

Global mapping of optometry workforce



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Background: Vision impairment is a growing global burden issue, and appropriately trained optometrists are essential for its management. However, there is a shortage of optometrists worldwide, which hampers eye care planning. Few studies have addressed this shortage quantitatively.

Aim: The study aimed to describe the distribution of the global optometric workforce.

Setting: Global and country level.

Methods: From February 2017 to May 2020, a standardised questionnaire in English was utilised to collect data on the global number and distribution of optometrists from key informants. Optometrists were categorised based on the World Council of Optometry's guidelines, from levels two to four. Optometrist-to-population ratios were calculated for all countries and regions and compared with targets of 1:50 000 (in developing contexts) or 1:10 000 (in developed contexts).

Results: An 80.9% response was achieved with responses from 123 of the 152 countries invited. Most (40.7%) key informants were academics. The total number of optometrists across 21 Global Burden of Disease (GBD) regions was 331 781. Sixty-six (53.7%) countries met the 1:50 000 optometrist-to-population ratio. There was a noticeable positive correlation ($r = 0.7$) between the prevalence of blindness and vision impairment and the optometrist-to-population ratios. Strong inverse relationships existed between a country's gross domestic product and optometrist-to-population ratio.

Conclusion: High-income countries met the target for optometrist-to-patient ratios, while low- to middle-income countries and low-income countries did not meet the targets. Low optometrist-to-patient ratios were strongly associated with a higher magnitude of blindness and vision impairment.

Contribution: This article provides the first consolidation of the global optometry workforce.

Keywords: optometrist; practitioner-to-population ratio; mapping; optometry workforce; global distribution.

Introduction

Skilled and motivated health workers in sufficient numbers located appropriately in places with unmet needs are critical to deliver effective health services and improve health outcomes.¹ The World Report on Vision highlighted the need for an increase in eye health human resources to address the enormous magnitude of vision and eye health problems² – at least 2.2 billion people globally have a vision impairment, of which about 1 billion people have problems that are preventable or yet to be addressed.² While budgets define the ability of countries to provide resources, even with enough finances, the paucity of relevant and appropriately trained human resources, especially optometrists and ophthalmologists,³ are still a barrier to equitable access to quality eye care. Hence, 90% of the burden caused by vision impairment is found in developing countries.

Holden et al.⁴ estimated that 2.6 billion people were living with myopia, while Frick et al.⁵ reported 1.8 billion people living with presbyopia. Holden et al.⁴ also established the alarming projection of 5 billion people living with myopia by 2050. This looming crisis will not only add to the number of people with uncorrected refractive error (URE) but also the number of people with other potentially blinding conditions such as glaucoma, retinal detachment and cataracts. Furthermore,

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conditions such as diabetic retinopathy, age-related macular degeneration and ailments arising from evolving visually demanding lifestyles (dry eye and binocularity problems) will increase the need for vision care and further amplify a global burden, which already exceeds the human resources for eye health currently available worldwide.

An optometrist, whose core function is detecting, measuring and correcting refractive error, and detecting and managing primary eye care and other conditions of public health concern that add to the global burden of vision impairment, is best placed to contribute to the disease control strategy. The World Council of Optometry defines an optometrist as a healthcare professional who is autonomous, educated and regulated (licensed or registered). Optometrists are the primary healthcare practitioners of the eye and visual system who provide comprehensive eye and vision care, which includes refraction and dispensing, detection or diagnosis and management of eye disease, and visual system rehabilitation.⁶ Optometrists are predominantly located in the private sector and there is limited integration of optometry into the public sector, with some countries having no optometry posts in the public sector. Private sector optometrists are mainly focused on the provision of refractive services and the screening for diseases, with some exceptions where their scope of practice allows for the treatment of diseases as seen in the United States. Public sector optometrists play two roles, provision of refractive services and co-management of diseases with ophthalmologists.

