

SUPPLEMENTARY MATERIAL

Appendix 1. Global availability of health workforce statistics

Table A1. Overview of statistics availability for five health workers occupations (medical doctors, nurses, midwives, dentists, pharmacists).

Occupation	Medical doctors	Nurses	Midwives	Dentists	Pharmacists
Number of countries with stock data	194	194	122	192	187
Number of countries with data in the last five years*	171	178	110	171	146
Number of countries with at least 5 data points	163	176	88	147	133
Number of countries with graduates reported	78 (mostly European region 48)	124	105	74 (mostly European region 48)	78 (mostly European region 48)
Number of countries with age reported	119	131	81	36	45
Countries with no data			† Kuwait, Bahamas, Bahrain, United Arab Emirates, Lesotho, South Sudan, Nicaragua, Cabo Verde, Colombia, China, Guatemala, Cuba, North Macedonia, Saint Kitts and Nevis, Dominican Republic, Dominica, Namibia, El Salvador, Venezuela, Grenada, Saint Vincent and the Grenadines, Panama	Somalia, Vietnam.	Cuba, Micronesia (Federated States of), North Macedonia, Saint Kitts and Nevis, Somalia, Uruguay, Venezuela (Bolivarian Republic of).

For all occupations but midwives the maximum number of countries reporting is 194, for midwives it is 144 as 50 countries reported within the count of nursing personnel.

* At least one data point reported for the period 2016-2020

† Excluding 50 countries for which the number of midwives are included in the count of nursing personnel

Appendix 2. Contribution of other occupations to the overall stock of health workers**Table A2 – The estimated share of other occupations among 82 countries reporting stock statistics for at least 15 occupations*.**

WHO region	Number of countries	Median	Average	Min	Max
African region	34	45%	45%	9%	80%
Region of the Americas	10	27%	27%	9%	51%
Eastern Mediterranean region	10	43%	40%	16%	58%
European region	8	19%	24%	7%	65%
South-East Asia region	10	49%	47%	23%	67%
Western Pacific region	10	27%	29%	11%	47%
Total	82	36%	39%	7%	80%

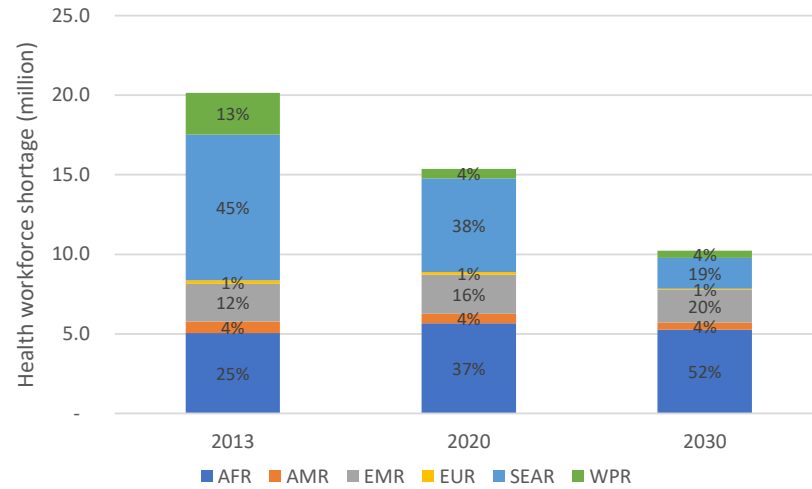
* At least dentists, medical doctors, midwifery personnel, nursing personnel, pharmacists and ten other occupations

Table A3 – Relative contribution of medical doctors, nursing personnel, midwifery personnel, dentists, pharmacists, and other occupations among 82 countries reporting stock data for at least 15 occupations*.

WHO region	Median % of dentists	Median % of medical doctors	Median % of midwifery personnel	Median % of nursing personnel	Median % of pharmacists	Median % of other occupations
African region	0.3%	5.9%	5.8%	36%	0.9%	45%
Region of the Americas	3.0%	25%	0.05%	38%	2.6%	27%
Eastern Mediterranean region	3.4%	16%	2.9%	35%	4.3%	43%
European region	5.5%	28%	1.5%	37%	2.7%	19%
South-East Asia region	1.5%	11%	2.6%	28%	2.8%	49%
Western Pacific region	1.8%	12%	0.5%	52%	1.7%	27%
Total	1.5%	12%	2.2%	36%	1.7%	36%

* At least dentists, medical doctors, midwifery personnel, nursing personnel, pharmacists and ten other occupations

Note: the row sum of percentages does not necessarily add-up to 100% as the median is computed separately by country as unit of analysis and not weighted by population size.

