

Analysis of human resources for oral health globally: inequitable distribution

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Background: Oral diseases affect most of the global population. The aim of this paper was to provide a contemporary analysis of 'human resources for oral health' (HROH) by examining the size and distribution of the dental workforce according to World Health Organization (WHO) region and in the most populous countries. **Method:** Publicly available data on HROH and population size were sourced from the WHO, Central Intelligence Agency, United Nations, World Bank and the UK registration body. Population-to-dentist *and* dental-workforce ratios were calculated according to WHO region and for the 25 most populous countries globally. Workforce trends over time were examined for one high-income country, the UK. **Results:** The majority of the world's 1.6 million dentists are based in Europe and the Americas, such that 69% of the world's dentists serve 27% of the global population. Africa has only 1% of the global workforce and thus there are marked inequalities in access to dental personnel, as demonstrated by population to dental-workforce ratios. Gaps exist in dental-workforce data, most notably relating to mid-level clinical providers, such as dental hygienists and therapists, and HROH data are not regularly updated. Workforce expansion and migration may result in rapid changes in dentist numbers. **Conclusion:** Marked inequalities in the distribution of global HROH exist between regions and countries, with inequalities most apparent in areas of high population growth. Detailed contemporary data on all groups of HROH are required to inform global workforce reform in support of addressing population oral health needs.

Key words: Dental, population, workforce, human resources, global, inequalities, access, oral health

INTRODUCTION

Dentistry is the professional clinical discipline concerned with the prevention, detection, management and treatment of oral and dental diseases and their sequelae. The World Dental Federation (FDI) has instituted a 'call for global action' on meeting the challenge of oral disease¹. Formally recognised as part of the chronic non-communicable disease burden by the United Nations (UN)², and confirmed by the papers on the Global Burden of Disease^{3–6}, untreated dental caries in permanent teeth was the most prevalent oral condition of the 291 included in the 2010 analysis⁴. The major oral disorders (dental caries, periodontal diseases) and the outcome of their management (total tooth loss) are amongst the top 35 causes of years lived with a disability globally and together they are calculated to cause 15 million years of life lived with a disability (YLLD)⁴. Much disease

should, where possible, be prevented; however, dental caries and periodontal diseases are progressive. Oral diseases must be treated, and the risk of future disease managed, in an evidence-based preventative manner^{5,6}. The importance of having sufficient human resources for health was clearly recognised on the global landscape with the publication, in 2016, of the Global Strategy for Human Resources for Health, 2030^{7,8}. Within dentistry, the dental workforce, which may be equivalently termed 'human resources for oral health' (HROH), has not yet received the attention merited given the prevalence of oral diseases. This paper provides an introduction to some of the relevant issues.

Dental professionals serve the oral health needs and demands of patients across the life course and therefore any consideration of HROH must relate to the size and health of the population⁹. Population growth and longevity provide additional challenges¹⁰ and thus

it is important to monitor the dental workforce globally in order to inform future planning within, and between, countries^{5,8,11}. The importance of good relationships between national and global dental associations has been emphasised¹² in relation to workforce issues; and there is vigorous debate on the role of mid-level providers in delivering the necessary skill-mix for future dental care, particularly in relation to bringing care to areas and population groups that are under-served by dentists¹³. Meeting global health goals^{14,15} and facilitating access to care includes an emphasis on country-specific action⁸. This paper aims to initiate debate by profiling the global dental workforce. The following research questions are addressed:

- What is the size and distribution of the dental workforce according to region?
- What is the variation in population-to-dentist ratio according to World Health Organization (WHO) region?
- What is the variation in population to dental-workforce ratios in the world's most populous countries?
- How may workforce to population ratios change over time?

The aim of this paper is thus to provide a contemporary analysis of the global dental workforce (HROH), examining the size and distribution of the dental workforce (including variation in population to dental-workforce ratios) according to WHO region and, for the world's 25 most populous countries, consider how the situation is changing and make recommendations for action.

