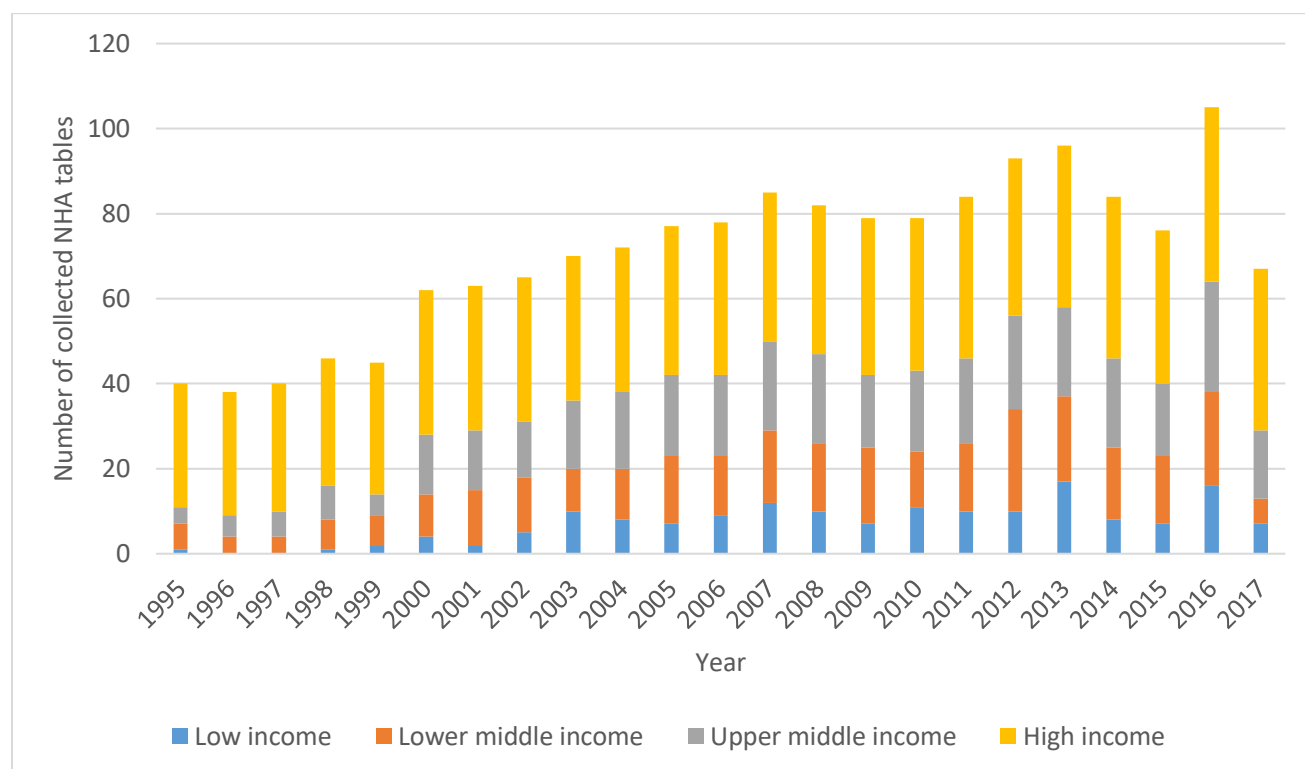


Figure 2. Completeness of collected national health accounts by years

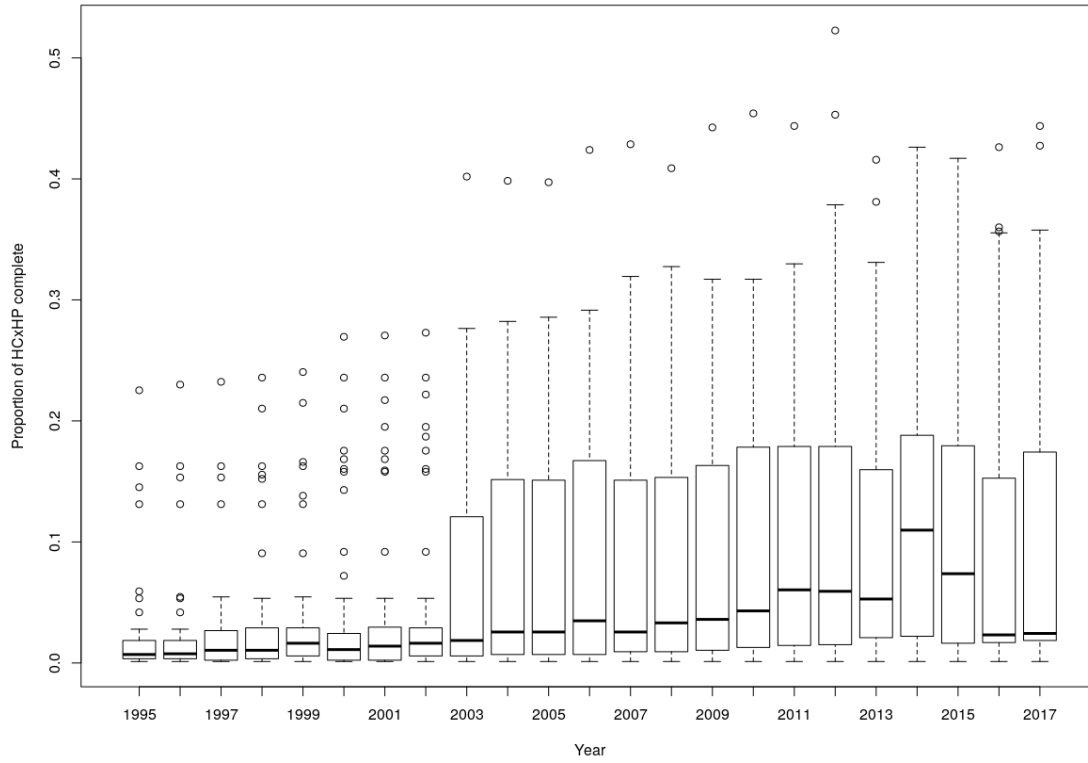
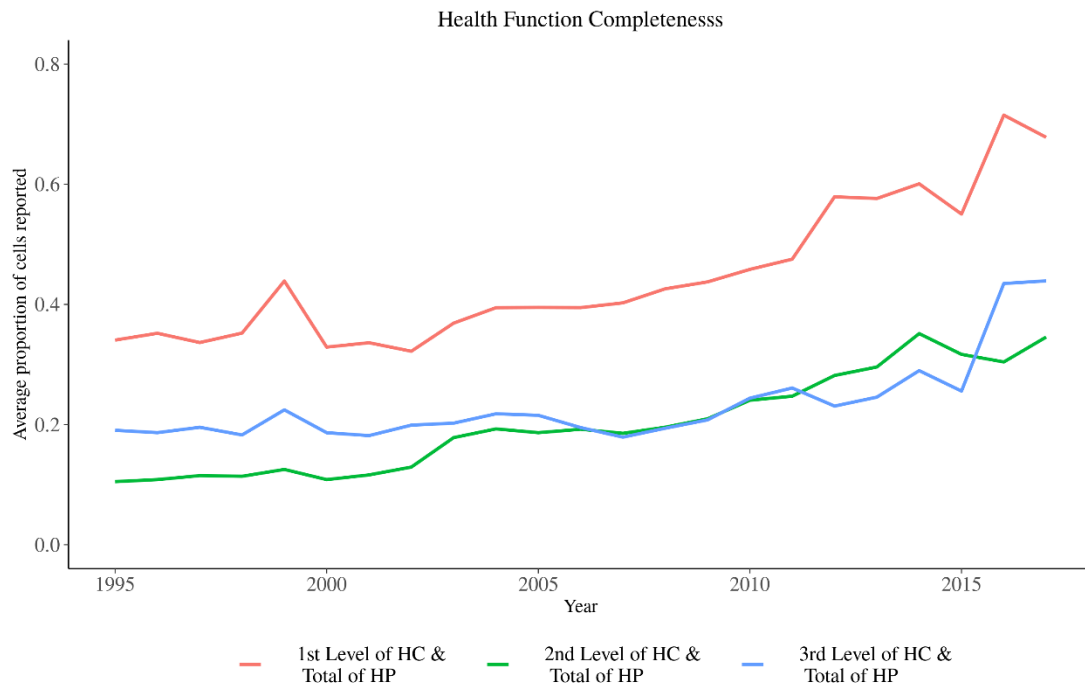
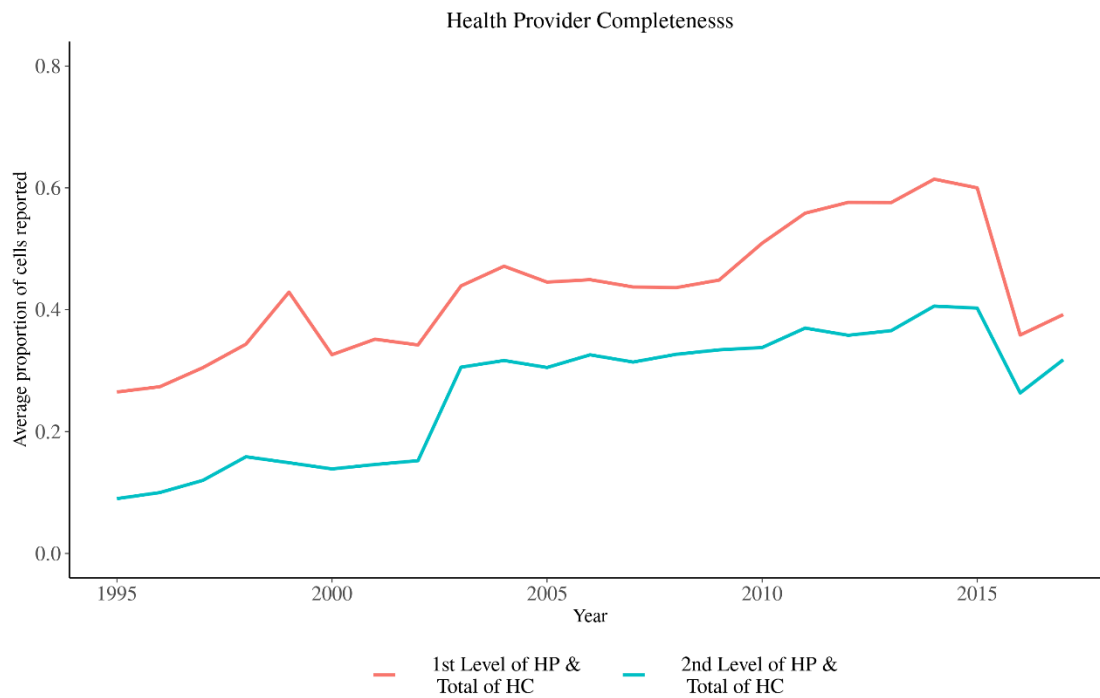


Figure 3. Completeness of health function and health provider collect national health accounts by year

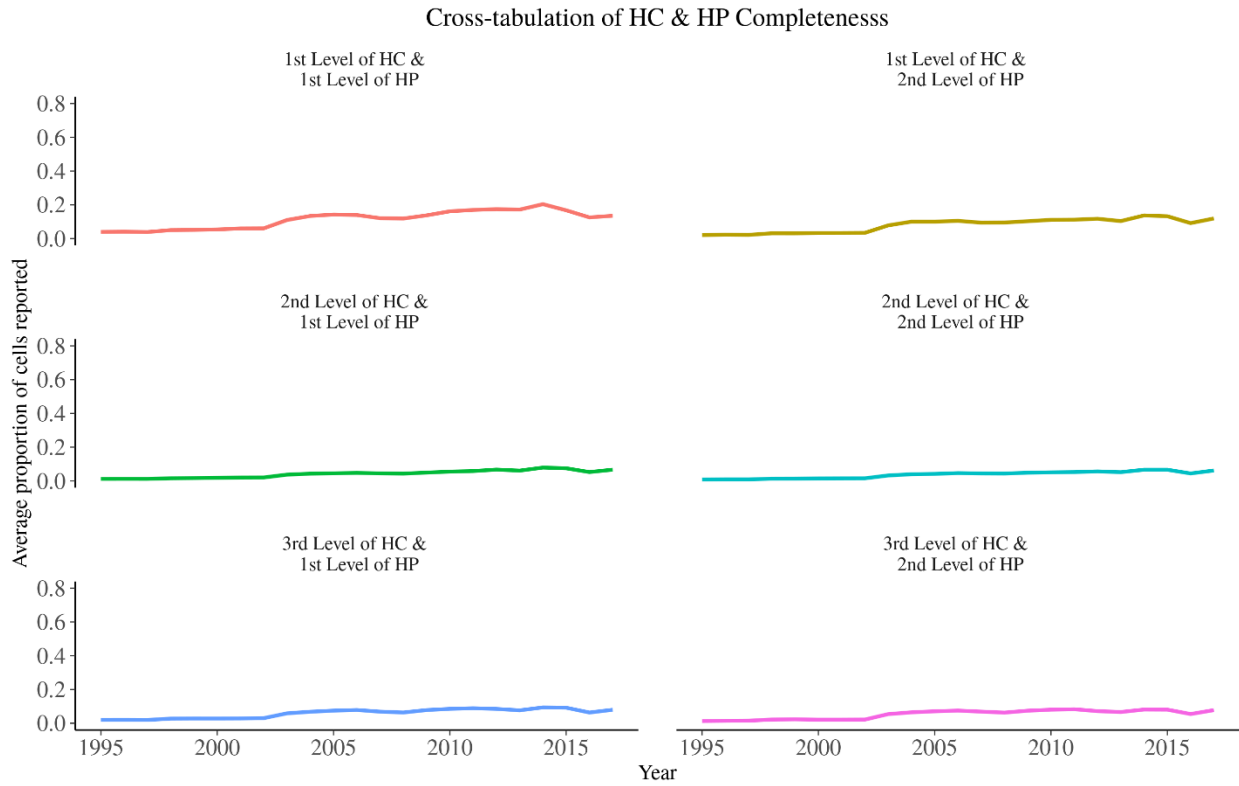
Panel A. Health function totals



Panel B. Health provider totals



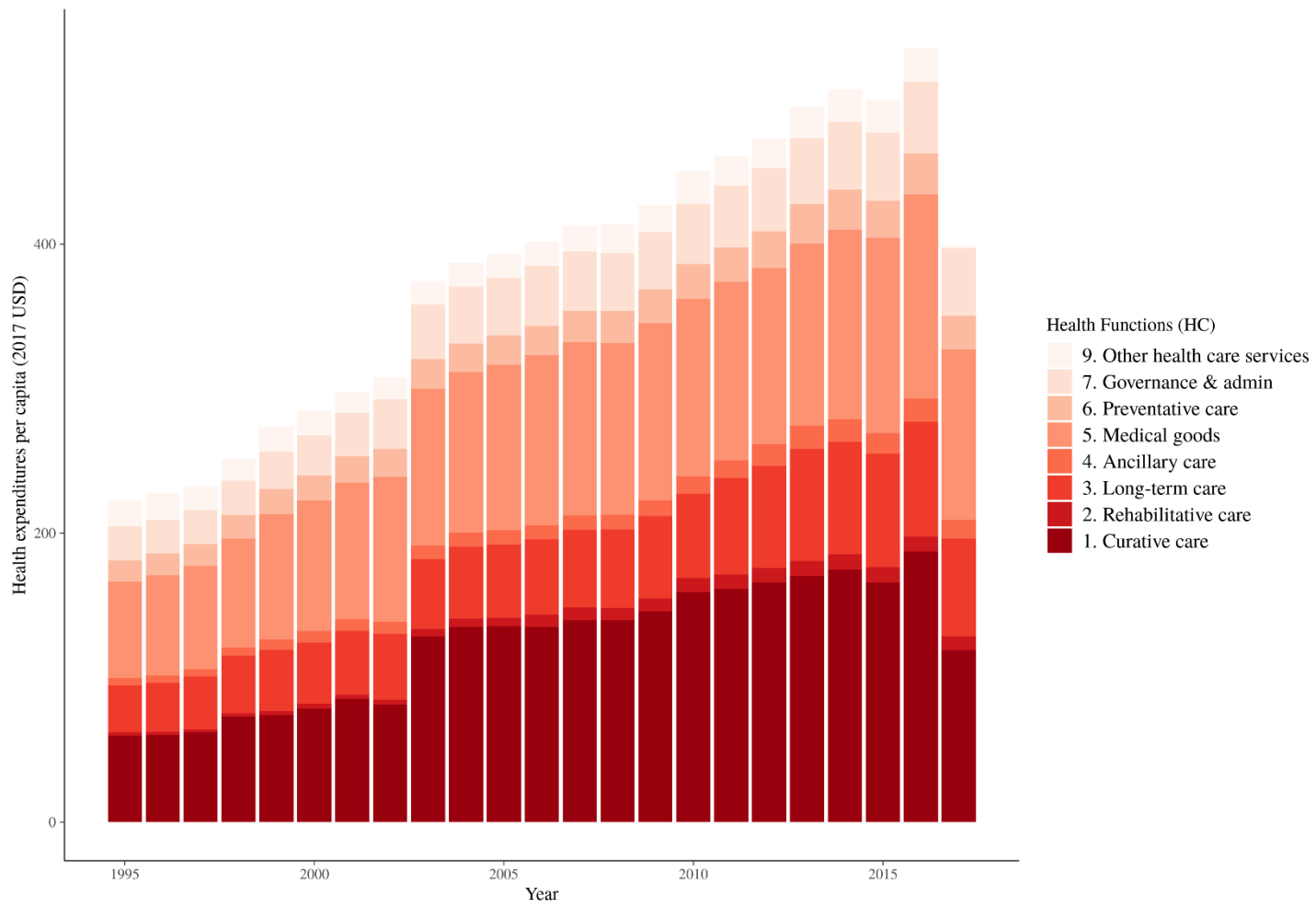
Panel C. Health function and health provider cross-tabulation



Note: Example of 1st Level is HC 5 or HP 6; 2nd level is HC 5.1 or HP 6.2; 3rd Level if only for HC categories and an example is HC 5.1.1

Figure 4. Global trends of raw health functions and health providers expenditures per capita

Panel A. Health functions



Panel B. Health providers

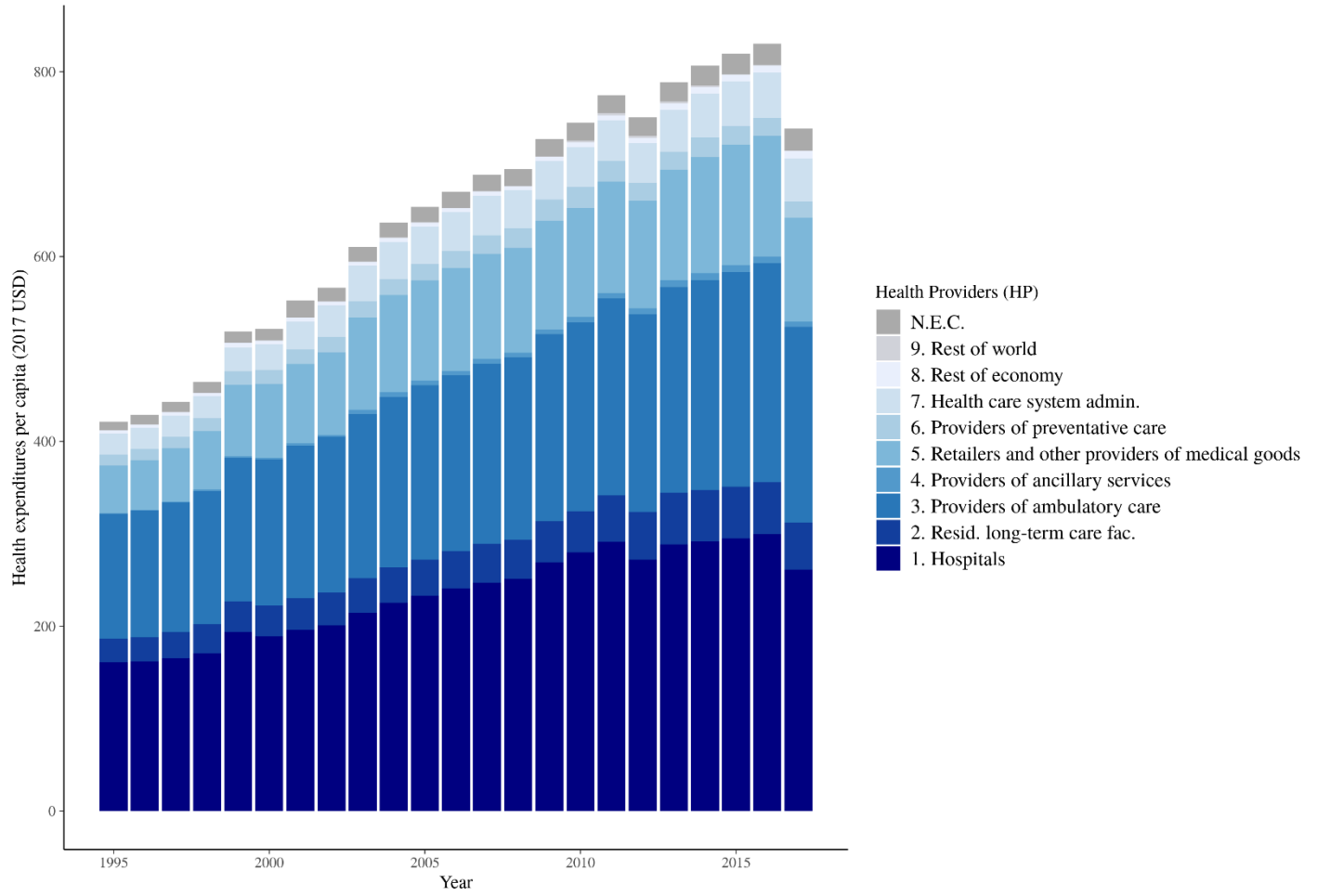
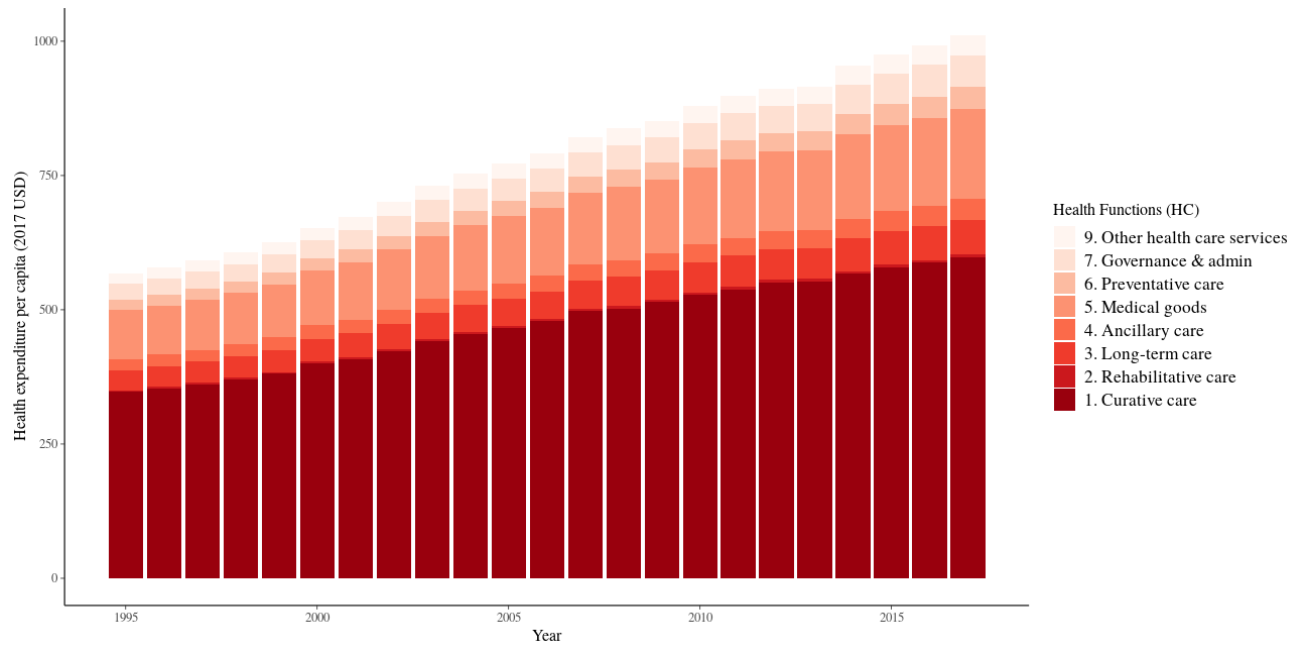


Figure 5. Globally estimated health expenditures per capita by health functions and health providers

Panel A. Health functions



Panel B. Health providers

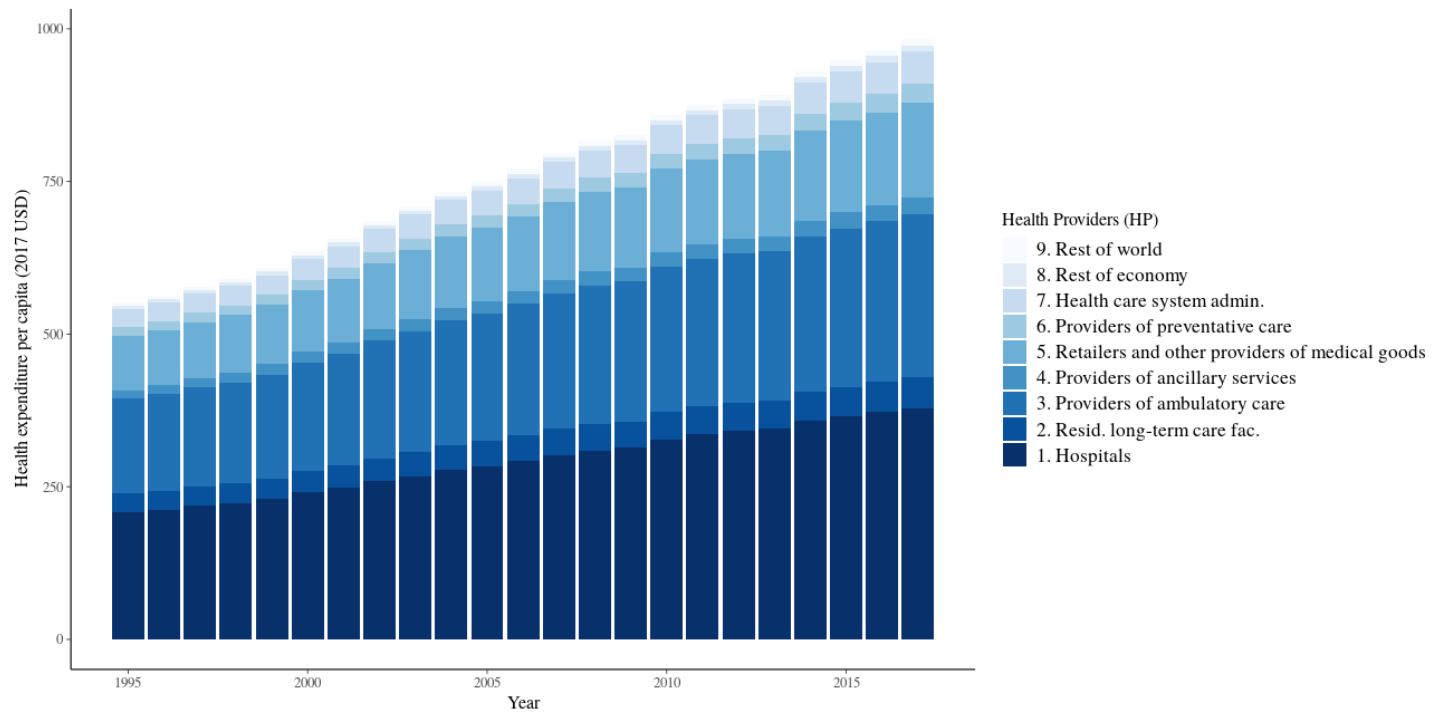
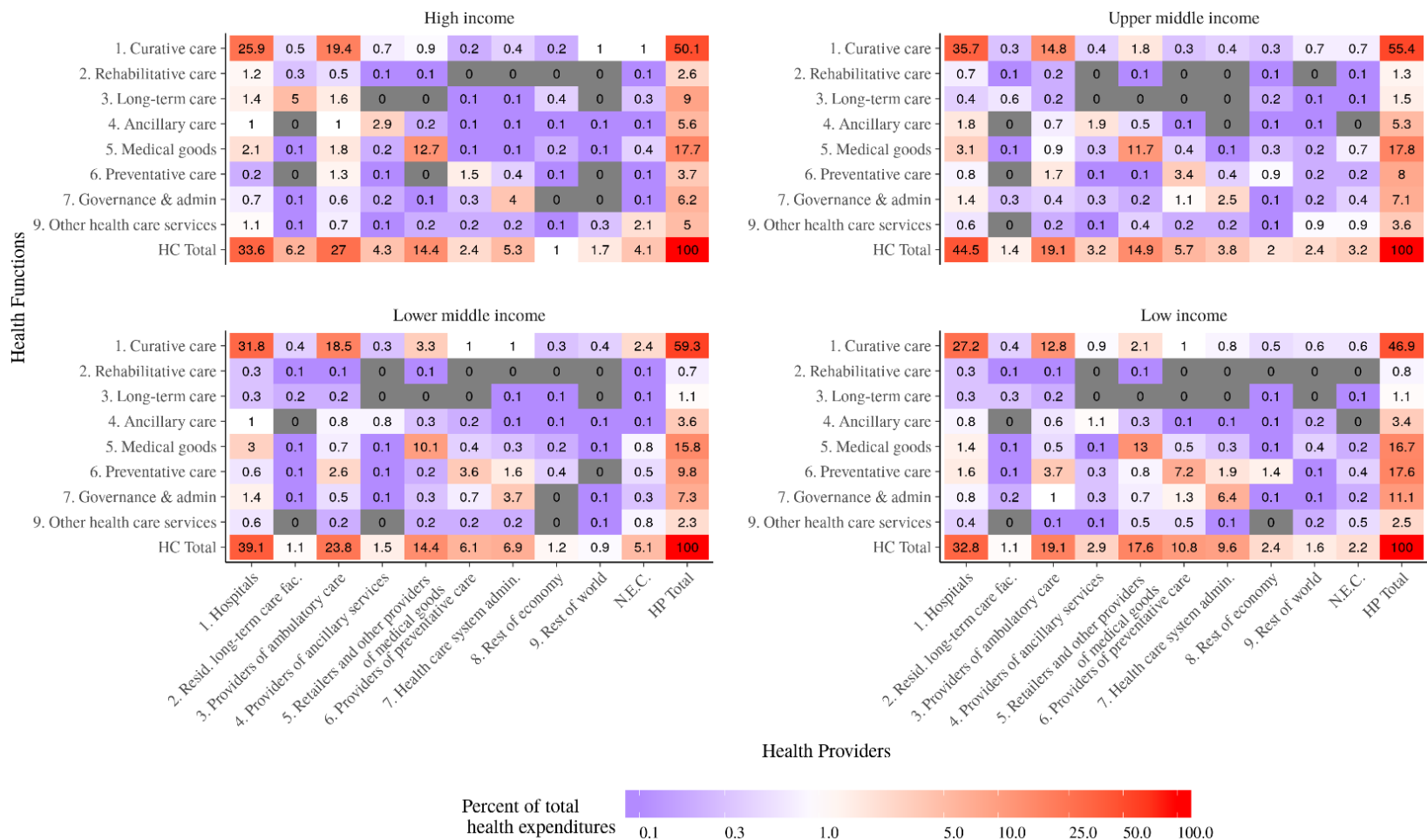


Figure 6. Global estimate of health spending by health functions and health providers as a percent of total health expenditures, 2017



Note: N.E.C. are expenditures not elsewhere classified by the System of Health Accounts framework.

Figure 7. Estimate of health spending by health functions and health providers as a percent of total health expenditures, by World Bank income groups in 2017



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Aim 2

Estimating primary health care expenditures for low- and middle-income countries, 2000 to 2017

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Introduction

A well-functioning primary health care (PHC) system has the ability to lower the cost of care, improve health related outcomes across ages and diseases, and lead to more equitable health care access.¹⁻⁶ Highlighted in the 1978 Declaration of Alma Ata, health advocates have emphasized the role of PHC systems with the hope of achieving “health for all.”⁷ This goal has yet to be reached. However, as stated in the 2018 Declaration of Astana, the pursuit to provide equitable access to health care persists.^{8,4,9}

There are many factors that must be measured to assess the functionality of a primary health care system, from policies and staffing to accessibility and responsiveness of the health system.¹⁰⁻¹² Expenditure on primary health care is one key factor to evaluate, yet there have been few attempts at systematically measuring health expenditures for PHC that make comparisons within and between countries.¹³⁻¹⁵ None of these attempts were able to calculate PHC expenditures for a large set of low- and middle-income countries. The first was conducted in 2016 and updated in 2019 by the Organization for Economic Co-operation and Development (OECD). This work estimated PHC expenditure for OECD member nations, most of which are high income countries.^{15,16} The second was published in 2019 by the Vande Maele et al, focusing on 36 low and middle income countries and only the most recent years of data.¹⁴ The World Health Organization (WHO) built upon Vande Maele’s work and publishes PHC expenditure estimates on their Global Health Expenditure Database for 88 countries, including high income countries, with 2 years of data at most (2016 and 2017).¹⁷

In the efforts by WHO and OECD, PHC expenditure was estimated using country-reported National Health Account (NHAs) expenditures categorized using the System of Health Account 2011 health care functions (services) and providers.^{14,15,18} The OECD’s definition relied on expert feedback to identify function and provider categories that needed to be included in its estimation of PHC expenditures. This process identified the sum of general outpatient curative care, outpatient dental care, home-based curative care and preventive services expenditures spent within providers of ambulatory care as the most appropriate proxy for primary care expenditure. They explored including all providers of these healthcare services, which they deem ‘basic care.’ Basic care estimates were calculated with and without prescribed pharmaceuticals and over-the-counter medicines. ‘Primary care spending’ was estimated to be 14% of total health expenditure for 22 OECD countries in 2016, ranging from roughly 10% in Slovak Republic and Switzerland to over 18% in Australia and Poland. For ‘basic care’ and ‘basic care including pharmaceuticals’, an average of 17% and 33% of health expenditure in 2016 was estimated in 22 OECD countries, respectively.¹⁵

Vande Maele explored eight definitions of PHC expenditures for 36 low- and middle-income countries with adequately reported health expenditure data.¹⁴ Across the 36 countries, Vande Maele estimated that 40% of health expenditures were for ‘PHC basic’ which included expenditures from general outpatient, dental, home-based curative care, preventive care, long-term outpatient and home-based care. When medical goods and governance and administration were added to ‘PHC basic’ it was estimated that 67% of health expenditures were for primary health care.

The WHO built upon Vande Maele et al and currently reports PHC expenditures for 88 countries (including high, middle, and low income countries) on their Global Health Expenditure Database.¹⁷ The definition includes expenditures for general outpatient, dental, home-based curative care, preventive care, long-term outpatient and home-based care, 80% of governance and administration, and 80% of medical goods.