Appendix 3. Distribution of the estimated global health workforce shortage by WHO region in 2013, 2020 and projected shortage in 2030

Note: Relative contribution of each region to shortage is displayed as percentage inside bars.

Figure A1. Distribution of the global health workforce shortage by WHO region in 2013, 2020 and projected shortage in 2030

Appendix 4. Computation of global shortage with alternative scenario: 1. to maintain densities as in 2020, 2. and alternatively to reach a specific level of essential health services coverage

Shortage estimation to maintain densities as of 2020

As alternative scenario, the main analysis was reproduced with accounting for attrition between 2020 and 2030 to estimate how many health workers should be hired between 2020 and 2030 to maintain the densities of health workers as in 2020. A total of 13.7 million health workers would be required primarily in high income countries (Figure A2).

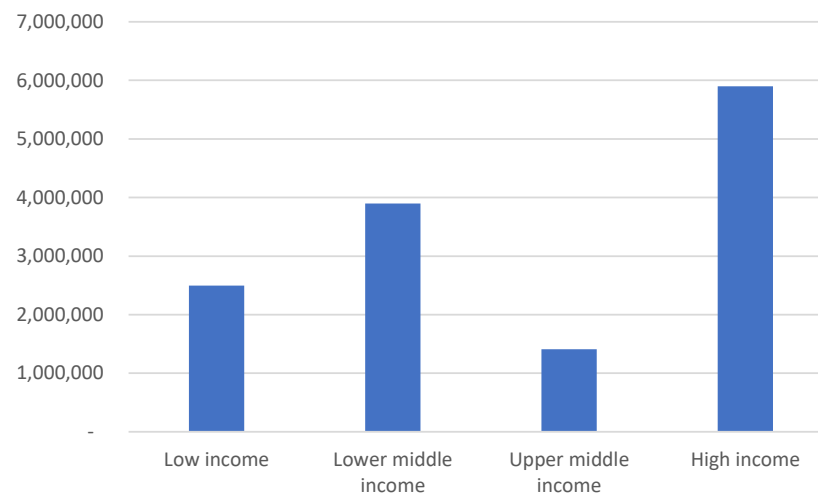
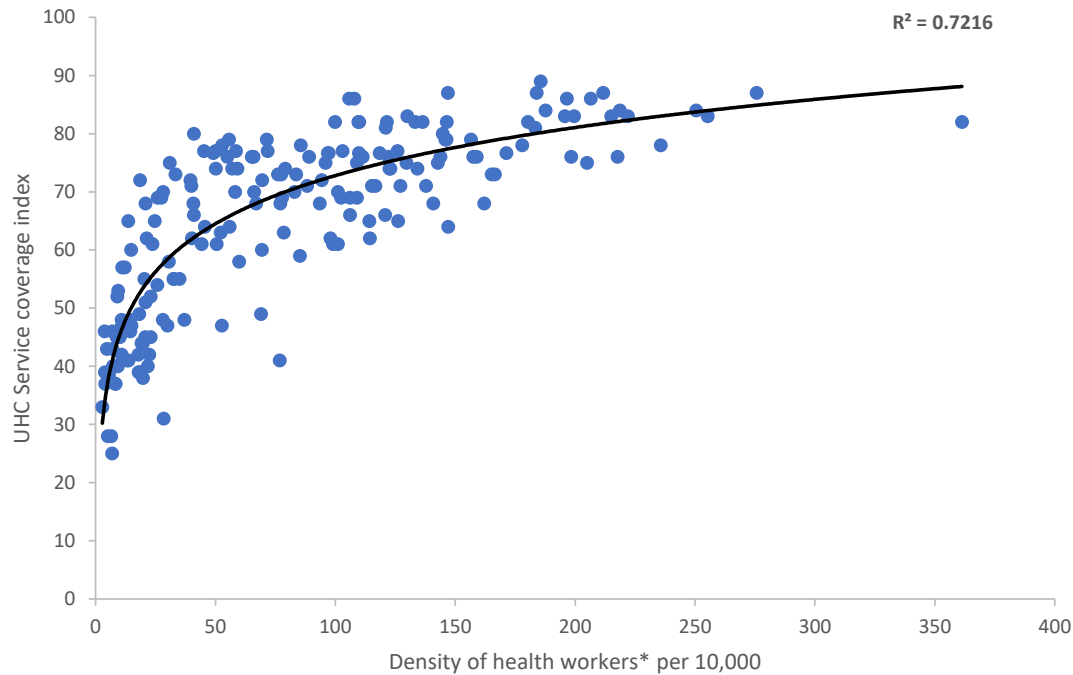


Figure A2. Number of health workers to hire by income group between 2020 and 2030 to balance the attrition of health workers and to maintain individual country densities as in 2020

Alternative shortage estimation to reach service coverage targets

The global health workforce density in 2013, factoring in the other occupations, were plotted against the Universal Health Coverage Service Coverage Index (UHC SCI) (Figure A3).



