Chapter 4: Results

- Supply: The overall supply capacity of trained public health professionals from two sources – (i) Medical Colleges and (ii) institutions (other than medical colleges, including Schools of Public Health) offering public health programs was estimated to be 15,575. However, after taking factors like seat vacancy, migration, death of the trained workforce into consideration, this number is likely to be lower; it reduces to 9,134 (Best Guess Scenario), 10,220 (Optimistic Scenario) and 11,171 (Aspirational Scenario).

- Need: Service target approach was adopted for estimation of public health professionals currently needed in India. The overall need for the year 2017 for public health professionals was 1,80,916.

- Demand: The data regarding the demand of PHPs in India is not available. The global demand for health workers would be double the current stock of health workers by 2030. Considering the fact that PHPs are a part of overall health workforce; we assume that the global demand for PHPs will also increase over this period.

- Gap estimation: In 2017 there is an overall gap of approximately 26,298 PHPs (at optimistic scenario with a moderate seat occupancy). However, if the Public Health Cadre as outlined in the National Health Policy 2017 is set up, then by 2026 the gap will be 27,289 PHPs.

- Career opportunities: The nature of jobs for public health professionals in India includes teaching and training, research, policy and programs & practice. These jobs are offered in public, private, NGO and INGO sector.

- Competencies: Competency framework for MPH graduates included Epidemiology, Biostatistics, Gender issues, Ethics, Health policy, Health management, Research methodology and Public health technologies – as core competency domains.

- Tuition fee of public health programs: An analysis of the tuition fee of select post graduate public health programs depicts a wide variability. Fees range from Rs 480 to Rs 14,29,461 for the entire program (median – Rs 1,18,560). Tuition fee ranges from Rs 480 to Rs 1,90,000 for institutes owned by public sector, whereas the tuition fee ranges from Rs 28,500 to Rs 14,29,461 for institutes owned by private sector.
4.1 Estimating the current supply of public health professionals in India

Health workforce in India comprises of broadly eight categories of professionals namely: doctors [allopathic, alternative medicine], nursing and midwifery professionals, public health professionals [medical, non-medical], pharmacists, dentists, paramedical workers [allied health professionals], grass-root workers (frontline workers) and support staff. The thesis is restricted to only one of these eight categories i.e. public health professionals [medical, non-medical]. Public health professionals include - public health researchers, practitioners and educators, who work with communities and populations (43) and contribute towards prevention of occurrence of health problems through implementation of health programs, developing policies, administering services, regulating health systems and conducting research. (37) Public health professionals are thus a component of the overall health workforce and play a vital role in the creation and maintenance of a healthy community. (15)

MBBS graduates have been excluded for the purpose of current work as their sizeable number works in providing clinical care. Even if they are employed in the public sector, their preeminent role is in provision of clinical care when compared to public health activities. Therefore, we have not considered MBBS graduates as a part of public health professionals. However, MBBS doctors with specialized training in public health have been included for this work.

Public health professionals trained in foreign countries were not included in the research work as their number is very small and it is difficult to track them due to the unavailability of a single database at country level.

Traditionally, public health education in India was imparted through medical schools and was open only for medical graduates. The last two decades have witnessed an emergence of institutions (including Schools of Public Health) offering public health programs to non-medical graduates.(109) The public health education is expected to play an important role in building the capacity of public health professionals to solve health problems.(110) This section reports the results of an assessment of the supply side for public health professionals in the country.
4.1.1. Supply of public health professionals from public health related courses offered to medical graduates through medical colleges & National Board of Examinations (NBE)

Quantitative Analysis
A detailed analysis of supply (of programs and seats) related to public health programs from medical colleges & National Board of Examinations (NBE) is provided in subsequent paragraphs (provided in Table 11).
Table 11: Public health related courses offered to medical graduates through medical colleges & National Board of Examinations (NBE)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Supply from Medical Colleges &amp; NBE</th>
<th>Programs</th>
<th>Seats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Core public health programs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ph. D - Community Medicine (CM)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>MD - Social &amp; Preventive Medicine / Community Medicine</td>
<td>246</td>
<td>890</td>
</tr>
<tr>
<td>3</td>
<td>Diploma in Public Health (DPH)</td>
<td>39</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>Diploma in Community Medicine (DCM)</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Programs specific to public health domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ph. D - Hospital Administration (HA)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>MD - Community Health Administration (CHA)</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>MD - Tropical Medicine (TM)</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>MD - Hospital Administration (HA)</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>9</td>
<td>Master of Hospital Administration (MHA)</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>Diploma in Hospital Administration</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>Diploma in Health Administration</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Diploma in Health Education</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>Diploma in Industrial Health</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Diplomate of National Board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Family Medicine</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>15</td>
<td>Social and Preventive Medicine</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Health and Hospital Administration</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>Field Epidemiology</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>18</td>
<td>Maternal and Child Health</td>
<td>4</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Total supply capacity from Medical Colleges &amp; NBE</td>
<td></td>
<td>1128</td>
</tr>
</tbody>
</table>

Source: Medical Council of India & National Board of Examinations – 2017 (111, 112)
a. Medical colleges (Doctor of Medicine (MD) and other post graduate programs):
Medical colleges in India offer public health programs contributing to production of public health
professionals in India. We classified these programs in two categories. The first category includes
core public health programs such as Ph. D - Community Medicine (CM); MD - Social &
Preventive Medicine / Community Medicine, Diploma in Public Health (DPH) and Diploma in
Community Medicine (DCM). The second category includes programs specific to public health
domains such as Ph. D - Hospital Administration (HA), MD - Community Health Administration
(CHA), MD - Tropical Medicine (TM), MD - Hospital Administration (HA), Master of Hospital
Administration (MHA), Diploma in Hospital Administration, Diploma in Health Administration,
Diploma in Health Education and Diploma in Industrial Health.
Majority of the PHPs come from first category - offering core public health programs i.e. Ph.D.
(Community Medicine) – one institute; MD (Social & Preventive Medicine / Community
Medicine) – 246 institutes, 890 seats; Diploma in Public Health (DPH) – 39 institutes, 90 seats;
and Diploma in Community Medicine (DCM) - six programs, 11 seats. (111)
From the second category - programs specific to public health domains i.e. Ph.D. (Hospital
Administration) – one institute; MD (Community Health Administration) – one institute, ten seats;
MD (Tropical Medicine) – one institute, seven seats; MD (Hospital Administration) – eight
institutes, 31 seats; Masters in Hospital Administration (MHA) – two institutes, 16 seats; ::
Diploma in Hospital Administration - one institute, six seats; Diploma in Health Administration –
one institute, six seats; Diploma in Health Education – two institutes, 20 seats; and Diploma in
Industrial Health – three institutes.(111)
b. Diplomate of National Board
In the context of public health, NBE offers programs in Family Medicine, Social and Preventive
Medicine, Health and Hospital Administration, Field Epidemiology, Maternal and Child Health.
Currently the DNB programs in Family Medicine through 11 institutes, Social and Preventive
Medicine are offered through one institutes, Health and Hospital Administration through three
institutes, Field Epidemiology through one institute, Maternal and Child Health through four
institutes.(111, 112)
4.1.2. Supply of public health professionals from institutions (other than medical colleges, including Schools of Public Health) offering public health programs contributing to production of public health professionals in India

Public health professionals include professionals from several other disciplines and diverse fields encompassing: behavioral sciences/health promotion and communication, biostatistics, medical/health sciences, environmental health, epidemiology, health services administration/management, international/global health, maternal and child health, nutrition, public health laboratory practice, public health policy and public health practice.(44)

a. Public health programs
A detailed analysis of the supply from Bachelors in Public Health (BPH)/Bachelor of Science in Public Health and Master of Public Health (MPH) has been provided in table 12.

Table 12: Estimating the current supply through public health programs

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Public health programs</th>
<th>Programs</th>
<th>Seats*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bachelor of Public Health (BPH)/Bachelor of Science in Public Health</td>
<td>6</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>Master of Public Health (MPH)</td>
<td>44</td>
<td>1190</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>1,370</td>
</tr>
</tbody>
</table>

*Approximately

Bachelor of Public Health (BPH)
Bachelor of Public Health (BPH) is an undergraduate degree preparing students for careers in public, private, or non-profit sector in public health areas such as environmental health, health administration, epidemiology, nutrition, biostatistics, or health policy and planning.(113) In India, currently six BPH programs are being offered by Padmashree School of Public Health – Bangalore, Dr. Giri Lal Gupta Institute of Public Health, Lucknow University – Lucknow, Lachoo Memorial College of Science & Technology – Jodhpur, Bharath University – Chennai, MJRP College of Health Care and Allied Sciences – Jaipur and School of Nursing and Health Sciences, Noida International University - Greater Noida. Eligibility criteria for these programs includes a pass in higher secondary or equivalent qualification with English, Physics, Chemistry, Biology or Botany
and Zoology with 50% marks. Majority of the BPH programs are of three-year duration followed by a period of six months internship. However, one of the BPH programs offered by Padmashree School of Public Health, Bangalore is of four-year duration. These courses offer approximately 180 BPH seats annually.

Master of Public Health (MPH)
A detailed case study has been undertaken where we have analyzed the MPH programs in India. This case study is presented subsequently in Appendix XIII, whereas we have summarized the results of the same in the box below.


This scoping review identified 46 institutions that have ever offered a MPH program in India. However, out of these 46, two institutions discontinued their MPH programs in 2013 onwards. In the academic year 2016–2017, 44 institutions offered 46 MPH programs (two institutions offered two different types of MPH programs). Thus, for India in 2016–2017, there was one MPH program in existence per 28.7 million population. Of these 44 institutions, 42 had at least one student enrolment in 2016–2017, whereas, two institutions had no enrolments. Findings on these 44 institutions and the 46 MPH programs offered in 2016–2017 are summarized next.

Evolution and growth

The first MPH program in India was launched at Mahatma Gandhi University, Kottayam, Kerala, in 1995. This was followed by the Achutha Menon Centre for Health Science Studies, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Kerala in 1997. During the decade from 1997 to 2006, four institutions commenced MPH programs – Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad in 2000; the National Centre for Disease Control, New Delhi in 2005; and both Jawaharlal Nehru University, New Delhi and the Interdisciplinary School of Health Sciences, University of Pune, Pune in 2007. In the decade from 2007 to 2016, MPH programs were launched by 40 institutions, including an upsurge in the number of private institutions offering MPH programs. MPH programs offered at Birla Institute of
Technology and Sciences, Pilani, Rajasthan and Chitkara University, Punjab were discontinued in 2013.

Figure 5: Evolution of institutes offering Master of Public Health (MPH) programmes in India (n = 46)

* Ownership and geographical coverage

Of the 44 institutions currently offering MPH programs, 26 are privately owned and 18 are in the public sector. Tata Institute of Social Sciences offers two MPH programs, one in social epidemiology and the other in health policy, economics and finance. Sri Ramaswamy Memorial University also offers two programs: a MPH and a Master of Business Administration (MBA)/MPH dual degree. In terms of geographical location, eight institutions are situated in Karnataka; six in Delhi-National Capital Region; five in Maharashtra; four each in Uttar Pradesh and Tamil Nadu; three in Kerala; two each in Chandigarh, Gujarat, Rajasthan, Telangana and West Bengal; and one each in Himachal Pradesh, Nagaland, Odisha and Puducherry. The concentration of institutions offering the MPH is therefore mostly outside the Empowered Action Group states that are targeted for special government health and development assistance.
Eligibility

MPH programs in India are postgraduate-level courses aimed at building the human resources capacity in public health. Most of the MPH programs provide opportunity to graduates from multidisciplinary medical backgrounds such as medicine, dentistry, physiotherapy, occupational therapy, AYUSH (ayurveda, yoga and naturopathy, unani, siddha and homoeopathy), nursing, veterinary sciences or pharmacy; and non-medical backgrounds such as engineering, statistics/biostatistics, demography, population studies, nutrition, sociology, economics, psychology, anthropology, social work, management, life sciences, social sciences, management, law, arts, etc., to enroll for the program. In addition to these eligibility criteria, some institutions give preference to candidates with a prior health background, i.e. of working in health services. The eligibility criteria for MPH programs are variable; for example, some institutions enroll AYUSH graduates in their MPH programs, while some do not allow them to enroll, even though they are trained in health sciences.

Duration

Of the 46 MPH programs offered, 44 are of 2 years’ duration. In addition, there are two 3-year programs: Rajiv Gandhi University of Health Sciences, Karnataka’s MPH (Honors) and Sri Ramaswamy Memorial University’s MBA/MPH program.

