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Global distribution of surgeons, anaesthesiologists, and obstetricians.

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then, could overestimate the surgical burden due to some conditions (especially the more chronic) and underestimate that due to other conditions. Our sensitivity analyses imply, however, that this overestimate is small to moderate at worst.

The strengths of this study are what it can show. Our survey includes a broad range of providers actively engaged in health-care delivery in both developing and developed-nation contexts. The significant concordance among all the respondents and among our multiple estimation methods lends robustness to our conclusions. Finally, by asking respondents about the role of surgery writ large—as opposed to limiting our estimates only to patients who actually receive an operation—our results are arguably more representative of the involvement of surgery in global health.

In conclusion, about 30% of the global burden of disease could be surgical. This estimation is robust to multiple estimation methods and avoids limiting the delineation of “surgical disease” only to patients who end up on an operating table. Although non-surgeons estimate a lower burden of surgical disease than do surgeons, all providers estimate a burden that is more than double the canonical 11% estimation published in 2006.¹

This finding suggests that the scale-up of a functional surgical system could have a beneficial impact on a large portion of the global burden of disease. Importantly, these results also suggest that it might finally be time to retire the prior, lower estimate of the global burden of surgical disease. Acknowledging the size of the burden of surgical disease will enhance awareness among the global health community and advocate for closing the gaps in access to surgical services.

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Global distribution of surgeons, anaesthesiologists, and obstetricians

An insufficient surgical workforce is a major barrier to safe surgical care for billions of people worldwide.¹ Although a critical shortage of a spectrum of surgical providers has been described in many countries, the global number and distribution remain poorly assessed.² Meanwhile, more data on the surgical workforce are crucial for international com-

parisons and the development of national workforce plans tailored to populations needs. We aimed to quantify the global surgical specialist workforce by country, and to build a WHO surgical workforce database in the process.

Data on the number of licensed, qualified physician surgeons, anaesthesiologists, and obstetricians (see appendix for full definitions) were retrieved from Ministries of Health, WHO country offices, professional societies, members of the WHO Global Initiative for Emergency & Essential Surgical Care, and from publicly available sources (see appendix p 4) for full details of data sources). Data were entered in the WHO Global Surgical Workforce Database. Data were obtained for 167 countries representing 92% of the global population (for characteristics see appendix p 9). Estimates of missing values were developed using multiple imputation based on national health system indicators (appendix p 10). Median and IQR were calculated from the imputed data, and used together with primary data to provide global estimates. Estimated total number of providers and density per 100 000 population were calculated and tabulated and heat maps were created to show the surgical specialist workforce density by country.

Worldwide, there are an estimated 1112 727 specialist surgeons (IQR 1059 158–1177 912), 550 134 anaesthesiologists (529 008–572 916) and 483 357 obstetricians (456 093–517 638; appendix p 11 and p 16). Low-income and lower-middle-income countries, representing 48% of the global population, have 20% of this workforce, or 19% of all surgeons, 15% of anaesthesiologists, and 29% of obstetricians. Africa and southeast Asia are particularly underserved. In terms of density, low-income countries have 0.7 providers per 100 000 population (IQR 0.5–1.9), compared with 5.5 (1.8–28.2) in lower-middle income countries, 22.6 (11.6–56.7)

See Online for appendix



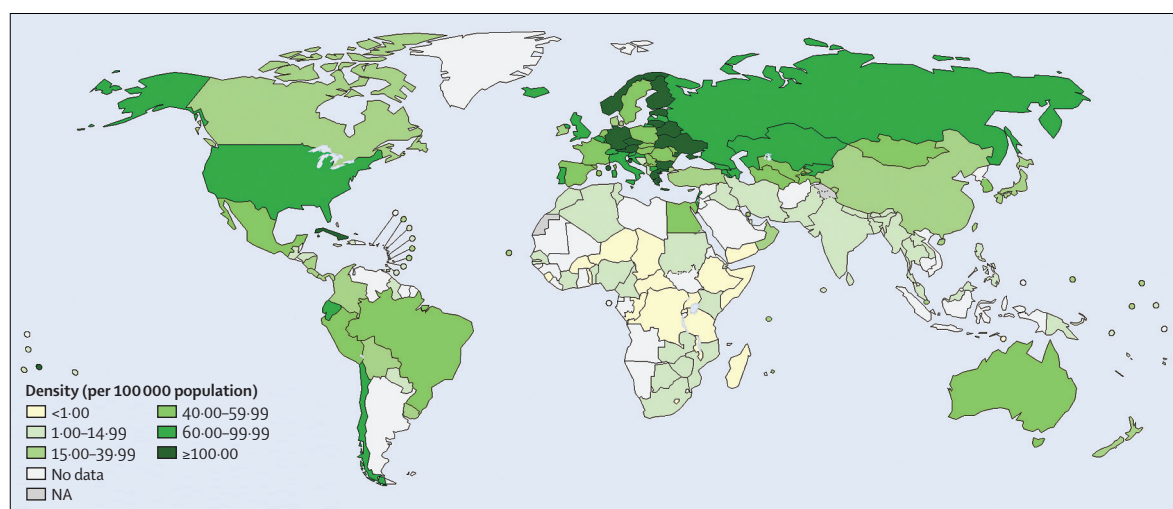


Figure: Global distribution of surgeons, anaesthesiologists, and obstetricians, per 100 000 population
 NA=countries or territories that are not WHO members and thus excluded from our data.

in upper-middle-income countries, and 56.9 (32.0–85.3) in high-income countries. There are also significant differences by WHO region (appendix p 17; figure).

