


The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage?

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ABSTRACT

Objective The 2016 Global Strategy on Human Resources for Health: Workforce 2030 projected a global shortage of 18 million health workers by 2030. This article provides an assessment of the health workforce stock in 2020 and presents a revised estimate of the projected shortage by 2030.

Methods Latest data reported through WHO's National Health Workforce Accounts (NHWA) were extracted to assess health workforce stock for 2020. Using a stock and flow model, projections were computed for the year 2030. The global health workforce shortage estimation was revised.

Results In 2020, the global workforce stock was 29.1 million nurses, 12.7 million medical doctors, 3.7 million pharmacists, 2.5 million dentists, 2.2 million midwives and 14.9 million additional occupations, tallying to 65.1 million health workers. It was not equitably distributed with a 6.5-fold difference in density between high-income and low-income countries. The projected health workforce size by 2030 is 84 million health workers. This represents an average growth of 29% from 2020 to 2030 which is faster than the population growth rate (9.7%). This reassessment presents a revised global health workforce shortage of 15 million health workers in 2020 decreasing to 10 million health workers by 2030 (a 33% decrease globally). WHO African and Eastern Mediterranean regions' shortages are projected to decrease by only 7% and 15%, respectively.

Conclusions The latest NHWA data show progress in the increasing size of the health workforce globally as more jobs are and will continue to be created in the health economy. It however masks considerable inequities, particularly in WHO African and Eastern Mediterranean regions, and alarmingly among the 47 countries on the WHO Support and Safeguards List. Progress should be acknowledged with caution considering the immeasurable impact of COVID-19 pandemic on health workers globally.

INTRODUCTION

Health workers play a central role in health systems. This is evidenced globally by the COVID-19 pandemic, during which the most common cause of disruptions to essential health services reported was the lack of staffing.¹ Health workers are also recognised

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ The Global Strategy on Human Resources for Health: Workforce 2030 highlighted a projected health workforce (HWF) shortage of 18 million health workers by 2030.
- ⇒ Following 5 years of the National Health Workforce Accounts (NHWA) global implementation, data availability has significantly improved which allows for a reassessment of the HWF shortage by 2030.

WHAT THIS STUDY ADDS

- ⇒ The latest NHWA data for the year 2020 show a total stock of 65 million health workers globally, which represents an increase of 14 million net jobs as compared with 2013, and furthermore a potential increase of 19 million net jobs by 2030.
- ⇒ Consequently, the revised estimates of the global HWF shortages indicate a reduction (of the 18 million figure) to 15 million in 2020 and a projected number of 10 million by 2030 based on current trajectories into the future (mostly depicting a pre-COVID-19 situation).
- ⇒ Significant regional disparities remain, and inequities have increased, as the projected 2030 shortage will cluster in the 47 countries included in the WHO support and safeguard list. Those countries alone will bear two-third of the global shortage.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

- ⇒ Given the latest available data, the COVID-19 pandemic has no observable effect on these trends; economic uncertainties however are likely to impose constraints on the employment of newly graduated health workers in some countries and could derail and reverse the progress to date.
- ⇒ The results of this reassessment is a high alert for the need for sustainable investments in the health-care workforce, particularly in regions and countries highlighted in this analysis.

as central to attaining, sustaining and accelerating progress towards Universal Health Coverage (UHC).²

With the growing global recognition of the role of health workforce, the United Nations

Sustainable Development Goals (SDGs) defined a specific target in SDG3.c ‘to increase recruitment of health workforce, especially in least developed countries and small island developing states (SIDS)’. The Global Strategy on Human Resources for Health: Workforce 2030 (GSHRH) sets out the global policy agenda to ensure a health workforce that is fit for purpose to attain the targets of UHC and the SDGs.³ The GSHRH provided estimates of the size of the global health workforce in 2013 and projections to 2030. It estimated a global shortage of 18 million health workers by 2030. This projection was based on data availed by the WHO Global Health Observatory at the time, with some degree of uncertainty related to both the variability in quality and completeness of the underlying data and to the assumptions made. It required the addition of tracer indicators to estimate the median health workforce densities to be used as thresholds for estimating the global shortage.

The decision by the World Health Assembly in 2016 to adopt the progressive implementation of the National Health Workforce Accounts (NHWA)⁴ and annual reporting to WHO has led to significant improvements in data quality and availability. Partnered activities such as the State of the World’s Nursing 2020⁵ and the State of the World’s Midwifery 2021⁶ have also generated empirical data. In addition, improved data on the number of dentists, pharmacists and other health occupations facilitated their inclusion in the global estimates.