As noted by OECD and Vande Maele et al, both sets of estimates of PHC expenditures are only a proxy to actual PHC expenditure. The reason for this is that National Health Accounts were not created to track this information directly. For example, OECD, Vande Maele, and WHO were unable to include any portion of inpatient expenditures which contains some health care services that could be considered primary health care. In addition, no definition included expenditures for inpatient labor and delivery. Another example is medical goods; the OECD completely excluded medical goods from their 'Primary care spending' estimate, while Vande Maele and WHO make the broad assumption that some proportion of all medical good expenditures are considered part of primary health care.

In addition to the major challenge of National Health Accounts (NHAs) not directly tracking PHC expenditures, NHAs are also often not available for low and middle income countries. Even when National Health Accounts are available, they lack the necessary detail to apply the definitions proposed by either OECD or Vande Maele.¹⁹⁻²¹

To address the challenge of missing health expenditures for some countries, this work leverages the outcomes of the Aim 1 of this dissertation which produced a set of complete, estimated, health expenditures by health care functions and providers for all low and middle income countries between 2000 and 2017. This complete set of expenditures allowed us to also apply a more precise definition of PHC expenditures, which builds upon the OECD, Vande Maele, and the WHO definitions. We then used additional data sources to further improve our definition of PHC expenditures. Specifically, I estimated and included the cost of inpatient delivery and the proportion of prescription drugs that are for primary health care. In line with research that defines PHC as being a set of primary care services provided in a primary care setting, I explored a definition of PHC expenditures that were only spent in ambulatory settings.^{15,16,22,23} We then compare across these definitions of PHC expenditures.

Data & Methods

To overcome the issue of missing health expenditure data in calculating PHC expenditures, this work draws upon data from Aim 1 (Scheider et al), which produced estimates of expenditures for health care functions and providers for 195 countries, from 2000-2017. Aim 1 collected and synthesized all publicly available National Health Accounts reporting health care function or provider expenditure.²⁰ Using these data within a Bayesian statistical model, I estimated 861 health care function and provider category combinations for all countries between 2000 and 2017. With these estimates, we estimated PHC expenditure. Table 1 presents which health functions and provider categories were included and how they compare to previous methods using the NHAs to estimate PHC expenditure by WHO and OECD.

In addition to drawing estimates from the modeled NHAs, we used data from IQVIA Analytics Link to estimate the proportion of health expenditures on prescription drugs that we considered part of primary health care.^{24,25} IQVIA data contained prescribed drug expenditures for 49 countries, between 2014 and 2018. These expenditures were reported by the pharmaceutical molecule name as a total for the country and/or by the channel the prescriptions were purchased - hospitals or retailers. To identify the proportion of prescribed pharmaceutical expenditures for primary health care within the IQVIA data, the molecule name was matched with the WHO Essential Medicine List.²⁶ Any pharmaceuticals not matched with the Essential Medicine List were assumed not to be for primary care. Of the 460 pharmaceutical molecules in the WHO Essential Medicine List, 289 were matched within the IQVIA data. A complete list of countries within the IQVIA data and the channels reported, as well as a list of

pharmaceutical molecules matched between the WHO Essential Medicine List and IQVIA is provided in the appendix.

A Spatio-Temporal Gaussian Process Regression (ST-GPR) was used to estimate the proportion of prescribed pharmaceutical expenditures that are for primary care within hospitals, retailers, and a weighted average for all countries between 2000 to 2017.²⁷ I modelled prescribed essential medicines expenditure as a proportion of total prescription medicine expenditure, aggregated across and for each retail and hospital settings. All covariates considered were either from the Global Burden of Disease 2017 study or estimates produced by Aim 1I.^{20,28} Covariates for each model were selected based on Akaike information criterion using the base step function in R version 3.6.0 and are presented in the appendix.

These country-year specific estimates of the proportion of prescribed medicines that are for primary health care within hospitals, retailers, and an average between the two channels were applied to the complete set of health care function and provider estimates. For prescribed pharmaceutical expenditures (HC 5.1.1) within hospitals (HP 1) and ambulatory care providers (HP 3) I applied the country-year specific estimate of prescribed medicines that are for primary health care within hospitals. For prescribed pharmaceutical expenditures within retailers of medical goods (HP 5) I applied the country-year specific estimate of prescribed medicines that are for primary health care within retailers. For all other health care providers with any amount of prescribed pharmaceutical expenditures we applied the average of the two channels for that given country-year.

Inpatient labor and delivery expenditures are not clearly identified in National Health Account data. To incorporate inpatient vaginal delivery expenditures in our estimates of PHC, we derived country-specific volume and cost of inpatient vaginal and Cesarean-section delivery for all countries between 2000 and 2017. Although the cesarean section estimates were not included in our final definition of PHC, they were used as part of the process of estimating the cost and volume of inpatient vaginal delivery. The total number, or volume, of births by delivery method was drawn from 1,043 country-years of data from the Demographic and Health Surveys, Multiple Indicator Cluster Surveys, and online databases provided by the OECD, the Canadian Institute for Health Information, and the United States' Healthcare Cost and Utilization Project.²⁹⁻³⁴ 160 country-years of cost data were drawn from published literature, and three databases: Healthcare Cost and Utilization Project, Canadian Institute for Health Information, and Health Care Cost Institute.^{31,32,35}

With these data we estimated the proportion of all deliveries that were inpatient vaginal deliveries and cesarean sections using Spatio-Temporal Gaussian Process Regression (ST-GPR).²⁷ The modeled proportions were multiplied by the number of births from the Global Burden of Disease study to estimate the total number of inpatient vaginal and cesarean deliveries by country and year.³⁶ In order to estimate the cost of inpatient vaginal deliveries, only 33 cost estimates specifically for inpatient vaginal deliveries were identified from the literature. However, the cost of cesarean sections was found for 160 country-years. First ST-GPR was used to model a complete time-series of cesarean section costs. Then based on country-years where both vaginal and cesarean section costs were available, the ratio of the inpatient vaginal to cesarean cost of delivery [for every country-year in the study] was estimated. This modeled ratio was then multiplied by the predicted costs of cesarean section to estimate the cost of vaginal delivery for each country and year. Finally, the predicted volume and cost estimates were multiplied to produce estimates of inpatient vaginal delivery expenditures.

PHC Trends Analysis

Using the PHC expenditures measurement strategy identified in column 1 of Table 1, we estimated the relationship between PHC expenditures and gross domestic product. We used a generalized additive model with non-linear penalized splines to estimate across all countries how the share of PHC expenditures of total health expenditures change as gross domestic product per capita increased after controlling for trends in time. Using a similar approach, we estimated the relationship between income and the composition of PHC expenditures, inside and outside of ambulatory settings, and non-PHC expenditures. The generalized additive models used the mgcv package and were run on R version 6.3.0 and is represented in equation 1 below.³⁷

Equation 1
$$PHC\ expenditure_{HC,c,t} = \alpha + f(\ln \ln GDP\ pc_{c,t}) + f(year)$$

Where $f()$ represents the penalized spline smoothing function, HC presents the healthcare function category, c indicates country, and t represents time.

Country Reported PHC Estimates

Based upon the national health accounts (NHAs) reviewed with Aim 1, all instances of reported primary health care (PHC) expenditures from NHA reports were captured. As definitions of PHC expenditure by countries who create NHAs varies, we attempted to categorize these expenditures based upon if the definition focused on the types of facilities or the services provided. Facility types and platforms were sourced from the Disease Control Priorities research, which identified platforms as 1) population level, 2) community level, 3) health center, 3) first-level hospital, and 4) referral and specialized hospital settings. All extracted PHC expenditures were converted to per capita 2017 US dollars as to be comparable with the PHC estimates.

Results

Figure 1 presents a map of the estimated proportion of prescribed pharmaceutical expenditures that are for primary health care in 2017 for low- and middle-income countries (LMICs). On average 27.6% with a minimum and maximum of 13.0% and 42.3% of prescribed pharmaceuticals were spent for PHC across LMICs. Of all study countries, China and Peru are estimated to have the lowest proportion of expenditures on essential prescribed pharmaceuticals with 13.0% and 15.2% of prescribed pharmaceuticals spent for PHC, respectively. Sierra Leone and Zimbabwe are estimated to have the highest proportion of expenditure on essential prescribed pharmaceuticals with 42.3% and 40.3%, respectively.

Figure 2 presents our estimates of PHC expenditures per capita in low- and middle- income countries between 2000 and 2017. The estimates show that low-income countries have increased from \$11 per capita (UIs \$10-\$12) in 2000 to \$17 per capita (UIs \$15-\$19) in 2017; equating to a 2.64% (UIs 2.37-2.92) annual rate of increase. However, the estimates suggest that low-income countries' expenditure on PHC peaked at \$17 per capita (UIs \$15-\$19) in 2014 and have since plateaued. Meanwhile, lower-middle- and upper-middle-income countries have not shown a similar plateau. Lower-middle income countries were estimated to have spent \$16 per capita (UIs \$12-\$21) in 2000 and \$34 per capita (UIs \$24-\$44) in 2017.

We find that in upper-middle-income countries PHC expenditures totaled \$71 per capita (UIs \$57-\$84) in 2000 and \$171 per capita (UIs \$139-\$202) in 2017. Table 2 presents country estimates of PHC expenditures as a share of total health expenditures for 2000 and 2017 using our proposed definitions of PHC (Table 1, columns 1 & 2, “PHC” & “PHC Ambulatory”). In addition, inpatient vaginal delivery expenditures were estimated to total \$1.48 per capita (UIs \$1.12-\$1.86) in low- and middle-income countries in 2017. This equates to 1.7% (UIs 0.9%-4.1%) of estimated primary health care expenditures in the same year.

Figure 3 panel A shows the relationship between GDP and PHC expenditures using the generalized additive model in equation 1. We can see that countries with lower gross domestic product per capita spent more of their PHC expenditures on preventative care, while medical goods and outpatient care made up a large share of PHC expenditures in countries with higher income. Figure 3 panel B depicts how PHC expenditures in an ambulatory setting, PHC expenditures outside of an ambulatory setting, and non-PHC expenditures change as income changes. We see that as income increases, PHC expenditures decrease as a share of total health expenditures and that PHC expenditures in an ambulatory setting makes up larger proportion of PHC expenditures.

Figure 4 Panel A presents the estimates of PHC expenditures per capita in 2017 US dollars across income groups using our two definitions of PHC. For all LMICs, \$91.4 per capita (IQR \$24.1-\$138.5) was estimated to have been spent on PHC. This breaks down into \$18.3 (IQR \$13.1-\$22.7), \$47.4 (IQR \$28.7-\$57.1), and \$167.5 (IQR \$106.9-\$192.7) per capita for low-income, lower-middle-, and upper-middle-income countries, respectively. Limited to just ambulatory settings, PHC expenditures drop to \$36 (IQR \$7-\$55) per capita across all LMICs.

When measured as a share of total health expenditures, primary health care was found to decrease as countries’ income increased (Figure 4 pane B). For all study countries, a median value of 40.2% (IQR 35.9%-42.9%) of total health expenditures was estimated to have been spent on PHC. This breaks down into 45.8% (IQR 37.3%-53.3%), 39.6% (IQR 37.6%-42.9%), and 37.7% (IQR 33.9%-39.2%) for low, lower-middle, and upper-middle-income countries, respectively. However, by limiting PHC expenditures to ambulatory settings we see that the median estimate of PHC expenditures increased as income increased.

Figure 6 Panel A presents the comparison of the extracted PHC expenditures (x-axis) – sourced from reviewed National Health Accounts - and the estimated PHC expenditures (y-axis, which consider all PHC services irrelevant of the provider). Figure 5 Panel B presents the comparison of the same extracted PHC expenditures (x-axis) and the estimated PHC expenditures within ambulatory settings (y-axis).

Discussion

Based on this research PHC expenditures increased from \$209.6 billion (UIs \$169.0-\$248.1) in 2000 to \$574.2 billion (UIs \$469.7-\$675.6) in 2017. While middle-income countries have continued to see a relatively steady annual increase in PHC expenditures during this time period, low-income countries have seemingly plateaued since 2014 when they spent \$17 per capita (\$15-\$19) which equates to 47.0% (UIs 40.8%-52.4%) of total health expenditures in these countries. Though increased expenditure on PHC systems, in and of itself, does not lead to improved equitable health outcomes, the finding that low-income countries, which endure the majority of the global burden of disease, have seemingly stalled their expenditure on PHC is reason for concern.^{38,39}

The use of pharmaceutical costs data and the WHO essential medicines list showed an average of 27·6% of prescribed pharmaceuticals were spent for PHC across LMICs. This is in stark contrast to the 80% assumed by the current definition used by the WHO. In fact, the maximum estimated proportion of essential prescribed pharmaceuticals was found to be 40·3% and 42·3% in Zimbabwe and Sierra Leone, respectively.

As proposed originally by Starfield and more recently by Baillieu et al, PHC services should ideally be provided within PHC settings (such as a health post or center) and by primary care providers.^{10,22,23} While the System of Health Accounts framework that this research relies upon does not provide refined details of health care facility or provider types (such as primary care providers or health posts and clinics), it does allow for the distinction between providers of ambulatory care from hospitals and long-term facilities.¹⁸ Using this detail, we demonstrated how trends in PHC expenditures within ambulatory settings make up a smaller share of total health expenditures in lower income countries. This distinction may illuminate a potential underlying patient perception that ambulatory settings do not provide the same quality of PHC services as hospitals in lower income countries, thus increasing utilization of services provided in the hospital setting.

Interestingly, it was found that PHC expenditures when measured within ambulatory settings align more closely with the estimates of PHC expenditures reported by countries in their NHA reports. It is unclear if this alignment is due to countries consciously defining their PHC expenditure estimate to the ambulatory setting or more driven by lack of clarity of health PHC services provided outside of ambulatory settings. It is possible that countries underestimate their PHC expenditures by limiting their estimates to low-level health facilities (such as health posts, clinics) and cannot account for primary care services being provided in non-primary care settings. Additionally, very few country-reported estimates of PHC captured from reviewed NHAs included administrative costs.

Limitations

This research has several limitations. Most importantly, as with previous work, this research relies upon data and a framework that were not created to track and measure primary health care expenditures across countries and time.^{14–16,19,20} As a consequence, these findings and results should be taken as proxy measures of true PHC expenditures. Our estimation strategy to understand the proportion of pharmaceutical expenditures that are for PHC relied upon sales data from national audits but for a majority of high income countries and only between 2014 to 2017.^{24,25} It is unclear exactly how the influence of these costs would effect our results; one potential is that low income settings may have additional PHC pharmaceuticals and fewer expenditures on non-essential medicines, leading to underestimations. The available cost data for inpatient vaginal delivery is limited to only a few country-years and thus the reliance on more robust estimates of Cesarean-section costs was built into our methods. Ultimately, these estimates are considered a first-order estimation and although they provide a valuable addition, they require additional research to substantiate. The financing source of health expenditures for primary health care is an important dimension that this study was not able to incorporate in the current iteration.

Tables and Figures

Table 1. Comparison of categories included in different measurements of primary health care expenditures

Health expenditure categories	Health Care Functions	This research		Previous research	
		PHC	PHC Ambulatory	WHO GHED	OECD 2019
		1	2	3	4
General outpatient curative care	HC 1.3.1	Included	Ambulatory settings	Included	Ambulatory settings
General dental curative care	HC 1.3.2	Included	Ambulatory settings	Included	Ambulatory settings
Curative outpatient care not elsewhere classified	HC 1.3.nec*	Included	Ambulatory settings	Included	Excluded
Home-based curative care	HC 1.4	Included	Ambulatory settings	Included	Excluded
Long-term outpatient care	HC 3.3	Included	Ambulatory settings	Included	Excluded
Long-term home-based care	HC 3.4	Included	Ambulatory settings	Included	Excluded
Preventive care	HC 6	Included	Ambulatory settings	Included	Included
Prescribed medicines	HC 5.1.1	Country-year estimated proportion based on essential medicines	Country-year estimated proportion based on essential medicines in ambulatory settings	80%	Excluded
Over-the-counter drugs	HC 5.1.2	Included	Ambulatory settings	80%	Excluded
Other medical nondurable goods	HC 5.1.3	Included	Included	80%	Excluded
Therapeutic appliances and other medical goods	HC 5.2	Excluded	Excluded	80%	Excluded
Medical goods not elsewhere classified	HC 5.nec*	Excluded	Excluded	80%	Excluded
Health system admin and governance	HC 7	Share of PHC/Total expenditure	Share of PHC in ambulatory setting/Total expenditure	80%	Excluded
Inpatient Vaginal Delivery	NA	Included	Excluded	Excluded	Excluded

Caption: Components of various measurements of primary health care expenditures. These include two measurements from this research, one from the World Health Organization Global Health Expenditure Database (WHO GHED), and another from the Organization for Economic Cooperation and Development (OECD). NEC = not elsewhere classified; HC = health care functions. *Created when reported total is greater than sum of subcomponent. Health care functions are sourced from the 2011 System of Health Accounts.

Table 2. Primary health care expenditures with uncertainty intervals in 2017 for all countries

Country	PHC per capita (2017 USD)	PHC as a share of THE
Afghanistan	\$26 (17-36)	41.5% (26.9-58.3)
Albania	\$119 (77-164)	36.3% (23.5-49.8)
Algeria	\$103 (77-125)	38.3% (28.8-46.6)
American Samoa	\$247 (185-303)	37.8% (28.2-46.3)
Angola	\$46 (34-56)	38.3% (28.8-47.2)
Argentina	\$469 (352-575)	37.8% (28.4-46.4)
Armenia	\$207 (149-259)	53.3% (38.4-66.9)
Azerbaijan	\$103 (77-127)	37.8% (28.3-46.5)
Bangladesh	\$16 (10-23)	41.2% (25.0-58.7)
Belarus	\$133 (102-161)	38.9% (29.7-47.0)
Belize	\$110 (83-136)	39.2% (29.6-48.2)
Benin	\$14 (8-20)	39.6% (23.7-56.8)
Bhutan	\$25 (13-37)	32.1% (16.1-47.0)
Bolivia	\$58 (19-84)	27.7% (9.1-39.9)
Bosnia and Herzegovina	\$176 (96-265)	34.6% (18.9-52.1)
Botswana	\$208 (125-305)	46.4% (27.8-68.1)
Brazil	\$315 (115-486)	34.5% (12.6-53.3)
Bulgaria	\$237 (136-337)	35.3% (20.3-50.2)
Burkina Faso	\$21 (17-27)	54.5% (42.6-68.0)
Burundi	\$16 (12-21)	55.6% (39.9-71.9)
Cambodia	\$33 (15-59)	41.8% (19.2-74.0)
Cameroon	\$23 (17-30)	39.4% (29.1-51.3)
Cape Verde	\$62 (39-85)	38.6% (24.2-53.4)
Central African Republic	\$8 (6-10)	37.4% (28.2-47.0)
Chad	\$11 (8-13)	38.1% (28.5-46.8)
China	\$144 (110-180)	32.7% (25.2-41.0)
Colombia	\$173 (129-211)	38.2% (28.6-46.8)
Comoros	\$22 (4-35)	32.4% (5.1-50.4)
Congo (Brazzaville)	\$22 (14-32)	44.9% (27.4-64.1)
Costa Rica	\$322 (249-400)	33.9% (26.3-42.2)
Cuba	\$457 (346-553)	39.0% (29.5-47.2)
Côte d'Ivoire	\$34 (22-47)	45.5% (30.3-64.0)
DR Congo	\$9 (7-10)	53.1% (43.2-63.3)
Djibouti	\$22 (16-27)	37.8% (28.5-46.8)
Dominica	\$198 (82-398)	41.3% (17.1-83.2)
Dominican Republic	\$95 (52-163)	21.3% (11.7-36.5)
Ecuador	\$151 (63-245)	29.0% (12.1-47.1)
Egypt	\$50 (33-71)	39.3% (25.7-55.5)
El Salvador	\$109 (51-179)	34.9% (16.4-57.4)
Equatorial Guinea	\$110 (85-133)	40.7% (31.3-49.4)

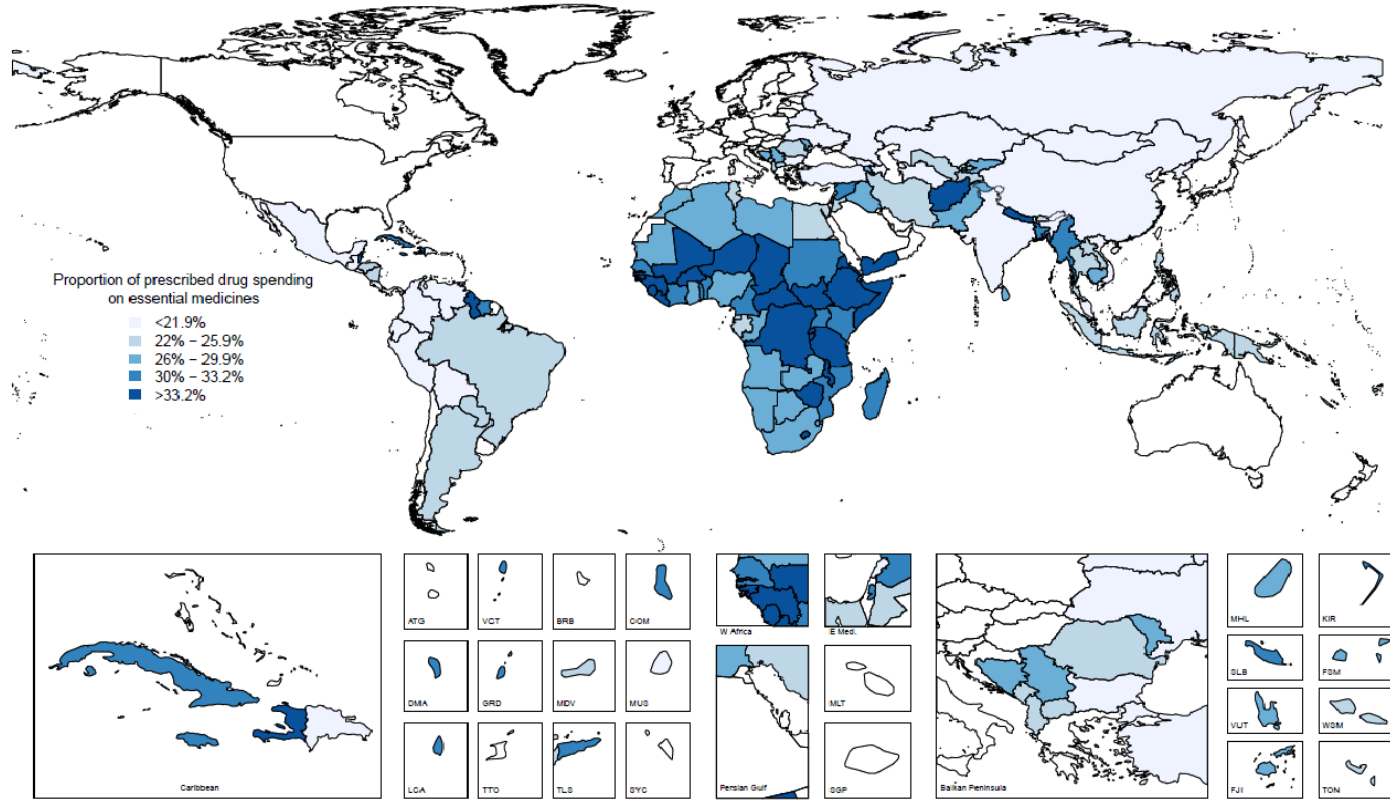
Eritrea	\$11 (8-13)	38.4% (29.0-47.4)
eSwatini	\$110 (56-172)	38.4% (19.7-59.9)
Ethiopia	\$17 (11-22)	57.5% (36.4-76.4)
Federated States of Micronesia	\$55 (34-79)	40.4% (25.1-57.7)
Fiji	\$80 (54-108)	40.5% (27.4-54.9)
Gabon	\$98 (68-139)	37.1% (25.8-52.4)
Georgia	\$105 (68-148)	32.6% (21.1-45.9)
Ghana	\$29 (18-46)	44.3% (26.9-69.5)
Grenada	\$187 (141-231)	38.7% (29.1-47.8)
Guatemala	\$93 (41-144)	35.2% (15.4-54.3)
Guinea	\$22 (14-29)	57.0% (35.6-73.5)
Guinea-Bissau	\$23 (17-28)	37.2% (27.9-46.4)
Guyana	\$159 (103-214)	63.1% (40.7-84.6)
Haiti	\$23 (16-29)	48.7% (34.8-63.2)
Honduras	\$72 (54-88)	38.6% (29.2-47.6)
India	\$30 (12-51)	43.3% (16.7-72.7)
Indonesia	\$49 (25-68)	40.2% (20.4-56.3)
Iran	\$149 (117-182)	32.9% (26.0-40.2)
Iraq	\$67 (27-95)	41.0% (16.4-58.0)
Jamaica	\$125 (94-154)	39.0% (29.4-48.0)
Jordan	\$79 (41-128)	28.1% (14.4-45.3)
Kazakhstan	\$102 (78-129)	33.8% (25.8-42.8)
Kenya	\$42 (23-62)	49.6% (27.3-72.9)
Kiribati	\$85 (48-123)	38.4% (21.8-55.4)
Kyrgyzstan	\$32 (22-44)	38.5% (26.2-53.2)
Laos	\$24 (13-40)	41.9% (22.3-68.5)
Lebanon	\$167 (79-278)	32.6% (15.5-54.3)
Lesotho	\$55 (42-66)	39.4% (29.9-47.1)
Liberia	\$24 (11-37)	36.5% (16.1-56.0)
Libya	\$154 (117-188)	39.1% (29.8-47.6)
Madagascar	\$8 (4-16)	35.1% (17.9-71.9)
Malawi	\$22 (17-27)	53.5% (41.9-66.1)
Malaysia	\$145 (114-170)	37.2% (29.3-43.7)
Maldives	\$420 (195-615)	43.5% (20.2-63.7)
Mali	\$17 (10-23)	54.3% (32.7-75.2)
Marshall Islands	\$154 (115-192)	37.4% (28.0-46.4)
Mauritania	\$18 (12-27)	31.3% (20.6-46.3)
Mauritius	\$193 (106-291)	32.0% (17.7-48.3)
Mexico	\$177 (139-221)	34.9% (27.3-43.6)
Moldova	\$96 (53-134)	50.0% (27.7-70.1)
Mongolia	\$68 (44-95)	43.7% (28.5-61.3)
Montenegro	\$219 (139-303)	33.8% (21.5-46.8)
Morocco	\$65 (32-92)	38.9% (19.4-55.0)

Mozambique	\$9 (4-16)	31.8% (13.4-56.9)
Myanmar	\$26 (15-37)	47.3% (27.7-65.8)
Namibia	\$186 (119-262)	36.0% (23.1-50.6)
Nepal	\$25 (15-36)	51.6% (31.7-74.2)
Nicaragua	\$80 (55-107)	42.6% (29.3-57.0)
Niger	\$12 (7-18)	46.3% (27.0-68.7)
Nigeria	\$31 (17-48)	46.6% (24.9-72.0)
North Korea	\$30 (22-36)	37.7% (28.2-46.5)
North Macedonia	\$163 (125-195)	40.3% (31.0-48.3)
Pakistan	\$16 (9-24)	36.8% (21.0-56.1)
Palestine	\$150 (108-190)	41.4% (29.9-52.4)
Papua New Guinea	\$14 (7-24)	26.8% (13.1-45.8)
Paraguay	\$107 (63-167)	28.1% (16.5-44.0)
Peru	\$129 (98-157)	39.3% (29.7-47.7)
Philippines	\$52 (34-74)	37.5% (24.9-53.8)
Romania	\$179 (107-252)	32.4% (19.4-45.7)
Russia	\$302 (201-382)	52.7% (35.1-66.7)
Rwanda	\$24 (12-41)	51.4% (26.4-88.5)
Saint Lucia	\$196 (147-241)	38.8% (29.0-47.6)
Saint Vincent and the Grenadines	\$125 (94-154)	39.2% (29.4-48.0)
Samoa	\$67 (31-114)	30.3% (13.9-51.2)
Senegal	\$28 (20-38)	44.3% (30.8-59.3)
Serbia	\$171 (75-386)	39.9% (17.4-90.4)
Sierra Leone	\$52 (34-66)	76.8% (50.2-97.4)
Solomon Islands	\$42 (32-52)	37.7% (28.3-46.5)
Somalia	\$3 (2-3)	37.1% (27.8-46.3)
South Africa	\$187 (109-275)	35.8% (20.9-52.6)
South Sudan	\$15 (9-20)	52.2% (31.7-70.8)
Sri Lanka	\$58 (34-92)	35.8% (21.0-56.1)
Sudan	\$29 (22-36)	38.6% (28.9-47.3)
Suriname	\$126 (79-181)	36.1% (22.7-51.7)
Syria	\$17 (13-21)	38.6% (29.0-47.0)
São Tomé and Príncipe	\$39 (29-48)	37.3% (28.0-46.3)
Tajikistan	\$16 (10-25)	27.9% (17.8-42.4)
Tanzania	\$25 (17-33)	61.8% (41.0-81.2)
Thailand	\$145 (109-178)	58.8% (44.0-71.8)
The Gambia	\$19 (9-29)	46.0% (22.1-68.9)
Timor-Leste	\$40 (21-56)	56.7% (30.2-79.3)
Togo	\$19 (12-27)	48.8% (30.9-68.0)
Tonga	\$84 (44-131)	37.9% (19.8-59.1)
Tunisia	\$72 (39-115)	28.2% (15.4-45.2)
Turkey	\$132 (79-192)	29.3% (17.7-42.6)

Turkmenistan	\$200 (149-247)	37.4% (27.8-46.0)
Uganda	\$15 (9-23)	36.1% (21.9-53.6)
Ukraine	\$51 (37-66)	29.2% (21.5-37.9)
Uzbekistan	\$36 (27-44)	37.8% (28.3-46.2)
Vanuatu	\$40 (22-60)	42.1% (23.5-62.4)
Venezuela	\$39 (29-47)	39.8% (30.3-48.4)
Vietnam	\$43 (23-68)	33.4% (17.5-53.2)
Yemen	\$15 (11-20)	36.4% (25.2-47.4)
Zambia	\$32 (15-50)	42.4% (20.3-67.3)
Zimbabwe	\$56 (32-77)	45.9% (26.2-63.6)

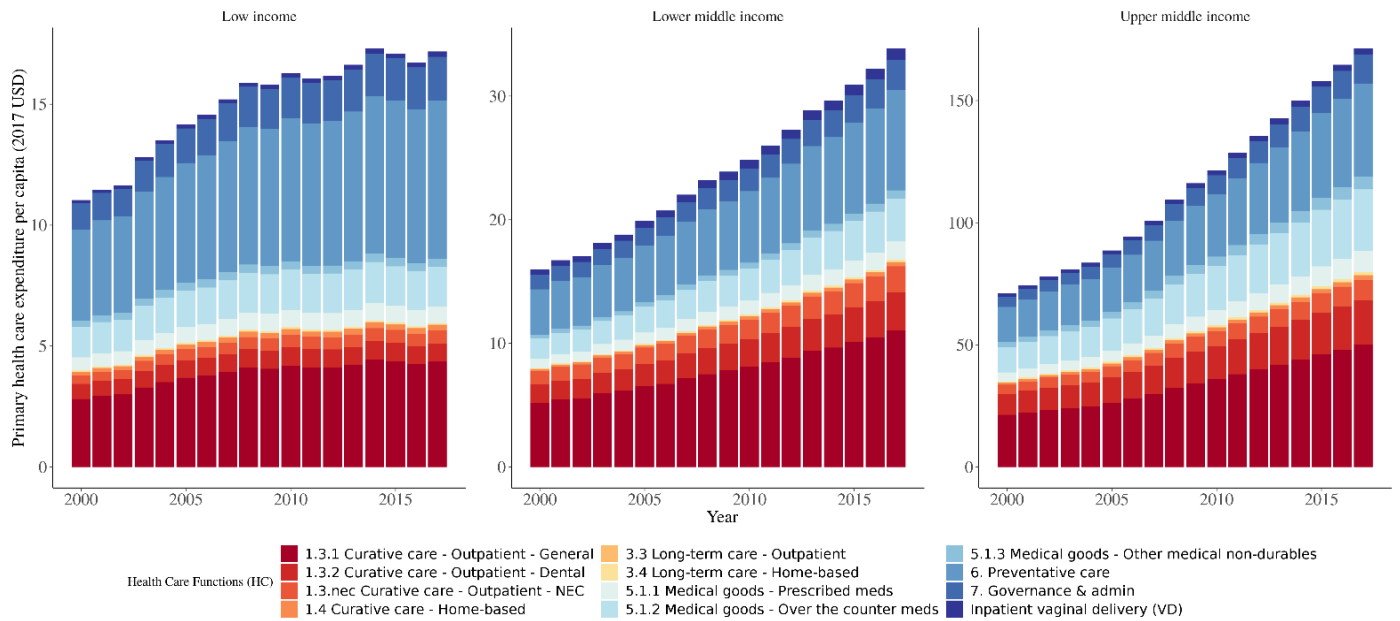
Caption: Primary health care expenditures with 95% uncertainty intervals in 2017 for all low- and middle-income countries. Presented both in 2017 US dollars per capita and as a share of total health expenditures (THE).

Figure 1. Map of 2017 estimated fraction of prescription pharmaceutical expenditures on essential medicines in low- and middle-income countries



Caption: Figure 1 presents the estimated proportion of prescribed pharmaceutical expenditures on essential medicines in 135 low- and middle-income countries.

