Need for Increased Investment in Human Resource for Health in India: Estimating the Required Investment for Increased Production of Health Professionals for Achieving Universal Health Coverage and Sustainable Development Goals by 2030.

Anup Karan (anup.karan@iiphd.org)
Indian Institute of Public Health Delhi, Public Health Foundation of India https://orcid.org/0000-0002-3452-4326

Himanshu Negandhi
PFHI: Public Health Foundation of India

Mehnaz Kabeer
PFHI: Public Health Foundation of India

Tomas Zapata
World Health Organization Regional Office for South-East Asia

Dilip Mairembam
World Health Organization Regional Office for South-East Asia

Hilde De Graeve
World Health Organization Regional Office for South-East Asia

James Buchan
University of Technology, Sydney

Sanjay Zodpey
PHFI: Public Health Foundation of India

Research

Keywords: Health workforce, Human resources for health, Investment in health, India

Posted Date: November 15th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-1043860/v1

Version of Record: A version of this preprint was published at Human Resources for Health on March 2nd, 2023. See the published version at https://doi.org/10.1186/s12960-023-00802-y.

Abstract

BACKGROUND: COVID-19 has reinforced the importance of having sufficient, well-distributed and competent health workforce. In addition to improving health outcomes, increased investment has the potential to generate employment, increase labour productivity along with fostering economic growth. With COVID-19 highlighting the gaps in human resources for health in India, there is a need to better and empirically understand the level of required investment for increasing the production of health workforce in India for achieving the UHC/SDGs.

METHODS: The study used data from a range of sources including National Health Workforce Account 2018, Periodic Labour Force Survey 2018-19, population projection of Census of India, and review of government documents and reports. The study estimated shortages in the health workforce and required investments to achieve recommended health worker: population ratio thresholds by the terminal year of the SDGs 2030.

RESULTS: Our results suggest that to meet the threshold of 34.5 skilled health worker per 10,000 population, there will be a shortfall of 0.16 million doctors and 0.65 nurses/midwives in the total stock of human resources for health by the year 2030. The shortages at the same threshold will be much higher (0.57 million doctors and 1.98 million nurses/midwives) in active health workforce by 2030. The shortages are even higher when compared with a higher threshold of 44.5 health workers per 10,000 population. The estimated investment for the required increase in the production of health workforce ranges from INR 523 billion to 2,580 billion for doctors. For nurses/midwives, the required investment is INR 1,096 billion. Such investment during 2021-25 has the potential of an additional employment generation within the health sector to the tune of 5.4 million and contribute to national income to the extent of INR 3,429 billion annually.

Conclusion: India needs to significantly increase the production of doctors and nurses(/midwives) through investing in opening up of new medical colleges. Nursing sector should be prioritized to encourage talents to join nursing profession and provide quality education. India needs to set-up a benchmark of skill-mix ratio and provide attractive employment opportunities in health sector to increase the demand and absorb the new supply of graduates.

Introduction

Strengthening human resources for health (HRH) is a pre-requisite to a strong and resilient health system. Only by securing a sufficient, equitably distributed, adequately supported and well-performing health workforce can a country meet its health goals (1, 2). COVID-19 has reinforced the criticality of this. However, several studies and reports in the recent past have highlighted global shortage and skewed distribution of HRH and need for increased investment in HRH at the global level (1–4). The Global Strategy on Human Resources for Health: Workforce 2030 projected a shortfall of 18 million health workers by 2030, mostly in low- and lower-middle income countries (4–6). A recent WHO report estimated a shortage of about 1.8 million health workforce in India alone (7). Given the acute shortage of health

workforce coupled with the current health crisis posed by COVID-19 pandemic, India needs to significantly enhance investment in health in general and HRH in particular. The present study aims to estimate the potential shortages of health workforce in India by the terminal year of the Sustainable Development Goals (SDGs) and a required level of investment for increased production of health workforce to bridge this gap.

United Nations High-Level Commission on Health Employment and Economic Growth (ComHEEG), noted that enhanced investment in health workforce can deliver a triple return of improved health outcomes, global health security and economic growth (8). The Global Strategy Report also emphasized that investment in health workforce is a driver of progress towards several SDGs (4, 8).

The current COVID-19 pandemic significantly exposed the limitations of India's health system. With the highest number of COVID-19 infection (over 34 million) and the case fatality (approximately 457 thousand), the need of an increased investment in the India's health system is the most important learning from the current pandemic crisis and needs urgent policy attention.

Increased investment in health in India is a long felt-need. India's National Health Policy 2017 set a spending target of 2.5% of GDP by 2025, from a current level of 1.1% of the GDP (9). The 15th Finance Commission and the *NITI Aayog* have also emphasized the need of enhanced government health spending. The health sector in India, currently growing at more than 22% per annum, is likely to grow to US$ 372 billion by 2022 and provides opportunity for increased investment in several areas of health sector (10).

Investment in health workforce in India has potential to advance multiple development priorities within and beyond health sectors. An enhanced investment in health workforce in India will not only strengthen the health system and improve the accessibility to health workers but also generate employment opportunities for health professionals, associate health workers and subordinate/support staff, enhance female labour force participation and share of formal employment in total employment (7). More than 90% of employment in India is in informal sector. However, in the health sector, the formal employment is as high as 50%. Also, Increasing the number of health jobs is a major opportunity to rapidly increase participation of women in the labour market (7, 11, 12).

Several studies in the recent past have highlighted acute shortage, skewed distribution and poor quality of health workforce in India (12–19) and noted that density of health workforce in India is less than half of the WHO recommended density threshold of 44.5 skilled health workers per 10,000 persons required for achieving the UHC and SDGs by 2030. Similar concerns have been raised about the low quality of health workforce both in public and private sector (20, 21). The reported shortages are more severe for nurses/midwives compared to doctors leading to a highly inadequate skill-mix of doctors and nurses/midwives (12, 17, 22). Improved absorption capacity (demand) of public sector for health workforce is often cited as one of the measures to improve health workforce availbaility for population (12, 23, 24). Most of the previous studies recommended need for increased production of health professionals, also reflecting a large difference between the registration/stock of health professionals and

active health workforce in India (7, 12, 18, 19). The reported difference is to the extent of 40-50% with the latter being lower.

There are several reasons why qualified health professionals are not part of the current active health workforce. Past studies noted that the registration council's data are not regularly updated to account for attrition of qualified health professionals due to migration, death and retirement. Also, there are issues with double counting in the registration data. Moreever, a recent study reflects that more than 30% of the doctors and more than 50% of the nurses with adequate qualifications are not part of the current health workforce just because they do not wish to join the labour market. In addition there are also adequately qualified health professionals who are unemployed (4%) and working in non- health sectors (12).

India has taken many initiatives to overcome the HRH related challenges. Recently government of India constituted National Medical Commission (NMC) by an Act of Parliament with the aim and objectives of improving equity and quality in medical education on the one hand and encourage use of latest technology, follow ethical values and community perspective on the other (25). Government also started a centrally sponsored schemes to upgrade district hospitals to medical colleges and building new medical colleges with fund allocation in the range INR 1,890 million to INR 3,250 million (26). While, for increasing the intake capacity of MBBS seats in existing medical colleges, 12 million per seat is being allocated for strengthening and up-gradation of medical colleges in states (27). Similarly, state of Gujarat allocated 60% share of INR 600 million to seats upgradation from 150 to 250 seats in medical college (28). In the 11th five year plan (2007-12), INR 60 million was allocated to states, for upgrading a school of nursing attached to medical college into a college of nursing (29, 30). Also, INR 265 million is allocated for the construction of nursing colleges in the state of Bihar (31). *NITI Aayog's* strategy for "New India@75" also aims at creating 1.5 million jobs in the public health sector, creating more employment opportunities, primarily for women by 2022-2023 (32). Similarly, *NITI Aayog's* annual report 2019-20, re-emphasizes the importance of nursing sector reforms, providing quality education and structural reforms for maximizing their productivity (33).