The present article therefore provides an assessment of the health workforce stock for the year 2020 based on latest data reported by Member States and a projection to 2030. The analysis also provides an overview of the trends in the global health workforce shortages between 2013 and 2020, and projections to 2030. An improved data-driven understanding of the global health workforce is quintessentially important for planning, policy and investment decisions. And more critically when those are linked to COVID-19 recovery priorities in job creation and social protection as well as informing global equity priorities, such as the WHO Health Workforce Support and Safeguards list (HWF-SSL) 2020.⁷

METHODS

Health workforce data on the stock, age groupings and the number of graduates were extracted for each country and every year between 2000 and 2020 from the NHWA⁴ platform on the 4 January 2022. The NHWA online platform is a global repository of countries’ reported health workforce data, and is the central monitoring mechanism of global health workforce indicators and targets articulated in the GSHRH, the UN SDG3.c⁸ and the subindicators of the WHO 13th Global Programme of Work.⁹ Aligned with the NHWA definitions and the Organisation for Economic Co-operation and Development (OECD)/EUROSTAT/WHO-EURO joint data collection, the stock in the data extracted and later referred in this paper was defined as ‘the number of practicing health workers’ and

was therefore limited to the number of health workers delivering care to the population. When no information on practising health workers was available, the stock of ‘professionally active health workers’ was used instead and when the latter was also not available, the stock of ‘licensed to practice health workers’ was used. Country data were summarised and presented by WHO regions, and the World Bank income group,¹⁰ with an extra identification of SIDS.¹¹ Results were also reported for the group of 47 countries in the WHO HWF-SSL⁷ prioritised in monitoring the implementation of the WHO Global Code of Practice on the International Recruitment of Health Personnel. Occupations were classified according to ILO’s International Standard Classification of Occupation.¹²

To compute the density of health workers per 10 000 population for each country, year and occupation, the population size data were extracted from the World Population Prospects (2019 release) of the United Nations’ Population Division.¹³ The baseline density for each occupation was computed for the year 2020. When no data were available for the year 2020, the latest available stock data before 2020 was used instead (see online supplemental appendix 5 for the latest year available by country and the NHWA data portal: <https://apps.who.int/nhwportal/> for further details by year). To compare health workers densities with those used in the time of the GSHRH development, data for the latest year until 2013 were also extracted. These data for year 2013 were mostly retrospectively completed by Member States since the launch of the GSHRH and therefore form a stable baseline to compare with. For the few countries with missing stock data (2 countries for dentists, 22 for midwives, 7 for pharmacists), the average density of countries in the same income group was used.

For each occupation group, the projection of health workers to year 2030 relied on a simple stock and flow model over 10 years which factors in production and attrition of health workers as follows:

$$\text{Health workforce stock}_{2030} \approx (\text{health workforce stock}_{2020} \times (1 - \% \text{ age}_{65+}) \times (1 - 0.1 \times \% \text{ age}_{55-64})^{(10-1)} + 10 \times 0.7 \times \text{number of graduates annually})$$

The use of the percentage of health workers older than 65+ years was applied in the first projection year (2021) and later the share of those aged 55–64 years in the following years (2022–2030) were used to factor in attrition from 2021 to 2030. This modelling approach was initially applied in the State of the World’s Nursing 2020.⁵ Because the age of retirement is commonly 65 years in many countries,¹⁴ the share of those aged 65+ years was considered as an attrition on an annual basis. One-tenth of those aged 55–64 years were considered as moving to the category 65+ years. Health systems’ absorption capacity of new graduates from health professional education was also factored in the modelling by adding-in a fixed 70% of the annual graduates. This estimated percentage was approximated from OECD Stat¹⁵ data by activity level, which shows an average ratio between practising and

licensed to practice health workers of around 70% for physicians (74%), nurses (70%), dentists (70%) and pharmacists (66%). The fixed 70% absorption capacity considered across all country income groups comes with assumption that in each country the education market would self-regulate relative to the availability of positions in the health labour market of each country. It could be argued however that the absorption capacity could vary and be somewhat lower in low-income countries. As a sensitivity analysis, a varying absorption capacity of 70%, 60%, 50% and 40% were used for high-income, upper middle-income, lower middle-income and low-income countries, respectively.

