FINDINGS: HEALTH CARE'S GLOBAL CLIMATE FOOTPRINT

This paper contributes to a growing body of evidence documenting the extent and nature of health care's climate footprint. Six key conclusions can be drawn from this study.

1. Health care is a major contributor to the climate crisis

Health care, a sector whose mission is to "first, do no harm" and to heal, has a significant climate footprint and makes a major contribution to the climate crisis, which is quickly evolving into a global health emergency. A growing number of national and international studies confirm and shed light on this finding.

This study, the only comprehensive global analysis to date, finds that the global health care sector had a climate footprint of 2.0GtCO_2e in 2014, equivalent to 4.4% of global net emissions.

If health care were a country, it would be the fifth-largest emitter on the planet. Health care's climate footprint is smaller than that of China, the United States, India, and Russia but larger than Japan's and Brazil's.

The global health care climate footprint is equivalent to the greenhouse gas emissions from 514 coal-fired power plants.[24]

The highest contributions to the global health care climate footprint come from the United States (546 million metric tons of CO_2e), China (342 MtCO_2e), and the European Union (248 MtCO_2e). (See Appendix A for a ranking of the 43 countries, plus the EU.)

Health care emissions make up a varying percentage of each country's climate footprint. They range from highs in the United States (7.6%), Switzerland (6.7%) and Japan (6.4%) to lows in India (1.5%) and Indonesia (1.9%). Data was not available for many low- and middle-income countries. Most of the 43 countries in the study fall close to the world average of 4.4% (Figure 7).

2. More than half of health care's footprint comes from energy use

Emissions emanating directly from health care facilities (Scope 1) make up 17% of the sector's worldwide footprint. Indirect emissions from purchased electricity, steam, cooling and heating (Scope 2) comprise another 12%. And the lion's share of emissions — 71% — come from what is known as Scope 3, and are primarily derived from the health care supply chain — the production, transport, use, and disposal of goods and services that the sector consumes.

When viewed across all three scopes, more than half of the health sector's footprint is attributable to energy use, primarily consumption of electricity, gas, steam and air conditioning supply combined with health sector operational emissions.

Other significant activities that contribute to health care's footprint include: agriculture (9% including catering at health facilities, growing cotton for surgical gowns, etc.), pharmaceuticals[b,21] and chemicals (not including the energy used to produce them, 5%), transport (7%), and waste treatment (3%). In addition, a limited estimate covering only 31 countries shows that an additional nearly 1% of health care's global climate footprint or nearly four million metric tons of health care emissions come from the sector's use of anesthetic gases (0.6%) and metered dose inhalers (0.3%). (See: Metered Dose Inhalers on page 17 and Anesthetic Gases on page 31)

b. Other studies in this field have found the contribution of pharmaceuticals to be greater that our stated result here. This is a result of different reporting practice. We present the emissions from the manufacturing of pharmaceuticals and chemicals, whereas previous reporting give the full embodied emissions in the pharmaceutical products purchased by health care. Primarily, these numbers differ since emissions from energy used in the supply chain are captured in the results when reporting full embodied emissions.

FINDINGS: HEALTH CARE'S GLOBAL CLIMATE FOOTPRINT

Global footprint by GHGP categories

Figure 5 shows the global health care footprint split according to GHGP Scopes. Results were mapped to these categories as described in Figure 3.

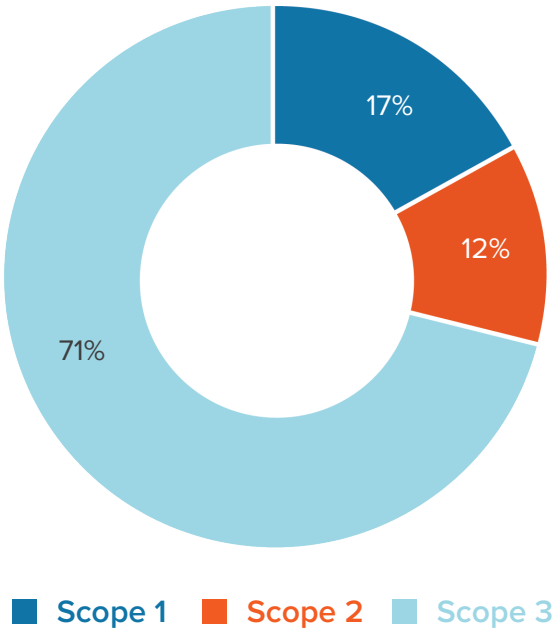


Figure 5: Global health care footprint split by GHGP Scopes

Climate footprint by WIOD emissions sources

Figure 6 shows the global health care footprint traced back to the original emissions sectors; given in WIOD categories and the groupings detailed in Appendix B.