Although past studies have documented various concerns related to HRH in India, the strategies and the magnitude of required investments to overcome these challenges have not been adequately discussed. The main objectives of the present study are three folds: (i) estimate the magnitude of HRH (doctors and nurses/midwives) shortages currently and for the year 2030; (ii) estimate quantum of investment required for production of additional health workforce to bridge the gaps by 2030; and iii) estimate potential benefits of such investments in terms of employment generation in health sector and contribution to national income.

Materials And Methods

The present study uses data from a range of sources: (i) National Health Workforce Accounts (NHWA), (34) (ii) Periodic Labour Force Survey (PLFS), July 2018- June 2019, National Sample Survey Office (NSSO), Government of India (35); annual supply of new graduates (doctors and nurses/midwives) from the National Medical Commission (NMC) and Indian Nursing Council (INC) (36, 37); (iv) population

projection from Census of India 2019 (38) and (v) web-sites of different government and private medical/nursing educational institutions. In addition to this, we also undertook detailed review of literature from government and private sources providing information on unit costs of opening new institution/seat expansion for doctors and nurses/midwives.

NHWA data

NHWA provides country-wise data on the stock of different categories of health workers. The latest data of HRH stock for India is available for 2018. The present study uses all-India level data of two health professional categories: doctors and nurses/midwives.

NSSO data

The second source of data is taken from nationally representative PLFS, July 2018-June 2019. The sample size of the survey is 101,579 households (55,812 rural and 45,767 urban) and 420,757 persons (239,817 rural and 180,940 urban). The survey provides information on detailed activity status, employment status, sector of employment and occupation types of each worker, educational achievements of each individuals along with other socio-economic and demographic background of each individual covered in the sample (35).

Estimation of total health workforce

We estimated size of health workforce in terms of total production, total stock and active health workforce. The 'total production' represents total number of doctors registered with NMC and nurses/midwives registered with INC and collated in the NHWA data base. We defined 'total stock' after accounting for net migration (outmigration – in-migration), deaths and retirements of health professionals from the total produced health professionals. Using PLFS 2018-19, we estimated 'active health workforce' as the health professionals actually working in human health services (12). The PLFS 2018-19 could not identify disaggregated numbers of health professionals by allopathic doctors, AYUSH doctors and dentists employed in hospital settings. We applied the ratio of different health professionals outside the hospital sector on the hospital sector to arrive at the total estimate of different categories of health workers (12).

Using different data as explained above, we estimated the baseline number of doctors and nurses/midwives as of January 2021 and projected the estimates for each year between 2021 and 2030. For projection of total production and stock of health professionals and active health workforce up to 2030, we used standard method as discussed in Ridoutt et al. (39). However, we used a range of indicators from India to modify the method for the present analysis purpose. The shortage of HRH was estimated as the difference between estimated density of HRH per 10,000 persons for each year between 2021 and 2030 and the ILO & WHO recommended different density thresholds. The required levels of investment to bridge the gaps by the year 2030 was estimated using alternative assumptions of increasing the number of seats in the existing institutions and opening new institutions (Table 1) and using information on unit cost of opening new institution. The proposed different scenarios represent different bounds of investments: 1) lower bound, to overcome the projected shortages in total stock 2) upper bound, to

overcome the projected shortages in active health workforce. and 3) middle bound, by reducing at least 50% of the existing labour market attrition by 2030. Two alternative scenarios are also presented as i) if all proposed seat expansion is considered only in government institutions and ii) if indigenous medicine (*Ayurveda, Yoga, Unani, Siddha and Homeopathy* [AYUSH]) practitioners considered as a part of total health workforce.

Table 1
Detailed strategy for increased production and to overcome HRH shortages by 2030

Strategy	Strategy details	Doctors: Strategy at different thresholds	Nurses(/midwives): Strategy at different thresholds	Investment bound
Strategy 1	To overcome projected shortages in actual stock	**34.5 & 44.5**: Seat expansion + Opening new colleges	**34.5**: Full utilization of existing capacities + Seat expansion (no new colleges required) **44.5**: Full utilization of existing capacities + Seat expansion + Opening new colleges	Lower bound of investment
Strategy 2	To overcome projected shortages in active health workforce	**34.5 & 44.5**: Seat expansion + Opening new colleges	**34.5 & 44.5**: Full utilization of existing capacities + Seat expansion + Opening new colleges	Upper bound of investment
Strategy 3	To overcome projected shortages in active health workforce by reducing at least 50% of the existing labour market attrition by 2030	**34.5 & 44.5**: Seat expansion + Opening new colleges + Encouraging and reskilling 50% of out of labour health professionals to join workforce	**34.5 & 44.5**: Full utilization of existing capacities + Seat expansion + Opening new colleges + Encouraging and reskilling 50% of out of labour health professionals to join workforce	Middle bound of investment

Notes: Numbers in bold are the two reference thresholds of HRH: population ratio. NA is not applicable

Strategy	Strategy details	Doctors: Strategy at different thresholds	Nurses(/midwives): Strategy at different thresholds	Investment bound
Strategy 4	Scenario 1: Considering seat expansion in only government institutions *-Lower bound of investment* *-Middle bound of investment* *-Upper bound of investment*	**34.5 & 44.5**: Seat expansion (only in government colleges) + Opening new colleges (In addition, middle bound of investment includes encouraging and reskilling 50% of out of labour health professionals to join workforce)	NA	Investment range using alternative strategies and scenarios for doctors
	Scenario 2: Considering indigenous medicine (AYUSH) practitioners as part of health workforce	**34.5**: Seat expansion + including AYUSH practitioners (no new colleges required) **44.5**: Seat expansion + Opening new colleges + including AYUSH practitioners	NA	
Notes: Numbers in bold are the two reference thresholds of HRH: population ratio. NA is not applicable				

Finally, we estimated projected return to investment for the year 2030 by using Gross Value Added (GVA) data and GVA per worker in health sector. The detailed estimation procedures are presented in an Annexure as Supplementary material.

Results

Current size and density of HRH

Using NSSO and NHWA data, we estimated current size of HRH at the all-India level (Table 2). Mainly, three parameters are presented: 1) total production of health professionals, 2) actual stock of health professionals and 3) active health workforce. NHWA data reported 1.16 million doctors, 2.34 million nurses/midwives as total production in the country as of 2018. The data also records approximately 0.79 million AYUSH practitioners.

Table 2
Size and composition of HRH in India

	Total production, 2018		**Actual stock, 2018***		**Active health workforce 2019^**		**Active health**
Parameters	Number (in million)	Density / 10000 population	Number (in million)	Density / 10000 population	Number (in million)	Density / 10000 population	workforce as % of Actual stock
Allopathic doctor	1.16	8.8	1.05	7.9	0.66	5	63
Nurses /midwives	2.34	17.7	2.18	16.5	0.79	6	36
Allopathic doctors + Nurses /midwives	**3.5**	**26.5**	**3.23**	**24.4**	1.45	**11**	**45**
AYUSH practitioners	0.79	6	0.76	5.8	0.25	1.9	33
Allopathic doctors + Nurses /midwives + AYUSH	**4.29**	**32.5**	**3.99**	**30.2**	1.7	**12.9**	**42.6**

Sources: NHWA 2018 and PLFS 2018-19.