The importance of optometry was highlighted as an essential workforce in the Universal Eye Health: A Global Action Plan 2014–2019.⁷ However, the insufficient number of optometrists means limited screening and reduced accessibility to refractive services and optical correction. This has contributed to a large number of vision impaired people because of URE, a condition that can be safely and inexpensively corrected, yet has become the primary cause of vision impairment.⁸

There have been attempts to quantify the global number of optometrists previously, but they did not provide a robust estimate, partly because these results were generated from a few countries where optometry is well-defined and regulated. The World Council of Optometry, which represents a large proportion of optometrists globally, suggests that it represents 200 000 optometrists from 89 member organisations in over 48 countries.⁹ Fricke et al.¹⁰ estimated the number of 'functional clinical refractionists' (a person who spends 100% of the clinical time providing refraction services) to be 167 013 – a figure that is probably biased towards optometrists. The gross estimate of 300 000 optometrists is often used as the existing number of optometrists globally, but this estimate is not based on a formal evaluation. The estimate is further affected by the varying definitions of the profession of optometry that are used across countries. The result is an inaccurate estimate of an 'optometry pool' of eye care workers of varying educational backgrounds providing refraction and/or refractive services at different levels of care and competency.

This raises the following questions: (1) how many optometry personnel are there globally? (2) where are they distributed and (3) at what level of competency are they practising? Unless these questions are answered, developing adequate strategies to overcome this burden will be difficult to achieve.

The primary objectives of this study were to determine the ratio of optometrists to the population according to Global Burden of Disease (GBD) Regions and its association with the gross domestic product (GDP) per capita and prevalence of blindness and moderate and severe vision impairment. We also investigated the number of training institutes and optometry graduates in the countries. We hypothesised that in countries with a lower number of optometry workforces, the prevalence of blindness and vision impairment would be higher than in countries where the number of optometry workforces is meeting the recommended practitioner-to-population ratio.

Research methods and design

A cross-sectional study utilising quantitative methods was conducted from February 2017 to May 2020. Non-random, purposive sampling and a key informant strategy were employed. The key informants were linked to either the World Council of Optometry members, other ophthalmic groups, prominent academics or individuals playing a key role in eye health development. These individuals were invited to complete the questionnaire, which focussed on ascertaining the quantity and distribution of optometrists globally. When necessary, clarification on the questionnaire was provided via direct communication, either verbally or via digital communications. A standardised English language questionnaire was designed to obtain the key indicators needed. Concerted efforts were made to reach those countries that initially did not respond. If the original key informant could not respond to the questionnaire, they were asked for referrals to other individuals who could provide the necessary information.

The original English language questionnaire was translated into Spanish, French and Mandarin for ease of completion for those whose primary language was not English and were not comfortable responding to an English questionnaire. Translators were used to translate the responses to English if they were self-administered in languages other than English. The questionnaire was distributed via an email link or on paper or Microsoft Office Word format for internet-limited settings. Respondents provided consent to participate before answering the specific research questions.

According to the Institute for Health Metric and Evaluation (IHME), there were 200 GBD countries (<http://ghdx.healthdata.org/countries>).¹¹ However, 152 countries were included in the study, with 48 countries being excluded because of unobtainable key informants as optometry does not formally exist in all countries. Data collected were reviewed, missing data were identified and key informants

were approached to provide the missing data or clarification, where possible.

The main questions presented to respondents were as follows:

- What was the source of the information provided?
- What was the number of professionals functioning at the various WCO competency levels?
- How many Optometry training institutions were there in the country?
- How many optometrists graduated from the optometry training institutions per annum?
- Was optometry regulated?