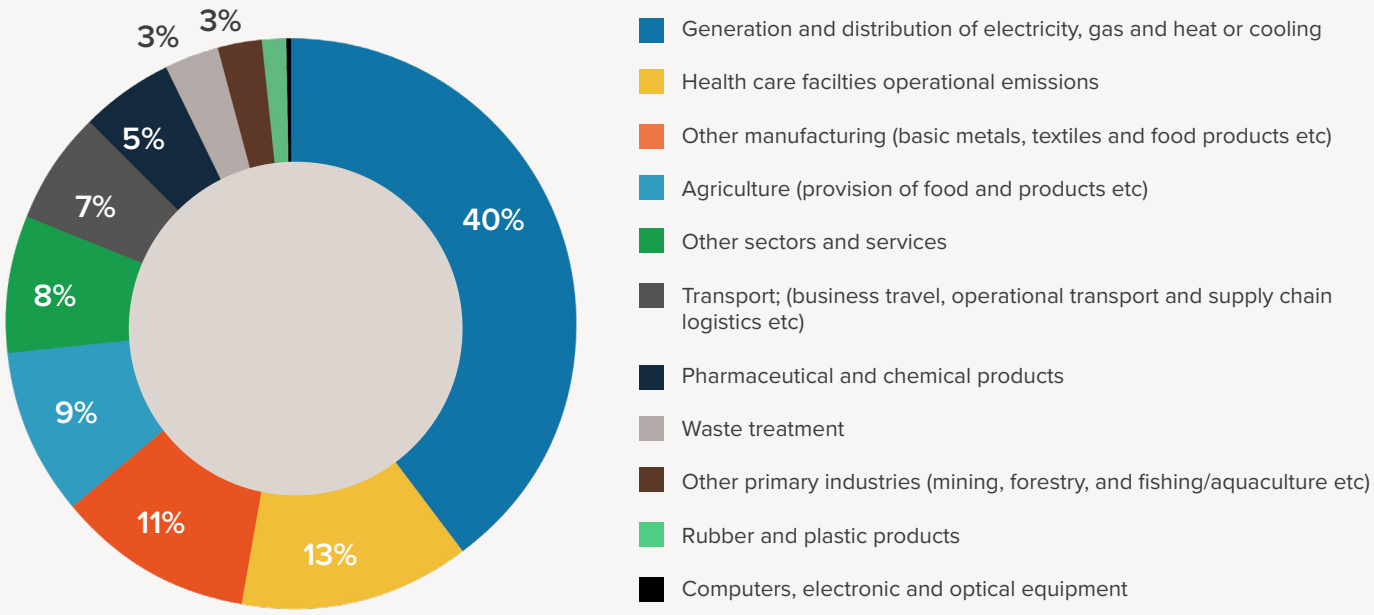


Figure 6: Global health care emissions split by production sector. Definitions of categories used in the legend are provided in Appendix B. [c,25]

c. This breakdown differs to sector splits reported in previous work in this area (such as by the NHS in the United Kingdom). These studies attributed supply chain emissions to sectors providing goods and services directly to the health care sector, whereas in this study, emissions are traced through the supply chain to the original emitter.

Relationship of GHGP categories to WIOD emissions sources

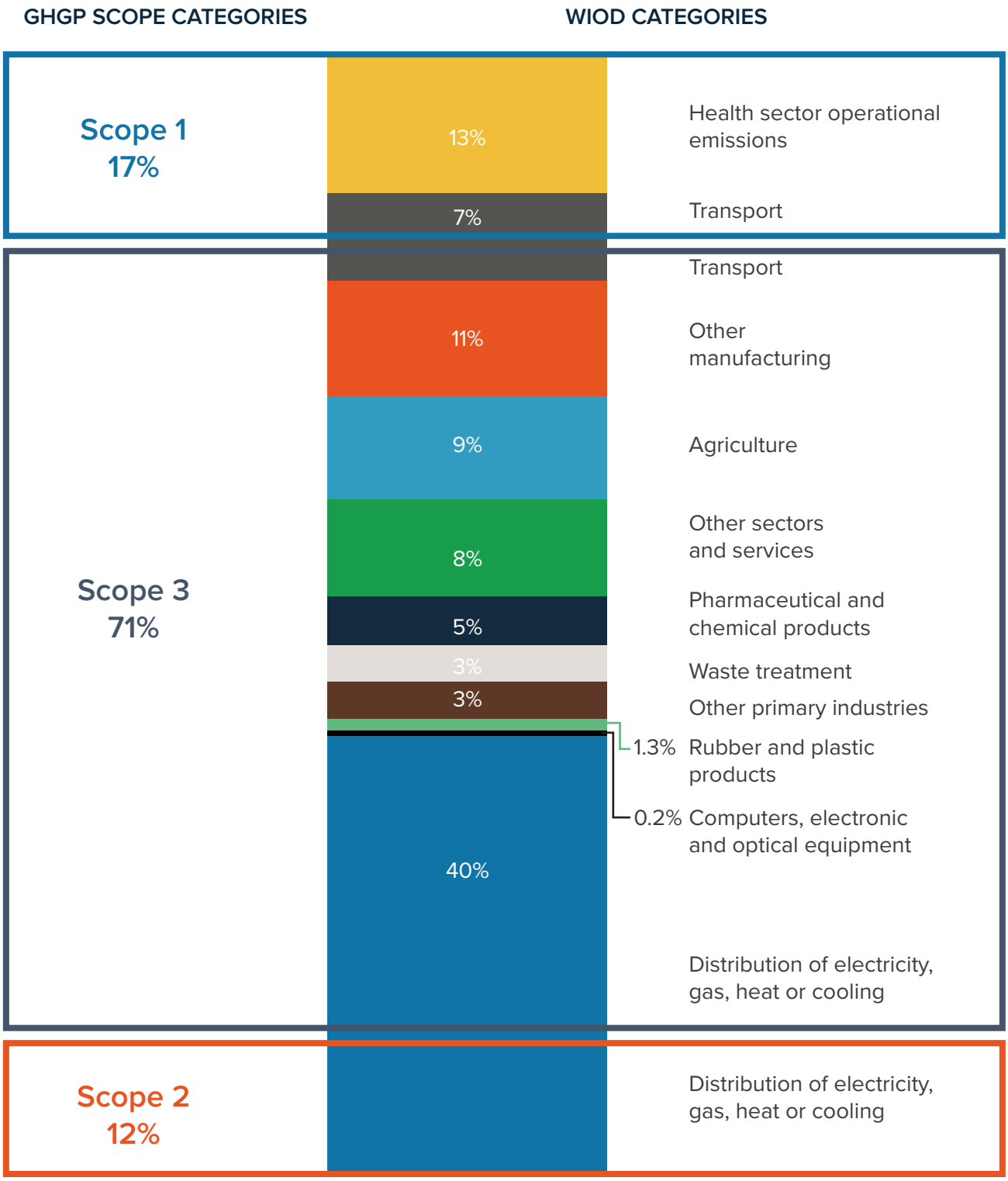


Figure 6a shows the proportion of WIOD emissions sources attributable to GHGP Scopes 1, 2 and 3.