Notes: *Adjusted for attrition (Out-migration): Allopathic Doctors: (- 6 %); Nurses: (- 3.3 %), death rate (for both nurses and doctors:(-2.5% to -2.1%), retirement rate(doctors):(-1.07%), retirement rate(nurses): (-1.02%); ^Estimated from PLFS:2018-2019 after accounting for adequate qualifications and population projection as of January 2019 (Census of India 2019).

Total stock of health professionals as of 2018 are estimated to be 1.05 million doctors and 2.18 million nurses/midwives. However, the size of the estimated active health workforce, is considerably lower, 0.66 million doctors and 0.79 million nurses/midwives. At the aggregate level, adding numbers of doctors and nurses/midwives together the size of active health workforce is around 45% of the total actual stock of health professionals. Accordingly, the density, of health professionals available in stock is 24.4 per 10,000 population when considering only allopathic doctors and nurses/midwives. However, including AYUSH professionals the density of health worker stock increases to 30.2 per 10,000 population. Density of active health workforce is estimated to be around 11 and 12.9 by excluding and including AYUSH respectively.

As far as skill-mix of HRH is concerned, doctor: nurse/midwives ratio is estimated to be 1:2 in the production and stock data, while active health workforce data reflects 1:1.2 ratio. This essentially reflects

that proportion of qualified nurses/midwives not active in human health service is much larger as compared with that of doctors (12, 18).

Supply side estimates of HRH

Table 3 presents the projections of total cumulative production, stock of health professionals and active health workforce, separately for doctors, nurses/midwives and AYUSH practitioners by the year 2030. As of 2030, total cumulative production will be 2.06 million doctors while only a little over half of this supply (1.1 million) will be working in health services. While the actual available stock in nurses/midwives will be 2.74 million by 2030, only about half (1.4 million) of this stock will be active health workforce.

Table 3
Projected estimates of HRH, by 2030

Parameters	Doctors	Nurses /midwives	Doctors +Nurses /midwives	AYUSH	Doctors +Nurses /midwives +AYUSH
Total production of health professionals (in million)*	2.06 (14.1)	3.94 (26.9)	**6 (41)**	1.29 (8.8)	**7.29 (49.8)**
Total stock of health professionals (in million)**	1.51 (10.3)	2.74 (18.7)	**4.25 (29)**	0.93 (6.4)	**5.18 (35.4)**
Active health workforce (in million)^	1.1 (7.5)	1.41 (9.6)	**2.51 (17.1)**	0.51 (3.5)	**3.02 (20.6)**
Sources: NHWA 2018; PLFS 2018-19 and Census of India 2011.					
Notes: *includes estimated pass-outs from all institutions established and announced to be established by 2025; **adjusted for attrition (mortality, retirement and migration);^Estimated from PLFS:2018-19, moderate labour market attrition of 20%-doctors and 30%-Nurses and attrition (mortality, retirement and migration). Figures in parentheses are density per 10000 persons. Doctors-Net migration rate:(+5%), death rate:(-2.5 to -2.1%), retirement rate:(-1.07%) and Nurses(/midwives)-Annual Migration:(-4.6%), death rate:(-2.5 to -2.1%), retirement rate:(-1.02%).					

Moreover, the total stock of HRH including doctors and nurses/midwives by the year 2030 will be about 4.25 million and 5.18 million without and with AYUSH professionals respectively. However, there will be only 2.51 million doctors and nurses /midwives in the active health workforce. Including AYUSH in the workforce, the number of active health workers increases to 3.02 million by 2030. The density of health professionals is about 29 skilled health professionals per 10,000 persons when considering the stock, which comes down to 17.1 skilled doctors and nurses/midwives in the active health workforce. If we include AYUSH professionals, the density is around 20.6 skilled doctors and nurses/midwives in active health workforce.

Health worker shortages at different thresholds

The required number of doctors and nurses (/midwives) to meet the overall HRH: population ratio thresholds of 34.5 and 44.5 per 10,000 population (2, 4, 40–44) were estimated assuming a doctor: nurses/midwives ratio of 1:2 (Appendix Table A-1). The stock shortage for doctors is 0.16 million by the year 2030 at the 34.5 density threshold (Figure 1). The shortages at the same threshold are much higher (0.57 million) for doctors in active health workforce. At the density of 44.5, both the stock and active health workforce are reporting doctor shortage of 0.64 million and 1.05 million respectively. The nurse's shortage in stock reaches up to 0.65 million by the year 2030 to meet the density threshold of 34.5. The shortages at the same threshold are more than three-folds (1.98 million) if we consider the number of nurses /midwives actively working. At the density threshold of 44.5 skilled health worker per 10,000 population, the shortages of nurse/midwives in the stock and active health workforce are estimated to be approximately 1.63 million and 2.96 million respectively by 2030.

Strategies and required levels of investment

The strategies to increase the production of doctors and nurses/midwives by expanding the seat capacity of the existing institutions or opening new institutions or both are presented in Table 4. Total number of existing and upcoming institutions by 2025 are 675 medical colleges and 7,110 nursing institutes with respective seat capacity of 95,325 and 289,000 (Appendix Table A-II). Given the total number of institutions and average annual pass-outs of 136 doctors and 19 Nurses/midwives per institution, there is significant scope to increase the number of seats and institutions. However, for the increased production of nurses/midwives, improved utilization of the existing capacities would be crucial. Currently only 19 nurses on an average per institution pass-out annually with the existing capacity of 41 seats per nursing institution.

Table 4
New investment required for meeting the doctors and nurses/midwives shortages at different health worker: population ratio thresholds, by 2030

Parameters	Health worker density threshold^	Required new production ('000') per annum during 2021-25*	Required number of seat expansion per college (Total seats '000')	Required number of new colleges (Total seats '000')	Estimated total cost of investment (In INR billion)^^
Lower bound of investment – Actual stock shortages					
Doctors	34.5	39	39(26)	87(13)	523
	44.5	160	39(26)	892(134)	2,941
Nurses /midwives	34.5	161	21(149) + 2(14)**	0	0
	44.5	406	21(149) + 20 (142)***	1,918 (115)	707
Upper bound of investment – Active health workforce shortages					
Doctors	34.5	142	39(26)	772 (116)	2,580
	44.5	263	39(26)	1,578(237)	4,998
Nurses /midwives	34.5	494	21(149) + 20(142)***	3,385(203)	1,096
	44.5	740	21(149) + 20(142)***	7,475(448)	2,180
Middle bound of investment- by considering 50% of the out of workforce qualified health personnel into active health workforce ^^^					
Doctors	34.5	95	39(26)	458(69)	1,636
	44.5	216	39(26)	1,263(189)	4,053
Nurses /midwives	34.5	357	21(149)*** + 20(142)	1,100(66)	491

Note: ^ Skilled health worker density per 10,000 population*Required production per annum for a duration of 4 years (Total required production/4); ^^Doctors: The investment estimates includes cost of seats (INR 10 million per seat) expansion in existing (/proposed) colleges and cost of opening new institutions (INR 3,000 million per institution) and for nurses(/midwives): The investment estimates includes cost of seats (INR 1.4 million per seat) expansion in existing (/proposed) colleges and cost of opening new institutions (INR 265 million per institution);**includes increasing pass-out rate in existing institution by 21 seats per institution (no cost involved) and seat expansion by 2 per institution (cost not considered for increasing 2 seat per institution);***includes increasing pass-out rate in existing institution by 21 seats per institution (no cost involved) and seat expansion by 20 per institution (INR 1.4 million per seat) ^^^Doctors: Annual shortages estimated after including 50% of medically qualified health professionals who are not part of health workforce (0.19 million doctors) to the total shortages by 2030 and in nurses(/midwives), annual shortages estimated after including 50% of medically qualified health professionals who are not part of health workforce (0.55 million nurses(/midwives) to the total shortages by 2030.

