

**Understanding the role of the health workforce in driving health spending: trends across  
OECD countries and implications for the US**

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**Abstract**

Understanding the role of the health workforce in driving health spending: trends across OECD countries and implications for the US

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Given its high levels of health spending but lacking proportionately better health outcomes, the US has focused much policy attention on improving health spending efficiency and reducing health spending overall. One factor potentially related to health spending that would be both affected by decreases in spending and a potential driver of health spending per capita itself is the health workforce. Using regression and decomposition analyses, we estimated the magnitude and significance of the total health spending per capita and total health workforce density relationship across OECD countries and what share of the variance in health spending can be explained by variation in the health workforce. We used an expanded health workforce definition that included both front-line caregivers and background health care workers. Our findings suggest that there is a strong relationship between health spending and the health workforce and that further research is needed to pursue the potential for health spending changes to affect the health workforce.

## **Background**

Health spending has been increasing steadily across all developed countries over the last several decades (1). The United States in particular has come under close scrutiny for its health spending increases; not only has total US health spending also been increasing, but the US also spends more per capita on health than any other country in the world (1). Yet this scrutiny over US health spending is not simply due to a desire to cut costs. Rather, much focus has been placed on the disconnect between US health spending and US health outcomes. Indeed, the US spends on the most on health per capita but ranks 29th in the world in terms of health care access and quality (2). These shortcomings of the US health care system in combination with its high levels of spending have therefore become significant policy priorities with legislators and politicians across the aisle calling for reductions in health spending.

Understanding where to reduce per capita health spending is critical to this task. Studies have identified several potential drivers of health spending in the US that have then been further researched as targets for change. Much of the policy focus has been on reining in demand-side spending drivers, from individual risk factors (e.g., obesity) and population growth and aging to inefficiencies and waste (1,3–6). Consideration of supply-side drivers has remained largely focused on specific factors such as high prices for technology and pharmaceuticals (3,5,7–10). Little attention has been paid to health workforce costs as a supply-side driver, as few policymakers would look to reduce employment and contract the job market or reduce salaries.

Yet if policies are put in place that begin to effectively reduce demand-side spending drivers, what will the consequences for supply-side health spending drivers be? While the reduction in technology and pharmaceutical costs may be acceptable, job loss in the health care sector likely would not be when so much attention is paid to increasing employment. Establishing the strength of the relationship between the health workforce and health spending is therefore beneficial to understanding whether unintended consequences may arise from reducing health spending in other areas.

Existing studies have been inconclusive, with some finding that the relationship between physician, nurse, pharmacist, or administrator densities and health spending is not significant while others suggest that these densities are strong potential drivers of health spending (3,11–18). All of these studies, however, suffer from narrow health workforce definitions. The majority of research has focused on front-line caregivers, such as physicians, nurses, and pharmacists, at the expense of excluding all ‘background’ health care workers employed by the health care sector. Of research that has been done on background health care workers, all have limited their analyses to administrators, thus excluding other types of background workers in addition to excluding front-line caregivers.

The relationship between the health workforce and health spending per capita therefore cannot be satisfactorily extrapolated from existing research. Health care costs are neither solely derived from front-line caregivers nor from background health care workers, such as administrators, managers, and medical scribes. Costs associated with both portions of the workforce are bundled together into total health care costs (11). Research using only one aspect of the workforce therefore excludes an important potential factor in health spending, as

a country may have an average number of front-line caregivers but an above-average number of background health care workers or vice versa.

Previous analytical studies have also been limited in their attempts to control for country health status when analyzing the association between health spending and the health workforce. Country health can affect both health spending and health workforce density as countries spend more on diagnoses and treatments and as hospitals and medical establishments hire more health care workers to take on the additional load. Existing statistical analyses, however, have often included population demographics but have stopped short of controlling for direct measures of morbidity (15,16,19).

The effect of the total health workforce – including front-line and background health care workers – on total health spending per capita across countries has not previously been studied. We expect that the relationship between workforce and spending will change with the inclusion of background care workers and more accurately reflect the costs that the workforce contributes to health spending. We also expect that including more direct measures of country health will allow us to more comprehensively control for this important confounder.

While our study only analyzes health workforce density, salaries for each type of employee in the health workforce are clearly an important factor when considering the relationship between the health workforce and health spending especially as front-line caregiver salaries have increased slightly in the US over time (18,20). Due to the dearth of salary information for background health care workers, however, we focused on health workforce density so that we would be able to retain our broader health workforce definition.