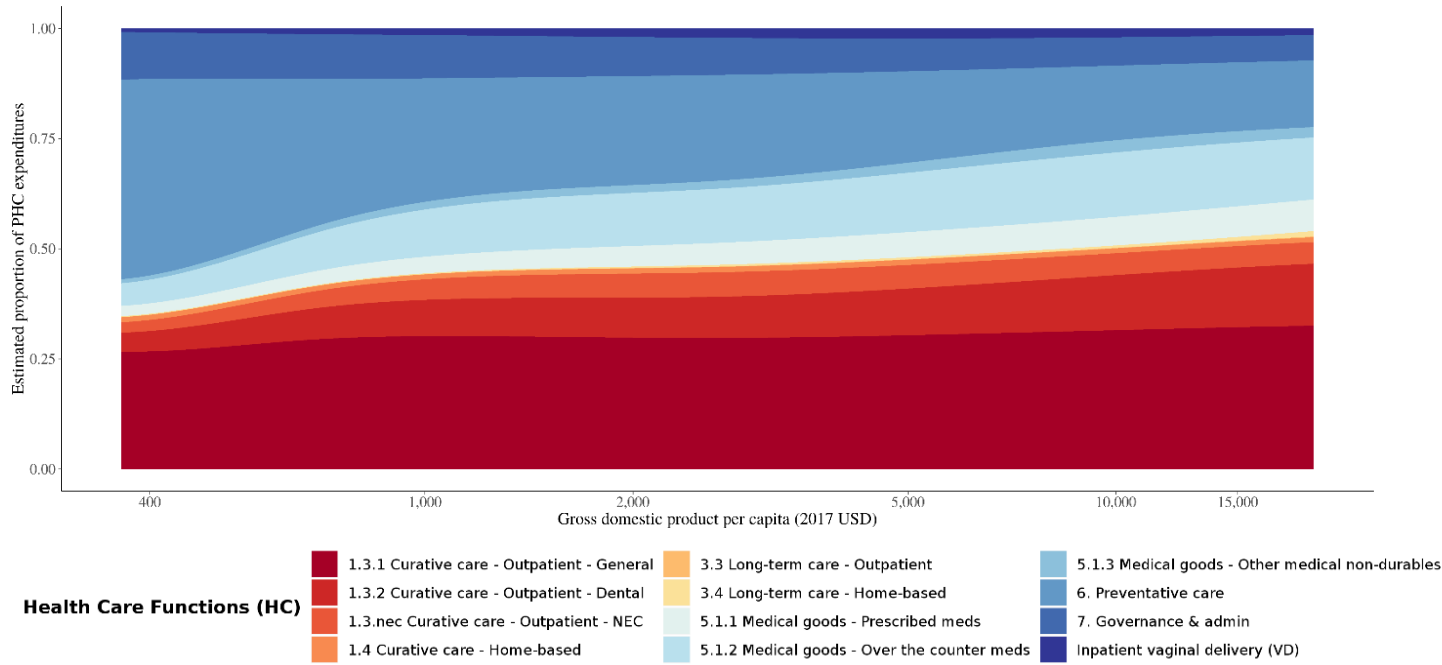
Figure 2. Primary health care expenditures per capita estimates by World Bank income groups, 2000 to 2017



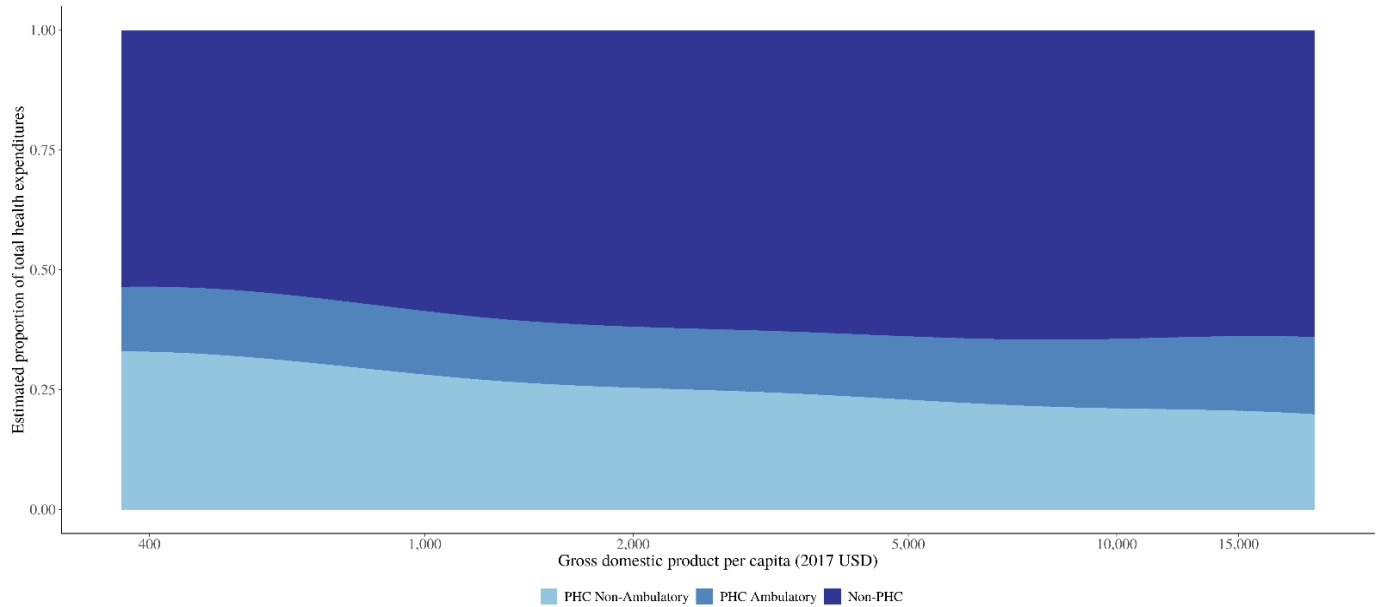
Caption: Figure 2 presents primary health care expenditures, in 2017 US dollars per capita, by health care functions and World Bank income groups between 2000 and 2017. Health care functions are based upon the 2011 System of Health Account categories with the addition of inpatient vaginal delivery. Vertical axes change between figures for different income groups. NEC = not elsewhere classified.

Figure 3. Primary health care expenditures across gross domestic product

Panel A. Composition of primary health care expenditures by functions, 2017



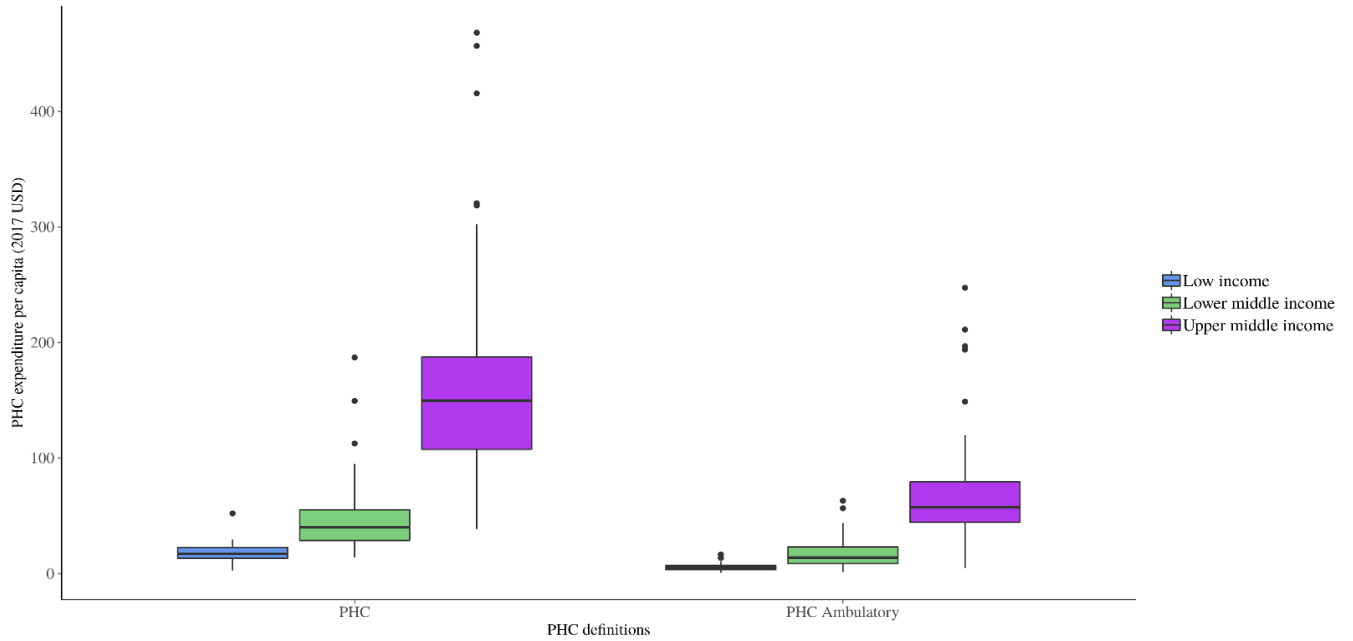
Panel B. Composition of health expenditures, 2017



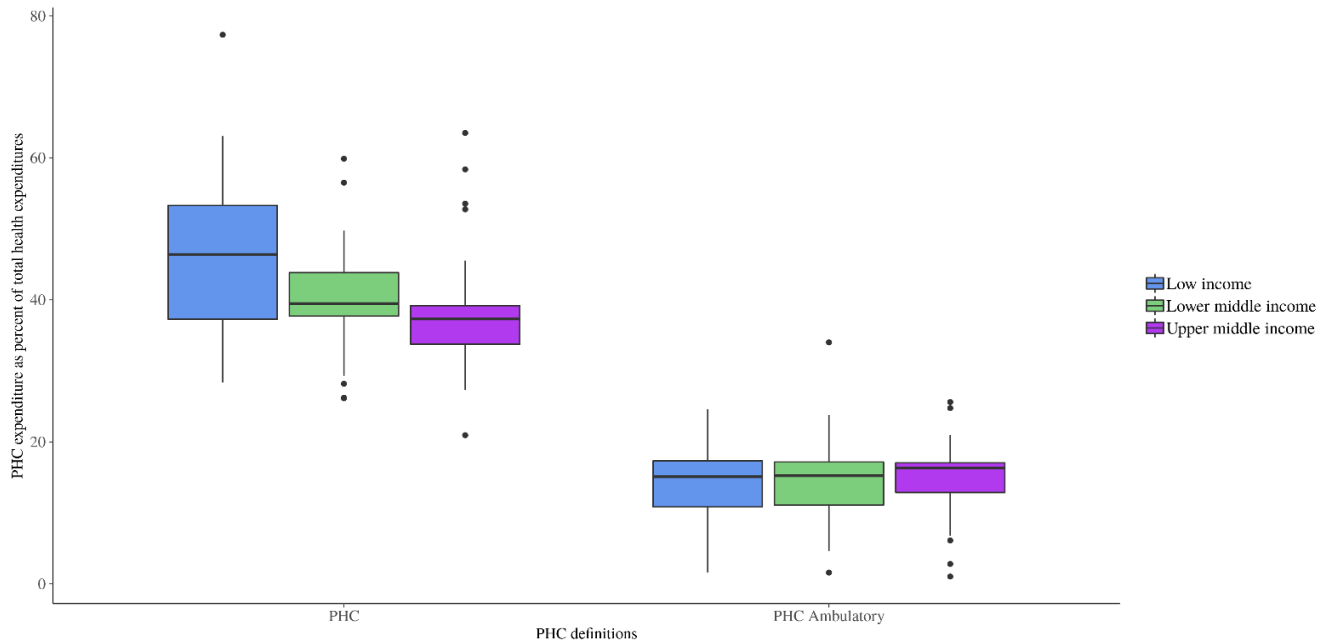
Caption: Panel A shows the relationship between the components of primary health care expenditures and gross domestic product per capita in 2017 US dollars. Health care functions are based upon the 2011 System of Health Account categories. NEC = not elsewhere classified. Panel B shows the relationship between gross domestic product per capita in 2017 US dollars and the composition of total health expenditures by non-primary care, ambulatory primary care, and non-ambulatory primary care.

Figure 4. Primary health care expenditures by measurement strategies and World Bank income groups in 2017

Panel A. PHC expenditures per capita



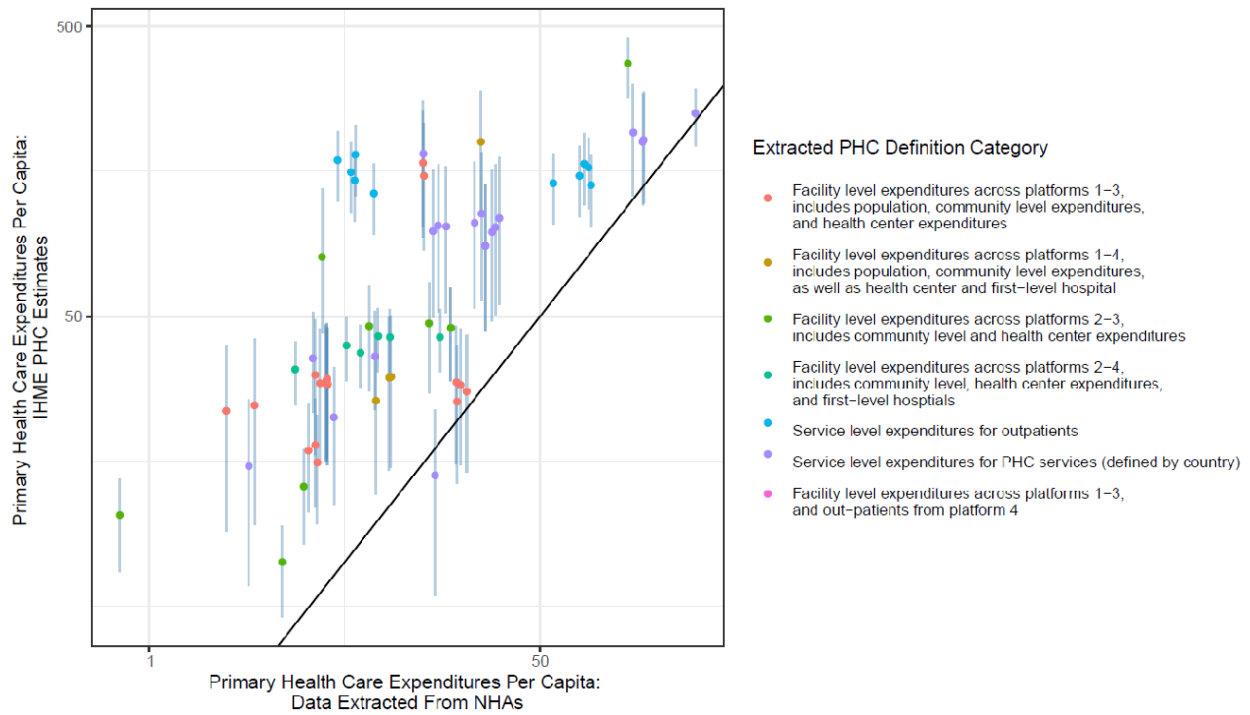
Panel B. PHC expenditures as percent of total health expenditures



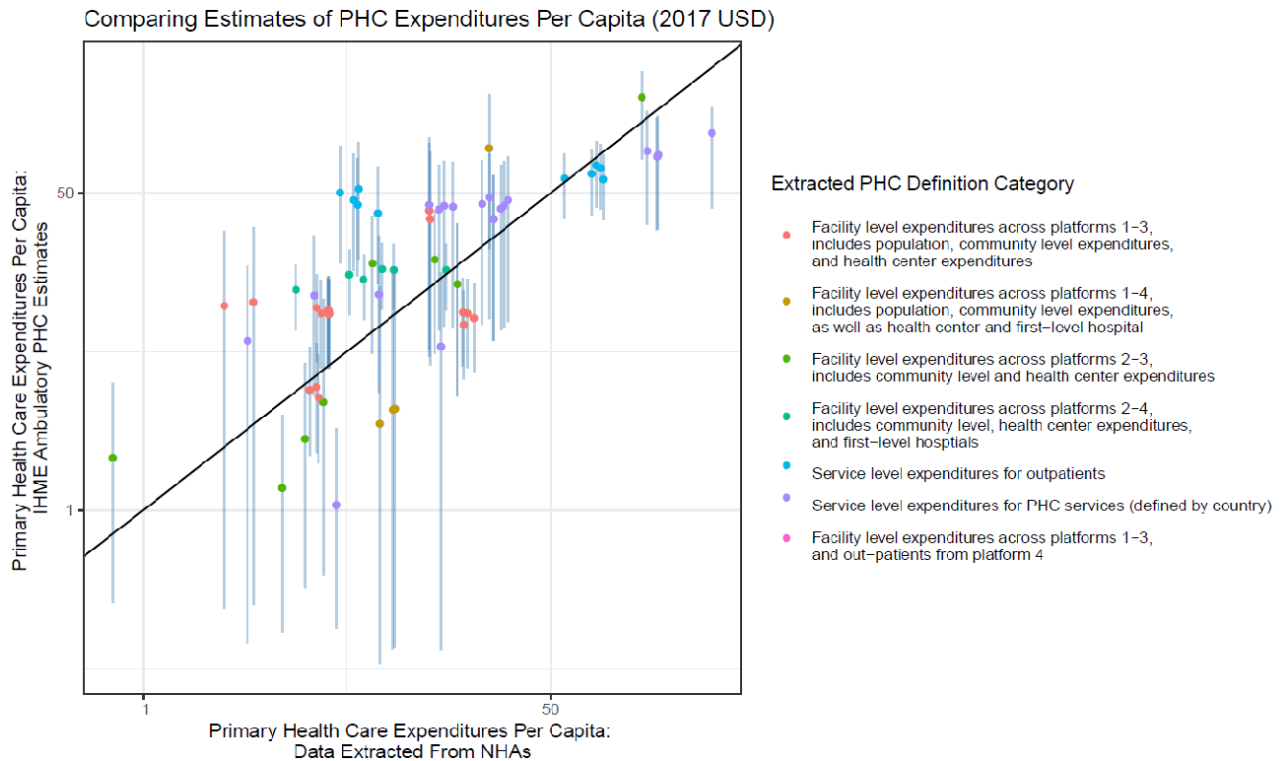
Caption: Panel A presents primary health care expenditures per capita (in 2017 US dollars) by World Bank income groups for two definitions of primary health care: (1) across all providers and (2) for only ambulatory providers (as defined within Table 1). Panel B presents primary health care expenditures as a percent of total health expenditures by World Bank income groups for the same definitions of primary health care outlined above.

Figure 6. Comparing PHC expenditures

Panel A. Comparing IHME estimates of PHC expenditures with NHA extracted estimates



Panel B. Comparing IHME estimates of PHC expenditures within ambulatory settings and NHA extracted estimates



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Aim 3

Estimating the relationship between primary health care expenditures and health outcomes and intermediate health outputs across low- and middle-income countries

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Introduction

A strong PHC system has been shown to improve health related outcomes, such as mortality due to vaccine preventable childhood diseases and chronic heart diseases.¹⁻⁷ Starfield and colleagues conducted a literature review of the relationship between the supply of primary care physicians with health outcomes, finding that areas with a higher ratio of primary care physicians to population were more likely to have improved total and cause-specific mortality, low birthweight, and self-reported health than areas with a lower ratio of primary care physicians to population.³ In 2014, Rasella et al found that between 2000 and 2009 higher coverage of Brazil's Family Health Program was associated with improvements in mortality rates from cerebrovascular and health diseases after controlling for demographic, social, and economic confounders.⁴ Given the often long period of time needed to observe changes in health outcomes, intermediate health outputs are commonly used as proxies for health outcomes given their relative timely reporting.

Similar to health outcomes, certain intermediate health outputs have been seen to improve with a strong PHC system.⁸ These include the percent of population with access to health care, coverage of vaccinations, and patient satisfaction with the health system.^{6,9-15} A literature review by Kruk and colleagues found that low- and middle-income countries (LMICs) which "made primary care a cornerstone of their health systems" expanded access to preventive and curative services resulting in improved coverage of these services.⁸ In Nigeria, the Midwives Service Scheme was introduced in 2009 and found to increase coverage of deliveries by skilled birth attendants as well as usage of contraceptive methods.¹⁴

However, neither the impacts between PHC expenditures and health outcomes and intermediate health outcomes have been tested systematically across LMICs. A main reason for this lack of information is that there has never been a complete set of comparable PHC expenditure estimates across LMICs. Understanding not only the degree of PHC investment, but the relationship between these investments and changes in related health outputs and outcomes could position LMICs and policy-makers to better reach the health-related Sustainable Development Goal and the push for Universal Healthcare Coverage.^{6,16}

Aim 2 of this research produced comparable estimates of PHC expenditures across 135 LMICs between 2000 and 2017. This current Aim used the complete set of estimates from Aim 2 and explored the relationship between PHC expenditures and related health outcomes and intermediate health outputs from the Global Burden of Disease.¹⁷ Using binary correlations and significance tests, as well as multiple panel time-series regression methods, this research attempted to identify where relationships were and were not able to be identified between PHC expenditures and health outcomes and outputs.

Data & Methods

PHC Expenditures

Drawing upon the estimates produced in Aim 2, estimates of PHC expenditures included the following health care function categories (based upon the system of health account framework¹⁸):

1. Curative care - general outpatient, general dental, home-based, and curative care not elsewhere classified
2. Long-term care - outpatient and home-based
3. Preventive care

4. Medicines and medical goods - essential prescribed medicines, over-the-counter drugs, other medical nondurable goods, therapeutic appliances and other medical goods
5. Health system administrative and governance: estimated as the proportion of total health system administrative and governance expenditures that PHC makes up of total health expenditures (not including health system admin and governance)
6. Inpatient vaginal delivery

Additionally, the expenditures within the above categories were split by the type of healthcare providers that these services were provided in to create two estimates of PHC expenditures: 1) including expenditures across all health care providers, and 2) including expenditures from only ambulatory settings. Table 1 of Aim 2 presents these measurement strategies compared to previous approaches developed by the Organization for Economic Cooperation and Development (OCED) and the World Health Organization (WHO).

PHC Outcome and Output Analysis

The association between the estimated PHC expenditures as share of total health expenditures and health outcomes and intermediate health outputs of interest was measured using bivariate analyses as exploration then multivariate panel fixed effects models (Equation 1) to control for confounding and country contextual variables. The rationale for using PHC expenditures as a share of total health expenditures is twofold. Firstly, PHC expenditures are not the only health expenditures changing over time within and between countries. However, there is a strong correlation between PHC and non-PHC expenditures and so including both as absolute or per capita dollars in a single regression inhibits the ability to draw separate conclusions. Secondly, by including PHC expenditures as a share of total health expenditures we are making the case for dollars, which are already being allocated toward health, shifting to PHC as opposed to dollars that may be for another purpose and arguably harder to reallocate.

The dependent variables (y_{it}) used were annual national estimates of health outcomes and intermediate outputs that had been identified as related to a well-functioning health system either in practice or in theory and were consistently estimated with the Global Burden of Disease.[PHCPI, WHO report, and GBD citation] The health outcomes used as dependent variables were 1) age-standardized mortality rate, 2) maternal mortality rate, 3) neonatal mortality rate, 4) mortality rate of children under five years old, 5) non-communicable disease disability adjusted life years, 6) communicable disease disability adjusted life years, and 7) the prevalence of diabetes. The intermediate health outputs used were 1) coverage of the fourth antenatal care visit (ANC4), 2) coverage of the third dose of diphtheria-tetanus-pertussis vaccine (DTP3), 3) measles vaccination coverage, 4) smoking prevalence of people of reproductive age, 5) antiretroviral treatment coverage, 6) coverage of deliveries attended by a skilled birth attendant, 7) health worker density, 8) Universal Healthcare Coverage (UHC) effective coverage index, and 9) the Healthcare Access and Quality Index. All dependent variables are from work by the Global Burden of Disease.^{17,19–21} A more linear relationship was found between the independent and dependent variables if those that are measured as a proportion were logit transformed and the others were natural log transformed. Our variable of interest, PHC expenditures divided by total health expenditures, and total health expenditures per capita were included. Using a stepwise process, we identified and controlled for country and time varying covariates (X_{it}) for each dependent variable. These covariates included average years of education, total fertility rate, prevalence of HIV, the number of hospital beds, lag distributed income, urbanicity, and the share of health expenditures that

government and out-of-pocket make up.¹⁹ Country fixed effects (γ_i) and year fixed effects (γ_t) were included and a normally distributed error term (ε_{it}) was assumed. Country and time are represented in Equation 1 as i and t , respectively.

$$\text{Equation 1. } y_{it} = \alpha + \gamma_i + \gamma_t + \beta_1 \left(\frac{\text{PHC Expenditures}}{\text{Total Health Expenditures}} \right)_{it} + \beta_2 \text{Total health expenditures}_{it} + \beta_3 X_{it} + \varepsilon_{it}$$

Using Equation 1, when the dependent variable is log transformed, β_1 – the coefficient of our variable of interest – can be interpreted as a 1 percent change in PHC expenditures as a share of total health expenditures relates to a $\exp(\beta_1)-1$ change in the dependent (y_{it}) variable. The coefficients' standard errors were Huber-White robust adjusted, to address heteroskaticity, and are clustered by years to address any serial-correlation over time. In addition, since the relationship between PHC expenditures and 16 health outcomes and outputs are analyzed we adjust for multiple hypotheses using Bonferroni correction.²²⁻²⁵ The panel regressions were conducted using the plm package in R, version 6.3.0.²⁶

Results

Figure 1 presents the binary relationships between 2017 PHC expenditures and the health outcomes and outputs for this same year. We see that there is a significant ($p < 0.05$) negative relationship between PHC expenditures per capita and the all-age maternal, neonatal, and under-5 mortality rates, communicable, maternal, and neonatal DALYs, and non-communicable disease DALYs. We also see that there is a significant ($p < 0.05$) positive relationship between PHC expenditures per capita and the HAQ index, UHC effective coverage index, density of health workers, prevalence of smoking, antenatal care coverage (4+ visits), DTP3 and measles immunization coverage, and skilled birth attendant coverage. All of these relationships, aside from the prevalence of smoking, are positive findings based on the binary relationship between PHC expenditures and these health outcomes and intermediate health outputs. When PHC expenditures are calculated as a share of total health expenditures we see many of these relationships invert or become insignificant.

Table 1 presents the regression coefficients and their Huber-White, Bonferroni adjusted standard errors for the country fixed effects panel regression models across all 135 low- and middle income countries. Each column represents a different model where all that is changing is the dependent variable - the health outcome. Each model controls for total health expenditures (THE), income (lag distributed income, LDI), fertility rate, hospital capacity, average years of education, HIV prevalence, urbanicity, the proportion of the population that is over 65 years old, and the proportion of total health expenditures that out-of-pocket (OOP) and government health expenditures as a source (GHES) make up. After controlling for these potential confounders, effect modifiers, and precision variables we can see that across the seven health outcomes only the maternal mortality rate shows a significant ($p\text{-value} \leq .001$) decrease with an increase in our variable of interest - PHC expenditures as a share of total health expenditures (PHC/THE). Specifically, with a 1 percent increase in PHC expenditures in all LMICs our model estimates a decrease of roughly 1 maternal death per 100,000 live births. Table 2 presents similar regression outputs as Table 1, however, instead of health outcomes as the dependent variables they are health outputs. These regressions control for the same variables as in Table 1 and we find that an increase in PHC/THE is related to a significant improvement in the HAQ index ($p\text{-value} \leq 0.05$), antenatal care coverage (4+ visits) (ANC4, $p\text{-value} \leq .001$), and the measles vaccine coverage ($p\text{-value} \leq .001$).

Figure 2 panel A presents the coefficients for our variable of interest found in Table 1. Additionally, this figure presents the coefficient for the same models as in Table 1, but limiting the dataset to specific income groups. We see that both lower- and upper-middle-income countries were found to have significant improvements in maternal mortality (p-value $\leq .05$) and (p-value $\leq .001$) with more PHC expenditures. Low- and lower-middle income countries show significant improvements in neonatal mortality with additional PHC expenditures (p-value $\leq .05$) and (p-value $\leq .001$). Lower-middle income countries with more PHC expenditures had improvements in communicable burden of disease (p-value $\leq .01$) diabetes prevalence (p-value $\leq .01$) and under-5 mortality (p-value $\leq .05$). Low-income countries that spent more on PHC had significantly higher non-communicable disease burden (p-value $\leq .001$).

Similar to the previous panel, Figure 2 panel B shows the coefficients for our variable of interest found in Table 2. Additionally, this figure presents the coefficient for the same models as in Table 2, but limiting the dataset to specific income groups. These sub-analyses show that all income groups had statistically significant improvements in ANC4 coverage with more of their health expenditures being spent on PHC. We also see that upper-middle-income countries which spent more on PHC had significant improvements in coverage of the third dose of diphtheria-tetanus-pertussis (p-value $\leq .001$), the measles (p-value $\leq .05$) vaccines, and the health access and quality (p-value $\leq .001$) and UHC (p-value $\leq .01$) indices. However, this analysis also showed that health worker density decreased for upper-middle-income countries (p-value $\leq .01$) and UHC index decreased in low-income countries (p-value $\leq .01$) which spent more on PHC. Lastly, this sub-analyses indicates that lower-middle incomes countries that spent more on PHC had statistically significant higher coverage of skilled birth attendance (p-value $\leq .05$). These results were reinforced by robustness checks using a 10-year lagged fixed effects panel regression model and a mixed effects model with a Mundlak adjustment. Section B of the appendix presents these analyses in full. An additional sensitivity analysis was conducted where the intermediate health outputs of smoking prevalence, ANC4 coverage, coverage of skilled birth attendance, and mean body mass index were included as potential covariates in the health outcome analyses. These sensitivity analyses did not change the relationships between the health outcomes and PHC expenditures. Due to potential circularity between the estimation of the health outcomes conducted in the Global Burden of Disease these analyses were not included in the final presented regressions.

Discussion

For more than four decades, primary health care has been at the center of the debate of how policy-makers and health care systems can improve health related outcomes equitably.^{9,10,27-29} PHC is often considered the backbone of a health system and touted as a means to reach the health related Sustainable Development Goals, such as providing Universal Healthcare Coverage and reducing maternal, neonatal, and under-five mortality.^{4,6,16,30,31} Inputs for a well-functioning PHC system range from policies and staffing, to accessibility and responsiveness of the health system.^{32,2,11,33} One key input is expenditure for primary health care.^{10,11} However, due to lack of data, the trends in past PHC expenditures and their relationship to health outcomes and outputs has not been explored across countries using statistical methods.

With the complete time-series of PHC expenditures for LMICs from Aim 2 of this work, this third Aim explored the relationship between PHC expenditures and health outcomes and intermediate health outputs. The outcomes and outputs used in this research were identified as core indicators which are used to measure PHC performance across countries.¹¹ Through bivariate analyses it was found that

when measured in per capita space, PHC expenditures show significant positive impacts on many health outcomes and intermediate health outputs. However, when measured as a share of total health expenditures, PHC has conflicting relationships with the same measures of health outcome and outputs.

After adjusting for relevant confounding variables, this research found an association between higher PHC expenditure as a share of total health expenditures and improvements in maternal mortality rate, ANC4 coverage, measles vaccination coverage, and an index measuring access and quality of healthcare. While these findings are very promising and reinforce the previous literature, the interpretation of the relationship between PHC expenditures and maternal mortality would mean that PHC expenditures would need to increase by 70% in the next ten years to reach the Sustainable Development Goal of cutting maternal mortality to 70 maternal deaths per 100,000 live births.^{3,5} Needless to say, shifting health spending so dramatically seems unrealistic over the next decade. So while increasing PHC expenditures would likely improve maternal mortality, a need for greater focus on other factors that could contribute to improved maternal outcomes such as the quality of care, access to health care, and patient trust of health systems.

Perhaps more concerning is that we do not find statistically significant associations between PHC expenditures and other indicators of broad health gains, such as all-age adult mortality, communicable and non-communicable disease burden, and the UHC effective coverage index. Given the important role that PHC can and should play in improving health for these types of health outcomes, ongoing efforts are needed to understand these null findings, identify positive outliers, and address what can be done to ensure that PHC has the broadest impact possible. While these findings are concerning, an emphasis must be made that the use of observational data, like in this research, cannot draw causality between PHC expenditures and health outcomes and outputs. Still these findings highlight interesting differences in the relationships between PHC expenditures and outcomes and outputs by income groups. Additional research is needed into the interaction between PHC expenditures and key factors such as policies that drive differences across national health systems, patient perception of healthcare quality and provision within countries, availability and quality of services within categories of care, and how to ensure that PHC impacts key health care areas beyond maternal and child health.

In conclusion, this research found that PHC expenditures were most associated with maternal and child health outcomes and outputs, but not health outcomes related to NCDs or adult health. This is a major concern for policy-makers and health systems globally as the intent for reaching UHC and the Sustainable Development Goals is larger than just maternal and child health outcomes. Further research is needed to understand how to ensure that PHC expenditures address all major health focus areas, including NCDs and adult health.