Parameters	Health worker density threshold^	Required new production ('000') per annum during 2021-25*	Required number of seat expansion per college (Total seats '000')	Required number of new colleges (Total seats '000')	Estimated total cost of investment (In INR billion)^^
	44.5	603	21(149)*** + 20(142)	5,190(311)	1,574

Note: ^ Skilled health worker density per 10,000 population*Required production per annum for a duration of 4 years (Total required production/4); ^^Doctors: The investment estimates includes cost of seats (INR 10 million per seat) expansion in existing (/proposed) colleges and cost of opening new institutions (INR 3,000 million per institution) and for nurses(/midwives): The investment estimates includes cost of seats (INR 1.4 million per seat) expansion in existing (/proposed) colleges and cost of opening new institutions (INR 265 million per institution);**includes increasing pass-out rate in existing institution by 21 seats per institution (no cost involved) and seat expansion by 2 per institution (cost not considered for increasing 2 seat per institution);***includes increasing pass-out rate in existing institution by 21 seats per institution (no cost involved) and seat expansion by 20 per institution (INR 1.4 million per seat) ^^^Doctors: Annual shortages estimated after including 50% of medically qualified health professionals who are not part of health workforce (0.19 million doctors) to the total shortages by 2030 and in nurses(/midwives), annual shortages estimated after including 50% of medically qualified health professionals who are not part of health workforce (0.55 million nurses(/midwives) to the total shortages by 2030.

Given the levels of infrastructure in the existing institution, an increase of 35-40 seats per institutions in medical colleges and 20 seats per institution in nursing institute is possible. The remaining shortages can be bridged by opening new institutions. Increasing 35-40 seats in medical colleges and 20 seats in nursing institutions on average will lead to an average seat capacity of 170-175 seats per medical college and 61 seats per nursing institutes (Table 4). In such scenario an additional 87 medical college with similar seat capacity will be required to meet the stock shortage of doctors at the 34.5 density threshold. There will be no need of opening new nursing institutes as improved pass-out rate will be almost equal to the stock shortages in nurses at the 34.5 density threshold. However, to bridge the stock shortages at the 44.5 threshold there will be requirement of opening 892 new medical colleges and 1,918 new nursing institutions along with seat expansion in the existing institutions.

Further, to bridge the shortages of active health workforce, along with the seat expansion there will be requirement of opening 772 new medical colleges and 3,385 new nursing institutes at the 34.5 threshold and 1,578 medical colleges and 7,475 nursing institutes at the density threshold of 44.5. With lower seat expansion, the shortages can be met only by opening higher number of institutions ranging from 87 and 1,691 medical colleges depending on the gaps to be met in stock or active health workforce on the one hand and 34.5 and 44.5 density thresholds on the other (Appendix Table A-III).

Accordingly, the required levels of investment were estimated by applying unit costs (INR 10 million for one seat expansion and INR 3,000 million for opening one medical college for doctors and INR 1.4 million for one seat expansion and INR 265 million for opening one new nursing institute) over the total number of seat expansion and new institutions required to be increased. The size of the required investment varied depending on the gaps to be met in stock or active health workforce on the one hand and 34.5 and 44.5 density thresholds on the other. Meeting the HRH shortage and required investment in stock and active

health workforce are two extreme bounds (call it lower bound and upper bound). To meet the stock gaps, the required investment ranged between INR 523 billion and INR 2,941 billion at the density thresholds of 34.5 and 44.5 respectively. For stock of nurses, the required investment is about INR 707 billion at the density thresholds of 44.5. However, bridging the shortages of active health workforce at the 34.5 density threshold, investment requirements are INR 2,580 billion for doctors and 1,096 for nurses/midwives. At the 44.5 threshold, the investment requirements are INR 4,998 billion for doctors and INR 2,180 billon for nurses/midwives.

We also present a medium bound of investment (Table 4), which has been estimated by considering inclusion of 50% of the qualified health professionals who are out of labour force. If efforts are made to attract at least 50% of the out of labour force health professionals to be part of the active health workforce there will be an investment requirement of INR 1,636 and INR 4,053 billion at the density thresholds of 34.5 and 44.5 respectively for bridging the shortage of doctors by 2030. For bridging the gaps in nurses/midwives the respective investment requirements are estimated to be INR 491 and INR 1,574 billion. Different other scenarios of combinations of seat expansion and opening new institutions are presented in Appendix Table A-IV. However, the estimated costs doesn't include the likely costs of different efforts, other than opening new institutions and seat expansion.

In yet another alternative scenario, we only considered seat expansion in government medical colleges. In this scenario, we estimated an additional capacity of 26,726 seats in government medical colleges by increasing the seats intake up to 200 per college, exclusively in colleges with current uptake below 200. The required investment under this scenario is estimated to be INR 519 to 2,576 billion at the 34.5 threshold and INR 2,973 to 4,993 billion at the 44.5 threshold (Figure 2). We also estimated the potential shortages in doctors and the related investment requirement by considering AYUSH as part of active health workforce (Figure 2) and the estimated investment requirement for bridging the doctors' shortage is INR 146 and INR 2,446 billion at threshold 34.5 and 44.5 respectively (Appendix Table A-IV).

Economic benefits of investment in HRH, by 2030

Although investment in HRH has multiple pathways to economic growth (8, 45), in the present study we only estimated potential benefits in terms of employment generation and labour productivity. We used the quantum of investment required for overcoming the HRH shortages in active health workforce as the benchmark for estimating the potential employment generation and labour productivity benefits. At the density threshold of 34.5, the estimated upper bound of investment of INR 3,676 billion has the potential to create employment for 5.4 million health workers. The additional employment of 2.55 million, consisting of doctors and nurses/midwives can generate new 1.51 million employment of support staff and 1.35 million health associate personnel separately, after adjusting for a labour market attrition rate of 20%. The labour productivity (GVA/employment) per worker in the health sector for the year 2019-20 is estimated to be INR 633 thousand. Using this estimated labour productivity in 2030 reflects that the marginal GVA (due to the additional employment generated by 2030) could be INR 3,429 billion during 2026-30 (Table 5).

Table 5
Estimates of benefits of investment in terms of new employment and contribution to national gross value added by 2030

Parameter	Required HRH Investment during 2021-25	New employment generation (In million)				Total gross value added during 2026-30
	(In billion)	health workers	Support staff*	Health associate**	Total	(In billion)
34.5 skilled health worker per 10000 population	3,676	2.55	1.51	1.35	5.42	3,429
44.5 skilled health worker per 10000 population	7,178	4.01	2.38	2.13	8.52	5,392
Note: *Supportive staff include other support workers such as administrators, clerks, accountants, motor drivers, garbage collectors etc.; ** Includes health associates such as nutritionists, dieticians, optometrists etc.						