In our analysis, we aimed to evaluate the role of the health workforce in driving health spending per capita with an innovative approach, using a broad measure of the health workforce and several measures of country morbidities. In doing so, we looked to establish whether the health workforce has a strong enough economic relationship to health spending to suggest that policies to reduce health spending, even in other areas, need to be considering consequences for the workforce. We estimated the magnitude and significance of the relationship between total health spending and health workforce density across multiple developed countries to answer this question and estimated what share of the variance in health spending can be explained by variation in the health workforce.

### **Study Data and Methods**

*Data.* For this analysis we focused on countries belonging to the Organisation for Economic Co-operation and Development (OECD) that had health workforce data available from the International Labour Organization (ILO) for any years between 1995 and 2015. Thirty-two countries were therefore included in the analysis. Of the 36 countries in the OECD, the excluded countries were: Lithuania, Mexico, New Zealand, and Turkey; all were excluded due to lack of workforce data. Fourteen of the 32 included countries had complete time series from 1995 to 2015, and 12 countries were missing between 1 and 5 years of data.

As noted, we used estimates from the ILO for total health workforce, which we converted into workforce density per 1,000 population. The total health workforce values from the ILO include all occupations across a single employment activity, 'human health and social work activities.' While the value for total health workforce was in excess of the sum of the sub-

categories, some of the sub-categories included were managers, professionals, technicians and associate professionals, clerical support workers, and services and sales workers.

Our data for total health spending per capita came from the Institute for Health Metrics and Evaluation, which we converted from 2017 purchasing power parity dollars to 2017 US dollars. These total health spending values include government spending, pre-paid private spending, out-of-pocket spending, and, where applicable, development assistance for health.

We included in our analysis gross domestic product (GDP) per capita to account for country wealth. Data for GDP per capita came from IHME. We also controlled for country health because how sick a country's population will be associated with their health spending. Our selection of country health indicators was selected based on leading causes of morbidity and mortality in high-income countries, which were subset by selecting health measures most likely to affect health spending without being affected by health spending in return (7,11,21). These include percent of the population above the age of 65, diabetes prevalence, Alzheimer's prevalence, lung cancer prevalence, obesity prevalence, and depression prevalence. All country health indicator data was from IHME.

*Analyses.* To answer our research question, we conducted regression analyses using three separate models and two approaches to our third model. Our models used total health spending per capita as our outcome variable and our primary independent variable of interest was health workforce density per 1,000 population. We ran several collinearity tests to establish that none of our included variables were collinear enough to warrant exclusion.

We used a linear within-between model to take advantage of the flexibility of a random effects model and the less biased fixed effects estimation. To do so, we country-demean the

individual observations by subtracting the country mean – the between effect – from each individual observation. Both means and demeaned variables are included in the regression equation, with the mean coefficients reflecting between-country effects and the demeaned coefficients remaining equivalent to within-country effects (22).

With our first model we regressed total health spending per capita on health workforce density per 1,000 population to establish the baseline relationship with no additional explanatory variables. We specified our second model using backwards variable selection at the 0.1 significance level. Our second model builds off of our first model but includes GDP per capita as well as several measures of country health: percent of the population over the age of 65, diabetes incidence, and Alzheimer's prevalence. We specified our third model using Bayesian Model Averaging to establish which variables are most likely to be important. Our third model also builds off of our first model and includes GDP per capita and several country health measures: percent of the population over the age of 65, Alzheimer's prevalence, obesity prevalence, lung cancer incidence, and chronic obstructive pulmonary disease (COPD) incidence.

We also used a Shapley-Owen decomposition analysis of the  $R^2$  of third model results to establish what share of the variance can be explained by variation in the health workforce. We decomposed the  $R^2$  into partial  $R^2$  values for each variable, with each partial  $R^2$  representing the relative importance of each variable.

Sensitivity analyses. We performed sensitivity analyses to confirm our findings. First, we used multiple imputation of our health workforce density variable to produce a fully complete time-series between 1995-2015 for all 32 countries. To inform the imputation, we included all

variables used in our models in addition to three health workforce variables produced by IHME for physician density, nurse and midwife density, and pharmacist density. We re-ran our three models using the imputed data to compare results. The purpose of this analysis was to establish whether data missingness was driving the total health spending and health workforce density relationship.

We also performed an analysis excluding all data points flagged as potentially unreliable in the ILO health workforce density dataset. We then re-ran the original analyses on the subset data and compared results. The purpose of this analysis was to establish whether a subset of higher quality data would alter the association between total health spending and health workforce density.