* includes dentists, medical doctors, midwifery personnel, nursing personnel, pharmacists and other workers estimated by region specific share of other occupations

Note: the black line represents the log-linear correlation between UHC SCI and health workers density, with corresponding R^2 displayed.

Figure A3 Correlation between global health workforce density per 10,000 population and the Universal Health Coverage Service Coverage Index (UHC SCI) for the year 2013.

From the equation of this log-linear correlation, thresholds of health workers density were identified for specific UHC SCI levels. The corresponding health workers density for a UHC SCI of 50 was 14.9 per 10,000 population, for UHC SCI of 60 it was 34.6 per 10,000, for UHC SCI of 70 it was 80.2 per 10,000, and for UHC SCI of 80 it was 186.3 per 10,000 population.

These thresholds were then compared to the density of health workers in each country for years 2013, 2020 and for the projected densities in 2030. And the difference provided the estimated shortage as the number of health workers required to attain the UHC SCI level as per the correlation identified above (Table A4).

Table A4 – Estimation of the global health workforce shortage (in million) to reach Universal Health Coverage Service Coverage Index of 50, 60, 70, 80, for the years 2013, 2020 and for the projected stock of health workers to 2030.

Year	UHC SCI Threshold of 50	UHC SCI Threshold of 60	UHC SCI Threshold of 70	UHC SCI Threshold of 80
2013	0.50	3.35	22.99	85.07

2020	0.28	2.44	16.02	83.40
2030*	0.22	2.10	12.48	78.10

* Based on the stock of health workers projected to 2030 from a simple stock and flow model that uses for each occupational group the stock in 2020, the expected number of workers retiring from the age distribution of health workers and the number of graduates.

The scenario with a UHC SCI threshold value of 70 produced global shortage estimation for years 2013, 2020 and 2030 (23 million, 16 million, 12 million, respectively) of the same order of magnitude and same decreasing trend as those computed in the main analysis (20 million, 15 million, 10 million respectively). This was expected as the median UHC SCI was 69.5, hence corresponding to the median value of the densities of health workers globally in 2013. Compared to the main analysis, this method was based on a single UHC SCI threshold value and did not factor in occupation specific distribution which explains why results slightly vary.

These analyses relied on UHC SCI as an external benchmark for health outcome, but other metrics could have been used such as childhood mortality, burden of disease, etc.

It is important to also mention that the analysis based on UHC SCI with threshold of densities for health workforce does not account for other important health system inputs such as financing, medicine, infrastructure, amongst others... Therefore, the interpretation of the potential impact of the estimated health workforce shortage on essential health service coverage is to be interpreted with caution.

Appendix 5. Latest year of data reported by country for five health workers occupations

Country	Dentists	Medical doctors	Midwifery personnel*	Nursing personnel	Pharmacists
Afghanistan	2019	2020	2018	2018	2018
Albania	2018	2020	2020	2020	2018
Algeria	2018	2018	2018	2018	2018
Andorra	2015	2015	2015	2015	2015
Angola	2018	2018	.	2018	2018
Antigua and Barbuda	2014	2017	2019	2019	2007
Argentina	2018	2020	.	2017	2004
Armenia	2017	2017	2017	2015	2015
Australia	2019	2020	2019	2019	2019
Austria	2020	2020	2020	2019	2020
Azerbaijan	2014	2019	2014	2014	2014
Bahamas	2017	2017	.	2018	2011
Bahrain	2015	2015	.	2015	2015
Bangladesh	2020	2020	2020	2020	2018
Barbados	2017	2017	2019	2018	2005
Belarus	2018	2019	2015	2015	2015
Belgium	2020	2020	2020	2020	2020
Belize	2019	2018	.	2018	2017
Benin	2018	2019	2019	2019	2018
Bhutan	2020	2020	.	2020	2020
Bolivia	2017	2017	.	2017	2016
Bosnia and Herzegovina	2015	2015	.	2018	2015
Botswana	2019	2018	2018	2018	2018
Brazil	2018	2019	.	2019	2017
Brunei Darussalam	2019	2017	.	2018	2015
Bulgaria	2019	2018	2018	2018	2015
Burkina Faso	2019	2020	2019	2019	2019
Burundi	2018	2020	.	2020	2018
Cambodia	2018	2014	2019	2019	2014
Cameroon	2020	2020	2020	2020	2020
Canada	2019	2019	.	2020	2020
Cape Verde	2019	2018	.	2018	2018
Central African Republic	2018	2018	.	2018	2018
Chad	2018	2020	2020	2020	2020
Chile	2020	2020	2020	2020	2020
China	2017	2019	.	2019	2017
Colombia	2020	2020	.	2020	2020
Comoros	2018	2018	.	2018	2018
Congo	2018	2018	.	2018	2018
Cook Islands	2019	2014	2019	2019	2014
Costa Rica	2020	2020	.	2020	2020