Specializations offered

Thirty institutions do not offer any specialization as part of their MPH program, whereas 14 offer specializations in domains such as epidemiology, nutrition, health promotion and health management, maternal and child health, field epidemiology, community nutrition, health economics, financing and policy, health systems, and occupational and environmental health.

Pedagogy

All MPH programs are taught on-campus, apart from the program offered by the Global Open University, Nagaland, which is a distance-learning course. Course work covers standard fields of public health, including epidemiology, biostatistics, environmental health and health policy. Most on-campus programs include teaching with practical/field experience.
Faculty

The faculty in most of the institutions have a multidisciplinary background. However, MPH programs offered through medical colleges are predominantly taught by faculty with a medical background. Faculty numbers for MPH teaching were available for 41 institutions and ranged from 1 to 25, with a median of 6. The ratio of faculty number to student enrolments in 2016–2017 of these 41 institutions ranged between 1:0.1 and 1:42. Institutions with very minimal faculty, for example one, bring external faculty from other institutions to teach their program.

Intake capacity versus enrolments

In the 2016–2017 academic year, out of 44 institutions, 1190 places were being offered on MPH programs but only 704 students were enrolled. Two institutions had zero enrolments, 16 had fewer than 10 enrolments, 13 had 10–20 enrolments and 13 had more than 20 enrolments. At 59%, the place occupancy for MPH programs in India compares poorly with that for the Bachelor of Medicine and Bachelor of Surgery (MBBS) qualification, which is anecdotally 95%. However, place occupancy for the Bachelor of Dental Surgery program has recently reduced to around 50%.(118)

The number of students graduating from an Indian institution with a MPH degree can only be estimated. During 2007–2016, more than 4300 enrolments took place in MPH programs in India. Assuming 95% of students successfully graduated from these MPH programs, there have been around 4100 MPH graduates. Information on employment of MPH graduates was available for three institutions; 93% of MPH graduates were in some form of employment.

Accreditation and curriculum

Currently, no formal regulatory mechanism exists in the country for the accreditation of public health courses, including MPH programs.(25) In 2011, the National Commission for Human Resources for Health Bill was introduced,(119) which included formation of a National Council for Human Resource in Health for the regulation and accreditation of health education.(25) However, the bill has not yet been enacted. The curriculum of the MPH programs is therefore variable, as these programs are offered by different universities and institutions and no standard curriculum exists in the country.(25)
b. Public health domains
A detailed analysis of each domain is provided in subsequent paragraphs. The information regarding supply in each domain was collected and has been provided in table 13. The names of programs covered under each domain have been provided in table 14.

Table 13: Estimating the current supply through public health domains

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Public health domains</th>
<th>Programs</th>
<th>Seats*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biostatistics</td>
<td>26</td>
<td>356</td>
</tr>
<tr>
<td>2</td>
<td>Demography</td>
<td>53</td>
<td>1153</td>
</tr>
<tr>
<td>3</td>
<td>Occupational and environmental health</td>
<td>33</td>
<td>675</td>
</tr>
<tr>
<td>4</td>
<td>Epidemiology</td>
<td>16</td>
<td>194</td>
</tr>
<tr>
<td>5</td>
<td>Public health engineering/ environmental engineering</td>
<td>42</td>
<td>1100</td>
</tr>
<tr>
<td>6</td>
<td>Entomology</td>
<td>14</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>Public health laboratory</td>
<td>12</td>
<td>500</td>
</tr>
<tr>
<td>8</td>
<td>Health administration/ management</td>
<td>45</td>
<td>2096</td>
</tr>
<tr>
<td>9</td>
<td>Hospital administration/ management</td>
<td>57</td>
<td>1454</td>
</tr>
<tr>
<td>10</td>
<td>Health &amp; Hospital Management/ Administration</td>
<td>27</td>
<td>1179</td>
</tr>
<tr>
<td>11</td>
<td>Health economics, health care financing &amp; health policy</td>
<td>8</td>
<td>130</td>
</tr>
<tr>
<td>12</td>
<td>Monitoring and evaluation</td>
<td>11</td>
<td>250</td>
</tr>
<tr>
<td>13</td>
<td>Public health nutrition</td>
<td>16</td>
<td>350</td>
</tr>
<tr>
<td>14</td>
<td>Health promotion</td>
<td>9</td>
<td>240</td>
</tr>
<tr>
<td>15</td>
<td>Public health law</td>
<td>6</td>
<td>300</td>
</tr>
<tr>
<td>16</td>
<td>Veterinary public health</td>
<td>84</td>
<td>2000</td>
</tr>
<tr>
<td>17</td>
<td>Public Health Ethics</td>
<td>8</td>
<td>200</td>
</tr>
<tr>
<td>18</td>
<td>Maternal &amp; child health</td>
<td>16</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>13077</td>
</tr>
</tbody>
</table>

*Approximately
Table 14: Names of programs covered under each domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Name of programs/ courses^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biostatistics</td>
<td>Ph.D., MSc, Advanced PGD, PGD, Certificate</td>
</tr>
<tr>
<td>Demography</td>
<td>Ph.D., MPhil, MSc, MPS, MA, PGD, Diploma, Certificate</td>
</tr>
<tr>
<td>Occupational and environmental health</td>
<td>Ph.D., MSc, PG certificate, PGD in Industrial Safety, AFIH</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>Ph.D., MPhil, MSc, PGD</td>
</tr>
<tr>
<td>Public health engineering/ environmental engineering</td>
<td>M.E./ M.Tech, B.E./ B.Tech, Diploma</td>
</tr>
<tr>
<td>Entomology</td>
<td>Ph.D., Integrated Masters &amp; Ph.D., MSc, PGD</td>
</tr>
<tr>
<td>Public health laboratory</td>
<td>M.Sc., B.Sc., Advance Diploma, Certificate</td>
</tr>
<tr>
<td>Health management/ administration</td>
<td>Ph.D., Master of Health Administration (MHA), MBA, BBA, PGD PHM, Diploma</td>
</tr>
<tr>
<td>Hospital management/ administration</td>
<td>MBA, Master of Hospital Administration (MHA), BBA, MHM, PGDHM</td>
</tr>
<tr>
<td>Health &amp; hospital management/ administration</td>
<td>Ph.D., MPhil, MBA, BBA, PGDHMM, Diploma</td>
</tr>
<tr>
<td>Health economics, health care financing &amp; health policy</td>
<td>Ph.D., MPhil, M. A, PGD</td>
</tr>
<tr>
<td>Monitoring and evaluation</td>
<td>Diploma, Certificate</td>
</tr>
<tr>
<td>Public health nutrition</td>
<td>Ph.D., M.Sc./M. A (Dietetics &amp; Food Service Management), M.Sc. Foods and Nutrition, PGDAND, PGDPHN, Diploma, Certificate</td>
</tr>
<tr>
<td>Health promotion</td>
<td>PGDHP, DHPE, DNHE</td>
</tr>
<tr>
<td>Public health law</td>
<td>Mental Health Law and Human Rights, PGD in Law and Medicine, PGD in Medical Law and Ethics, PGD in Health Science in Medico Legal Practice</td>
</tr>
<tr>
<td>Veterinary public health</td>
<td>Ph.D., MVSc, MVMH, BVSc &amp; AH, PGCCVH</td>
</tr>
<tr>
<td>Public health ethics</td>
<td>PGD, Diploma, Advanced Certificate, Certificate</td>
</tr>
<tr>
<td>Maternal &amp; child health</td>
<td>PGDMRCH, PGDMCH, Diploma in MCH&amp;FW, Certificate</td>
</tr>
</tbody>
</table>

^Certificate courses: we have included certificate courses of more than three months duration.

Biostatistics
As per definition Biostatistics is the branch of statistics responsible for the proper interpretation of scientific data generated in the biology, public health and other health sciences (i.e. the biomedical sciences).(120) Currently in the country there are around 26 programs in biostatistics. As each year more multinational pharmaceutical industries and research organizations are booming in India, the demand for biostatisticians and postgraduates of biostatistics is growing in academic research centres and universities, pharmaceutical industries and in government sectors.(121)

The eligibility criteria for post-graduate programs range from minimum of recognized bachelor's degree with medical subject or any other subject with mathematics or statistics as one of the subjects, to a maximum of master's degree in the field of statistics - as per the nature of programs. For the master's level programs, bachelor's degree with mathematics or statistics are required as the main subjects.(28) These courses offer around 356 seats in biostatistics annually.

Demography
As defined by Grundy E et. al. demography is concerned with 'numbering of the people’ and with understanding population dynamics—how populations change in response to the interplay between fertility, mortality, and migration.(122) Fifty three courses offer around 1,153 seats annually in biostatistics in the country. The minimum eligibility criteria for these programs varies from a graduate degree in any stream, preferably geography, sociology, economics, psychology, anthropology, social work, mathematics, and statistics.(123)

Occupational and environmental health
Environmental health is defined as the branch of public health that is concerned with all aspects of the natural and built environment that may affect human health.(124) Whereas occupational health is referred to the identification and control of the risks arising from physical, chemical, and other workplace hazards to establish and maintain a safe and healthy working environment.(125) Currently around 33 programs are offered in occupational & environmental health in the country.
Institutes like All India Institute of Hygiene and Public Health (AIHPH) – Kolkata, Sri Ramachandra Medical College and Research Institute (SRM) – Chennai, Institute of Science, Training and Advanced Research (previously BVM Engineering College) – Anand, Amrita Institute of Medical Sciences – Kochi, National Institute of Industrial Engineering (NITIE) – Mumbai, Armed Forces Medical College (AFMC) – Pune, Annamalai University – Chennai, Mahatma Gandhi Labour Institute (MGLI) – Ahmedabad, Indian Institute of Public Health- Gandhinagar, Gujarat – offer various courses. Eligibility criteria for these programs varies from graduate degree in science, medicine, technology, engineering, physics, chemistry etc. Approximately these courses offer around 675 seats in occupational and environmental health in the country.

Epidemiology
As per World Health Organization (WHO), epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems.(126) Role of epidemiologists has gained immense prominence in recent times, with introduction of the Integrated Disease Surveillance Project (IDSP) in 2004 which established the position of epidemiologists at district level.(127) The project has been continued as Integrated Disease Surveillance Program under NHM for all States.(128) Epidemiologists are also needed at medical colleges, international organizations, bilateral organizations, public health projects, research and training institutions, national health programs and nongovernmental organizations.

In the country, currently there are 16 programs offering degree/ diploma in epidemiology. Undergraduates in medicine, health and allied sciences, or bachelor of any science subject are eligible for these programs. Approximately these courses offer 194 seats in epidemiology annually.

Public health engineering/ environmental engineering
As per National Institute of Disaster Management The main function of the public health engineering department is to plan, implement & maintain rural and urban water supply schemes, rural sanitation schemes. The district level administration of the public health engineering department undertakes field investigation, survey, data collection, preparation, execution & maintenance of schemes.(129) Currently, around 42 programs are being offered in public health engineering in the country. For the diploma programs, a class X examination passed candidate (under 10+2 system of examination) with mathematics as one of the subject is eligible to apply.
For B.E/ B.Tech in public health engineering programs; a pass in class XII examination with mathematics as one of the subject is required. For M.E/ M Tech in public health engineering – a bachelor’s degree in environmental engineering, civil engineering, chemical engineering, polymer sciences and technology or equivalent degree, mechanical engineering, mining engineering with three years’ experience in environmental department or organization is required.(18) Approximately these courses offer around 1100 seats in public health engineering annually.