Finally, we performed a regression analysis including all country health variables that were not originally included in our models due to the results of our backwards elimination and Bayesian Model Averaging variable selection. The purpose of this analysis was to establish whether the inclusion of different health variables may change the relationship between the health workforce and health spending.

*Limitations.* Our study had several limitations. First, the data quality for the ILO health workforce density variable is poor for many estimates. The ILO uses labor force and household surveys as well as population censuses but flags a large proportion of the data points as being potentially unreliable or has having a break in methodology. We attempted to account for this by running a sensitivity analysis with only data points not flagged as unreliable to assess the effect of data quality on our results.

Second, the data completeness for the ILO health workforce density data was limited. As previously discussed, only 14 of 32 countries had full time series'. We attempted to account for this limitation by multiply imputing the health workforce density variable in order to assess whether the missingness was not at random and was driving the workforce-spending relationship.

Third, the data from IHME, though complete across all country-years, introduces its own limitations. The total health spending data estimated by IHME, for example, uses unreliable underlying data based on a single series with only one data point per country, as opposed to collecting data from multiple sources. We were also limited by any limitations of IHME's Global Burden of Disease estimations, again including reliance on the quality and quantity of the data sources available to inform the estimates.

Fourth, our health workforce density definition was limited by what we could download from the ILO. The available data was not disaggregated at the most granular level; the economic activity granularity went only down to "human health and social work activities," necessitating that we include social work workforce individuals in our total health workforce aggregate. However, some social workers could be considered as part of the health workforce as they work in hospitals and other healthcare settings. Additionally, we were not able to expand our health workforce definition to health insurance companies, as they were aggregated with other insurance employment categories and thus we would have vastly overestimated their numbers had we included all insurance workers.

Fifth, we were limited in our ability to define and control for country health. The causal direction of country health and health spending is impossible to fully dissociate and thus some

circularity will always remain. For example, while increased health spending may not reduce Alzheimer's prevalence through prevention or cures, increased health spending could lead to more diagnoses of Alzheimer's and thus appear to increase Alzheimer's prevalence. We were also not able to include several leading causes of morbidity and mortality that are impacted by increased health spending.

Finally, we were unable to find satisfactory salary data to include in the analysis. Excluding salary data limits our ability to generalize our results as we do not control for the potential that health spending is driven in part by health workers being paid varying salaries across countries. Additionally, we were not able to include provider-patient care intensity such as how many patients a provider treats in a day, a measure that relates to supply and demand and thus could affect health worker densities.

All analyses were performed using either Stata or R.

## **Study Results**

The total number of country-years in our dataset was 562. In 2015, total health spending per capita in US dollars ranged from \$800 in Poland to \$9,839 in the United States. Annualized rates of change in total health spending between 1995-2015 ranged from 1.4 in Israel to 7.4 in South Korea. Just as total health spending differs widely across countries, there is a substantial range of health workforce density across countries. In 2015, health workforce density ranged from 19.6 per 1,000 in Greece to 100.4 per 1,000 in Norway. In the United States specifically, the workforce density has increased from 53.8 per 1,000 in 2000 to 64.2 in 2015.

Both total health spending per capita and health workforce density have increased over time, though total health spending has experienced larger absolute increases (Figure 1). Cross-sectionally, total health spending and health workforce density have a high correlation, with a correlation coefficient of 0.72 in 2015 and a correlation of 0.72 over all years (Figure 2).

In our first within-countries estimation regression model, using only total health spending and health workforce density, we found that there was a significant association between the two variables and approximately a one-to-one relationship. For every one percent increase in health workforce density, there is a 1.02 percent increase in total health spending per capita (Table 1).

We found a smaller yet persistent effect in our second model, with a 0.21 percent increase in total health spending per capita for each one percent increase in the health workforce (Table 1). The association, however, remained statistically significant. This finding reflects the large effect country wealth and population age structure – particularly aging – have on health spending, as they soak up much of the reduction in health workforce effect size.

We found that the results of our third model's within-countries estimation results were not substantively different from those of our second model (Table 1). The effect size of health workforce density on total health spending per capita was statistically significant at 0.26, and GDP per capita and percent of the population over the age of 65 remained significant. With regards to disease prevalence, only obesity prevalence was statistically significant but its effect size was nearly four times as large as that of GDP per capita at 2.31 – for every one percent increase in obesity prevalence, there was an associated 2.31 percent increase in health spending in our within-countries estimation.