Cote d'Ivoire	2019	2019	2019	2019	2019
Croatia	2019	2019	.	2016	2015
Cuba	2018	2018	.	2018	.
Cyprus	2018	2019	2019	2016	2015
Czech Republic	2019	2020	2019	2019	2019
Democratic People's Republic of Korea	2017	2017	2017	2017	2017
Democratic Republic of the Congo	2018	2018	.	2018	2018
Denmark	2018	2018	2018	2018	2018
Djibouti	2014	2014	2014	2014	2014
Dominica	2018	2018	.	2017	2001
Dominican Republic	2019	2019	.	2019	2019
Ecuador	2017	2017	.	2018	2015
Egypt	2018	2019	.	2018	2018
El Salvador	2018	2018	.	2018	2017
Equatorial Guinea	2004	2017	.	2018	2018
Eritrea	2018	2020	.	2018	2018
Estonia	2019	2019	2019	2019	2019
Eswatini	2020	2020	.	2020	2020
Ethiopia	2020	2020	2020	2020	2020
Fiji	2019	2015	2019	2019	2015
Finland	2018	2018	2018	2018	2018
France	2019	2019	2019	2019	2019
Gabon	2019	2020	2019	2019	2019
Gambia	2020	2020	2020	2020	2020
Georgia	2020	2020	.	2020	2019
Germany	2019	2020	2019	2019	2019
Ghana	2018	2020	2020	2020	2020
Greece	2019	2019	2019	2019	2019
Grenada	2018	2018	.	2018	2016
Guatemala	2020	2020	.	2020	2020
Guinea	2018	2018	.	2018	2018
Guinea-Bissau	2020	2020	2020	2020	2020
Guyana	2020	2020	2020	2020	2020
Haiti	2018	2018	2018	2018	2018
Honduras	2017	2020	2019	2018	2000
Hungary	2019	2020	2019	2019	2019
Iceland	2020	2019	.	2020	2020
India	2020	2020	.	2020	2020
Indonesia	2020	2020	2020	2020	2020
Iran, Islamic Republic of	2018	2018	2018	2018	2018
Iraq	2020	2020	2020	2020	2020
Ireland	2020	2020	2019	2019	2020

Israel	2020	2020	2020	2020	2020
Italy	2020	2020	2020	2020	2020
Jamaica	2017	2018	2018	2018	2018
Japan	2018	2018	2018	2018	2018
Jordan	2019	2019	2019	2019	2019
Kazakhstan	2015	2020	2015	2015	2015
Kenya	2019	2018	.	2018	2018
Kiribati	2016	2013	.	2018	2016
Kuwait	2015	2020	.	2020	2014
Kyrgyzstan	2018	2014	2019	2019	2014
Lao People's Democratic Republic	2020	2020	2020	2020	2020
Latvia	2020	2020	2020	2020	2020
Lebanon	2018	2019	2018	2018	2018
Lesotho	2019	2018	.	2018	2018
Liberia	2019	2018	.	2018	2018
Libyan Arab Jamahiriya	2017	2017	2017	2017	2017
Lithuania	2020	2020	2020	2020	2020
Luxembourg	2017	2017	2017	2017	2017
Madagascar	2018	2018	2018	2018	2018
Malawi	2020	2020	.	2020	2020
Malaysia	2018	2020	.	2019	2015
Maldives	2020	2020	.	2020	2020
Mali	2018	2018	2018	2018	2018
Malta	2019	2015	2018	2018	2015
Marshall Islands	2019	2012	.	2018	2012
Mauritania	2019	2018	2018	2018	2018
Mauritius	2019	2020	.	2018	2018
Mexico	2019	2019	2019	2019	2010
Micronesia, Federated States of	2008	2020	2019	2019	.
Monaco	2014	2014	2014	2014	2014
Mongolia	2018	2018	2019	2018	2018
Montenegro	2020	2020	2020	2020	2020
Morocco	2017	2017	2017	2017	2017
Mozambique	2020	2020	2020	2020	2020
Myanmar	2019	2019	2019	2019	2019
Namibia	2018	2018	.	2018	2018
Nauru	2019	2015	.	2018	2015
Nepal	2020	2020	2020	2020	2020
Netherlands	2019	2020	.	2020	2019
New Zealand	2019	2020	2020	2020	2020
Nicaragua	2018	2018	.	2017	2014
Niger	2018	2020	2018	2018	2018