The revised shortage of health workers was measured relative to thresholds, which are estimated by the median density of health workers for five occupational groups (medical doctors, nursing personnel, midwifery personnel, dentists and pharmacists) in 2013. The median density of each occupation was used to bring our method as close as possible to that applied in the GSHRH estimation for which the shortage threshold was equivalent to the world's median density of three of the five occupational groups (medical doctors, nursing personnel, midwifery personnel). For each occupation, the difference between its median (threshold) density and the observed density was converted into a stock count (by multiplying the difference between the two densities by the population size in the specific country) and computed for 2013, 2020 and the projection to 2030. Next, the stock count was summed up across the five occupations and then increased by a region-specific proportion to account for other occupations similar to the approach used in the GSHRH estimation. The proportion of other occupations was determined using data from 82 countries that reported stock data for at least 15 occupations including the 5 occupations mentioned above (online supplemental appendix 2).

Data extraction was conducted from the NHA data platform (2021 update) and data analysis was conducted with Stata.¹⁶

RESULTS

Workforce in 2020

For the five occupation groups, recent stock data were reported by the great majority of countries (online supplemental appendix 1). Aggregating data for the 194 Member States of WHO, the five occupation groups (dentists, medical doctors, midwifery personnel, nursing personnel and pharmacists) represent a total of 50.1 million health workers in 2020 (table 1). Adding the share of other occupations (online supplemental appendix 2) gives an estimated total of 65 million health workers out of which nursing personnel represent one-third (29.1 million). Compared with 2013, this stock has increased by 29% globally, 3 times greater than the population increase over the same period (8.2% growth).

Accounting for the population size and the density of health workers per 10 000 population in 2020 reveals a striking inequity, with high-income countries having a health workers density that is 6.5 times that of low-income countries (figure 1).

This finding underscores the fact that slightly more than one-fifth (22%) of the world's population have close to half (47%) of the global health workforce. This inequity has marginally decreased since 2013 when it was 7.6 times greater. Figure 2 depicts the inequitable distribution of health workers at a more granular level and the degree of subregional disparities.

For the SIDS, the density of the five occupation groups only increased slightly from 57.9 to 59.3 per 10 000 between 2013 and 2020. In 2013, it was higher in SIDS (5.4%) as compared with other countries while in 2020 the density in SIDS became lower (8.4%).

Projection to 2030

The projection of stock (table 2) indicates that the global health workforce could reach 84 million health workers in 2030. This is a projected global increase of 29% which is 3 times faster than the equivalent population increase (a projected increase of 9.5% globally) in the period 2020–2030.

Table 1 Stock of SDG3.c health workers (medical doctors, nurses, midwives, dentists, pharmacists) in 2020 by WHO region (in millions)

Region	Dentists	Medical doctors	Midwives	Nurses	Pharmacists
African region	0.04	0.33	0.25	1.19	0.09
Region of the Americas	0.59	2.49	0.10	8.27	0.59
Eastern Mediterranean region	0.19	0.80	0.09	1.11	0.23
European region	0.57	3.41	0.40	7.39	0.60
South-East Asia region	0.30	1.55	0.55	3.58	1.32
Western Pacific region	0.84	4.07	0.81	7.56	0.85
Global*	2.54	12.65	2.20	29.10	3.69

*The total of the five occupations is 2.54+12.65+2.20+29.10+3.69=50.1 million.
SDG, Sustainable Development Goal.

