Measuring the composition and availability of human resources for health by sex in 204 countries and territories, 1990–2023, and workforce gaps for universal health coverage: a systematic analysis for the Global Burden of Disease Study 2023

*GBD 2023 Human Resources for Health Collaborators**

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Summary

Background Understanding the size, gender composition, and cadre mix of the health workforce and how it has evolved across time and locations can inform policies for planning, recruitment, training, and retention of human resources for health (HRH), and improvement of access to the health-care workforce among populations. Using comparable and standardised data sources, we aim to describe the composition and density of health workers by sex among 20 cadres for 204 countries and territories over 1990–2023 and quantify workforce shortfalls relative to universal health coverage (UHC) attainment.

Methods We used 1816 country-years of data from population-based surveys, 82 from censuses, 3888 from administrative sources, and 96 from scientific literature. We harmonised reported occupation in all sources with the International Standard Classification of Occupations 2008. We produced estimates for 20 cadres and the total health workforce disaggregated by sex using spatiotemporal Gaussian process regression, a standardised method in the Global Burden of Diseases, Injuries, and Risk Factors study. Finally, stochastic frontier meta-regression was used to estimate the minimum density of doctors, nurses and midwives, dentists, and pharmacists required to reach a score of 80 out of 100 on the UHC effective coverage index.

Findings In 2023, there were 122·1 million (95% uncertainty interval 115·4–130·5) health workers across 20 cadres, an increase of 81·2 million (72·0–90·5) or 198·5% (161·9–245·6) relative to 1990. Of that total, there were 15·1 million (13·1–18·2) doctors, 33·2 million (30·8–36·3) nurses, 2·4 million (2·0–2·9) midwives, and 7·6 million (6·7–8·6) community health workers (CHWs). 68·9% (66·9–70·6) of all health workers in 2023 were female, and female health workers accounted for 71·4% (64·5–77·4) of net HRH workforce growth. Less than half of doctors were female (43·9%, 34·5–53·2) and most nurses (80·7%, 76·2–83·1), midwives (96·0%, 83·9–98·5), and CHWs (89·5%, 83·6–93·7) were female. Substantial differences in HRH density remained into 2023: sub-Saharan Africa had the lowest HRH densities across cadres, with the exception of CHWs, while high-income countries had the highest HRH densities. To reach 80 out of 100 on the UHC index, an additional 7·1 million (6·6–7·5) doctors, 23·9 million (21·8–26·1) nurses and midwives, 1·8 million (1·6–1·9) dentists, and 1·6 million (1·4–1·9) pharmacists are required globally.

Interpretation The global health workforce has expanded substantially since 1990, largely due to women entering the formal health workforce. However, this expansion has been uneven across regions and persistent shortfalls remain in doctors, nurses and midwives, dentists, and pharmacists relative to moderate UHC attainment. Addressing these gaps will require expansion of training capacity, retention and remuneration policies for early-career workers, and gender-responsive workforce arrangements.

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Introduction

A sufficient supply of human resources for health (HRH) is fundamental to the functioning of health systems.[1] Addressing shortages in health workforce size and shortcomings in HRH performance are imperative for preparing for health challenges around the world. Comparable and comprehensive information on HRH cadres, or the groups of specially trained personnel active in the health workforce, enables comparison across countries that can shed light on the unique organisational and labour force arrangements underpinning health-care delivery.[1,2]

Research in context

Evidence before this study

There is a paucity of comparable sex-disaggregated estimates of the health workforce by cadre across time and country, limiting both diagnosis of workforce gaps and the design of equitable workforce policies. Global estimates of doctors, nurses, and other human resources for health (HRH) cadres have been published for more than 100 countries in non-peer-reviewed reports by WHO and the International Labour Organization (ILO) as well as in peer-reviewed publications by the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD). WHO–ILO reports from 2022, 2019, and previous years provided estimates of the sex composition of doctors, nurses, and other HRH, as well as health and social sector workers, an aggregate that includes workers outside of the health sector. WHO–ILO-estimated sex shares are limited in not comprehensively presenting trends over time for all locations and cadres, omitting some countries, numerous years, and many types of workers. A PubMed title and abstract search from inception to June 25, 2026, using the terms: "global" AND ("health workforce" OR "health professional" OR "health provider" OR "health personnel" OR "human resources for health") AND ("sex" OR "gender"), identified just two additional peer-reviewed, multicountry studies on HRH sex composition, both covering 25 or fewer, primarily high-income, countries. No existing evidence provides comparable, sex-specific estimates for more than four cadres and total HRH across all countries over 1990–2023. This precludes full understanding of how the availability, cadre mix, and gender composition of HRH influence the delivery of health services and are shaped by health system design in different contexts.

Added value of this study

This study provides the first global, sex-disaggregated estimates of 20 health worker cadres across 204 countries and territories from 1990 to 2023, including the first global quantification of community health workers (CHWs) and offering the most comprehensive assessment of the global health workforce to date. By harmonising survey, census, and administrative sources using International Standard Classification of Occupations 2008 classifications and model-based adjustments, it overcomes limitations in existing HRH data systems. Relative to GBD 2019 estimates of HRH, this study uses an additional 1459 country-years of data. These updated estimates were analysed with an improved stochastic frontier meta-analysis approach, a frontier estimation methodology used to evaluate the minimum HRH density observed in countries attaining a given level of the universal health coverage (UHC) effective coverage index for the cadres identified in Sustainable Development Goal indicator 3.c.1. The use of minimum thresholds recognises that performance can be attained with different cadre mixes while also offering guidance on minimum health workforce needs. These innovations produce new findings that were not possible with previously available estimates, including the quantification of sex-specific HRH growth, information on the global feminisation of health cadres, and new cadre-specific thresholds for UHC. Overall, these findings provide new insights into gender dynamics, cadre composition, and global workforce shortages, with direct relevance for national and international health workforce planning.

Implications of all the available evidence

Comparable information on the size, cadre mix, and gender composition of HRH is essential in workforce planning for building a resilient health workforce to attain UHC and prepare for future health threats. Since 1990, there has been extensive growth in human resources for health, driven primarily by women formally joining the health workforce. Women accounted for almost three-quarters of health workforce growth and made up more than two-thirds of the health workforce in 2023. Despite these large increases in formal health workforce participation, women continue to be less than 50% of doctors and are more likely to be working as nurses, midwives, CHWs, and other health workers, who tend to have fewer opportunities to occupy leadership positions. These circumstances lead to structural imbalances in the gender composition of health system leadership versus the health workforce. Evidence consistently emphasises that millions more health workers are needed globally to attain just moderate levels of UHC.

Describing the distribution of sex within each health worker cadre is also important. Sex-disaggregated data and analysis are critical to ensuring that women's role in health systems informs health workforce assessment and planning.[3] Female health workers might leave the workforce or not enter in the first place if there are not policies that, for example, ensure fair remuneration levels, eliminate violence and harassment, address leadership disparities, and accommodate caregiving responsibilities.[3,4] Without accounting for sex composition along with cadre mix, health systems could suffer from lower HRH productivity and the loss of talent and human capital.[5,6]

Existing research suggests the health workforce exhibits high levels of occupational segregation by sex, with some cadres, such as doctors, undergoing increasing so-called feminisation, or the movement of women into historically male-dominated occupations, over time.[7] Most of this research, however, focuses on single countries or high-income countries, with a much more limited evidence base describing health workers by sex and cadre for low-income and middle-income countries. Existing peer-reviewed studies have examined the sex composition of HRH over time in 25 or fewer countries only, with most data sourced from high-income settings.[8,9] Global reports from the International Labour

Organization (ILO) and WHO have used data from 100 or more countries to estimate the sex composition of HRH cadres.[1,4,10–12] However, these reports did not present trends over time by individual location, cadre, and sex composition simultaneously; these reports also did not provide sex-composition estimates of key HRH cadres, such as community health workers (CHWs), pharmacists and pharmaceutical assistants, dentists and dental assistants, and total HRH. Although existing research has made advances in measuring the densities of HRH globally,[13] gaps persist in information about the sex composition of specific HRH cadres for all countries and how that has changed over the past 30 years with new policies and socioeconomic development. Overall, comparable sex-disaggregated estimates of the health workforce by cadre across time and country have not been available to date.

The present study uses comparable and standardised data sources and standard methodology from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) to assess the composition and density of health workers by sex, with a focus on 20 HRH cadres in 204 countries and territories from 1990 to 2023.[14] We also assess the minimum densities associated with attaining a moderate UHC effective coverage index score, focusing on the cadres emphasised in Sustainable Development Goal (SDG) target 3.c.1. With these estimates, decision makers can assess how the size, sex, and cadre composition of their health workforce has evolved over the past 30 years as well as appreciate the current magnitude of HRH shortfalls, information essential for workforce planning and policy reform.

Methods

Overview

We estimated 20 HRH cadres for 204 countries and territories for the period of 1990 to 2023 for GBD 2023. Relative to previous GBD 2019 estimates, this study estimates an expanded set of HRH cadres, including nurses, midwives, and CHWs separately for the first time. This study also disaggregates all cadres by sex for the first time. We increased the number of country-years of data used by 1459 relative to GBD 2019 estimates and harmonised all data sources with the most up-to-date occupation coding system, International Standard Classification of Occupations 2008 (ISCO-08). Compliance with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) is described in appendix 1 (pp 5–6).

Health workers can be described in terms of sex (biological categorisations of people as males, females, or intersex) or by their gender identity (a person's internal sense of the self that is shaped by socially constructed roles and norms tied to sex assigned at birth).[15] Nearly all of our data identified individuals by a binary definition of sex. We therefore used sex rather than a broader definition of gender identity in our description of health workers.

ISCO-08 categories were used to classify occupations in 73·3% of data and enabled us to estimate nurses separately from midwives and estimate CHW densities. The exact ISCO-08 codes used for each health worker cadre are shown in appendix 1 (pp 7–9). We mapped data sources that used former ISCO coding systems to ISCO-08 using concordance documentation provided by the ILO.[16] Country-specific coding systems (6·1% of sources) were used only when the matches for HRH cadres were strictly unambiguous.

We used the UHC effective coverage index produced as part of GBD 2023 to estimate minimum HRH density thresholds.[17] The UHC effective coverage index is composed of 23 effective coverage indicators representing a range of health service types. Indicators were weighted based on the potential disability-adjusted life-years gained from full coverage.

Data sources

We used population-based surveys, censuses, administrative data, and scientific literature. Surveys and censuses captured self-reported employment status and current occupation. In population-based sources, health workers were counted if they were working for pay or if respondents were on temporary leave or vacation, consistent with globally recognised definitions of employment.[18] In administrative sources and some scientific literature, we were unable to verify employment status and receipt of pay systematically, but these sources are understood to capture the employed workforce as well. 82 country-years of census data and 1816 country-years of survey data were used. Administrative records were sourced primarily from WHO's National Health Workforce Accounts database[19] and the Eurostat Health Database,[20] amounting to 3888 country-years (appendix 1 pp 9–22). Scientific literature sources (96 country-years) were used primarily to augment CHW data because information on this cadre is available in ISCO-08 but not previous ISCO classifications.

We estimated the count per 10 000 population (or density) for 20 distinct health worker cadres. When converting the denominator from the working-age population to the total population, which was necessary for some labour force surveys, or when working with counts that were converted into densities, we used GBD 2023 estimates of population.[21] In the main text, we focused on results for the largest cadres: doctors; nurses; midwives; dentists and dental assistants; pharmacists and pharmaceutical assistants; and CHWs, along with total HRH. We grouped all other HRH cadres into the other HRH category in the main text, with estimates for the remaining cadres in appendix 2, consisting of: clinical officers and medical assistants; physiotherapists and prosthetic technicians; medical imaging and therapeutic equipment technicians; medical laboratory technicians; health-care aides and ambulance workers; environmental