Nigeria	2019	2018	2019	2019	2019
Niue	2008	2008	.	2018	2008
Norway	2020	2020	2020	2020	2020
Oman	2020	2020	2020	2020	2020
Pakistan	2019	2019	2019	2019	2019
Palau	2020	2020	2020	2020	2020
Panama	2019	2019	.	2019	2019
Papua New Guinea	2019	2019	.	2019	2018
Paraguay	2018	2020	2019	2018	2018
Peru	2018	2018	2019	2018	2018
Philippines	2019	2020	2019	2019	2017
Poland	2020	2020	2020	2020	2020
Portugal	2018	2019	2019	2019	2019
Qatar	2019	2018	2018	2018	2018
Republic of Korea	2019	2019	2019	2019	2019
Republic of Moldova	2020	2020	2020	2020	2020
Romania	2017	2017	2017	2017	2017
Russian Federation	2020	2020	2020	2020	2020
Rwanda	2018	2019	2019	2019	2018
Saint Kitts and Nevis	2018	2018	.	2015	.
Saint Lucia	2017	2017	2017	2017	2017
Saint Vincent and the Grenadines	2012	2012	.	2018	2004
Samoa	2020	2020	2020	2020	2020
San Marino	2018	2014	2014	2014	2014
Sao Tome and Principe	2019	2019	2019	2019	2019
Saudi Arabia	2020	2020	2019	2019	2018
Senegal	2019	2019	2019	2019	2019
Serbia	2015	2016	.	2016	2016
Seychelles	2019	2019	.	2018	2018
Sierra Leone	2018	2018	2019	2018	2018
Singapore	2018	2019	.	2017	2016
Slovakia	2019	2019	2019	2019	2019
Slovenia	2019	2019	2019	2019	2019
Solomon Islands	2019	2016	.	2018	2016
Somalia	.	2014	2014	2014	.
South Africa	2019	2019	.	2018	2016
South Sudan	2018	2018	.	2018	2018
Spain	2019	2019	2019	2019	2019
Sri Lanka	2020	2020	2020	2020	2020
Sudan	2015	2017	.	2018	2017
Suriname	2019	2018	2019	2019	2019
Sweden	2018	2019	2019	2018	2019
Switzerland	2019	2020	2019	2019	2019

Syrian Arab Republic	2016	2016	.	2016	2016
Tajikistan	2014	2014	2014	2014	2003
Thailand	2019	2020	.	2019	2019
The former Yugoslav Republic of Macedonia	2015	2015	.	2015	.
Timor-Leste	2020	2020	2020	2020	2020
Togo	2018	2020	2020	2020	2020
Tonga	2020	2020	2020	2020	2020
Trinidad and Tobago	2019	2019	2019	2019	2018
Tunisia	2016	2017	.	2017	2017
Turkey	2019	2019	2019	2019	2019
Turkmenistan	2014	2014	2014	2014	2014
Tuvalu	2020	2020	.	2020	2020
Uganda	2020	2020	2020	2020	2020
Ukraine	2014	2014	2014	2014	2014
United Arab Emirates	2019	2019	.	2019	2019
United Kingdom	2020	2020	2020	2020	2020
United Republic of Tanzania	2018	2018	.	2018	2018
United States of America	2018	2018	.	2018	2010
Uruguay	2017	2017	2019	2019	.
Uzbekistan	2014	2014	2014	2014	2014
Vanuatu	2019	2016	2019	2019	2012
Venezuela, Bolivarian Republic of	2017	2017	.	2018	.
Viet Nam	.	2016	2016	2016	2016
Yemen	2014	2014	.	2018	2014
Zambia	2018	2018	2018	2018	2018
Zimbabwe	2020	2020	2020	2020	2020

**In many countries, nurses trained with midwifery skills are counted and reported as nurses which makes the distinction between nursing personnel and midwifery personnel difficult to draw.*