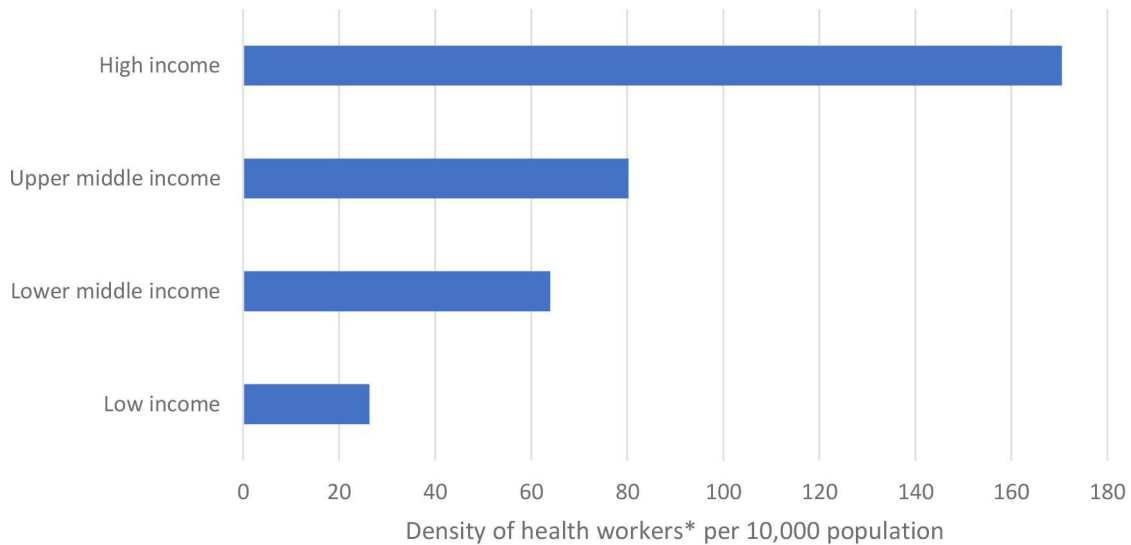


Figure 1 Density of health workers per 10 000 population in 2020 by income group. *Includes dentists, medical doctors, midwifery personnel, nursing personnel and pharmacists.

Results of the sensitivity analysis (which considers a varying absorption capacity of new graduates by income group) show that the projected stock of the global health workforce is 76 million health workers, which would correspond to a global increase of 17% between 2020 and 2030.

Health workforce shortage

Using the median densities of health workers in 2013 for the five occupations, a combined threshold of 51.2 health workers per 10 000 population was estimated. To compare, including only medical doctors, midwifery personnel and nursing personnel as considered in the GSHRH estimation, the combined threshold becomes 47.6 which is close to the value of 44.5 estimated in 2016.³ Hence, the analysis proceeds with the new threshold

(based on the five occupations) to estimate the shortage of health workers for the years 2013, 2020 and for the projected health workforce stock in 2030 (table 3).

Results presented in table 3 show that the global shortage estimates to 15.4 million health workers in 2020 globally and is projected to be around 10.2 million in 2030 (a decrease of about 34%). In similar sense, results from the sensitivity analysis show that the projected health workforce shortage for 2030 is 12.9 million health workers, that is, a 16% decrease of shortage since 2020.

Although the overall trend is showing a notable decrease in the shortage for most occupations, regional disparities exist (online supplemental appendix 3). The largest decrease in the shortage was observed for WHO Western Pacific region. In contrast, the changes