See Online for appendix 1

See Online for appendix 2

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
Global	**151·4 (143·1–161·8)**	**18·8 (16·3–22·5)**	**41·2 (38·2–45·1)**	**8·4 (7·2–10·7)**	**7·5 (6·2–9·8)**	**2·9 (2·5–3·6)**	**9·4 (8·3–10·7)**	**63·2 (56·0–71·1)**
High SDI	415·5 (389·0–447·4)	33·7 (32·3–36·2)	100·9 (94·8–108·4)	17·7 (16·3–19·8)	17·4 (16·1–20·7)	3·8 (3·4–4·6)	0·4 (0·2–0·8)	241·7 (214·3–269·7)
High-middle SDI	208·5 (194·5–223·7)	26·6 (22·6–32·6)	55·8 (50·8–62·5)	9·5 (8·4–11·1)	11·2 (8·7–16·1)	3·4 (3·1–4·0)	24·5 (19·7–31·5)	77·5 (67·8–87·7)
Middle SDI	116·4 (106·7–127·8)	23·7 (18·4–30·6)	43·2 (37·9–49·8)	6·7 (5·1–9·2)	8·8 (5·5–13·9)	3·3 (2·4–4·4)	9·3 (7·8–10·8)	21·4 (18·6–24·2)
Low-middle SDI	64·7 (58·0–73·2)	9·1 (6·4–13·9)	12·2 (9·1–16·9)	6·8 (4·5–10·4)	2·3 (1·6–3·5)	2·2 (1·4–3·5)	11·8 (9·5–14·9)	20·2 (17·6–23·0)
Low SDI	37·6 (34·8–41·2)	3·8 (2·9–5·8)	9·9 (7·7–12·5)	2·9 (2·3–4·3)	0·7 (0·6–0·8)	2·2 (2·0–2·5)	9·9 (9·1–10·8)	8·2 (7·1–9·3)
Central Europe, eastern Europe, and central Asia	**238·3 (224·3–255·8)**	**31·6 (28·3–36·1)**	**78·5 (72·2–86·8)**	**13·0 (11·3–15·4)**	**10·0 (9·0–12·0)**	**3·7 (3·2–4·4)**	**1·3 (0·9–1·7)**	**100·3 (87·9–113·5)**
Central Asia	142·7 (136·3–151·8)	29·9 (28·1–32·2)	76·6 (72·0–84·0)	5·7 (4·1–8·8)	4·6 (3·7–6·6)	3·4 (2·5–4·6)	0·2 (0·1–0·5)	22·2 (19·4–25·2)
Armenia	136·1 (122·9–151·2)	33·0 (26·4–40·5)	41·9 (32·4–53·1)	13·9 (7·9–22·8)	5·3 (3·5–8·2)	3·3 (2·4–4·3)	0·2 (0·1–0·4)	38·3 (33·4–43·5)
Azerbaijan	132·9 (119·2–150·6)	32·6 (26·6–39·9)	55·9 (44·2–71·0)	6·0 (3·1–10·9)	6·4 (3·8–11·8)	3·9 (2·4–5·8)	0·2 (0·1–0·4)	27·9 (24·3–31·6)
Georgia	189·8 (176·4–204·7)	49·9 (42·3–58·8)	74·8 (66·5–82·9)	19·6 (14·1–25·8)	16·7 (13·9–20·3)	1·0 (0·5–1·8)	0·0 (0·0–0·0)	27·8 (24·2–31·5)
Kazakhstan	160·3 (145·4–174·4)	38·6 (33·9–45·0)	64·0 (52·3–76·1)	7·3 (4·4–12·0)	5·0 (2·6–8·4)	4·2 (3·1–5·3)	0·2 (0·1–0·4)	41·0 (35·8–46·5)
Kyrgyzstan	79·4 (70·2–89·8)	19·1 (14·8–23·7)	38·2 (29·3–47·7)	2·3 (1·1–4·5)	4·1 (2·2–6·8)	2·2 (1·4–3·2)	0·2 (0·1–0·5)	13·4 (11·7–15·2)
Mongolia	132·3 (115·7–149·6)	42·2 (34·5–51·6)	53·0 (41·2–65·8)	12·8 (9·4–16·5)	3·9 (2·6–5·6)	6·6 (4·5–9·7)	1·0 (0·5–1·6)	12·7 (11·1–14·4)
Tajikistan	99·5 (89·4–110·0)	19·7 (15·2–24·1)	65·7 (56·9–74·8)	4·1 (2·1–8·0)	5·3 (2·5–9·9)	1·3 (0·9–1·9)	0·2 (0·1–0·6)	3·1 (2·7–3·5)
Turkmenistan	102·4 (90·5–116·1)	25·9 (21·2–31·5)	44·4 (33·8–56·6)	4·6 (2·7–8·0)	3·1 (1·6–5·5)	2·3 (1·2–3·6)	0·2 (0·1–0·4)	21·9 (19·1–24·8)
Uzbekistan	163·7 (139·0–194·2)	26·1 (19·2–33·5)	111·6 (89·2–141·0)	2·9 (1·2–6·1)	2·6 (1·1–4·9)	4·0 (2·5–5·8)	0·2 (0·1–0·5)	16·4 (14·3–18·5)
Central Europe	250·0 (234·7–264·9)	32·8 (31·4–34·7)	66·8 (62·9–71·6)	19·8 (17·0–24·4)	13·9 (10·6–19·4)	2·9 (2·8–3·1)	1·1 (0·7–1·6)	112·7 (98·5–127·5)
Albania	153·8 (132·8–179·7)	30·7 (20·8–41·1)	61·5 (43·8–83·0)	13·4 (6·7–24·8)	15·1 (8·2–24·0)	3·9 (2·4–6·2)	0·3 (0·1–0·8)	28·8 (25·1–32·6)
Bosnia and Herzegovina	130·5 (118·1–146·2)	19·8 (12·5–30·9)	68·7 (59·1–78·6)	5·7 (2·8–10·7)	4·5 (2·4–7·8)	3·2 (2·1–4·9)	0·3 (0·1–0·8)	28·2 (24·6–32·0)
Bulgaria	263·9 (244·4–286·2)	43·5 (37·2–52·5)	42·8 (34·1–52·6)	13·9 (10·0–19·2)	13·3 (10·4–16·5)	5·0 (3·6–6·7)	0·3 (0·1–0·8)	145·1 (127·4–164·0)
Croatia	263·4 (241·6–285·0)	32·4 (25·8–39·1)	78·7 (67·5–93·5)	19·2 (13·8–25·5)	17·2 (12·5–22·3)	4·1 (3·0–5·6)	0·0 (0·0–0·0)	111·9 (97·8–126·7)
Czechia	303·2 (277·2–328·8)	41·6 (34·2–51·3)	91·8 (78·1–108·0)	16·4 (12·1–22·1)	13·8 (9·6–19·2)	4·3 (2·9–6·5)	0·0 (0·0–0·0)	135·3 (118·4–153·1)
Hungary	282·8 (256·6–307·3)	19·7 (14·2–25·6)	53·7 (43·7–64·7)	19·0 (14·5–25·1)	13·1 (9·4–17·7)	2·5 (1·8–3·4)	4·3 (2·7–6·1)	170·4 (149·0–192·7)
Montenegro	152·0 (139·7–166·2)	19·1 (15·1–24·2)	54·7 (48·3–62·3)	6·6 (4·9–9·4)	0·9 (0·6–1·5)	4·0 (3·4–4·6)	0·3 (0·1–0·7)	66·4 (57·9–75·3)
North Macedonia	164·8 (150·2–180·1)	32·2 (24·8–39·5)	52·9 (43·7–64·3)	14·4 (10·9–18·7)	11·8 (8·8–16·7)	4·3 (3·3–5·8)	0·3 (0·1–0·7)	48·8 (42·6–55·4)
Poland	274·7 (250·7–298·5)	38·6 (33·2–46·0)	57·5 (45·8–70·7)	26·2 (19·2–37·7)	14·5 (6·5–26·0)	2·5 (1·6–3·6)	0·1 (0·1–0·3)	135·3 (118·3–153·1)
Romania	220·2 (204·7–235·4)	26·4 (20·3–32·7)	83·1 (73·0–92·8)	22·0 (17·9–26·2)	17·0 (12·9–23·9)	1·7 (1·1–2·6)	3·2 (1·4–5·9)	66·9 (58·4–75·8)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Serbia	132·4 (119·4–147·0)	24·2 (18·3–31·1)	50·3 (42·1–60·2)	9·6 (6·0–13·6)	9·9 (5·0–18·8)	2·9 (1·6–4·8)	1·0 (0·5–1·9)	34·6 (30·1–39·2)
Slovakia	296·8 (273·2–322·2)	30·2 (23·7–38·4)	84·4 (71·5–99·7)	13·6 (10·5–17·2)	10·8 (8·1–14·6)	3·6 (2·5–5·1)	0·0 (0·0–0·1)	154·2 (135·7–174·2)
Slovenia	335·3 (308·8–364·5)	35·5 (27·0–44·2)	116·5 (102·4–132·1)	18·2 (12·1–25·2)	18·5 (10·9–30·4)	2·3 (1·5–3·5)	0·0 (0·0–0·0)	144·2 (126·2–163·2)
Eastern Europe	278·6 (256·9–305·0)	31·8 (25·4–39·9)	85·7 (74·2–101·4)	12·8 (10·7–16·4)	10·5 (8·7–12·6)	4·2 (3·2–5·6)	1·9 (1·3–2·5)	131·7 (115·6–148·9)
Belarus	269·6 (251·3–288·1)	46·1 (39·7–53·5)	102·1 (90·6–114·7)	23·5 (18·8–28·1)	20·5 (15·1–27·5)	5·3 (3·8–6·8)	1·8 (0·8–4·4)	70·4 (61·4–79·8)
Estonia	293·6 (266·9–319·3)	32·6 (26·1–41·1)	67·1 (54·7–79·7)	13·1 (9·8–16·9)	21·7 (16·7–29·3)	3·9 (2·9–5·1)	0·0 (0·0–0·0)	155·1 (135·9–175·4)
Latvia	285·1 (258·3–312·5)	31·4 (24·8–38·2)	41·1 (29·6–53·4)	16·4 (12·4–21·0)	15·9 (11·4–24·0)	2·1 (1·4–3·1)	0·1 (0·0–0·1)	178·1 (156·3–201·1)
Lithuania	310·2 (283·5–335·3)	40·9 (33·6–50·2)	62·6 (52·3–78·0)	16·5 (12·2–21·6)	22·8 (15·2–32·6)	3·4 (2·5–4·5)	0·4 (0·2–0·8)	163·5 (143·8–184·8)
Moldova	163·9 (148·0–179·3)	35·4 (30·2–41·1)	52·8 (41·1–66·2)	8·7 (4·3–15·6)	12·0 (9·0–16·8)	1·7 (0·7–3·3)	0·7 (0·3–1·7)	52·7 (45·9–59·7)
Russia	299·4 (270·2–330·1)	28·3 (19·5–37·6)	92·4 (76·8–111·8)	12·1 (7·2–19·0)	8·9 (6·2–13·5)	4·2 (3·0–6·2)	2·0 (1·0–3·2)	151·4 (133·2–171·2)
Ukraine	207·9 (173·9–260·9)	40·6 (15·6–93·6)	63·4 (50·9–78·3)	12·7 (5·6–30·4)	12·4 (5·6–22·1)	4·3 (1·8–9·2)	1·7 (0·8–4·1)	72·7 (63·3–82·4)
High income	**513·6 (477·8–555·7)**	**36·5 (34·1–39·4)**	**121·8 (111·9–134·2)**	**16·8 (15·5–18·4)**	**20·6 (18·3–25·5)**	**4·0 (3·4–5·1)**	**0·1 (0·1–0·3)**	**313·8 (278·9–349·5)**
Australasia	665·7 (611·8–726·1)	40·4 (34·9–46·3)	128·4 (112·2–147·3)	21·1 (15·2–30·4)	10·2 (6·9–16·2)	7·8 (6·4–9·3)	3·2 (1·5–7·4)	454·7 (404·1–506·2)
Australia	682·0 (625·9–745·2)	41·0 (32·2–49·6)	129·1 (112·0–148·9)	22·1 (14·7–33·9)	9·1 (6·5–13·8)	7·6 (5·9–9·3)	3·3 (1·5–7·9)	469·8 (417·6–522·9)
New Zealand	585·3 (539·5–632·6)	37·5 (29·4–49·4)	125·0 (111·8–140·0)	15·8 (10·1–24·0)	15·3 (8·6–28·4)	8·6 (6·6–10·7)	2·6 (1·2–5·6)	380·5 (337·7–424·3)
High-income Asia Pacific	360·5 (335·5–387·5)	23·5 (18·9–29·9)	122·1 (115·7–129·6)	25·9 (20·8–31·7)	23·3 (15·8–38·2)	1·3 (1·0–1·6)	0·0 (0·0–0·0)	164·4 (144·8–185·3)
Brunei	225·4 (201·6–250·7)	19·6 (12·8–28·8)	58·5 (44·6–75·8)	6·6 (3·3–13·2)	7·0 (3·6–12·2)	8·5 (6·6–10·4)	0·0 (0·0–0·0)	125·3 (109·6–141·7)
Japan	404·6 (369·6–442·0)	24·3 (17·1–34·7)	117·3 (101·1–133·8)	30·3 (23·3–39·1)	23·5 (15·0–40·2)	1·2 (0·8–1·6)	0·0 (0·0–0·0)	208·0 (183·3–234·4)
South Korea	250·5 (222·3–280·6)	21·1 (15·5–28·5)	140·8 (120·1–166·4)	16·9 (11·0–26·8)	25·1 (17·3–36·9)	1·5 (1·0–2·1)	0·0 (0·0–0·0)	45·1 (39·3–51·1)
Singapore	403·3 (368·2–444·6)	28·5 (22·3–35·8)	64·7 (55·7–75·4)	14·1 (8·7–21·8)	5·7 (3·8–7·7)	0·2 (0·1–0·5)	0·0 (0·0–0·0)	290·1 (256·5–325·4)
High-income North America	669·4 (612·3–732·6)	29·7 (25·9–34·6)	156·2 (133·9–184·8)	13·2 (10·9–15·3)	20·5 (17·8–24·5)	2·3 (2·0–2·6)	0·1 (0·0–0·1)	447·4 (399·6–497·0)
Canada	597·8 (551·7–647·5)	27·6 (21·1–35·2)	110·6 (96·8–126·9)	15·5 (11·5–19·9)	18·2 (11·1–30·9)	0·5 (0·3–0·9)	0·1 (0·0–0·1)	425·4 (384·0–470·0)
Greenland	377·8 (328·1–451·3)	22·7 (11·9–43·1)	87·6 (48·2–144·7)	13·8 (3·0–54·2)	22·3 (11·1–39·2)	4·6 (2·0–9·4)	0·1 (0·1–0·3)	226·7 (200·3–255·8)
USA	677·7 (618·0–743·0)	29·9 (25·8–35·6)	161·4 (136·7–192·7)	12·9 (10·5–15·2)	20·8 (17·8–24·6)	2·5 (2·2–2·8)	0·1 (0·0–0·1)	450·0 (401·4–500·1)
Southern Latin America	213·9 (200·9–229·3)	44·8 (40·7–49·3)	58·5 (54·0–63·2)	7·7 (5·5–10·8)	16·8 (13·4–24·3)	3·5 (3·3–3·9)	0·1 (0·1–0·3)	82·4 (72·0–93·4)
Argentina	190·3 (174·6–210·2)	50·7 (44·7–56·9)	45·7 (37·0–54·8)	9·2 (6·4–13·3)	16·1 (10·3–27·4)	1·3 (1·1–1·7)	0·2 (0·1–0·5)	67·2 (58·6–76·2)
Chile	256·4 (237·0–277·7)	28·8 (23·0–34·4)	86·6 (76·5–98·4)	4·6 (3·0–7·4)	19·7 (14·6–25·7)	9·6 (8·3–11·0)	0·0 (0·0–0·0)	107·2 (93·6–121·4)
Uruguay	305·1 (279·3–333·0)	51·2 (40·4–64·5)	80·4 (68·9–94·0)	4·2 (2·7–6·3)	11·9 (7·6–17·4)	1·1 (0·7–1·4)	0·0 (0·0–0·1)	156·3 (137·0–176·7)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Western Europe	475·6 (443·1–511·1)	47·7 (44·9–51·8)	98·4 (87·5–113·8)	17·2 (16·2–19·0)	21·0 (18·4–26·3)	6·7 (4·9–10·1)	0·1 (0·0–0·1)	284·5 (252·5–317·3)
Andorra	467·5 (431·2–511·0)	44·2 (38·2–50·9)	42·9 (36·8–50·7)	13·6 (10·0–18·9)	23·5 (14·6–43·5)	2·2 (1·7–2·7)	0·0 (0·0–0·0)	341·2 (304·1–379·5)
Austria	419·9 (379·0–463·0)	50·9 (45·0–58·2)	77·8 (54·6–112·1)	19·8 (15·0–26·0)	22·5 (14·0–35·6)	3·1 (2·6–3·7)	0·0 (0·0–0·1)	245·7 (217·2–276·6)
Belgium	490·9 (442·8–541·6)	38·6 (32·0–47·7)	171·7 (141·7–211·4)	17·7 (13·4–23·2)	14·5 (10·3–19·7)	7·6 (5·3–10·8)	0·0 (0·0–0·0)	240·8 (213·3–271·4)
Cyprus	243·1 (220·7–268·1)	44·9 (36·9–52·8)	36·4 (25·9–48·4)	16·9 (8·4–32·7)	15·2 (10·3–21·3)	8·7 (4·1–16·7)	0·4 (0·2–0·9)	120·6 (105·4–136·5)
Denmark	798·1 (731·9–859·5)	55·0 (45·3–68·0)	113·9 (93·3–134·9)	17·7 (12·3–24·6)	19·6 (13·8–27·9)	7·1 (4·3–11·3)	0·0 (0·0–0·0)	584·8 (525·5–644·7)
Finland	646·0 (587·8–710·2)	32·6 (22·1–43·7)	145·3 (113·2–186·8)	20·8 (14·4–29·5)	20·0 (13·7–28·3)	5·2 (2·8–9·2)	0·0 (0·0–0·0)	422·0 (377·6–467·5)
France	367·6 (336·0–397·2)	33·7 (28·8–39·3)	81·6 (67·4–95·8)	37·2 (31·0–45·1)	12·8 (9·9–16·3)	4·3 (3·8–4·7)	0·2 (0·1–0·4)	197·8 (172·5–224·4)
Germany	533·5 (484·6–584·1)	52·1 (43·5–59·6)	130·7 (108·5–159·7)	17·8 (13·5–23·7)	23·8 (16·1–35·0)	11·7 (5·4–23·4)	0·0 (0·0–0·0)	297·4 (263·6–332·3)
Greece	188·2 (171·9–207·1)	44·2 (36·8–54·3)	40·6 (31·8–52·4)	11·4 (8·5–15·1)	14·0 (10·5–19·0)	3·2 (2·7–3·7)	0·0 (0·0–0·0)	74·8 (65·3–84·7)
Iceland	642·7 (595·4–694·6)	45·7 (39·4–53·7)	149·6 (133·5–163·7)	18·5 (14·5–23·3)	18·1 (14·0–22·5)	7·3 (6·7–8·0)	0·0 (0·0–0·0)	403·4 (358·8–448·9)
Ireland	599·6 (555·8–644·9)	25·3 (20·3–31·4)	139·4 (126·4–154·4)	14·0 (11·3–16·9)	19·4 (11·4–31·6)	9·9 (8·6–11·4)	0·0 (0·0–0·0)	391·6 (346·3–438·1)
Israel	395·0 (359·6–433·0)	34·7 (27·5–41·5)	57·1 (44·7–73·0)	11·7 (8·8–15·0)	22·6 (17·8–27·4)	2·6 (2·0–3·4)	0·3 (0·1–0·5)	266·2 (235·5–298·4)
Italy	265·7 (242·5–290·3)	43·1 (35·9–52·2)	61·6 (50·7–78·7)	16·4 (12·3–20·4)	17·7 (12·2–26·4)	3·1 (2·5–3·8)	0·1 (0·0–0·2)	123·7 (108·4–139·9)
Luxembourg	459·4 (414·8–507·5)	43·2 (25·0–64·5)	139·4 (119·8–164·3)	12·0 (6·1–23·5)	12·8 (7·6–20·9)	4·7 (2·3–9·1)	0·0 (0·0–0·0)	247·2 (218·1–279·2)