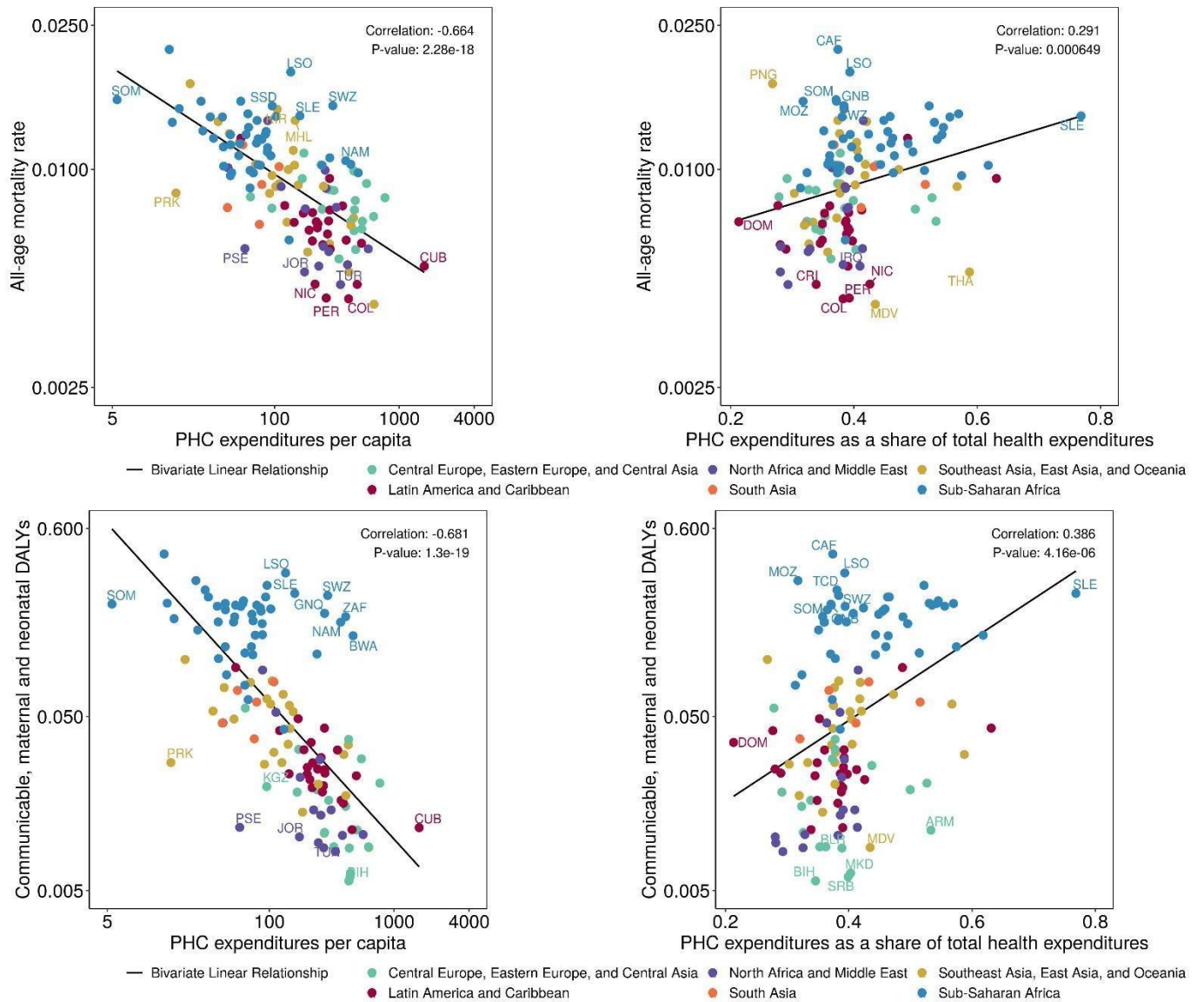
Limitations

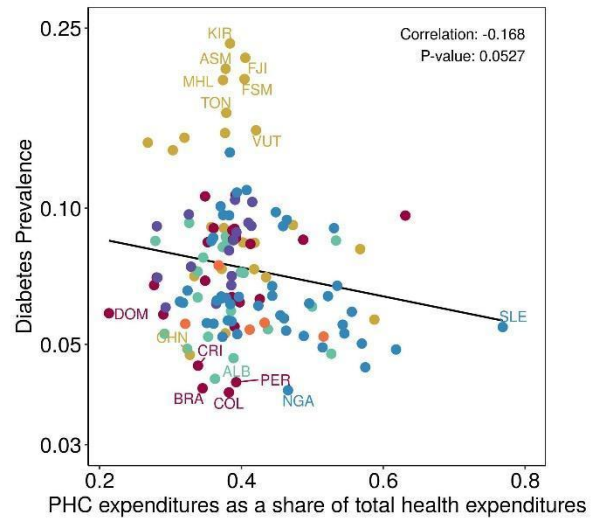
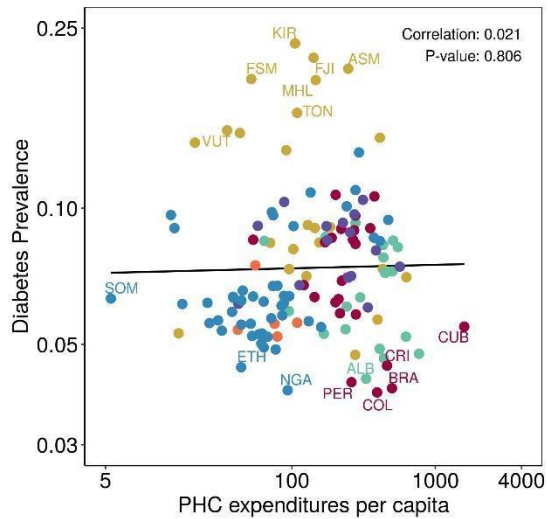
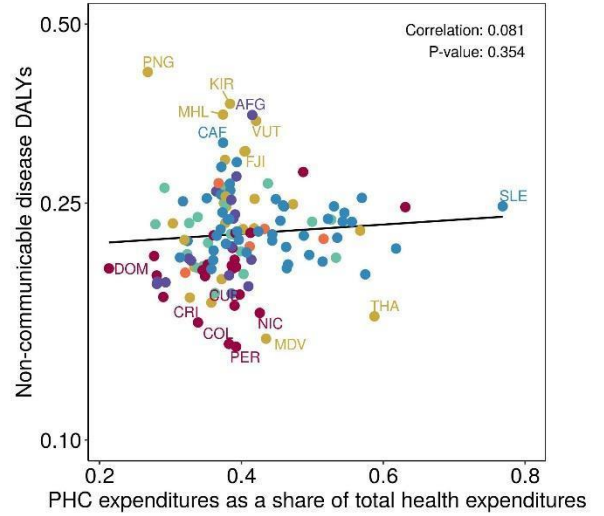
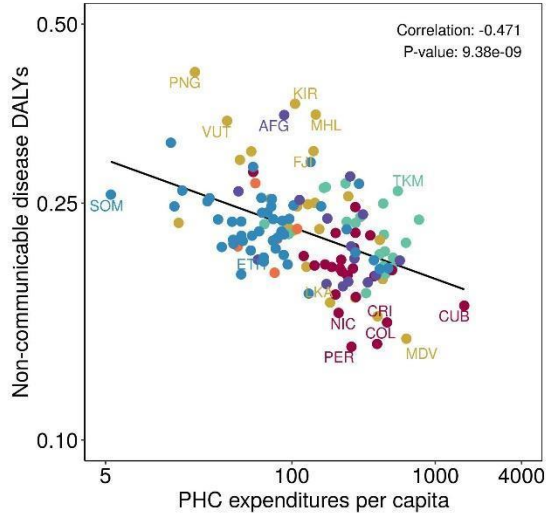
There are a number of limitations to this research, many previously mentioned in the estimation of PHC expenditures discussed in Aim 2. Most importantly, as with previous work, this research relies upon data and a framework that were not created to track and measure primary health care expenditures across countries and time.^{18,34,35} As a consequence, these findings and results should be taken as proxy measures of true PHC expenditures. Additionally, many essential components take place between the expenditure of funds and reaching health outcomes, such as differences in allocative inefficiencies and socio-economic differences within countries. To the extent possible this analysis attempts to control for covariates which are known to have relationships with these essential components (income, education,

and hospital bed density). The estimates of health expenditures that were used relied upon income to fill in missing data points which may cause blending of the relationships between PHC expenditures and income. This may have resulted in removal of what otherwise would be significant findings, but should not change those that were found to be significant. The Health Access and Quality index was also used as a covariate to fill in missing data years of PHC expenditures, causing the potential circularity in the panel regression for these outcomes. Lastly, the relationships between PHC expenditures and health outcomes and outputs presented here are drawn from estimates which contain uncertainty, but we currently do not incorporate these into the panel regression analysis.

Figures & Tables

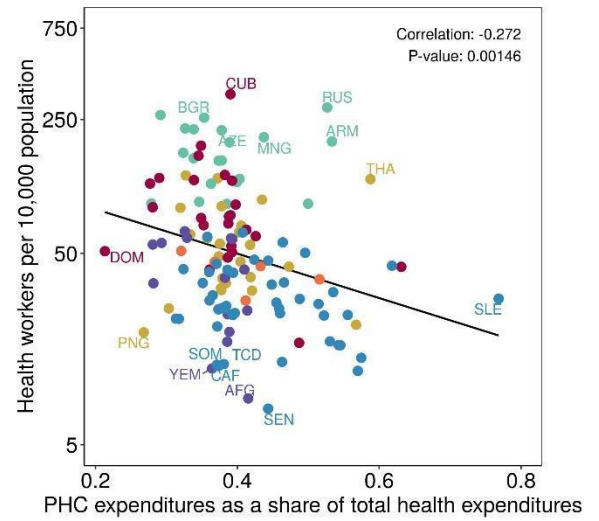
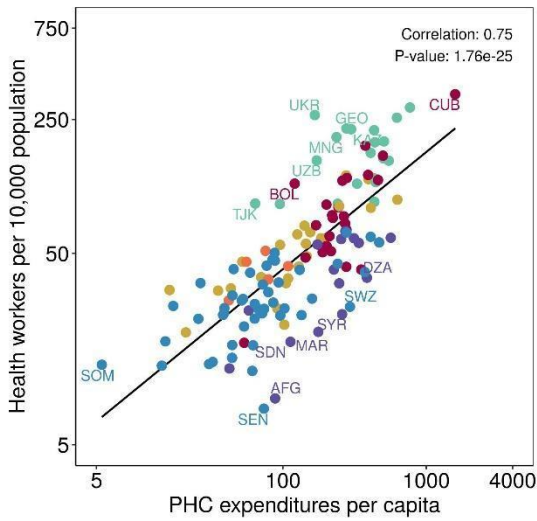
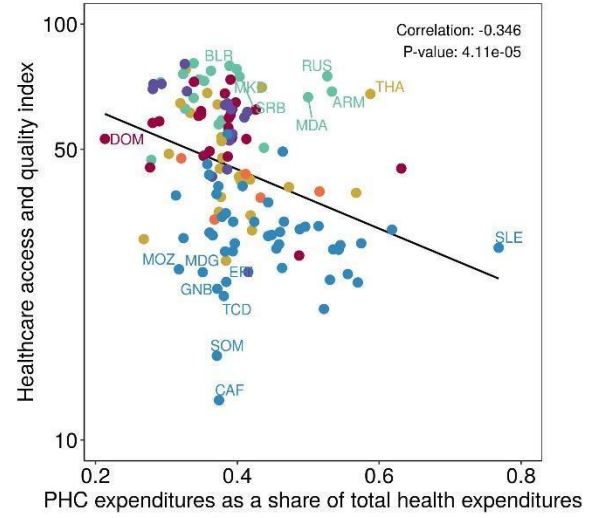
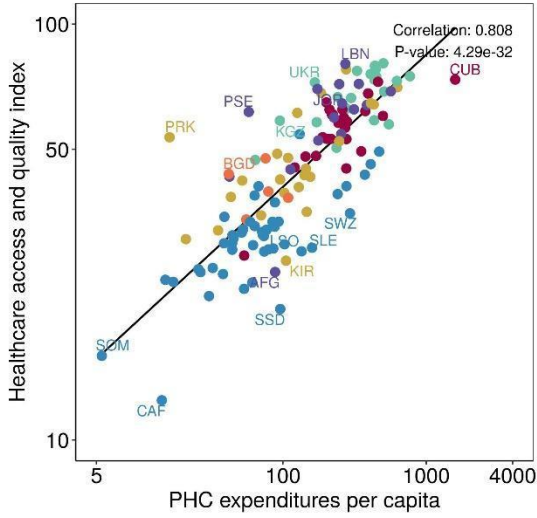
Figure 1. Binary relationships between PHC expenditures and health outcomes and intermediate health outputs, 2017



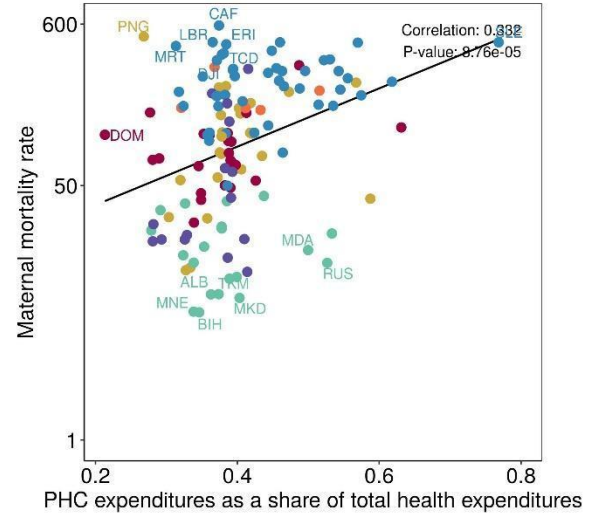
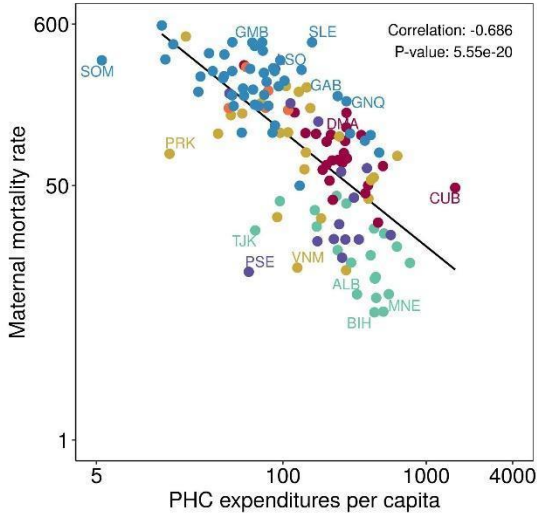


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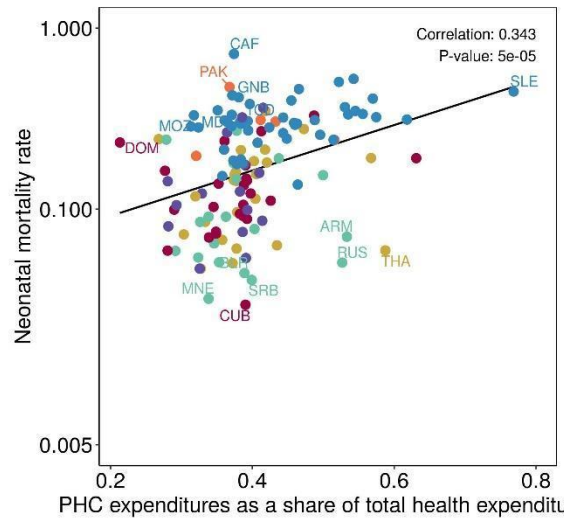
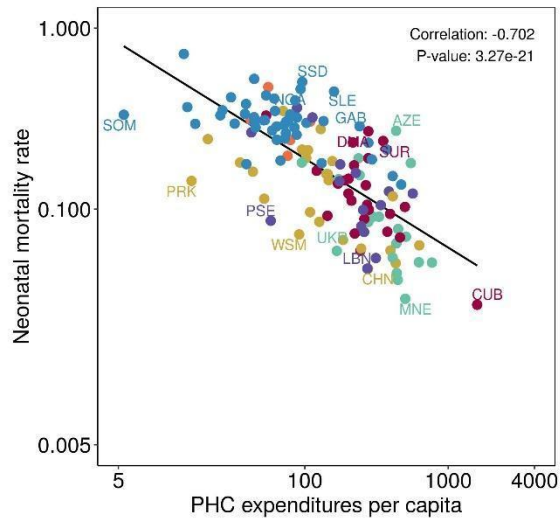


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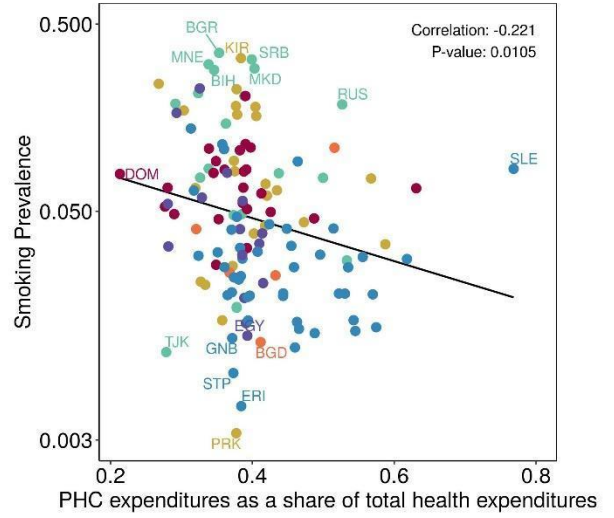
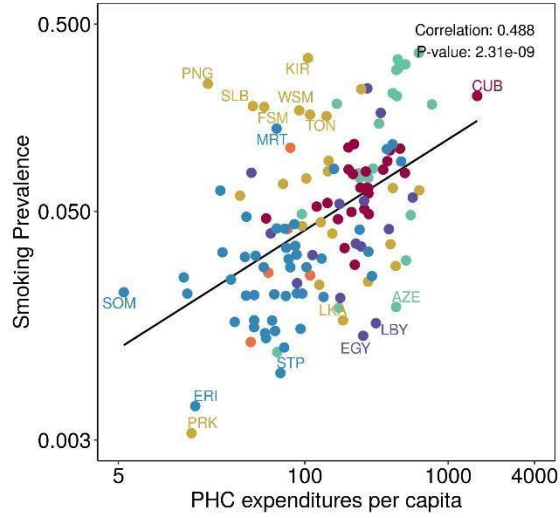
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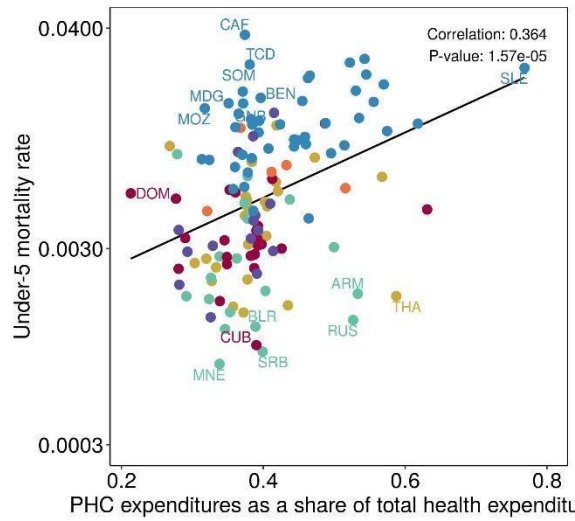
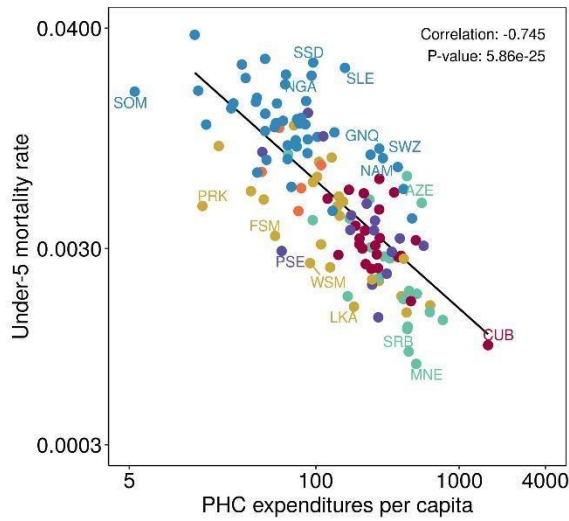
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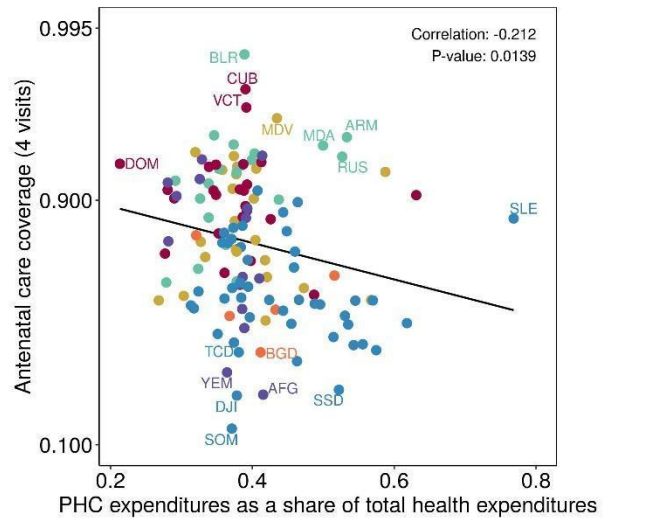
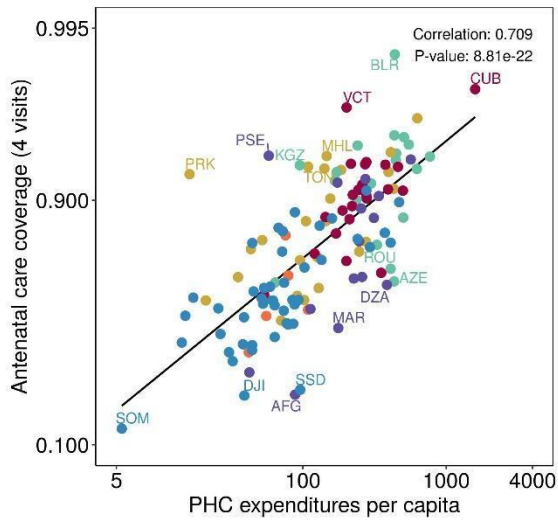
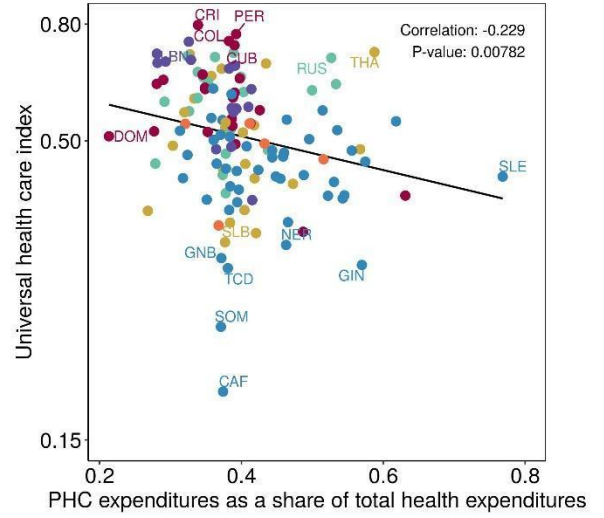
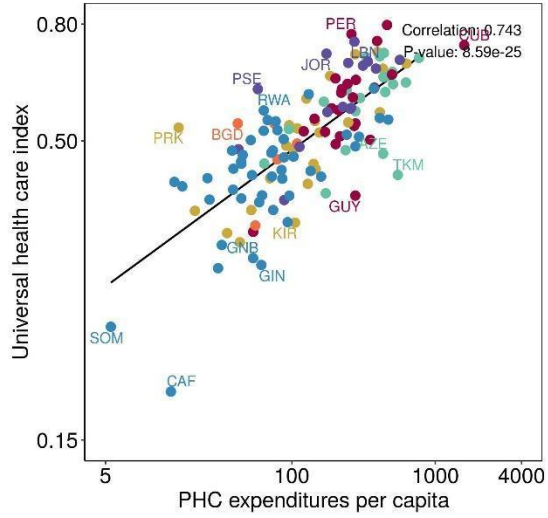
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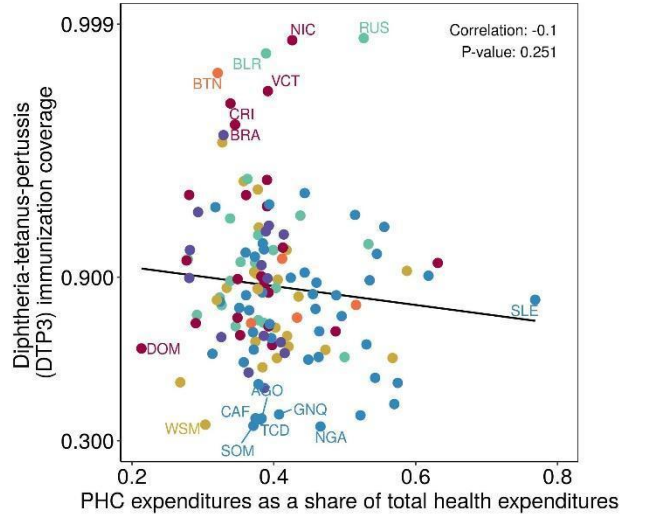
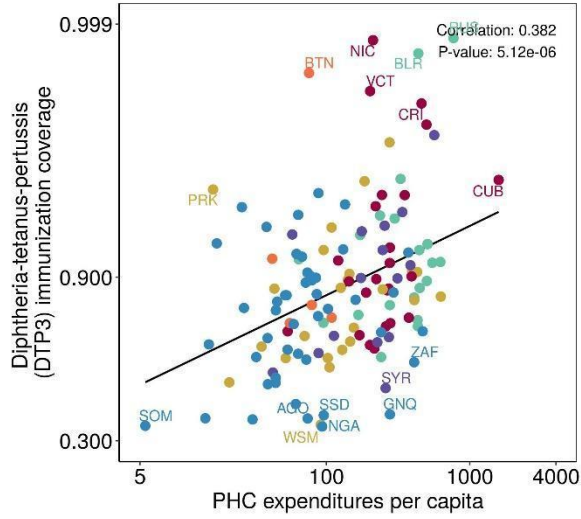
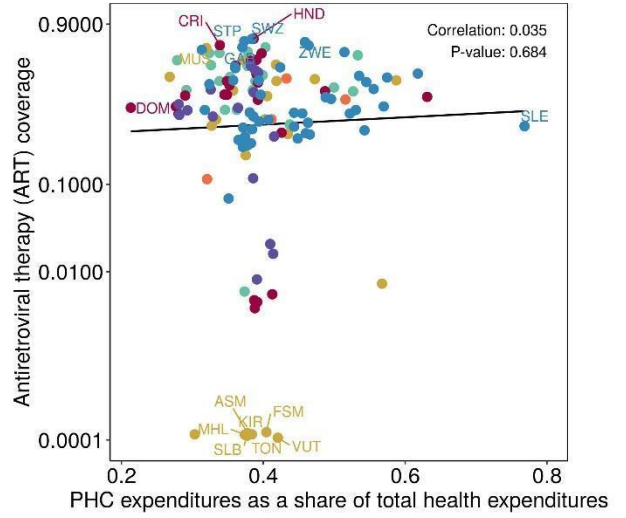
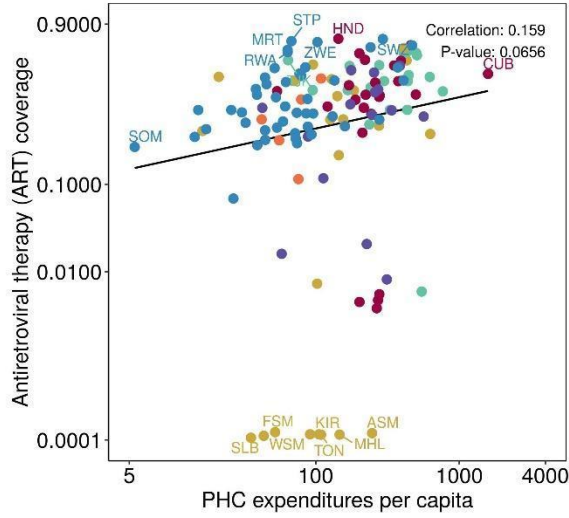


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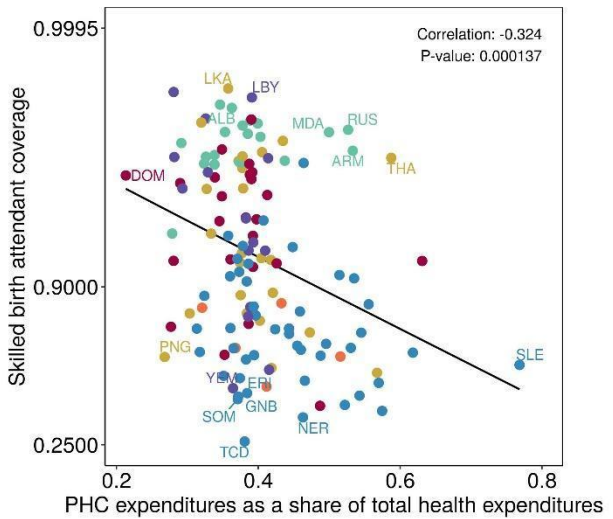
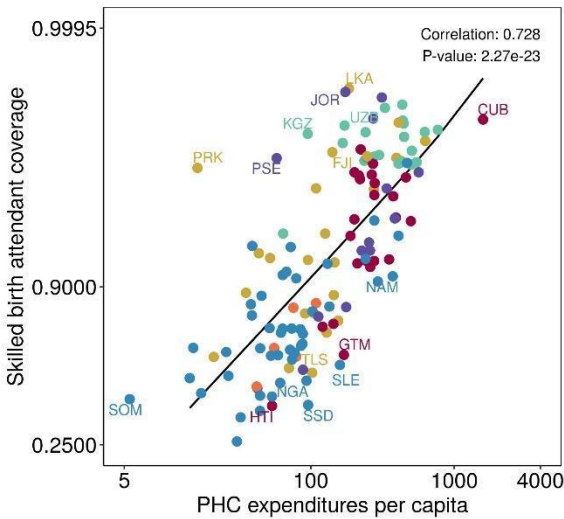
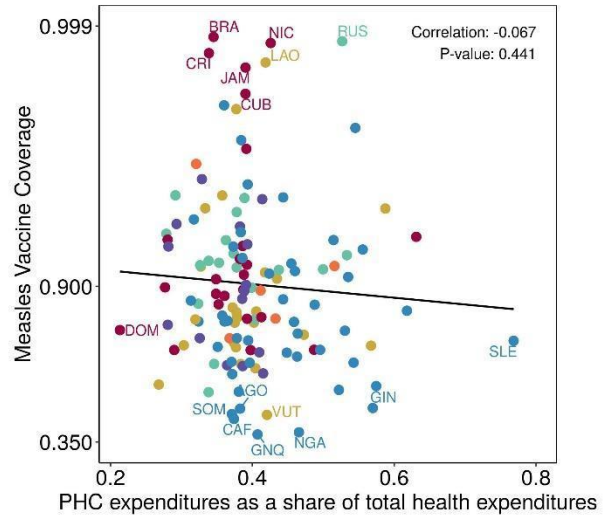
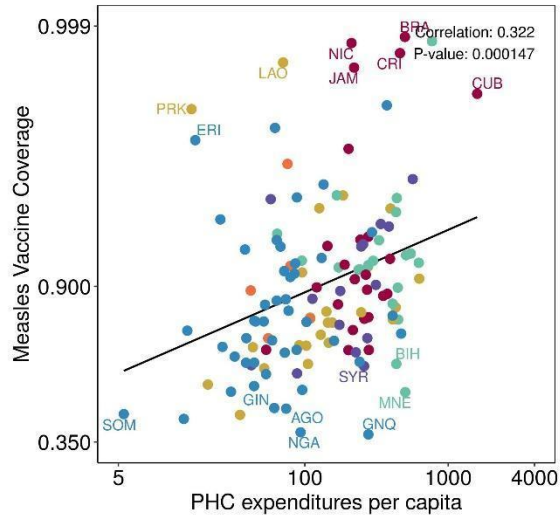
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 ● South Asia
 ● Sub-Saharan Africa
 ● Latin America and Caribbean



- Central Europe, Eastern Europe, and Central Asia
- North Africa and Middle East
- Southeast Asia, East Asia, and Oceania
- Latin America and Caribbean
- South Asia
- Sub-Saharan Africa



— Bivariate Linear Relationship ● Central Europe, Eastern Europe, and Central Asia ● North Africa and Middle East ● Southeast Asia, East Asia, and Oceania
 ● Latin America and Caribbean ● South Asia ● Sub-Saharan Africa

Notes: Please note that figures on the left are in 2017 USD per capita and figures on the right are as a share of total health expenditures. The Pearson’s correlation and significance of the correlations are included in the upper right-hand corners of each graphic. Countries that have ISO3 labeled are either those with the largest absolute residual value from the linear regression line or are at the extremes of PHC expenditures.