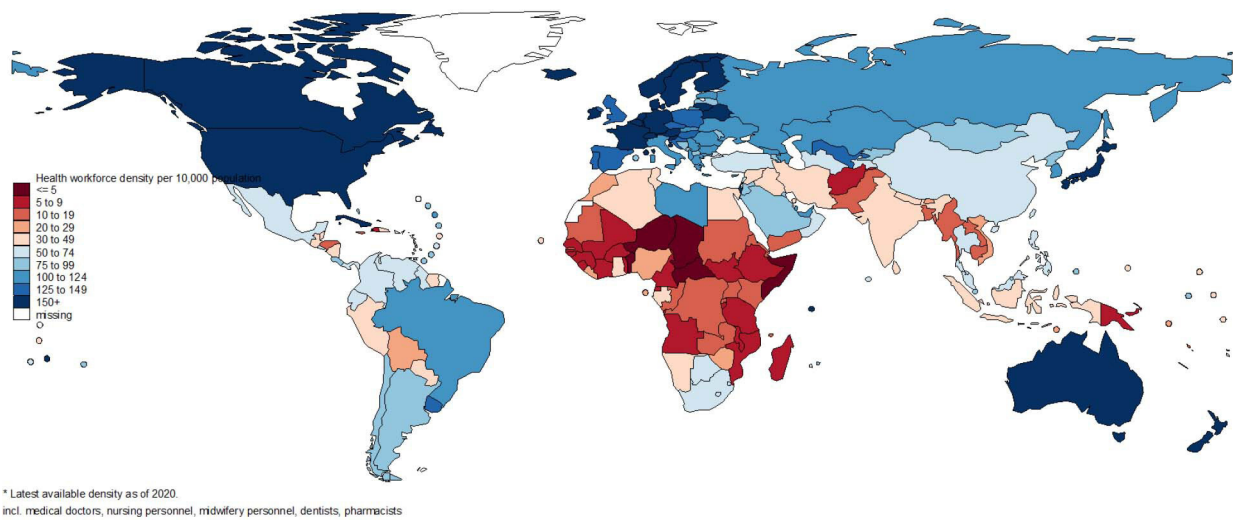


Figure 2 Map of health workers (dentists, medical doctors, midwifery personnel, nursing personnel, pharmacists) density per 10 000 population in 2020. Cut-off points used for density per 10000: 5, 10, 20, 30, 50, 75, 100, 125, 150. The middle cut-off point used is 50 health workers per 10 000 population and is close to the shortage benchmark (see “health workforce shortage section“ below), therefore countries in red colour scale on the map can be considered as having a health workforce shortage.

Table 2 The projected stock of SDG3.c health workers (dentists, medical doctors, midwives, nurses, pharmacists) in 2030 by WHO region (in millions)

Region	Dentists	Medical doctors	Midwives	Nurses	Pharmacists
African region	0.05	0.41	0.41	1.79	0.16
Region of the Americas	0.73	2.56	0.15	8.61	0.79
Eastern Mediterranean region	0.26	0.99	0.16	1.47	0.36
European region	0.62	3.43	0.50	8.22	0.67
South-East Asia region	0.50	2.44	0.63	6.42	4.06
Western Pacific region	1.06	4.33	1.21	9.77	1.20
Global	3.21	14.15	3.05	36.27	7.24

SDG, Sustainable Development Goal.

in shortages remain unclear for WHO African region with an estimated shortage of 5.1 million, 5.7 million and 5.3 million in 2013, 2020 and 2030, respectively. Hence, factoring in the rapid increase in population size, health worker shortages in WHO African region is projected to constitute 52% of the global shortage by 2030 while representing a quarter in 2013. As for the SIDS, the difference in the projected decrease in shortage between 2020 and 2030 is less (−12%) than that estimated for other countries (−34%). The 47 countries in the WHO HWF-SSL represented half of the estimated shortage of health workers in 2020, and it is projected to only slightly decrease (9%) by 2030. Alarming, these 47 countries between them will encompass 69% of the global health workforce shortage by 2030.

DISCUSSION

The GSHRH highlighted a projected health workforce shortage of 18 million health workers by 2030.³ It

Table 3 Estimation of the global health workforce shortage (in millions) in 2013, 2020 and projected in 2030 by occupation

	2013	2020	2030 (projected)
Dentists	0.49	0.26	0.22
Medical doctors	3.05	2.66	1.94
Midwifery personnel	0.36	0.41	0.31
Nursing personnel	9.89	7.07	4.50
Pharmacists	0.33	0.29	0.19
Other occupations	6.02	4.69	3.08
Total	20.15	15.37	10.23

Shortage estimated against occupation-specific threshold established from the median density of 51.2 health workers (dentists, medical doctors, midwifery personnel, nursing personnel and pharmacists) per 10 000 population in 2013. Projections to 2030 were based on a stock and flow model accounting for attrition (due to retirement) and the replenishment of the health workforce by new graduates.

*Estimated by applying the share of other occupations by region computed from a subset of 82 countries reporting the stock for at least 15 occupational groups.

identified gaps in data reporting and triggered dedicated policies and efforts to monitor health workforce through the progressive implementation of the NHWA.¹⁷ Five years on, data availability and quality significantly improved allowing the present reassessment to take place. The latest NHWA data for year 2020 measures a total global stock of 65.1 million health workers (dentists, medical doctors, midwives, nurses, pharmacists and other health workers) which indicates an increase of 14 million net jobs (a 27% increase) as compared with 2013. This growth in the size of the health workforce is >3 times faster than the population growth rate over the same period. Although some data improvement could have had a role in the change in reported number, it is important to note that the figure used for 2013 is not the number that was reported in the Global Strategy on Human Resources for Health: workforce 2030, but on a revised estimate that includes the retrospective reporting, hence could be now considered as a solid reference stock.

The analysis to 2030 indicates a projected growth rate of 2.7% annually (as compared with an 0.9% growth of global population), which represents an increase in 19 million net jobs that could reach 84 million health workers in 2030. This increasing stock of employed health workers in the health economy is consistent with the predictions stated in the GSHRH³ and the UN High Level Commission on Health Employment and Economic Growth.¹⁸ Both identified strong economic demand—mostly in upper middle-income and high-income countries—that could create up to 40 million additional jobs by 2030. In spite of this consistency, the 2030 estimate of 84 million health workers should be viewed with a degree of caution as it is based on the prevailing graduation rates and cannot as yet factor in the multidimensional impact of the COVID-19 pandemic neither on healthcare workers^{19 20} nor on the education market.