3. Health care's climate footprint generally reflects overall national emissions patterns

It should come as no surprise that the world's biggest climate polluters also host the world's health sectors with the biggest climate footprints. At the same time, those countries with high overall per capita emissions, find that reality reflected in their health sectors as well.

Absolute emissions

The United States, China, and the European Union are the top three contributors to health care's climate footprint. They also rank as the top three in the world in overall emissions.[31]

When taken together the top ten health care carbon emitters (including the European Union as a single emitter) comprise 75% of health care's total global emissions.

It is interesting to note that while China is the number one absolute greenhouse gas emitter in the world today, this study finds that the United States far surpasses it in terms of absolute health care emissions (US = 546 Mt; China = 342 Mt).[d]

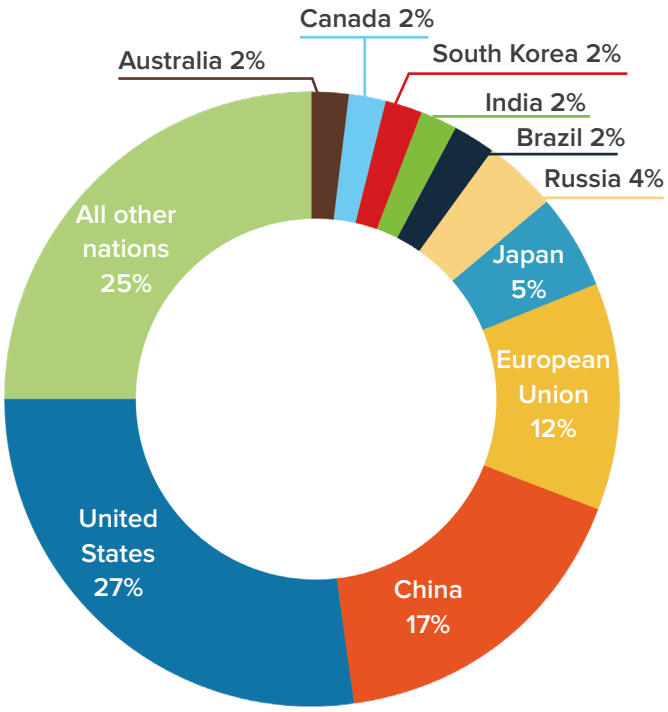


Figure 8: Top ten emitters plus all other nations as percentage of global health care footprint.

	Health care country/region emissions by ranking	Total country/region emissions by ranking
1	United States	China
2	China	United States
3	European Union	European Union
4	Japan	India
5	Russia	Russia
6	Brazil	Japan
7	India	Brazil
8	South Korea	Canada
9	Canada	South Korea
10	Australia	Mexico
	Mexico (11)	Australia (17)

Table 1: Top ten health care carbon emitters compared to total top ten emitters

d. In a different finding, Pichler et. al. found the Chinese health care sector's climate footprint to be significantly greater (600Mt) and larger than that of the United States. The differences between this study and Pichler et al's paper is discussed in Study Limitations on Page 16.

Per capita emissions

This picture changes when health care emissions are viewed on a per capita basis. Globally, the average emissions per capita for health care activities was 0.28 tCO_2e. Per capita emissions is an important metric for understanding and forging solutions to climate change on the basis of equity.

For instance, India, which has the seventh largest absolute health sector climate footprint in the world (39 Mt CO_2e), has the lowest health-related emissions per capita (0.03 metric tons) of all 43 nations in this paper. Meanwhile the United States' health sector, the world's number one emitter in both absolute and per capita terms (546Mt absolute, 1.72 metric tons per capita), produces 57 times more emissions per person than does India. Other top health sector emitters, such as Australia, Canada, and Switzerland emit between 30 and 50 times more per capita than does India.

China, number two in terms of absolute health sector emissions, has per capita emissions (0.25) that fall just below the world average (0.28). This rate of emissions means that China's health sector produces 6 times more greenhouse gases per person than India's does. But China's health system also emits one-seventh the greenhouse gases per capita as does the United States, one-third that of Korea, and just under one-half that of the European Union.

Health care emissions per capita by country				
Top emitters: (over 1t per capita)	**Major emitters** (between the 0.50t and 1t per capita)	**Higher than average emitters** (between global average 0.28t and 0.50t per capita)	**Lower than average emitters**	**Unknown**
Australia	Austria	Bulgaria	Brazil	Rest of World (ROW)
Canada	Belgium	Cyprus	China	
Switzerland	Denmark	Czech Republic	Croatia	
United States	Estonia	France	Hungary	
	Finland	Greece	India	
	Germany	Italy	Indonesia	
	Ireland	Malta	Latvia	
	Japan	Poland	Lithuania	
	Korea	Portugal	Mexico	
	Luxembourg	Slovenia	Romania	
	Netherlands	Spain	Slovak Republic	
	Norway	Sweden	Turkey	
	Russia	European Union		
	Taiwan			
	United Kingdom			