METHODS

Publicly available information on the dental workforce and populations, according to country, were sourced via the Internet. Dental workforce data from 191 countries out of the 193 UN member states were obtained from the WHO database¹⁶. Information on dental-workforce capacity, namely mid-level providers (dental hygienists and therapists), and oral health data were obtained from the Country Area Profile Project (CAPP)¹⁷. Population demographic data were obtained from the Central Intelligence Agency (CIA) World Factbook¹⁸ and the WHO¹⁹, and projections of population growth were obtained from the UN Department of Economics and Social Affairs¹⁰. Country-specific data on wealth were obtained from the World Bank²⁰. Using this information, the population-to-dentist ratio was calculated for each WHO region and the most populous countries globally. This is considered, together with available evidence on dental caries experience in 12-year-old children [decayed, missing and filled teeth (DMFT)]. Dental workforce data for the UK were obtained from the regulatory body for dental professionals, the General Dental

Council (GDC)²¹⁻²³, and population data were obtained from the Office of National Statistics²⁴, to examine change in one populous high-income country over time.

RESULTS

Available data from the FDI and the WHO suggest that there are at least 1.6 million dentists globally, unevenly distributed across the six WHO regions (*Table 1*). The Americas, followed by Europe, have the most dentists, hosting at least two-thirds of the profession (69%) in these two regions alone, whilst having only 26% of the population. In contrast, Africa has only 1% of the global workforce of dentists. Inequalities are even more apparent when considering population-to-dentist ratios, which range from approximately 1,400:1 in the Americas to over 40,000:1 in Africa.

Intraregional disparities also exist. For example, within South East Asia, South Korea has a population-to-dentist ratio of 2,043:1, whereas in Nepal it is considerably higher, at 122,003:1. Within countries, variation in population-to-dentist ratio between urban and rural areas is most dramatic within low-income countries, which have fewer dentists overall. For example, whilst 65.7% of the population lives in rural settings in The Democratic Republic of Congo, 79% of dentists are located in urban areas.

The 25 largest countries in the world, hosting 5.25 billion of the world's population, vary greatly in their dental need, as represented by mean levels of dental caries experience (DMFT of 12-year-old children) and dental-workforce capacity (*Table 2*). Inequalities in workforce provision between developed and developing countries may, however, appear even starker when examining the population per clinical dental professional, rather than merely per dentist. The data in *Table 2* suggest that some countries with already high numbers of dentists may also have high

Table 1 Total number of dentists according to World Health Organization (WHO) region and globally

Region	Total no. of dentists*	Population [†]	Population per dentist
The Americas	671,189	966,494,931	1,440
Europe	450,555	906,995,748	2,013
Western Pacific	238,595	1,857,588,459	7,786
South East Asia	122,545	1,855,067,718	15,138
Eastern Mediterranean	110,545	612,580,128	5,541
Africa	22,110	927,370,720	41,943
Global	1,615,539	7,126,097,704	4,411

*Reference [16].[†]Reference [18] and WHO Source: United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2012 Revision, New York, 2013.

Table 2 Dental professionals and dental diseases in the 25 largest countries by population

Order of country (according to population size)	Country	Total population*	% Urban population†	Average DMFT in 12-year-old children‡	Number of dentists§	Date	Number of hygienists¶ (including dental therapists)	Date	Number of therapists¶	Date	Population per dentist	Population per clinical dental provider
1	China	1,343,239,923	47	0.5	51,012	2005		1995	16,643	1995	26,332	19,854
2	India	1,205,073,612	30	1.3	93,332	2008					12,912	12,912
3	USA	313,847,465	82	1.2	134,245	2000	112,000	2000			2,338	1,275
4	Indonesia	248,645,008	44	0.9	32,189	2010		2004	4,636 (inc. DH)	2004	7,725	6,752
5	Brazil	199,321,413	87	2.8	227,141	2008	390	2004			878	876
6	Pakistan	190,291,129	36	1.38	9,822	2009	350	2003			19,374	18,707
7	Nigeria	170,123,740	50	0.5	2,571	2008	400	2004	1,100	2004	66,170	41,789
8	Bangladesh	161,083,804	28	1	2,742	2007					58,747	58,747
9	Russian Federation	142,517,670	73	2.9	45,628	2006					3,123	3,123
10	Japan	127,368,088	67	1.7	94,882	2006	73,297	2004			1,342	1,342
11	Mexico	114,975,406	78	2	148,456	2004	5,000	2001			774	749
12	Philippines	103,775,002	49	2.9	45,903	2004	800	2000			2,261	2,222
13	Viet Nam	91,519,289	30	1.9	1,500**	(2002-9)			800	2000	6,099	5,791
14	Ethiopia	91,195,675	17	1.55	60	2003			32	2000	1,519,928	991,257
15	Egypt	83,688,164	43	0.4	33,476	2009					2,500	2,500
16	Germany	81,305,856	74	0.7	64,287	2009	350	2008			1,265	1,258
17	Turkey	79,749,461	70	1.9	20,589	2009					3,873	3,873
18	Iran	78,868,711	71	1.9	13,210	2005	650	2004			5,970	5,690
19	Democratic Republic of the Congo	73,599,190	35	0.4-1.1	159	2004					462,888	462,888
20	Thailand	67,091,089	34	1.9	4,129	2004	58	2004	3,307	2004	16,249	8,953
21	France	65,630,692	85	1.2	41,876	2010	0	2008	0	2008	1,567	1,567
22	UK	63,047,162	80	0.7	32,189	2010	5,340	2008	1,154	2008	1,959	1,630
23	Italy	61,261,254	68	1.1	31,085	2009	4,000	2007			1,971	1,746
24	South Africa	48,810,427	62	1.1	5,988	2004	955	2006	443	2006	8,151	6,609
25	Republic of Korea	48,860,500	83	3.1	23,912	2008	13,769	2000			2,043	1,297