Malta	400·5 (369·3–432·9)	42·2 (34·3–49·9)	78·9 (69·8–88·8)	21·1 (14·4–29·2)	10·4 (6·8–16·5)	6·0 (5·2–7·0)	0·0 (0·0–0·1)	241·9 (213·5–273·0)
Monaco	642·7 (539·8–800·1)	80·5 (64·1–101·4)	213·6 (124·1–367·4)	29·4 (20·4–43·0)	23·9 (13·1–46·7)	6·7 (2·6–13·7)	0·0 (0·0–0·0)	288·7 (253·3–324·4)
Netherlands	769·6 (712·1–827·1)	52·7 (44·2–63·6)	97·8 (81·1–114·7)	14·5 (9·6–19·9)	20·4 (14·6–27·9)	16·4 (8·8–26·4)	0·0 (0·0–0·0)	567·9 (511·5–627·1)
Norway	958·4 (856·4–1073·5)	51·5 (44·6–60·5)	184·1 (106·6–292·9)	16·3 (9·4–30·1)	13·7 (9·7–19·1)	9·9 (4·7–19·5)	0·0 (0·0–0·0)	682·8 (614·9–753·7)
Portugal	268·8 (249·0–291·1)	34·2 (27·0–41·9)	78·2 (70·6–86·8)	14·0 (10·8–18·0)	18·9 (14·0–25·4)	3·7 (3·1–4·3)	0·7 (0·3–1·6)	119·1 (104·1–134·7)
San Marino	407·7 (373·0–444·4)	43·0 (35·5–51·8)	84·3 (69·9–100·2)	19·9 (14·2–29·2)	21·9 (12·1–41·6)	5·6 (4·4–7·0)	0·0 (0·0–0·0)	233·1 (207·3–261·5)
Spain	366·7 (340·6–397·3)	64·3 (56·4–74·4)	74·3 (64·6–87·2)	27·0 (22·4–32·5)	17·7 (13·1–24·7)	2·2 (1·8–2·5)	0·0 (0·0–0·0)	181·2 (160·2–204·5)
Sweden	862·3 (795·8–937·5)	52·9 (40·8–68·8)	112·6 (94·4–134·6)	14·5 (10·1–21·1)	20·3 (11·8–35·8)	9·1 (8·1–10·5)	0·0 (0·0–0·0)	653·0 (586·8–719·0)
Switzerland	766·0 (705·8–830·1)	42·4 (36·4–50·8)	184·1 (157·7–210·7)	24·4 (17·5–33·9)	24·2 (14·9–38·2)	4·1 (3·5–4·9)	0·0 (0·0–0·0)	486·7 (430·8–547·1)
UK	494·9 (456·3–540·0)	41·4 (35·2–49·2)	87·7 (72·0–107·2)	12·3 (8·8–17·0)	25·7 (15·5–41·2)	5·8 (4·1–8·2)	0·1 (0·0–0·1)	321·9 (286·4–358·0)
Latin America and Caribbean	**129·9 (121·6–140·6)**	**23·1 (20·3–26·6)**	**41·6 (35·3–49·0)**	**4·7 (3·9–6·2)**	**14·3 (11·4–17·6)**	**1·1 (0·8–1·6)**	**10·8 (9·7–12·2)**	**34·3 (29·9–38·9)**
Andean Latin America	108·5 (100·3–116·0)	19·5 (17·1–22·8)	31·0 (25·7–36·5)	4·6 (3·5–6·2)	7·6 (5·8–9·9)	4·0 (3·7–4·3)	0·4 (0·3–0·7)	41·4 (36·1–46·9)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Bolivia	134·2 (117·5–152·2)	15·6 (10·7–23·1)	47·5 (36·8–61·4)	11·2 (7·6–16·1)	16·7 (11·9–23·9)	1·1 (0·4–2·3)	0·1 (0·0–0·1)	42·0 (36·6–47·6)
Ecuador	108·8 (93·7–125·2)	29·5 (20·1–39·5)	30·9 (20·4–44·0)	1·6 (0·9–2·8)	11·8 (7·3–17·3)	0·9 (0·5–1·6)	1·6 (0·9–2·5)	32·5 (28·3–36·9)
Peru	99·9 (90·7–110·6)	15·9 (12·2–20·1)	25·5 (20·0–32·8)	3·9 (2·5–6·7)	2·6 (1·1–5·4)	6·4 (6·0–6·9)	0·0 (0·0–0·0)	45·6 (39·7–51·7)
Caribbean	140·4 (124·8–161·1)	45·0 (38·6–56·3)	39·0 (27·9–54·6)	6·2 (4·6–11·1)	9·1 (7·1–11·9)	2·0 (0·7–4·8)	3·5 (1·6–8·3)	35·7 (31·2–40·4)
Antigua and Barbuda	218·5 (182·4–259·8)	34·1 (18·5–58·7)	62·1 (39·7–90·4)	9·5 (3·3–25·8)	3·3 (1·4–6·4)	28·2 (18·8–41·8)	3·1 (1·4–7·2)	78·2 (68·3–88·6)
The Bahamas	341·9 (304·8–386·9)	27·2 (13·4–49·6)	44·0 (27·2–63·5)	10·6 (3·6–33·7)	6·6 (2·8–13·3)	NA	0·1 (0·1–0·4)	249·7 (221·5–280·4)
Barbados	205·6 (183·0–226·4)	28·0 (21·5–36·1)	40·5 (33·1–49·1)	15·3 (9·7–23·0)	7·1 (2·9–15·2)	5·2 (2·7–9·3)	0·6 (0·3–1·4)	108·9 (95·3–123·3)
Belize	77·3 (64·9–91·3)	14·5 (7·1–28·1)	22·5 (17·5–29·3)	10·0 (5·6–15·9)	3·2 (1·5–6·6)	1·9 (0·6–4·3)	4·9 (2·2–11·9)	20·1 (17·5–22·8)
Bermuda	748·9 (650·5–856·3)	58·1 (21·3–114·7)	76·6 (32·2–165·8)	15·3 (5·2–43·2)	14·4 (5·6–30·8)	3·6 (0·9–9·6)	0·2 (0·1–0·5)	580·6 (523·6–642·6)
Cuba	283·4 (249·4–322·0)	96·6 (80·9–115·2)	77·1 (53·2–108·8)	10·2 (5·0–24·0)	24·1 (17·8–34·1)	2·6 (0·6–6·8)	4·5 (1·9–10·8)	68·4 (59·7–77·5)
Dominica	130·0 (99·2–170·9)	15·8 (8·0–29·7)	69·6 (43·5–103·7)	9·9 (3·3–27·5)	4·9 (1·9–9·6)	NA	3·9 (1·7–9·4)	22·7 (19·8–25·8)
Dominican Republic	122·1 (109·8–136·2)	54·6 (45·9–64·3)	28·4 (20·9–37·2)	3·4 (2·1–5·3)	5·9 (3·6–9·8)	2·3 (0·6–6·0)	3·3 (1·6–7·5)	24·3 (21·2–27·6)
Grenada	118·0 (95·0–145·5)	18·0 (9·3–33·7)	52·5 (34·0–72·8)	11·4 (5·6–19·6)	4·2 (1·8–8·8)	NA	3·8 (1·7–6·4)	25·6 (22·4–29·1)
Guyana	104·6 (87·2–128·7)	16·0 (8·5–28·0)	46·9 (31·2–66·1)	5·7 (2·8–11·7)	5·1 (2·4–9·6)	4·5 (3·1–6·6)	6·6 (4·2–10·0)	19·8 (17·2–22·4)
Haiti	24·9 (18·9–34·8)	3·1 (1·2–7·3)	7·6 (3·3–16·1)	1·0 (0·3–3·1)	0·3 (0·1–0·8)	0·3 (0·1–0·7)	4·0 (1·8–9·6)	8·5 (7·4–9·7)
Jamaica	74·5 (64·2–86·8)	5·7 (3·0–10·2)	17·8 (11·6–24·8)	5·0 (2·6–10·6)	3·0 (1·5–5·9)	1·6 (0·6–3·3)	3·4 (1·8–6·2)	38·0 (33·1–43·1)
Puerto Rico	221·0 (145·4–353·2)	63·1 (23·0–151·3)	85·2 (35·8–184·3)	18·3 (5·5–58·6)	15·1 (5·8–33·9)	4·6 (1·1–12·1)	0·0 (0·0–0·0)	34·7 (30·3–39·4)
Saint Kitts and Nevis	206·9 (182·4–240·1)	36·8 (22·5–56·9)	65·6 (51·0–85·1)	10·5 (3·6–29·7)	8·5 (3·7–15·9)	NA	0·8 (0·3–1·3)	81·8 (71·4–92·6)
Saint Lucia	155·1 (124·8–187·1)	61·3 (41·3–88·6)	43·7 (26·8–65·0)	7·1 (3·0–16·6)	4·9 (2·1–10·6)	8·0 (6·1–10·4)	4·4 (1·9–10·8)	25·6 (22·3–29·1)
Saint Vincent and the Grenadines	106·6 (80·7–143·1)	18·8 (7·8–43·9)	61·2 (40·2–88·0)	5·3 (1·8–12·8)	4·6 (1·8–10·5)	2·5 (0·6–6·6)	4·4 (2·0–9·9)	9·8 (8·6–11·2)
Suriname	93·5 (81·0–106·6)	14·9 (10·6–20·1)	26·4 (18·1–37·1)	5·0 (2·6–8·8)	3·4 (1·8–6·0)	1·7 (0·8–3·2)	3·9 (1·9–8·4)	38·1 (33·2–43·2)
Trinidad and Tobago	151·6 (134·8–170·2)	47·8 (38·7–58·8)	45·8 (37·2–56·4)	16·6 (9·1–28·2)	6·5 (3·4–12·3)	0·5 (0·1–1·4)	0·2 (0·1–0·4)	34·3 (30·0–38·9)
Virgin Islands	265·9 (194·3–391·3)	66·3 (24·2–159·0)	78·5 (32·9–169·8)	16·8 (5·5–49·3)	14·8 (5·9–31·4)	3·8 (1·0–10·2)	0·1 (0·0–0·2)	85·7 (74·9–97·1)
Central Latin America	104·2 (96·0–114·7)	21·6 (16·9–26·5)	30·7 (26·5–35·1)	4·4 (3·8–5·4)	12·8 (8·5–19·8)	0·6 (0·4–0·8)	6·3 (4·9–8·3)	27·8 (24·3–31·6)
Colombia	135·8 (116·5–163·3)	26·4 (20·9–32·7)	20·4 (15·0–26·9)	13·7 (11·3–17·3)	31·3 (15·1–58·5)	0·7 (0·2–1·8)	2·8 (1·2–6·7)	40·6 (35·4–46·1)
Costa Rica	139·1 (122·9–158·9)	19·9 (14·2–27·4)	28·3 (22·5–35·8)	20·2 (14·3–27·3)	27·4 (19·0–42·5)	0·5 (0·1–1·5)	1·0 (0·5–2·3)	41·6 (36·3–47·2)
El Salvador	84·5 (74·4–96·3)	16·2 (11·9–21·7)	30·4 (24·8–37·3)	1·0 (0·5–1·7)	12·9 (9·3–18·3)	0·2 (0·1–0·5)	10·9 (7·9–14·9)	12·8 (11·2–14·6)
Guatemala	69·8 (57·8–86·0)	15·0 (7·6–27·1)	26·0 (18·5–35·4)	5·4 (3·0–9·2)	6·5 (3·1–12·4)	0·2 (0·0–0·4)	0·2 (0·1–0·5)	16·5 (14·4–18·7)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Honduras	40·1 (31·3–50·6)	8·3 (3·9–15·7)	11·3 (6·4–18·2)	1·9 (0·7–4·8)	7·0 (3·7–11·3)	3·1 (2·2–4·7)	7·0 (3·6–11·8)	1·6 (1·4–1·8)
Mexico	110·7 (100·1–121·8)	24·6 (18·4–31·0)	39·3 (32·2–46·6)	1·1 (0·6–1·8)	8·9 (6·7–11·4)	0·3 (0·1–0·6)	10·1 (6·7–14·5)	26·5 (23·1–30·0)
Nicaragua	63·3 (48·8–85·3)	10·9 (3·8–20·7)	20·6 (11·6–36·0)	1·7 (0·6–4·2)	7·4 (3·0–15·9)	0·5 (0·1–1·3)	3·6 (1·6–8·7)	18·7 (16·3–21·2)
Panama	180·6 (162·7–198·9)	17·8 (13·1–25·1)	49·4 (40·4–59·8)	6·2 (4·2–8·6)	8·5 (5·6–12·8)	3·7 (2·9–4·7)	0·6 (0·3–1·4)	94·4 (82·4–106·9)
Venezuela	62·9 (50·8–79·5)	13·6 (7·1–24·0)	19·8 (11·7–30·3)	2·8 (1·0–6·8)	4·4 (2·0–9·4)	0·5 (0·1–1·4)	0·0 (0·0–0·0)	21·7 (19·0–24·7)
Tropical Latin America	164·9 (147·3–188·2)	21·3 (16·4–27·6)	58·4 (44·2–76·9)	4·8 (3·1–7·6)	19·0 (14·0–24·6)	0·7 (0·3–1·3)	21·0 (16·6–26·0)	39·7 (34·7–45·1)
Brazil	167·1 (149·4–190·5)	21·4 (16·0–28·1)	59·3 (45·0–77·9)	4·7 (3·1–7·5)	19·4 (14·3–25·1)	NA	21·5 (17·1–26·7)	40·2 (35·1–45·6)
Paraguay	94·3 (77·0–114·6)	18·7 (10·0–32·0)	28·4 (17·2–45·5)	6·5 (3·1–11·4)	7·4 (3·2–15·5)	6·8 (4·4–10·0)	2·4 (1·1–5·6)	24·1 (21·0–27·3)
North Africa and Middle East	**76·4 (72·1–81·5)**	**14·5 (12·7–17·5)**	**21·8 (20·0–24·1)**	**9·2 (7·3–12·0)**	**5·1 (4·5–6·0)**	**3·0 (2·8–3·4)**	**1·1 (0·9–1·5)**	**21·7 (19·0–24·5)**
Afghanistan	23·1 (18·8–28·7)	4·0 (1·9–7·9)	4·8 (2·4–8·9)	1·7 (0·8–3·9)	0·4 (0·2–0·8)	2·2 (1·8–2·8)	7·9 (6·9–9·1)	2·0 (1·7–2·2)
Algeria	52·5 (42·7–63·0)	18·3 (12·9–25·2)	13·4 (8·0–20·7)	5·1 (2·3–10·2)	4·0 (2·2–6·3)	2·1 (1·7–2·6)	0·3 (0·1–0·7)	9·4 (8·2–10·7)
Bahrain	170·2 (151·5–190·7)	9·7 (5·3–16·4)	26·2 (18·4–36·6)	4·2 (2·1–8·6)	1·6 (1·1–2·2)	NA	0·0 (0·0–0·1)	125·3 (109·7–141·8)
Egypt	64·3 (52·8–80·8)	11·5 (7·1–18·3)	24·7 (16·7–35·3)	8·5 (3·7–17·4)	3·1 (1·8–5·4)	1·5 (0·4–4·4)	0·2 (0·1–0·3)	14·8 (12·9–16·8)
Iran	77·4 (66·6–87·6)	18·9 (13·8–25·2)	22·2 (15·3–30·3)	6·1 (3·4–10·3)	6·7 (4·5–9·3)	8·7 (8·2–9·4)	3·1 (1·9–5·1)	11·7 (10·2–13·3)
Iraq	51·1 (43·1–59·8)	11·1 (7·4–16·1)	12·3 (8·0–17·2)	10·4 (6·9–14·3)	5·3 (3·5–7·4)	2·0 (1·5–2·6)	0·7 (0·3–1·3)	9·4 (8·2–10·6)
Jordan	88·1 (77·3–100·0)	9·7 (5·5–15·6)	29·9 (23·7–37·5)	15·9 (10·7–22·8)	8·6 (6·1–12·1)	6·4 (5·0–8·3)	0·0 (0·0–0·0)	17·6 (15·3–20·0)
Kuwait	290·5 (260·0–330·4)	25·4 (17·4–36·6)	64·9 (47·5–87·9)	16·1 (9·4–25·3)	11·4 (6·7–18·0)	NA	0·0 (0·0–0·0)	168·8 (148·3–190·8)
Lebanon	90·0 (76·8–108·2)	26·9 (18·6–38·3)	18·4 (11·3–27·6)	18·2 (11·6–27·6)	12·2 (8·6–17·3)	1·4 (0·8–2·2)	0·2 (0·1–0·6)	12·7 (11·0–14·4)
Libya	110·2 (84·2–142·7)	22·3 (12·0–37·6)	57·9 (35·9–86·9)	8·5 (4·6–16·2)	8·4 (5·1–12·4)	1·8 (0·9–3·2)	0·2 (0·1–0·5)	11·2 (9·7–12·7)
Morocco	36·1 (27·4–47·7)	9·7 (5·0–17·9)	11·1 (5·9–18·6)	3·8 (1·5–9·1)	2·4 (1·0–4·7)	1·9 (1·5–2·4)	0·3 (0·1–0·7)	6·9 (6·0–7·8)
Oman	123·2 (113·5–136·1)	21·1 (15·9–27·8)	43·6 (36·0–52·9)	12·3 (9·0–16·0)	4·6 (3·2–6·3)	2·0 (1·6–2·5)	0·2 (0·1–0·5)	39·4 (34·4–44·7)
Palestine	61·5 (40·1–91·7)	10·3 (3·8–24·5)	34·6 (17·6–60·9)	6·4 (1·2–26·7)	3·0 (0·9–7·7)	2·5 (1·5–3·7)	0·3 (0·1–0·7)	4·4 (3·8–5·0)
Qatar	391·6 (358·0–427·7)	28·7 (22·6–36·6)	81·1 (68·6–95·7)	14·0 (10·2–17·8)	10·4 (8·0–13·2)	1·2 (0·8–1·6)	0·2 (0·1–0·5)	255·9 (226·4–287·8)
Saudi Arabia	204·7 (191·6–219·0)	34·7 (30·0–40·1)	63·8 (56·8–71·8)	15·5 (12·3–21·0)	10·1 (7·6–13·7)	1·5 (1·2–1·8)	1·3 (0·8–2·0)	77·9 (68·0–88·3)
Sudan	38·7 (27·3–53·7)	6·7 (2·7–14·9)	17·5 (9·6–29·5)	3·5 (1·1–10·7)	4·1 (1·9–7·9)	4·6 (2·5–7·4)	0·5 (0·2–0·9)	1·7 (1·5–1·9)
Syria	87·1 (76·5–100·8)	20·5 (14·5–28·8)	20·0 (14·5–27·6)	22·1 (15·9–30·3)	13·2 (10·1–17·5)	2·3 (1·7–3·3)	0·3 (0·1–0·7)	8·6 (7·5–9·8)
Tunisia	55·7 (45·5–67·3)	14·6 (9·6–21·5)	25·0 (17·8–33·5)	3·7 (1·8–6·9)	4·9 (2·9–8·1)	2·3 (1·0–4·6)	0·3 (0·1–0·6)	4·8 (4·2–5·4)
Türkiye	79·1 (67·1–92·3)	16·1 (11·4–22·4)	15·5 (10·4–21·5)	18·7 (10·9–29·0)	6·1 (4·2–8·2)	1·7 (1·3–2·2)	0·0 (0·0–0·0)	21·0 (18·3–23·9)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
United Arab Emirates	418·9 (383·6–458·4)	31·0 (26·2–36·8)	66·1 (54·4–80·5)	17·5 (14·2–20·9)	12·7 (10·0–16·3)	0·8 (0·4–1·3)	0·0 (0·0–0·0)	290·9 (257·4–327·0)
Yemen	17·5 (13·6–22·6)	2·1 (0·9–4·7)	6·6 (3·7–10·3)	1·9 (0·7–4·9)	0·5 (0·2–1·0)	1·6 (1·4–2·0)	0·1 (0·0–0·2)	4·6 (4·0–5·2)
South Asia	**68·6 (60·7–78·5)**	**10·0 (6·6–15·7)**	**10·2 (6·6–15·6)**	**8·2 (5·4–12·6)**	**2·2 (1·3–3·6)**	**1·7 (0·9–3·0)**	**13·6 (10·5–17·6)**	**22·8 (19·9–25·9)**
Bangladesh	56·7 (50·4–64·0)	7·9 (5·3–12·1)	5·7 (3·1–9·4)	11·0 (9·5–14·2)	1·2 (0·9–1·5)	1·7 (1·0–2·6)	7·1 (4·4–10·4)	22·1 (19·3–25·0)
Bhutan	95·7 (84·6–109·7)	8·6 (5·7–12·6)	30·5 (24·1–38·5)	5·8 (3·8–8·2)	3·4 (2·7–4·2)	0·8 (0·3–2·1)	12·3 (7·8–17·6)	34·3 (29·9–38·9)
India	73·1 (63·4–86·2)	10·5 (6·1–18·0)	10·8 (6·0–18·2)	8·1 (4·4–13·7)	2·5 (1·3–4·3)	1·2 (0·4–2·6)	16·2 (12·2–21·4)	23·9 (20·8–27·1)