Table 2: Health care emissions per capita by country

FINDINGS: HEALTH CARE'S GLOBAL CLIMATE FOOTPRINT

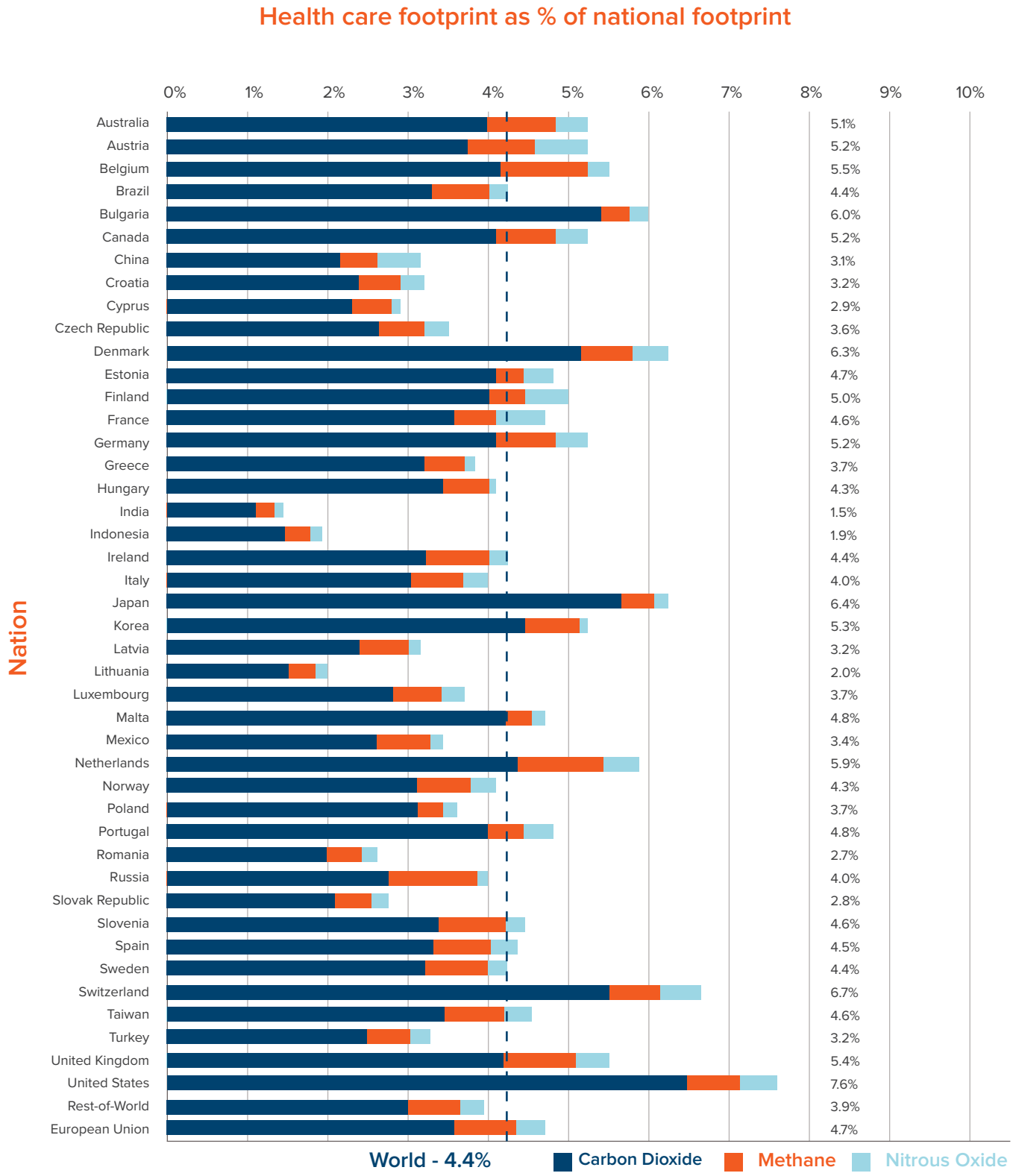


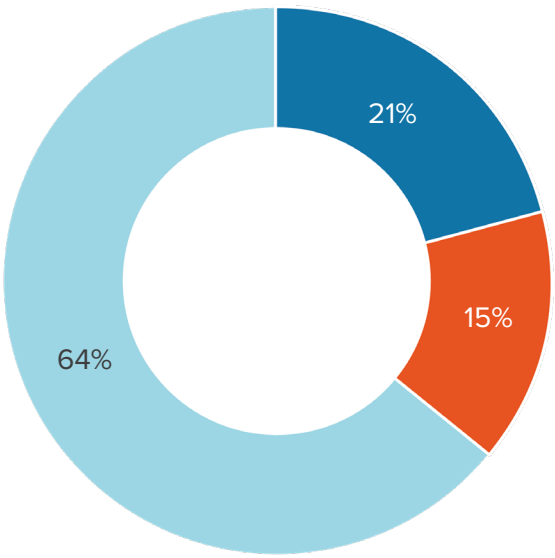
Figure 7: Health care footprint as a percentage of national emissions for all nations and regions covered in this study

Snapshots

The following section provides a series of snapshots of the global large emitting health care countries including the United States, China, India, and Brazil, as well as the 28 nations of the European Union.

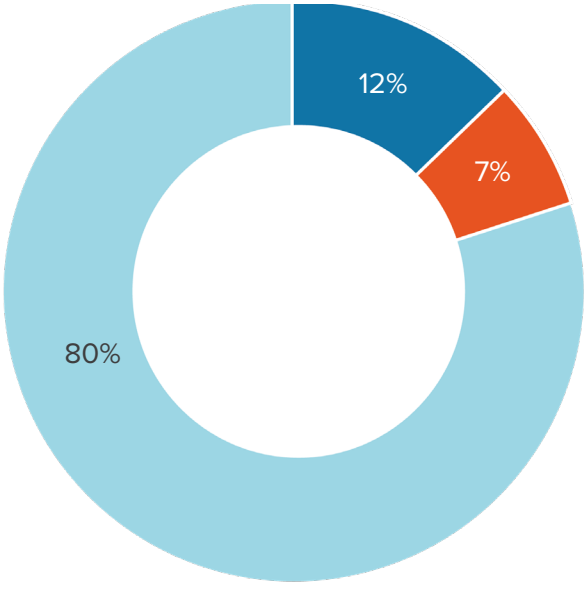
A full set of country snapshots of all 43 countries, is provided in Appendix C.