*Reference [18].

†UN Department of Economics and Social Affairs, http://esa.un.org/unpd/wpp/Sorting-Tables/tab-sorting_population.htm, accessed 14th July 2012.‡WHO Oral Health Database, <http://www.mah.se/CAPP/Country-Oral-Health-Profiles/According-to-Alphabetical/Global-DMFT-for-12-year-olds-2011/>, accessed 08th November 2012.

§Reference [16].

¶Malmö University Oral Health Database, Country/Area Profile Project, <http://www.mah.se/CAPP/>, accessed 08th November 2012.**FDI Oral Health Atlas, <http://www.fdiworldental.org/oral-health-atlas>, accessed 08th November 2012. DH, dental hygienists; DMFT, decayed, missing and filled teeth.

numbers of mid-level providers. For example, Japan has nearly 95,000 dentists and over 73,000 dental hygienists, making a population-to-dental-workforce ratio of 1,342:1. Interestingly, South Korea has the highest reported levels of need in a populous country, with an average of 3.1 DMFT in 12-year-old children; it has a population-to-dentist ratio of 2,043:1, which is decreased to 1,297:1 when dental hygienists are included. In contrast, Ethiopia has a population-to-dentist ratio of 1.5 million:1, which is decreased only to 1 million:1 when other clinical dental personnel are included; thus, the majority of the dental caries experience in 12-year-old children is likely to be untreated. Ethiopia therefore provided an example of the extreme workforce capacity challenges that exist in parts of the African region. Moreover, out of the 25 largest countries in the world, the three with the highest population-to-dentist ratio are in the African region (Ethiopia, Democratic Republic of the Congo and Nigeria), despite having survey data showing oral disease in their 12-year-old children, albeit not be as high as in some other countries.

The available information on dentists largely spans a period of 20 years from 1990 to 2010, with six countries having data prior to 1998. Many of the latter are small countries (e.g. Monaco and San Marino) and therefore are unlikely to have a major effect on the global calculations. Data on dentists from many of the low-income countries were not as up-to-date as those from high-income countries, and data on dental care professionals are almost non-existent. Although only a limited number of countries report data on dental hygienists and therapists, lack of evidence of mid-level providers may not mean that they do not exist.

Country-specific data highlight that the nature of the dental workforce may change quickly, and significantly, in a short timescale. For example, in the UK, between 2007 and 2014, the population increased by 5.1%, whilst the population of registered dentists increased by 15.8%, therefore significantly improving the population-to-dentist ratio in a 7-year time span (*Table 3*).

Looking to the future, population projections from the UN suggest that the populations of Asia and Africa are going to increase rapidly over the next 75 years (*Figure 1*). Importantly in relation to HROH, these are the two WHO regions in which large population-to-dentist ratios already exist, therefore suggesting that as the population increases, inequalities are set to increase unless there is a significant growth in dental-workforce capacity. In contrast, the population in areas that have a low number of people per dentist, such as the Americas and Europe, is predicted to increase only very slightly, whilst the number of dentists is likely to remain high and even increase.

DISCUSSION

This paper provides evidence of current inequalities in the size and distribution of the dental workforce globally; inequalities that are predicted to increase. Furthermore, it highlights major gaps in HROH data and data quality, which must be addressed in line with the Global Strategy on Human Resources for Health, 2016⁸. This descriptive analysis has a number of limitations that form an important component of the findings and recommendations for change.