Table 1. Low- and Middle-Income Countries: Fixed Effects: Health Outcomes

	<i>Dependent variable:</i>						
	All-age mortality	Communicable DALYs	Non-communicable DALYs	Diabetes Prevalence	Maternal mortality	Neonatal mortality	Under-5 mortality
PHC/THE	1.076 (0.819)	0.995 (1.329)	0.071 (0.391)	-0.846 (0.388)	-10.309*** (1.681)	-3.285 (1.124)	-0.120 (1.167)
Total Health Expenditure per capita (log)	-0.020 (0.012)	-0.065** (0.019)	0.023** (0.006)	-0.008 (0.006)	-0.028 (0.026)	-0.077*** (0.017)	-0.075** (0.020)
LDI per capita (log)	-0.150*** (0.019)	-0.297*** (0.039)	-0.121*** (0.009)	-0.010 (0.007)	-0.442*** (0.041)	-0.213*** (0.028)	-0.305*** (0.027)
Fertility rate (log)	-0.031 (0.026)	-0.063 (0.044)	-0.027 (0.014)	-0.030 (0.013)	-0.400*** (0.064)	-0.337*** (0.041)	-0.152* (0.050)
Hospital beds per 1000 (log)	-0.127*** (0.027)	0.082 (0.052)	-0.131*** (0.017)		-0.695*** (0.085)	-0.120 (0.054)	-0.057 (0.046)
Education yrs. per capita (log)	-0.200*** (0.037)	-0.553*** (0.064)		0.164*** (0.020)	-0.226 (0.093)	-0.548*** (0.074)	-0.751*** (0.081)
HIV Prevalence (log)	0.053*** (0.006)	0.069*** (0.013)	0.004 (0.003)	0.027*** (0.004)	-0.003 (0.020)	-0.106*** (0.010)	-0.057*** (0.011)
Urbanicity (logit)	-0.084** (0.023)	-0.158*** (0.037)	-0.031 (0.011)	-0.024* (0.007)	-0.139 (0.052)	-0.075 (0.027)	-0.174*** (0.040)
OOP as a share of THE (logit)		-0.006		-0.009	-0.036	0.003	0.004

		(0.012)		(0.003)	(0.016)	(0.009)	(0.010)
GHEs as a share of THE (logit)	-0.0001	-0.025	0.006	0.008*	0.004	-0.044***	-0.027*
	(0.006)	(0.010)	(0.003)	(0.002)	(0.012)	(0.008)	(0.009)
Population over 65 (logit)	0.112***	0.145***	0.027	-0.050***	0.213***	-0.118**	0.055
	(0.023)	(0.035)	(0.010)	(0.012)	(0.048)	(0.033)	(0.045)
Observations	2,430	2,430	2,430	2,430	2,430	2,414	2,430
R ²	0.152	0.224	0.141	0.110	0.218	0.289	0.205
Adjusted R ²	0.092	0.169	0.080	0.046	0.162	0.238	0.148

Note:

*p<0.05; **p<0.01; ***p<0.001

Table 2. Low- and Middle-Income Countries: Fixed Effects: Health Outputs

	<i>Dependent variable:</i>								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE	1.294*	-1.072	-0.954	-0.249	12.556***	-10.301	9.311	20.975***	-2.713
	(0.415)	(0.622)	(0.627)	(0.573)	(2.223)	(10.507)	(4.982)	(4.927)	(3.364)
THE per capita (log)	-0.010	0.129***	0.009	0.002	0.232***	0.552*	0.212*	0.560***	0.154*
	(0.007)	(0.009)	(0.011)	(0.010)	(0.036)	(0.176)	(0.069)	(0.080)	(0.051)
LDI per capita (log)	0.216***	0.289***	0.018	0.165* ..	0.474***	1.122**		-0.426*	0.941***
	(0.010)	(0.018)	(0.017)	(0.014)	(0.053)	(0.291)		(0.125)	(0.082)
Fertility rate (log)	-0.082***	-0.331***	0.136***	0.074* .	-0.355***	1.816***	-0.362	-0.902**	-0.787***
	(0.016)	(0.025)	(0.027)	(0.020)	(0.082)	(0.408)	(0.242)	(0.256)	(0.098)
Hospital beds per 1000 (log)	0.077***	0.209***	0.088	-0.026	-0.123	0.687	-0.718*	-1.375***	1.037***
	(0.018)	(0.029)	(0.034)	(0.021)	(0.106)	(0.509)	(0.213)	(0.259)	(0.150)
Education yrs. per capita (log)	0.469***	-0.070	-0.010	0.202* ..	1.085***	5.917***	2.183***	2.273***	1.356***
	(0.028)	(0.044)	(0.045)	(0.033)	(0.123)	(0.674)	(0.273)	(0.349)	(0.143)

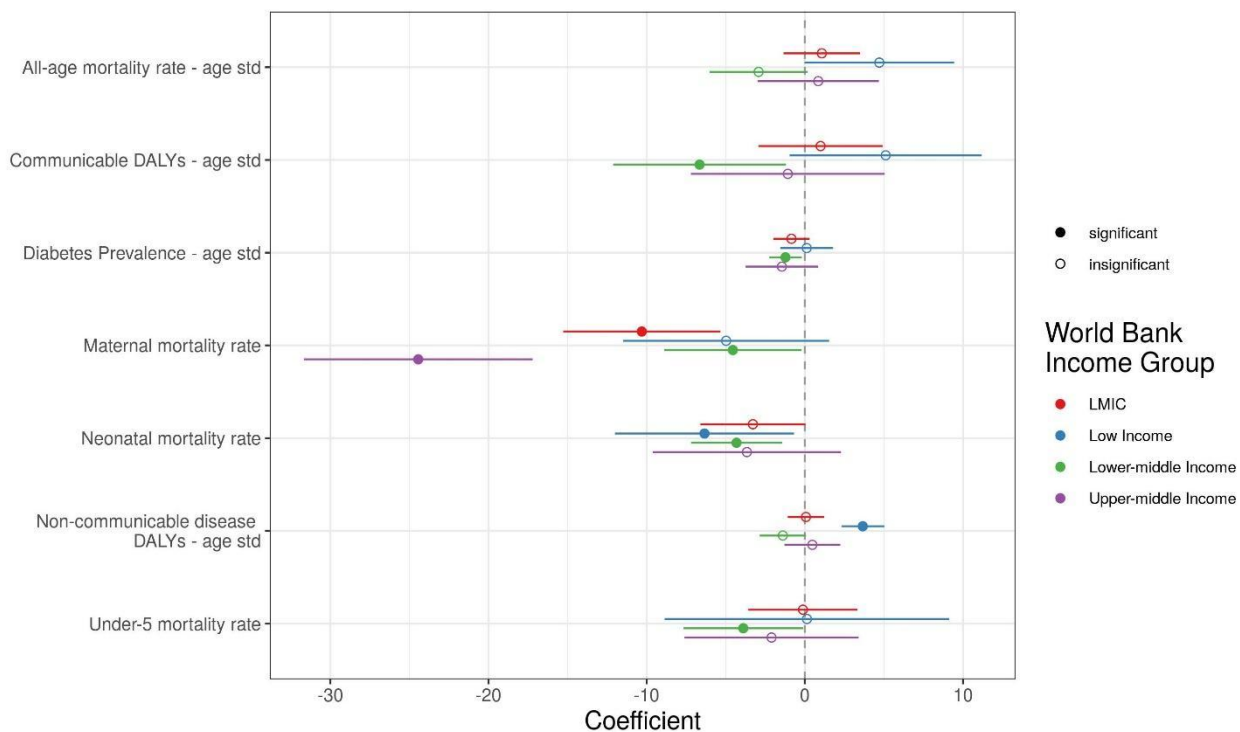
HIV Prevalence (log)	-0.008	0.025***	0.024**	0.061* ..	0.147***	0.125	-0.004		0.079
	(0.005)	(0.006)	(0.007)	(0.005)	(0.026)	(0.115)	(0.048)		(0.027)
Urbanicity (logit)	0.103***		0.097***	0.065* .	0.420***	-0.562	0.683***	0.380	-0.050
	(0.015)		(0.017)	(0.018)	(0.069)	(0.380)	(0.110)	(0.144)	(0.095)
OOP as a share of THE (logit)	-0.018**	-0.014	0.011	-0.008		0.355	-0.112	0.068	-0.092*
	(0.005)	(0.006)	(0.007)	(0.006)		(0.126)	(0.039)	(0.044)	(0.030)
GHEs as a share of THE (logit)	-0.005	-0.002		-0.009	0.042	0.258		0.174***	0.144***
	(0.004)	(0.006)		(0.006)	(0.016)	(0.108)		(0.038)	(0.025)
Population over 65 (logit)	-0.060***	0.004	-0.081*	0.162* ..	0.547***	-2.897***	0.135	-0.114	0.056
	(0.011)	(0.021)	(0.027)	(0.017)	(0.064)	(0.384)	(0.179)	(0.164)	(0.081)
Observations	2,430	2,430	2,430	2,430	2,430	2,430	2,430	2,430	2,430
R ²	0.503	0.429	0.049	0.281	0.252	0.138	0.072	0.082	0.263
Adjusted R ²	0.467	0.388	-0.019	0.230	0.199	0.076	0.007	0.017	0.210

Note:

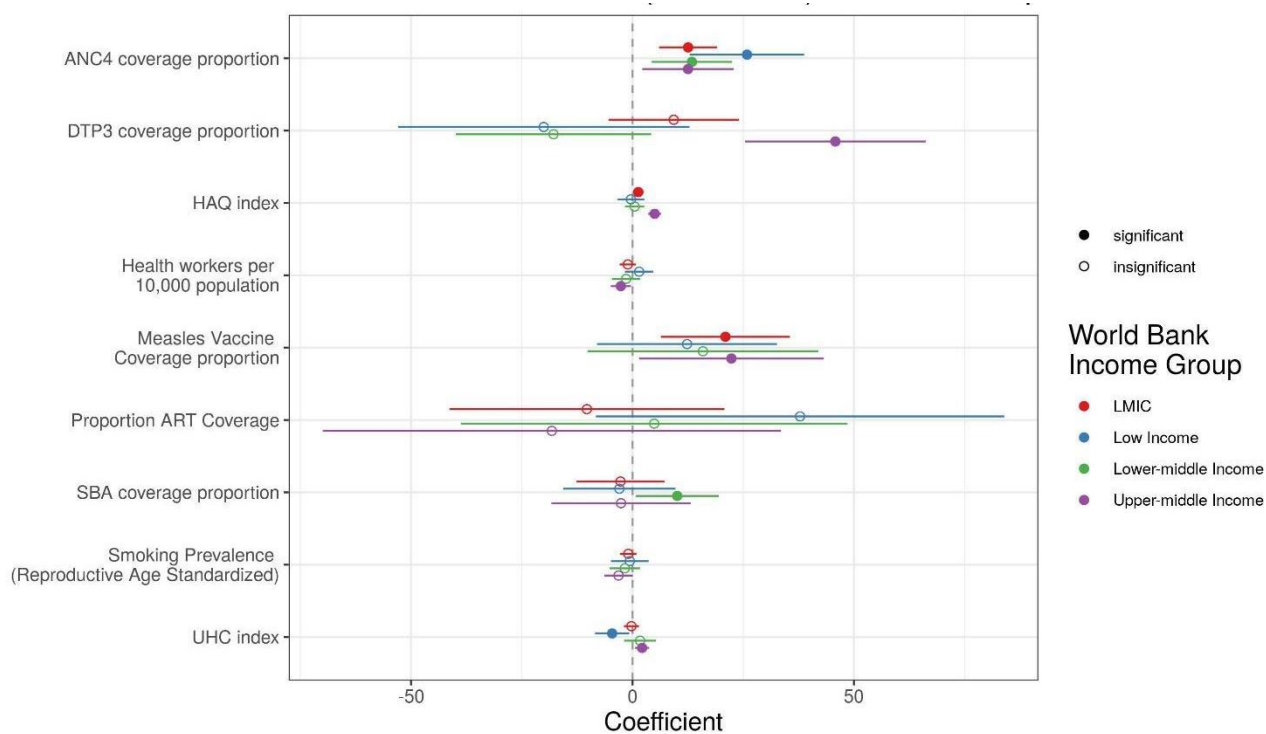
*p<0.05; **p<0.01; ***p<0.001

Figure 2. Fixed effect models coefficients of primary health care as a share of total health expenditures

Panel A. Health Outcomes



Panel B. Intermediate Health Outputs



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Appendices

Aim 1

Table of collected NHA country-year counts and completeness (please see excel sheet in email)

Table of Health Function Transition Between System of Health Accounts Versions

SHA 2011 codes	Description	SHA 1.0 codes
HC.1	Curative care	HC.1
HC.1.1	Inpatient curative care	HC.1.1
HC.1.1.1	General inpatient curative care	
HC.1.1.2	Specialised inpatient curative care	
HC.1.2	Day curative care	HC.1.2
HC.1.2.1	General day curative care	
HC.1.2.2	Specialised day curative care	
HC.1.3	Outpatient curative care	HC.1.3
HC.1.3.1	General outpatient curative care	HC.1.3.1
HC.1.3.2	Dental outpatient curative care	HC.1.3.2
HC.1.3.3	Specialised outpatient curative care	HC.1.3.3
HC.1.4	Home-based curative care	HC.1.4
HC.2	Rehabilitative care	HC.2
HC.2.1	Inpatient rehabilitative care	HC.2.1
HC.2.2	Day rehabilitative care	HC.2.2
HC.2.3	Outpatient rehabilitative care	HC.2.3
HC.2.4	Home-based rehabilitative care	HC.2.4
HC.3	Long-term care (health)	HC.3
HC.3.1	Inpatient long-term care (health)	HC.3.1
HC.3.2	Day long-term care (health)	HC.3.2
HC.3.3	Outpatient long-term care (health)	part of HC.3
HC.3.4	Home-based long-term care (health)	HC.3.3
HC.4	Ancillary services (non-specified by function)	HC.4
HC.4.1	Laboratory services	HC.4.1
HC.4.2	Imaging services	HC.4.2
HC.4.3	Patient transportation	HC.4.3
HC.5	Medical goods (non-specified by function)	HC.5
HC.5.1	Pharmaceuticals and other medical non-durable goods	HC.5.1
HC.5.1.1	Prescribed medicines	HC.5.1.1
HC.5.1.2	Over-the-counter medicines	HC.5.1.2
HC.5.1.3	Other medical non-durable goods	HC.5.1.3
HC.5.2	Therapeutic appliances and other medical goods	HC.5.2
HC.5.2.1	Glasses and other vision products	HC.5.2.1
HC.5.2.2	Hearing aids	HC.5.2.3
HC.5.2.3	Other orthopaedic appliances and prosthetics (excluding glasses and hearing aids)	HC.5.2.2
HC.5.2.9	All other medical durables, including medical technical devices	HC.5.2.4- HC.5.2.9

HC.6	Preventive care	HC.6, part of HC.R.4, HC.R.5
HC.6.1	Information, education and counseling programmes	Part of HC.6.9, part of HCR4, HC.R.5
HC.6.2	Immunisation programmes	Part of HC.6.3
HC.6.3	Early disease detection programmes	Part of HC.6.3, HC.6.4
HC.6.4	Healthy condition monitoring programmes	Part of HC.6.1, HC.6.2, HC.6.5
HC.6.5	Epidemiological surveillance and risk and disease control programmes	HC.6, part of HC. 4, HC. 5
HC.6.6	Preparing for disaster and emergency response programmes	Part of HC.6
HC.7	Governance, and health system and financing administration	HC.7
HC.7.1	Governance and Health system administration	HC.7.1
HC.7.2	Administration of health financing	HC.7.2
HC.9	Other health care services not elsewhere classified (n.e.c.)	

Table of Collected Data by Health Functions (HC) and Health Providers (HP)

HC Category Name	HP Category Name	Number of Data Points Collected
HC Total	HP Total	1293
6. Preventative care	HP Total	1069
7. Governance & admin	HP Total	1060
5. Medical goods	HP Total	1020
HC Total	6. Providers of preventative care	981
HC Total	1. Hospitals	940
4. Ancillary care	HP Total	935
HC Total	3. Providers of ambulatory care	915
HC Total	5. Retailers and other providers of medical goods	915
HC Total	7. Health care system admin.	914
5.1 Medical goods - Pharms & other medical non-durable goods	HP Total	861
3. Long-term care	HP Total	792
1. Curative care	HP Total	767
1.3.2 Curative care - Outpatient - Dental	HP Total	750
1.3 Curative care - Outpatient	HP Total	743
6. Preventative care	6. Providers of preventative care	733
5.2 Medical goods - Therapeutic appliances & prosthetics	HP Total	732
1.1 Curative care - Inpatient	HP Total	712
5. Medical goods	5. Retailers and other providers of medical goods	698
7. Governance & admin	7. Health care system admin.	692
HC Total	8. Rest of economy	687
HC Total	2. Resid. long-term care fac.	686
2. Rehabilitative care	HP Total	685
3.1 Long-term care - Inpatient	HP Total	682
HC Total	3.1 Providers of ambulatory care - Medical practices	681
HC Total	4. Providers of ancillary services	679
HC Total	3.2 Providers of ambulatory care - Dental practices	651
1.3.1 Curative care - Outpatient - General	HP Total	643
HC Total	9. Rest of world	621
4. Ancillary care	4. Providers of ancillary services	614
HC Total	1.1 Hospitals - General	604
5.1 Medical goods - Pharms & other medical non-durable goods	5. Retailers and other providers of medical goods	597
5.2 Medical goods - Therapeutic appliances & prosthetics	5. Retailers and other providers of medical goods	585

1.3.3 Curative care - Outpatient - Specialized	HP Total	584
3.4 Long-term care - Home-based	HP Total	572
HC Total	3.3 Providers of ambulatory care - Other practices	570
1. Curative care	1. Hospitals	561
5.1.1 Medical goods - Prescribed meds	HP Total	557
1.3.2 Curative care - Outpatient - Dental	3.2 Providers of ambulatory care - Dental practices	557
1. Curative care	3. Providers of ambulatory care	556
6. Preventative care	3. Providers of ambulatory care	542
9. Other health care services	HP Total	537
HC Total	3.4 Providers of ambulatory care - Ambulatory health care centers	536
1.3 Curative care - Outpatient	3.1 Providers of ambulatory care - Medical practices	533
1.3 Curative care - Outpatient	3. Providers of ambulatory care	530
3. Long-term care	2. Resid. long-term care fac.	524
1.3.2 Curative care - Outpatient - Dental	3. Providers of ambulatory care	514
HC Total	3.5 Providers of home health care services	511
1.3 Curative care - Outpatient	3.2 Providers of ambulatory care - Dental practices	510
1.1 Curative care - Inpatient	1.1 Hospitals - General	509
1.1 Curative care - Inpatient	1. Hospitals	508
HC Total	1.2 Hospitals - Mental health	506
3. Long-term care	3. Providers of ambulatory care	496
1.3 Curative care - Outpatient	1.1 Hospitals - General	494
1.3 Curative care - Outpatient	1. Hospitals	490
3.1 Long-term care - Inpatient	2. Resid. long-term care fac.	489
HC Total	1.3 Hospitals - Specialized	483
1. Curative care	3.1 Providers of ambulatory care - Medical practices	483
1.3.1 Curative care - Outpatient - General	3. Providers of ambulatory care	476
2. Rehabilitative care	1. Hospitals	474
1. Curative care	3.2 Providers of ambulatory care - Dental practices	469
5.1.2 Medical goods - Over the counter meds	HP Total	464
1.3.nec Curative care - Outpatient - NEC	HP Total	463
1. Curative care	1.1 Hospitals - General	460
1.2 Curative care - Day	HP Total	454
2.1 Rehabilitative care - Inpatient	HP Total	453
6. Preventative care	8. Rest of economy	452
3.4 Long-term care - Home-based	3. Providers of ambulatory care	446
2. Rehabilitative care	3. Providers of ambulatory care	445
1. Curative care	3.3 Providers of ambulatory care - Other practices	443
5.1.1 Medical goods - Prescribed meds	5. Retailers and other providers of medical goods	443

2.3 Rehabilitative care - Outpatient	HP Total	442
5.1.3 Medical goods - Other medical non-durables	HP Total	439
3. Long-term care	3.5 Providers of home health care services	437
1.3.1 Curative care - Outpatient - General	3.1 Providers of ambulatory care - Medical practices	437
4. Ancillary care	1. Hospitals	431
1.4 Curative care - Home-based	HP Total	431
1.3 Curative care - Outpatient	3.3 Providers of ambulatory care - Other practices	428
3.4 Long-term care - Home-based	3.5 Providers of home health care services	417
6. Preventative care	1. Hospitals	409
3. Long-term care	1. Hospitals	405
1.3.3 Curative care - Outpatient - Specialized	3. Providers of ambulatory care	402
4. Ancillary care	3. Providers of ambulatory care	399
1.3 Curative care - Outpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	399
1.1 Curative care - Inpatient	1.2 Hospitals - Mental health	395
5.1.2 Medical goods - Over the counter meds	5. Retailers and other providers of medical goods	391
1.2 Curative care - Day	1. Hospitals	388
2.1 Rehabilitative care - Inpatient	1. Hospitals	385
5.1.3 Medical goods - Other medical non-durables	5. Retailers and other providers of medical goods	379
2.3 Rehabilitative care - Outpatient	3. Providers of ambulatory care	374
1. Curative care	1.2 Hospitals - Mental health	371
1. Curative care	9. Rest of world	369
1.1 Curative care - Inpatient	1.3 Hospitals - Specialized	362
1.3.3 Curative care - Outpatient - Specialized	3.1 Providers of ambulatory care - Medical practices	360
3.1 Long-term care - Inpatient	1. Hospitals	360
1. Curative care	3.4 Providers of ambulatory care - Ambulatory health care centers	354
5. Medical goods	3. Providers of ambulatory care	351
2. Rehabilitative care	1.1 Hospitals - General	347
1.3.3 Curative care - Outpatient - Specialized	1. Hospitals	347
1.4 Curative care - Home-based	3. Providers of ambulatory care	347
1.2 Curative care - Day	1.1 Hospitals - General	341
4. Ancillary care	1.1 Hospitals - General	340
1.1 Curative care - Inpatient	3. Providers of ambulatory care	340
6. Preventative care	3.1 Providers of ambulatory care - Medical practices	338
6. Preventative care	3.4 Providers of ambulatory care - Ambulatory health care centers	335
1. Curative care	1.3 Hospitals - Specialized	331
6.1 Prevention care - IEC programs	HP Total	327
1.1 Curative care - Inpatient	9. Rest of world	325
1.3.3 Curative care - Outpatient - Specialized	1.1 Hospitals - General	321

5. Medical goods	1. Hospitals	318
HC Total	N.E.C.	317
1.3.1 Curative care - Outpatient - General	1. Hospitals	316
3. Long-term care	8. Rest of economy	314
1.3.nec Curative care - Outpatient - NEC	3. Providers of ambulatory care	313
3.2 Long-term care - Day	HP Total	299
2. Rehabilitative care	3.3 Providers of ambulatory care - Other practices	298
6.2 Prevention care - Immunization programs	HP Total	297
6.4 Prevention care - Healthy condition monitoring programs	HP Total	297
3. Long-term care	1.1 Hospitals - General	294
2.1 Rehabilitative care - Inpatient	1.1 Hospitals - General	292
3.1 Long-term care - Inpatient	1.1 Hospitals - General	292
2.3 Rehabilitative care - Outpatient	1. Hospitals	286
4. Ancillary care	8. Rest of economy	284
1.3.1 Curative care - Outpatient - General	1.1 Hospitals - General	284
6. Preventative care	7. Health care system admin.	282
6. Preventative care	1.1 Hospitals - General	281
3.4 Long-term care - Home-based	8. Rest of economy	281
2. Rehabilitative care	3.4 Providers of ambulatory care - Ambulatory health care centers	279
6.5 Prevention care - Epi surveillance and risk and disease control programs	HP Total	276
2. Rehabilitative care	1.3 Hospitals - Specialized	272
2.1 Rehabilitative care - Inpatient	1.3 Hospitals - Specialized	270
4. Ancillary care	3.1 Providers of ambulatory care - Medical practices	269
5.1 Medical goods - Pharms & other medical non-durable goods	1. Hospitals	268
2.3 Rehabilitative care - Outpatient	3.3 Providers of ambulatory care - Other practices	268
1.3.nec Curative care - Outpatient - NEC	3.3 Providers of ambulatory care - Other practices	265
1.2 Curative care - Day	3. Providers of ambulatory care	264
1.3 Curative care - Outpatient	1.2 Hospitals - Mental health	263
5.1 Medical goods - Pharms & other medical non-durable goods	3. Providers of ambulatory care	263
2. Rehabilitative care	2. Resid. long-term care fac.	261
1. Curative care	8. Rest of economy	258
1.1 Curative care - Inpatient	3.1 Providers of ambulatory care - Medical practices	255
6.1 Prevention care - IEC programs	6. Providers of preventative care	252
2.3 Rehabilitative care - Outpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	252
6. Preventative care	4. Providers of ancillary services	249
1.3.1 Curative care - Outpatient - General	3.4 Providers of ambulatory care - Ambulatory health care centers	248

1.3 Curative care - Outpatient	1.3 Hospitals - Specialized	246
5. Medical goods	1.1 Hospitals - General	239
1. Curative care	2. Resid. long-term care fac.	238
6.3 Prevention care - Early disease detection	HP Total	236
2. Rehabilitative care	3.1 Providers of ambulatory care - Medical practices	232
1.3 Curative care - Outpatient	8. Rest of economy	231
2.2 Rehabilitative care - Day	HP Total	228
6. Preventative care	3.3 Providers of ambulatory care - Other practices	226
1.3 Curative care - Outpatient	9. Rest of world	226
1.3.2 Curative care - Outpatient - Dental	1. Hospitals	223
1.3.3 Curative care - Outpatient - Specialized	3.4 Providers of ambulatory care - Ambulatory health care centers	223
1.3.3 Curative care - Outpatient - Specialized	1.3 Hospitals - Specialized	223
5. Medical goods	3.1 Providers of ambulatory care - Medical practices	220
5.1 Medical goods - Pharms & other medical non-durable goods	1.1 Hospitals - General	218
9. Other health care services	N.E.C.	216
3. Long-term care	3.4 Providers of ambulatory care - Ambulatory health care centers	215
2.3 Rehabilitative care - Outpatient	3.1 Providers of ambulatory care - Medical practices	214
6.5 Prevention care - Epi surveillance and risk and disease control programs	6. Providers of preventative care	213
1.4 Curative care - Home-based	3.1 Providers of ambulatory care - Medical practices	213
1.4 Curative care - Home-based	1. Hospitals	211
1. Curative care	3.5 Providers of home health care services	207
2.2 Rehabilitative care - Day	1. Hospitals	206
4. Ancillary care	3.4 Providers of ambulatory care - Ambulatory health care centers	203
1.3 Curative care - Outpatient	2. Resid. long-term care fac.	199
3.1 Long-term care - Inpatient	1.2 Hospitals - Mental health	198
3.1 Long-term care - Inpatient	3. Providers of ambulatory care	198
1.3.1 Curative care - Outpatient - General	3.3 Providers of ambulatory care - Other practices	197
2.3 Rehabilitative care - Outpatient	1.3 Hospitals - Specialized	197
1.3.1 Curative care - Outpatient - General	8. Rest of economy	196
3. Long-term care	1.3 Hospitals - Specialized	195
3.4 Long-term care - Home-based	1. Hospitals	195
6. Preventative care	3.2 Providers of ambulatory care - Dental practices	193
4. Ancillary care	1.3 Hospitals - Specialized	193
1.3.3 Curative care - Outpatient - Specialized	1.2 Hospitals - Mental health	192
2.3 Rehabilitative care - Outpatient	1.1 Hospitals - General	190

6.4 Prevention care - Healthy condition monitoring programs	3. Providers of ambulatory care	190
2.1 Rehabilitative care - Inpatient	2. Resid. long-term care fac.	187
3. Long-term care	1.2 Hospitals - Mental health	186
3.4 Long-term care - Home-based	2. Resid. long-term care fac.	186
5. Medical goods	9. Rest of world	184
5.1.1 Medical goods - Prescribed meds	1. Hospitals	184
1.4 Curative care - Home-based	1.1 Hospitals - General	183
1.3.nec Curative care - Outpatient - NEC	1. Hospitals	181
1.3.nec Curative care - Outpatient - NEC	3.4 Providers of ambulatory care - Ambulatory health care centers	181
1.3.2 Curative care - Outpatient - Dental	1.1 Hospitals - General	180
2. Rehabilitative care	1.2 Hospitals - Mental health	177
3. Long-term care	3.1 Providers of ambulatory care - Medical practices	177
3.1 Long-term care - Inpatient	1.3 Hospitals - Specialized	175
1.3.3 Curative care - Outpatient - Specialized	3.3 Providers of ambulatory care - Other practices	174
3.2 Long-term care - Day	2. Resid. long-term care fac.	174
1.2 Curative care - Day	1.3 Hospitals - Specialized	174
3.4 Long-term care - Home-based	3.4 Providers of ambulatory care - Ambulatory health care centers	173
1.4 Curative care - Home-based	3.5 Providers of home health care services	172
1.2 Curative care - Day	3.1 Providers of ambulatory care - Medical practices	171
5.1 Medical goods - Pharms & other medical non-durable goods	3.1 Providers of ambulatory care - Medical practices	169
1.3.1 Curative care - Outpatient - General	9. Rest of world	168
6.4 Prevention care - Healthy condition monitoring programs	6. Providers of preventative care	168
1.3.2 Curative care - Outpatient - Dental	3.4 Providers of ambulatory care - Ambulatory health care centers	168
6.3 Prevention care - Early disease detection	6. Providers of preventative care	167
1. Curative care	5. Retailers and other providers of medical goods	166
5.1.1 Medical goods - Prescribed meds	1.1 Hospitals - General	166
3.3 Long-term care - Outpatient	HP Total	166
1.2 Curative care - Day	3.4 Providers of ambulatory care - Ambulatory health care centers	166
1.4 Curative care - Home-based	3.4 Providers of ambulatory care - Ambulatory health care centers	164
6.2 Prevention care - Immunization programs	6. Providers of preventative care	162
6. Preventative care	1.3 Hospitals - Specialized	162
6.1 Prevention care - IEC programs	3. Providers of ambulatory care	160
1.1 Curative care - Inpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	160
2.1 Rehabilitative care - Inpatient	1.2 Hospitals - Mental health	158
1.3.nec Curative care - Outpatient - NEC	1.1 Hospitals - General	158

5.1 Medical goods - Pharms & other medical non-durable goods	9. Rest of world	158
2.2 Rehabilitative care - Day	1.1 Hospitals - General	157
5. Medical goods	8. Rest of economy	156
6.4 Prevention care - Healthy condition monitoring programs	1. Hospitals	156
5.2 Medical goods - Therapeutic appliances & prosthetics	3. Providers of ambulatory care	151
6.nec Prevention care - NEC	HP Total	150
1.3.1 Curative care - Outpatient - General	1.3 Hospitals - Specialized	150
5.2 Medical goods - Therapeutic appliances & prosthetics	1. Hospitals	147
1.2 Curative care - Day	1.2 Hospitals - Mental health	146
5. Medical goods	3.4 Providers of ambulatory care - Ambulatory health care centers	145
3.4 Long-term care - Home-based	1.1 Hospitals - General	145
7. Governance & admin	6. Providers of preventative care	143
7. Governance & admin	9. Rest of world	142
6.3 Prevention care - Early disease detection	3. Providers of ambulatory care	142
3.2 Long-term care - Day	1. Hospitals	142
6.4 Prevention care - Healthy condition monitoring programs	3.1 Providers of ambulatory care - Medical practices	142
1. Curative care	6. Providers of preventative care	140
2.4 Rehabilitative care - Home-based	HP Total	139
6.3 Prevention care - Early disease detection	1. Hospitals	137
5.2 Medical goods - Therapeutic appliances & prosthetics	1.1 Hospitals - General	136
5.1.1 Medical goods - Prescribed meds	3. Providers of ambulatory care	135
6.4 Prevention care - Healthy condition monitoring programs	1.1 Hospitals - General	133
2.1 Rehabilitative care - Inpatient	3. Providers of ambulatory care	129
6.6 Prevention care - Preparing for disaster and emergency response programs	HP Total	127
6.4 Prevention care - Healthy condition monitoring programs	8. Rest of economy	127
1.3.1 Curative care - Outpatient - General	3.2 Providers of ambulatory care - Dental practices	126
3. Long-term care	3.3 Providers of ambulatory care - Other practices	126
6. Preventative care	2. Resid. long-term care fac.	125
3.4 Long-term care - Home-based	3.1 Providers of ambulatory care - Medical practices	125
5.1 Medical goods - Pharms & other medical non-durable goods	3.4 Providers of ambulatory care - Ambulatory health care centers	124
1.3.nec Curative care - Outpatient - NEC	3.1 Providers of ambulatory care - Medical practices	123
1.1 Curative care - Inpatient	2. Resid. long-term care fac.	123
2.2 Rehabilitative care - Day	3. Providers of ambulatory care	122
6.2 Prevention care - Immunization programs	3. Providers of ambulatory care	121

4. Ancillary care	9. Rest of world	120
1. Curative care	4. Providers of ancillary services	120
5.1.1 Medical goods - Prescribed meds	3.1 Providers of ambulatory care - Medical practices	120
1.3.1 Curative care - Outpatient - General	1.2 Hospitals - Mental health	117
1.3.2 Curative care - Outpatient - Dental	3.1 Providers of ambulatory care - Medical practices	117
2.3 Rehabilitative care - Outpatient	2. Resid. long-term care fac.	116
1.3 Curative care - Outpatient	6. Providers of preventative care	115
6. Preventative care	9. Rest of world	115
4. Ancillary care	1.2 Hospitals - Mental health	114
1.3.3 Curative care - Outpatient - Specialized	2. Resid. long-term care fac.	114
1.3 Curative care - Outpatient	5. Retailers and other providers of medical goods	113
5. Medical goods	7. Health care system admin.	112
3.1 Long-term care - Inpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	112
5. Medical goods	3.2 Providers of ambulatory care - Dental practices	110
1.3.2 Curative care - Outpatient - Dental	9. Rest of world	110
6.3 Prevention care - Early disease detection	3.1 Providers of ambulatory care - Medical practices	110
1.3 Curative care - Outpatient	4. Providers of ancillary services	110
5.1 Medical goods - Pharms & other medical non-durable goods	8. Rest of economy	110
1.3 Curative care - Outpatient	7. Health care system admin.	109
1. Curative care	7. Health care system admin.	108
6.1 Prevention care - IEC programs	3.4 Providers of ambulatory care - Ambulatory health care centers	108
1.3.2 Curative care - Outpatient - Dental	8. Rest of economy	107
6.1 Prevention care - IEC programs	1.1 Hospitals - General	107
6. Preventative care	1.2 Hospitals - Mental health	107
2. Rehabilitative care	8. Rest of economy	106
6.5 Prevention care - Epi surveillance and risk and disease control programs	7. Health care system admin.	106
3.2 Long-term care - Day	3. Providers of ambulatory care	106
6.nec Prevention care - NEC	6. Providers of preventative care	105
5.2 Medical goods - Therapeutic appliances & prosthetics	8. Rest of economy	105
6.1 Prevention care - IEC programs	8. Rest of economy	104
6.3 Prevention care - Early disease detection	1.1 Hospitals - General	102
1.1 Curative care - Inpatient	3.3 Providers of ambulatory care - Other practices	99
7. Governance & admin	8. Rest of economy	99
1.1 Curative care - Inpatient	8. Rest of economy	98
1.3.1 Curative care - Outpatient - General	7. Health care system admin.	97
1.3.1 Curative care - Outpatient - General	2. Resid. long-term care fac.	97
3.4 Long-term care - Home-based	1.3 Hospitals - Specialized	97

3.4 Long-term care - Home-based	3.3 Providers of ambulatory care - Other practices	96
6.1 Prevention care - IEC programs	1. Hospitals	95
1.3.2 Curative care - Outpatient - Dental	1.3 Hospitals - Specialized	95
1.3.3 Curative care - Outpatient - Specialized	9. Rest of world	95
6.4 Prevention care - Healthy condition monitoring programs	3.4 Providers of ambulatory care - Ambulatory health care centers	95
1.3.3 Curative care - Outpatient - Specialized	8. Rest of economy	93
1.3.3 Curative care - Outpatient - Specialized	3.2 Providers of ambulatory care - Dental practices	91
9. Other health care services	3. Providers of ambulatory care	91
6.4 Prevention care - Healthy condition monitoring programs	3.2 Providers of ambulatory care - Dental practices	89
5.2 Medical goods - Therapeutic appliances & prosthetics	3.4 Providers of ambulatory care - Ambulatory health care centers	89
2.4 Rehabilitative care - Home-based	1. Hospitals	88
2.4 Rehabilitative care - Home-based	3. Providers of ambulatory care	88
1.4 Curative care - Home-based	3.3 Providers of ambulatory care - Other practices	87
4. Ancillary care	6. Providers of preventative care	86
5.1.3 Medical goods - Other medical non-durables	3. Providers of ambulatory care	86
3.1 Long-term care - Inpatient	8. Rest of economy	86
2.1 Rehabilitative care - Inpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	85
6. Preventative care	5. Retailers and other providers of medical goods	85
3.3 Long-term care - Outpatient	3. Providers of ambulatory care	85
6.4 Prevention care - Healthy condition monitoring programs	7. Health care system admin.	85
3.1 Long-term care - Inpatient	3.1 Providers of ambulatory care - Medical practices	85
1.3.nec Curative care - Outpatient - NEC	1.3 Hospitals - Specialized	85
5. Medical goods	6. Providers of preventative care	84
5.1.1 Medical goods - Prescribed meds	9. Rest of world	84
6.6 Prevention care - Preparing for disaster and emergency response programs	6. Providers of preventative care	81
5.1 Medical goods - Pharms & other medical non-durable goods	7. Health care system admin.	81
2.2 Rehabilitative care - Day	1.3 Hospitals - Specialized	81
5. Medical goods	4. Providers of ancillary services	81
5.1 Medical goods - Pharms & other medical non-durable goods	3.2 Providers of ambulatory care - Dental practices	81
2.3 Rehabilitative care - Outpatient	8. Rest of economy	81
9. Other health care services	8. Rest of economy	80
4. Ancillary care	3.2 Providers of ambulatory care - Dental practices	80
5. Medical goods	1.3 Hospitals - Specialized	80
6.2 Prevention care - Immunization programs	3.1 Providers of ambulatory care - Medical practices	80