Entomology
Public Health Entomology comprehensively examines vector-borne disease prevention, surveillance, and control from a governmental and public health perspective with worldwide application.(130) Entomologists work towards protecting the environment; sustaining agricultural production; preventing the spread of disease; helping farmers to produce food and saving endangered species. They also study various pests, their control and conduct research to develop new and improved methods for controlling or eliminating pests.(131)

Currently in India, there are 14 programs being offered in entomology which are offered by government institutions. The eligibility criterion for these courses includes graduate degree in zoology, botany, life sciences, medical laboratory technology, microbiology, biochemistry, zoology or doctorate in medicine in community medicine, social & preventive medicine, MSc in medical entomology etc. Based on study published during 2015 on the specialized training programs in medical entomology, it was observed that the annual output of trained medical entomology specialists is below 100 which is far below the need for medical entomologists in the country.(22)

Public health laboratory
Public health laboratories are crucial for public health systems as they operate as a first line of defense to protect the public against diseases and other health hazards.(132) Currently there are 14 programs offering public health laboratory courses, which in turn train around 500 professionals annually. Professionals working in public health laboratories come from four different programs into the system, namely microbiology, biochemistry, laboratory technology and clinical pathology programs.(23) Undergraduate training in microbiology is conducted in Medical schools, as a part of MBBS course and in BSc (Medical Microbiology) as a part of taught in science colleges. Candidates who have passed higher secondary school (class XII) with physics, chemistry and biology up are eligible for Bachelor's degree in Science (B.Sc.) Medical Microbiology. Medical
as well as science graduates are eligible to apply for post graduate course in microbiology. Candidates who have passed B.Sc. with 55% marks are eligible to apply for MSc. Medical Microbiology. (23) Apart from these, diploma programs in laboratory technology and clinical pathology are available for SSC (10th Standard) pass and medical graduates respectively. Further public health laboratory staff is trained under various national health programs such as: Revised National Tuberculosis Control Program (RNTCP), National AIDS Control Program (NACP), Integrated disease surveillance project (IDSP) etc. (23)

Health administration/ management
A health management professional is expected to juggle a variety of responsibilities. The presence of trained management professionals in the health sector, to work for hospitals, pharmaceutical companies, health insurance and third-party administration, and other healthcare provider organizations - is a growing phenomenon. (25) A total of 45 institutions have been identified which offer such courses. We estimate that approximately 2,096 qualified professionals will graduate annually from these institutions providing training in Health Management/ Administration. The eligibility criteria for these courses vary from institutes to institutes, with a minimum requirement of having a recognized Bachelor’s degree in any stream, preferably with Medical or Paramedical and Life Sciences background. MBBS, BDS, AYUSH, or Physiotherapy, Allied Health Science, and Pharmacy are given preference over others. (25) The course modules cover management lessons like Principles of Management, Human Resource Management, Organizational Behavior, Strategic Management, etc. Health-specific modules include Demography, Epidemiology, Health Economics, Project Management, NGO Management, Survey Research Methods, Quality Assurance, Legal Aspects, and Research Methodology. Most programs require the students to undergo 3–6 months of internship to have an industry interface, during which they undergo a project in the related field. (25) (15)

Hospital administration/ management
Hospital management has been defined as management of all aspects of a hospital; a coordination of all elements of a hospital. (133) Currently there are about 57 institutes offering various programs in hospital administration/ management in the country. These institutes annually produce more than 1454 qualified professionals to work in the domain of hospital management. Some institutes offer post-graduate diplomas of one to two-year duration. (26) Candidates with graduation in medicine, science or allied health are eligible to apply in hospital management courses.
Some institutes offering MBA in hospital management are Manipal Institute of Management - Manipal, Jamia Hamdard - New Delhi, Lovely Professional University (LPU) – Punjab, Dr. D.Y. Patil Medical College for Women and Hospital – Maharashtra, Sri Ramachandra Medical College & Research Institute - Tamil Nadu, Punjab University - Chandigarh, Sharda University - Uttar Pradesh, MGM University of Health Sciences – Maharashtra etc.

Health & hospital administration/management
Seeing the continuous growth of the health industry, several institutions offer programs in health and hospital administration/management to train health professionals in management skills for Hospitals and Healthcare organizations. In India, around 27 institutes offer these programs with 1,179 seats across the country. Candidates with graduation in medicine, science, allied health, nursing, pharmacy etc. are eligible to apply in health & hospital administration/management courses.

A detailed case study has been undertaken and we have separately analyzed the three domains of health management/administration; hospital management/administration; and health & hospital management/administration in the form of case study which is presented subsequently.


Supply estimation
On the basis of information collected there are total 475 academic programs (offering health (hospital) management / administration) having enrolment capacity of 6963 seats collectively (2017). The details have been provided in Table 15:
Table 15: Supply of HMPs through medical colleges and institutes (offering health (hospital) management / administration)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Source</th>
<th>Background as eligibility criteria</th>
<th>Name of program</th>
<th>Number of programs</th>
<th>Number of seats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medical colleges offering programs in:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Health management/ administration.; Hospital management/ administration;</td>
<td>Medical</td>
<td>MD - Community Health Administration (CHA), Diploma in Health Administration, MD - Hospital Administration (HA), Diploma in Hospital Administration,</td>
<td>11</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>Community medicine; preventive &amp; social medicine; public health</td>
<td>Medical</td>
<td>MD - Social &amp; Preventive Medicine / Community Medicine, Diploma in Public Health (DPH), Diploma in Community Medicine (DCM)</td>
<td>291</td>
<td>991</td>
</tr>
<tr>
<td></td>
<td>Institutes (other than medical colleges) offering programs in:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Health management/ administration</td>
<td>Medical &amp; non-medical</td>
<td>Ph.D., Master of Health Administration (MHA), MBA, BBA, PGDPHM, Diploma</td>
<td>45</td>
<td>2096</td>
</tr>
<tr>
<td>4</td>
<td>Hospital management/ administration</td>
<td>Medical &amp; non-medical</td>
<td>MBA, Master of Hospital Administration (MHA), BBA, MHM, PGDHM</td>
<td>57</td>
<td>1454</td>
</tr>
<tr>
<td>5</td>
<td>Health &amp; hospital management/ administration</td>
<td>Medical &amp; non-medical</td>
<td>Ph.D., MPhil, MBA, BBA, PGDHHM, Diploma</td>
<td>27</td>
<td>1179</td>
</tr>
<tr>
<td>6</td>
<td>Master of Public Health (MPH)</td>
<td>Medical &amp; non-medical</td>
<td>MPH</td>
<td>44</td>
<td>1190</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td>475</td>
<td>6963</td>
</tr>
</tbody>
</table>
Thus, considering the differential seat occupancy for the year 2017, 2024 and 2030 it was observed that following number of HMPs are produced annually in the three scenarios (Figure 6). In case, the growth in the programs offering health management would continue to grow by 50 per cent by 2030 then it would increase from 4004 (2017) to 6006 by 2030 (in moderate scenario).

Figure 6: Health Management Professionals HMPs produced annually in Best Guess, Optimistic and Aspirational scenarios in India (2017 to 2026)

Considering the differential seat occupancy for the year 2017, 2024 and 2030 it was observed that following number of HMPs are produced annually from these two streams (six categories). (Table 16).
Table 16: HMPs produced annually in Best Guess, Optimistic and Aspirational scenarios in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenarios - seat occupancy</th>
<th>Medical Colleges</th>
<th>Other institutions</th>
<th>Total HMPs produced annually</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Health management/administration; Hospital management/administration</td>
<td>Community medicine; preventive &amp; social medicine; public health</td>
<td>Health management/administration</td>
</tr>
<tr>
<td>2017</td>
<td>Best Guess – Low</td>
<td>46</td>
<td>173</td>
<td>1378</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>52</td>
<td>196</td>
<td>1561</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>58</td>
<td>219</td>
<td>1744</td>
</tr>
<tr>
<td>2024*</td>
<td>Best Guess – Low</td>
<td>58</td>
<td>220</td>
<td>1749</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>66</td>
<td>249</td>
<td>1982</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>74</td>
<td>278</td>
<td>2214</td>
</tr>
<tr>
<td>2030*</td>
<td>Best Guess – Low</td>
<td>69</td>
<td>260</td>
<td>2066</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>78</td>
<td>294</td>
<td>2342</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>87</td>
<td>329</td>
<td>2616</td>
</tr>
</tbody>
</table>

*Forecasted estimates
Need estimation through service target approach

Based on “service target approach” a normative need of around 11,304 HMPs was estimated for 2017, based on the number of positions available for HMPs in India. In the year 2010, as estimated by Sharma et. al. there was an estimated requirement for 19,930 qualified health management professionals in the health sector. (25) We updated the numbers for the year 2017, using similar methodology for our study. India with 36 states (29 states and 7 union territories), 640 districts and around 5,988 blocks will require a program manager at each level i.e. State Program Manager, District Program Manager and Block Program Manager respectively. Thus, approximately 6,664 trained professionals would be needed to serve these positions in the public sector.

Around a thousand consultants would be required in institutes like NIHFW, NHSRC, SHSRCs, etc. to work in their projects/ departments. About 200 consultants/specialists will be needed at each state level across the country. More than 400 trained professionals would be employed across 90 large NGOs(134) in the country. Around 500 professionals would be needed across international organizations, while 1500 professionals would be necessary in academic/research organizations across the country. Similarly, around 1000 professionals will be needed to work in Corporate Social Responsibility roles with corporate organizations. Thus, an estimated 11,304 HMPs are required to function in this capacity across the health sector.

We assumed the following additional positions in health management with the setting up of the public health cadre - one at state, two at district and one at each block level.(101) At the country level we would need approximately 7,300 HMPs additionally in 2026 (i.e. 1x36 states + 2x640 districts + 1x5988 blocks). We assumed that - 1/3rd of the states will implement public health cadre by 2020, another 1/3rd by 2023 and all states by 2026. Thus, as per our estimates there will be a requirement of around 2435 HMPs by 2020, 5681 HMPs by 2024 and 7,304 HMPs by the year 2026.

Need estimation through benchmark analysis

Assuming in India today, the number of HMPs in health workforce is around 9,608 (i.e. 85% of total 11,304 positions are occupied). Thus, if we calculate the number of health management professionals (HMPs) per one lakh population based on the current population of India i.e. 1.33 Billion (World Bank, Oct 2017) (135) then it comes out to be 0.72 HMP per 100,000 population. The normative need for HMPs was calculated on the basis of benchmark analysis in USA’s
scenarios of HMPs: population ratio. On the basis of NACCHO’s ‘Potential Local Public Health Workforce Benchmarks’ for Health services managers employed by local government there should be 2.97 HMPs per 100,000 population.(106) As per this benchmark analysis, currently in the year 2017 there is a need of 39,774 HMPs in India to reach USA’s 2.97:100,000 ratio. This would further grow up to 44,936 by the year 2030.

Gap estimation

In the ‘moderate seat occupancy - optimistic scenario’, in the year 2017 there is a gap of 26,748 HMPs which is met by the year 2027. However, if the Public Health Cadre is instituted assuming - 1/3rd of the states will implement Public Health Cadre by 2020, another 1/3rd by 2023 and all states by 2026 – then in the year 2030 around 7,304 HMPs; then this gap is met by 2030. Similarly, in the ‘low seat occupancy – best guess scenario’ in the year 2017 there is a gap of 27,219 PHPs which is met by the 2029. However, by the year 2030 there is a gap of 4,545 HMPs in case the Public Health Cadre is instituted - with the requirement of 7,304 HMPs additionally. In ‘high seat occupancy – aspirational scenario’ the gap is met by the year 2026 and in case Public Health Cadre is instituted then it is met by 2028. Figure 7 illustrates the three scenarios.

Figure 7: Gap in the number of HMPs calculated against a normative need of 2.97 HMPs per 100,000 population
Health economics, health care financing & health policy
As per Dang A et. al. health economic studies provide information to decision makers for efficient use of available resources for maximizing health benefits.(136) Currently there are nine courses being offered in various domains of health economics, healthcare financing and healthcare policy. The eligibility criterion for doctoral programs in health economics or health policy; is post graduate degree in life sciences/public health/health sciences/MBBS. Similarly, for entering masters’ program - a bachelors’ degree in health sciences is required. These institutes annually offer approximately 130 seats. This includes 100 seats offered by post graduate diploma program offered through e-learning mode.

Monitoring and evaluation
As stated by Keeble in 2011; monitoring and evaluation (M&E) in public health, is to know whether the intended results are being achieved as planned in the national health action plan, and whether public health interventions are making positive contributions towards improving people’s health.(137) Currently, 11 programs are offered to graduates/post-graduates with relevant understanding of public health. Applicants currently engaged in public health related activities such as health professionals working with directorates of health services at central, state, and district levels (Health Programs - Integrated Disease Surveillance Project, National Vector Borne Disease Control Program, HIV/AIDS, Nutrition, Maternal and Child Health Programs etc.); international and local non-governmental agencies; and academic and research institutions are also eligible to apply. These courses offer around 250 seats annually.

Public health nutrition
As per The Nutrition Society, public health nutrition focuses on the promotion of good health through nutrition and the primary prevention of nutrition related illness in the population.(138) As per a study conducted during 2011, there were nearly 190 institutes in India offering one or more of the nutrition courses. For masters’ level program in public health nutrition - the eligibility criteria include graduation in life sciences, food & Nutrition or PG Diploma in Dietetics & Public Health Nutrition. Currently 16 programs are being offered in public health nutrition across India with around intake capacity of 350 seats.