At the higher density threshold of 44.5 the benefit in the health sector is to the tune of INR 5,392 billion annually with the required investment of INR 7,178 billion. Here it is important to note that the estimated investment is a one-time requirement to be completed during the period of 2021-2025 but the contribution to GVA because of the increased employment will be each year for a long period of time. If the required investment is spread over a period of 4 years (during 2021-25), the same is estimated to be 0.4% and 0.8% of GDP at the 34.5 and 44.5 density thresholds respectively.

Discussion And Policy Implications

The returns of investment in HRH is emphatically emphasized in literature as its effects are many folds, including beyond the health sector (2, 3, 8, 45). In Indian context, it not only complements the initiatives taken towards achieving UHC but also it has potential to generate employment, improve female labour force participation and increase formalization of labour market, if commensurate measures are undertaken to increase the demand for health workers in health system. Past studies have highlighted acute shortage and skewed distribution of health workforce in India and the need to invest in improving the HRH: population ratios is the need of the hour (10, 12, 15, 18).

The present study estimated the health worker shortages and the required magnitude of investment to overcome the shortages and meet the ILO & WHO recommended thresholds of HRH: population ratio with a supply-side perspective. Past studies highlighted the need of multipronged strategies, to bridge the shortages in health workforce, which range from increased production of doctors and nurses/midwives (23) to raising the demand of health workers at the health system level and filling up any existing

vacancies at the facility levels (12, 18). Also, improving the working conditions and remuneration of doctors and nurses/midwives has the potential to increase the number of graduates that enter into the health workforce (46, 47). Since many of these strategies may not involve a substantial new investment and can be addressed with annual increased budgetary allocation to health sector, we focused on estimating the required capital investment for increased production of health workforce.

When considering the active health workforce shortages, required investment is much higher to meet the shortages compared to the shortages in the stock of health professionals registered with medical and nursing councils. The investment amount ranges from INR 523 billion to INR 2,580 billion for doctors and 1,096 billion for nurses respectively to meet 34.5 HRH: population threshold. However, the required investment cost is much higher INR 3 thousand to 7 thousand billion to meet the density threshold of 44.5.

One of the main reasons of the differences in actual stock and active health workforce is labour market attrition, around 30% of health professionals with degree in medicine are not in labour force and only 40% of health professionals with diploma in medicine are the part of the current health workforce (12). If efforts are made to engage 50% of these not-working (out of labour force) professionals into the active health workforce, by providing an improved work environment, flexible working hours, raising the retirement age-limit etc., the shortages in health workforce significantly declines and the required investment to bridge the gap in active health workforce comes down by 20%. Further, including both AYUSH practitioners and engaging 50% out of labour workforce in active health workforce, there will be no shortages of doctors to meet 34.5 HRH: population thresholds. However, the required investment will still be approximately INR 2.5 thousand billion to meet the threshold of 44.5.

It is important to attract talent to join nursing profession through incentivizing nursing education and by providing attractive employment opportunities. Improvising the quality of nursing education and achieving higher pass-out rates from existing institutions can improvise the nurse's availability in workforce. Creating a national licensing exam for nurses/midwives could be considered as an instrument to improve quality of education. Factors such as low demand for trained nurses, poor quality of nursing education, lack of non-technical skills knowledge, desire to opt for higher education and a range of socio-economic factors are some of the reasons affecting the employment opportunities of nurses (48). Also, low retention rate of nurses in the system has been one of the most important reasons for the shortage of nurses in active workforce (49). There are only a few studies available to understand the nurse's turnover rates in India. Past studies reported about 28-35 per cent attrition rates among nurses, as a large proportion of them are either not absorbed in the health system or leave employment after a few years of working. Poor working conditions and low remuneration are often cited as the reasons (46, 50). Out-migration of health professionals is also a challenge, a major proportion of the workforce, 6.6% and 3% of doctors and nurses respectively registered within Indian councils are working in OECD countries (51). Thus, it is important to recognize these challenges and concerns, to have an adequate skill-mix balance. More detailed and in-depth studies are required to understand the reasons of low turnover and lack of employment opportunities for nurses and midwives in India.

On the supply side, the distribution of institutions is lopsided in the country, where public institutions produce only half of the total number of new graduate doctors. While, in case of nurses, the majority (90%) of educational institutions are in private sector (36, 37). The estimated volume of investment can be distributed to balance the situation between public and private sector. Distributing the opening of the proposed new institutions in less developed states and closer to remote areas usually demonstrate greater retention of doctors in local areas. However, there is need to take care of the quality of the educational institution in remote areas (52).

Moreover, the strategies should be not only opening of new institutions and expanding intake capacity. Greater emphasis to increase current public health spending attracting talent to join nursing workforce, along with preparing and investing in healthcare settings to absorb them, are the required supporting measures (9, 23).

The estimated marginal gross value addition because of increased employment of 5.42 million new workers is to the tune of annual INR 3,429 billion at constant 2019-20 prices. However, once the shortages are met with these one-time investments during period 2021-25, the returns will be perpetual. For instance, if the estimated investment is made during the next 1-2 years, the return to the investment will be 5 times higher of the estimated annual marginal value added of INR 3,429 (for the period 2026-2030) as of 2030. Thus, these investments not only help towards achieving UHC and SDGs but will also contribute to the national income.

Limitations

The study only estimated one-time capital investment need for producing increased numbers of doctors and nurses. The study did not estimate the required annual recurring expenditure likely to be incurred on faculty recruitment, consumables, maintenance etc. on the supply side and raising the demand for health workers, improving working conditions and remuneration etc. on the demand side. Also, the estimated required investment is likely to be underestimated, if the distribution of new institution is required to be opened in remote areas, on account of addressing quality issues. Similarly, the size of the benefits estimated in this study is only limited to potential employment generation and labour productivity in the health sector and only for one year. However, the benefits of such investments are expected to flow beyond the health sector and for many years. The study recommends that a more detailed study for estimating total costs of investments and benefits should be conducted.

Conclusions

India needs to significantly increase level of investments in production of health workforce and mainstreaming them in active health workforce. Although several interventions such as improving working conditions of health workers, raising the demand of health workers in the health system, filling up existing vacancies and continuum of training and skill development are required to bridge the existing and potential shortage of health workers, new investments in the production of health workforce has the potential to benefit India within and beyond health sector.

Abbreviations

ANM – Auxiliary Nurse Midwife; AYUSH – Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy; BRICS – Brazil, Russia, India, China and South Africa; ComHEEG – High-Level Commission on Health Employment and Economic Growth; CSS-Centrally Sponsored Scheme; GNM – General Nurse Midwife; GVA – Gross Value Added; HRH – Human Resources for Health; ILO: International Labour Organization; INR – Indian National Rupee; LMICs – Lower and Middle Income Countries; MoHFW – Ministry of Health and Family Welfare; NHP – National Health Policy; NHWA – National Health Workforce Account; NITI Aayog – National Institution for Transforming India; NSSO – National Sample Survey Office; OECD – Organization for Economic Cooperation and Development; PLFS – Periodic Labour Force Survey; SDG's – Sustainable Development Goals; UHC – Universal Health Coverage; UN – United Nations; WHO – World Health Organization; WPR – Worker Population Ratio.