5.1 Medical goods - Pharms & other medical non-durable goods	1.2 Hospitals - Mental health	78
6. Preventative care	3.5 Providers of home health care services	77
5.1.1 Medical goods - Prescribed meds	3.4 Providers of ambulatory care - Ambulatory health care centers	76
3.3 Long-term care - Outpatient	1. Hospitals	76
5. Medical goods	1.2 Hospitals - Mental health	75
6.1 Prevention care - IEC programs	7. Health care system admin.	75
1.3 Curative care - Outpatient	3.5 Providers of home health care services	75
6.1 Prevention care - IEC programs	3.3 Providers of ambulatory care - Other practices	75
2.3 Rehabilitative care - Outpatient	1.2 Hospitals - Mental health	75
9. Other health care services	7. Health care system admin.	74
1.3.1 Curative care - Outpatient - General	6. Providers of preventative care	74
9. Other health care services	1. Hospitals	73
5.2 Medical goods - Therapeutic appliances & prosthetics	3.1 Providers of ambulatory care - Medical practices	73
1.4 Curative care - Home-based	8. Rest of economy	73
5.1 Medical goods - Pharms & other medical non-durable goods	6. Providers of preventative care	72
1.3.nec Curative care - Outpatient - NEC	9. Rest of world	72
2.2 Rehabilitative care - Day	3.4 Providers of ambulatory care - Ambulatory health care centers	72
5.1 Medical goods - Pharms & other medical non-durable goods	4. Providers of ancillary services	72
6.1 Prevention care - IEC programs	3.1 Providers of ambulatory care - Medical practices	72
1. nec Curative care - NEC	HP Total	72
1.1 Curative care - Inpatient	6. Providers of preventative care	71
2.2 Rehabilitative care - Day	3.1 Providers of ambulatory care - Medical practices	70
2. Rehabilitative care	3.5 Providers of home health care services	70
1.3.nec Curative care - Outpatient - NEC	8. Rest of economy	69
6.3 Prevention care - Early disease detection	3.4 Providers of ambulatory care - Ambulatory health care centers	69
6.4 Prevention care - Healthy condition monitoring programs	1.3 Hospitals - Specialized	69
5. Medical goods	2. Resid. long-term care fac.	69
7. Governance & admin	3. Providers of ambulatory care	68
HC Total	1.nec Hospitals - Other	68
1.3.nec Curative care - Outpatient - NEC	1.2 Hospitals - Mental health	67
5. Medical goods	3.3 Providers of ambulatory care - Other practices	67
1.4 Curative care - Home-based	1.3 Hospitals - Specialized	67
3.2 Long-term care - Day	1.1 Hospitals - General	66
1.3.1 Curative care - Outpatient - General	4. Providers of ancillary services	66
5.1.1 Medical goods - Prescribed meds	3.2 Providers of ambulatory care - Dental practices	66

5.1.1 Medical goods - Prescribed meds	1.2 Hospitals - Mental health	63
5.2 Medical goods - Therapeutic appliances & prosthetics	9. Rest of world	63
9. Other health care services	9. Rest of world	63
1.4 Curative care - Home-based	2. Resid. long-term care fac.	63
3.2 Long-term care - Day	1.2 Hospitals - Mental health	63
5.1.1 Medical goods - Prescribed meds	1.3 Hospitals - Specialized	63
5.2 Medical goods - Therapeutic appliances & prosthetics	3.2 Providers of ambulatory care - Dental practices	62
3. Long-term care	7. Health care system admin.	62
2. Rehabilitative care	9. Rest of world	62
5.1 Medical goods - Pharms & other medical non-durable goods	1.3 Hospitals - Specialized	61
5.1.1 Medical goods - Prescribed meds	7. Health care system admin.	61
6.1 Prevention care - IEC programs	1.3 Hospitals - Specialized	60
5.2 Medical goods - Therapeutic appliances & prosthetics	1.3 Hospitals - Specialized	60
1.3.nec Curative care - Outpatient - NEC	2. Resid. long-term care fac.	60
6.2 Prevention care - Immunization programs	3.4 Providers of ambulatory care - Ambulatory health care centers	59
1.3.3 Curative care - Outpatient - Specialized	4. Providers of ancillary services	59
4. Ancillary care	3.3 Providers of ambulatory care - Other practices	59
1.3.2 Curative care - Outpatient - Dental	2. Resid. long-term care fac.	59
5.1.3 Medical goods - Other medical non-durables	1.1 Hospitals - General	59
2.2 Rehabilitative care - Day	1.2 Hospitals - Mental health	58
2. Rehabilitative care	4. Providers of ancillary services	58
3.1 Long-term care - Inpatient	3.5 Providers of home health care services	58
5.1.3 Medical goods - Other medical non-durables	1. Hospitals	58
2.1 Rehabilitative care - Inpatient	8. Rest of economy	58
4. Ancillary care	5. Retailers and other providers of medical goods	57
5.2 Medical goods - Therapeutic appliances & prosthetics	3.3 Providers of ambulatory care - Other practices	57
2.1 Rehabilitative care - Inpatient	3.1 Providers of ambulatory care - Medical practices	57
1.4 Curative care - Home-based	3.2 Providers of ambulatory care - Dental practices	57
3.2 Long-term care - Day	1.3 Hospitals - Specialized	56
3. Long-term care	5. Retailers and other providers of medical goods	56
1.4 Curative care - Home-based	1.2 Hospitals - Mental health	56
1.2 Curative care - Day	2. Resid. long-term care fac.	56
2.4 Rehabilitative care - Home-based	1.1 Hospitals - General	56
7. Governance & admin	1. Hospitals	55
9. Other health care services	1.1 Hospitals - General	55
4. Ancillary care	2. Resid. long-term care fac.	55
2. Rehabilitative care	7. Health care system admin.	55

1.3.3 Curative care - Outpatient - Specialized	5. Retailers and other providers of medical goods	55
1.3 Curative care - Outpatient	N.E.C.	55
4. Ancillary care	7. Health care system admin.	54
9. Other health care services	6. Providers of preventative care	54
1.1 Curative care - Inpatient	N.E.C.	54
1.3.2 Curative care - Outpatient - Dental	3.3 Providers of ambulatory care - Other practices	54
1.3.2 Curative care - Outpatient - Dental	5. Retailers and other providers of medical goods	54
1.1 Curative care - Inpatient	3.2 Providers of ambulatory care - Dental practices	53
3.2 Long-term care - Day	3.4 Providers of ambulatory care - Ambulatory health care centers	51
6.5 Prevention care - Epi surveillance and risk and disease control programs	3. Providers of ambulatory care	51
6.4 Prevention care - Healthy condition monitoring programs	3.3 Providers of ambulatory care - Other practices	51
5.1 Medical goods - Pharms & other medical non-durable goods	3.3 Providers of ambulatory care - Other practices	50
2.1 Rehabilitative care - Inpatient	9. Rest of world	50
3. Long-term care	9. Rest of world	50
3.4 Long-term care - Home-based	1.2 Hospitals - Mental health	50
1.1 Curative care - Inpatient	7. Health care system admin.	49
1.3.1 Curative care - Outpatient - General	3.5 Providers of home health care services	49
5.1.1 Medical goods - Prescribed meds	6. Providers of preventative care	48
6.5 Prevention care - Epi surveillance and risk and disease control programs	8. Rest of economy	48
1. Curative care	N.E.C.	47
3.1 Long-term care - Inpatient	7. Health care system admin.	47
3.4 Long-term care - Home-based	7. Health care system admin.	47
5.1.3 Medical goods - Other medical non-durables	3.4 Providers of ambulatory care - Ambulatory health care centers	47
9. Other health care services	3.3 Providers of ambulatory care - Other practices	47
1.3.nec Curative care - Outpatient - NEC	4. Providers of ancillary services	47
1.1 Curative care - Inpatient	4. Providers of ancillary services	46
6.3 Prevention care - Early disease detection	1.3 Hospitals - Specialized	46
3.3 Long-term care - Outpatient	1.2 Hospitals - Mental health	46
2. Rehabilitative care	5. Retailers and other providers of medical goods	46
5.2 Medical goods - Therapeutic appliances & prosthetics	2. Resid. long-term care fac.	45
1.2 Curative care - Day	8. Rest of economy	45
1.2 Curative care - Day	9. Rest of world	44
6. Preventative care	N.E.C.	44
2.4 Rehabilitative care - Home-based	3.5 Providers of home health care services	43
5.2 Medical goods - Therapeutic appliances & prosthetics	4. Providers of ancillary services	43

2. Rehabilitative care	6. Providers of preventative care	42
1.3.2 Curative care - Outpatient - Dental	7. Health care system admin.	42
6.3 Prevention care - Early disease detection	7. Health care system admin.	41
6.2 Prevention care - Immunization programs	1. Hospitals	41
5.1.2 Medical goods - Over the counter meds	3. Providers of ambulatory care	41
1.3.nec Curative care - Outpatient - NEC	5. Retailers and other providers of medical goods	41
7. Governance & admin	3.4 Providers of ambulatory care - Ambulatory health care centers	40
1.3.3 Curative care - Outpatient - Specialized	7. Health care system admin.	40
6.3 Prevention care - Early disease detection	8. Rest of economy	40
6.5 Prevention care - Epi surveillance and risk and disease control programs	1. Hospitals	39
9. Other health care services	3.4 Providers of ambulatory care - Ambulatory health care centers	39
6.2 Prevention care - Immunization programs	1.1 Hospitals - General	39
5.1.3 Medical goods - Other medical non-durables	3.3 Providers of ambulatory care - Other practices	39
1.3.3 Curative care - Outpatient - Specialized	3.5 Providers of home health care services	39
2.4 Rehabilitative care - Home-based	3.3 Providers of ambulatory care - Other practices	39
3.3 Long-term care - Outpatient	1.1 Hospitals - General	39
2. Rehabilitative care	3.2 Providers of ambulatory care - Dental practices	39
5. Medical goods	3.5 Providers of home health care services	39
5.1 Medical goods - Pharms & other medical non-durable goods	2. Resid. long-term care fac.	39
3.4 Long-term care - Home-based	5. Retailers and other providers of medical goods	38
9. Other health care services	2. Resid. long-term care fac.	38
5.1.3 Medical goods - Other medical non-durables	8. Rest of economy	38
1.4 Curative care - Home-based	5. Retailers and other providers of medical goods	38
3.2 Long-term care - Day	3.5 Providers of home health care services	38
6.3 Prevention care - Early disease detection	4. Providers of ancillary services	37
1.3.1 Curative care - Outpatient - General	5. Retailers and other providers of medical goods	37
2.4 Rehabilitative care - Home-based	3.4 Providers of ambulatory care - Ambulatory health care centers	36
3.1 Long-term care - Inpatient	3.3 Providers of ambulatory care - Other practices	36
9. Other health care services	5. Retailers and other providers of medical goods	36
7. Governance & admin	1.1 Hospitals - General	35
6.nec Prevention care - NEC	3. Providers of ambulatory care	35
5.1 Medical goods - Pharms & other medical non-durable goods	3.5 Providers of home health care services	35
3.1 Long-term care - Inpatient	9. Rest of world	35

1.1 Curative care - Inpatient	5. Retailers and other providers of medical goods	34
6.2 Prevention care - Immunization programs	7. Health care system admin.	34
3.nec Long-term care - NEC	HP Total	34
3.3 Long-term care - Outpatient	3.1 Providers of ambulatory care - Medical practices	34
6.6 Prevention care - Preparing for disaster and emergency response programs	7. Health care system admin.	34
3.3 Long-term care - Outpatient	3.3 Providers of ambulatory care - Other practices	34
5.1.3 Medical goods - Other medical non-durables	3.5 Providers of home health care services	34
3.2 Long-term care - Day	3.1 Providers of ambulatory care - Medical practices	34
2.4 Rehabilitative care - Home-based	3.1 Providers of ambulatory care - Medical practices	34
5.1.3 Medical goods - Other medical non-durables	4. Providers of ancillary services	33
3.3 Long-term care - Outpatient	2. Resid. long-term care fac.	33
6.4 Prevention care - Healthy condition monitoring programs	4. Providers of ancillary services	33
9. Other health care services	1.3 Hospitals - Specialized	33
2.3 Rehabilitative care - Outpatient	4. Providers of ancillary services	33
6.1 Prevention care - IEC programs	9. Rest of world	32
5. Medical goods	N.E.C.	32
5.2 Medical goods - Therapeutic appliances & prosthetics	7. Health care system admin.	32
3.3 Long-term care - Outpatient	3.4 Providers of ambulatory care - Ambulatory health care centers	32
6.2 Prevention care - Immunization programs	8. Rest of economy	32
1.3.3 Curative care - Outpatient - Specialized	N.E.C.	32
6.nec Prevention care - NEC	1.1 Hospitals - General	31
1.3.3 Curative care - Outpatient - Specialized	6. Providers of preventative care	31
6.nec Prevention care - NEC	1. Hospitals	31
6.nec Prevention care - NEC	3.4 Providers of ambulatory care - Ambulatory health care centers	31
3. Long-term care	4. Providers of ancillary services	31
5.1.1 Medical goods - Prescribed meds	4. Providers of ancillary services	31
1.3.1 Curative care - Outpatient - General	N.E.C.	31
1.2 Curative care - Day	3.2 Providers of ambulatory care - Dental practices	31
5.1.2 Medical goods - Over the counter meds	3.1 Providers of ambulatory care - Medical practices	31
4. Ancillary care	N.E.C.	30
7. Governance & admin	3.1 Providers of ambulatory care - Medical practices	30
3.4 Long-term care - Home-based	4. Providers of ancillary services	30
2.3 Rehabilitative care - Outpatient	3.5 Providers of home health care services	30
5.1.3 Medical goods - Other medical non-durables	1.3 Hospitals - Specialized	30
5.2 Medical goods - Therapeutic appliances & prosthetics	3.5 Providers of home health care services	30

5.2 Medical goods - Therapeutic appliances & prosthetics	6. Providers of preventative care	29
5.1.3 Medical goods - Other medical non-durables	7. Health care system admin.	29
6.5 Prevention care - Epi surveillance and risk and disease control programs	3.4 Providers of ambulatory care - Ambulatory health care centers	29
2.nec Rehabilitative care - NEC	HP Total	29
9. Other health care services	3.1 Providers of ambulatory care - Medical practices	29
9. Other health care services	4. Providers of ancillary services	29
1.3.nec Curative care - Outpatient - NEC	3.2 Providers of ambulatory care - Dental practices	29
5.1.3 Medical goods - Other medical non-durables	3.1 Providers of ambulatory care - Medical practices	29
2.2 Rehabilitative care - Day	2. Resid. long-term care fac.	29
4. Ancillary care	3.5 Providers of home health care services	28
5.nec Medical goods - NEC	HP Total	28
6.nec Prevention care - NEC	7. Health care system admin.	28
6.5 Prevention care - Epi surveillance and risk and disease control programs	1.1 Hospitals - General	28
6.1 Prevention care - IEC programs	4. Providers of ancillary services	28
6.nec Prevention care - NEC	8. Rest of economy	28
5.1.2 Medical goods - Over the counter meds	1. Hospitals	28
2.1 Rehabilitative care - Inpatient	7. Health care system admin.	27
7. Governance & admin	4. Providers of ancillary services	27
3.3 Long-term care - Outpatient	1.3 Hospitals - Specialized	27
6.3 Prevention care - Early disease detection	3.2 Providers of ambulatory care - Dental practices	26
5.1.2 Medical goods - Over the counter meds	8. Rest of economy	26
2.3 Rehabilitative care - Outpatient	5. Retailers and other providers of medical goods	26
1. nec Curative care - NEC	1.1 Hospitals - General	26
5.1.3 Medical goods - Other medical non-durables	9. Rest of world	26
6.1 Prevention care - IEC programs	3.2 Providers of ambulatory care - Dental practices	26
2.3 Rehabilitative care - Outpatient	6. Providers of preventative care	25
5.1 Medical goods - Pharms & other medical non-durable goods	N.E.C.	25
6.4 Prevention care - Healthy condition monitoring programs	1.2 Hospitals - Mental health	25
1.3.nec Curative care - Outpatient - NEC	3.5 Providers of home health care services	25
3.2 Long-term care - Day	8. Rest of economy	25
1.3.nec Curative care - Outpatient - NEC	6. Providers of preventative care	24
6.2 Prevention care - Immunization programs	5. Retailers and other providers of medical goods	24
2.4 Rehabilitative care - Home-based	2. Resid. long-term care fac.	24
1.3 Curative care - Outpatient	1.nec Hospitals - Other	24
HC Total	3.nec Providers of ambulatory care - NEC	24
7. Governance & admin	N.E.C.	24

6.1 Prevention care - IEC programs	5. Retailers and other providers of medical goods	24
2.4 Rehabilitative care - Home-based	1.3 Hospitals - Specialized	23
1.3.2 Curative care - Outpatient - Dental	1.2 Hospitals - Mental health	23
3. Long-term care	3.2 Providers of ambulatory care - Dental practices	23
3.1 Long-term care - Inpatient	5. Retailers and other providers of medical goods	23
6.5 Prevention care - Epi surveillance and risk and disease control programs	4. Providers of ancillary services	22
6.1 Prevention care - IEC programs	1.2 Hospitals - Mental health	22
1.1 Curative care - Inpatient	1.nec Hospitals - Other	22
5.1.1 Medical goods - Prescribed meds	N.E.C.	22
6.5 Prevention care - Epi surveillance and risk and disease control programs	1.3 Hospitals - Specialized	21
6.6 Prevention care - Preparing for disaster and emergency response programs	1. Hospitals	21
6.6 Prevention care - Preparing for disaster and emergency response programs	1.1 Hospitals - General	21
2.1 Rehabilitative care - Inpatient	5. Retailers and other providers of medical goods	21
3.4 Long-term care - Home-based	3.2 Providers of ambulatory care - Dental practices	21
5.1.1 Medical goods - Prescribed meds	3.5 Providers of home health care services	21
2.2 Rehabilitative care - Day	8. Rest of economy	21
2.3 Rehabilitative care - Outpatient	9. Rest of world	21
2.4 Rehabilitative care - Home-based	3.2 Providers of ambulatory care - Dental practices	21
5.2 Medical goods - Therapeutic appliances & prosthetics	N.E.C.	20
5.1.2 Medical goods - Over the counter meds	6. Providers of preventative care	20
3.3 Long-term care - Outpatient	3.5 Providers of home health care services	20
2.2 Rehabilitative care - Day	3.3 Providers of ambulatory care - Other practices	20
2.2 Rehabilitative care - Day	4. Providers of ancillary services	20
9. Other health care services	1.2 Hospitals - Mental health	20
1.2 Curative care - Day	5. Retailers and other providers of medical goods	20
1.3.2 Curative care - Outpatient - Dental	N.E.C.	20
5.1.1 Medical goods - Prescribed meds	8. Rest of economy	20
5.1.3 Medical goods - Other medical non-durables	3.2 Providers of ambulatory care - Dental practices	20
1.4 Curative care - Home-based	9. Rest of world	20
3.3 Long-term care - Outpatient	8. Rest of economy	19
2. Rehabilitative care	N.E.C.	19
1.3.2 Curative care - Outpatient - Dental	4. Providers of ancillary services	19
5.1.3 Medical goods - Other medical non-durables	N.E.C.	19
2.3 Rehabilitative care - Outpatient	3.2 Providers of ambulatory care - Dental practices	19

5.1.3 Medical goods - Other medical non-durables	1.2 Hospitals - Mental health	19
2.4 Rehabilitative care - Home-based	1.2 Hospitals - Mental health	19
6.4 Prevention care - Healthy condition monitoring programs	3.5 Providers of home health care services	18
1.3.2 Curative care - Outpatient - Dental	3.5 Providers of home health care services	18
9. Other health care services	3.2 Providers of ambulatory care - Dental practices	18
6.4 Prevention care - Healthy condition monitoring programs	5. Retailers and other providers of medical goods	18
2.4 Rehabilitative care - Home-based	5. Retailers and other providers of medical goods	18
7. Governance & admin	5. Retailers and other providers of medical goods	17
1. nec Curative care - NEC	1. Hospitals	17
1.2 Curative care - Day	3.3 Providers of ambulatory care - Other practices	17
1.1 Curative care - Inpatient	3.5 Providers of home health care services	17
5.2 Medical goods - Therapeutic appliances & prosthetics	1.2 Hospitals - Mental health	17
1.2 Curative care - Day	N.E.C.	17
1.2 Curative care - Day	6. Providers of preventative care	17
5.1.3 Medical goods - Other medical non-durables	2. Resid. long-term care fac.	17
5.1.2 Medical goods - Over the counter meds	3.2 Providers of ambulatory care - Dental practices	17
5.1.1 Medical goods - Prescribed meds	3.3 Providers of ambulatory care - Other practices	16
2.4 Rehabilitative care - Home-based	4. Providers of ancillary services	16
6.1 Prevention care - IEC programs	3.5 Providers of home health care services	16
6.5 Prevention care - Epi surveillance and risk and disease control programs	3.1 Providers of ambulatory care - Medical practices	16
5.1.2 Medical goods - Over the counter meds	9. Rest of world	16
1.2 Curative care - Day	4. Providers of ancillary services	16
3.4 Long-term care - Home-based	9. Rest of world	16
6.nec Prevention care - NEC	9. Rest of world	15
1.4 Curative care - Home-based	4. Providers of ancillary services	15
6.6 Prevention care - Preparing for disaster and emergency response programs	4. Providers of ancillary services	15
6.3 Prevention care - Early disease detection	3.3 Providers of ambulatory care - Other practices	15
6.2 Prevention care - Immunization programs	1.3 Hospitals - Specialized	15
1.2 Curative care - Day	3.5 Providers of home health care services	15
9. Other health care services	3.5 Providers of home health care services	15
5.1.1 Medical goods - Prescribed meds	2. Resid. long-term care fac.	15
1.4 Curative care - Home-based	N.E.C.	15
2.3 Rehabilitative care - Outpatient	7. Health care system admin.	15
7. Governance & admin	1.3 Hospitals - Specialized	15
3. Long-term care	6. Providers of preventative care	14

2.1 Rehabilitative care - Inpatient	3.3 Providers of ambulatory care - Other practices	14
1.3.nec Curative care - Outpatient - NEC	7. Health care system admin.	14
5.1.2 Medical goods - Over the counter meds	3.4 Providers of ambulatory care - Ambulatory health care centers	13
2.1 Rehabilitative care - Inpatient	4. Providers of ancillary services	13
2.1 Rehabilitative care - Inpatient	N.E.C.	13
2.3 Rehabilitative care - Outpatient	N.E.C.	13
6.6 Prevention care - Preparing for disaster and emergency response programs	8. Rest of economy	13
6.nec Prevention care - NEC	N.E.C.	12
5.1.3 Medical goods - Other medical non-durables	6. Providers of preventative care	12
6.5 Prevention care - Epi surveillance and risk and disease control programs	9. Rest of world	12
1. Curative care	1.nec Hospitals - Other	12
3.1 Long-term care - Inpatient	4. Providers of ancillary services	12
3. Long-term care	N.E.C.	12
3.1 Long-term care - Inpatient	N.E.C.	12
3.4 Long-term care - Home-based	N.E.C.	12
6.nec Prevention care - NEC	5. Retailers and other providers of medical goods	12
6. Preventative care	1.nec Hospitals - Other	12
7. Governance & admin	1.2 Hospitals - Mental health	11
2.1 Rehabilitative care - Inpatient	3.5 Providers of home health care services	11
6.nec Prevention care - NEC	3.1 Providers of ambulatory care - Medical practices	11
6.3 Prevention care - Early disease detection	1.2 Hospitals - Mental health	11
6.6 Prevention care - Preparing for disaster and emergency response programs	1.2 Hospitals - Mental health	11
6.4 Prevention care - Healthy condition monitoring programs	2. Resid. long-term care fac.	11
2.nec Rehabilitative care - NEC	1. Hospitals	10
6.4 Prevention care - Healthy condition monitoring programs	9. Rest of world	10
2.1 Rehabilitative care - Inpatient	3.2 Providers of ambulatory care - Dental practices	10
1.3.nec Curative care - Outpatient - NEC	N.E.C.	10
6.nec Prevention care - NEC	3.3 Providers of ambulatory care - Other practices	9
5.nec Medical goods - NEC	5. Retailers and other providers of medical goods	9
6.6 Prevention care - Preparing for disaster and emergency response programs	1.3 Hospitals - Specialized	9
3.2 Long-term care - Day	3.3 Providers of ambulatory care - Other practices	9
6.nec Prevention care - NEC	1.3 Hospitals - Specialized	9
6.1 Prevention care - IEC programs	2. Resid. long-term care fac.	9
6.nec Prevention care - NEC	4. Providers of ancillary services	9
6.nec Prevention care - NEC	1.2 Hospitals - Mental health	9

6.nec Prevention care - NEC	2. Resid. long-term care fac.	9
6.1 Prevention care - IEC programs	N.E.C.	8
2.4 Rehabilitative care - Home-based	8. Rest of economy	8
1.2 Curative care - Day	7. Health care system admin.	8
3.3 Long-term care - Outpatient	7. Health care system admin.	8
6.3 Prevention care - Early disease detection	2. Resid. long-term care fac.	8
6.3 Prevention care - Early disease detection	5. Retailers and other providers of medical goods	8
1.3 Curative care - Outpatient	3.nec Providers of ambulatory care - NEC	8
1. nec Curative care - NEC	1.3 Hospitals - Specialized	8
6.2 Prevention care - Immunization programs	3.3 Providers of ambulatory care - Other practices	8
6. Preventative care	3.nec Providers of ambulatory care - NEC	8
7. Governance & admin	2. Resid. long-term care fac.	8
6.2 Prevention care - Immunization programs	1.2 Hospitals - Mental health	8
6.nec Prevention care - NEC	1.nec Hospitals - Other	8
2.2 Rehabilitative care - Day	7. Health care system admin.	7
3.2 Long-term care - Day	7. Health care system admin.	7
3.4 Long-term care - Home-based	6. Providers of preventative care	7
5.1.2 Medical goods - Over the counter meds	N.E.C.	7
6.3 Prevention care - Early disease detection	3.5 Providers of home health care services	7
1. nec Curative care - NEC	N.E.C.	7
4. Ancillary care	1.nec Hospitals - Other	7
4. Ancillary care	3.nec Providers of ambulatory care - NEC	7
1.1 Curative care - Inpatient	3.nec Providers of ambulatory care - NEC	7
2.nec Rehabilitative care - NEC	1.1 Hospitals - General	7
2.4 Rehabilitative care - Home-based	6. Providers of preventative care	7
5.1.2 Medical goods - Over the counter meds	1.1 Hospitals - General	6
1.3.2 Curative care - Outpatient - Dental	6. Providers of preventative care	6
1. nec Curative care - NEC	1.nec Hospitals - Other	6
6.2 Prevention care - Immunization programs	9. Rest of world	6
6.2 Prevention care - Immunization programs	N.E.C.	6
6.3 Prevention care - Early disease detection	N.E.C.	6
6.4 Prevention care - Healthy condition monitoring programs	N.E.C.	6
6.6 Prevention care - Preparing for disaster and emergency response programs	3. Providers of ambulatory care	6
1. Curative care	3.nec Providers of ambulatory care - NEC	6
6.6 Prevention care - Preparing for disaster and emergency response programs	3.4 Providers of ambulatory care - Ambulatory health care centers	6
5.1.2 Medical goods - Over the counter meds	7. Health care system admin.	6
6.2 Prevention care - Immunization programs	4. Providers of ancillary services	5
1.3.1 Curative care - Outpatient - General	1.nec Hospitals - Other	5
1.3.nec Curative care - Outpatient - NEC	1.nec Hospitals - Other	5
3.nec Long-term care - NEC	8. Rest of economy	5

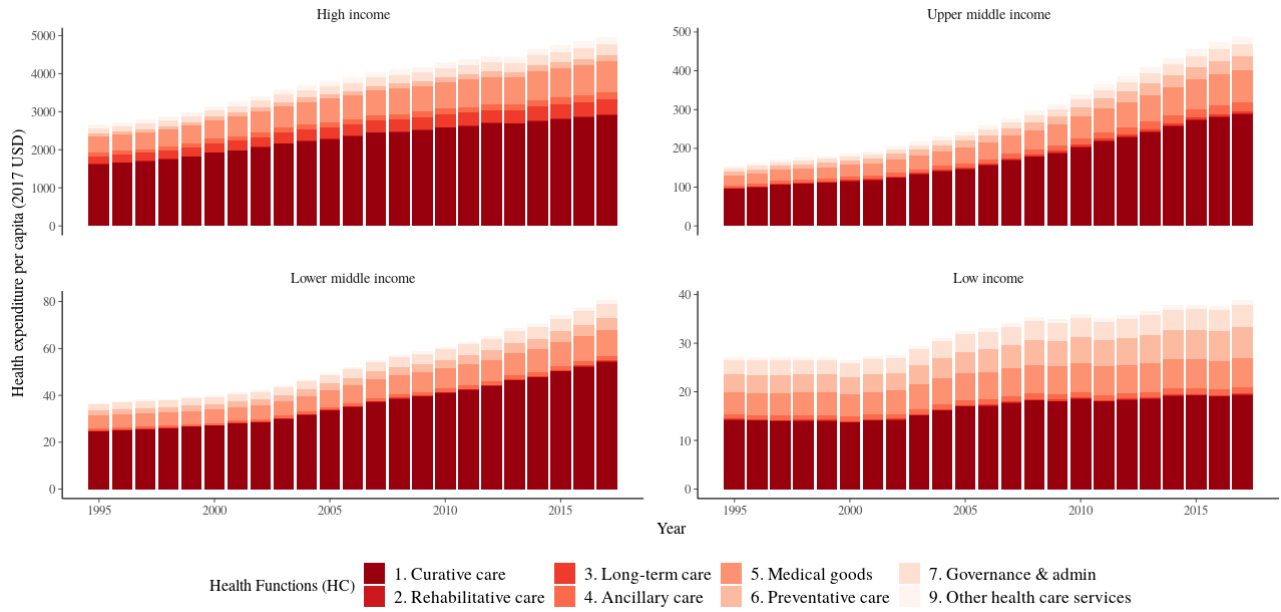
6.6 Prevention care - Preparing for disaster and emergency response programs	9. Rest of world	5
2.2 Rehabilitative care - Day	3.5 Providers of home health care services	5
5. Medical goods	1.nec Hospitals - Other	5
5.1 Medical goods - Pharms & other medical non-durable goods	1.nec Hospitals - Other	5
1. nec Curative care - NEC	3. Providers of ambulatory care	5
1. nec Curative care - NEC	3.1 Providers of ambulatory care - Medical practices	5
1.4 Curative care - Home-based	6. Providers of preventative care	4
1.3.1 Curative care - Outpatient - General	3.nec Providers of ambulatory care - NEC	4
9. Other health care services	3.nec Providers of ambulatory care - NEC	4
9. Other health care services	1.nec Hospitals - Other	4
6.5 Prevention care - Epi surveillance and risk and disease control programs	3.3 Providers of ambulatory care - Other practices	4
5. Medical goods	3.nec Providers of ambulatory care - NEC	4
5.1.2 Medical goods - Over the counter meds	2. Resid. long-term care fac.	4
6.2 Prevention care - Immunization programs	2. Resid. long-term care fac.	4
1. nec Curative care - NEC	3.nec Providers of ambulatory care - NEC	4
6.3 Prevention care - Early disease detection	1.nec Hospitals - Other	4
6.2 Prevention care - Immunization programs	3.5 Providers of home health care services	4
5.1.2 Medical goods - Over the counter meds	1.2 Hospitals - Mental health	4
5.1.2 Medical goods - Over the counter meds	3.5 Providers of home health care services	4
6.6 Prevention care - Preparing for disaster and emergency response programs	3.5 Providers of home health care services	4
6.nec Prevention care - NEC	3.5 Providers of home health care services	4
3.2 Long-term care - Day	6. Providers of preventative care	3
1. nec Curative care - NEC	8. Rest of economy	3
2.nec Rehabilitative care - NEC	9. Rest of world	3
1. nec Curative care - NEC	9. Rest of world	3
2.1 Rehabilitative care - Inpatient	6. Providers of preventative care	3
3.1 Long-term care - Inpatient	3.2 Providers of ambulatory care - Dental practices	3
2.2 Rehabilitative care - Day	N.E.C.	3
2.2 Rehabilitative care - Day	5. Retailers and other providers of medical goods	3
3.2 Long-term care - Day	N.E.C.	3
2.nec Rehabilitative care - NEC	1.3 Hospitals - Specialized	3
7. Governance & admin	1.nec Hospitals - Other	3
2.4 Rehabilitative care - Home-based	7. Health care system admin.	3
1. nec Curative care - NEC	3.4 Providers of ambulatory care - Ambulatory health care centers	3
6.6 Prevention care - Preparing for disaster and emergency response programs	2. Resid. long-term care fac.	3
1.3.2 Curative care - Outpatient - Dental	1.nec Hospitals - Other	2
3.nec Long-term care - NEC	9. Rest of world	2
3.1 Long-term care - Inpatient	6. Providers of preventative care	2

1.3.3 Curative care - Outpatient - Specialized	1.nec Hospitals - Other	2
1.3.2 Curative care - Outpatient - Dental	3.nec Providers of ambulatory care - NEC	2
1.3.3 Curative care - Outpatient - Specialized	3.nec Providers of ambulatory care - NEC	2
1.2 Curative care - Day	1.nec Hospitals - Other	2
2.2 Rehabilitative care - Day	9. Rest of world	2
7. Governance & admin	3.nec Providers of ambulatory care - NEC	2
2.nec Rehabilitative care - NEC	6. Providers of preventative care	2
3.3 Long-term care - Outpatient	9. Rest of world	2
6.2 Prevention care - Immunization programs	3.2 Providers of ambulatory care - Dental practices	2
6.1 Prevention care - IEC programs	1.nec Hospitals - Other	2
3. Long-term care	3.nec Providers of ambulatory care - NEC	2
7. Governance & admin	3.3 Providers of ambulatory care - Other practices	2
6.5 Prevention care - Epi surveillance and risk and disease control programs	N.E.C.	2
2.nec Rehabilitative care - NEC	2. Resid. long-term care fac.	2
2.2 Rehabilitative care - Day	6. Providers of preventative care	1
7. Governance & admin	3.2 Providers of ambulatory care - Dental practices	1
6.6 Prevention care - Preparing for disaster and emergency response programs	3.1 Providers of ambulatory care - Medical practices	1
3.nec Long-term care - NEC	3. Providers of ambulatory care	1
1. nec Curative care - NEC	4. Providers of ancillary services	1
3.3 Long-term care - Outpatient	6. Providers of preventative care	1
5.nec Medical goods - NEC	6. Providers of preventative care	1
2. Rehabilitative care	3.nec Providers of ambulatory care - NEC	1
2.3 Rehabilitative care - Outpatient	3.nec Providers of ambulatory care - NEC	1
5.1.1 Medical goods - Prescribed meds	1.nec Hospitals - Other	1
1.2 Curative care - Day	3.nec Providers of ambulatory care - NEC	1
1.3.nec Curative care - Outpatient - NEC	3.nec Providers of ambulatory care - NEC	1
1. nec Curative care - NEC	3.2 Providers of ambulatory care - Dental practices	1
1. nec Curative care - NEC	3.3 Providers of ambulatory care - Other practices	1
2.4 Rehabilitative care - Home-based	9. Rest of world	1
2.4 Rehabilitative care - Home-based	N.E.C.	1
2. Rehabilitative care	1.nec Hospitals - Other	1
3. Long-term care	1.nec Hospitals - Other	1
6.nec Prevention care - NEC	3.nec Providers of ambulatory care - NEC	1
6.5 Prevention care - Epi surveillance and risk and disease control programs	3.5 Providers of home health care services	1
1. nec Curative care - NEC	6. Providers of preventative care	1
2.2 Rehabilitative care - Day	3.2 Providers of ambulatory care - Dental practices	1
3.nec Long-term care - NEC	1.3 Hospitals - Specialized	1
2.nec Rehabilitative care - NEC	N.E.C.	1