For the between-countries estimation of our third model, we found the association between total health spending and health workforce density remained significant. In contrast to the second and third models' estimates, the effect size was 0.45, over fifty percent larger than the within-countries effect. GDP per capita, percent of the population over age 65, and Alzheimer's prevalence were also statistically significant while obesity prevalence lost its statistical significance.

We used a Shapley-Owen decomposition analysis of our third model's total  $R^2$  of 0.93 to decompose the variation in health care spending (Table 2). The largest share of the variance in total health spending can be explained by GDP per capita, with 51 percent or a partial  $R^2$  of 0.51. The second largest share, however, can be explained by the health workforce density, with 31 percent of the  $R^2$  or a partial  $R^2$  of 0.31. Alzheimer's prevalence explains 11 percent of the variance while all other country health variables provide negligible explanatory power.

For our sensitivity analyses, we found that the significance and effect size of the relationship between total health spending and health workforce density were similar across regression models, both for within-countries and between-countries estimations. The expansion of the dataset through multiple imputation of our workforce density variable and the contraction of the dataset by removing all country-years where the ILO flagged the workforce data as "unreliable" both produced results very similar to our third model. Finally, the inclusion of all country health variables that had been initially considered – which included musculoskeletal disorder prevalence, ischemic heart disease prevalence, and stroke incidence – did not significantly change the effect size of the health workforce and the health workforce effect remained statistically significant.

## **Discussion**

The consequences of effective health spending reduction policies are unlikely to be limited to the policy target and spending alone; any factors related to health spending will also be affected. Given the size of the health workforce in the US and the political desire to increase employment and expand the labor force, knowing whether the health workforce has a strong relationship with health spending is critical for informing the workforce-related impact of health spending policies (23).

Existing studies have found that various parts of the health workforce may have a relationship with health spending, but they have used narrow definitions of the workforce – including only front-line caregivers such as physicians and nurses or, when analyzing background health care employees, have focused solely on administrative workers (3,11–14). As such, these results fall short of fully specifying the workforce-spending association and do not necessarily reflect the complete relationship. Our definition of the workforce was therefore greatly expanded to encompass managers, technicians, service workers, elementary occupation workers, and others, in addition to the front-line professionals and administrative employees.

Using this expanded health workforce definition, our primary findings are that there is a significant and substantial relationship between the health workforce and health spending both across and within countries. These results were obtained using regression models that controlled for both country wealth and country health variables, with varying country health variables included in each model. That the statistical significance of the workforce variable

remains across all models suggests a certain amount of robustness in the workforce-spending relationship can be expected.

Our results also find that health workforce explains 31 percent of the variation in health spending between countries, second behind GDP per capita and far ahead of the nearest country health variable. This result further supports the finding that there is a substantial relationship between the health workforce and health spending, though the country health variable suffers from incompleteness in terms of covering all possible health drivers and as such we may have seen a larger country health effect with an expanded country health variable which could subsume some of the health workforce effect.

The immediate implication of our results is that health spending and the health workforce are intimately related both within and between countries. Currently, much of the policy discussions in the US surrounding health spending focus on the need to reduce health spending and halt health spending increases often deemed unsustainable (24). Given the likely repercussions of cutting job growth, reducing spending by reducing the health workforce is untenable and as such, the health workforce rarely becomes part of the health spending discussion. As our results find, however, this is a potentially misplaced approach, because a change in health spending may be accompanied by changes in the health workforce. Importantly, a large trade-off to our broadened definition of the health workforce is a loss of granularity for establishing where policy decisions should be made; future studies should therefore aim to include both broad definitions and specific professions.

Of course, health workforce density is only part of the equation – health workforce salary is another. How the health workforce and patient outcomes would be affected, through

loss of jobs or decreased salaries, can therefore not be ascertained with this analysis, though the importance of GDP per capita – which inherently subsumes salaries – suggests there may be a significant relationship. Further research is needed to tease apart the effects of density versus salary, though researchers must be careful to include salaries of both front-line caregivers and background health care workers, just as densities of both types of workers must be considered together. There is limited salary data currently available, even among OECD countries, so more comprehensive data must first be produced and obtained. Only then can the full relationship between health workforce and health spending be specified.