Declarations

ETHICS APPROVAL: Ethical clearance for this study was obtained from the Institutional Ethics Committee (IEC) of the Indian Institute of Public Health Delhi under 'Expedited Review'.

CONSENT TO PARTICIPATE – Not applicable.

CONSENT FOR PUBLICATION: Not applicable

AVAILABILITY OF DATA AND MATERIALS: Data for this study was used from secondary sources. Micro data from the NSSO is available for free in public domain from the official website (http://microdata.gov.in/nada43/index.php/catalog/146) of the National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India.

COMPETING INTEREST:

JB is Editor in Chief of the journal "Human Resources for Health" but blinded to the review process.

FUNDING:

This article is part of a research project funded by WHO (grant number WHO Registration 2020/1046152-0; Purchase Order 202588325) to the Public Health Foundation of India.

AUTHOR'S CONTRIBUTIONS

AK, DM, HN, JB, SZ and TZ jointly conceptualised the idea. AK, HN and MK developed early analytical framework. AK, HN, and MZ analysed the data. AK, HN and MK prepared the first draft. DM, HG, JB, SZ and TZ provided extensive comments to the first draft and contributed to developing the final draft. AK, DM, HG, HN, JB, MK, SZ and TZ all reviewed the final draft and consented to the final manuscript.

ACKNOWLEDGEMENT – None

References

1. Cometto G, Campbell J. Investing in human resources for health: beyond health outcomes. Hum Resour Health. 2016;14(1). https://doi.org/10.1186/s12960-016-0147-2 (Accessed 23 Feb 2021)
2. Campbell J, Dussault G, Buchan J, Pozo-Martin F, Guerra Arias M, Leone C, et al. A universal truth: no health without a workforce. Forum report, third Global Forum on Human Resources for Health, Recife, Brazil. Geneva: Global Health Workforce Alliance and World Health Organization;2013. https://www.who.int/workforcealliance/knowledge/resources/GHWA_AUniversalTruthReport.pdf (Accessed 13 Dec 2020.)
3. Scheil-Adlung X, Behrendt T, Wong L. Health sector employment: a tracer indicator for universal health coverage in national Social Protection Floors. Human Resources Health;13(1):66. https://doi.org/10.1186/s12960-015-0056-9 (Accessed 23 Feb 2021).
4. WHO. Global strategy on human resources for health: workforce 2030. Geneva, World Health Organization. 2016. https://apps.who.int/iris/bitstream/handle/10665/250368/9789241511131-eng.pdf?sequence=1. (Accessed 13 Dec 2020).
5. Resolution WHA67.24. Follow-up of the Recife Political Declaration on Human Resources for Health: renewed commitments towards universal health coverage. In: Sixty seventh World Health Assembly, Geneva, 19–24 May 2014. Resolutions and decisions, annexes. Geneva: World Health Organization; 2014.
6. https://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_34-en.pdf (Accessed 31 Aug 2021)
7. WHO Global Strategy on People-Centred and Integrated Health Services – interim report. Geneva: World Health Organization; 2015. https://www.who.int/servicedeliverysafety/areas/people-centred-care/Framework_Q-A.pdf?ua=1 (Accessed 31 Aug 2021)
8. WHO. Decade for health workforce strengthening in SEAR 2015–2024, mid-term review of progress. World Health Organization, 2020. https://apps.who.int/iris/handle/10665/333611. (Accessed 3 Apr 2021).
9. WHO. High-Level Commission on Health Employment and Economic Growth. Geneva, World Health Organization. 2016. https://apps.who.int/iris/bitstream/handle/10665/250047/9789241511308-eng.pdf (Accessed 13 Dec 2020).
10. MOHFW. National Health Policy 2017. Ministry of Health and Family welfare, New Delhi. 2017. https://www.nhp.gov.in/nhpfiles/national_health_policy_2017.pdf. (Accessed 13 Dec 2020).
11. Sarwal R; Prasad U; Madangopal K; Kalal S; Kaur D; Kumar A; Regy P; Sharma J. Investment Opportunities in India's Healthcare Sector. NITI Aayog. March 2021. https://niti.gov.in/sites/default/files/2021-03/InvestmentOpportunities_HealthcareSector_0.pdf. (Accessed 25 May 2021).
12. WHO. Gender equity in the health workforce: Analysis of 104 countries. World Health Organization. 2019.https://apps.who.int/iris/bitstream/handle/10665/311314/WHO-HIS-HWF-Gender-WP1-2019.1-eng.pdf. (Accessed 4 Feb 2021).

13. Karan A, Negandhi H, Hussain S, Zapata T, Mairembam D, De Graeve H, et al. Size, composition and distribution of health workforce in India: why, and where to invest? Hum Resour Health. 2021;19(1):39. https://doi.org/10.1186/s12960-021-00575-2. (Accessed 29 Mar 2021).
14. Hazarika I. Health workforce in India: assessment of availability, production and distribution. WHO South-East Asia J Public Health. 2013;2(2):106. http://www.who-seajph.org/text.asp?2013/2/2/106/122944. (Accessed 25 May 2021).
15. Rao M, Rao KD, Kumar AS, Chatterjee M, Sundararaman T. Human resources for health in India. The Lancet. 2011;377(9765):587–98. https://linkinghub.elsevier.com/retrieve/pii/S0140673610618880. (Accessed 25 Feb 2021).
16. Rao KD, Shahrawat R, Bhatnagar A. Composition and distribution of the health workforce in India: estimates based on data from the National Sample Survey.2016 WHO South-East Asia J Public Health. 2016; 5(2): 133–140.
17. Anand S, Fan V. The health workforce in India. In: Human Resources for Health Observer Series No.16. World Health Organization. 2016. https://www.who.int/hrh/resources/16058health_workforce_India.pdf. (Accessed on 25 May 2021).
18. Gill R. Scarcity of Nurses in India: A Myth or Reality? Journal of Health Management. 2016;18(4):509–22. https://doi.org/10.1177/0972063416665932.
19. Karan A, Negandhi H, Nair R, Sharma A, Tiwari R, Zodpey S. Size, composition and distribution of human resource for health in India: new estimates using National Sample Survey and Registry data. BMJ Open. 2019;9(4):e025979.https://doi.org/10. 1136/bmjopen-2018-025979. (Accessed on 3 Apr 2021).
20. Zapata, T., Zakoji, M., Kanda, M., Travis, P., Tangcharoensathien, V., Buchan, J., Jhalani, M., 2021. Implementing a decade of strengthening the health workforce in the WHO South-East Asia Region: achievements and way forward for primary health care. WHO South-East Asia J Public Health 10, 2021;10, Suppl S1:76–86
21. Berendes S, Heywood P, Oliver S, Garner P. Quality of Private and Public Ambulatory Health Care in Low and Middle Income Countries: Systematic Review of Comparative Studies. Jenkins R, editor. PLoS Med; 8(4):e1000433. Available from: https://doi.org/10.1371/journal.pmed.1000433 (Accessed on 28 Aug 2021)
22. Das J. The Quality of Medical Care in Low-Income Countries: From Providers to Markets. PLoS Med;8(4):e1000432. Available from: https://doi.org/10.1371/journal.pmed.1000432 (Accessed on 28 Aug 2021)
23. Gill Reema. Nursing Shortage in India with special reference to International Migration of Nurses. Social Medicine. 2011; 6(1): 52–59.
24. High Level Expert Group Report on Universal Health Coverage for India, Planning Commission of India, 2012. https://niti.gov.in/planningcommission.gov.in/docs/reports/genrep/rep_uhc0812.pdf. (Accessed 25 Feb 2020).