Unequivocally, the pace of progress has significantly reduced the previously estimated global shortage to 15.4 million in 2020 and is projected to further decline to 10.2 million in 2030: lower than that estimated in the GSHRH³ or through other methods.²¹ Part of this can be explained by the availability of better and more recent data allowing for a better assessment of the

shortage. For instance, the GSHRH estimates predicted a 17% decrease in shortage between 2013 and 2030, while this reassessment estimates a 49% decline between 2013 and 2030, largely explained by better data on additional health occupations and their collective contributions in expanding access to UHC.

This global progress is however uneven. WHO African and the Eastern Mediterranean regions did not show improvements of their health workforce shortage between 2013 and 2020, which is projected to remain stagnant by 2030. One possible explanation is their notable population growth rate of 28% and 18%, respectively, between 2020 and 2030, compared with about 5% in other WHO regions. Our findings further suggest that at this pace, the projected 2030 shortage will be clustered in 47 countries (mostly in WHO African region), included in the WHO HWF-SSL and between them encompass two-third of the global shortage by 2030. This is an alarming situation for the African region's health systems that are facing an increasing demand for health services by a growing population size and the rising demand to accelerate progress towards the SDG health-related targets.²² Despite the clear focus on SIDS articulated in SDG3.c, these countries show less progress in reducing their shortages in comparison with other countries. SIDS countries are facing several challenges, such service delivery as in hard-to-reach areas and limited national education capacity, which may explain the modest reduction of the shortage. This finding underscores the urgency for dedicated actions and support to SIDS countries.

Limitations

While this paper presents an estimate for year 2020 with latest data for almost all countries, it must be noted that in the case of few countries' data the latest year available was sometimes >3 years earlier than 2020 (online supplemental appendix 5). For most countries, the density used for year 2020 and applied to the population of 2020 came either from 2018, 2019 or 2020 (78% of countries for dentists, 76% for medical doctors, 71% for midwives, 83% for nurses and 64% for pharmacists). For these countries, the potential change in density between 2018 and 2020 can be considered as negligible. However, for the remaining countries, when latest data dated before 2018, there is a slight possibility of underestimating the stock of 2020 given that density expected to have increased over time. Alternative approaches could be used, such as multiple imputation, to fill empirical data gaps, however those would require specific development to include both the profiling of countries with missing data and the interpolation of missing values in trends by occupation group.

The method used for projecting the global health workforce to 2030 relied on a simple stock and flow model. It has however a few limitations. First, the model assumes a fixed production capacity throughout the period. The model used is therefore conservative and may slightly underestimate or overestimate the production capacity

of individual countries over time. Second, no data on health worker migration were used in the modelling. It can be expected that the attrition factor due to outmigration varies by country and might affect the shortage estimate. In particular, the COVID-19 pandemic could have disrupted international mobility and countries most dependent on international migration, such as high-income countries, may experience a slower progression of their overall stock to 2030. On the whole, the impact of attrition due to migration is difficult to estimate, however it can be speculated that the degree of potential variation on our estimation would be equivalent to the average share of foreign-trained nurses from OECD Stat of about 6.3%.¹⁵ It can be expected that countries in African region and South-East Asia region would be affected also by having higher retention of health workers during this period, but this might not necessarily have translated into new jobs. Third, the age distribution used as an attrition factor was considered as fixed. The age at retirement was set at 65 years, which is in line with data from OECD.¹⁴ A faster attrition rate might occur because the majority of health workers are women,²³ who may retire on average at a slightly younger age than men. Fourth, our reassessment assumed that 70% of new graduates would be constantly employed over the coming years. It implies that 30% of graduates would be trained as health workers but being unemployed or working in other sectors than health such as in public administration, in education, etc. As a consequence, the overall stock of health workers in each country by 2030 would be higher than the estimation of practising health workers considered in the present paper. This fixed 70% share of graduates becoming employed is an uncertain assumption in light of potential fiscal space constraints linked to the social and economic impact of the COVID-19 pandemic.²⁴ A sensitivity analysis was also conducted and considered 'what if' only 50% of new graduates were absorbed in the health sector annually in all countries, the projected workforce would be around 75.9 million health workers by 2030 as compared with 84 million with a 70% absorption capacity. If all countries were to experience a major reduction of 30% absorption capacity, the projected health workforce would be 67.5 million health workers by 2030. These sensitivity analyses stipulate the necessity to sustain a high absorption capacity in the years leading to 2030. Beyond the impact of COVID-19, the absorption capacity of new graduates could also vary by income group and by occupation. A sensitivity analysis using a varying absorption capacity relative to income groups showed a projected stock of 76 million health workers and a shortage of 12.9 million by 2030. Fifth, the attraction to and retention of jobs in the health sector (postpandemic) may become a relative unknown given the negative impact of attrition due to concerns over higher risks of infections, risks to mental health and well-being, stigmatisation¹⁹ among others. Put together however, these limitations are least problematic for the short-term projection (over 10 years) presented in this analysis.