## **Conclusion**

Our findings suggest that health spending in the US does not exist in a vacuum and that factors related to health spending such as the health workforce should be considered when examining policies that might constrain health spending growth. While future research is required to evaluate the spending-workforce relationship further, particularly with a focus on including broad health workforce definitions and profession-specific data as well as salary data, our results point to the potential for spending changes to affect the health workforce. Indeed, the relationship between health spending and health workforce density was substantial and is unlikely to be fully explained away even with the inclusion of additional health spending drivers.

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Health workforce spending over time, by workforce density, 1995–2015

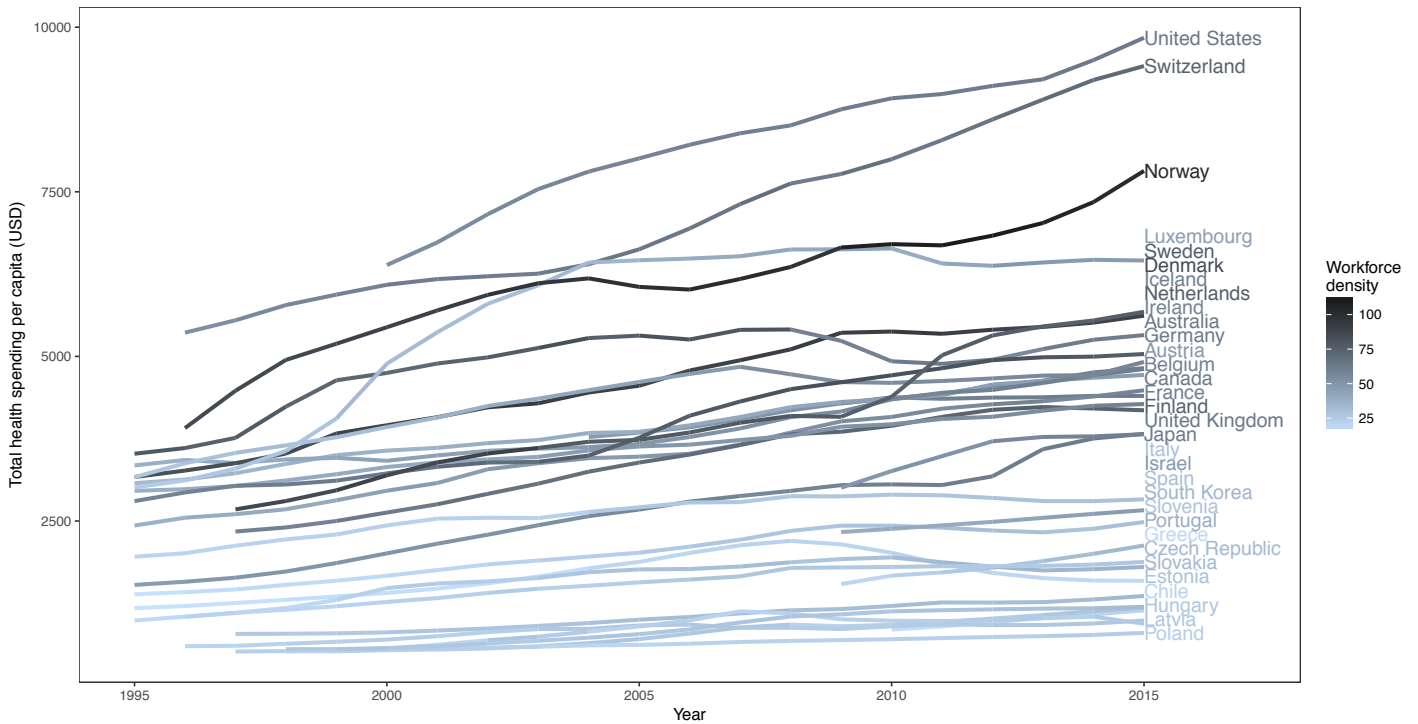


Figure 1. Total health spending per capita (USD) across time, by health workforce density (per 1,000), 1995-2015.