Health promotion
Health promotion is the process of enabling people to increase control over, and to improve, their health.(139) Currently nine programs are offering health promotion/health education in India.
Eligibility criteria for health promotion programs varies from graduate degree in medicine, dentistry, nursing, pharmacy, psychology, biological sciences, social sciences, allied health sciences etc.

Institutes like Family Welfare and Training Research Centre – Mumbai, Public Health Foundation of India (PHFI) - New Delhi, All India Institute of Hygiene and Public Health (AIHPh) – Kolkata, National Institute of Health and Family Welfare (NIHFW) – New Delhi, Central Health Education Bureau - New Delhi, Indira Gandhi National Open University (IGNOU) – New Delhi. Approximately more than 240 seats are offered by these programs in the country.

Veterinary public health
As per World Health Organization (WHO) Veterinary Public Health (VPH) has been defined as the sum of all contributions to the physical, mental and social well-being of humans through an understanding and application of veterinary science.(140) Currently in India 84 institutes offer bachelor, master degree and doctorate degree programs in veterinary public health. The eligibility criteria for bachelor’s program requires a pass in intermediate science (10+2) exam in the subjects of physics, chemistry, biology and English. A doctoral degree requires a master’s degree in the respective/related subject as eligibility criterion. For the post graduate diploma program, bachelor’s in veterinary sciences and animal husbandry or BHMS is required for admission. Approximately these courses offer around 2000 seats in veterinary public health annually.

Public health law
As described by Hazarika et. al. “public health law focusses on the nexus between law, public health and the legal tools which are applicable to public health issues.”(17) Currently only six institutions are offering academic courses on health law in India. Some of the institutes offering programs in public health law are as follows: Centre for Enquiry into Health and Allied Themes - Mumbai, KLE University – Belgaum, National Law School India University - Bangalore, Annamalai University - Tamil Nadu etc. Few institutes offering master’s in public health program teach a course module on health law as well. (15) Approximately these courses offer around 300 seats in public health law annually.

Public health ethics
As per a definition coined in the year 2010, public health ethics lays the moral foundation of public health as an injunction to maximize welfare, and therefore health as a component of welfare.(141)
Currently, in India a total of eight programs dedicatedly teach ethics whereas five of these rely on classroom-based direct learning. Not a single program out of these focuses exclusively on public health ethics. In a study conducted in 2014 it was observed that the primary thrust of seven programs is on research ethics or bioethics, two is on clinical or healthcare ethics, whereas one deals with the legal aspects. The curricula of 14 MPH programs have an ethics component where public health ethics has been incorporated as a dedicated module. These programs being diploma, certificate and online in nature offer close about 200 seats in public health ethics in the country.

Maternal & child health
As per WHO’s definition, maternal health refers to the health of women during pregnancy, childbirth and the postpartum period. The term ‘Maternal and Child Health’ (MCH) encompasses the provision of key services through government, private, and not-for-profit organizations, partnerships, and professionals. Currently in India, around 16 institutes are offering maternal and child health courses through regular or distance learning mode. Each institute has its own eligibility criteria for admission. The duration of these courses range from 6 months to 3 years. Some of these institutes are namely Indira Gandhi National Open University – New Delhi, Shivalik Institute of Paramedical Technology - Chandigarh, Chhatrapati Shahuji Maharaj Medical University – Lucknow, NIMS University – Jaipur, Dr. Babasaheb Ambedkar Open University – Gujarat, All India Institute of Hygiene and Public Health - Kolkata, Indian Institute of Public Health – Delhi. Approximately these courses offer around 800 seats in maternal & child health annually.

Additionally, an analysis was carried out for RCH trainings under National Health Mission (NHM). RCH trainings are conducted for in-service candidates (both contractual and permanent). There are eight training programs which are conducted in maternal health such as Emergency Obstetric Care (EmOC), Basic Emergency Obstetric Care (BEmOC), Skilled Birth Attendant (SBA), Life Saving Anesthesia Skills (LSAS), Medical Termination of Pregnancy (MTP)/ Manual Vacuum Aspiration (MVA), Minilap, Advanced Laparoscopy Training and Reproductive Tract Infection (RTI)/ Sexually Transmitted Infections (STI) Management. The training duration of these programs range from one week to 18 weeks. These training programs are majorly conducted for Medical Officers (MOs) and Specialists.
Similarly, 18 training programs are conducted in child health under RCH namely Integrated Management of Neonatal and Childhood Illnesses (IMNCI), Facility Based IMNCI (F-IMNCI), Facility Based Newborn Care (FBNBC), Navjaat Shishu Suraksha Karyakram (NSSK), Immunization, Sick Newborn Care Units (SNCU) and School Health.

Urban health

We undertook a curriculum scan of the existing health professional courses in India and urban health-specific independent training programs being offered in India. The findings related specifically to public health programs have been presented in table 17:

Table 17: Scope and content of urban health teaching and training in public health courses in India

<table>
<thead>
<tr>
<th>Program</th>
<th>Scope and content of urban health in curriculum content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. in Community Medicine</td>
<td>Doctoral level programs being offered in Community Medicine and other public health related disciplines offers ‘Urban Health’ as area of research. Doctoral program in the health sector have a multidisciplinary focus and is open to postgraduates from medicine, dentistry, nursing, AYUSH, public health, health economics and allied sciences.</td>
</tr>
<tr>
<td>Doctor of Medicine (MD)</td>
<td>Urban health is a crosscutting domain and is taught as a part of various sections of MD Community Medicine curriculum. ‘Urban Health’ is taught by covering common health problems (medical, social, environmental, economic, and psychological) of urban slum dwellers. Organization of health services for slum dwellers in urban areas is also a main constituent of urban health. Additionally, policy on urban health and health issues of migrant populations are also covered.</td>
</tr>
<tr>
<td>Diploma in Public Health (DPH)</td>
<td>‘Health Administration’ deals with community development component in both urban and rural areas. Details of implementation and evaluation of National Health Programs are also covered in DPH program. The training methodology for DPH includes ‘Community Health Survey’ which gives hands-on working experience to the students in rural as well as urban communities. Some aspects of urban health are covered as a part of environmental health, sociology, health care delivery system, etc.</td>
</tr>
<tr>
<td>Program</td>
<td>Scope and content and of urban health in curriculum content</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Masters in Public Health (MPH)</td>
<td>Urban health is either taught as a module or as a part of a related paper in MPH Programs. Additionally, topics like: Environmental and Occupational Health, Industrial Health, Urban Health, Urbanization etc. cover urban health areas. The MPH programs also offer field-visits to urban and rural areas. Hands-on working experience is also provided to the students of working in rural as well as urban communities.(81) However, the content of MPH programs is quite variable from one institution to another institution in India and so the emphasis on urban health related issues.</td>
</tr>
<tr>
<td>Master in Business Administration in Health &amp; Hospital Management (MBA-HHM)</td>
<td>The MBA-HHM program covers urban health as a part of 'Health Care Delivery System and Policy in India'.</td>
</tr>
<tr>
<td>Master of Health Administration (MHA)</td>
<td>The MHA program covers urban health as a module of two credits. However, credits and contents are variable from one program to another one.</td>
</tr>
<tr>
<td>Post Graduate Diploma in Public Health Management (PGDPHM)</td>
<td>The PGDPHM program teaches ‘Urban Health’ in its curriculum. It deals urban health as a cross-cutting domain and covers issues related to urban health in various modules.</td>
</tr>
</tbody>
</table>
Findings from IDIs and FGDs: Supply

As per some respondents interviewed during the study, it was evident that in India public health education is mainly imparted through medical colleges.

“As earlier public health education was main domain of community medicine people, but many people have opened MPH institutes, so in my knowledge mainly the medical colleges are the main institute of public health, means where the cadre can be trained” (Senior Policy Maker, Govt. of Odisha)

Of late since the launch of National Health Mission (NHM) in the year 2006, new colleges have come up been established and have started offering public health programs. The lack of uniformity in course curriculum and teaching methodology was clearly spelt out in the interviews. As per the respondents each public health institution offers a different program, with a different methodology and curriculum. It was mentioned that few programs lacked practical field experience i.e. exposure of working within the community at grassroots level.

“If you ask me why do they talk about clinical aspect of public health…because drafting a policy on paper sitting in air-conditioned rooms is different and doing practically along with community movement which is for a country like India with 125 crore population is different.” (Senior Medical Advisor - in a leading pharmaceutical company)

Some names of public health institutions that came out as response as most famous public health institutions has been mentioned in the world cloud (figure 8). The word cloud summarizes the top responses by depicting the most frequent names in larger, darker type within the cloud as compared to other less frequent responses.
Figure 8: Word cloud created from first responses received from respondents when asked about most famous public health institutions in India
Supply estimation

There are 1128 seats being offered in public health related courses offered to medical graduates through medical colleges & NBE and 14,447 seats are offered by institutions (other than medical colleges, including Schools of Public Health) offering public health programs. Thus, considering the differential seat occupancy for the year 2017, 2022 and 2026 it was observed that following number of PHPs are produced annually in the three scenarios (Table 18).
<table>
<thead>
<tr>
<th>Year</th>
<th>Scenarios - seat occupancy</th>
<th>Medical Colleges offering public health programs</th>
<th>Institutions (other than medical colleges, including Schools of Public Health) offering public health programs</th>
<th>Total PHPs produced annually</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seats offered</td>
<td>Seats offered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>Best Guess – Low</td>
<td>1005</td>
<td>8129</td>
<td>9134</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>1124</td>
<td>9096</td>
<td>10220</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>1229</td>
<td>9942</td>
<td>11171</td>
</tr>
<tr>
<td>2022*</td>
<td>Best Guess – Low</td>
<td>1563</td>
<td>12645</td>
<td>14208</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>1749</td>
<td>14149</td>
<td>15898</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>1911</td>
<td>15466</td>
<td>17377</td>
</tr>
<tr>
<td>2026*</td>
<td>Best Guess – Low</td>
<td>2009</td>
<td>16259</td>
<td>18268</td>
</tr>
<tr>
<td></td>
<td>Optimistic – Moderate</td>
<td>2248</td>
<td>18193</td>
<td>20441</td>
</tr>
<tr>
<td></td>
<td>Aspirational – High</td>
<td>2458</td>
<td>19884</td>
<td>22342</td>
</tr>
</tbody>
</table>

*Forecasted estimates
The projected supply estimates (from 2017 to 2026) in these three scenarios have been presented in figure 9.

![Figure 9: Public Health Professionals PHPs produced annually in Best Guess, Optimistic and Aspirational scenarios in India (2017 to 2026)](image)

The forecasted figures for the year 2026 show around 2,248 seats from various public health related courses offered to medical graduates through medical colleges & NBE; and around 18,192 seats from institutions (other than medical colleges) offering public health programs. Approximately 89 per cent of the total PHPs will be supplied through institutions (other than medical colleges, including Schools of Public Health) offering public health programs. This has been illustrated in figure 10.
Figure 10: Distribution of PHPs supplied by Medical Colleges vs Institutions (other than medical colleges, including Schools of Public Health) offering public health programs
4.2 Estimating the current need and demand of public health professionals in India

4.2.1 Need for PHPs in India
In the absence of a council or registry of public health professionals, ‘service target approach’ was adopted for estimation of public health professionals currently needed in India. Standards were created based on assumptions made by interacting with public health experts and review of literature.

Biostatistics
As per the norms suggested by Medical Council of India (MCI) there is a need for a biostatistician in every medical college’s Department of Preventive and Social Medicine/Community Medicine. Hence with 474 medical colleges, this amounts to a demand for 474 biostatisticians. Additionally, to serve the 27 long-term programs as faculty, 96 faculty members trained in epidemiology are required with the faculty: student ratio of 1:1 for doctoral and 1:4 for masters’ programs. Also, around 229 faculty members are required to teach biostatistics in 229 institutes offering health management, hospital administration, public health and occupational health programs.

Additionally, around 1000 professionals are needed in national research and training institutes (such as NIHFW, NHSRC, SHSRCs, etc.). Approximately 1500 biostatistics trained professionals are needed in academic & research organizations. Similarly, close about 1500 biostatisticians are needed for corporate sector and international organizations. Close about 1080 professionals are needed to work in Contract Research Organization (CRO) as Clinical Researcher. To summarize the net demand for biostatisticians in the country, it sums up to be around 5879 professionals.