United States



United States health care	Value	Unit
Climate footprint	547	$MtCO_2e$
Emissions per capita	1.72	tCO_2e/ capita
Emissions as % of national footprint	7.6	%
Expenditure per capita	9053	USD
Expenditure as percentage of GDP	16.5	%
% of footprint generated domestically	78.2	%
Health sector footprint equivalence to coal power plant emissions[32]	141	coal-fired power plants in one year

China

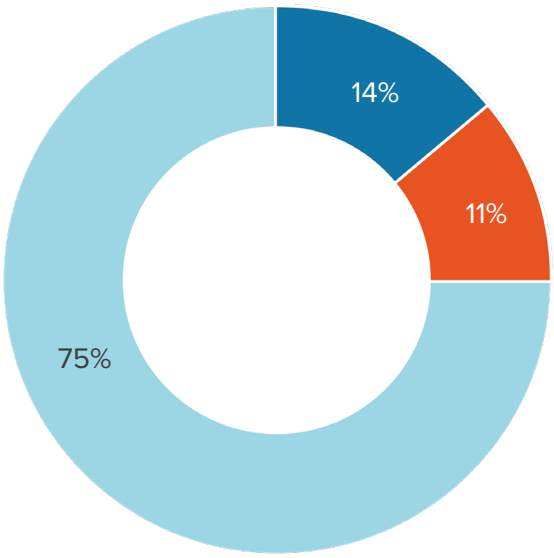


China health care	Value	Unit
Climate footprint	342	$MtCO_2e$
Emissions per capita	0.25	tCO_2e/ capita
Emissions as % of national footprint	3.0	%
Expenditure per capita	362	USD
Expenditure as percentage of GDP	4.8	%
% of footprint generated domestically	90.5	%
Health sector footprint equivalence to coal power plant emissions[32]	87.8	coal-fired power plants in one year

Scope 1 Scope 2 Scope 3

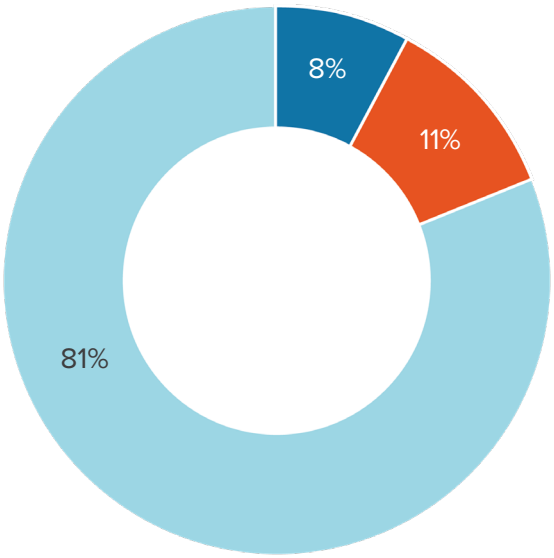
FINDINGS: HEALTH CARE'S GLOBAL CLIMATE FOOTPRINT

European Union



European Union health care	Value	Unit
Climate footprint	249	$MtCO_2e$
Emissions per capita	0.49	tCO_2e/ capita
Emissions as % of national footprint	4.7	%
Expenditure per capita	3668	USD
Expenditure as percentage of GDP	10.0	%
Health sector footprint equivalence to coal power plant emissions[32]	64	coal-fired power plants in one year

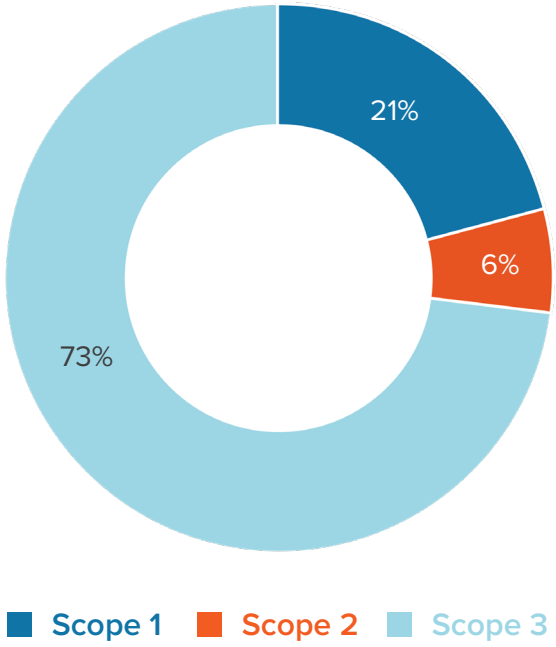
India



India health care	Value	Unit
Climate footprint	39	$MtCO_2e$
Emissions per capita	0.03	tCO_2e/ capita
Emissions as % of national footprint	1.5	%
Expenditure per capita	57	USD
Expenditure as percentage of GDP	3.6	%
% of footprint generated domestically	80.1	%
Health sector footprint equivalence to coal power plant emissions[32]	10	coal-fired power plants in one year