The World Council of Optometry (WCO) Competency Model was used to define optometry with four categories of services that were:

- **Category 1 – Optical technology services:** Management and dispensing of ophthalmic lenses, ophthalmic frames and other ophthalmic devices that correct defects of the visual system.
- **Category 2 – Visual function services:** Investigation, examination, measurement, diagnosis and correction or management of defects of the visual system.
- **Category 3 – Ocular diagnostic services:** Investigation, examination and evaluation of the eye and adnexa and associated systemic factors to detect, diagnose, and manage the disease.
- **Category 4 – Ocular therapeutic services:** Use of pharmaceutical agents and other procedures to manage ocular conditions or disease.

Based on this optometry workforce scope of practice, practitioners practising at Category 2 and above were considered as Optometrists. Our analysis excluded practitioners functioning at Category 1, who are concerned solely with dispensing spectacles, without investigation, examination, measurement, diagnosis and correction or management of the visual system defects.

Data were captured in a Microsoft Excel spreadsheet and then exported to Statistical Package for the Social Sciences (SPSS, version 26.0) for data cleaning and subsequent analysis. Descriptive statistics in the forms of frequencies and distributions were used to assess the response rates across 21 GBD regions, key informant's background and the source of information, the country's capacity in training optometrists, regulation and continuous medical education in the respective country. The number of optometrists and the total population in the country were used to calculate the optometrist-to-population ratios, regionally and by country. Spearman's correlation analysis was used to test the association between the optometrist-to-population ratio and the demographic variables such as country's GDP per capita, the age-standardised prevalence of blindness and moderate and severe vision impairment (MSVI), with the significance level set at 5%.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of KwaZulu-Natal, Human and Social Sciences Research Ethics Committee (no. HSS/2135/016).

Results

Response rate

We received responses from 123 of the 152 countries invited to participate, resulting in an overall response rate of 80.9%. Forty-eight of the 200 GBD countries were excluded because of unobtainable key informants. Table 1 shows the distribution of responses of countries by GBD region.¹¹ Regions with lower response rates were mainly from sub-Saharan Africa, with the Central region being the lowest with 50.0%, followed by Western and Southern regions with 63.2% and 66.7%, respectively.

Key informant's background and source of information

Most respondents were affiliated with universities or research institutes (53 countries, 43.1%) or professional associations (42 countries, 34.1%) (Table 2). Most key informants were academics (40.7%), followed by association representatives (30.9%). More than half of the respondents' information (55.3%) was from government sources, primarily the Ministry of Health, Health Council Registry and Medical Council Registry.

TABLE 1: Total number of countries included in the study and the response rates (N = 152).

Global burden of disease regions	Total number of countries included	Total number of responded countries	Response rate (%)
Andean Latin America	3	3	100.0
Australasia	2	2	100.0
Caribbean	16	11	68.8
Central Asia	2	2	100.0
Central Europe	5	5	100.0
Central Latin America	9	6	66.7
Central sub-Saharan Africa	4	2	50.0
East Asia	2	2	100.0
Eastern Europe	4	3	75.0
Eastern sub-Saharan Africa	15	13	86.7
High-income Asia Pacific	4	3	75.0
High-income North America	2	2	100.0
North Africa and Middle East	14	10	71.4
Oceania	8	7	87.5
South Asia	4	3	75.0
Southeast Asia	11	11	100.0
Southern Latin America	3	3	100.0
Southern sub-Saharan Africa	6	4	66.7
Tropical Latin America	2	2	100.0
Western Europe	17	17	100.0
Western sub-Saharan Africa	19	12	63.2
Total	152	123	80.9

Source: Institute for Health Metric and Evaluation (IHME). List of Global Burden of Disease countries [home page on the Internet]. [cited n.d.]. Viewed from: <http://ghdx.healthdata.org/countries>

TABLE 2: Affiliations, key informants and source of information ($n = 123$ responded countries).