Demography
To estimate the demand for demographers a similar approach was adopted. It was estimated that to serve the 53 long-term programs as faculty, 188 faculty members trained in demography/population studies are required with the faculty: student ratio of 1:1 for doctoral and 1:4 for masters’ programs. Additionally, if we consider that around 1500 demographers are needed in leading national research and training institutes (such as NIHFW, NHSRC, SHSRCs, etc.) for various programs/research projects. Nowadays, the corporate sector is as well coming up with research projects involving demographers, thus around 500 professionals will also be needed for the same. Close about 1000 professionals will be needed for work in international organizations.
Similarly, about 500 demographers may work as Market Risk Analyst, Economist, Public Affairs Officer etc. in the industry. Finally, 1000 professionals would be needed to work as Research Scientist (for projects funded by Union Ministry of Health, State governments, World Bank, United Nations Population Fund, World Health Organization, International Labour Organization, and other government and non-government organizations). Thus, the overall demand is estimated to be around 4688 for demographers in the country.

Occupational Health
To estimate the requirement of professionals trained in occupational health strategy was adopted on the lines of a similar study conducted during 2013. This study was based on estimates of 2010. As on March 31, 2011, it was estimated that total workforce in the organized sector in India is 29.00 million. As per DGFASLI estimates of 2013, there are 2,92,310 working registered industrial factories in India and about 14.04 million workers. As per 2013 estimates, these factories have employed 10,579 FMOs and 2,801 SOs (DGFASLI, 2013). Thus additional 11,268 FMOs and 2,984 SOs will be required for the remaining 14.95 million population in the organized sector with the current ratio. Thus for 29.00 million of total workforce engaged in organized sector, we would require a total of 21,847 FMOs and 5,785 SOs (Table 19).

Table 19: Need estimation for professionals trained in occupational health

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Existing scenario</th>
<th>Estimated based on current ratio</th>
<th>Estimated based on existing norms of Indian Factories Act²</th>
<th>Estimated based on existing norms of Indian Factories Act²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total working population in organized sector</td>
<td>29,000,000</td>
<td>14,957,590</td>
<td>29,000,000</td>
<td>29,000,000</td>
</tr>
<tr>
<td>Existing number of factory medical officers</td>
<td>10579</td>
<td>21,847</td>
<td>58000</td>
<td>145000</td>
</tr>
<tr>
<td>Parameters</td>
<td>Existing scenario</td>
<td>Estimated based on current ratio</td>
<td>Estimated based on existing norms of Indian Factories Act&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Estimated based on existing norms of Indian Factories Act&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Existing number of occupational health nurses/dresser-cum-compounders</td>
<td>No information available</td>
<td>21,847</td>
<td>58000</td>
<td>145000</td>
</tr>
<tr>
<td>Existing number of safety officers</td>
<td>2801</td>
<td>5,785</td>
<td>29000</td>
<td>29000</td>
</tr>
</tbody>
</table>

<sup>a</sup>Assumption: Each of the working factories are nonhazardous in nature and thus require one occupational health physician for each 500 workers and one safety officer for each 1000 workers.

<sup>b</sup>Assumption: Each of the working factories are hazardous in nature and thus require one occupational health physician for each 200 workers and one safety officer for each 1000 workers.

Considering the existing norms of Indian Factories Act (Factories Act, 2008) for hazardous units and assuming each of the working factories employs more than 200 workers, 1,45,000 full-time FMOs, similar number of occupational health nurses and dresser-cum-compounders are required for the organized sector, thereby indicating a huge deficit. Considering the present norms related to the employment of SOs, i.e. one SO for every 1000 working population, a total of 29,000 SOs would be required against presently employed 2,801 SOs in operational factories in India. Further if all these units are nonhazardous and following the norms of Indian Factories Act of one occupational health physician, occupational health nurse and dresser-cum-compounder each for 500 workers and one SO for each 1000 workers, the estimated numbers are 58,000 each for occupational health physician, occupational health nurse and dresser cum-compounder and 29,000 for SOs.

Epidemiology
As per stated in a study undertaken in 2015, Medical Council of India’s (MCI’s) norms suggest that in every medical college’s Department of Preventive and Social Medicine/Community Medicine must have one epidemiologist.(30) Hence with 474 medical colleges, this amounts to a
demand for 474 epidemiologists. Additionally, to serve the 20 long-term programs and three long-term FETPs (30) as faculty, 71 faculty members trained in epidemiology are required. Also, around 262 faculty members are required to teach epidemiology in 262 institutes offering health management, hospital administration, public health and occupational health programs additionally as they include epidemiology as a part of their curricula.(30)

Additionally, under IDSP one epidemiologist is needed at the state headquarters, amounting to 36 consultants and one epidemiologist for each district of the country which amounts to 640. Apart from this, trained epidemiologists are needed for ICMR’s 23 permanent institutes, national health programs, international organizations, bilateral organizations and NGOs in the health sector. This number was accounted to be approximately around 1950. Thus, taking a 10 per cent increase into account this consolidated demand becomes around 2100. To summarize the net demand for epidemiologists in the country sums up to be around 3645 trained professionals.

Public health engineering/ environmental engineering
To serve the 42 long-term programs, around 168 faculty members trained in public health engineering/ environmental engineering will be needed with the faculty:student ratio of 1:4 for masters’ programs. The Ministry of Urban Development, being the nodal Ministry formulates the policies and strategies pertaining to various aspects of Urban Development including Water Supply, Sanitation and Municipal Solid Waste Management in the country.(145) Thus, under the technical wing of MoUD the Central Public Health and Environmental Engineering Organization (CPHEEO) has been constituted. Thus, under this we estimate that 15-20 public health engineers are needed in central and state departments of public health and environmental engineering. Thus around 555 professionals will be needed for the same. Additionally, for each block of the country one public health engineer will be needed which accounts for 5,988 more public health engineers. Approximately 500 professionals will be needed to work in international organizations and 1,500 for Academic/research organizations. Thus, there is an estimated need for around 8,711 public health engineers in the country.

Entomology
As stated in the demand–supply analysis carried out for capacity-building measures in medical entomology in the year 2015, each state surveillance team and district would need one medical
entomologist at state and district level. This total account to be approximately 676 consultants. Apart from this, trained medical entomologists are needed in training institutions. Entomologists are also needed to work in vector-borne disease programs and malaria programs. Thus, at least 998 specialists would be needed for working in medical entomology.

Public health laboratory
To upgrade laboratories at all levels, from peripheral to national level, laboratory strengthening under IDSP was undertaken. Under this a five level laboratory network was planned which included: Peripheral Laboratories and Microscopic Centers (L1 labs); District Public Health Laboratories (L2 Labs); Disease Specific State Laboratory (L3 Labs); Regional Laboratories (L4 Labs) and National Reference Laboratories (L5 Labs). states suggested that many Primary/Community health centre (Level 1) laboratories had already been renovated under Revised National TB control and Enhanced Malaria Control projects. Public health laboratory technicians largely constitute the workforce of the five-level laboratory network. As per a recent study conducted in the year 2014 by Pandey et. al. - by 2017, a total of 300 District Public Health Labs (including the initial 50 labs) were to be made functional for diagnosis of common epidemic prone diseases. The study stated that for successful functioning of these labs, it is crucial that qualified microbiologists manage these district laboratories. As per Rural Health Statistics there was an overall requirement of 30,864 laboratory statisticians at PHCs and CHCs. Additionally, as per IPHS norms, each district hospital should have at least one laboratory technician (146) which estimates around 773. If we include the number of laboratory technicians needed for private hospitals @1 per hospital, then this numbers accounts to be 11,810. Thus, the total estimated need for trained public health laboratory technicians is around 44,087.

Health management
Deriving findings from a study undertaken in 2010 by Sharma et. al. a demand analysis for the health management professionals was carried out. It was estimated that around 36 states of India (29 states + 7 union territories (UTs)) and 640 districts – a program manager will be required at each level as State Program Manager (SPM) and District Program Manager (DPM) respectively. Similarly, around 5,988 trained health management professionals will be required as Block Program Managers at block level across India. Additionally, approximately 1,000 consultants would be required in national institutes/ research institutes/ institutes of national importance like National Institute of Health & Family Welfare (NIHFW), National Health System Resource Centre
(NHSRC), State Health System Resource Centre (SHSRC) etc. (KS paper) Around 200 consultants/specialists would be employed in each state at the state level across the country. Approximately 440 trained health managers would be employed across 88 large NGOs in the country. (25) Around 500 professionals would be additionally needed across international organizations, 1,500 trained professionals would be necessary in academic/research organizations and 1,000 professionals would be needed to work in corporate sector. (25) Thus, an estimated 11,304 professionals would be required to function in this capacity across the health sector.

Hospital management
As per a study carried out by Sharma et. al in 2011, it was estimated that hospital management industry would need around 21,750 professionals to meet the demand. The requirement was estimated for various components of the health and hospital industry including: 1,500 medical college hospitals, 1,300 district hospitals (DH), 8,000 community health centers (CHC), rural hospitals at blocks, 1,000 consultants working at MoHFW, Directorates & Public Health Depts., resource centers at national & state level, 1,500 hospitals run by municipal corporations & municipal councils, 150 national & state run hospitals, 400 Armed Forces Medical Services, 500 in other PSUs, 300 in health insurance industry, 500 pharmaceutical industry, 500 Health & Hospital Information & Technology, 500 in Medical Tourism, 300 industry - run hospitals, 3500 in major corporate hospitals, 500 in Individual & trust run hospitals, 1000 in Research, training & education - organizations/ institutions, 300 in Hospital Management consultancy firms. It was stated that the industry is annually growing at 10-12 per cent. Thus, it was forecasted that requirement of these professionals would increase proportionately. Hence the requirement of professionals trained in hospital management is 36,975 for the year 2017.

Health economics and financing
Approach for ‘health economics and financing’ domain was adopted by a study undertaken in the year 2013 by Hasan et. al. (16) It was suggested that at least one health economist is needed at each district, each state, as well as the national level. This accounts to a total 677 (1 national level + 36 states/ UTs + 640 district level). Additionally, around 350 health economists will be needed for various national health programs at the state and national levels. (16) Similarly, nearly 640 health economics trained professionals are needed by various non-governmental organizations, multi-lateral and bi-lateral organizations. (16) It was stated also stated that around 800 trained
professionals in health economics and financing will be needed for work in various large, medium and small Indian pharmaceutical companies.(16) However, accounting growth by an annual growth rate of five per cent (147) this requirement estimates to be 960. Similarly, the requirement of research-based international and large pharmaceutical companies increases from 100 to 120 professionals. Similarly accounting an annual growth in the health insurance sector at 17 per cent (148) since last two years, the requirement becomes 134.

Thus, the overall requirement for health professionals with health economics & financing background accounts to be around 2,881.

Monitoring and evaluation
Monitoring and evaluation specialists are mainly needed by Ministry of Health & Family Welfare at national & state levels to monitor and evaluate the progress and implementation of national health programs in the country. This total including the M&E officers employed with national institutes (NIHFW, SIHFW, NHSRC etc.) roughly accounts for 500 professionals. Additionally, various non-governmental organizations, multi-lateral and bi-lateral organizations to monitor the progress of various national health programs and additionally need 500 professionals for the same. Thus, overall need for M&E experts is of around 1,000 professionals.

Public health nutrition
To serve the 16 long-term programs as faculty, 61 faculty members trained in public health nutrition are required with the faculty: student ratio of 1:1 for doctoral and 1:4 for masters’ programs. As per IPHS norms, each district hospital should have at least one dietician (146) which estimates around 773. If we include the number of dieticians required for each private hospital @1 per hospital, then this numbers accounts to be 11,810. Additionally, country’s medical college hospitals to require 474 and CHCs require around 5,510 dieticians.

Under National Rural Health Mission (NRHM), the health department introduced District Early Intervention Centre (DEIC) with an objective to ensure better medical care to children, especially those who are enrolled in government schools.(149) Currently in country there are 136 such DEIC (92-construction, 44-under construction; 2015).(150) Additionally, 875 public health nutritionists are estimated to be required for Nutrition Rehabilitation Centre (NRC). NRC is a health facility where children with Severe Acute Malnutrition (SAM) are admitted and managed.(151)
Additionally for various teaching, training and research activities around 1,000 public health nutritionists are needed for various national and state level institutes (such as NIHFW, SIHFWs, NHSRC, SHRCs etc.) Similarly, around 1,500 public health nutritionists are needed for research, advocacy and monitoring purposes by various bilateral agencies, INGOs, NGOs etc. Thus, in the country there is an overall need for 22,139 trained public health nutritionists.