Nepal	85·2 (75·1–96·5)	10·1 (6·8–15·0)	29·1 (21·4–36·8)	6·2 (4·3–9·5)	2·7 (1·8–4·0)	12·3 (10·7–14·1)	16·6 (13·8–19·5)	8·2 (7·2–9·3)
Pakistan	49·0 (42·6–56·3)	8·4 (5·1–12·6)	7·2 (4·8–10·6)	7·2 (4·6–10·4)	1·0 (0·6–1·5)	3·2 (1·6–5·5)	3·0 (1·8–4·3)	19·1 (16·6–21·7)
Southeast Asia, east Asia, and Oceania	**118·1 (108·6–130·0)**	**23·9 (18·2–31·8)**	**42·0 (37·8–47·6)**	**7·3 (5·0–10·5)**	**8·1 (4·5–13·9)**	**3·9 (2·7–5·5)**	**13·5 (10·9–16·1)**	**19·6 (17·1–22·2)**
East Asia	129·2 (116·4–145·2)	31·1 (23·6–40·9)	51·2 (44·5–59·9)	8·2 (5·3–11·7)	10·6 (5·5–18·9)	1·0 (0·5–2·1)	5·6 (3·4–7·9)	21·6 (18·9–24·5)
China	129·1 (115·2–146·0)	31·7 (23·7–41·7)	50·5 (43·1–59·8)	7·8 (4·9–11·5)	10·6 (5·0–19·3)	0·7 (0·2–1·8)	5·6 (3·3–8·1)	22·1 (19·3–25·1)
North Korea	79·7 (59·9–108·0)	10·0 (3·6–23·9)	44·9 (29·3–67·9)	7·7 (3·9–16·4)	3·9 (1·5–8·2)	4·0 (1·1–10·2)	5·4 (2·3–13·1)	3·8 (3·3–4·3)
Taiwan*	191·2 (139·5–255·6)	17·3 (7·8–33·9)	97·5 (58·2–149·5)	31·6 (14·7–67·3)	19·0 (9·5–35·0)	13·8 (5·1–30·2)	0·0 (0·0–0·0)	12·0 (10·4–13·6)
Oceania	28·1 (23·6–34·0)	2·6 (1·8–4·5)	12·8 (10·4–18·3)	1·0 (0·5–2·2)	1·1 (0·7–1·8)	1·6 (0·8–3·5)	5·4 (2·9–9·9)	3·6 (3·1–4·1)
American Samoa	125·9 (77·4–209·8)	16·1 (5·9–38·6)	78·1 (32·8–169·0)	6·2 (2·2–16·6)	9·1 (3·6–19·5)	6·7 (1·7–17·8)	4·1 (1·8–9·9)	5·7 (4·9–6·4)
Cook Islands	190·1 (165·1–220·2)	17·6 (11·0–27·5)	80·0 (63·3–101·4)	7·6 (4·0–14·9)	14·1 (8·0–21·9)	20·1 (8·8–38·8)	4·7 (2·1–11·4)	45·9 (40·1–52·1)
Fiji	72·0 (55·0–92·2)	11·9 (5·8–22·6)	36·1 (22·9–52·0)	4·4 (1·9–10·3)	4·0 (2·3–6·3)	4·0 (1·8–8·1)	0·3 (0·1–0·8)	11·4 (10·0–13·0)
Guam	207·0 (157·4–278·2)	24·0 (8·8–57·6)	139·8 (91·8–205·6)	9·8 (3·4–27·0)	16·1 (6·4–34·3)	8·6 (2·2–22·9)	0·1 (0·0–0·2)	8·6 (7·5–9·7)
Kiribati	75·7 (53·1–102·8)	4·2 (1·6–9·8)	45·0 (26·4–67·4)	2·1 (0·9–4·4)	1·9 (0·8–3·6)	10·5 (3·0–24·0)	5·9 (2·6–14·4)	6·1 (5·3–7·0)
Marshall Islands	85·3 (62·3–114·5)	8·5 (3·3–19·6)	49·4 (29·1–73·6)	2·5 (0·8–7·6)	5·3 (2·6–10·0)	4·7 (1·3–11·8)	8·4 (3·7–18·2)	6·6 (5·8–7·5)
Federated States of Micronesia	58·6 (43·7–77·5)	10·6 (5·7–18·7)	25·9 (14·2–41·6)	3·0 (1·2–6·9)	3·2 (1·2–6·6)	2·6 (0·7–6·6)	3·5 (1·5–8·4)	9·8 (8·6–11·1)
Nauru	143·7 (107·7–200·4)	14·1 (6·6–25·6)	88·4 (57·1–138·8)	10·9 (6·7–17·4)	7·4 (3·9–11·9)	5·9 (1·5–15·6)	6·6 (3·2–11·3)	10·4 (9·1–11·8)
Niue	200·8 (150·5–261·3)	18·4 (7·3–35·7)	137·8 (99·8–192·6)	6·4 (2·6–16·3)	17·9 (7·2–36·0)	12·7 (3·5–37·6)	0·7 (0·3–1·6)	6·9 (6·0–7·8)
Northern Mariana Islands	158·7 (96·4–267·8)	21·4 (7·8–51·3)	100·1 (42·1–216·7)	8·3 (3·0–21·8)	13·4 (5·3–28·5)	7·4 (1·9–19·6)	0·2 (0·1–0·6)	8·0 (6·9–9·0)
Palau	187·9 (172·7–205·1)	23·1 (18·4–28·6)	72·4 (61·1–85·2)	8·3 (5·2–14·4)	11·5 (8·3–16·4)	1·7 (0·4–4·5)	6·4 (3·1–13·2)	64·4 (56·2–73·0)
Papua New Guinea	16·1 (11·8–22·5)	1·0 (0·4–2·3)	5·7 (2·5–11·8)	0·3 (0·1–1·1)	0·3 (0·2–0·6)	0·8 (0·2–2·1)	5·8 (3·2–9·9)	2·1 (1·8–2·4)
Samoa	53·8 (39·1–70·6)	6·4 (3·3–12·1)	28·6 (17·2–42·6)	1·9 (0·9–3·6)	3·0 (1·6–5·3)	5·1 (1·5–11·8)	5·1 (2·2–12·5)	3·7 (3·2–4·2)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Solomon Islands	41·8 (31·5–55·7)	2·8 (1·1–6·3)	19·1 (10·5–31·7)	1·3 (0·4–4·1)	1·1 (0·7–1·6)	2·4 (0·6–6·3)	6·5 (2·8–15·8)	8·7 (7·6–9·9)
Tokelau	323·1 (285·8–366·0)	20·7 (14·5–28·6)	197·4 (166·3–232·1)	6·3 (2·3–16·8)	19·0 (11·3–27·9)	51·3 (35·8–72·9)	4·0 (1·8–9·8)	24·4 (21·2–27·6)
Tonga	80·7 (67·8–95·6)	11·2 (7·1–17·5)	46·4 (37·5–58·1)	3·7 (1·9–6·4)	5·4 (2·9–8·7)	3·4 (0·9–8·5)	4·9 (2·2–12·0)	5·6 (4·9–6·4)
Tuvalu	87·7 (66·2–115·2)	13·9 (7·6–23·8)	45·8 (30·8–64·9)	4·0 (1·7–10·1)	3·6 (1·8–6·7)	11·5 (3·1–32·3)	5·3 (2·3–12·8)	3·7 (3·2–4·2)
Vanuatu	35·5 (24·3–49·2)	2·3 (0·8–5·3)	17·1 (8·8–33·3)	1·3 (0·4–4·1)	1·1 (0·6–1·8)	3·3 (0·9–8·6)	7·2 (3·4–16·1)	3·3 (2·8–3·7)
Southeast Asia	96·8 (88·6–107·7)	9·5 (6·6–14·2)	23·5 (20·1–27·9)	5·5 (3·8–8·0)	2·9 (2·1–4·5)	9·9 (7·2–13·8)	29·9 (24·0–37·4)	15·6 (13·6–17·7)
Cambodia	37·0 (28·1–48·3)	7·1 (3·5–12·5)	10·5 (5·9–16·3)	1·6 (0·6–4·2)	0·8 (0·4–1·4)	7·4 (3·2–16·4)	1·6 (0·7–4·0)	8·1 (7·0–9·2)
Indonesia	75·6 (65·0–87·4)	6·6 (4·0–10·6)	26·8 (20·4–34·8)	4·0 (2·5–6·9)	1·8 (1·3–2·5)	16·3 (10·0–25·3)	2·0 (0·9–4·3)	18·2 (15·8–20·6)
Laos	34·7 (28·2–44·1)	4·5 (2·3–8·4)	12·6 (8·0–18·0)	3·8 (1·7–8·7)	1·1 (0·6–1·7)	2·9 (0·9–6·5)	0·7 (0·3–1·6)	9·1 (7·9–10·3)
Malaysia	126·8 (117·5–137·8)	24·5 (20·2–29·7)	46·8 (40·7–53·1)	8·6 (6·3–11·7)	6·8 (4·8–9·8)	0·5 (0·1–1·3)	3·8 (1·6–9·1)	35·8 (31·2–40·6)
Maldives	144·9 (121·1–169·8)	17·7 (11·3–26·4)	66·9 (46·6–91·3)	15·9 (10·7–22·8)	2·7 (1·7–3·9)	3·2 (1·3–6·5)	9·0 (5·2–12·9)	29·5 (25·8–33·5)
Mauritius	105·5 (89·1–124·1)	27·8 (19·7–38·9)	42·8 (34·0–54·1)	13·4 (7·9–21·1)	6·4 (3·2–11·9)	6·0 (1·6–14·8)	3·7 (1·7–8·7)	5·6 (4·9–6·3)
Myanmar	32·3 (24·0–42·0)	8·6 (4·5–15·2)	9·6 (5·0–16·3)	2·1 (0·8–6·5)	1·1 (0·6–1·7)	4·7 (1·4–10·7)	0·7 (0·3–1·8)	5·5 (4·8–6·2)
Philippines	132·7 (110·7–163·5)	9·2 (5·3–15·0)	16·0 (10·1–23·1)	10·8 (6·4–17·1)	4·8 (2·5–8·6)	8·5 (3·9–16·5)	74·9 (52·6–103·6)	8·4 (7·3–9·6)
Seychelles	201·5 (178·2–226·4)	68·5 (54·5–85·5)	69·0 (56·0–83·2)	14·1 (10·2–18·7)	13·1 (8·9–18·1)	28·5 (19·6–39·0)	1·0 (0·4–2·5)	7·3 (6·3–8·3)
Sri Lanka	56·0 (46·6–66·8)	11·7 (8·1–16·3)	22·2 (16·7–28·4)	2·9 (1·4–6·0)	1·2 (0·9–1·6)	5·4 (2·2–11·6)	4·0 (1·7–9·7)	8·7 (7·6–9·8)
Thailand	214·8 (183·2–255·0)	11·9 (7·5–18·5)	28·3 (20·8–37·3)	5·0 (2·7–8·5)	4·7 (2·5–8·5)	2·8 (0·7–7·4)	149·0 (118·5–191·6)	13·2 (11·5–14·9)
Timor-Leste	36·5 (28·0–45·5)	9·1 (4·9–15·9)	14·3 (9·0–20·7)	4·0 (1·9–9·4)	0·8 (0·4–1·5)	4·0 (1·9–7·4)	2·0 (0·9–4·9)	2·4 (2·1–2·7)
Viet Nam	80·9 (64·6–104·7)	11·6 (7·0–18·4)	22·0 (11·6–40·9)	6·0 (2·7–12·8)	2·9 (1·2–7·0)	6·4 (1·9–13·9)	11·4 (5·2–23·9)	20·5 (17·9–23·3)
Sub-Saharan Africa	**41·2 (37·4–45·3)**	**2·9 (2·2–4·5)**	**14·5 (11·6–18·1)**	**1·8 (1·4–2·6)**	**0·7 (0·6–0·9)**	**2·7 (2·4–3·1)**	**10·1 (9·0–11·6)**	**8·5 (7·4–9·7)**
Central sub-Saharan Africa	62·2 (57·0–67·0)	3·0 (2·1–5·0)	15·5 (12·2–19·6)	0·8 (0·4–2·2)	0·5 (0·3–0·8)	0·8 (0·6–1·0)	35·7 (32·2–39·2)	5·9 (5·2–6·7)
Angola	34·5 (24·9–43·9)	3·8 (1·9–6·9)	21·9 (13·9–31·5)	2·1 (0·9–4·6)	0·7 (0·4–1·1)	1·2 (0·5–2·4)	0·7 (0·3–1·6)	4·1 (3·6–4·7)
Central African Republic	11·9 (9·3–15·6)	0·7 (0·3–1·7)	3·4 (1·6–6·8)	0·4 (0·2–0·8)	0·1 (0·1–0·3)	1·0 (0·5–1·9)	2·8 (1·8–4·1)	3·4 (3·0–3·9)
Congo (Brazzaville)	27·2 (21·1–36·0)	2·1 (0·9–4·7)	12·1 (6·6–20·2)	0·5 (0·2–1·2)	0·6 (0·2–1·4)	2·0 (1·4–3·0)	1·7 (0·8–4·2)	8·1 (7·1–9·2)
DR Congo	77·9 (69·5–86·4)	2·8 (1·1–6·2)	13·9 (8·3–20·7)	0·4 (0·1–1·3)	0·4 (0·2–0·8)	0·5 (0·2–0·9)	54·2 (49·0–59·7)	5·9 (5·1–6·6)
Equatorial Guinea	47·8 (39·5–59·2)	2·9 (1·1–6·5)	15·3 (8·6–25·2)	1·2 (0·5–2·4)	1·2 (0·5–2·4)	0·3 (0·1–0·7)	0·9 (0·4–1·9)	26·1 (22·7–29·6)
Gabon	73·3 (62·9–85·5)	8·6 (5·4–13·9)	32·0 (23·4–43·3)	2·5 (1·1–5·5)	0·7 (0·4–1·1)	4·9 (4·0–5·9)	0·7 (0·3–1·6)	23·9 (20·9–27·1)
Eastern sub-Saharan Africa	33·0 (29·3–36·7)	3·5 (2·7–5·3)	11·0 (8·6–13·7)	1·7 (1·1–2·8)	0·5 (0·3–0·7)	2·0 (1·7–2·4)	7·1 (5·6–9·1)	7·3 (6·3–8·2)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Burundi	28·4 (22·8–35·0)	2·3 (0·9–5·1)	9·4 (5·7–13·9)	0·6 (0·1–2·2)	0·2 (0·1–0·4)	0·3 (0·1–0·6)	9·0 (5·9–12·6)	6·6 (5·8–7·5)
Comoros	40·1 (31·7–49·9)	10·3 (6·5–16·1)	10·4 (5·8–16·6)	2·5 (1·1–5·7)	0·9 (0·5–1·4)	6·8 (5·7–7·9)	4·0 (1·7–9·6)	5·3 (4·6–6·0)
Djibouti	22·0 (15·5–31·8)	5·3 (2·3–11·3)	3·9 (1·8–8·5)	3·2 (0·9–10·0)	0·9 (0·3–1·7)	0·9 (0·4–1·9)	3·8 (1·7–9·2)	4·0 (3·5–4·5)
Eritrea	25·8 (20·8–32·7)	1·6 (0·6–3·6)	9·3 (5·2–14·4)	2·0 (0·8–5·0)	0·6 (0·4–1·1)	0·3 (0·1–0·6)	5·7 (3·3–9·3)	6·3 (5·5–7·2)
Ethiopia	27·7 (21·9–35·2)	3·8 (1·7–7·9)	10·5 (6·2–16·1)	2·6 (1·3–5·5)	0·5 (0·3–0·9)	2·0 (1·5–2·9)	3·8 (2·8–4·8)	4·4 (3·8–5·0)
Kenya	58·5 (50·9–67·2)	3·0 (1·3–6·6)	20·6 (14·5–28·1)	2·2 (1·1–4·7)	0·6 (0·3–0·9)	0·2 (0·1–0·4)	18·5 (15·1–22·7)	13·4 (11·7–15·2)
Madagascar	37·7 (32·3–44·8)	4·9 (2·1–10·3)	3·3 (1·4–6·9)	0·2 (0·1–0·9)	0·3 (0·1–0·7)	1·5 (0·8–2·2)	13·6 (10·0–17·2)	13·9 (12·1–15·7)
Malawi	24·5 (19·5–31·5)	2·3 (0·9–5·1)	7·4 (3·7–12·9)	0·8 (0·2–2·7)	0·4 (0·2–0·7)	0·4 (0·1–1·0)	5·6 (2·9–10·5)	7·7 (6·8–8·8)
Mozambique	18·4 (15·1–22·9)	2·4 (1·1–5·1)	4·6 (2·3–8·3)	0·9 (0·4–1·9)	0·4 (0·2–0·6)	3·4 (2·4–4·6)	2·1 (1·0–4·7)	4·7 (4·1–5·3)
Rwanda	63·1 (50·6–77·5)	9·5 (6·7–13·1)	11·9 (8·8–15·7)	1·6 (0·8–3·3)	0·5 (0·3–0·9)	1·3 (0·9–2·0)	34·6 (23·4–47·0)	3·6 (3·2–4·1)
Somalia	10·2 (7·1–15·0)	1·3 (0·5–3·1)	4·1 (1·7–8·9)	0·4 (0·1–1·6)	0·1 (0·0–0·3)	0·8 (0·2–2·0)	1·4 (0·6–3·3)	2·0 (1·7–2·3)
South Sudan	19·7 (15·4–25·7)	1·6 (0·6–3·8)	5·7 (2·9–10·1)	1·2 (0·4–3·7)	0·3 (0·2–0·6)	3·2 (2·4–4·2)	2·6 (1·2–6·0)	5·1 (4·4–5·7)
Uganda	32·7 (26·0–40·0)	2·6 (1·1–5·2)	12·5 (7·6–19·2)	1·2 (0·4–3·3)	0·6 (0·3–0·9)	7·6 (6·0–9·6)	4·7 (2·6–8·0)	3·6 (3·1–4·0)
Tanzania	30·5 (23·4–38·1)	4·1 (1·9–7·8)	10·6 (6·1–16·0)	2·0 (0·9–4·7)	0·6 (0·3–1·1)	0·6 (0·2–1·3)	3·4 (1·6–7·6)	9·1 (8·0–10·4)
Zambia	44·1 (36·8–53·5)	4·1 (2·0–7·0)	21·6 (15·6–30·5)	3·1 (1·6–5·9)	0·5 (0·3–0·9)	0·9 (0·5–1·5)	1·3 (0·7–1·9)	12·6 (11·0–14·3)
Southern sub-Saharan Africa	88·0 (69·8–112·2)	7·8 (5·1–12·0)	50·2 (32·2–72·5)	4·6 (3·3–6·3)	2·3 (1·6–3·1)	1·6 (1·2–2·1)	11·0 (10·4–11·8)	10·5 (9·2–11·9)
Botswana	64·1 (54·5–74·6)	4·8 (2·5–8·3)	33·5 (25·2–42·7)	3·6 (2·2–6·4)	1·6 (1·3–2·1)	0·6 (0·2–1·4)	1·8 (0·7–3·3)	18·1 (15·8–20·6)
eSwatini	87·2 (77·2–98·8)	6·0 (3·2–11·5)	44·3 (35·4–54·9)	1·8 (0·8–3·5)	0·6 (0·3–1·1)	1·2 (0·3–3·3)	26·8 (25·4–28·2)	6·5 (5·6–7·3)
Lesotho	102·7 (94·3–113·4)	4·5 (1·8–9·9)	9·7 (4·1–20·7)	3·4 (1·7–7·2)	1·1 (0·6–1·8)	1·2 (0·3–3·1)	76·1 (72·9–79·4)	6·7 (5·9–7·6)
Namibia	60·1 (51·0–70·6)	5·7 (3·2–9·5)	26·2 (18·6–35·1)	3·8 (2·1–6·0)	1·5 (1·1–1·9)	2·0 (1·0–3·8)	8·5 (6·8–10·5)	12·5 (10·9–14·2)
South Africa	97·5 (74·4–128·5)	9·6 (6·2–14·5)	59·5 (36·5–89·0)	5·3 (3·6–7·7)	2·8 (1·8–4·0)	0·6 (0·3–0·9)	8·8 (7·7–10·0)	11·0 (9·6–12·5)
Zimbabwe	56·7 (47·1–65·6)	2·1 (0·9–4·6)	25·4 (17·6–34·4)	2·2 (0·9–5·2)	0·6 (0·4–0·9)	6·1 (4·6–8·0)	12·6 (10·6–14·8)	7·8 (6·8–8·8)
Western sub-Saharan Africa	34·2 (31·1–38·1)	1·5 (1·1–2·6)	11·0 (9·0–13·3)	1·6 (1·2–2·5)	0·7 (0·5–0·8)	4·1 (3·4–4·9)	5·3 (4·0–6·8)	10·0 (8·7–11·3)
Benin	27·0 (21·9–34·0)	0·8 (0·3–1·8)	14·6 (9·9–20·1)	1·8 (0·6–5·2)	0·5 (0·2–0·9)	1·6 (1·2–2·2)	3·1 (2·1–4·6)	4·6 (4·0–5·2)
Burkina Faso	20·0 (16·2–25·3)	0·8 (0·3–1·9)	8·1 (4·7–12·0)	0·7 (0·2–2·7)	0·3 (0·1–0·5)	3·8 (3·0–4·9)	1·3 (0·6–3·0)	5·0 (4·4–5·7)
Cabo Verde	44·6 (38·5–52·0)	3·6 (1·7–7·2)	23·5 (18·2–29·8)	0·7 (0·2–2·0)	1·6 (0·7–3·4)	NA	1·3 (0·6–2·9)	12·9 (11·2–14·6)
Cameroon	16·4 (12·7–21·5)	1·8 (0·7–3·8)	6·4 (3·1–11·2)	0·5 (0·2–1·7)	0·3 (0·1–0·6)	0·5 (0·2–1·2)	0·1 (0·1–0·3)	6·7 (5·8–7·6)
Chad	11·4 (8·6–14·8)	0·6 (0·2–1·3)	3·2 (1·6–5·8)	0·4 (0·1–1·1)	0·1 (0·1–0·3)	0·5 (0·2–0·9)	4·5 (2·7–7·5)	2·1 (1·8–2·4)