25. Ministry of Health and Family Welfare. Annual report, Rural Health statistics 2019-20. Ministry of Health and Family Welfare. Government of India, 2020; Available from: https://hmis.nhp.gov.in/downloadfile?filepath=publications/Rural-Health-Statistics/RHS%202019-20.pdf (Accessed on 28 Aug 2021)
26. National Medical Commission. Introduction | NMC. Official National Medical Commission website, Government of India. 2021. Available from: https://www.nmc.org.in/about-nmc/introduction/ (Accessed on 28 Aug 2021)
27. Lok Sabha, Ulaka SS, Jadhav P, Chaudhary P, Bohra R. New medical colleges. Government of India. Lok Sabha, Ministry of Health And Family Welfare, Department Of Health And Family Welfare;(113):6. http://164.100.24.220/loksabhaquestions/annex/174/AU1090.pdf. (Accessed 28 Jan 2021)
28. Ministry of Health and Family Welfare. Medical Education Policy & Medical Education, 14 Chapter, document, 2018-19. Ministry of Health and Family Welfare, Government of India, 2019. https://main.mohfw.gov.in/sites/default/files/14%20Chapter%20237-239AN2018-19.pdf
29. Government of Gujarat. Budget document 2017-18, Government of Gujarat, India.2017. https://financedepartment.gujarat.gov.in/Documents/Bud-Eng_751_2017-3-3_355.pdf. (Accessed 7 Mar 2021).
30. Sharma G. GoI approves upgradation of 3 more Nursing Schools into Colleges. Daily Excelsior. 2020.https://www.dailyexcelsior.com/goi-approves-upgradation-of-3-more-nursing-schools-into-colleges/ (Accessed 6 Mar 2021).
31. Government of India. Status of implementation of various schemes under strengthening/upgradation of Nursing Services (Human Resource for Health) and Development of Nursing services during XIth Plan. 2014. http://nursingandmidwifery.gov.in/11thFiveyearPlan.pdf. (Accessed 6 Mar 2021)
32. Bihar Medical Services & Infrastructure Corporation. Medical infrastructure uploads, JAN-18. Bihar Medical Services & Infrastructure Corporation, Government of Bihar, India. 2018. http://bmsicl.gov.in/uploads/Infrastructure/JAN-18.pdf. (Accessed 6 Mar 2021).
33. NITI Aayog. Strategy for New India @75, Government of India, NITI Aayog. 2018. https://niti.gov.in/writereaddata/files/Strategy_for_New_India.pdf. (Accessed 13 Dec 2020).
34. NITI Aayog. Annual Report 2019-20. Government of India, NITI Aayog. 2019. https://niti.gov.in/sites/default/files/2020-02/Annual_Report_2019-20.pdf. (Accessed 13 Dec 2020).
35. WHO. Global Health Observatory data repository | By category. Geneva, World Health Organization; 2021. https://apps.who.int/gho/data/node.main. (Accessed 27 Feb 2021).
36. NSSO. Annual Report PLFS 2018-19. National Sample Survey Organization, Ministry of Statistics and Programme Implementation, Government of India.2020. http://mospi.nic.in/sites/default/files/publication_reports/Annual_Report_PLFS_2018_19_HL.pdf (Accessed 27 Feb 2021).
37. INC. Indian Nursing Council, Official Indian nursing council website, Government India, Establish Uniforms Standards, Training Nurses, Midwives, Health Visitors. 2021. https://www.indiannursingcouncil.org/ (Accessed 23 Mar 2021).

38. NMC. National Medical Commission, Official National Medical Commission website, Government of India. 2021. https://www.nmc.org.in/. (Accessed 31 Jan 2021).
39. MOHFW. Population projections for India and states 2011 – 2036: Report of technical group on population projections, New Delhi, National Commission on Population, November 2019. Ministry of Health and Family Welfare, Government of India. 2019. https://nhm.gov.in/New_Updates_2018/Report_Population_Projection_2019.pdf
40. Ridoutt L, Cowles C, Madden L, Stewart G. Planned and unplanned futures for the Public Health Physician Workforce in Australia. Sydney. 2017;127.
41. Social Protection Floors Recommendation (202), 2012: National Floors of Social Protection. Geneva, International Labour Office, 2012.
42. Social health protection: an ILO strategy towards universal access to health care. Geneva, International Labour Organization, 2008 Social Security Policy Briefings; https://www.ilo.org/secsoc/information-resources/publications-and-tools/policy-papers/WCMS_SECSOC_5956/lang–en/index.htm (Accessed 12 Jun 2021).
43. World Social Security Report 2010–2011: providing coverage in times of crisis and beyond. Geneva, International Labour Office, 2011.
44. Scheil-Adlung X et al. New approaches to measuring deficits in social health protection coverage in vulnerable countries. Geneva, World Health Organization, 2010 https://www.who.int/healthsystems/topics/financing/healthreport/BP56MeasurementILO.pdf (Accessed 12 Jun 2021).
45. Scheil-Adlung X. Health workforce benchmarks for universal health coverage and sustainable development. Bull World Health Organization;91(11):888–9.https://www.who.int/bulletin/volumes/91/11/13-126953.pdf (Accessed 12 Jun 2021).
46. Buchan J, Dhillon IS, Campbell J, editors. Health Employment and Economic Growth: An Evidence Base. Geneva: World Health Organization; 2017.
47. https://apps.who.int/iris/handle/10665/326411 (Accessed 12 Jun 2021).
48. Goel S, Angeli F, Bhatnagar N, Singla N, Grover M, Maarse H. Retaining health workforce in rural and underserved areas of India: What works and what doesn't? A critical interpretative synthesis. The National Medical Journal Of India. 2016;29(4):7.
49. Chandrasekhar G, Warrier U. A Study on the Possible Reasons for Attrition of Junior Doctors in India. International Journal of Health System and Disaster Management. 2017;5(2):5.
50. Seth K. The influence of training programs on career aspirations: evidence from a cross-sectional study of nursing students in India. Hum Resour Health. 2016;14(1):20. https://doi.org/10.1186/s12960-016-0116-9. (Accessed 29 Mar 2021).
51. Dasgupta P. Turnover Intentions among Nurses in Private Hospitals: Antecedents and Mediators. jshrm. 2015;4(3). https://doi.org/10.21863/jshrm/2015.4.3.014. (Accessed 29 Mar 2021).
52. Lakshman S. Nurse Turnover in India: Factors Impacting Nurses' Decisions to Leave Employment. South Asian Journal of Human Resources Management. 2016;3(2):109–28.

https://doi.org/10.1177/2322093716657470. (Accessed 29 March 2021).

53. Walton-Roberts M, Rajan SI. Global Demand for Medical Professionals Drives Indians Abroad Despite Acute Domestic Health-Care Worker Shortages. 2020;12.
54. Sabde Y, Diwan V, Mahadik VK, Parashar V, Negandhi H, Trushna T, et al. Medical schools in India: pattern of establishment and impact on public health - a Geographic Information System (GIS) based exploratory study. BMC Public Health; 20(1):755. Available from: https://doi.org/10.1186/s12889-020-08797-0 (Accessed 27 Aug 2021).