Veterinary public health
Like other domains, to serve the 84 long-term programs as faculty, approximately 288 faculty members trained in veterinary public health are required. Considering the availability of one public health veterinary at Tehsil/Mandal/Block Veterinary Centres (5,988) and District Veterinary Centres (640) – the total need for public health veterinary becomes 6,628. Additionally, to work as veterinary consultants in areas such as diagnosis, surveillance, epidemiology, control, prevention and elimination of zoonoses and of diseases etc. there is a need for 1,500 trained professionals in academic/research organizations and 500 in bilateral organizations, INGOs, NGOs etc. Thus, the total need is estimated to be around 8,916 trained veterinary public health professionals in the country.

Public health law
The two domains of Public Health Law and Public Health Ethics go hand-in-hand as public health ethics thrust legal aspects of public health and vice versa. In public health law, to serve the seven long-term programs as faculty, 28 faculty members trained in public health law are required. Additionally, around 500 trained public health law professionals would be needed by government bodies, academic & research organizations and another 500 by bilateral agencies including international organizations/ NGOs etc. Such organizations largely depend on public health law experts for formulation, advocacy and assessment of public health legislations. For public health law we estimated the requirement to be around 1028 professionals.

Public health ethics
Similarly, in public health ethics, to serve the eight long-term programs as faculty, 32 faculty members trained in public health law are required. Approximately, 500 trained public health law professionals would be needed by government bodies, academic & research organizations and another 500 by bilateral agencies including international organizations/ NGOs etc. Such organizations depend on public health ethics experts for areas like bioethics, ethics in
pharmaceutical and drug management and human research ethics. For public health ethics the need was estimated to be around 1032 professionals.

Urban health
India’s urban population will be doubled from 377 million in 2011 to 915 million in 2050 thus, capacity building in urban health and related issues is critical.(90)

Findings from IDIs and FGDs: Need

During the IDIs and FGDs, the need for public health professionals was echoed at all levels from policy makers to students of public health programs. It was observed that public health is an important core area pertaining to the health system. It is evident that doctors trained in public health are not sufficiently available in the country thus the government needs to focus towards bringing together all the stakeholders; the state health departments, education department, central government services, health facilities, armed forces, municipal corporation and other who are involved in the delivery of public health in the country. From ensuring availability of safe drinking water to regulation of immunization services in the country, there is a need for trained public health workforce.

“Yeah definitely! Because in government service as far as public health is... there is need and at the same time in states like Odisha, there is high crunch of public health professionals....so definitely there is a need for focus on public health experts.” (Senior Policy Maker, Govt. of Odisha)

“Definitely there is a need but there is currently a need-demand paradox in the country! So, need is definitely there but there are lot of problems.” (Professor, Community Medicine and Public Health, Maharashtra)

“there is a need but are we able to build competencies and skills that we need to understand. So, coming back to your question, is there a need...the answer is yes! There is a huge need.” (Scientist, Environmental Health - Madhya Pradesh)

“Yes! there is a need but there is demand supply paradox. Because even if there is a need, there is no enough job opportunities available especially in the govt sector. Because these public health
jobs are skewed towards med professional...” (Director in a MNC providing information, services and technology for the healthcare industry, Delhi-NCR)

“Yeah, the need is increasing! Higher level posts are for MD/clinicians – but these people are more interested in clinical practice or working on the projects. Public health professionals like MPH that is a cadre of specialty, they can take better care of these projects, MPH/ MD also.” (Student of public health program, Maharashtra)

“With only clinical focus, you can’t help people. Public health is a profession that can help you lead the way.” (Student of public health program, Gujarat)

“Yes, there is more need compared to other countries which are more developed rather...they are more concentrating on public health and doing well. But in our state, we have more at tertiary level, than secondary, than primary level.” (Public Health Professionals FGD participant, Karnataka)

As per the respondents there is a need for trained public health workforce in epidemiology, statistics, health economics, healthcare financing, research and management.

“As per as public health department is concerned we require epidemiologists.” (Country Coordinator in a research organization, Maharashtra)

“I would say program managers basically because they include monitoring and evaluation specialists because they are more research oriented.” (Senior Technical Consultant in TB Program, Tamil Nadu)

“I think public health managers are required the most. Because there are lots of public health programs running so there is a need to integrate/ manage them effectively in an efficient manner and optimum utilization of them for the patients.” (Senior Consultant, Public and Private Healthcare Consulting in an MNC, Delhi-NCR)

“Epidemiologists, statistician...there is scarcity of both.” (Head of Department, Community Medicine in a Government Medical College, Bihar)

“Program management coordinator, health finance managers are needed in the country.” (Student of public health program, Gujarat)
To increase the need the creation of more public health job opportunity along with the public health cadre was predominantly suggested. Additionally, it was proposed during some of the interviews that public health today in India needs to be governed by a separate Ministry of Public Health instead of Ministry of Health & Family Welfare.

“community medicine ka requirement hai...but public health professionals ka jo cadre hai usko upliftment nahi milta hai...growth opportunity is restricted...log aana nahi chahate...” ~ “There is a requirement for community medicine... but public health professionals’ cadre does not get upliftment... growth opportunity is restricted...people doesn’t want to join.” (Public Health Professional, Maharashtra)

“yes obviously! A public health government department is needed...India needs a public health ministry apart from MoHFW.” (Student of public health program, Gujarat)

“India needs a ministry of public health...as the present existing MoHFW is focused on too many things that it loses focus.” (Member - Health Task Force, Government of Karnataka, Karnataka)

Need estimation
An overall normative need of around 1,80,916 PHPs was estimated for 2017, based on the number of positions (domain specific) available for PHPs in India. The domain wise normative need has
been mentioned in Table 20. In this table actual number for 2017 has been updated by authors using methodology adopted by authors(16-30) in previous studies for these domains.

Table 20: Domain wise normative need (2017- as per Service Target Approach)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Need*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biostatistics(28)</td>
<td>5879</td>
</tr>
<tr>
<td>Demography(29)</td>
<td>4688</td>
</tr>
<tr>
<td>Occupational and environmental health(27)</td>
<td>27632</td>
</tr>
<tr>
<td>Epidemiology(30)</td>
<td>3646</td>
</tr>
<tr>
<td>Public health engineering/ environmental engineering(18)</td>
<td>8711</td>
</tr>
<tr>
<td>Entomology(22)</td>
<td>998</td>
</tr>
<tr>
<td>Public health laboratory(23)</td>
<td>44087</td>
</tr>
<tr>
<td>Health administration/ management(25)</td>
<td>11304</td>
</tr>
<tr>
<td>Hospital administration/ management(26)</td>
<td>36975</td>
</tr>
<tr>
<td>Health economics, health care financing &amp; health policy(16)</td>
<td>2881</td>
</tr>
<tr>
<td>Monitoring and evaluation(21)</td>
<td>1000</td>
</tr>
<tr>
<td>Public health nutrition(20)</td>
<td>22139</td>
</tr>
<tr>
<td>Veterinary public health(19)</td>
<td>8916</td>
</tr>
<tr>
<td>Public health law(17)</td>
<td>1028</td>
</tr>
<tr>
<td>Public health ethics(24)</td>
<td>1032</td>
</tr>
<tr>
<td>Total need</td>
<td>180916</td>
</tr>
</tbody>
</table>

*Updated numbers using methodology undertaken by authors in previous studies for each domain.

Need for PHPs working in maternal & child health and health promotion were not accounted for due to the cross-cutting nature of these domains.

Need for Public Health Cadre: We assumed the following additional positions with the setting up of the public health cadre - nine at state, 14 at district and four at each block level.(101) At the country level we would need approximately 33,000 PHPs additionally in 2026 (i.e. 9x36 states + 14x640 districts + 4x5988 blocks). We assumed that - 1/3rd of the states will implement PH cadre by 2020, another 1/3rd by 2023 and all states by 2026. Additional need for PHPs for Public Health Cadre have been provided in table 21.
Table 21: Additional need for PHPs for Public Health Cadre (2020 to 2026)

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional need for PHPs for Public Health Cadre</td>
<td>11079</td>
<td>14772</td>
<td>18464</td>
<td>22157</td>
<td>25850</td>
<td>29543</td>
<td>33236</td>
</tr>
</tbody>
</table>

4.2.2 Demand for PHPs in India

*Findings from literature review*

The data regarding the demand of PHPs in India is not available. As PHPs are also constituent of the health workforce, the demand data available for health professionals was reviewed. As stated in a recent study, by the year 2030, global demand for health workers may rise upto 80 million workers, which would be double the current stock of health workers (2013). (11) While the supply of health workers is expected to reach 65 million over the same period, which may estimate into a worldwide net shortage of 15 million health workers. (11) As per this study by Liu et. al., efforts to scale-up health services to achieve UHC and health development goals are confronted by acute shortages and inequitable distribution of skilled health workers in many low- and middle-income countries.(11) This study’s demand model projection utilizes per capita indicators of gross domestic product (GDP), based on purchasing power parity, household out-of-pocket (OOP) health expenditures, as well as the size of the population aged 65 or over as the main predictors. Additional structural factors affecting the labour market, such as attrition, training capacity, labour regulations, and migration were excluded as these data are largely unavailable across countries or over time. (11) This HRH shortage in turn translates into a constraint towards delivering essential health services.(11) Thus, knowing the importance of the public health workforce in the Indian public health system, and criticality of time and resources invested for educating and developing skilled public health workforce, it becomes crucial to understand the factors that affect the size of the future public health workforce and plan appropriately.
India is a group of states with diverse socioeconomic status, governance, health systems and health situations. India’s health workforce is a combination of both registered, formal health-care providers and informal medical practitioners.\(^{(70)}\)

As per work undertaken in the past, India’s health sector is facing a need and demand paradox.\(^{(152)}\) There are poorly defined public health career opportunities for public health graduates. In the public sector, most of the public health based managerial and leadership positions are occupied by physicians/doctors with additional qualifications in either public health or community medicine or preventive and social medicine.\(^{(152)}\) In the absence of systematic efforts for creation of a job market, the “need” is translated into “demand” for public health professionals.\(^{(153)}\) Thus, a framework for career pathways for the public health professional is needed to be designed and established.

Recently the National Health Policy 2017 has proposed creation of a public health management cadre in all states, with a qualification in public health or related discipline as an entry criterion.\(^{(154)}\) The policy also advocates an appropriate career structure and recruitment policy to attract young and talented multidisciplinary professionals from - “sociology, economics, anthropology, nursing, hospital management, communications, etc. who have since undergone public health management training”.\(^{(154)}\) As stated by Rao S K in 2004, developing a public health cadre will also advance the promotional and career opportunities of existing staff and cadre.\(^{(155)}\) National Commission on Macroeconomics and Health has identified that failure to develop a public health cadre and widening the eligibility criteria to include clinicians, without making public health training a mandatory requirement for working in posts that need public health skills, have adversely affected the implementation of public health programs.\(^{(155)}\)

Additionally, there is need to revise the salary brackets of public health professionals in India. PHPs are expected to work in tough terrains on poor pay packages by most of the organizations working in the field of public health.\(^{(156)}\) This trend must be changed soon to generate demand for these public health programs and ensuring higher seat occupancy at SPHs. The government should ensure good quality of life for PHPs entering into the public system in order to meet the HRH shortage.\(^{(156)}\)
Findings from IDIs and FGDs: Demand

Respondents said in unison that there existed a demand, but it was mostly restricted to the private, NGO and INGO sectors as compared to the public sector. Also, there exists an immense shortage in national health programs for public health professionals.

“Presently if we take IDSP program in India around 640 districts are there. Out of 640 positions in 640 districts – hardly some 300 districts have epidemiologists, and these are not trained epidemiologists but AYUSH doctors that are being forced to do the job…” (Senior Public Health Professional, Tamil Nadu)

“Demand is mostly from development organizations and research organizations.” (Associate Professor, Department of Community Medicine, Karnataka)

“In private sector also, day by day demand is increasing, particularly there are organizations dealing with international health issues and NGOs – so they need public health specialists, including MPH of course.” (Country Coordinator in a research organization), Maharashtra

“Particularly in the public-sector demand is slow. Demand from public health sector is less compared to your developed sector, research institute. They have higher demand, compared to public sector.” (Director in Regional Medical Research Centre, Odisha)

Due to low demand, particularly in the public sector, the pay scales/ salary packages being offered to the public health graduates are also low in the public sector. Thus, in the absence of monetary incentives the young aspirants avoid studying public health which in turn contributes to further loss in demand for public health as a profession.