(Table 1 continues on next page)

	All health workers	Doctors	Nursing personnel	Pharmacists and pharmaceutical assistants	Dentists and dental assistants	Midwifery personnel	Community health workers	Other health workers
(Continued from previous page)								
Côte d'Ivoire	30·9 (25·3–36·7)	1·1 (0·4–2·6)	14·0 (9·7–19·3)	1·0 (0·3–2·9)	0·4 (0·2–0·7)	2·8 (2·2–3·6)	4·6 (2·7–7·4)	7·2 (6·2–8·1)
The Gambia	29·1 (24·0–34·9)	0·8 (0·3–1·9)	8·9 (5·1–14·2)	0·7 (0·3–1·3)	0·3 (0·1–0·5)	1·9 (1·2–2·9)	6·4 (4·1–9·4)	10·2 (8·9–11·5)
Ghana	74·7 (65·6–84·6)	3·3 (1·7–6·1)	40·8 (32·7–49·5)	7·6 (4·7–11·4)	1·0 (0·6–1·6)	8·2 (6·6–10·3)	5·6 (3·4–8·0)	8·2 (7·2–9·4)
Guinea	23·5 (18·5–29·7)	1·4 (0·6–2·9)	6·4 (3·3–10·3)	0·5 (0·1–1·8)	0·2 (0·1–0·6)	1·1 (0·5–1·9)	12·0 (8·6–15·2)	1·8 (1·6–2·0)
Guinea-Bissau	46·7 (39·1–54·2)	1·3 (0·5–3·0)	18·2 (12·5–25·2)	0·5 (0·2–0·9)	0·3 (0·1–0·5)	1·1 (0·5–1·8)	21·3 (17·8–25·5)	4·1 (3·5–4·6)
Liberia	38·8 (32·8–46·3)	0·9 (0·3–2·2)	8·1 (4·2–13·9)	1·2 (0·5–2·7)	0·2 (0·1–0·4)	1·7 (1·2–2·4)	23·0 (19·2–27·3)	3·7 (3·2–4·2)
Mali	12·2 (9·0–17·1)	1·0 (0·4–2·4)	4·6 (2·3–8·8)	0·9 (0·2–3·5)	0·2 (0·1–0·4)	1·5 (0·9–2·4)	1·2 (0·6–2·9)	2·8 (2·4–3·2)
Mauritania	29·3 (22·7–37·6)	1·3 (0·5–2·8)	16·9 (10·7–24·0)	1·1 (0·4–3·0)	0·7 (0·4–1·3)	3·3 (2·4–4·5)	1·4 (0·6–3·3)	4·7 (4·1–5·3)
Niger	15·6 (11·9–20·2)	0·9 (0·3–2·0)	4·3 (2·1–8·0)	0·2 (0·1–0·6)	0·1 (0·0–0·3)	0·6 (0·3–1·0)	7·7 (5·0–10·8)	1·9 (1·6–2·1)
Nigeria	41·4 (35·6–47·4)	1·7 (0·8–3·5)	9·8 (6·0–14·4)	1·7 (0·8–3·6)	1·0 (0·7–1·4)	6·0 (4·4–7·7)	5·5 (3·7–7·6)	15·6 (13·6–17·7)
São Tomé and Príncipe	42·9 (33·1–54·5)	5·4 (2·4–11·1)	22·8 (14·6–32·4)	2·7 (1·2–6·3)	0·9 (0·4–1·9)	2·1 (1·3–3·2)	2·3 (1·0–3·9)	6·8 (5·9–7·7)
Senegal	25·0 (20·7–30·1)	0·8 (0·4–1·5)	7·2 (4·0–11·1)	0·5 (0·2–1·3)	0·3 (0·2–0·5)	1·6 (1·2–2·0)	9·8 (7·5–12·7)	4·9 (4·2–5·5)
Sierra Leone	28·3 (22·0–36·1)	2·0 (0·9–4·2)	14·5 (8·6–21·3)	1·0 (0·4–2·4)	0·4 (0·2–0·7)	2·9 (1·9–4·1)	0·9 (0·4–2·0)	6·7 (5·8–7·6)
Togo	25·9 (21·8–31·2)	0·7 (0·3–1·8)	5·1 (2·6–9·1)	0·5 (0·1–2·1)	0·2 (0·1–0·5)	2·3 (1·7–3·1)	8·8 (6·7–11·4)	8·2 (7·2–9·4)

Density is reported in count of workers per 10 000 population. Data in parentheses are 95% uncertainty intervals. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. NA=not applicable (no estimate provided because available evidence does not indicate the existence of a distinct midwifery cadre separate from nursing in that location). SDI=Socio-demographic Index. *The United Nations recognises Taiwan as a province of China.

Table 1: **Estimated density of health workers for all GBD super-regions, regions, and 204 countries and territories in 2023**

health workers; optometrists and opticians; dieticians and nutritionists; audiologists, speech therapists, and counsellors; psychologists; personal care workers; and traditional and complementary practitioners (appendix 1 p 9).