Figures

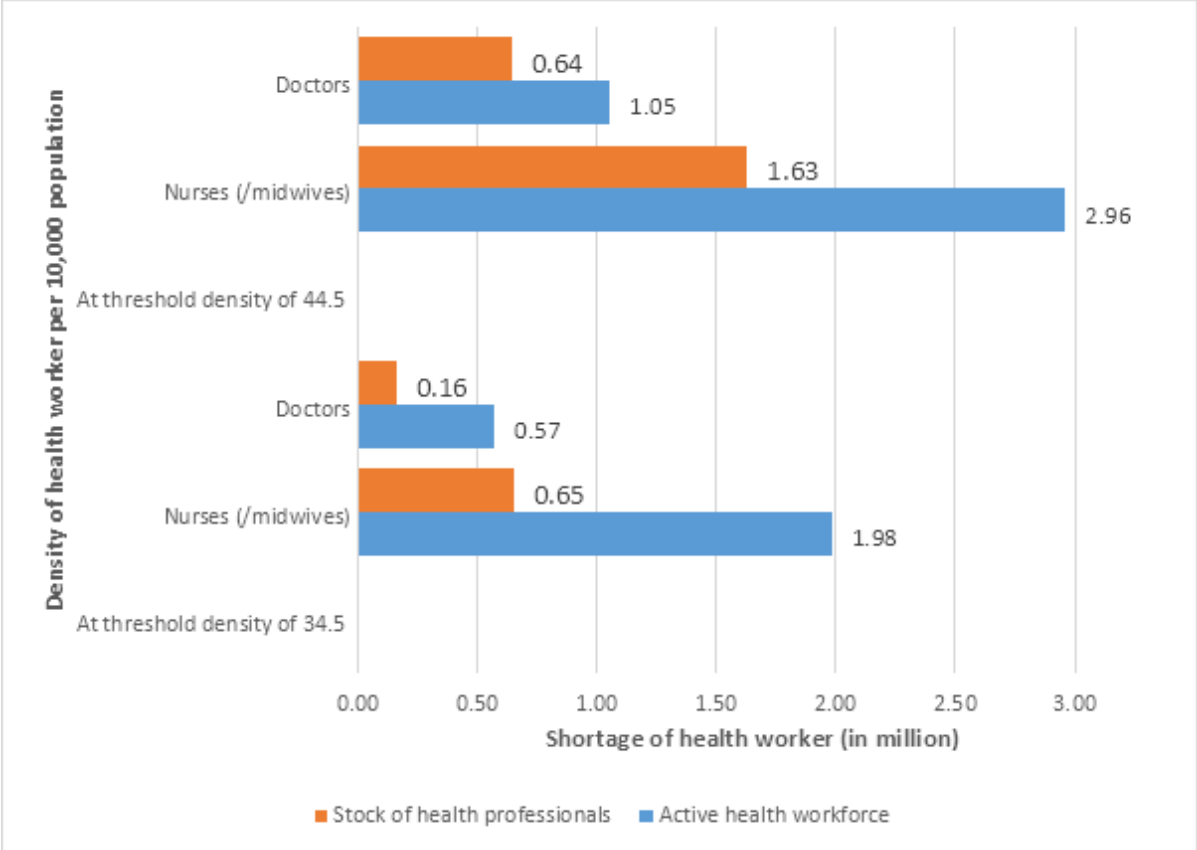

Figure 1

Estimates of shortages (in million) of health worker by 2030 at different health workers-population density thresholds per 10,000 population Sources: NHWA 2018; PLFS 2018-19 and Census of India 2011. Note: With an assumed, doctors: nurses /midwives ratio of 1:2

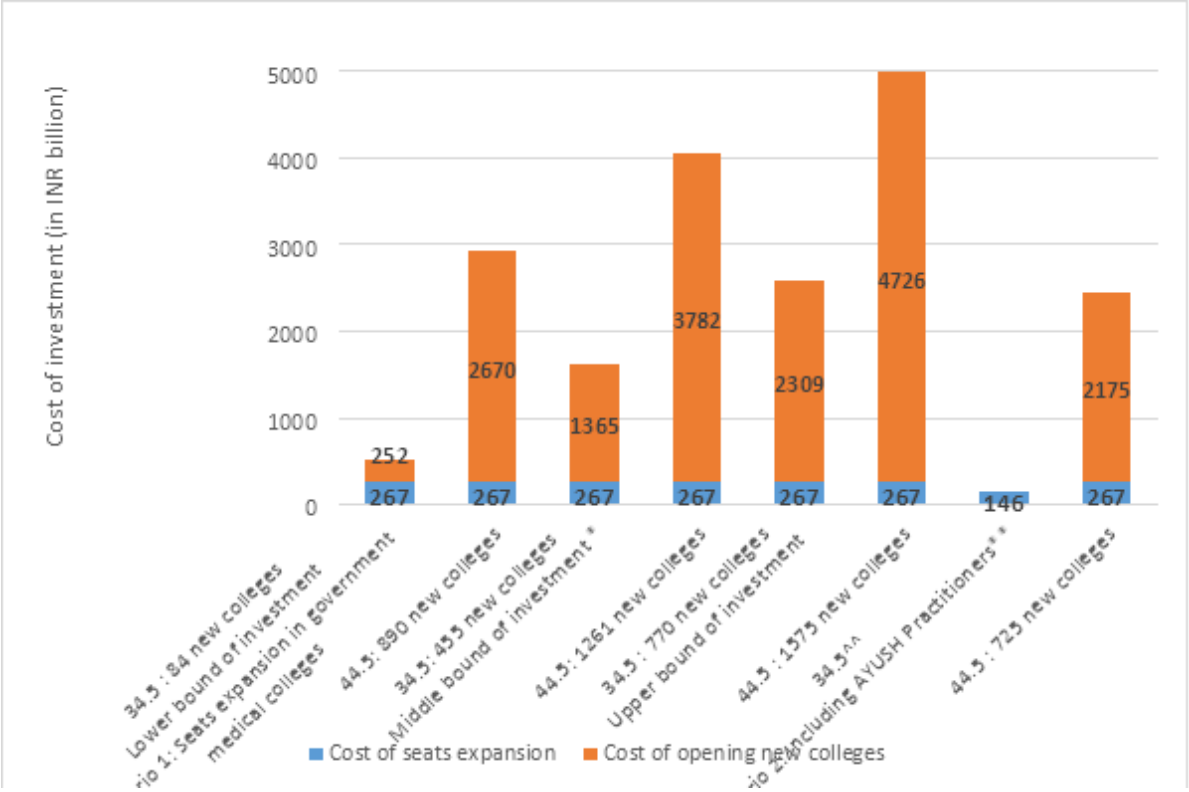

Figure 2

Strategy 4 and required investment (in billion) to overcome doctor's shortages by 2030, using government colleges and including AYUSH practitioners^ Note: *Investment required to overcome annual shortages, estimated after adopting scenario 1 (Strategy 4)- Including 50% of medically qualified health professionals who are not part of health workforce (0.19 million doctors) to the total shortages by 2030;**Investment required to overcome annual shortages estimated including 0.51 AYUSH practitioners to the total shortages by 2030;^Doctors: Required production per annum for a duration of 4 years (Total required production/4), investment estimates includes cost of seats expansion (INR 10 million per seat) in existing (/proposed) colleges and cost of opening new institutions (INR 3,000 million per institution);^^ with seat expansion by 22 seats per institution (no new colleges required)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable.docx
- SupplemetaryDcument1.docx