Health workforce against health spending in 2015,  $r = 0.87$

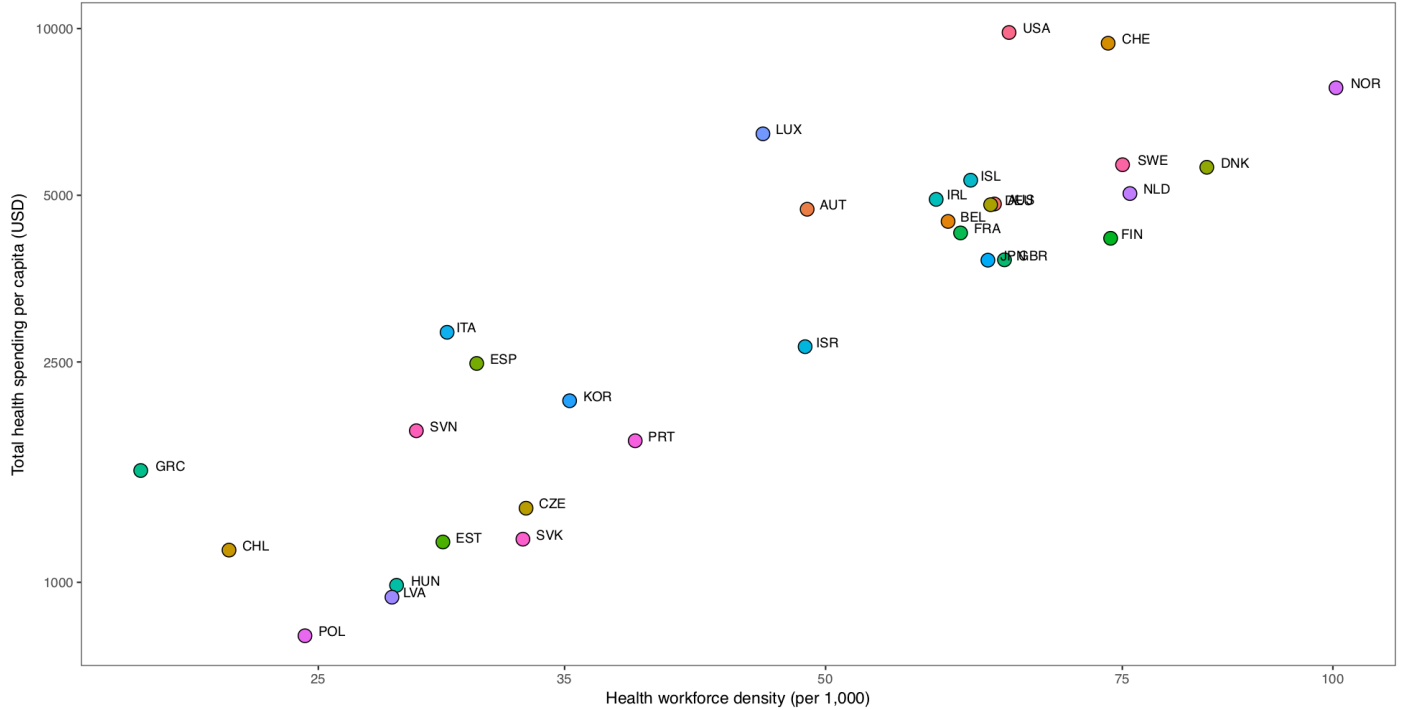


Figure 2. Total health workforce density (per 1,000) against total health spending per capita (USD) in 2015.

Table 1. Estimated effects of selected variables on total health spending per capita (USD).

	Model 1 (within countries)	Model 2 (within countries)	Model 3 (within countries)	Model 3 (between countries)
Health workforce density	1.02*** (0.78-1.27)	0.21* (0.03-0.46)	0.26* (0.03-0.49)	0.45*** (0.25-0.66)
GDP per capita		0.89*** (0.62-1.17)	0.81*** (0.50-1.12)	1.27*** (0.88-1.67)
Percent of population over 65		0.59*** (0.16-1.03)	0.61** (0.19-1.03)	-0.46* (-0.91--0.03)
Diabetes prevalence		-0.38 (-1.05-0.31)	-0.40 (-0.97-0.17)	-0.20 (-0.52-0.11)
Alzheimer's prevalence		-0.38 (-0.86-0.09)	-0.31 (-0.80-0.17)	0.60** (0.21-1.00)
Lung cancer prevalence		0.49*** (0.22-0.75)		
Obesity prevalence			2.31* (0.01-4.60)	1.53 (-0.25-3.31)
Depression prevalence			-0.60 (-1.62-0.42)	0.22 (-0.16-0.60)
No. of observations	562	562	562	562

Table 2. Shapley decomposition analysis of R<sup>2</sup> of Model 3 (between countries).

Variable	Partial R-squared
Health workforce density	0.31
GDP per capita	0.51
Percent of population over 65	0.02
Alzheimer's prevalence	0.11
Obesity prevalence	0.004
Depression prevalence	0.03
Diabetes prevalence	0.007