Respondent information	Number of countries	%
Affiliations		
University/research Institute	53	43.1
Association <i>Association of Optometry, Association of Optician, College of Optometrist, Society of Technical Opticians, College of Opticians, Contactologists and Optometers, Ophthalmologist's Society</i>	42	34.1
Government Ministerial Unit <i>Ministry of Health, Ministry of Education, Medical Council, Optical Council</i>	14	11.4
Non-governmental organisation	11	9.0
Optical practice	2	1.6
Did not specify	1	0.8
Total	123	100.0
Key informants		
Academia <i>University director, head of department, Dean of faculty, lecturer, professor</i>	50	40.7
Association representative <i>director, CEO, chairman, chair, president, secretary, member, coordinator</i>	38	30.9
Eye care personnel <i>optometrist, ophthalmologist</i>	15	12.2
Government representative <i>National eye care coordinator, council director, council secretary, council member, diplomat, coordinator</i>	9	7.3
Non-governmental organisation <i>Representative Foundation director, foundation manager, country director, programme manager</i>	9	7.3
Did not specify	2	1.6
Total	123	100.0
Source of information		
Government <i>Ministry of Health, Health Council Register, Medical Council Register, Health Practitioner Registration Agency, Ministry of Public Health, Patient Safety Authority</i>	68	55.3
Associations <i>European Academy of Optics and Optometry, College graduation list, Eye Institute, School of Optometry Register</i>	11	8.9
WHO Reports <i>Biblioteca Regional de Medicina (BIREME), Pan American Health Organisation (PAHO WHO ECSAR)</i>	8	6.5
IAPB Vision Atlas	2	1.6
Other Sources <i>On the ground research, desktop search, public health study, NGO database, general information, self, private email, personal awareness, trade register, hospital data, manufacturers, syllabus curriculum.</i>	21	17.1
Did not specify	12	9.8
Total	123	100.0

CEO, chief executive officer; WHO, World Health Organization; IAPB, International Agency for the Prevention of Blindness; NGO, non-governmental organisation.

The distribution of optometrists across Global Burden of Disease regions

As guided by the World Council of Optometry, practitioners practising at Category 2 to 4 were considered to be optometrists. The reported number of optometrists across 21 GBD regions was 331781 as of the year 2019, covering 88.5% of the global population (6.79 billion in 123 countries) (Table 3).¹² The number of Category 4 optometrists was three times less than those practising at Category 2 (55427 and 169076, respectively). Seven regions reported no optometrists

practising at Category 4 referring to Andean Latin America, Southern Latin America, Tropical Latin America, Central Asia, Central and Eastern Europe and High-income Asia Pacific.

Considering the optometrist-to-population ratio, globally, one optometrist is serving an average of 20479 persons. The unequal workforce distribution across countries and regions showed that in Central sub-Saharan Africa, one optometrist serves 1198141 people, compared with 3877 people in Western Europe. Among the 123 countries, 66 (53.7%) met the World Health Organization recommended 1 optometrist to 50000 persons target (1:50000),¹³ while only 33 (26.8%) reached the 1:10000 target as previously found in many developed countries.¹⁴ All the countries in Australasia, Central Europe, High-income Asia Pacific and High-income North America regions achieved both the recommended targets (Table 3).

Relationship between the optometrist-to-population ratio and the country demographic characteristics

A higher age-standardised prevalence of blindness was significantly associated with a lower optometrist-to-population ratio at the country level ($p < 0.001$, $r = 0.721$) (Figure 1). This correlation was considered strong as the r -value was more than 0.7. A similar finding was reported for the age-standardised prevalence of mild and severe vision impairment, where a significant moderate direct positive relationship between the burden of disease and the optometrist-to-population ratio was observed ($p < 0.001$, $r = 0.636$) (Figure 2).

A significant inverse relationship was observed between the country GDP per capita and the optometrist-to-population ratio ($p < 0.001$, $r = -0.770$) (Figure 3). Lower country GDP per capita is correlated with a greater deficit of optometrists in the country.