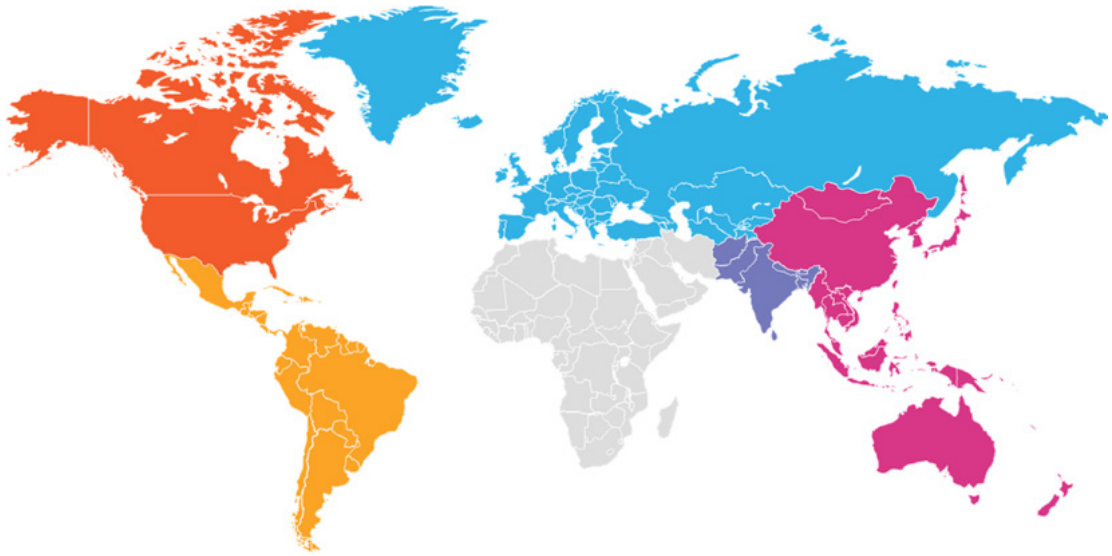
Scope 1 Scope 2 Scope 3

Brazil



Brazil health care	Value	Unit
Climate footprint	44	$MtCO_2e$
Emissions per capita	0.21	tCO_2e/ capita
Emissions as % of national footprint	4.4	%
Expenditure per capita	1301	USD
Expenditure as percentage of GDP	10.8	%
% of footprint generated domestically	70.6	%
Health sector footprint equivalence to coal power plant emissions[32]	11.3	coal-fired power plants in one year

GHG emissions by region



North America	Latin America & Caribbean	East Asia Pacific	South Asia	Europe & Central Asia	
1.65	0.20	0.26	0.03	0.43	tCO_2e/capita
0.58	0.13	0.60	0.05	0.39	$GtCO_2e$ total
29	6	30	2	19	% global

Figure 9: Estimated health care emissions for World Bank regions other than Sub-Saharan Africa and Middle East and North Africa

Based on data points for 43 countries, we have been able to establish a series of regional estimates of health care emissions with a strong level of confidence (Figure 9). These estimates are for all regions except Africa and the Middle East, where the WIOD global database does not provide sufficient coverage for a confident estimate.

It is important to note that these estimates are based on figures from countries at the higher end of the global income distribution. So while we have full confidence in the estimate for the European Union, the values for regions such as Latin America which do not have full WIOD detail country coverage are estimated based on the WIOD detail country results, including those from neighboring countries. (See Appendix B for details on methodology). The opportunity exists to refine these estimates further once additional country-specific data becomes available.

With these caveats in mind, the picture these estimates paint is of the vast majority or 78% of health care emissions coming from the North America (29%), East Asia/Pacific (30%), and Europe/Central Asia regions (19%). Of the remaining 22% of global health care emissions, we can estimate that Latin America generates 6% and South Asia generates 2%. Although data is absent, we can also infer by deduction that the remaining 14% of health care emissions are generated by the health sectors in the 21 countries in the Middle East and North Africa together with the 48 countries in Sub-Saharan Africa.

4. Decarbonizing health care's supply chain is critical

The finding that 71% of health care's climate footprint is attributable to Scope 3 emissions is significant (Figure 3).While further study is needed, it is highly likely that the vast majority of these emissions emanate from the production, packaging, transport, and disposal of goods and services that health care purchases. These include pharmaceuticals and other chemicals, medical devices, hospital equipment, instruments, and more.

There is further work to be done to understand the full picture of GHG emissions emanating from health care's supply chain. In order to address the climate footprint of the health care supply chain, it will be essential to understand its global nature.

This paper finds that 76% of all health care emissions, including supply chain, are generated domestically. This means that around one-quarter of all health care emissions are generated outside of the country where the health care product is ultimately consumed. In some of the largest emitting countries the domestic emissions profile is even higher, with China reaching above 90%, the United States at 78%, India at 80%, and Brazil at 70%.

It will be important to further analyse and identify the climate footprint of countries' production for the health care supply chain, as well as which countries are the greatest consumers of these goods and services. For instance, when evaluating their Scope 3 emissions, NHS England SDU found that pharmaceuticals made the largest contribution to their climate emissions. Understanding this supply chain landscape, including what the climate footprint hotpots are in various countries' Scope 3 emissions, is an important next step. This will be essential for developing an approach to address this major component of health care's climate footprint.

5. Fossil fuel combustion is at the heart of health care's climate footprint

Energy — primarily the combustion of fossil fuels — makes up well over half of health care's climate footprint.

As Figure 6 shows, 40% of health care's climate footprint comes from electricity and thermal power supply attributed to health care-related activities. It is energy both purchased by health care facilities (Scope 2 emissions in Figure 5), as well as that purchased by manufacturers and suppliers of goods and services for the sector (Scope 3 in Figure 5). This includes, for instance, the energy purchased by pharmaceuticals and medical device industries.

Another 13% of health care's footprint primarily arises from on-site power generation in health care facilities and is shown in Figure 6 as "health sector operational emissions." This brings the total up to 53%. That figure will increase further when fossil fuels burned onsite in the health care supply chain, such as for transport or on-site combustion for heating, cooling and manufacturing are taken into account.