The shortage estimation also relies on a global comparison of densities of occupation groups and therefore provide a broad indication of the progress that would be required for countries with lowest density to scale-up their workforce relative to the threshold median density. It also suggests that health systems would become better equipped to ensure essential health services provision without necessarily reaching the UHC service coverage index (SCI) of at least 80.

Therefore, the shortage of health workers can be estimated using alternative methods and scenarios (online supplemental appendix 4). For instance, between 2020 and 2030, our analysis showed that 10 million health workers would retire globally, half of those are in high-income countries. Factoring in the population growth, an alternative scenario on the number of health workers required to compensate attrition due to retirements estimates that 13.7 million health workers will be needed by 2030 primarily in high-income countries.

Alternative scenarios can also consider target densities to reach a specific level of essential service coverage under the assumption of a perfectly causal relationship between UHC SCI and health workforce density. Such scenario would produce an estimated shortage as high as 78 million if all countries of the world were to reach a UHC SCI level of 80 in 2030 (online supplemental appendix 4).

CONCLUSIONS

Using the latest NHWA data, this paper illustrated progress in the total stock of the global health workforce between 2013 and 2020 and generated revised projections to 2030 that suggest a reasonable pace globally in reducing shortages. However, there are two issues of concern. First, the COVID-19 pandemic continues to entail an unprecedented global public health crisis coupled with economic uncertainties that are bound to affect all sorts of projections to 2030. For instance, the lack of economic activities and revenues may limit public expenditures on health and fall short in covering the recurrent cost of health workers' wages required. Second, pervasive inequity in health workers distribution remain, with low-income countries and SIDS presenting very low health worker densities in 2020 that are likely to remain stagnant by 2030. This reassessment demonstrated that, while the shortage is projected to rapidly decline in many countries, it is expected to remain high in low-income countries. More drastically, most of the shortage by 2030 (69%) will be found in 47 countries included in the WHO HWF-SSL.⁷ This is a fundamental threat to equity and the concept of 'universal' health coverage. The results of this analysis provide compelling evidence to why governments and global health development partners need to accelerate investments in health worker education, to facilitate the recruitment of new health workers, and to overcome fiscal space constraints that would jeopardise the progress attained in the last decade. Towards that end,

mounting evidence and mitigating measures have been explicitly addressed in the Working for Health Action Plan 2022–2030 tabled for endorsement and support by the 75th World Health Assembly.²⁵

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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%

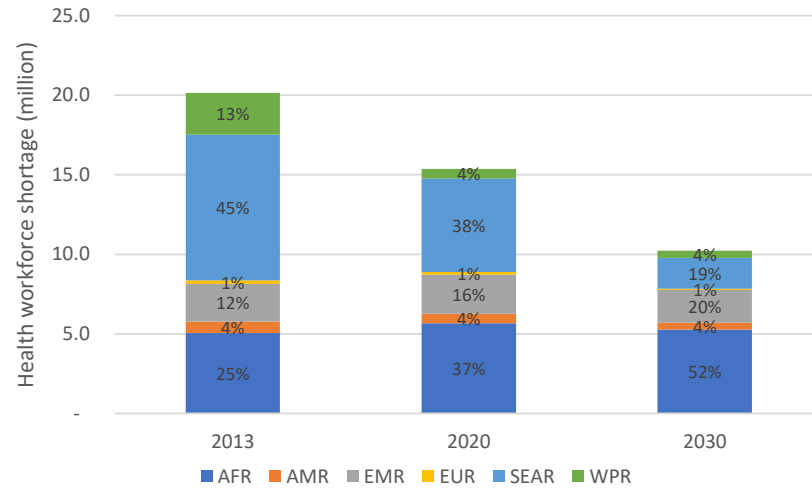
* At least dentists, medical doctors, midwifery personnel, nursing personnel, pharmacists and ten other occupations

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).