Countries capacity in training optometrist

A total of 19265 optometrists graduate from 123 countries annually (Table 4). Western Europe trained the highest number of optometrists among the 21 GBD regions (4594 graduates), followed by South Asia (4492 graduates), High-income Asia Pacific (2160 graduates) and East Asia (2100 graduates). Three regions did not have institutions within the countries to train optometrists, specifically, Central Asia, Central sub-Saharan Africa and Oceania.

Countries regulation on optometry and continuous medical education

Out of the 123 country responses, optometry was regulated as an eye care profession in less than half of them ($n = 54$, 43.9%) (Table 4). Optometry was recognised in all the countries in Australasia, high-income Asia Pacific and high-income North American regions. In 42 countries (34.1%) mandatory continuing professional education was imposed

TABLE 3: The number of optometrists and the ratio of optometrists to the population according to Global Burden of Disease regions.

Global burden of disease regions	Number of countries	Number of optometrists according to the scope of practice				2019 total population (thousands)	Optometrist-to-population ratio	Number of optometrists to reach the recommended 1 optometrist to 50 000 population (1:50 000) target	Total number of countries reached the recommended 150 000 target	Number of optometrists to reach the recommended 1 optometrist to 10 000 population (1:10 000) target	Total number of countries reached the recommended 1:10 000 target
		Category 2	Category 3	Category 4	Total number of optometrists						
Andean Latin America	3	3056	40	0	3096	61 237	1:19 779	1225	1	6123	0
Australasia	2	0	2260	3736	5996	29 985	1:5001	600	2	2998	2
Caribbean	11	40	408	56	504	31 467	1:62 435	629	8	3147	2
Central Asia	2	0	0	0	0	21 776	†	436	0	2178	0
Central Europe	5	2765	900	0	3665	67 341	1:18 374	1348	5	6735	5
Central Latin America	6	928	12 093	2491	15 512	213 544	1:13 766	4271	5	21 354	2
Central sub-Saharan Africa	2	97	0	2	99	118 616	1:1 198 141	2373	0	11 862	0
East Asia	2	2500	800	900	4200	1 457 558	1:34 704	29 151	0	145 755	0
Eastern Europe	3	2700	2	0	2702	151 241	1:55 974	3025	1	15 124	1
Eastern sub-Saharan Africa	13	946	2667	603	4216	436 107	1:103 441	8722	2	43 610	0
High-income Asia Pacific	3	47 197	100	0	47 297	183 933	1:3889	3678	3	18 393	3
High-income North America	2	0	0	42 720	42 720	366 476	1:8679	7329	2	36 648	2
North Africa and Middle East	10	3120	4095	11	7231	227 327	1:31 438	4547	6	23 733	1
Oceania	7	16	16	7	39	10 803	1:277 000	216	3	1081	0
South Asia	3	38 950	13 590	1078	53 618	1 611 592	1:30 057	32 232	2	161 159	0
Southeast Asia	11	3994	13 284	38	17 346	624 422	1:35 998	12 488	6	62 442	1
Southern Latin America	3	424	720	0	1144	67 195	1:58 737	1344	1	6720	0
Southern sub-Saharan Africa	4	10	3984	32	4026	77 632	1:19 283	1553	1	7764	0
Tropical Latin America	2	2000	1500	0	3500	218 095	1:62 313	4362	0	21 810	0
Western Europe	17	59 831	50 364	840	111 035	430 465	1:3877	8609	17	43 047	14
Western sub-Saharan Africa	12	508	414	2912	3834	387 793	1:101 146	7756	1	38 780	0
Total	123	169 076	107 272	55 427	331 781	6 794 609	1:20 479	135 892	66†	679 461	33§

Source: United Nation. World Population Prospect [home page on the Internet]. 2019. Viewed from: (<https://population.un.org/wpp/Download/Standard/Population/>); Holden B, Resnikoff S. The role of optometry in vision 2020. J Community Eye Health. 2002;15:33–36.

†. There was no optometrist in the Central Asia region; ‡. 53.7%; §. 26.8%.

to maintain optometrists' competency level and further equip them with up-to-date practices.