This conclusion points to the importance of society-wide transitions to clean energy to address both health care's climate footprint and to protect public health from the broader climate crisis (Action 2).

6. Health care spending and the sector's growth is an important factor in emissions

There is a strong but not absolute correlation between a country's health sector's climate footprint and a country's health spending. As Figure 10 shows, generally the higher the spending on health care (measured as percentage of a country's GDP) the higher the per capita health care emissions are in that country.

Other factors are also important, particularly the energy intensity of a country's economy and the emissions intensity of its energy system. For instance, in their 2019 study, Pichler et.al. found that a group of "14 mainly European countries has achieved absolute decoupling of health care expenditure from CO_2 emissions by combining growing real health care expenditure with a declining health climate footprint." Another 10 countries, including the United States, Canada, Australia, South Korea, Japan, and India achieved relative decoupling where emissions and health care expenditure have both increased, but the emissions grew at a slower pace than expenditure. They conclude that the emissions intensity of the domestic energy system and the energy intensity of the domestic economy have a significant influence on the climate footprint of health care.[16]

In this context, the direct link to health care spending is both clear, as well as important to recognize and address. Global health spending is expected to increase at an annual rate of 3.8%, from $9.2 trillion in 2014 to $24.2 trillion in 2040, with most of the growth expected in high- and middle-income countries.[33] Indeed, health spending will continue to grow as the population ages in advanced economies and middle-income countries invest significant amounts in strengthening their health infrastructure and services. Health system spending will also grow in many low-income countries as these nations develop and invest billions of dollars in health care for their populations. For instance, Development Assistance for Health (DAH) totals more than $37 billion annually and has a significant influence on health systems in low income countries.[34]

Health care growth and investment needs to be decoupled from GHG emissions, and aligned with the decarbonization of all aspects of how health is delivered, including the energy that it generates onsite, purchases, or is embodied in the supply chain. This will be essential to significantly decrease the sector's footprint in coming decades. Such a scenario can align health sector growth trajectories, as well as goals such as universal health coverage, with one another.

Decoupling growth from resource consumption, including climate emissions, is the explicit aim of a transition to a circular economy — an economy that instead of consuming and polluting, it regenerates and restores. Organizations such as the World Economic Forum, OECD and European Union have recognised the importance of a circular economy to achieving societal economic and environmental goals.[21,23,35] The principles of a circular economy can help health care organisations tackle even the hardest-to-mitigate aspects of their climate footprint.