Administrative data have potential biases that we addressed through cross-walking to survey and census data.[13] We note that biases in the administrative data have decreased over time, with improvements to data collection and assessment, and thus we updated the adjustment methodology that was deployed previously to produce GBD 2019 estimates. The methodology is described in detail in appendix 1 (pp 29–39).[13] We did not adjust sex shares because we did not find evidence of systematic source-type differences in sex shares (appendix 1 p 32).

Modelling

We used spatiotemporal Gaussian process regression (ST-GPR) to estimate densities and sex shares for each of the 20 cadres and total HRH. ST-GPR is a three-stage estimation tool that borrows information across location and time to produce estimates with uncertainty.[14,21] First, a linear mixed effects regression with random effects on location was fit using the Socio-demographic Index (SDI), a composite index measuring development status,[22] along with total health expenditure per capita, and the proportion of the employed population aged 15–69 years working as professionals. The female share of the employed population and the proportion of females aged 15–69 years working as professionals were used in addition to SDI for the cadre-specific sex shares. Second, a polynomial regression function (LOESS) was fit to smooth the residuals from the first-stage model. Third, the smoothed estimates were used as the mean in a Gaussian process regression, which accounts for input data variance and model uncertainty to produce 250 draws for every location-year(-sex) group. Point estimates for all reported quantities were calculated from the mean across draws and 95% uncertainty intervals (UIs) were computed from the 2·5th and 97·5th percentiles of draws. More details on all modelling steps are provided in appendix 1 (pp 40–46).

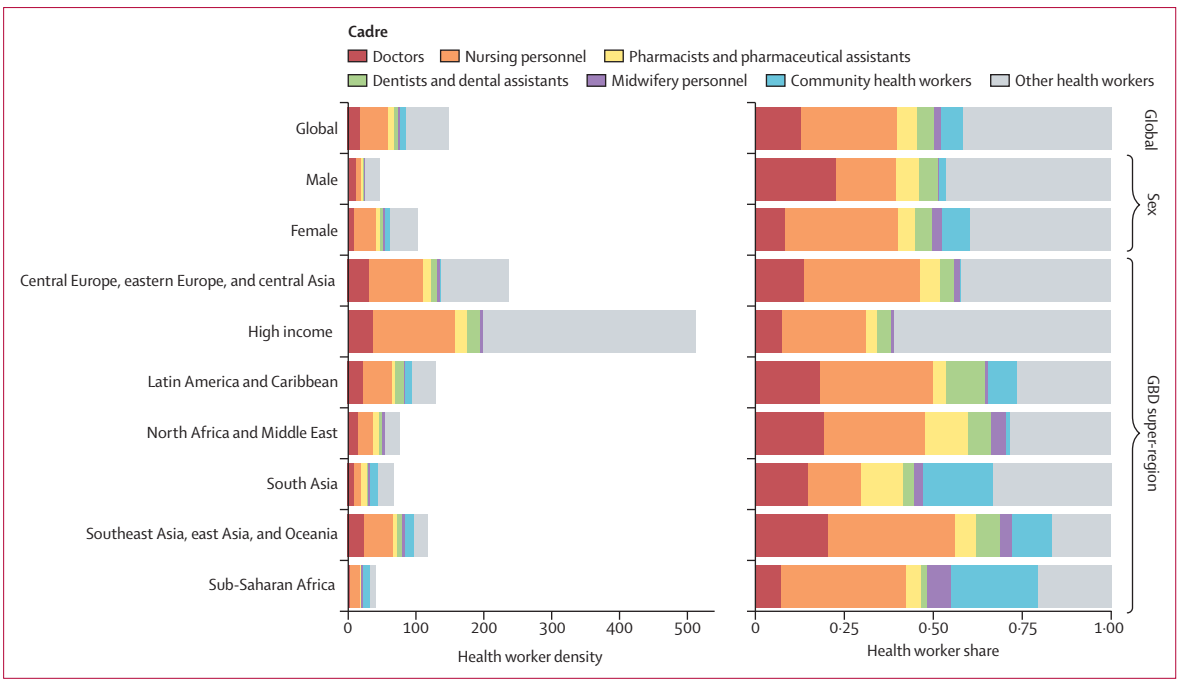


Figure 1: **Composition of the health workforce by cadre, sex, and GBD super-region, 2023**
Density is reported in count of workers per 10 000 population. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

We produced estimates of the minimum densities of the four cadres specified in SDG target 3.c.1 (doctors, nurses and midwives, dentists, and pharmacists) required to achieve moderate (80) to high (90) levels on the UHC effective coverage index, updating previous estimates from GBD 2019. Few, mostly high-income countries have achieved a UHC score of 90 or higher historically, and thus we focused on a UHC threshold of 80 as a more globally representative and moderate target.[13] Minimum density was determined based on the lowest levels of each HRH density along a production frontier that corresponded with the UHC thresholds (80 or 90). The production frontier was estimated using non-parametric stochastic frontier meta-analysis,[23] which fits a flexible spline to estimate the functional form of the relationship and was constrained to be monotonically increasing and concave. The production frontier represents the maximum UHC level expected based on current densities of HRH, with higher levels of UHC (or a smaller distance to the frontier) for a given HRH density representing higher levels of efficiency. Because we estimate each minimum cadre threshold separately, we do not consider the distinct skill mix required to attain UHC, only the minimum health worker densities required to attain a given UHC score. Additional details about estimating the frontier and shortages are reported in appendix 1 (pp 46–49).

Analyses and figures were generated with R (version 4.4.2), Python (version 3.12.3), or Stata (version 17.0).

Role of the funding source
The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results
Globally, 122·1 million (95% UI 115·4–130·5) health workers were actively working in health systems in 2023. There were 15·1 million (13·1–18·2) doctors, 33·2 million (30·8–36·3) nurses, 6·8 million (5·8–8·6) pharmacists and pharmaceutical assistants, 6·1 million (5·0–7·9) dentists and dental assistants, 2·4 million (2·0–2·9) midwifery personnel, and 7·6 million (6·7–8·6) CHWs (appendix 2 p 5). In table 1 and figure 1, we present the largest cadres across the health workforce: doctors, nurses, midwives, CHWs, pharmacists and pharmaceutical assistants, and dentists and dental assistants. We group all remaining 12 cadres into "other HRH" for visualisation; estimates are provided in appendix 2 (pp 32–127). Globally, nurses comprised the largest share of the total health workforce, amounting to 27·2% (25·1–29·5) in 2023 (figure 1), with densities of 41·2 (38·2–45·1) per 10 000 population. Doctors were the next largest cadre of health workers with densities of 18·8 (16·3–22·5), comprising 12·4% (10·9–14·7) of health workers in 2023.

Of total HRH in 2023, an estimated 68·9% (95% UI 66·9–70·6) were female. 43·9% (34·5–53·2) of doctors were female, compared with 80·7% (76·2–83·1) of nurses, 96·0% (83·9–98·5) of midwives, 89·5% (83·6–93·7) of CHWs, and the majority of other cadres in 2023 (figure 1).

The majority of dentists and dental assistants (66·9%, 61·1–72·1) and pharmacists and pharmaceutical assistants (63·0%, 51·6–70·6) were female, but there were substantial differences in sex shares in lower versus higher skilled positions: more pharmaceutical assistants (75·4%, 51·7–90·4) were female than pharmacists (53·4%, 47·7–59·0); and more dental assistants were female (90·1%, 83·7–93·7) than dentists (49·3%, 44·8–54·1) in 2023 (appendix 2 pp 127–139).

Across GBD super-regions, the density and mix of HRH differed substantially (figure 1, table 1). High-income countries had substantially more health workers overall and depended more on health workers outside of the main cadres, which includes personal care workers as well as specialised cadres such as psychologists and physical therapists. Although high-income countries also had the largest doctor densities per 10 000 population (36·5, 95% UI 34·1–39·4), the doctor density in central Europe, eastern Europe, and central Asia (31·6, 28·3–36·1) was nearly as high, despite much lower HRH densities overall. High-income countries exceeded all other super-regions in their nursing workforce density at 121·8 (111·9–134·2) per 10 000 population, over eight times higher than the density in sub-Saharan Africa (14·5, 11·6–18·1). The largest densities of HRH outside of the main cadres of focus were in high-income countries (313·8, 278·9–349·5), and central Europe, eastern Europe, and central Asia (100·3, 87·9–113·5).

Across countries, there was a wide range of doctor and nurse densities (figure 2A, C; table 1). Doctor densities were 96·6 (95% UI 80·9–115·2) per 10 000 population in Cuba in 2023, almost 50 times higher than locations with some of the fewest doctors in the world, such as Niger, which had a doctor density of less than two per 10 000 population (figure 2A). Similarly, nurse densities ranged widely (figure 2C). Nurse densities were less than seven per 10 000 population in three countries in sub-Saharan Africa, including Central African Republic (3·4, 1·6–6·8), Madagascar (3·3, 1·4–6·9), and Chad (3·2, 1·6–5·8). In contrast, nurse densities exceeded 110 per 10 000 in high-income locations such as Australia (129·1, 112·0–148·9), Belgium (171·7, 141·7–211·4), South Korea (140·8, 120·1–166·4), the USA (161·4, 136·7–192·7), and Finland (145·3, 113·2–186·8). Taking nurses and doctors together into account, we find a wide range of nurse to doctor ratios, with a 95-percentile range of 0·6–15·1 in 2023 (appendix 2 p 27).

The highest densities of CHWs were concentrated in south Asia (13·6 per 10 000 population, 95% UI 10·5–17·6), southeast Asia, east Asia, and Oceania (13·5, 10·9–16·1), Latin America and the Caribbean (10·8, 9·7–12·2), and sub-Saharan Africa (10·1, 9·0–11·6), with few countries outside of these super-regions relying heavily on this cadre (figure 1, table 1). In 2023, some of the countries with the highest densities of CHWs included Thailand (149·0, 118·5–191·6), Rwanda (34·6, 23·4–47·0), Kenya (18·5, 15·1–22·7), the Philippines (74·9, 52·6–103·6), Democratic Republic of the Congo (54·2, 49·0–59·7), Brazil (21·5, 17·1–26·7), and India (16·2, 12·2–21·4; table 1, appendix 2 p 4). In high-income countries, there was fewer than one CHW per 10 000 people on average.

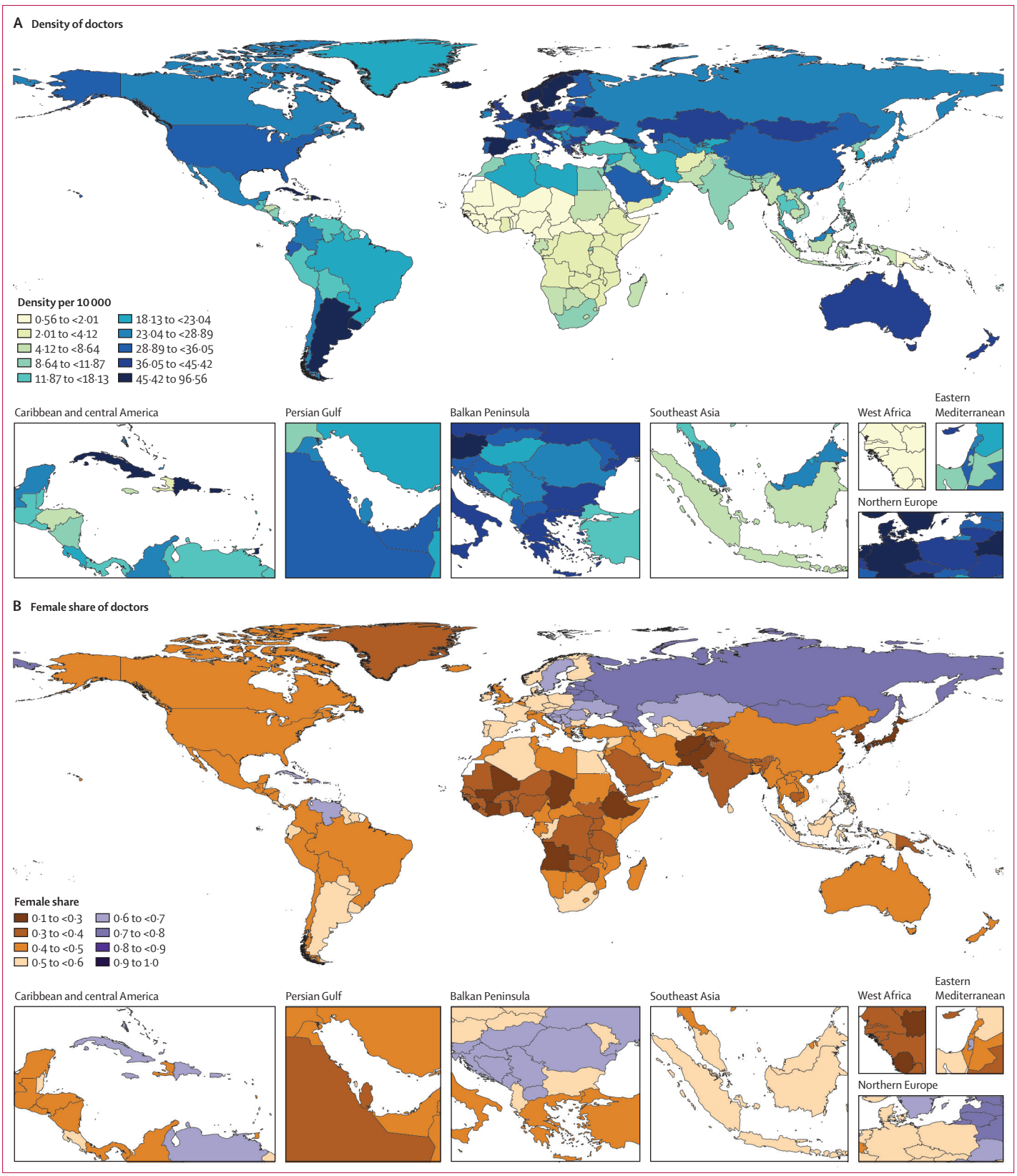
Notable differences in the sex composition of doctors and nursing personnel were apparent within and across locations. There was a large range in the share of doctors that were female (figure 2B), which exceeded 70% in Russia and other locations in eastern Europe and central Asia. This contrasts with a number of countries in sub-Saharan Africa, such as Ethiopia, Mali, and Chad, as well as in Asia, such as Afghanistan, Pakistan, and Japan, where between 20% and 30% of doctors were female in 2023. The female share was higher among nurses than among doctors in 99·0% of locations in 2023 (figure 1D); the female share was higher among all other HRH cadres in 88·2% of countries in 2023 (appendix 2 p 6). In 2023, 70% or more of nurses were female in 82·3% (95% UI 53·4–94·6) of locations.

Between 1990 and 2023, 81·2 million (95% UI 72·0–90·5) HRH were added to the health workforce, an increase of 198·5% (161·9–245·6). This included 18·9 million (12·9–24·1) more nurses and 8·7 million (6·6–12·0) more doctors. Patterns of growth differed by cadre (figure 3). In absolute terms, the densities of nurses and doctors increased most across our five cadres of focus, with densities increasing by 6·8 (2·7–11·1) per 10 000 for doctors globally and 14·4 (4·0–22·5) per 10 000 for nurses globally from 1990 to 2023. All super-regions except central Europe, eastern Europe, and central Asia increased their nursing workforce density by 40% or more during this time. Driving up the global doctor workforce size was a large expansion in doctors in China in particular, where the density of doctors increased from 13·2 (8·6–20·2) in 1990 to 31·7 (23·7–41·7) in 2023.