“Demand is not so much as of now… our seniors have passed out of the course (MPH)...salary offered was within 50,000 (per month) …it’s not a super career opportunity... jobs are not decently paid.” (Student of public health program, Gujarat)

It was widely suggested that the Government of India should create Public Health Cadre to increase demand for public health as a profession in the country.
“The government should be ready; the government should create some cadre or positions in their existing scheme of employees. There is a demand, but government is not ready to recognize a demand.” (Senior Technical Consultant in TB Program, Tamil Nadu)

“Demand in my view, we don’t have any demand – policy makers should make some laws…those who are working in public health sector or into research.” (Student of public health program, Assam)

4.3 Estimating current gap between supply and demand of PHPs

The annual supply was estimated from public health professionals graduating from the institutions using data from two sources - Medical Colleges and institutions (other than medical colleges, including Schools of Public Health) offering public health programs. The need estimates were calculated using “service target approach” and “benchmark analysis”. Demand estimates as mentioned in the previous section were not quantitatively available. Thus, we calculated the gap between need and supply of PHPs in India.

4.3.1 Gap estimation

In the ‘moderate seat occupancy (@68%) - optimistic scenario’, in the year 2017 there is a gap of around 26,298 PHPs however if PHPs are produced annually at a similar rate of 11 PHPs per 100,000 population and additionally if the Public Health Cadre is instituted assuming - 1/3rd of the states will implement Public Health Cadre by 2020, another 1/3rd by 2023 and all states by 2026 – then in the year 2026 this number remains up to 27,289 PHPs.

Similarly, in the ‘low seat occupancy (@60%) – best guess scenario’ in the year 2017 there is a gap of around 27,384 PHPs however this increases to be 40,243 PHPs. In ‘high seat occupancy (@75%) – aspirational scenario’ the gap of 25,347 PHPs reduces to around 15,954 PHPs in the year 2026. Figure 12 illustrates the three scenarios.
4.3.2 PHPs per 100,000 population
Assuming in India today, the number of PHPs in health workforce is 1,53,778 (i.e. 85% of total 1,80,916 positions are occupied). Thus, if we calculate the number of public health professionals (PHPs) per one lakh population based on the current population of India i.e. 1.33 Billion (World Bank, Oct 2017) (135) then it comes out to be 11 PHPs per 1,00,000 population. The normative need for PHPs was calculated on the basis of benchmark analysis in two scenarios of PHPs: population ratio. One on the basis of ASPH’s 220:100,000(31) and second on Brazil’s 100:100,000 PHPs: population ratio.(32) As per this analysis, currently in the year 2017 there is a demand of 13,39,180 PHPs as per Brazil’s 100:100,000 ratio and 29,46,196 as per USA’s 220:100 000 ratio. This would further grow up to 14,64,726 and 32,22,397 respectively by the year 2026.

Figure 12: Gap in the number of PHPs calculated against a need of 11 PHPs per 100 000 population and introduction of Public Health Cadre
4.4 Mapping of jobs for public health professionals in both public and private sector in India
Career opportunities for public health professionals were mapped through various primary and
secondary sources. Details regarding various public health jobs advertised in recruitment portals
like devnetjobsindia.org, naukri.com, indeed.com, monsterjobs.com etc. were compiled for
analysis. These 45 jobs were analyzed based on factors such as: job position/designation, domain,
organization offering the job, sector (Public/Private/NGO/INGO/Others), educational
qualification required, minimum job experience required (in years), maximum job experience
required (in years), location of posting, minimum remuneration (CTC offered in lakhs per annum),
maximum remuneration (CTC offered in lakhs per annum), roles and responsibilities for the job
role and competencies desired for the role. These jobs then later were mapped on the basis of
domain, experience and CTC offered. The same has been given in figure 13. These job positions
are arranged on the basis of their functional areas/ public health domains. Average remuneration
(CTC offered in lakhs per annum) has been represented with the relative size of the circles. The
average experience required for these job positions have been mentioned inside the circles.
Additionally, the titles for these job positions have been mentioned over the circles.
Figure 13: Mapping career opportunities for public health professionals (domain/sector/experience/average salary wise)

*Average remuneration (CTC offered in lakhs per annum) has been represented with the relative size of the circles*
The nature of jobs for public health professionals in India includes teaching and training, research, policy and programs & practice. These jobs are offered in public, private, NGO and INGO sector. In the public sector, PHPs work in areas such as: health (at centre, state, district, block and village levels), women and child welfare, defense, railways, PSUs, environment, food and agriculture, urban development, rural development, road safety and transport, coal, etc. In the private sector, role of PHPs expands to health care (hospitals/ health facilities), corporate sector, industry, pharmaceuticals, medical tourism, wellness initiatives, quality management, CROs and SMOs, information technology, insurance, media and journalism, Corporate Social Responsibilities initiatives, etc. Additionally, PHPs are hired to work in NGOs, INGOs, international organizations, foundations functioning in the development sector. PHPs in India contribute to following subject areas of public health: epidemiology, bio-statistics and data management, demography, health management, hospital management, environmental health, occupational health, social and behavioural sciences, health economics, nutrition, veterinary public health, entomology, public health engineering, health informatics, health technology assessment, health promotion, health communication, health journalism, public health laws, disease specific expertise, public health laboratory, health policy, ethics, monitoring and evaluation, international and global health, oral health, family health etc. Thus, public health can be considered a discovered discipline as it is not a person’s initial profession, but a choice embraced later in one’s career.

Figure 14: Designations of public health professionals in India
Findings from literature review

Similar to our research work, recently a study was undertaken by Dahal et. al. (2018)(157) the authors mapped around 427 jobs advertised in newspapers, organizations’ websites and recruitment portals during the year 2012-2015. These jobs were analyzed under various domains of public health sector mainly on the basis of their roles, titles, qualification, location, job discipline and experience required. The study findings highlighted that a wide range of job titles were available for PHPs including consultants, program officers, research officers, managers, medical officers and block coordinators. (157) These positions were mostly sought based on their work profile i.e. name of the project and department. Majority of the jobs were advertised for roles in Delhi which can be attributed to the fact that national organizations/ head offices of most organizations are based in Delhi. All the advertised jobs had details of compensation packages and experience required for the job. As per the study, work experience of 3-5 years with a master’s degree was the most desirable experience-study mix for public health jobs in India. (157) Jobs that preferred MPhil and/or Ph.D. candidates offered higher remuneration for these candidates as compared to simple graduates and post-graduates in public health. Additionally, it was observed that majority of the public health jobs were available in the work domain of: management of public health services/program/project which was followed by research and monitoring & evaluation. Public health postgraduates (from MPH and PG in Public Health programs) and social sciences were the most sought after candidates for the advertised public health jobs. (157) Among the Social Sciences- Sociology, Social work, Demography and Population Studies were the most preferred disciplines in demand. Experience in rural management/ development was also desirable in public health jobs advertised for the state and district level. (157)

A study undertaken during the year 2015, analyzed public health job opportunities in India as per employers’ perspective by sending out a structured questionnaire to 50 employers including HR professionals and senior public health managers.(91) The questionnaire focused mainly on issues related to qualifications, competencies and skill sets required for public health jobs. It was observed that primarily INGOs recruit PHPs which is followed by public sector organizations and NGOs. Majorly, the profile of program manager is offered to public health postgraduates in INGOs, NGOs, public sector & research organizations. (91) Structured application process followed in the NGO and INGO sector, considered Statement of Purpose (SOP) as the most
important documenting for shortlisting and evaluating competency of the graduates. Majority of the INGOs and NGOs absorbed candidates as interns on temporary or permanent contractual positions. (91) As per the employers, data management and communication skills were the most sought after essential skills considered while hiring a candidate. This was followed by statistical analysis and project planning.

According to work undertaken by Sharma et.al. (2013) on career opportunities for MPH graduates in India. (152) Majority of students enroll in MPH courses by choice having had an opportunity to work in the health sector after their graduation. In academic institutions, job opportunities in academia and research are available whereas non-academic career opportunities related to service delivery, program implementation & monitoring and evaluation also exist. (152) Graduates preferred taking up job in government or the public sector due to the involvement of a higher level of job security, which included retirement and health benefits. (152) Entry barriers for most of the public health jobs included a lack of transparency in the recruitment process; poor working and living conditions in rural areas; restricted professional (and personal) development; lack of clarity on transfers and staff deployment policies; lack of competitive salaries, unclear expectations about work roles, work expectations and feedback; job insecurity in not-for-profit and private sectors; lack of clear vision, mission and plans in government and organizations on health workforce issues; and poor linkages between the public health sector and academia. (152) Additionally, it was observed that structured career advancement pathway lacks for MPH graduates in India, particularly in the private and not-for-profit sector. (152)
Findings from IDIs and FGDs: Mapping Career Opportunities

Due to the ongoing National Health Mission (NHM), public health graduates find jobs in public sector at district, state and national level. These jobs are available in public health system, research organizations, academic institutions. The annual salary package ranges from INR 1.92 LPA up to INR 14.49 LPA.

“NHM offers lot of opportunities...one of our students have joined in Chhattisgarh as District Coordinator in Tobacco control initiatives, one joined as a district coordinator & few people joined in RCH as district level coordinator/ ASHA coordinator.” (Professor - Community Medicine, Maharashtra)

Job opportunities are available for both freshers as well as experienced professionals. MBBS with PG/ Diploma in Preventive and Social Medicine/Public Health/Epidemiology or Post Graduate Degree in Public Health/ Health Management/ Health and Hospital Administration/ Hospital Management or doctorate in relevant fields is the most sought-after qualification. The salary packages offered to MD (CM/ PSM) graduates being posted at PHCs/ CHCs is INR 6 LPA, 6.5 LPA and 7 LPA during internship in first, second and third year respectively. However, very few graduates join at rural positions due to poor living conditions.

“living conditions in remote areas is difficult, no electricity... Jobs are there, vacancies are there but students (graduates) doesn’t want to work... quality of life is poor in villages in PHCs/ CHCs.” (Head of Department - Community Medicine, Bihar)

Whereas, INGOs/ UN organizations/ contract research organization (CROs) pay an annual package of around INR 12-14 LPA to these graduates in their international projects.

“One of our students is getting 1.2 lakhs (per month) in Bangalore. She works on evidence synthesis, and she has only one year of experience.” (Professor - Community Medicine and Public Health, Maharashtra)
It was stated in interviews that the government should recognize public health as an essential qualification in the recruitment for public health positions. As such most of such qualification are mentioned as ‘desirable’ qualification instead of ‘mandatory’.

“the problem is that the government do not recognize public health qualification as an essential qualification in the recruitment of the public health positions. They may say that it is desirable but even in the government sector, where job requires public health competencies. The government doesn’t make it the MPH or public health qualification as an essential qualification in the recruitment for this post. So that’s a big problem.” (Professor, Community Medicine and Public Health, Maharashtra)

Public Health Cadre

As per recommendations given in a study conducted by Babu et. al. in the year 2014, there is shortage of requisite manpower at different levels, gaps in training status, weak program management and weak surveillance at district, block and community levels.(158) Thus to build a strong base for public health professional workforce in the country, there is a simultaneous need to create job opportunities and design career pathways in public health.(114)To formulate and implement the public health activities in the country effectively there is a need to establish a uniform public health cadre in India. There is a need from governments’ side to create more jobs at taluk-level, district-level and state level under the public health cadre.(158) The public health cadre currently exists in some of the states like Tamil Nadu, Odisha and Kerala; and efforts are being initiated in other states for design and development of such cadre.(114)

“At national level, we have already the public health cadre which is to be extended or widened, because we are hardly 80 people are working and at the same time we still require from the Government of India the public health personnel.” (Regional Director, Government of Odisha, Odisha)

“Cadre is recommended in public health as far as central govt is concerned is already there, but a cadre is more needed by public health institutions and ministry itself...” (Senior Public Health Professional, Government of India, Tamil Nadu)
“Definitely there is need for public health cadre. Once the public health cadre comes... not only people would know about public health...it will definitely create awareness and set up deliverable targets.” (Former Joint Director (Health & Policy) - Member Secretary on the Public Health Cadre Committee, Karnataka)

“See until and unless you don’t create a post – career opportunities won’t come out. We are heading professionally without any public health degree but still we won’t at least something job wise public health assistant or public health officer as public health specialist.” (Public Health Professionals FGD participant, Karnataka)

Also, it would be important to create more job opportunities for public health professionals belonging to non-medical background. These professionals are already handling certain crucial positions in the national health programs which are mainly managerial positions.