Discussion

The current study quantified the number of optometrists functioning according to the WCO competency level. The global optometrist-to-population ratio of one optometrist to 20479 persons appears reasonable when viewed in the developing world (1:50 000 recommended ratio).¹³ However, this ratio masks the unequal distribution of the workforce across countries or regions. For example, Central sub-Saharan Africa serves a population of 1 198 141 population, compared with 3877 in Western Europe. Approximately half of the countries (53.7%) met the 1:50 000 ratio, with all high-income regions meeting the 1:10 000 ratio.

Anecdotal evidence suggests that the ratio of optometrists to population is critically low in rural and outlying areas and magnifies the deficits displayed in our data. This paucity of optometrists in the developing world is further accentuated

when one considers intra-country variations whereby optometrists, like most eye care providers are confined to the major cities. While producing more optometrists is imperative to address the unequal distribution, the workforce must be more effectively distributed; a major challenge given the lack of incentives¹⁵ and facilities in rural and remote areas, making recruitment difficult.

Developing an adequate number for the workforce is a complex task because of numerous factors, including key elements such as the lack of educators, the length of training for professionals, regulatory barriers and the cost of setting up training institutions. However, Thompson et al. showed that implementing an optometry program deNovo in a developing country is cost-effective,¹⁶ which in the best case scenario reaches self-sufficiency in 10–12 years post setup, using conservative approaches and restricted means. A lower country GDP per capita is correlated with a greater shortage of optometrists in countries. As such, resources may not always be available for the establishment of schools of optometry. Strong advocacy supported by a robust evidence base such as the impact of poor vision on productivity^{17,18,19} or learning,^{20,21,22} which is documented, is needed to make a case for the value of optometry school development. International collaboration needs to be mobilised to ensure that academic, logistical and material support is provided for new schools, and new policy formulation needs to overcome regulatory barriers. However, the current status in the low-income countries indicates that the deficits seen in the number of optometrists will not be addressed soon. As few new optometrists are being trained, innovative strategies that encompass the following need to be explored:

- **Team approach:** While vision screening is performed at a primary level by allied health professionals, linking optometrists in the referral pathway is imperative to ensure a continuum of care. Optical assistants or technicians assisting in refractive services using some preliminary testing can help increase the effectiveness of

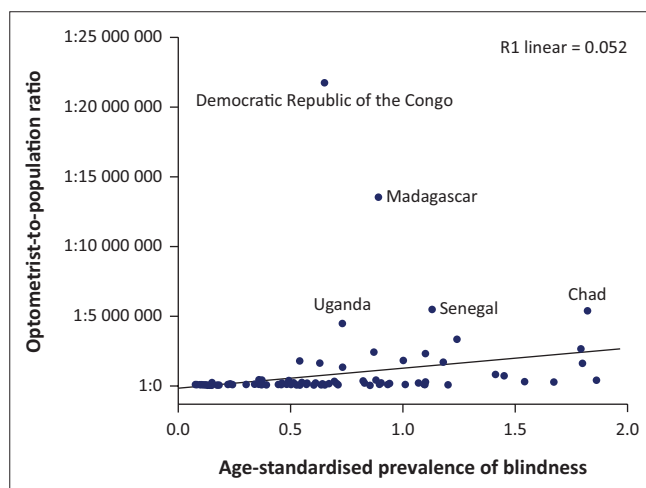


FIGURE 1: The relationship between the optometrist-to-population ratio and the age-standardised prevalence of blindness.