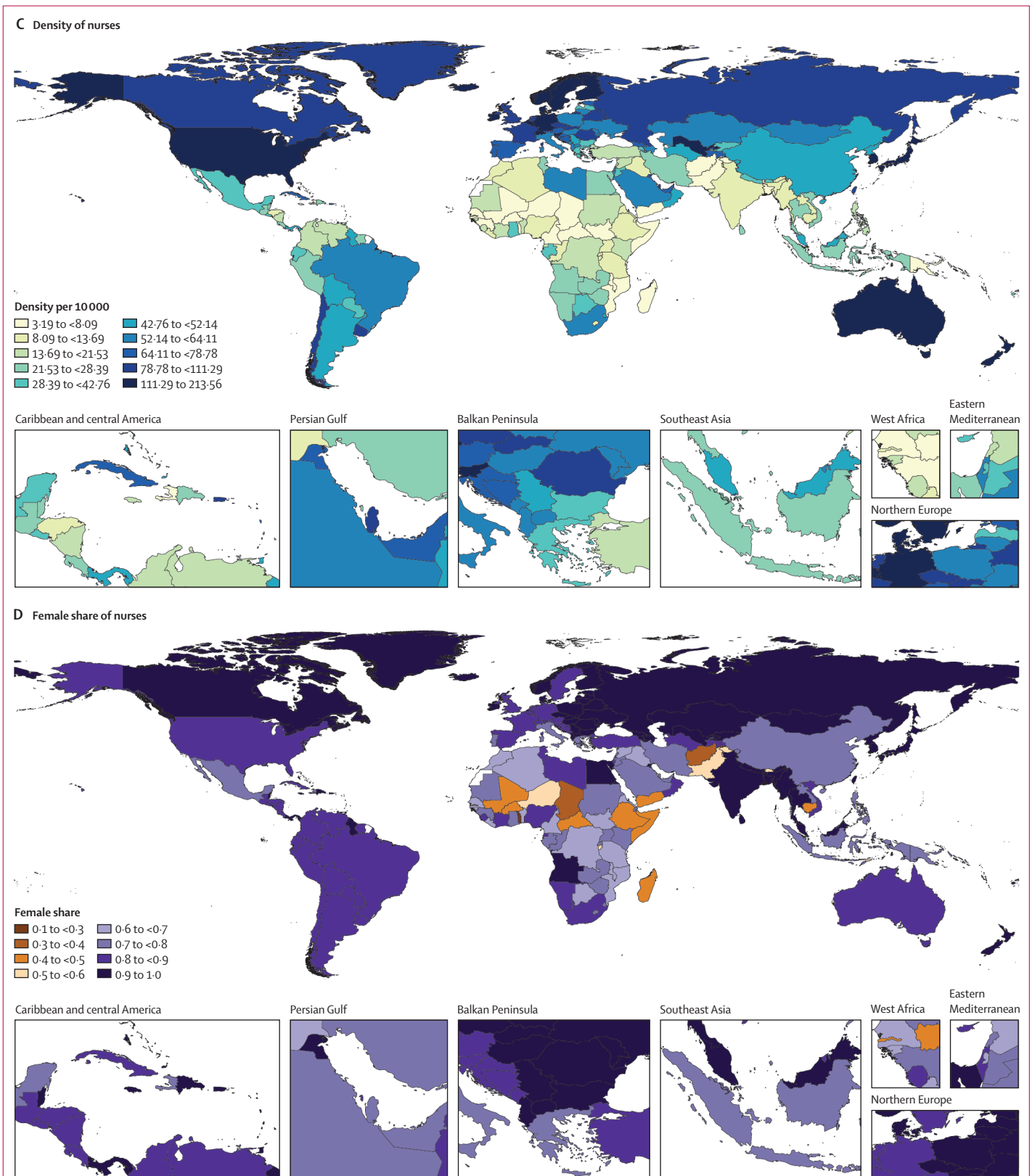
In the remaining cadres of focus trends differed. Dentist and dental assistant densities grew 113·1% (95% UI 36·2–212·5) relative to 1990, followed by pharmacists and pharmaceutical assistants, with growth of 111·2% (57·1–184·2). Consistent growth across super-regions underpinned these increases. CHWs, in contrast, both expanded and contracted, with major increases in sub-Saharan Africa, south Asia, and Latin America and the Caribbean, and declines in the remaining GBD super-regions.

The increased participation of women in the health workforce drove 71·4% (95% UI 64·5–77·4) of the growth in HRH between 1990 and 2023 (appendix 2 p 140), with more women becoming nurses than any other cadre. Across the cadres of focus, only among doctors did the difference in densities between males and females close during this time (appendix 2 p 26).

Globally, the minimum density of doctors associated with a score or 80 or higher on the UHC effective coverage index was 23·8 (95% UI 22·8–24·6) per 10 000 population, while this density was 64·5 (61·2–67·8)



(Figure 2 continues on next page)


C Density of nurses
Density per 10 000
3·19 to <8·09
8·09 to <13·69
13·69 to <21·53
21·53 to <28·39
28·39 to <42·76
42·76 to <52·14
52·14 to <64·11
64·11 to <78·78
78·78 to <111·29
111·29 to 213·56
Caribbean and central America
Persian Gulf
Balkan Peninsula
Southeast Asia
West Africa
Eastern Mediterranean
Northern Europe
D Female share of nurses
Female share
0·1 to <0·3
0·3 to <0·4
0·4 to <0·5
0·5 to <0·6
0·6 to <0·7
0·7 to <0·8
0·8 to <0·9
0·9 to 1·0
Caribbean and central America
Persian Gulf
Balkan Peninsula
Southeast Asia
West Africa
Eastern Mediterranean
Northern Europe

for nurses and midwives, 5·2 (4·9–5·5) for dentists, and 5·6 (5·3–6·1) for pharmacists (table 2). For 90 or higher on the UHC score, the minimum densities were higher for doctors (37·1, 36·5–37·6), nurses and midwives (99·9, 96·8–104·7), dentists (8·1, 7·9–8·3), and pharmacists (8·8, 8·4–9·7). Using the thresholds for an 80 or higher UHC score, we estimated a shortage of 34·4 million (31·5–37·4) HRH globally in 2023, including 7·1 million (6·6–7·5) doctors, 23·9 million (21·8–26·1) nurses and midwives, 1·8 million (1·6–1·9) dentists, and 1·6 million (1·4–1·9) pharmacists in 2023 (table 2). Shortages among GBD regions were largest in south Asia, which was short by 2·6 million (2·4–2·8) doctors, 10·0 million (9·3–10·6) nurses and midwives, 0·7 million (0·7–0·8) dentists, and 0·3 million (0·3–0·4) pharmacists. Sub-Saharan Africa also faced major shortages according to our analysis, requiring 2·5 million (2·4–2·6) more doctors, 5·7 million (5·3–6·1) more nurses and midwives, 0·6 million (0·5–0·6) more dentists, and 0·5 million (0·5–0·6) more pharmacists to attain moderate levels of UHC.

Discussion

This study assessed the supply and sex composition of 20 health worker cadres for 204 countries and territories between 1990 and 2023. We found that many more health workers are female than male and that cadre mix differed substantially by sex. Of the 81·2 million increase in total HRH between 1990 and 2023, 71·4% was driven by women formally joining the health workforce. However, this growth was disproportionately concentrated in cadres in which women have historically faced limited pathways into clinical leadership and senior management positions. Even with these increases, the global health workforce was short by 34·4 million workers in 2023.

Our findings emphasised how the cadre composition of the health workforce varies greatly, with large differences in the densities of doctors, nurses, CHWs, and other cadres across countries. This reflects different historical investment patterns, training system capacities, policy preferences (eg, reliance on community-based *vs* facility-based care), planned investment strategies, and the historical context out of which health systems have evolved. Future investigation into how cadre mix connects to the organisation, efficiency, and effectiveness of health systems will be useful for workforce planning efforts.

Our study provides the first global estimates of CHWs. In south Asia, Latin America and the Caribbean, southeast Asia, and sub-Saharan Africa, CHWs are much more prominent than in high-income settings. This cadre has one of the most diverse sets of training, remuneration arrangements, working conditions, and responsibilities and thus densities should be interpreted alongside understanding of those dimensions in a particular setting. High CHW densities can represent prioritisation of primary health-care delivery but could also be a marker of system-level shortfalls, where CHWs serve as low-cost labour substituting for more skilled workers.[24] Future analyses should investigate the extent to which expansion of the CHW workforce represents underinvestment in other HRH cadres versus concerted efforts to strengthen primary care.

Our estimates of HRH expansion since 1990 can be linked with specific reforms enabling rapid workforce growth. In China, for instance, the number of doctors more than doubled between 1990 and 2023, driven by reforms that quadrupled government investment in health care, expanded insurance coverage, and changed the organisation and financing of the health system.[25] A large expansion in the health workforce also occurred in Bolivia, where the Single Health System model increased government health expenditure along with strengthening primary care.[26] Türkiye's Health Transformation Program, launched in 2003, also entailed important increases in HRH as part of large increases in investments in the health sector.[27] In common across these countries was political and financial commitment to increase HRH, embedded in broader reforms to pursue UHC. Countries with persistent HRH gaps could consider similarly coupled reforms.

Increases in women's formal participation in the health workforce contributed to growth in HRH supply and are likely critical to future HRH expansions.[28] Although our data enabled us only to consider sex, not gender, we expand our discussion to the gendered social, institutional, and structural processes that explain differences in the female proportion of health workers across cadres and time. Plausible drivers include rising female educational attainment in many countries, which expands the pool of women qualified for health worker roles. Other possible explanations include occupational segregation that channels women towards caregiving professions. Occupational segregation in the health-care sector is longstanding and persistent: women predominate in nursing, midwifery, and CHW cadres, but are under-represented among doctors.[7,8] Within-cadre progression to leadership is also an issue: even in cadres where women predominate as workers, men are represented in the majority of senior management and clinical leadership roles.[5] Barriers to female leadership deprive health systems of talent and can lead to workforce strategies that fail to consider the challenges faced by the largely female workforce.[29] Low remuneration of some health worker cadres, such as CHWs, reinforces the devaluation of women's time and contribution to health systems. Gender discrimination and inequality in the health workforce have been linked to lower morale,

***Figure 2*: Density and female share of doctors and nurses by country and territory, 2023**

(A) Density per 10 000 population of doctors by country and territory. (B) Female share of doctors by country and territory. (C) Density per 10 000 population of nurses by country and territory. (D) Female share of nurses by country and territory. Density is reported in count of workers per 10 000 population.

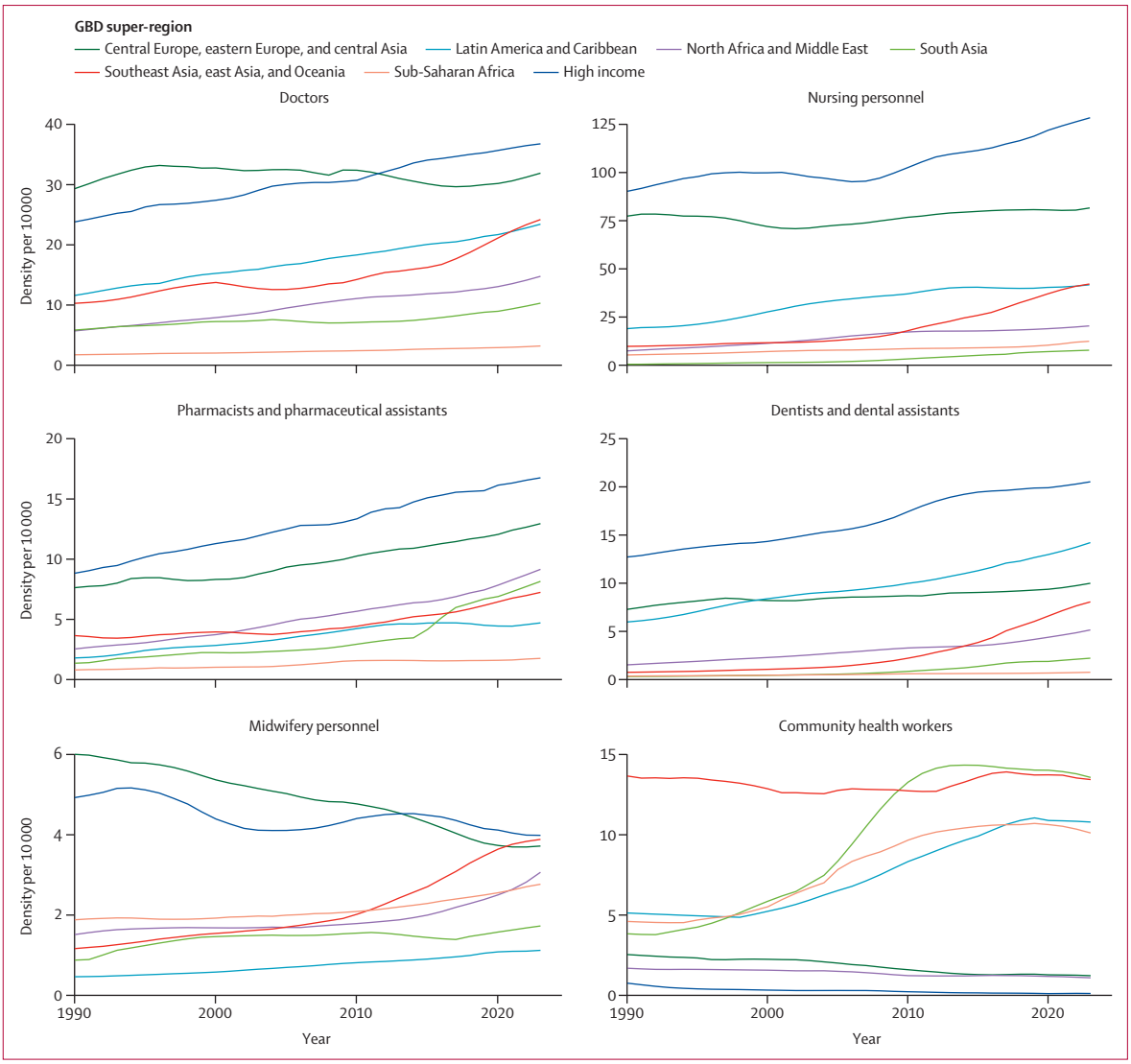


Figure 3: **Density of health workers per 10 000 population by cadre and GBD super-region, 1990–2023**
Density is reported in count of workers per 10 000 population. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

reduced productivity, absenteeism, maldistribution of workers, and attrition, all of which can contribute to HRH shortfalls and lower levels of productivity.[5,6]

Our estimates of workforce gaps showed that further expansion of the health workforce is required. We estimated need for an additional 34·4 million health workers, contrasting with a WHO estimate of need for 15·4 million health workers, including the four cadres we consider along with other HRH occupations.[30] Another recent approach estimated a 100 million cancer workforce shortage.[31] We note that the WHO approach considers health workforce needs relative to median density levels. Our methodology uses a UHC effective coverage index threshold of 80 and a frontier approach, considering minimum densities, beyond which more workers might be needed. The lower level of aspiration used by WHO might be more appropriate for immediate workforce planning, whereas our higher level of aspiration might be more appropriate for more ambitious, long-term goals. Nonetheless, both estimates are aligned in identifying that nursing shortages account for the largest share of global HRH need.