“We require to change recruitment rules (RRs) the problem is with RRs. At present there is not much scope for non-med background. In NHM few posts are non-medical posts...RRs to be changed at policy level.” (District Surveillance Officer, IDSP, Maharashtra)

There is a need to revisit overall public health employment structure in India and design appropriate pathways for the existing public health workforce. Public health is largely dominated by medical professionals however considering the multidisciplinary and holistic approach of public health as a field, it would be useful to redesign and reframe roles of medical and non-medical public health professionals and designing a sustainable model where they may coexist and complement each other’s deliverables in the health system. (114)

“They (non-medical background professionals) can go to program implementation side...PHC has managerial work, IAS people too look after secretarial work...Non – medical persons can take up these jobs.” (Public Health Professional, Maharashtra)
4.5 Competencies
As stated by Gebbie et. al., improvement in the health of the public depends mostly depends on quality and preparedness of the public health workforce which in turn depends on the relevance and quality of its education and training.(159)

Need of competency based public health training
Competency based public health education may prove to be helpful in ensuring that students are taught necessary knowledge and skills which translate research into practice. Imparting public health education through competency based curriculum is one mechanism which can help in translation and further dissemination of knowledge.(160) Recent work by Pandav et. al. on public health competency framework to standardize the core and cross-cutting competencies needed by public health workers(107) suggests family & community diagnosis, health planning & management, program implementation, human resource development, monitoring & evaluation, health promotion are some of the core competency domains identified in this study for MBBS doctors.(107)

During the interviews, respondents emphasized that teaching competency-based curriculum is critical for public health professionals as currently most of the public health programs in India are not practicum based. Thus, we received plenty of competencies as a response when we asked about the same from our respondents.

“Competencies? There are so many... public health is a multi-tasking, multi-disciplinary, multi-factorial thing.” (Associate Professor, Community Medicine, Maharashtra)

“from public health’s point of view, first basic competency is to be able to look at the pattern, such as vector borne diseases...and to understand risk factors...one should be able to do proper literature search and review about what is happening in the country especially epidemiology part of it.” (Associate Professor, Public Health, Delhi-NCR)

“diplomacy, advocacy, ability to communicate, confidence to work...public health people think having a publication in high impact journal is important...but I ask what does it mean to the last man on ground...” (Member - Health Task Force, Government of Karnataka, Karnataka)

“basic knowledge (technical), administrative knowledge, managerial skills, communication skills, basic knowledge in teaching programs...skill is very important, coordination with other
departments...management along with basic motivation and leadership.” (Public Health Professional, Maharashtra)

“scientific, medical writing...email etiquettes...soft skills, oral and written communication Analytical skills to analyze issues...training they (students of public health programs) undergo is directed towards knowledge enhancement rather than skill building.” (Director in a MNC providing information, services and technology for the healthcare industry, Delhi-NCR)

“working with people, drive for results, technical expertise...” (Health Officer (in an International Non-Governmental Organization, Jharkhand)

ASPH Competency Model

As per Association of Schools of Public Health (ASPH) competencies published in 2008 for Master of Public Health (MPH) graduates, the ASPH core competencies have been divided as five disciplines-specific domains (biostatistics, environmental health, epidemiology, health policy and management, and social and behavioural sciences) and seven crosscutting domains (communications and informatics, diversity and culture, leadership, professionalism, program planning, public health biology, and systems thinking).(161)

In Indian public health scenario, we selected Master of Public Health (MPH) program for competency assessment – since it consists of public health components in a more generalized manner. In absence of a public health council and any standard guidelines for MPH course curriculum, it was difficult to shortlist a curriculum for identification of public health competencies. Hence, out of 44 MPH programs being offered in the country – MPH curriculum of a government institution from South India with more than 260+ students (MPH) since past ten years, was shortlisted.
Identification of competency statements, links between MPH curricular content areas and competency statements & levels of competency for 'core competency domains' 

Table 22 lists the competency statements about expected competencies for MPH graduates that were identified through the in-depth interviews undertaken with experts during the research study.

Table 22: Competency statements for MPH graduates

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Competency statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conduct epidemiological investigation of communicable, non-communicable and other diseases</td>
</tr>
<tr>
<td>2</td>
<td>Analyze data and interpret pattern of vector-borne, communicable and non-communicable with the use of appropriate statistical packages</td>
</tr>
<tr>
<td>3</td>
<td>Design, conduct and analyze case control study</td>
</tr>
<tr>
<td>4</td>
<td>Identify the gaps, problems &amp; in-consistencies in real data set</td>
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<td>5</td>
<td>Demonstrate confidence while working with community</td>
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<tr>
<td>6</td>
<td>Should possess skills of health diplomacy and policy advocacy</td>
</tr>
<tr>
<td>7</td>
<td>Communicate effectively with communities, groups and individuals</td>
</tr>
<tr>
<td>8</td>
<td>Knowledge about the functioning of Indian public health system</td>
</tr>
<tr>
<td>9</td>
<td>Monitoring and evaluation of National Health Programs at central, state and district level</td>
</tr>
<tr>
<td>10</td>
<td>Exhibit drive for results</td>
</tr>
<tr>
<td>11</td>
<td>Ability to communicate with internal and external stakeholders in verbal and written form (including email etiquettes)</td>
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<tr>
<td>12</td>
<td>Knowledge of implementing projects in public health</td>
</tr>
<tr>
<td>13</td>
<td>Demonstrate and apply knowledge related to epidemiology</td>
</tr>
<tr>
<td>14</td>
<td>Management of human resource, finance, partnerships and stakeholder relations</td>
</tr>
<tr>
<td>15</td>
<td>Possess scientific and medical writing skills</td>
</tr>
<tr>
<td>16</td>
<td>Ability to work with multi-disciplinary people with diverse cultural, socioeconomic and educational backgrounds</td>
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<tr>
<td>17</td>
<td>Demonstrate knowledge about the concepts of public health</td>
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</tbody>
</table>

Table 23 links the MPH curricular content areas (which can be expected to cover these competencies) to these functions.
<table>
<thead>
<tr>
<th>Table 23: Links between the MPH curricular content areas (which can be expected to cover these competencies) and competency statements</th>
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<tbody>
<tr>
<td>Public health technologies</td>
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<tr>
<td>Intermediate biostatistics</td>
</tr>
<tr>
<td>Health policy analysis I</td>
</tr>
<tr>
<td>Intermediate epidemiology</td>
</tr>
<tr>
<td>Infectious disease epidemiology</td>
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<tr>
<td>Chronic disease epidemiology</td>
</tr>
<tr>
<td>Qualitative research methods</td>
</tr>
<tr>
<td>Anthropological perspectives in health</td>
</tr>
<tr>
<td>Quantitative research methods</td>
</tr>
<tr>
<td>Health management</td>
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<tr>
<td>Healthcare system in India</td>
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<tr>
<td>Health policy analysis I</td>
</tr>
<tr>
<td>Ethics in public health</td>
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<tr>
<td>Gender issues in health</td>
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<tr>
<td>Basic health economics</td>
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<tr>
<td>Health and environment</td>
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<tr>
<td>Health and development</td>
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<tr>
<td>Basic biostatistics</td>
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<tr>
<td>Introduction to epidemiology</td>
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<tr>
<td>Competency statement no.</td>
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<tr>
<td>Competency statement no.</td>
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<td>--------------------------</td>
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<tr>
<td>Public health technologists</td>
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<tr>
<td>Intermediate biosciences</td>
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<tr>
<td>Health policy analysis I</td>
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<tr>
<td>Intermediate epidemiology</td>
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<tr>
<td>Infectious disease epidemiology</td>
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<td>Chronic disease epidemiology</td>
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<td>Quantitative research methods</td>
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<td>Quantitative research methods in health</td>
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<td>Quantitative research methods in anthropology</td>
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<td>Health management</td>
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<td>Healthcare system in India</td>
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<td>Basic biosciences</td>
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<td>Introduction to epidemiology</td>
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<td>Competency statement no.</td>
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<tr>
<td>Introduction to epidemiology</td>
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<td>Basic biostatistics</td>
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Based on the Miller’s triangle, levels of the core competencies to be achieved by MPH graduates were identified and agreed upon. These results are depicted in table 24.

Table 24: Levels of competency for 'core competency domains'

<table>
<thead>
<tr>
<th>Core competency domains</th>
<th>Level of competency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(+++ Does, +++ Shows how, ++ Knows how, + Knows)</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>++++</td>
</tr>
<tr>
<td>Biostatistics</td>
<td>++++</td>
</tr>
<tr>
<td>Gender issues</td>
<td>++</td>
</tr>
<tr>
<td>Ethics</td>
<td>++</td>
</tr>
<tr>
<td>Health policy</td>
<td>++++</td>
</tr>
<tr>
<td>Health management</td>
<td>++++</td>
</tr>
<tr>
<td>Research methodology</td>
<td>++++</td>
</tr>
<tr>
<td>Public health technologies</td>
<td>++</td>
</tr>
</tbody>
</table>

The level of competency was assessed by me based on frequency of MPH curricular content areas as per the competency statements.

Competency domains for MPH graduates

As per work undertaken by Negandhi et. al., competency-driven approach towards public health education is inevitable as it addresses the supply-side of the health systems. It works towards striking the correct balance of skill-sets among future public health professionals. (21) Our curricular review of MPH program demonstrated that different curricular content areas contribute towards different public health functions. Epidemiology, biostatistics, health policy, health management and research methodology are covered in much greater depth than the other three domains (ethics, gender issues and public health technologies). The students have enough skills to automate statistical data, analyzing data, and report writing. Epidemiology and its related components had a highest concentration in the curriculum which is evident by the thickness of the circle boundaries. The study identified research, analysis, communication, advocacy, leadership, monitoring & evaluation, and project management, as cross-cutting competencies. The competency framework developed for MPH graduates has been presented in figure 15.
Figure 15: Master of Public Health (MPH) program's core competency domains
4.6 Tuition fee of public health programs

Quantitative Analysis
An analysis of the tuition fee of select post graduate public health programs (Master’s degree only) was undertaken. Tuition fees of 58 masters level programs were tabulated for further analysis (presented in figure 16) from Rs. 480 to Rs. 14,29,461 (median – Rs. 1,18,560). Tuition fee ranges from Rs. 480 to Rs. 1,90,000 for institutes owned by public sector, whereas the tuition fee ranges from Rs. 28,500 to Rs. 14,29,461 for institutes owned by private sector. It was also observed that government universities offer courses at a highly subsidized fee, which may amount to less than Rs. 5,000 as compared to private universities offering courses at high fees. Thus, there are limited number of seats in public universities and higher fees for pursuing public health programs in private universities. Henceforth, government should either offer more public health programs through public universities or set up more public health institutions offering varied public health courses. Also, special student scholarships for pursuing public health programs in private universities/institutions of repute should be available for interested candidates. This in turn may help in increasing the current pool of public health professionals and reducing the 20-25% seat vacancy rate for various public health programs in the country.
Figure 16: Tuition Fees for select public health programs with Master’s degree
Qualitative Analysis

When the students of public health programs were asked about the benefits/ utility and importance of these programs most of them found it to be very beneficial for their overall career growth. For students these programs were helpful in getting field exposure, learning research techniques, working in community, networking, gaining leadership skills and most importantly changing their point of view regarding public health as a field. Some of the statements from interviews conducted with students of various public health programs have been provided below:

“we were assigned with different task in the field to do follow up with cases…village mapping. it was not new for me when I joined an NGO in Chhattisgarh.” (Student of public health program, Maharashtra)

“There are things that I enjoy…would have never understood difference between qualitative and quantitative research. So much emphasis is given on research.” (Student of public health program, Maharashtra)

“(This program) has made me smart, I was very naïve I was just into books before…our lecturers, teachers made us look out of the box.” (Student of public health program, Gujarat)

“This program has given me lot of opportunity in every aspect environmental issue also focusing on problems of environmental pollution & I am happy to gain this kind of knowledge.” (Student of public health program, Manipur)

“I have already seen ground level reality and I can relate to that, next if I am moving to research, I am able to relate – why particular intervention is done…how the front-line workers respond to…after knowing intervention and my previous experience…I have found a middle way to it.” (Student of public health program, Assam)

Thus, the public health programs prove to be helpful not only for the students but also the country and they are largely building the national public health workforce base of the country.