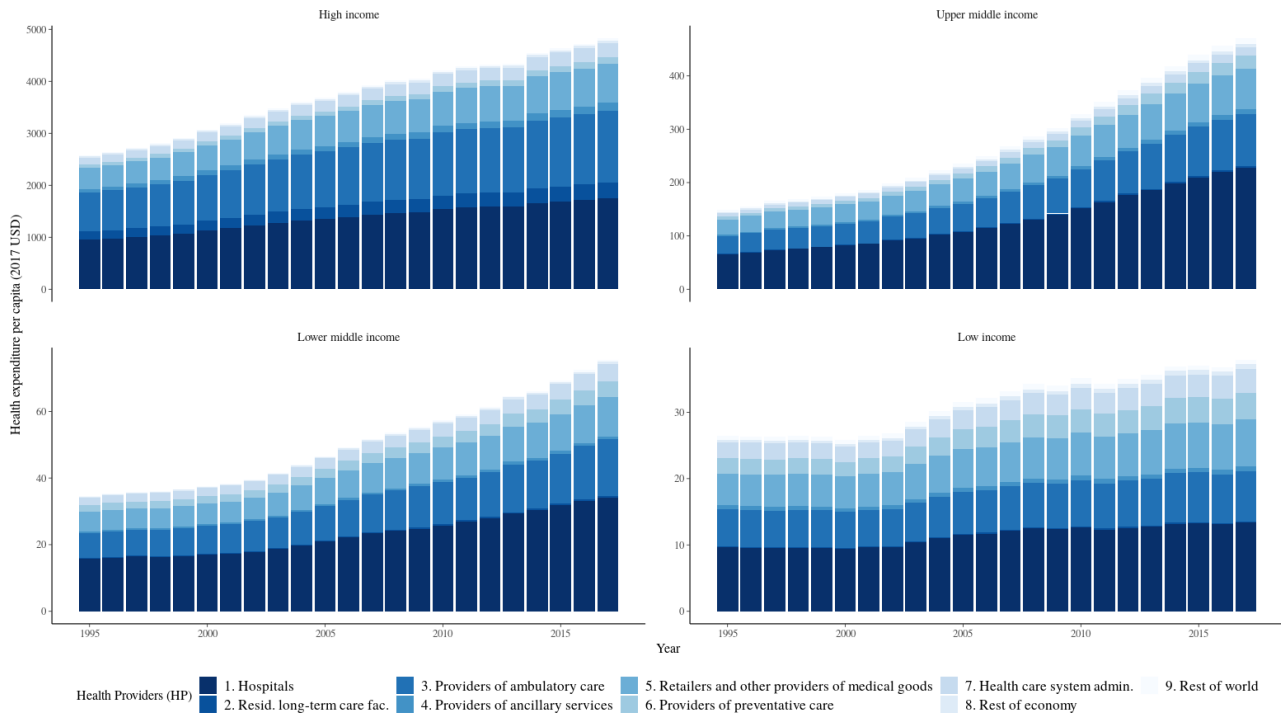
5.1.2 Medical goods - Over the counter meds	4. Providers of ancillary services	1
1.4 Curative care - Home-based	7. Health care system admin.	1
5.nec Medical goods - NEC	1. Hospitals	1
5.nec Medical goods - NEC	1.1 Hospitals - General	1
5.nec Medical goods - NEC	3. Providers of ambulatory care	1
5.nec Medical goods - NEC	3.4 Providers of ambulatory care - Ambulatory health care centers	1
6.1 Prevention care - IEC programs	3.nec Providers of ambulatory care - NEC	1
2.nec Rehabilitative care - NEC	7. Health care system admin.	1
5.nec Medical goods - NEC	1.3 Hospitals - Specialized	1
5.nec Medical goods - NEC	3.5 Providers of home health care services	1
2.nec Rehabilitative care - NEC	N.E.C.	1
1.2 Curative care - Day	2. Resid. long-term care fac.	1
1.4 Curative care - Home-based	3.1 Providers of ambulatory care - Medical practices	1
2.2 Rehabilitative care - Day	3.1 Providers of ambulatory care - Medical practices	1
2.2 Rehabilitative care - Day	4. Providers of ancillary services	1
2.2 Rehabilitative care - Day	5. Retailers and other providers of medical goods	1
2.2 Rehabilitative care - Day	7. Health care system admin.	1
2.2 Rehabilitative care - Day	8. Rest of economy	1
2.4 Rehabilitative care - Home-based	2. Resid. long-term care fac.	1
2.4 Rehabilitative care - Home-based	3.1 Providers of ambulatory care - Medical practices	1
2.4 Rehabilitative care - Home-based	4. Providers of ancillary services	1
5.1.2 Medical goods - Over the counter meds	1.3 Hospitals - Specialized	1
5.1.2 Medical goods - Over the counter meds	4. Providers of ancillary services	1
5.nec Medical goods - NEC	1. Hospitals	1
5.nec Medical goods - NEC	3. Providers of ambulatory care	1
5.nec Medical goods - NEC	3.4 Providers of ambulatory care - Ambulatory health care centers	1
6.1 Prevention case - IEC programs	3.nec Providers of ambulatory care - NEC	1
6.3 Prevention case - Early disease detection	3.nec Providers of ambulatory care - NEC	1
6.4 Prevention case - Healthy condition monitoring programs	3.nec Providers of ambulatory care - NEC	1
2.nec Rehabilitative care - NEC	7. Health care system admin.	1

Health expenditures by World Bank income groups

Panel A. Health Functions



Panel B. Health Providers



Aim 2

A. Detailed methods for estimating prescribed pharmaceutical expenditures for primary health care

We used data from IQVIA Analytics Link to estimate the proportion of health expenditures on prescription pharmaceuticals that we considered part of PHC.²⁴ IQVIA data obtained for our research contained prescribed pharmaceutical sales records for 49 countries, between 2014 and 2018. These expenditures were reported by the pharmaceutical molecule name as a total for the country and/or by the settings the prescriptions were purchased - hospitals or retailers. To identify the proportion of prescribed pharmaceutical expenditures for PHC within the IQVIA data, the molecule name was matched with the WHO Essential Medicine List.²⁶ Any pharmaceuticals not matched with the Essential Medicine List were assumed not to be for PHC. Of the 460 pharmaceutical molecules in the WHO Essential Medicine List, 289 were matched within the IQVIA data. A complete list of countries within the IQVIA data and the settings reported, as well as a list of pharmaceutical molecules matched between the WHO Essential Medicine List and IQVIA found below.

We used Spatio-Temporal Gaussian Process Regression (ST-GPR) to estimate the proportion of prescribed pharmaceutical expenditures that are for PHC within hospitals, retailers, and as an aggregate for all countries between 2000 and 2017.²⁷ We modelled expenditures for prescribed essential pharmaceuticals as a proportion of total prescription pharmaceutical expenditures reported in the IQVIA data, for retail and hospital settings separately and as an aggregate. All covariates considered were either from the Global Burden of Disease study or estimates produced by Schneider et al.²⁸[Schneider] Covariates considered for the linear first stage of ST-GPR for all models are shown in Table A.4. Covariates for each model were selected based on Akaike information criterion using the base step function in R version 3.6.0 and are presented in the appendix.

We applied these country-year, setting-specific estimates of the proportion of prescribed pharmaceuticals that are for PHC to the most appropriate cross-classification of health care function and provider expenditure estimates. For prescribed pharmaceutical expenditures (HC 5.1.1) within hospitals (HP 1) and ambulatory care providers (HP 3) we multiplied the country-year specific estimate of prescribed medicines that are for PHC within hospitals. For prescribed pharmaceutical expenditures within retailers of medical goods (HP 5) we applied the country-year specific estimate of prescribed pharmaceutical that are for PHC within retailers. For all other health care providers with any amount of prescribed pharmaceutical expenditures we applied the average of the two settings – hospitals and retailers - for that given country-year.

Table A.1 Channels available by country in IQVIA Analytics Link

Country	Channel
AUSTRALIA	HOSPITAL
AUSTRALIA	RETAIL
AUSTRIA	HOSPITAL
AUSTRIA	RETAIL
BELARUS	HOSPITAL
BELARUS	RETAIL
BELGIUM	HOSPITAL

BELGIUM	RETAIL
BOSNIA-HERZEGOVINA	COMBINED
BULGARIA	HOSPITAL
BULGARIA	RETAIL
CANADA	HOSPITAL
CANADA	RETAIL
CHINA	HOSPITAL
CHINA	RETAIL
CROATIA	HOSPITAL
CROATIA	RETAIL
CZECH REPUBLIC	HOSPITAL
CZECH REPUBLIC	RETAIL
FINLAND	HOSPITAL
FINLAND	RETAIL
FRANCE	HOSPITAL
FRANCE	RETAIL
GERMANY	HOSPITAL
GERMANY	RETAIL
HUNGARY	HOSPITAL
HUNGARY	RETAIL
INDIA	COMBINED
INDONESIA	HOSPITAL
INDONESIA	RETAIL
IRELAND	HOSPITAL
IRELAND	RETAIL
ITALY	HOSPITAL
ITALY	RETAIL
JAPAN	HOSPITAL
JAPAN	RETAIL
KAZAKHSTAN	HOSPITAL
KAZAKHSTAN	RETAIL
LATVIA	HOSPITAL
LATVIA	RETAIL
LITHUANIA	HOSPITAL
LITHUANIA	RETAIL
MALAYSIA	COMBINED
NETHERLANDS	HOSPITAL
NETHERLANDS	RETAIL

NEW ZEALAND	HOSPITAL
NEW ZEALAND	RETAIL
NORWAY	HOSPITAL
NORWAY	RETAIL
PHILIPPINES	HOSPITAL
PHILIPPINES	RETAIL
POLAND	HOSPITAL
POLAND	RETAIL
PORTUGAL	HOSPITAL
PORTUGAL	RETAIL
PUERTO RICO	HOSPITAL
PUERTO RICO	RETAIL
ROMANIA	HOSPITAL
ROMANIA	RETAIL
RUSSIA	HOSPITAL
RUSSIA	RETAIL
SAUDI ARABIA	HOSPITAL
SAUDI ARABIA	RETAIL
SERBIA	COMBINE D
SINGAPORE	COMBINE D
SLOVAK REPUBLIC	HOSPITAL
SLOVAK REPUBLIC	RETAIL
SLOVENIA	COMBINE D
SOUTH AFRICA	COMBINE D
SOUTH KOREA	HOSPITAL
SOUTH KOREA	RETAIL
SPAIN	HOSPITAL
SPAIN	RETAIL
SWEDEN	COMBINE D
SWITZERLAND	HOSPITAL
SWITZERLAND	RETAIL
TAIWAN	HOSPITAL
TAIWAN	RETAIL
THAILAND	HOSPITAL
THAILAND	RETAIL
TUNISIA	HOSPITAL
TUNISIA	RETAIL

TURKEY	HOSPITAL
TURKEY	RETAIL
UK	HOSPITAL
UK	RETAIL
USA	HOSPITAL
USA	RETAIL
VIETNAM	HOSPITAL
VIETNAM	RETAIL

Table A.2 WHO essential medicines included in analysis

AMPHOTERICIN B
MICONAZOLE
NATAMYCIN
TETRACYCLINE
METRONIDAZOLE
CLOTRIMAZOLE
DOXYCYCLINE
DEXAMETHASONE
HYDROCORTISONE
EPINEPHRINE
ACETYLSALICYLIC ACID
RANITIDINE
MISOPROSTOL
OMEPRAZOLE
ATROPINE
METOCLOPRAMIDE
ONDANSETRON
LACTULOSE
MANNITOL
NALOXONE
NYSTATIN
VANCOMYCIN
LOPERAMIDE
PREDNISOLONE
BETAMETHASONE
BUDESONIDE
BECLOMETASONE
SULFASALAZINE
METFORMIN
GLICLAZIDE
ERGOCALCIFEROL

COLECALCIFEROL
NICOTINAMIDE
CALCIUM
WARFARIN
CLOPIDOGREL
TRANEXAMIC ACID
PHYTOMENADIONE
HYDROXOCOBALAMIN
FOLIC ACID
DEXTRAN
BLOOD PLASMA
GLUCOSE
DIGOXIN
LIDOCAINE
IBUPROFEN
METHYLDOPA
HYDRALAZINE
HYDROCHLOROTHIAZIDE
FUROSEMIDE
SPIRONOLACTONE
AMILORIDE
TETRACAINE
PROPRANOLOL
TIMOLOL
BISOPROLOL
AMLODIPINE
NIFEDIPINE
VERAPAMIL
ENALAPRIL
LOSARTAN
SIMVASTATIN
GRISEOFULVIN
FLUCONAZOLE
TERBINAFINE
FLUCYTOSINE
CHLORAMPHENICOL
GENTAMICIN
MUPIROCIN
AMIKACIN
ACICLOVIR
POVIDONE-IODINE

IODINE
POTASSIUM PERMANGANATE
ETHANOL
RETINOL
CLINDAMYCIN
ERYTHROMYCIN
DAPSONE
EFLORNITHINE
IVERMECTIN
ACETIC ACID
ERGOMETRINE
LEVONORGESTREL
MEDROXYPROGESTERONE
ETONOGESTREL
OXYTOCIN
FLUDROCORTISONE
PROPYLTHIOURACIL
GLUCAGON
AMPICILLIN
AMOXICILLIN
PENICILLIN V
PENICILLIN G
CLOXACILLIN
CEFALEXIN
CEFAZOLIN
CEFOTAXIME
CEFTRIAZONE
CEFIXIME
SULFADIAZINE
SULFAMETHOXAZOLE + TRIMETHOPRIM
CLARITHROMYCIN
AZITHROMYCIN
OFLOXACIN
CIPROFLOXACIN
NITROFURANTOIN
SPECTINOMYCIN
ITRACONAZOLE
VORICONAZOLE
RIFAMPICIN
RIFABUTIN
ISONIAZID

PYRAZINAMIDE
ETHAMBUTOL
ISONIAZID + PYRIDOXINE + RIFAMPICIN
ETHAMBUTOL + ISONIAZID + PYRAZINAMIDE + RIFAMPICIN
CLOFAZIMINE
RIBAVIRIN
VALGANCICLOVIR
RITONAVIR
ATAZANAVIR
DARUNAVIR
SIMEPREVIR
ZIDOVUDINE
LAMIVUDINE
ABACAVIR
TENOFOVIR DISOPROXIL
ENTECAVIR
NEVIRAPINE
EFAVIRENZ
ABACAVIR + LAMIVUDINE
LAMIVUDINE + NEVIRAPINE + ZIDOVUDINE
EFAVIRENZ + EMTRICITABINE + TENOFOVIR DISOPROXIL
LOPINAVIR + RITONAVIR
EFAVIRENZ + LAMIVUDINE + TENOFOVIR DISOPROXIL
EMTRICITABINE + TENOFOVIR ALAFENAMIDE
RALTEGRAVIR
DOLUTEGRAVIR
DACLATASVIR
SOFOSBUVIR
DASABUVIR
LEDIPASVIR + SOFOSBUVIR
OMBITASVIR + PARITAPREVIR + RITONAVIR
IMMUNOGLOBULIN ANTI-CORYNEBACTERIUM DIPHTHERIAE TOXIN
IMMUNOGLOBULIN ANTIVENOM SNAKES
VACCINE, CHOLERA
VACCINE, PNEUMOCOCCAL
VACCINE, TETANUS
VACCINE, TYPHOID
VACCINE, JAPANESE ENCEPHALITIS
VACCINE, INFLUENZA
VACCINE, MEASLES
VACCINE, MUMPS

VACCINE, RABIES
VACCINE, ROTAVIRUS
VACCINE, RUBELLA
VACCINE, VARICELLA ZOSTER
VACCINE, YELLOW FEVER LIVE
FLUOROURACIL
VACCINE, TUBERCULOSIS
PENICILLAMINE
SUXAMETHONIUM
VECURONIUM BROMIDE
ATRACURIUM BESILATE
ALLOPURINOL
ISOFLURANE
FENTANYL
KETAMINE
PROPOFOL
BUPIVACAINE
MORPHINE
PARACETAMOL
PHENYTOIN
CARBAMAZEPINE
VALPROIC ACID
LAMOTRIGINE
BIPERIDEN
LEVODOPA
CHLORPROMAZINE
FLUPHENAZINE
HALOPERIDOL
RISPERIDONE
DIAZEPAM
MIDAZOLAM
CLOMIPRAMINE
AMITRIPTYLINE
FLUOXETINE
NEOSTIGMINE
PILOCARPINE
CHLOROQUINE
PRIMAQUINE
QUININE
MEFLOQUINE
ARTEMETHER

ARTESUNATE
ARTEMETHER + LUMEFANTRINE
BENZNIDAZOLE
SODIUM STIBOGLUCONATE
NIFURTIMOX
PRAZIQUANTEL
MEBENDAZOLE
ALBENDAZOLE
PYRANTEL
LEVAMISOLE
PERMETHRIN
BENZYL BENZOATE
XYLOMETAZOLINE
IPRATROPIUM BROMIDE
SALBUTAMOL
BUDESONIDE + FORMOTEROL
ACETYLCYSTEINE
CODEINE
CYCLIZINE
LORATADINE
ACETAZOLAMIDE
LATANOPROST
TROPICAMIDE
FLUORESCEIN
PROTAMINE
OXYGEN
TUBERCULIN TEST
IOHEXOL
CHARCOAL
ETHINYLESTRADIOL + LEVONORGESTREL
RIBOFLAVIN
ETHINYLESTRADIOL + NORGESTIMATE
ELECTROLYTE SOLUTIONS
SENNA
PYRIDOXINE
ULIPRISTAL ACETATE
THIAMINE
ESTRADIOL + NORETHISTERONE
ZINC
NITROGLYCERIN
ENOXAPARIN SODIUM

SENNA + SENNOSIDES A&B
GLIMEPIRIDE + PIOGLITAZONE
EMPAGLIFLOZIN + LINAGLIPTIN
ALOGLIPTIN + METFORMIN
CANAGLIFLOZIN + METFORMIN
DAPAGLIFLOZIN + METFORMIN
EMPAGLIFLOZIN + METFORMIN
GEMIGLIPTIN + METFORMIN
LINAGLIPTIN + METFORMIN
METFORMIN + SAXAGLIPTIN
METFORMIN + SITAGLIPTIN
METFORMIN + VILDAGLIPTIN
ALOGLIPTIN + PIOGLITAZONE
VACCINE, TICK BORNE ENCEPHALITIS
ETHAMBUTOL + ISONIAZID + PYRAZINAMIDE + RIFAMPICIN + STREPTOMYCIN
ETHAMBUTOL + ISONIAZID + RIFAMPICIN
ISONIAZID + PYRAZINAMIDE + RIFAMPICIN
ISONIAZID + PYRIDOXINE
ISONIAZID + RIFAMPICIN
ADENOSINE TRIPHOSPHATE + ARGININE + COENZYME A + DEXTRAN + INSULIN HUMAN BASE
ADENOSINE TRIPHOSPHATE + ARGININE + COENZYME A + DEXTRAN + INSULIN UNSPECIFIED BASE
ADENOSINE TRIPHOSPHATE + COENZYME A + INSULIN HUMAN BASE
ADENOSINE TRIPHOSPHATE + COENZYME A + INSULIN UNSPECIFIED BASE
INSULIN ASPART
INSULIN ASPART + INSULIN ASPART PROTAMINE CRYSTALLINE
INSULIN ASPART + INSULIN DEGLUDEC
INSULIN BOVINE BASE
INSULIN BOVINE ISOPHANE
INSULIN BOVINE PROTAMINE ZINC
INSULIN BOVINE ZINC SUSPENSION (COMPOUND)
INSULIN BOVINE ZINC SUSPENSION (UNSPECIFIED) + INSULIN PORCINE ZINC SUSPENSION (UNSPECIFIED)
INSULIN DEGLUDEC
INSULIN DEGLUDEC + LIRAGLUTIDE
INSULIN DETEMIR
INSULIN GLARGINE
INSULIN GLARGINE + LIXISENATIDE
INSULIN GLULISINE
INSULIN HUMAN BASE
INSULIN HUMAN BASE + INSULIN HUMAN ISOPHANE
INSULIN HUMAN ISOPHANE

INSULIN LISPRO
INSULIN LISPRO + INSULIN LISPRO PROTAMINE
INSULIN PORCINE BASE
INSULIN PORCINE BASE + INSULIN PORCINE ISOPHANE
INSULIN PORCINE BASE + INSULIN PORCINE PROTAMINE ISOPHANE
INSULIN PORCINE ISOPHANE
INSULIN UNSPECIFIED PROTAMINE ZINC
VACCINE, HUMAN PAPILLOMAVIRUS (HPV) TYPE-16 & 18
VACCINE, HUMAN PAPILLOMAVIRUS (HPV) TYPE-6,11,16 & 18
VACCINE, HUMAN PAPILLOMAVIRUS TYPE-6,11,16,18,31,33,45,52,58
VACCINE, MENINGOCOCCAL POLYSACCHARIDE AND OMV
VACCINE, MENINGOCOCCAL C CONJUGATE
VACCINE, MENINGOCOCCAL CONJUGATE

Table A.3 WHO essential medicines not available in IQVIA Analytics Link

POTASSIUM CHLORIDE
PAROMOMYCIN
ARTESUNATE AND AMODIAQUINE
SODIUM NITRITE
BARIUM SULFATE CONTAINING X-RAY CONTRAST MEDIA
CHLOROXYLENOL
BARIUM SULFATE WITHOUT SUSPENDING AGENTS
METHYLPHENOBARBITAL
HEPATITIS A, INACTIVATED, WHOLE VIRUS
ETHAMBUTOL AND ISONIAZID
RIFAMPICIN AND ISONIAZID
MELARSOPROL
METHYLTHIONINIUM CHLORIDE
CALCIUM GLUCONATE
DRUGS USED IN NICOTINE DEPENDENCE
TRICLABENDAZOLE
VAGINAL RING WITH PROGESTOGEN AND ESTROGEN
POLIOMYELITIS VACCINES
DILOXANIDE
HALOTHANE
DIPHTHERIA VACCINES
NITROUS OXIDE
PRUSSIAN BLUE
TUBERCULOSIS DIAGNOSTICS
CHLORINE CONTAINING PRODUCTS

SILVER SULFADIAZINE
BENZATHINE BENZYL PENICILLIN
TETANUS ANTITOXIN
LIDOCAINE, COMBINATIONS
PLASTIC IUD WITH COPPER
ZIDOVUDINE AND LAMIVUDINE
ARTESUNATE AND PYRONARIDINE
PENTAMIDINE ISETHIONATE
HEPATITIS VACCINES
MAGNESIUM SULFATE
DOCUSATE SODIUM
DIETHYLCARBAMAZINE
ORAL REHYDRATION SALT FORMULATIONS
SELENIUM SULFIDE
HEPATITIS B, PURIFIED ANTIGEN
SODIUM CHLORIDE
MILTEFOSINE
PLASTIC IUD WITH PROGESTOGEN
POTASSIUM IODIDE
SURAMIN SODIUM
BARIUM SULFATE WITH SUSPENDING AGENTS
ARTESUNATE AND MEFLOQUINE
NICLOSAMIDE
DICHLOROBENZYL ALCOHOL
AMODIAQUINE
PROGUANIL
RIFAPENTINE

Table A.4 covariates considered

Covariate	Transformation
DTP3 coverage proportion	Logit
Gross domestic product per capita	Natural log
Lag-distributed income per capita	Natural log
Healthcare access and quality index (HAQI)	Logit
Primary health care spending per capita	Natural log
Primary health care spending as a share of total health expenditure	Logit

Primary health care spending excluding drugs per capita	Natural log
Primary health care spending excluding drugs as a share of total health expenditure	Logit
Primary health care spending excluding prescription drugs per capita	Natural log
Primary health care spending excluding prescription drugs as a share of total health expenditure	Logit
Health spending in a hospital setting (HP1) per capita	Natural log
Health spending in a hospital setting (HP1) as a share of total health expenditure	Logit
Health spending from providers of medical goods (HP5) per capita	Natural log
Health spending from providers of medical goods (HP5) as a share of total health expenditure	Logit

Table A.5 Covariates selected for each model

Dependent variable	Covariates selected
Total prescription drug spending on essential medicines as a proportion of total prescription drug spending	Gross domestic product per capita, HAQI, primary health care spending excluding prescription drugs as a share of total health expenditure, random effects on GBD region
Prescription drug spending on essential medicines in hospitals as a fraction of total prescription drug spending in hospitals	Primary health care spending excluding prescription drugs as a share of total health expenditure, health spending from providers of medical goods (HP5) as a share of total health expenditure
Prescription drug spending on essential medicines in retail setting as a fraction of total prescription drug spending in retail setting	Primary health care spending excluding prescription drugs as a share of total health expenditure, HAQI, health spending from providers of medical goods (HP5) as a share of total health expenditure

B. Detailed methods for estimating inpatient vaginal delivery expenditures

In order to estimate spending on inpatient vaginal deliveries, we utilized a cost * volume approach. We estimated the volume and unit cost of inpatient vaginal deliveries for 195 countries from 2000-2017, and then multiplied the predicted volume and cost for each country-year. This framework is illustrated below in equation 1.

Equation 1.

$$\widehat{\text{Spending on Inpatient Vaginal Delivery}} = N \widehat{\text{Inpatient Vaginal Deliveries}} * \widehat{\text{Cost of Inpatient Vaginal Delivery}}$$

In the sections that follow, we outline (1) our methods for estimating the volume of inpatient vaginal deliveries, (2) the methods used to estimate the unit cost of inpatient vaginal deliveries, and (3) how we combined these predictions to produce our final estimates of spending on inpatient vaginal delivery.

ESTIMATING VOLUME OF INPATIENT DELIVERY

Methods

To estimate the number of inpatient vaginal deliveries for 195 countries from 2000 to 2017, we ran three models to produce complete time series of the following proportions: the proportion of all deliveries that are (1) vaginal deliveries in an inpatient setting (2) cesarean sections in an inpatient setting, and (3) either delivery type in an inpatient setting. *The second and third fractions were not directly used, but were modeled in order to give strength to the predictions of the first through a process of raking.* In order to estimate the total number of inpatient vaginal deliveries, the predicted fractions from the raked vaginal model were multiplied by the total number of births from the Global Burden of Disease study.³⁶ This calculation is presented below in equation 2.

Equation 2

$$N \widehat{\text{Inpatient Deliveries}} = \frac{N \widehat{\text{Inpatient Deliveries}}}{N \text{ Deliveries}} * \text{Total Births}$$

Sources of data

We extracted data from the following sources:

- Demographic and Health Surveys (DHS)
- Multiple Indicator Cluster Surveys (MICS)
- Online databases provided by the Organisation for Economic Co-operation and Development (OECD)
- Canadian Institute for Health Information (CIHI)
- Healthcare Cost and Utilization Project (HCUP)

Below in table B.1, we present the number of country-years of data by component that we used for each source. In the following sections, we briefly outline the differing ways in which we incorporated data from each source.

Table B.1

	Cesarean section	Inpatient Vaginal delivery	Total Inpatient delivery
--	------------------	----------------------------	--------------------------

DHS	457	457	457
MICS	126	0	0
OECD	448	0	539
CIHI	5	5	5
HCUP	7	7	7

DHS

Using the GHDx, we identified 86 DHS surveys with relevant data. For each birth year reported within each survey, we calculated the weighted proportion of all deliveries that were (1) cesarean sections in a hospital setting with a length of stay greater than 24 hours (2) vaginal deliveries in a hospital setting with a length of stay greater than 24 hours, and (3) any delivery type that took place hospital setting with a length of stay greater than 24 hours. When two surveys contained data for the same year, we dropped the data point with fewer observations. Finally, we removed all country-years of data with 140 or fewer observations. Visual inspections made clear that country years with sample sizes below this threshold were inconsistent with the rest of the data and appeared not to be representative of the broader population. This resulted in a removal of 12% of the data. However, because these data points only occurred on the ends of a survey’s time range, this did not prevent us from using any of the identified surveys.

MICS

We utilized 55 MICS surveys with relevant data within the GHDx (<http://ghdx.healthdata.org/>). Although we identified MICS data on delivery location and whether the birth was a cesarean section, we were not able to identify data on the length of stay in the birthing facility. As such, we did not feel confident that this data had the capacity to accurately represent inpatient vaginal deliveries or total inpatient deliveries, especially since some encoded delivery locations were somewhat vague (e.g. “Hospital/clinic/health center”). However, since the surgical nature of cesarean sections implies that patients remain in a health facility for at least 24 hours, we used MICS surveys to calculate, for each birth year, the weighted proportion of all deliveries that were cesarean sections in a hospital setting. Finally, to establish consistency between the treatment of MICS and DHS, we removed all country years with 140 or fewer observations. This removed 34% of the data points. However, because these data points only occurred on one end of a survey’s time range, this only prevented us from utilizing 3 of the identified surveys.

OECD

OECD databases provided 448 and 539 country-years of data on the rates of in-hospital cesarean sections and the total number of inpatient deliveries, respectively. Because these data were drawn from distinct OECD sources, we did not subtract these data to calculate the number of inpatient vaginal deliveries. Cesarean section rates were drawn directly from the OECD online database³⁰. We used OECD data on hospital discharges to calculate the rate of inpatient deliveries²⁹. Specifically, we summed the number of discharges that were assigned one of the following diagnostic related groups; “Complications

of pregnancy predominantly during labour and delivery”, “Single spontaneous delivery”, and “Other delivery.” In order to convert these sums to proportions, we divided them by the number of births from the Global Burden of Disease study. Finally, we manually outliered Norway’s total inpatient delivery data from 2011-2017, as these data represent a definitional break from the more robust, pre-2011 time series.

CIHI and HCUP

CIHI and HCUP are hospital databases from Canada and the US. Data from CIHI was downloaded directly.³² HCUP data was downloaded from the online querying system after the following selections were made: Get Quick Statistical Tables -> Inpatient -> National -> Do you want data on a specific diagnosis or procedure? : Yes -> MS-DRG -> Detailed Tables³¹. Within each database, we summed the number of cesarean sections and vaginal deliveries by year and divided by these numbers by the number of births from the Global Burden of Disease study. We then summed these proportions to calculate the proportion of all deliveries that took place in an inpatient setting.

Covariate Selection

Once we compiled data from the above sources, we split the data into the parts, corresponding to the three fractions outlined above: the proportion of all deliveries that are (1) vaginal deliveries in an inpatient setting (2) cesarean sections in an inpatient setting, and (3) any delivery type in an inpatient setting. These fractions were modeled in logit space such that the predictions for each would remain bound between 0 and 1. Each of these fractions was modeled individually, and we performed covariate selection to identify the best set of covariates for each model.

In order to select each model’s covariates, the following process was undertaken for each of the three fractional dependent variables outlined above: We first conducted a lasso regression to determine which covariates were least correlated, conditional on other covariates, with the dependent variable. Covariates with an estimated coefficient of zero were removed from the set of possible covariates. We then used linear mixed effects regression to assess all possible models based on combinations of the remaining covariates. Next, we selected the intersection of the 1000 models with the lowest Akaike information criterion (AIC) and the 1000 models with the lowest Bayesian information criterion (BIC). Finally, we completed a 10-fold cross-validation with out-of-sample predictions each of these remaining models. We selected the best model based on out-of-sample root mean squared error. Model selection considered the following covariates for inclusion in each model: Antenatal Care (4 visits) Coverage (proportion), In-Facility Delivery (proportion), Lag distributed income per capita, Skilled Birth Attendance (proportion), Total Fertility Rate, Healthcare access and quality index, Maternal Education (years per capita), and Socio-demographic Index. All covariates were drawn from the Global Burden of Disease study. Covariates bound between 0 and 1 were logit transformed, while the others were log transformed. The final selected covariates for each delivery fraction are shown below in Table B.2. Random effects were determined a priori.

Table B.2

	Selected Covariates
--	----------------------------

Cesarean section	Lag distributed income per capita, Maternal Education (years per capita), Antenatal Care (4 visits) Coverage (proportion), Skilled Birth Attendance (proportion), Socio-demographic Index, and In-Facility Delivery (proportion), with random effects at the country, region, and super region levels.
Inpatient Vaginal delivery	Lag distributed income per capita, Maternal Education (years per capita), and Socio-demographic Index, with random effects at the region, and super region levels.
Total Inpatient delivery	Skilled Birth Attendance (proportion), Healthcare access and quality index, and In-Facility Delivery (proportion), with random effects at the country, region, and super region levels.

Modeling

We modeled each of these logit-transformed delivery proportions (vaginal inpatient, cesarean inpatient, and total inpatient) using spatiotemporal Gaussian process regression (ST-GPR). ST-GPR generates a complete time-series of data for a set of locations, follows the data where it is available and borrows strength across time, geographic regions, and covariates' predictive power when data is not available. STGPR has three primary steps. First, a linear mixed effects model is run with a given set of predictors. These first-stage models are displayed above in Table B.2. Predictions from the first step provide the general trend within the data. In the second step, spatiotemporal patterns are estimated by applying a series of spatiotemporal weights to average the residuals of the first step linear model. These spatiotemporal patterns are then added to the linear predictions to generate spatiotemporally smoothed predictions. Finally, the smoothed predictions are passed as the mean function to a Gaussian process regression along with the data to produce final ST-GPR predictions. For every country-year for each model, 1,000 draws were generated from the Gaussian process regression model and used in subsequent calculations.

Raking

In order to strengthen the predictions of the volume of inpatient vaginal delivery, we raked the modeled vaginal and cesarean fractions such that they summed to the modeled inpatient delivery fraction. Raking was done at the draw level, such that the sum of draw 1 from the vaginal and cesarean proportions was forced equal draw 1 of the total inpatient delivery envelope. Draws were raked proportionally such that the original relationship between the vaginal and cesarean fractions was preserved.

Final Calculation

Once the country and year specific inpatient delivery fractions had been raked, we multiplied them by the total number of births from the Global Burden of Disease study to obtain the total number of inpatient vaginal deliveries, as illustrated in Equation 2. This multiplication was done at the draw level. Because these estimates were raked, the modeled total number of inpatient deliveries is equal to the predicted sum of the number of inpatient vaginal and cesarean deliveries.

ESTIMATING THE COST OF INPATIENT VAGINAL DELIVERY

Summary of methods

In order to estimate the cost of inpatient vaginal deliveries for 195 countries from 2000 to 2017, we conducted a literature review and extracted cost data from the existing research. Because data on the cost of inpatient vaginal deliveries was sparse, we leveraged more data on the cost of cesarean sections. Specifically, we modeled the extracted cesarean section costs to produce a complete time series, and then, using extracted data on the cost of vaginal deliveries in inpatient settings, scaled the modeled cesarean costs to estimate the cost of inpatient vaginal delivery.

Sources of data

Overall, we utilized 160 and 33 country-years of cesarean section and inpatient vaginal delivery unit costs, respectively. This data was drawn from 10 research articles and 3 databases.^{31,32,35,40-49} When aggregate volume and cost data were provided, we divided the two to estimate unit costs. When disaggregated unit costs were provided along with data weights (e.g. the cost of cesarean sections with and without complications, and the number or proportion of each), we took the weighted average of the disaggregate costs.