First, the existing available global data are not all contemporary, making accurate reporting and comparison over time difficult. The pace of change at country level demonstrated in the UK, as a result of policy changes and regional migration, highlights the importance of regular monitoring. Accordingly, moving forward, regular updates from all countries are important to inform a global action in support of universal health coverage and the UN sustainable development goals.

Second, the actual sources of the data are not quoted in the databases to enable verification and updating of the data on a regular basis.

Third, even if the number of professionals is correct, it is important to recognise that the actual number of dentists does not reflect their commitment to dentistry as many choose to work part-time, or plan to do so^{25–28}, whilst others may not be working because of illness or maternity leave, or they may hold non-clinical administrative roles within the profession. Additionally, specialists can comprise up to 20% of dentists nationally²⁹ and perhaps ought to be considered separately to primary care provision in workforce planning – a matter for further debate?

Fourth, although dental-workforce data generally are held by registration bodies, the registered workforce may not reflect the actual resident workforce. A dentist may be registered to practice in more than one country. For example, in the UK, in 2010, 6% of the GDC registrants were registered to a non-UK address²² and presumably were also on the register of their resident country and working there, or across countries. Thus, the number of dentists globally, both in actual numbers and whole time equivalents, may be lower than suggested by the data available and may not relate to workforce capacity to provide care.

Fifth, the data on dentists do not relate to the full clinical workforce as some countries have a significant volume of mid-level or ‘auxiliary’ clinical providers, such as dental therapists, hygienists, school nurses and dental assistants³⁰, which are not reported. Interestingly, some high-income countries that already have a well-established dental profession and good dentist provision also have high auxiliary provision, further demonstrating the inequalities in HROH capacity.

Table 3 UK population and numbers of dentists registered with the General Dental Council from 2007 to 2014

Variable	2007	2008	2009	2010	2011	2012	2013	2014
UK population*	60.98M	61.4M	61.8M	62.3M	63.2M	63.3M	63.7M	64.1M
Number of dentists†	35,419	36,281	37,049	38,379	39,307	39,894	40,423	41,007
Population per dentist	1,722:1	1,692:1	1,668:1	1,622:1	1,607:1	1,587:1	1,576:1	1,256:1

*Office for National Statistics. Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Population Estimates Time-series 1971 to Current Year 2014 [Available from: <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk-england-and-wales-scotland-and-northern-ireland/2013/sty-population-changes.html> 09.03.2015].

†General Dental Council. GDC Regulation Statistical Reports: Annual Reports and Accounts, 2011; 2012; 2013 and December 2014 Data [Available from: <http://www.gdc-uk.org/Newsandpublications/factsandfigures/Pages/default.aspx> 09.03.2015].M, million.

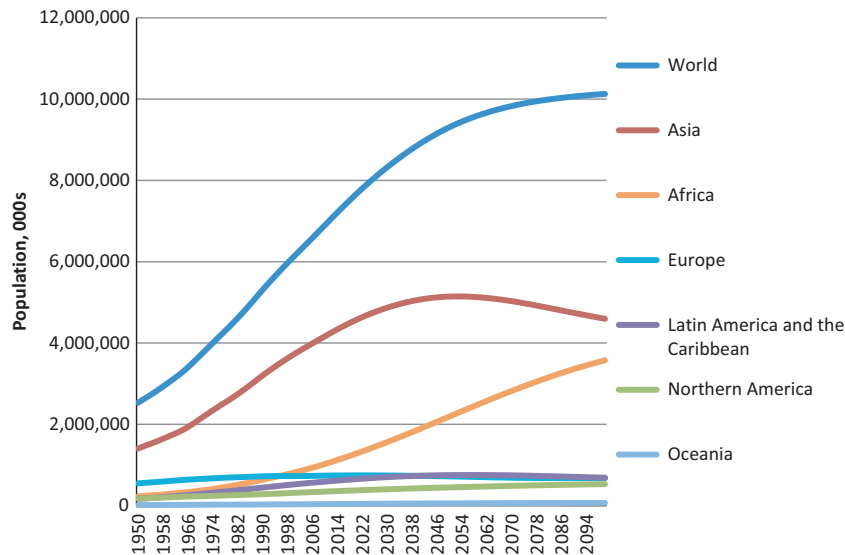


Figure 1. World population projections according to region and globally. Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects DEMOBASE extract. 2011.