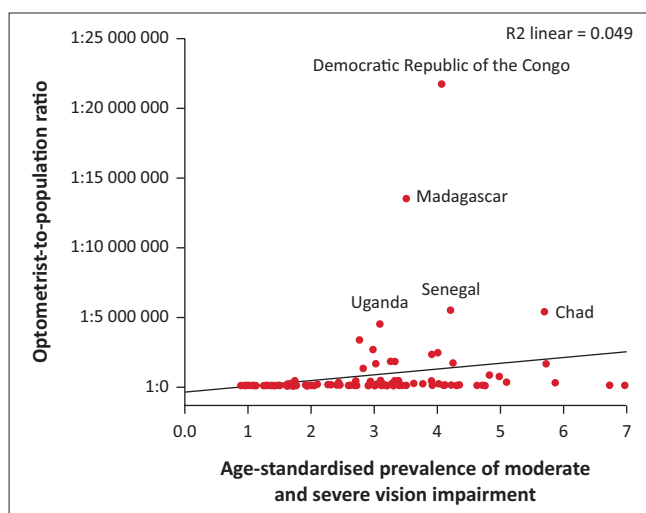
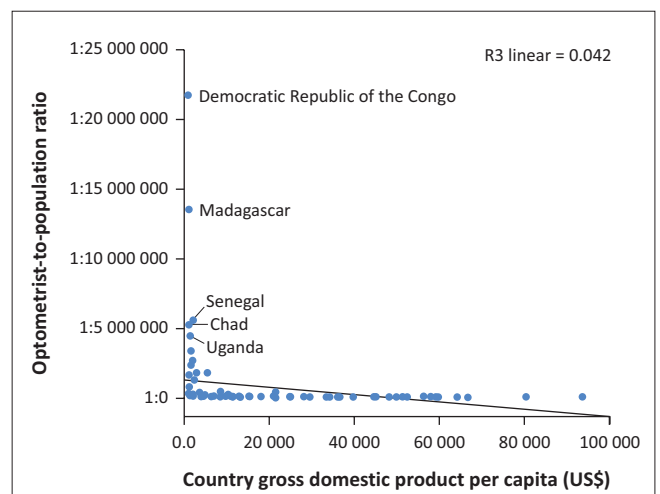


FIGURE 2: The relationship between the optometrist-to-population ratio and the age-standardised prevalence of mild and severe vision impairment.



US\$, United States dollar.

FIGURE 3: The relationship between the optometrist-to-population ratio and the country gross domestic product per capita.

TABLE 4: The number of training institutions, graduates per annum, countries with regulation and continuing medical education according to Global Burden of Disease Regions.

Global burden of disease regions	Number of countries	Number of institutions providing training			Number of graduates per annum			Total number of graduates per annum	Total number of countries with the optometry profession regulated	Total number of countries with mandatory continuing medical education for optometrists
		Category 2	Category 3	Category 4	Category 2	Category 3	Category 4			
Andean Latin America	3	6	1	0	71	0	0	71	1	0
Australasia	2	0	1	7	0	55	385	440	2	2
Caribbean	11	0	4	1	0	80	50	130	6	5
Central Asia	2	0	0	0	0	0	0	0	0	0
Central Europe	5	13	3	0	315	55	0	370	2	2
Central Latin America	6	4	13	25	125	102	500	727	4	2
Central sub-Saharan Africa	2	0	0	0	0	0	0	0	0	0
East Asia	2	28	28	19	1500	200	400	2100	0	0
Eastern Europe	3	5	0	0	70	0	0	70	1	1
Eastern sub-Saharan Africa	13	5	6	9	45	58	150	253	7	6
High-income Asia Pacific	3	71	0	0	2160	0	0	2160	3	2
High-income North America	2	0	0	23	0	0	1900	1900	2	2
North Africa and Middle East	10	4	12	0	90	300	0	390	5	3
Oceania	7	0	0	0	0	0	0	0	2	3
South Asia	3	86	118	12	1600	2570	322	4492	1	0
Southeast Asia	11	10	34	1	279	680	0	959	4	3
Southern Latin America	3	2	12	0	11	80	0	91	1	0
Southern sub-Saharan Africa	4	0	6	1	0	155	0	155	2	2
Tropical Latin America	2	2	3	0	0	200	0	200	0	0
Western Europe	17	18	51	5	2324	2180	90	4594	8	6
Western sub-Saharan Africa	12	6	2	7	83	80	0	163	3	3
Total	123	260	294	110	8673	6795	3797	19 265	54†	42‡