Currency Conversion

All final estimates are presented in 2017 United States dollars (USD). As such, it was necessary to convert all extracted cost data to 2017 USD. Data sources reported spending in either nominal local currency units (LCU) or nominal USD. To convert nominal LCU to USD, we applied deflators to nominal LCU to inflate to 2017 LCU. We then applied exchange rates to produce 2017 USD. When LCU were not reported, we extracted reported expenditure in nominal USD, applied corresponding nominal exchange rates to produce nominal LCU, inflated nominal LCU to 2017 LCU with deflators, and finally exchanged 2017 LCU to 2017 USD.

Scaling data from Gibbons et al.

Gibbons et al. (2010)⁴⁷ was our main source of cesarean section costs, especially for low- and middle-income countries. However, this research only provided the additional cost of caesarean section over and above the cost of vaginal delivery, and as such, “none of the routine costs associated with antenatal care visits were included, nor were other services that would be considered part of normal vaginal delivery” (p.6). In order to use this data in our models, it was necessary to scale the raw data. We assumed that the data from Gibbons et al. was equal to the cost of cesarean section (CS) minus the cost of vaginal delivery (VD).

In order to scale this data to the full cost of cesarean sections, we multiplied this raw data by the scalar

$\rho = \frac{CS \text{ cost}}{CS \text{ cost} - VD \text{ cost}}$, or the ratio between the full cost of cesarean sections and the additional cost of cesarean sections. We first calculated this ratio using data from sources which reported the full unit cost of both cesarean section and inpatient vaginal delivery. This calculation yielded 33 data points. We then ran a mixed effects linear regression on these 33 data points using lag-distributed income (LDI) from the Global Burden of Disease study as a covariate with random effects at

the country level. Next, we used the resulting model along with data on LDI to predict this ratio, $\hat{\rho}$, for all country-years of data for which we had extracted data from Gibbons et al. Finally, we multiplied the raw data from Gibbons et al. by these predicted ratios to scale the additional cost of cesarean sections up to the full cost. This calculation is illustrated below in Equation 3, where $\hat{\rho}$ is the predicted ratio described above.

Equation 3

$$\widehat{CS \text{ cost } Gibbons} = Gibbons \text{ raw data} * \hat{\rho}$$

After scaling, we used visual inspection to outlier the costs from Iceland and Estonia, which were unreasonably high. The remaining 121 scaled data points from Gibbons et al. were appended to the rest of the extracted data, yielding a total of 160 data points on the cost of cesarean sections, spanning 151 country years

Caesarean Cost Modeling

The methodology for modeling cesarean section costs was similar to that used in our volume models. The dependent variable in the cesarean section cost model was the natural log of the unit cost of cesarean sections. Covariates for this model were identified using the same methods as previously described for the volume models. Model selection considered the following covariates for inclusion in each model: Antenatal Care (4 visits) Coverage (proportion), In-Facility Delivery (proportion), Lag distributed income per capita, Skilled Birth Attendance (proportion), Total Fertility Rate, Healthcare access and quality index, Inpatient Unit Costs, Maternal Education (years per capita), and Socio-demographic Index. Inpatient unit costs were drawn from Moses et al. (2018)⁵⁰, and all other covariates were drawn from the Global Burden of Disease study.²⁸ Covariates bound between 0 and 1 were logit transformed, while the others were log transformed. The final selected model used the following covariates: Antenatal Care (4 visits) Coverage (proportion), Socio-demographic Index, Maternal Education (years per capita), Inpatient Unit Costs, with random effects at the country, region, and super region level. To detect and remove the influence of outlier data points, we used the selected model to measure Cooke's distance for each data point. We excluded 7 data points whose Cook's distance was greater than $4/n$, where n is the total number of data points in the model. After removing these outlier points, we ran ST-GPR on the data, using the selected model as the first stage of ST-GPR. The workings of ST-GPR are described above in the section on volume modeling. For every country-year, 1,000 draws were generated and used in subsequent calculations.

Calculating the Cost of Inpatient Vaginal Delivery

We did not identify sufficient data on the cost of inpatient vaginal deliveries to directly model these data. As such, similar to the way in which we scaled the data from Gibbons et al. (2010)⁴⁷, we used the available raw cost data to scale down the modeled cost of cesarean sections to the cost of inpatient vaginal delivery. Specifically, we calculated the ratio $\theta = \frac{VD \text{ cost}}{CS \text{ cost}}$ using data from sources which provided both cesarean and inpatient vaginal costs. This calculation yielded 33 data points. We then ran a mixed effects linear regression to predict this ratio with lag-distributed income (LDI) from the Global Burden of Disease study as a covariate and random effects at the country level. Next, we used this

model and data on LDI to predict the ratio $\hat{\theta}$ for all 195 countries from 2000 to 2017. Finally, for each country-year, we applied this ratio to scale down the draws from the caesarean section cost model to the cost of inpatient vaginal delivery. This calculation is illustrated below in Equation 4.

Equation 4

$$\widehat{VD\ cost} = \widehat{CS\ cost} * \hat{\theta}$$

TOTAL SPENDING ON INPATIENT VAGINAL DELIVERY

Calculating Total Spending

Before final calculations were done, the volume and cost models were vetted to ensure reasonable model fit using a custom Shiny app built in R. Once the best model versions were identified, the following steps were taken: The raked predictions of the number of inpatient vaginal deliveries were multiplied by the predicted costs of inpatient vaginal deliveries to yield total spending on inpatient vaginal deliveries, for each country-year. These calculations were done at the draw level to propagate uncertainty.

Adjusting the Estimates to Correspond with NHA Estimates

In order to ensure that our estimates correspond with existing estimates of inpatient spending, we compared the estimates of total inpatient delivery spending (cesarean + inpatient vaginal) to the predicted total inpatient spending from Schneider et al.²⁰ (In order to generate estimates of total inpatient spending, we multiplied the modeled cesarean volume and cost estimates produced above and summed these with the modeled inpatient vaginal delivery estimates). In order to compare to the NHA envelope, we divided the predicted spending on inpatient delivery by the predicted total inpatient spending. We identified, by visual inspection, that this proportion fell below 0.6 for almost all country years; however, in some countries, the proportion exceeded 1. As such, we applied the following correction to the estimates of delivery spending: For all country-years where the mean spending on inpatient delivery was higher than 60% of the total spending on inpatient care, we scaled down the draws of inpatient delivery spending such that (1) their new mean is 60% of all inpatient spending and (2) no delivery spending draws exceed the predicted total spending on inpatient care. This adjustment was only necessary for 5 countries: Bangladesh, Myanmar, Nepal, South Sudan, and Yemen. Finally, we proportionally raked the draws of spending on inpatient vaginal delivery and cesarean section such that they sum to this newly adjusted total. This yielded the final estimates of inpatient vaginal delivery spending which were used as a component of the spending on primary health care.

Aim 3

Section A. Tables of complete regression outputs for income group sub-analyses found in Figure 2 of main text

Low-Income Countries: Fixed Effects: Health Outputs

	Dependent variable:								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE	-0.356	1.490	-0.613	-4.600**	25.842***	37.829	-20.041	12.309	-2.972
	(1.026)	(1.086)	(1.439)	(1.304)	(4.371)	(15.600)	(11.131)	(6.875)	(4.286)
THE per capita (log)	0.028	0.190***	-0.025	0.036	0.473***	1.080***	0.120	0.737***	0.160
	(0.015)	(0.014)	(0.023)	(0.020)	(0.059)	(0.175)	(0.145)	(0.106)	(0.077)
LDI per capita (log)	0.287***	0.187***	0.011	0.334***	0.752***	1.158*			1.423***
	(0.028)	(0.030)	(0.048)	(0.036)	(0.114)	(0.364)			(0.148)
Fertility rate (log)	0.312***		0.029	0.146	1.260***	2.134*	1.126	0.244	1.604***
	(0.056)		(0.074)	(0.054)	(0.280)	(0.645)	(0.459)	(0.322)	(0.296)
Hospital beds per 1000 (log)		-0.510***	-0.044	-0.127	0.341	1.874	0.320	2.193***	
		(0.056)	(0.074)	(0.083)	(0.294)	(0.783)	(0.471)	(0.399)	
Education yrs. per capita (log)	0.207	-0.128	0.276*	0.319**	1.743***				-1.013*
	(0.080)	(0.075)	(0.091)	(0.086)	(0.417)				(0.296)
HIV Prevalence (log)	-0.046**	-0.032		0.140***	-0.083				-0.082
	(0.013)	(0.012)		(0.020)	(0.070)				(0.053)
Urbanicity (logit)	0.209	0.184**	-0.231		-1.394***	1.790	1.942**		2.685***
	(0.074)	(0.053)	(0.100)		(0.263)	(0.807)	(0.558)		(0.350)
OOP as a share of THE (logit)	0.016		-0.037	0.044**		0.436**	-0.102	0.422***	0.003
	(0.010)		(0.016)	(0.012)		(0.114)	(0.067)	(0.075)	(0.041)
GHEs as a share of THE (logit)	-0.019	-0.010		0.028	0.112*	-0.239			
	(0.009)	(0.007)		(0.013)	(0.033)	(0.096)			
Population over 65 (logit)	0.072	-0.047		-0.095	1.359***	0.961	0.116	1.380*	0.547
	(0.034)	(0.034)		(0.051)	(0.174)	(0.560)	(0.384)	(0.402)	(0.186)
Observations	558	558	558	558	558	558	558	558	558
R ²	0.429	0.662	0.038	0.437	0.369	0.150	0.089	0.114	0.453
Adjusted R ²	0.363	0.625	-0.068	0.373	0.297	0.055	-0.009	0.021	0.392
Note:	*p<0.05; **p<0.01; ***p<0.001								

Lower-Middle Income Countries: Fixed Effects: Health Outcomes

	<i>Dependent variable:</i>						
	All-age mortality	Communicable DALYs	Non-communicable DALYs	Diabetes Prevalence	Maternal mortality	Neonatal mortality	Under-5 mortality
PHC/THE	-2.925 (1.048)	-6.658** (1.847)	-1.392 (0.495)	-1.227** (0.349)	-4.550* (1.470)	-4.320*** (0.975)	-3.892* (1.282)
THE per capita (log)	-0.023 (0.021)	-0.043 (0.032)	0.003 (0.009)	0.001 (0.006)	0.102 (0.036)	-0.039 (0.017)	-0.027 (0.020)
LDI per capita (log)	-0.041 (0.038)	-0.170 (0.062)	-0.083*** (0.014)		-0.430*** (0.048)	-0.129*** (0.028)	-0.215*** (0.028)
Fertility rate (log)	-0.061 (0.048)	-0.013 (0.096)		-0.096*** (0.020)	-0.324** (0.086)	-0.256*** (0.058)	-0.110 (0.060)
Hospital beds per 1000 (log)	-0.103 (0.040)		-0.015 (0.022)	-0.062 (0.032)	-0.181 (0.079)		0.142 (0.061)
Education yrs. per capita (log)	-0.170 (0.071)		-0.040 (0.031)	0.151*** (0.030)	0.256 (0.120)	-0.635*** (0.091)	-0.875*** (0.083)
HIV Prevalence (log)	0.058*** (0.009)	0.081*** (0.019)	-0.002 (0.004)	0.001 (0.005)	-0.018 (0.016)	-0.059*** (0.012)	-0.005 (0.012)
Urbanicity (logit)	-0.062 (0.045)	-0.164 (0.092)	-0.001 (0.024)	-0.038 (0.019)	0.017 (0.060)	-0.087 (0.055)	-0.202** (0.057)
OOP as a share of THE (logit)		0.057 (0.021)	0.007 (0.005)	0.0004 (0.005)		-0.008 (0.010)	0.022 (0.012)
GHEs as a share of THE (logit)	0.007 (0.008)	0.022 (0.017)	0.007 (0.003)	0.003 (0.003)	0.037 (0.013)	-0.003 (0.009)	
Population over 65 (logit)	0.058 (0.039)	0.126 (0.070)	0.037 (0.022)	-0.085*** (0.020)	-0.244* (0.078)	-0.195*** (0.040)	-0.054 (0.053)
Observations	846	846	846	846	846	846	846
R ²	0.103	0.146	0.153	0.162	0.273	0.264	0.389
Adjusted R ²	0.018	0.066	0.073	0.083	0.204	0.195	0.332
Note:	*p<0.05; **p<0.01; ***p<0.001						

Lower-Middle Income Countries: Fixed Effects: Health Outputs

	<i>Dependent variable:</i>								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE	0.486 (0.746)	-1.454 (1.073)	-1.737 (1.163)	1.708 (1.217)	13.403*** (3.071)	4.895 (14.763)	-17.829 (7.457)	15.894 (8.811)	10.090* (3.180)
THE per capita (log)	-0.061*** (0.012)	0.079*** (0.019)	-0.025 (0.020)	-0.058* (0.019)	0.126 (0.077)	-0.057 (0.350)	-0.043 (0.151)	0.437 (0.148)	0.325*** (0.077)
LDI per capita (log)	0.254*** (0.019)	0.317*** (0.033)	0.033 (0.026)	0.201*** (0.028)	0.501*** (0.111)	1.553 (0.545)	0.130 (0.193)	-0.314 (0.224)	
Fertility rate (log)	0.017 (0.028)	-0.582*** (0.047)	0.476*** (0.059)	0.210*** (0.044)		2.976*** (0.636)	-2.139** (0.548)	-3.825*** (0.564)	-0.935*** (0.187)
Hospital beds per 1000 (log)		0.152 (0.065)		0.038 (0.038)	-0.504 (0.185)	2.358 (1.009)			0.027 (0.218)
Education yrs. per capita (log)	0.451*** (0.048)	-0.497*** (0.086)	0.063 (0.089)	0.019 (0.061)	0.598 (0.236)		1.569 (0.568)	-0.038 (0.575)	0.668 (0.287)
HIV Prevalence (log)	0.024*** (0.005)		0.041** (0.010)	-0.046*** (0.009)		-0.679** (0.196)	0.045 (0.086)	0.108 (0.087)	-0.004 (0.053)
Urbanicity (logit)	0.086 (0.036)	-0.156 (0.053)	0.109 (0.062)	0.159* (0.050)	0.395 (0.153)			1.161** (0.324)	0.493 (0.175)
OOP as a share of THE (logit)	-0.050*** (0.007)	-0.025 (0.015)	0.004 (0.013)	-0.057*** (0.010)					0.103 (0.039)
GHEs as a share of THE (logit)	-0.003 (0.005)	-0.030 (0.010)		-0.034*** (0.008)	-0.021 (0.027)	0.489 (0.184)	0.185 (0.080)	0.197 (0.067)	0.021 (0.028)
Population over 65 (logit)	0.016 (0.024)	0.066 (0.047)	0.028 (0.048)	-0.119* (0.038)	0.787*** (0.144)	-2.383 (0.846)	-0.151 (0.308)	-0.431 (0.294)	0.276 (0.191)
Observations	846	846	846	846	846	846	846	846	846
R ²	0.545	0.425	0.174	0.261	0.212	0.103	0.130	0.184	0.159
Adjusted R ²	0.502	0.370	0.097	0.190	0.140	0.020	0.051	0.108	0.079
Note:	*p<0.05; **p<0.01; ***p<0.001								

Upper-Middle Income Countries: Fixed Effects: Health Outcomes							
	Dependent variable:						
	All-age mortality	Communicable DALYs	Non-communicable DALYs	Diabetes Prevalence	Maternal mortality	Neonatal mortality	Under-5 mortality
PHC/THE	0.847 (1.297)	-1.078 (2.074)	0.476 (0.597)	-1.453 (0.777)	-24.442*** (2.449)	-3.664 (2.014)	-2.106 (1.863)
THE per capita (log)	-0.006 (0.019)	-0.054 (0.030)	0.041*** (0.009)	-0.004 (0.009)	-0.130 (0.050)	-0.006 (0.033)	0.004 (0.031)
LDI per capita (log)	-0.178*** (0.029)	-0.281** (0.074)	-0.148*** (0.018)		-0.377*** (0.088)	-0.259*** (0.059)	-0.330*** (0.048)
Fertility rate (log)	-0.086 (0.033)	-0.352*** (0.067)	-0.083** (0.022)		-0.784*** (0.109)	-0.451*** (0.075)	-0.432*** (0.069)
Hospital beds per 1000 (log)	-0.199*** (0.037)	0.088 (0.070)	-0.171*** (0.022)		-1.179*** (0.142)	-0.339*** (0.061)	-0.197* (0.063)
Education yrs. per capita (log)	-0.621*** (0.089)	-0.821*** (0.120)	-0.300*** (0.051)	0.300*** (0.046)	-0.766** (0.213)	-0.800*** (0.189)	-1.005*** (0.178)
HIV Prevalence (log)	0.033* (0.010)	0.075* (0.023)		0.033*** (0.007)	0.044 (0.039)	-0.154*** (0.019)	-0.102*** (0.018)
Urbanicity (logit)	-0.027 (0.017)		-0.020 (0.010)	0.001 (0.006)	-0.109 (0.061)		-0.086* (0.028)
OOP as a share of THE (logit)	-0.014 (0.013)	0.025 (0.021)		-0.027* (0.008)	-0.044 (0.038)	0.015 (0.019)	
GHEs as a share of THE (logit)	0.019 (0.012)	-0.015 (0.018)		-0.004 (0.006)	0.049 (0.029)	-0.049* (0.015)	-0.028 (0.015)
Population over 65 (logit)	0.185*** (0.034)	0.145 (0.066)	0.072** (0.019)	-0.001 (0.021)	0.600*** (0.096)	-0.042 (0.065)	0.126 (0.063)
Observations	1,026	1,026	1,026	1,026	1,026	1,026	1,026
R ²	0.197	0.230	0.245	0.141	0.331	0.341	0.297
Adjusted R ²	0.126	0.162	0.180	0.068	0.272	0.282	0.235
Note:	*p<0.05; **p<0.01; ***p<0.001						

Upper-Middle Income Countries: Fixed Effects: Health Outputs									
	Dependent variable:								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE	5.003*** (0.489)	-2.646** (0.769)	-3.162 (1.087)	2.162** (0.539)	12.521** (3.496)	-18.220 (17.503)	45.795*** (6.916)	22.325* (7.051)	-2.593 (5.318)
THE per capita (log)	-0.008 (0.008)	0.131*** (0.013)	0.079** (0.022)	-0.009 (0.008)	0.327*** (0.049)	0.223 (0.293)	0.235 (0.095)	0.415*** (0.101)	0.100 (0.074)
LDI per capita (log)	0.172*** (0.017)	0.256*** (0.025)	0.010 (0.027)	0.095*** (0.016)		1.802** (0.508)			1.205*** (0.157)
Fertility rate (log)	- 0.124*** (0.015)	-0.083 (0.031)	0.047 (0.031)	0.044 (0.019)				-0.201 (0.326)	-0.780*** (0.153)
Hospital beds per 1000 (log)	0.175*** (0.018)	0.188*** (0.029)		-0.063 (0.026)	-0.293 (0.118)	-0.017 (0.677)	-0.269 (0.241)	-1.848*** (0.350)	1.361*** (0.177)
Education yrs. per capita (log)		0.831*** (0.057)	0.270** (0.071)	0.084 (0.039)		6.035*** (1.288)	-0.130 (0.491)	1.681 (0.611)	3.318*** (0.299)
HIV Prevalence (log)	-0.013 (0.005)	0.003 (0.007)	-0.013 (0.011)	- 0.028*** (0.006)	0.190*** (0.036)	1.203*** (0.151)	0.049 (0.073)		0.236*** (0.038)
Urbanicity (logit)	0.054*** (0.006)	0.113*** (0.016)	0.154*** (0.017)	-0.012 (0.010)	0.539*** (0.090)	-1.578*** (0.209)	0.319 (0.113)	0.057 (0.113)	-0.309** (0.077)
OOP as a share of THE (logit)		0.022 (0.012)	0.062*** (0.012)	-0.002 (0.005)	0.027 (0.041)	0.686* (0.210)	-0.085 (0.081)		-0.253*** (0.049)
GHEs as a share of THE (logit)	0.006 (0.005)	0.007 (0.012)	0.040** (0.011)		0.167*** (0.037)	0.633* (0.185)	-0.099 (0.069)	0.007 (0.066)	
Population over 65 (logit)	- 0.125*** (0.018)	-0.135*** (0.033)	-0.207*** (0.046)	- 0.194*** (0.023)	0.340 (0.119)	-2.844*** (0.593)	0.015 (0.262)	-0.422 (0.308)	
Observations	1,026	1,026	1,026	1,026	1,026	1,026	1,026	1,026	1,026
R ²	0.555	0.520	0.125	0.286	0.273	0.228	0.063	0.071	0.407
Adjusted R ²	0.516	0.477	0.048	0.224	0.211	0.160	-0.018	-0.009	0.355
Note:	*p<0.05; **p<0.01; ***p<0.001								

Section B. Sensitivity Analyses

To substantiate the relationships found in the main regression analyses presented in the paper, sensitivity analyses were run using a 10- year lagged fixed effects panel regression model and a mixed effects model with a Mundlak adjustment. We found very similar relationships between our variable of interest (PHC/THE) and the various health outcomes and intermediate health outputs. In brief, maternal mortality, HAQ index, ANC4 coverage, and measles vaccine coverage are found to have significant improvements in at least 1 or both these sensitivity analyses with increasing PHC/THE.

LMIC: 10-year Long Difference: Health Outcomes

	<i>Dependent variable:</i>						
	All-age mortality	Communicable DALYs	Non-communicable DALYs	Diabetes Prevalence	Maternal mortality	Neonatal mortality	Under-5 mortality
PHC/THE	1.317 (1.122)	1.091 (1.712)	0.063 (0.487)	-0.830 (0.456)	-10.629*** (2.082)	-3.607 (1.318)	-0.511 (1.431)
THE per capita (log)	-0.020 (0.017)	-0.063 (0.025)	0.026 ⁺ (0.008)	-0.005 (0.007)	-0.027 (0.034)	-0.089** (0.023)	-0.085 ⁺ (0.028)
LDI per capita (log)	-0.158*** (0.027)	-0.297*** (0.049)	-0.124*** (0.012)	-0.015 (0.009)	-0.443*** (0.051)	-0.203*** (0.035)	-0.302*** (0.035)
Fertility rate (log)	-0.035 (0.034)	-0.068 (0.055)	-0.036 (0.017)	-0.027 (0.016)	-0.389*** (0.078)	-0.343*** (0.052)	-0.179 (0.062)
Hospital beds per 1000 (log)	-0.132** (0.036)	0.071 (0.062)	-0.133*** (0.021)		-0.695*** (0.105)	-0.132 (0.069)	-0.073 (0.056)
Education yrs. per capita (log)	-0.167** (0.047)	-0.528*** (0.079)		0.180*** (0.022)	-0.206 (0.115)	-0.556*** (0.092)	-0.747*** (0.098)
HIV Prevalence (log)	0.058*** (0.007)	0.079*** (0.015)	0.004 (0.004)	0.028*** (0.004)	-0.002 (0.025)	-0.099*** (0.012)	-0.045 ⁺ (0.014)
Urbanicity (logit)	-0.091 ⁺ (0.029)	-0.156 ⁺ (0.046)	-0.033 (0.014)	-0.027 ⁺ (0.008)	-0.162 (0.065)	-0.080 (0.034)	-0.177** (0.048)
OOP as a share of THE (logit)		-0.006 (0.017)		-0.010 (0.005)	-0.038 (0.023)	-0.009 (0.012)	-0.004 (0.015)
GHEs as a share of THE (logit)	0.002 (0.008)	-0.028 (0.014)	0.006 (0.005)	0.007 (0.004)	0.001 (0.017)	-0.058*** (0.011)	-0.034 (0.012)
Population over 65 (logit)	0.116*** (0.028)	0.162** (0.043)	0.030 (0.012)	-0.055** (0.014)	0.250*** (0.060)	-0.101 (0.042)	0.064 (0.054)
Constant	-0.107*** (0.016)	-0.196*** (0.027)	-0.062*** (0.005)	0.035*** (0.006)	-0.154*** (0.036)	-0.113*** (0.025)	-0.159*** (0.027)
Observations	1,080	1,080	1,080	1,080	1,080	1,073	1,080
R2	0.165	0.230	0.156	0.126	0.238	0.300	0.226
Adjusted R2	0.157	0.222	0.149	0.118	0.230	0.292	0.218
Note:	*p<0.05; **p<0.01; ***p<0.001						

LMIC: 10-year Long Difference: Health Outputs

	Dependent variable:								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE	1.268	-1.042	-1.051	-0.334	12.756***	1.073	7.085	23.316**	-3.448
	(0.561)	(0.707)	(0.853)	(0.790)	(2.871)	(15.577)	(6.415)	(6.000)	(4.431)
THE per capita (log)	-0.007	0.139***	0.018	0.005	0.278***	1.227***	0.231	0.659***	0.181
	(0.011)	(0.013)	(0.016)	(0.013)	(0.051)	(0.250)	(0.094)	(0.102)	(0.071)
LDI per capita (log)	0.208***	0.279***	0.008	0.165***	0.430***	0.594		-0.517*	0.929***
	(0.012)	(0.022)	(0.022)	(0.017)	(0.068)	(0.379)		(0.156)	(0.110)
Fertility rate (log)	-0.081***	-0.318***	0.146***	0.075	-0.323	2.098**	-0.141	-0.866	-0.828***
	(0.020)	(0.032)	(0.036)	(0.026)	(0.111)	(0.551)	(0.297)	(0.322)	(0.137)
Hospital beds per 1000 (log)	0.070*	0.200***	0.076	-0.033	-0.161	0.486	-0.764	-1.417***	1.097***
	(0.021)	(0.037)	(0.043)	(0.025)	(0.146)	(0.632)	(0.278)	(0.331)	(0.204)
Education yrs. per capita (log)	0.466***	-0.058	0.028	0.209***	1.117***	6.991***	2.370***	2.137***	1.409***
	(0.033)	(0.055)	(0.057)	(0.040)	(0.160)	(0.867)	(0.347)	(0.409)	(0.188)
HIV Prevalence (log)	-0.003	0.027**	0.031**	0.061***	0.155***	0.275	0.014		0.088
	(0.005)	(0.007)	(0.008)	(0.007)	(0.033)	(0.149)	(0.063)		(0.035)
Urbanicity (logit)	0.100***		0.102***	0.066	0.459***	-0.169	0.722***	0.460	-0.070
	(0.017)		(0.021)	(0.024)	(0.084)	(0.408)	(0.152)	(0.196)	(0.133)
OOP as a share of THE (logit)	-0.022*	-0.017	0.010	-0.005		0.110	-0.133	0.033	-0.121
	(0.007)	(0.009)	(0.010)	(0.009)		(0.179)	(0.054)	(0.061)	(0.048)
GHEs as a share of THE (logit)	-0.009	0.0001		-0.011	0.044	-0.149		0.132	0.140**
	(0.006)	(0.009)		(0.009)	(0.024)	(0.163)		(0.054)	(0.039)
Population over 65 (logit)	-0.058***	-0.002	-0.077	0.161***	0.529***	-3.653***	0.225	-0.262	0.002
	(0.013)	(0.026)	(0.034)	(0.021)	(0.080)	(0.469)	(0.235)	(0.205)	(0.108)
Constant	-0.013	0.156***	-0.066***	0.091***	-0.147	2.319***	-0.459**	-0.393	0.037
	(0.008)	(0.014)	(0.014)	(0.011)	(0.050)	(0.250)	(0.128)	(0.134)	(0.055)
Observations	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080
R ²	0.495	0.424	0.055	0.302	0.251	0.206	0.078	0.090	0.276
Adjusted R ²	0.490	0.419	0.046	0.295	0.244	0.198	0.070	0.082	0.268
Note:	*p<0.05; **p<0.01; ***p<0.001								

LMICs: Mundlak: Health Outcomes

	<i>Dependent variable:</i>						
	All-age mortality	Communicable DALYs	Non-communicable DALYs	Diabetes Prevalence	Maternal mortality	Neonatal mortality	Under-5 mortality
PHC/THE (Country Mean)	-0.248 (0.222)	0.934 (0.411)	-0.372 (0.167)	-0.349 (0.304)	0.241 (0.559)	0.136 (0.307)	-0.034 (0.284)
PHC/THE (Dev)	1.463 (0.798)	1.590 (1.273)	0.022 (0.426)	-1.151 (0.409)	-11.310*** (1.615)	-3.526* (1.115)	-0.380 (1.168)
THE per capita (log)	-0.036* (0.011)	-0.112*** (0.019)	0.002 (0.006)	-0.003 (0.006)	-0.095** (0.024)	-0.107*** (0.016)	-0.113*** (0.019)
LDI per capita (log)	-0.161*** (0.017)	-0.396*** (0.034)	-0.140*** (0.009)	0.011 (0.007)	-0.429*** (0.035)	-0.244*** (0.026)	-0.354*** (0.027)
Fertility rate (log)	0.040 (0.025)	0.047 (0.044)	0.093*** (0.011)	-0.031 (0.012)	-0.315*** (0.063)	-0.257*** (0.040)	-0.003 (0.048)
Hospital beds per 1000 (log)	0.127*** (0.018)	0.210*** (0.034)	0.017 (0.013)		-0.386*** (0.047)	0.069 (0.026)	0.193*** (0.030)
Education yrs. per capita (log)	-0.416*** (0.022)	-1.006*** (0.042)		0.270*** (0.012)	-0.610*** (0.045)	-0.792*** (0.037)	-1.075*** (0.039)
HIV Prevalence (log)	0.041*** (0.005)	0.095*** (0.011)	-0.007 (0.003)	0.035*** (0.004)	0.017 (0.015)	-0.083*** (0.008)	-0.031** (0.009)
Urbanicity (logit)	-0.046*** (0.011)	-0.051 (0.018)	-0.058*** (0.009)	-0.030** (0.009)	-0.105** (0.026)	-0.013 (0.023)	-0.015 (0.023)
OOP as a share of THE (logit)		-0.011 (0.012)		-0.012** (0.003)	-0.044 (0.015)	0.004 (0.009)	0.014 (0.010)
GHEs as a share of THE (logit)	-0.004 (0.006)	-0.035* (0.010)	0.011* (0.004)	0.007 (0.003)	0.001 (0.012)	-0.051*** (0.008)	-0.032** (0.009)
Population over 65 (logit)	0.001 (0.019)	-0.122** (0.033)	-0.011 (0.009)	-0.032 (0.011)	-0.013 (0.046)	-0.275*** (0.028)	-0.192*** (0.037)
Constant	-2.102*** (0.176)	2.587*** (0.315)	-0.416** (0.111)	-2.944*** (0.147)	10.216*** (0.401)	1.267*** (0.284)	-0.271 (0.316)
Observations	2,430	2,430	2,430	2,430	2,430	2,414	2,430
R ²	0.587	0.763	0.508	0.566	0.462	0.722	0.769
Adjusted R ²	0.585	0.762	0.506	0.564	0.459	0.720	0.768
Note:	*p<0.05; **p<0.01; ***p<0.001						

LMICs: Mundlak: Health Outputs

	Dependent variable:								
	HAQ Index	Health worker Density	Smoking Prevalence	UHC index	ANC4 coverage	ART Coverage	DTP3 coverage	Measles Vaccine Coverage	SBA coverage
PHC/THE (Country Mean)	0.255	0.433	-2.700**	0.447	1.336	5.612	1.623	1.574	1.649
	(0.178)	(0.405)	(0.727)	(0.178)	(1.089)	(2.125)	(1.200)	(0.896)	(1.007)
PHC/THE (Dev)	1.969***	-1.760*	-0.598	-0.523	12.509***	18.335	9.136	20.557***	0.356
	(0.412)	(0.587)	(0.638)	(0.627)	(2.123)	(13.108)	(5.135)	(4.868)	(3.269)
THE per capita (log)	0.004	0.158***	0.018	0.015	0.218***	1.256***	0.170	0.470***	0.191***
	(0.007)	(0.011)	(0.012)	(0.009)	(0.034)	(0.194)	(0.063)	(0.067)	(0.047)
LDI per capita (log)	0.194***	0.319***	0.007	0.185***	0.435***	0.797*		-0.363**	0.768***
	(0.009)	(0.017)	(0.017)	(0.013)	(0.047)	(0.239)		(0.095)	(0.064)
Fertility rate (log)	-0.107***	-0.342***	0.146***	0.013	-0.309**	-0.447	-0.576	-1.148***	-0.778***
	(0.016)	(0.027)	(0.029)	(0.019)	(0.079)	(0.410)	(0.208)	(0.211)	(0.094)
Hospital beds per 1000 (log)	0.019	0.028	0.194***	0.147***	0.010	-4.453***	-0.059	-0.132	0.445***
	(0.014)	(0.026)	(0.033)	(0.015)	(0.065)	(0.222)	(0.107)	(0.099)	(0.077)
Education yrs. per capita (log)	0.418***	0.395***	-0.127***	0.403***	0.838***	8.698***	0.819***	0.715***	1.444***
	(0.019)	(0.025)	(0.031)	(0.021)	(0.078)	(0.350)	(0.148)	(0.152)	(0.099)
HIV Prevalence (log)	-0.018***	0.057***	0.007	0.038***	0.111***	0.644***	-0.082		0.072*
	(0.004)	(0.006)	(0.006)	(0.004)	(0.021)	(0.068)	(0.030)		(0.022)
Urbanicity (logit)	0.059**		0.033	0.032***	0.070	0.021	0.110	0.067	0.051
	(0.007)		(0.018)	(0.007)	(0.042)	(0.124)	(0.060)	(0.063)	(0.062)
OOP as a share of THE (logit)	-0.021***	-0.018	0.012	0.024***		-0.539***	-0.158***	-0.043	-0.095*
	(0.005)	(0.007)	(0.008)	(0.006)		(0.129)	(0.037)	(0.041)	(0.029)
GHEs as a share of THE (logit)	-0.011	-0.001		-0.012	0.038	-0.505***		0.106	0.134***
	(0.004)	(0.006)		(0.006)	(0.016)	(0.123)		(0.038)	(0.025)
Population over 65 (logit)	-0.037*	0.125***	-0.096**	0.061***	0.467***	-0.414	-0.046	-0.334	0.107
	(0.011)	(0.020)	(0.027)	(0.015)	(0.054)	(0.308)	(0.153)	(0.145)	(0.072)
Constant	1.165***	0.378	-2.317***	3.647***	-3.205***	-28.917***	-1.164	0.982	-6.908***
	(0.107)	(0.234)	(0.339)	(0.139)	(0.673)	(2.182)	(0.985)	(0.974)	(0.729)
Observations	2,430	2,430	2,430	2,430	2,430	2,430	2,430	2,430	2,430
R ²	0.836	0.864	0.164	0.678	0.613	0.612	0.151	0.161	0.688
Adjusted R ²	0.835	0.863	0.160	0.677	0.611	0.610	0.147	0.157	0.686
Note:	*p<0.05; **p<0.01; ***p<0.001								