These professionals will not have been included in the numbers of dentists in the WHO data but are significantly contributing to dental care in these countries. Particularly in low- and middle-income countries, community health workers may play an important role in providing emergency dental care and in promoting oral health, yet there is no evidence on the extent of their contribution to the oral health agenda. Thus, in order to gain insight into dental personnel globally it would be helpful to collect data for auxiliary dental personnel as well as for dentists; this is not without its challenges, however, in that the remit and range of these mid-level providers varies greatly from country to country³⁰.

Crude population-to-dentist ratios are acknowledged to be a very blunt instrument for workforce analysis given the caveats above. Nonetheless, such are the existing global disparities, however, that this simple method presents a very stark picture of the challenges. The data continue to suggest that over two-thirds (69%) of the world's dentists appear to be practising in Europe and the Americas, although only 27% of the global population live in these WHO

regions²⁹. Looking to the future, given differential population growth, together with patterns of workforce education and migration, this disparity between Africa and the rest of the world is likely to increase further. And within Asia, there appears to be marked inequalities within the region because certain countries have a highly developed workforce, whereas others do not; and as a region they are likely to experience significant population growth.

Although the distribution of dentists and other dental professionals globally is far from uniform, it has to be acknowledged that the distribution of oral and dental disease is also non-uniform between and within countries. All too often, inequalities in health are compounded by poor access to dental professionals and uptake of dental care, which relate to the nature of the health-care system and the availability of HROH. In relation to future planning, population demography and needs must be considered; however, this is only possible where robust workforce and oral-health data are available. Low-income countries have difficulty in obtaining resources for surveys, both financial and human, and appear to be less likely to

hold contemporary data to support the arguments for workforce development. Practitioners with no formal training and poor infection control may be the only option for pain relief, thus exposing their patients to additional health risks. Poor access to care and cost are the main factors influencing the use of alternative non-trained providers, and patients doing so have poorer reported oral health³¹. Addressing these issues could be helped by collaboration between high- and low-income countries working in partnership.

A professional career in dentistry spans at least four decades and so decisions on workforce training and education have long-term implications. Under current predictions, as outlined above, the population in the African and Asian regions is set to increase dramatically over the next 75 years; therefore, the population-to-dentist ratios may worsen unless there is appropriate action. Certain countries, such as India, have responded to this challenge by opening many private dental schools, with some 206 establishments currently operational³²; however, this is not without its risks as there are insufficient opportunities for new graduates, which increases the risk of migration to high-income countries despite local oral health needs. It is very important to consider the issues around workforce migration in this era of global mobility, particularly as migration tends to increase inequalities in access to care between low- and high-income countries. It tends to be the more developed high-income countries that have targeted international recruitment in order to address perceived domestic shortages³³; this is just one of the factors that has contributed to the growth in the UK dental workforce, together with increased student numbers³⁴.

The needs in Africa are so great that it is not realistic, or appropriate, to meet them by training additional dentists and therefore alternative methods, such as using low- and mid-level providers, should be explored^{35,36}. The Cameroon is just one of a number of countries providing evidence of the potential of mid-level providers of dental care as an alternative model³⁷ to that of the American/European model, which has historically focussed largely on training dentists. Thus, each country needs to look carefully at the volume and composition of its current workforce, numbers in training across the dental team and workforce mobility, relating this to their oral health needs and changing population demography⁹, and of course paradigm of care. Given that oral diseases are largely preventable there is a strong need to tackle the wider determinants of health and re-orientate oral health-care towards prevention. Together, these initiatives, which require strong leadership, may in the longer term provide health care that is more appropriate than traditional models of dental care to the setting and population health needs.

In conclusion, major inequalities in dental-workforce provision exist globally and are evident between regions and countries. Furthermore, such inequalities are set to increase over the next 75 years, unless they are balanced by educational and health-system initiatives that train and retain appropriate HROH. New models of dental care are required to meet the oral health needs associated with the burden of non-communicable disease. Accurate and timely country-specific data on the dental workforce are therefore required to gain a clearer perspective on the global workforce and inform future developments. Overall, it is time for co-ordinated global action on HROH.

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Author contributions

J.G. developed the concept for this paper, and L.H. sourced and analysed the data. Both authors worked on the paper and approved the final version.

Conflict of interest

J.E.G. is the chair of the Dental Workforce Advisory Group for England within Health Education England (HEE) and is an Honorary Consultant in Dental Public Health to Public Health England (PHE). The views expressed are hers alone and do not represent the views of the National Health Service (NHS) or HEE.

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