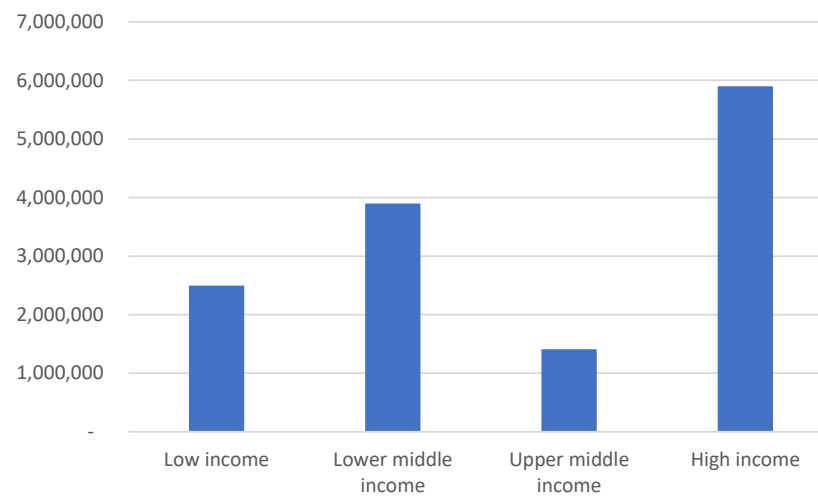
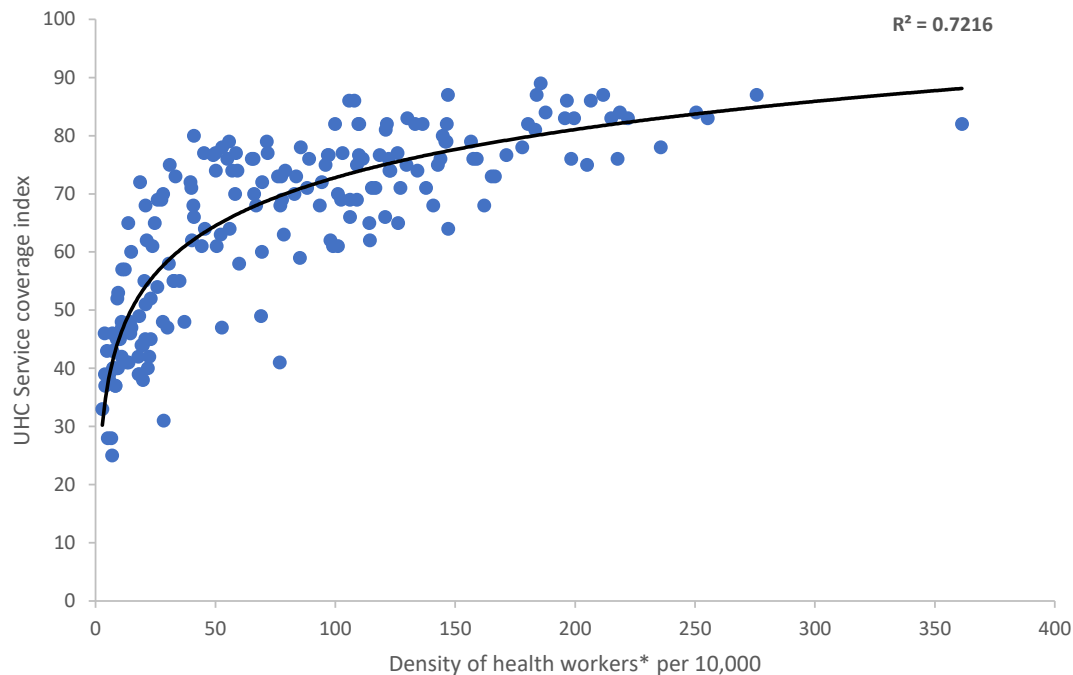


Figure A2. Number of health workers to hire by income group between 2020 and 2030 to balance the attrition of health workers and to maintain individual country densities as in 2020

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.*