FINDINGS: HEALTH CARE'S GLOBAL CLIMATE FOOTPRINT

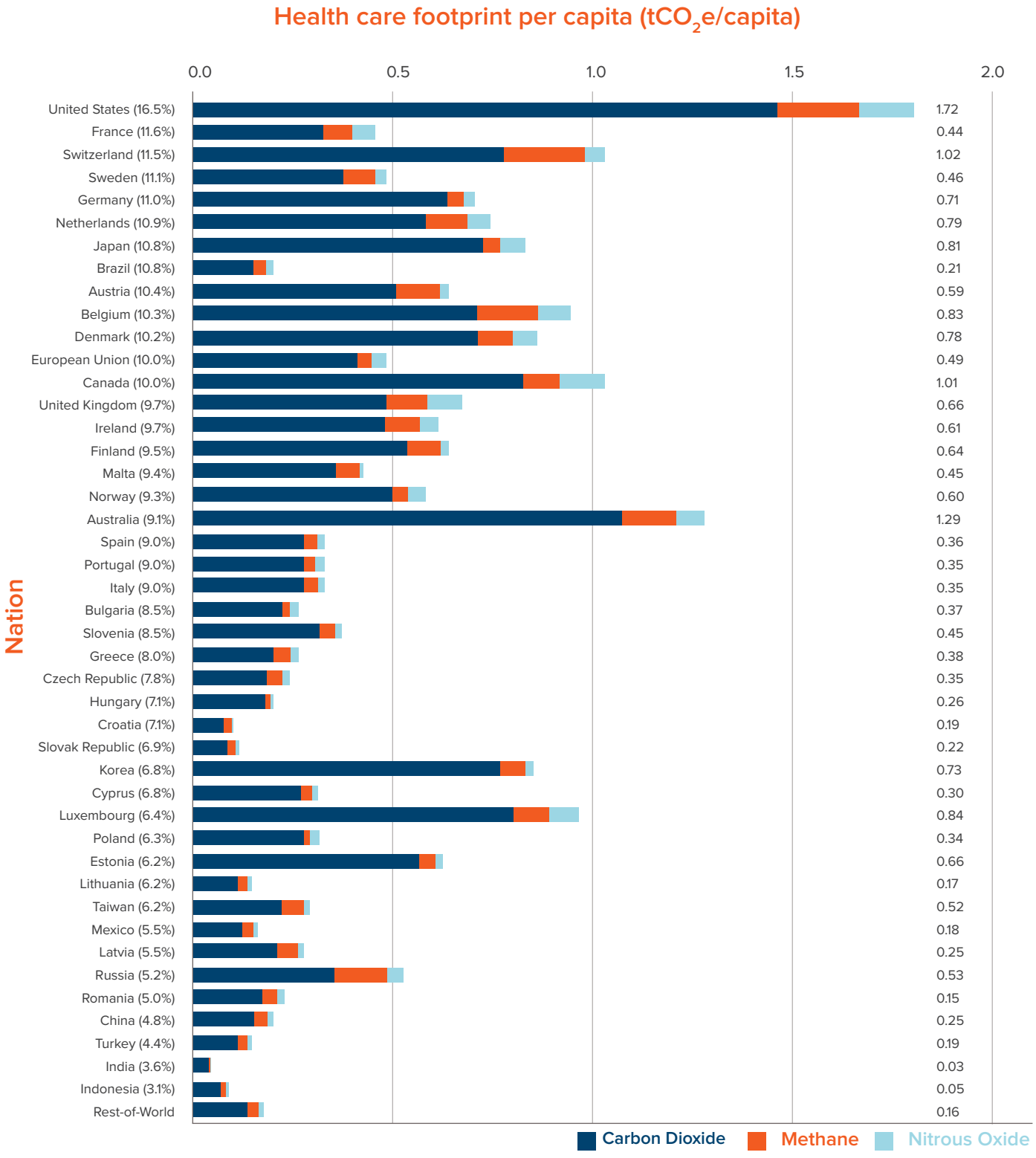


Figure 10: Health Care footprint per capita ordered by percentage of GDP spent on health care

Anesthetic Gases

The gases used for anesthesia are potent greenhouse gases. Commonly used anesthetics include nitrous oxide and the fluorinated gases sevoflurane, isoflurane, and desflurane. Global warming potentials range between 130 $kgCO_2e/kg$ (sevoflurane) and 2540 $kgCO_2e/kg$ (desflurane). At present, the majority of these gases enter the atmosphere.[29]

Research by the NHS Sustainable Development Unit indicates that the United Kingdom's anesthetic gas footprint is 1.7% and the majority can be attributed to nitrous oxide use.[30] Available data on the medical consumption of nitrous oxide for anesthesia is not global. UNFCCC reports for a subset of developed nations within its Annex 1 grouping.[27] Medical nitrous oxide use for these nations totalled 7 $MtCO_2e$, presenting an additional 0.4% to the global healthcare footprint, and an additional 2.5% on the global Scope 1 footprint. Together, these nations accounted for 15% of the global population, 57% of the global GDP, and 73% of global health expenditure in 2014, and so the full impact of nitrous oxide use in anesthesia on the global health care footprint can be expected to be substantially greater than the figures for Annex 1 nations alone.

For regions where full coverage is available in the UNFCCC data, nitrous oxide anesthesia adds an additional 0.7% to the North American and 1.0% to the European Union's health care footprint.

For fluorinated gases used in anesthesia, global emissions to atmosphere in 2014 was estimated to be $3.1 \pm 0.6 MtCO_2e$[27]. This figure presents an additional 0.2% on the global health care footprint. Due to increasing uptake of these gases, increasingly preferred to nitrous oxide, the footprint from anesthetic gases can be expected to increase.

Anesthetic gases therefore contribute at least 0.6% of health care's global climate impact. Wider adoption of waste anesthetic capture systems has the potential to be a high impact health care-specific climate mitigation measure.

For many individual health facilities and systems of hospitals the proportion of the contribution of both nitrous oxide and fluorinated anesthetic gases to their climate footprint can be significantly higher. For instance, Albert Einstein Hospital in Sao Paulo, Brazil found that GHG emissions from nitrous oxide contributed to 75% of their Scope 1 GHG emissions and nearly 35% of their total reported GHG emissions in 2013. Meanwhile a study of operating theaters in three health systems in the United States, United Kingdom, and Canada found that preferential use of desflurane resulted in a ten-fold higher quantity of anesthetic-related GHG emissions across hospitals in the study.

7. Significant data gaps remain

Global health care is a complex and diverse sector that has never been mapped to climate emissions before. Over the course of this paper, a series of data gaps emerged that we were not able to address given limited time and resources and/or the nature of the methodology we have used.

National and regional estimates are limited. One important gap exists between the global estimates and national estimates. By using the MRIO model we were able to produce a coherent estimate of health care's global climate footprint that allows for comparison between nations and regions. However, the limitation of this model is that we were not able to use specific country data. Therefore this paper's country estimates will differ from what will often be much more granular and accurate country estimates that are carried out at the national level.

Additionally, the absence of country specific data for this global model from Africa and the Middle East, as well as a large number of countries in Asia, Latin America, and the Caribbean, is a significant gap. The poor quality of available data for African countries leaves a major opportunity to improve the breadth of this study. For many other low- and middle-income countries in Latin America and Asia results were attributed to World Bank regions based on estimates using data from neighboring countries. Establishing the capacity for the health sector to understand, measure, and track its climate footprint in every region and every country is a fundamental step for aligning the sector with the ambition and vision of the Paris Agreement.

One solution we are recommending is that a standardized framework for national and sub-national health care climate footprint measurement be developed by WHO to ensure consistent and ongoing health sector climate footprint measurement and tracking (Policy Recommendations, Action 5).

WIOD categories are not broken down by Greenhouse Gas Protocol scopes. While the WIOD database provides an important lens to view health care's global climate footprint via a set of expenditure categories, this paper does not allocate those categories within the three GHG Protocol scopes. A deeper understanding of health care's global footprint will emerge once a structural path analysis can be conducted.

Health care's supply chain needs to be better understood. A structural path analysis can provide a more sophisticated understanding of health care's Scope 3 emissions and the global health care supply chain. Importantly this paper does not deliver a global estimate of the contribution of the pharmaceutical industry to health care's climate footprint. This is important as the NHS i n the UK found that pharmaceuticals made up 11% of England's health and social care footprint in 2015.[36]

The footprints of anesthetic gases and meter dosed inhalers need to be measured. Current data from 31 countries is insufficient. Anesthetic gases may also play a much more significant role in the footprint of health care facilities than reported in this paper and should not be overlooked.

The trajectory of health care emissions is not well understood. This paper provides an analysis based on data from one year (2014). It does not provide a time-sequenced approach that would allow for an understanding of the evolution of health care's footprint or for an analysis of the trajectory it is on.