WHO's *Global Strategy on Human Resources for Health: Workforce 2030* emphasised an array of strategies for bolstering the size and effectiveness of the health workforce.[32] This included expanding domestic training capabilities and ensuring decent work conditions, among other recommendations. Investments in expanding medical school enrolment, including in sub-Saharan Africa and south Asia, have potential to produce HRH for regions with the most need.[33,34] However, rapid workforce expansion could generate societal challenges. In

South Korea, for example, the doubling of medical school quotas in 2022 triggered widespread doctor strikes.[35] Digital transformation and artificial intelligence could enable more efficient use of specialty care, including for rural areas.[36] Careful consideration of remuneration as fair and to attract talent is also crucial. Health systems should strive to ensure health workers previously paid through development assistance channels are not lost to emigration to higher-income settings to attain higher remuneration.[1,37]

Planners are advised to consider institutional policies and practices through a gender lens.[3,5,38] Formal mentorship and sponsorship programmes, leadership development training, transparent promotion criteria, and gender-responsive leadership initiatives are all candidate strategies for addressing the within-cadre gender leadership gap.[29] Addressing workplace violence and sexual harassment along with formal reporting systems for harassment and assault are also critical.[6,39] Flexible work arrangements, universal provision of paid maternity and caregiving leave,[40,41] and caregiving arrangement policies that do not penalise career interruption[4,5,42] are all policies that could be considered to bolster HRH capacity by better supporting the female health workforce. Dismantling and refashioning stereotypes surrounding the health workforce to recruit male workers could also be considered.[43] Gender-neutral job advertisements and systems for peer support, mentorship, and sponsorship all represent ideas for addressing barriers related to socialisation and stereotypes.[4,29,39]

This study has several limitations. First, because of data constraints, this study relies on a binary sex categorisation as an approximation of the broader conceptualisation of gender. Second, availability of data was concentrated in high-income countries and among the doctor and nurse cadres (see appendix 1 pp 12–16). Third, although internationally recognised and standardised occupation coding systems were used, we note that none of these worker cadres are uniform in their duties globally, with CHW duties differing dramatically along with major variation in tasks done by nurses, pharmaceutical assistants, and dental assistants. Yet, this is the most widely recognised system available and the only system that can be fully operationalised for examining the health workforce. Wherever possible, we focused only on CHWs who were paid in some form, including honoraria and stipends, consistent with our definition of employment. However, it was not possible to verify in tabulated sources whether both volunteer and paid CHWs were included, potentially inflating our estimates. Fifth, our study period covered the COVID-19 pandemic, which might have disrupted some HRH data systems.[44,45] Sixth, our assessment of shortages was limited to the cadres included in the SDGs, with thresholds representing minimum indicative levels or cadre-level floors, not normative targets. Our shortage estimates are aspirational and not additive: the minimum density observed in countries attaining the UHC benchmark might have a high density in a complementary cadre. Attaining all four cadre-specific thresholds simultaneously is neither strictly necessary nor strictly sufficient. Furthermore, countries that already achieved the UHC benchmark should not automatically be interpreted as under-resourced; unmet demand driven by changing health needs and patient

	Number of countries with shortage	Sum of country-level shortages (number of workers)
Doctors (threshold: 23·8 per 10 000 population)		
Global	121 (120–125)	7 090 000 (6 610 000–7 470 000)
Central Europe, eastern Europe, and central Asia	5 (5–6)	13 400 (10 200–16 300)
High income	2 (2–2)	201 (150–243)
Latin America and Caribbean	19 (19–20)	204 000 (168 000–232 000)
North Africa and Middle East	16 (16–16)	639 000 (581 000–685 000)
South Asia	5 (5–5)	2 620 000 (2 430 000–2 770 000)
Southeast Asia, east Asia, and Oceania	28 (27–30)	1 090 000 (1 020 000–1 150 000)
Sub-Saharan Africa	46 (46–46)	2 530 000 (2 400 000–2 620 000)
Nurses and midwives (threshold: 64·5 per 10 000 population)		
Global	132 (131–137)	23 900 000 (21 800 000–26 100 000)
Central Europe, eastern Europe, and central Asia	13 (13–16)	96 000 (62 500–132 000)
High income	2 (2–3)	105 000 (85 700–124 000)
Latin America and Caribbean	26 (25–26)	1 310 000 (1 120 000–1 500 000)
North Africa and Middle East	17 (17–18)	2 530 000 (2 340 000–2 740 000)
South Asia	5 (5–5)	9 960 000 (9 340 000–10 600 000)
Southeast Asia, east Asia, and Oceania	23 (23–23)	4 230 000 (3 510 000–4 950 000)
Sub-Saharan Africa	46 (46–46)	5 710 000 (5 310 000–6 110 000)
Dentists (threshold: 5·2 per 10 000 population)		
Global	119 (118–121)	1 760 000 (1 620 000–1 860 000)
Central Europe, eastern Europe, and central Asia	11 (11–11)	32 800 (29 500–35 200)
High income	1 (1–1)	120 (106–130)
Latin America and Caribbean	18 (18–19)	28 000 (24 900–30 500)
North Africa and Middle East	11 (10–12)	94 000 (83 000–104 000)
South Asia	5 (5–5)	745 000 (688 000–787 000)
Southeast Asia, east Asia, and Oceania	27 (27–27)	272 000 (250 000–289 000)
Sub-Saharan Africa	46 (46–46)	585 000 (549 000–612 000)
Pharmacists (threshold: 5·6 per 10 000 population)		
Global	123 (121–130)	1 640 000 (1 420 000–1 930 000)
Central Europe, eastern Europe, and central Asia	10 (10–11)	39 200 (35 500–44 100)
High income	3 (3–4)	7 660 (6 860–9 140)
Latin America and Caribbean	21 (20–23)	214 000 (195 000–240 000)
North Africa and Middle East	10 (9–11)	103 000 (89 500–121 000)
South Asia	5 (5–5)	338 000 (272 000–425 000)
Southeast Asia, east Asia, and Oceania	29 (29–30)	392 000 (318 000–491 000)
Sub-Saharan Africa	45 (45–46)	549 000 (508 000–604 000)

Data in parentheses are 95% uncertainty intervals. Estimates for shortages are based on the frontier shown in appendix 2 (p 141) and correspond to the minimum level of each HRH cadre required to attain a score of 80 or higher on the UHC effective coverage index. Minimum threshold estimation is focused on the four cadres in Sustainable Development Goal target 3.c.1. GBD=Global Burden of Diseases, Injuries, and Risk Factors Study. HRH=human resources for health. UHC=universal health coverage.

Table 2: **Health worker shortages for four cadre groups at a threshold of 80 out of 100 on the UHC effective coverage index, globally and by GBD super-region, 2023**

expectations could result in need for additional HRH. UHC is also challenging to measure and our analysis is missing important determinants of UHC, such as social and economic development, financing, governance, benefit design, and infrastructure. Seventh, density is widely reported in our study but does not capture skill mix, productivity, distribution within countries, and other factors, such that countries with the same density can face very different workforce constraints. Eighth, because of estimation and adjustment, density estimates, including estimates of uncertainty, can differ from statistics reported by ministries of health and other sources. Some labour force surveys have small sample sizes that introduce noise, but we addressed this through inverse-variance-based weighting in ST-GPR. Some labour force surveys and censuses use national classifications mapped to ISCO, which could lead to misclassification. Finally, we omit key characteristics of the health workforce. Age will be important to assess in the future, since generational effects and workers ageing out are critical factors. Better estimating professional specialties in the future is also important for assessing efficiency, training, and allocation of HRH. Estimating sector (eg, private, public), remuneration levels, emigration status, and full-time versus part-time employment status are crucial future directions as well.

In conclusion, the world faces substantial shortfalls in HRH. For many settings where HRH data remain incomplete or inconsistent, these estimates offer a strategic foundation for countries to benchmark progress against peers, identify structural shortages, understand gender imbalances, and assess alignment between workforce composition and UHC attainment. By integrating gender and cadre mix assessments into planning and policies, countries can strengthen HRH in pursuit of UHC and confront the many health challenges of this century.

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Please see appendix 3 (pp 42–56) for more detailed information about individual author contributions to the research, divided into the following categories: managing the overall research enterprise; writing the first draft of the manuscript; primary responsibility for applying analytical methods to produce estimates; primary responsibility for seeking, cataloguing, extracting, or cleaning data; designing or coding figures and tables; providing data or critical feedback on data sources; developing methods or computational machinery; providing critical feedback on methods or results; drafting the manuscript or revising it critically for important intellectual content; and managing the estimation or publications process.

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Data sharing

This study follows the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER). Data used in these analyses are available on Global Health Data Exchange (GHDx) tool at https://ghdx.healthdata.org/gbd-2023.

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References

1 WHO. Health employment and economic growth: an evidence base. 2017. https://www.who.int/publications/b/33487 (accessed June 15, 2025).
2 Szabo S, Nove A, Matthews Z, et al. Health workforce demography: a framework to improve understanding of the health workforce and support achievement of the Sustainable Development Goals. *Hum Resour Health* 2020; **18:** 7.
3 George A. Human resources for health: a gender analysis. June, 2007. https://www.hrhresourcecenter.org/node/1546.html (accessed Oct 1, 2025).
4 WHO. Delivered by women, led by men: a gender and equity analysis of the global health and social workforce (Human Resources for Health Observer Series No. 24). March 14, 2019. https://www.who.int/publications/i/item/9789241515467 (accessed June 16, 2025).
5 Newman C, Nayebare A, Gacko NMNN, et al. Systemic structural gender discrimination and inequality in the health workforce: theoretical lenses for gender analysis, multi-country evidence and implications for implementation and HRH policy. *Hum Resour Health* 2023; **21:** 37.
6 Ajuwa MP, Veyrier C-A, Cousin Cabrolier L, et al. Workplace violence against female healthcare workers: a systematic review and meta-analysis. *BMJ Open* 2024; **14:** e079396.
7 Lapeyre N, Le Feuvre N. Feminization of the medical profession and professional dynamics in healthcare. *Rev Fr Aff Soc* 2005; **1:** 59–81.
8 Shannon G, Minckas N, Tan D, Haghparast-Bidgoli H, Batura N, Mannell J. Feminisation of the health workforce and wage conditions of health professions: an exploratory analysis. *Hum Resour Health* 2019; **17:** 72.
9 Gupta N, Diallo K, Zurn P, Dal Poz MR. Assessing human resources for health: what can be learned from labour force surveys? *Hum Resour Health* 2003; **1:** 5.
10 Boniol M, McIsaac M, Xu L, Wuliji T, Diallo K, Campbell J. Gender equity in the health workforce: analysis of 104 countries. March 18, 2019. https://www.who.int/publications/i/item/gender-equity-in-the-health-workforce-analysis-of-104-countries (accessed June 15, 2025).
11 International Labour Organization. Improving employment and working conditions in health services. March 21, 2017. https://www.ilo.org/publications/improving-employment-and-working-conditions-health-services (accessed June 16, 2025).
12 WHO. The gender pay gap in the health and care sector: a global analysis in the time of COVID-19. July 13, 2022. https://www.who.int/publications/i/item/9789240052895 (accessed June 16, 2025).
13 Haakenstad A, Irvine CMS, Knight M, et al, and the GBD 2019 Human Resources for Health Collaborators. Measuring the availability of human resources for health and its relationship to universal health coverage for 204 countries and territories from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2022; **399:** 2129–54.
14 Naghavi M, Kyu H, Bhoomadevi A, et al, and the GBD 2023 Causes of Death Collaborators. Global burden of 292 causes of death in 204 countries and territories and 660 subnational locations, 1990–2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet* 2025; **406:** 1811–72.
15 Flor LS, Friedman J, Spencer CN, et al. Quantifying the effects of the COVID-19 pandemic on gender equality on health, social, and economic indicators: a comprehensive review of data from March, 2020, to September, 2021. *Lancet* 2022; **399:** 2381–97.
16 International Labour Organization. International Standard Classification of Occupations 2008 (ISCO-08): structure, group definitions and correspondence tables. May 10, 2012. https://www.ilo.org/publications/international-standard-classification-occupations-2008-isco-08-structure (accessed Oct 1, 2025).
17 Lozano R, Fullman N, Mumford JE, et al, and the GBD 2019 Universal Health Coverage Collaborators. Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020; **396:** 1250–84.
18 International Labour Organization. Resolution concerning statistics of work, employment and labour underutilization (including amendments). Nov 7, 2023. https://www.ilo.org/resource/resolution-concerning-statistics-work-employment-and-labour (accessed Jan 8, 2026).
19 WHO. National health workforce accounts: a handbook, second edition. 2023. https://www.who.int/publications/i/item/9789240081291 (accessed Oct 1, 2025).
20 European Union. Health care resources database. 2025. https://ec.europa.eu/eurostat/web/health/database (accessed Aug 14, 2025).
21 Schumacher A, Zheng P, Barber RM, et al, and the GBD 2023 Demographics Collaborators. Global age-sex-specific all-cause mortality and life expectancy estimates for 204 countries and territories and 660 subnational locations, 1950–2023: a demographic analysis for the Global Burden of Disease Study 2023. *Lancet* 2025; **406:** 1731–810.
22 Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Socio-Demographic Index (SDI) 1950–2019. 2020. https://doi.org/10.6069/D8QB-JK35 (accessed July 7, 2026).
23 Zheng P, Worku N, Bannick M, et al. Robust nonparametric stochastic frontier analysis. *SSRN* 2024; published online April 11. https://doi.org/10.2139/ssrn.4791808 (preprint).
24 Hirschhorn LR, Govender I, Zulu JM. Community health workers: essential in ensuring primary health care for equitable universal health coverage, but more knowledge and action is needed. *BMC Prim Care* 2023; **24:** 219.

25 Yip W, Fu H, Chen AT, et al. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *Lancet* 2019; **394:** 1192–204.

26 WHO. Universal health access and coverage, a reference for the world. 2020. https://www.who.int/about/accountability/results/who-results-report-2020-mtr/country-story/2020/universal-health-access-and-coverage-a-reference-for-the-world (accessed Aug 15, 2025).

27 Ökem ZG, Çakar M. What have health care reforms achieved in Turkey? An appraisal of the "Health Transformation Programme". *Health Policy* 2015; **119:** 1153–63.

28 Friedman J, York H, Graetz N, et al. Measuring and forecasting progress towards the education-related SDG targets. *Nature* 2020; **580:** 636–39.

29 Mousa M, Boyle J, Skouteris H, et al. Advancing women in healthcare leadership: a systematic review and meta-synthesis of multi-sector evidence on organisational interventions. *EClinicalMedicine* 2021; **39:** 101084.

30 Boniol M, Kunjumen T, Nair TS, Siyam A, Campbell J, Diallo K. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage? *BMJ Glob Health* 2022; **7:** e009316.

31 Hricak H, Ward ZJ, Moraes FY, et al. Cancer workforce—a global crisis: a *Lancet Oncology* Commission. *Lancet Oncol* 2026; **27:** e279–316.

32 WHO. Global strategy on human resources for health: Workforce 2030. July 7, 2020. https://www.who.int/publications/i/item/9789241511131 (accessed Oct 1, 2025).

33 Duppati SS. Expansion and challenges of medical education in India: a focus on rural and international migration trends. Impact and Policy Research Institute. April 28, 2025. https://www.impriindia.com/insights/medical-education-in-india/ (accessed Oct 3, 2025).

34 Rosenberg J, Juvonen M, Ng MZ, et al. Medical schools in Africa: seeing momentum. *BMJ Glob Health* 2024; **9:** e014468.

35 Murphy F, Minue S. South Korean doctors end 18 month strike. *BMJ* 2025; **390:** r1876.

36 WHO. Global strategy on digital health 2020–2025. Aug 18, 2021. https://www.who.int/publications/i/item/9789240020924 (accessed July 7, 2026).

37 Apeagyei AE, Bisignano C, Elliott H, et al. Tracking development assistance for health, 1990–2030: historical trends, recent cuts, and outlook. *Lancet* 2025; **406:** 337–48.

38 Global Health 50/50. The Global Health 50/50 Report: how gender-responsive are the world's most influential global health organisations? 2018. https://global5050.org/report/ (accessed Aug 14, 2025).

39 El Arnaout N, Chehab RF, Rafii B, Alameddine M. Gender equity in planning, development and management of human resources for health: a scoping review. *Hum Resour Health* 2019; **17:** 52.

40 Sharma N, Chakrabarti S, Grover S. Gender differences in caregiving among family - caregivers of people with mental illnesses. *World J Psychiatry* 2016; **6:** 7–17.

41 International Labour Organization. More than 120 nations provide paid maternity leave. Feb 16, 1998. https://www.ilo.org/resource/news/more-120-nations-provide-paid-maternity-leave (accessed Oct 1, 2025).

42 International Labour Organization. Women at work: trends 2016. March 8, 2016. https://www.ilo.org/publications/major-publications/women-work-trends-2016 (accessed Aug 14, 2025).

43 Davis R, Shaw T. Addressing shortages in nursing with male representation: a literature review. *Hosp Top* 2026; **104:** 76–80.

44 WHO. The impact of COVID-19 on health and care workers: a closer look at deaths. Sept 13, 2021. https://www.who.int/publications/i/item/WHO-HWF-WorkingPaper-2021.1 (accessed Aug 28, 2025).

45 Shen K, Eddelbuettel JCP, Eisenberg MD. Job flows into and out of health care before and after the COVID-19 pandemic. *JAMA Health Forum* 2024; **5:** e234964.