†, 43.9%; ‡, 34.1%.

optometrists. Similarly, the referral pathway for available optometrists to ophthalmologists and other specialty services for a higher level of care needs to be facilitated. In adopting a team approach, optometrists can provide the care needed by three types of patients: those who need ongoing care, those at early-stage disease and those with symptomatic conditions without vision impairment but still needing services.²³

- **Technology:** Strategies such as using more cost-effective tools to increase the quality of care and the output of optometrists need to be explored. Furthermore, the optometry workforce needs to be mobilised to reach outlying rural areas via outreach activity or supporting social businesses in under-developed areas. Tele-health overseen by optometry may support distance monitoring and oversight to potentially provide a greater reach for the profession. These strategies, however, need to be carefully developed without compromising the quality of care.
- **Upskilling:** In countries where optometry is not developed, post-graduate and continuing professional education must be explored to expand the knowledge and skills of existing cadres so that they can be integrated into the optometry profession. This takes on increasing importance in an era where other morbidities such as diabetic retinopathy and glaucoma are becoming a significant threat to visual health if detection and treatment are delayed.

The World Report on Vision states that at least 1 billion people in the world with vision impairment could have been prevented from being affected or have yet to be addressed.²

Of this, almost 950 million is related to refractive error and presbyopia; both are key responsibilities of optometrists to address. The correlation between low numbers of optometrists and a high prevalence of vision impairment and blindness in regions, thus indicates that unless urgent action is taken to increase the number of optometrists trained and deployed to underserved areas in low-income countries, plans to eliminate preventable vision impairment will remain elusive. In addition, implementing comprehensive eye care will be difficult to provide as this requires a team, with the optometrists as a critical component of that team.

Although optometrists were trained and competent in delivering primary eye care to the populations, more than half of the participating countries did not officially regulate this profession as part of the health system. This implies that advocacy work must be undertaken to make optometry visible to the governing bodies, the relevant authorities and the public. The recognition of the profession is vital to enable funding priority in training an adequate number for the optometry workforce to support the population's needs in eye health services.

While this study had a good response rate, one limitation was the inability to reach all countries where optometry is practised, or where optometric care is delivered under a different technical terminology. There is a need to expand this data collection to all of the 200 GBD countries. However, the data identify the divide between the low-income and high-income regions and countries in the training and

deployment of optometrists. A follow-up study will be conducted to ensure that more countries are included.

Conclusion

The study found that high-income countries met the target for optometrist-to-patient ratios. Low-to middle-income countries and low-income countries did not only fail to meet the targets, but they are also far from reaching them. The low optometrist-to-patient ratios are strongly associated with a higher magnitude of blindness and vision impairment.

The number of optometrists worldwide is increasing, but gaps remain in numerous areas around the world. Unless these gaps are addressed, we will not make a significant contribution towards achieving targets related to Universal Health Coverage and the Sustainable Development Goals outlined by the United Nations. According to the World Report on Vision²:

Everyone, if they live long enough, will experience at least one eye condition in their lifetime. For example, many people will have had conjunctivitis as a child, will need spectacles due to presbyopia sometime after 40 years of age, or require cataract surgery later in life. (p. 24)

This statement amplifies the need for eye care globally. With the lack of optometrists in the low-income areas of the world, optometry training and output will have to be significantly accelerated or upscaled to address the increased demand for eye care.

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Competing interests

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Authors' contributions

K.S.N., P.G.-P., P.M., S.B., V.F.C., L.B. contributed to the design and implementation of the research; K.S.N., P.G.-P., A.C.Y. wrote the first draft; all authors contributed to the review and editing of the manuscript.

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Data availability

All data generated or analysed during this study are available within the article.

Disclaimer

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