The results of this study represent the first truly global compilation of national surgical specialist workforce data and constitute a first step towards routinely collecting surgical workforce data through the WHO Global Surgical Workforce Database.³ The workforce of fully trained surgeons, anaesthesiologists, and obstetricians is critically inadequate in many parts of the world, and grossly inequitably distributed.

The results of this study must be interpreted carefully. Our database, consisting of official or published country-level data, will need to be validated and expanded. Through emphasising aggregate numbers and by using imputations based on general health-system indicators, we have sought to minimise the role of missing or potentially erroneous data points. More importantly, our data do not fully describe the health workforce that does surgery and anaesthesia, since physicians and other health-care providers who were not licensed as surgeons were excluded from the current study to facilitate

international comparisons. Adjunct data regarding the considerable number of associate clinicians who do surgery would add a valuable level of granularity and nuance to the current description of the global surgical workforce. Our results do, however, confirm the global misdistribution of surgical specialists, and indicate that most of the world's surgical patients are either served by non-physicians or non-specialists, or they are not served at all. This also affects the many low-resource countries where surgical task-shifting is used. Defined as the redistribution of responsibilities from highly qualified professionals to those with fewer qualifications, task shifting has been used as a way to increase access to surgical care and reduce surgical costs. However, without trained surgeons, anaesthesiologists, and obstetricians to act as supervisors and educators, such systematised and formally structured task-shifting programmes are challenged.¹

Also, our results do not capture the actual access to specialist providers, affected by factors such as financial barriers and the urban-rural distribution. National and subnational assessments will need to be undertaken to assess these national specifics. Our data provide

a snapshot of the specialist surgeon, anaesthesiologist, and obstetrician workforce today, but say little about the dynamics of that workforce. Continued data collection over time and longitudinal follow-up of the surgical specialist workforce will allow for detection of trends in workforce distribution as well as assessments of strategic workforce investments.

In summary, the surgical specialist workforce is critically inadequate in large parts of the world and grossly inequitably distributed. To tackle the growing global burden of surgical disease, there is an acute need to increase both the number and the distribution of the surgical specialist workforce. Although we encourage validation and expansion of our dataset, we believe that the data presented here can inform further efforts to improve access to surgical care worldwide. At a minimum, our results represent a baseline against which future workforce surveys—and, hopefully, surgical workforce growth—can be measured.

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International migration of surgeons, anaesthesiologists, and obstetricians

One of the most significant barriers to surgical care worldwide is the shortage of surgeons, anaesthesiologists, and obstetricians, which in resource-

poor settings is exacerbated by emigration.¹ We contacted 75 high-income countries with a request for data on the number of specialist surgeons, anaesthesiologists, and obstetricians and their country of initial medical qualification. Data were retrieved from national administrative sources (see appendix for details). Specialists were defined according to the licensing authority of the respective country. Countries in workforce crisis were defined according to the WHO definition of having less than 228 physicians, nurses, and midwives per 100 000 population.²

The primary outcome was “dependency”, defined as the proportion of physicians within each specialty with a medical degree from a low-income or middle-income country. This dependency was calculated for each clinical specialty, WHO region, and World Bank income category. Aggregated data were requested from each data source to avoid exposure of personal information.

Data on numbers of surgeons, anaesthesiologists, and obstetricians, and their country of initial medical qualification, were received from 14 high-income countries (appendix p 3). The surgical workforce of 295 477 practitioners in these countries included 53 428 international medical graduates (18.1%), of whom 35 481 (66.4%) were from low-income and middle-income countries (appendix p 3). High-income countries’ dependence on surgeons, anaesthesiologists, and obstetricians from low-income and middle-income countries was 12.0%, of which the greatest proportion came from the southeast Asian (13 433 of 295 477 [4.5%]) and eastern Mediterranean (8317 of 295 477 [2.8%]) regions (figure). Half of all surgeons, anaesthesiologists, and obstetricians who had migrated from low-income and middle-income countries came from a country in workforce crisis (17 707 [49.9%]).

The data provided by our study are relevant to both lower and higher income countries, and can help policy makers understand and predict the supply and demand of their future surgical workforce. For lower-income countries, addressing the shortage of surgical providers is fundamental to meeting the increasing need for surgical care.³ For higher-income countries that still depend on an influx of surgical professionals from lower-income countries, there should be much greater domestic capacity to meet the demand for surgeons, anaesthesiologists, and obstetricians. The internationally ratified Global Code of Practice on the International Recruitment of Health Personnel⁴ aims to bring awareness in all countries to the importance of national workforce planning, resource allocation, and data collection.

Although previous studies of international migration of physicians have used data from even fewer high-income countries,⁵ our study is limited by the inclusion of only 14 out of 75 high-income countries. This study is also limited by the fact that not all countries categorise specialists and subspecialists the same way, limiting comparisons between particular specialties. It is important to emphasise that the study results are based on the emigration of medical graduates, not necessarily fully trained specialists. Also, our study design did not address internal migration or the geographical maldistribution of the surgical workforce within countries due to migration into urban settings and to non-governmental organisations and administration, nor did we capture the surgical workforce migrating regionally between low-income or middle-income countries. These limitations translate into a likely underestimation of the degree of migration out of the most severely affected settings, and we acknowledge that in analysing the surgical workforce, one should also

See Online for appendix

