

National Public Health Institutes: A Scoping Review

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Abstract

Background. During the last century, national public health institutes (NPHIs) emerged to address enduring and emergency public health challenges. Outbreaks have often compelled countries to establish NPHIs. Likewise, the Covid-19 pandemic may inspire countries to create or strengthen NPHIs. Despite their historic legacies and contributions to public health, no review of NPHI literature has been published to date. The aim of this scoping review is to provide an overview of the NPHI literature published since 2000 and map characteristics of articles including format, authorship, geographic focus, methods, language, and focal topic. We also investigate whether the NPHI literature addresses public health capacity building domains. Finally, the study identifies gaps and areas for future research.

Methods. The scoping review was guided the Arksey and O'Malley methodological framework and utilized the PRISMA-ScR checklist. The search was conducted in Medline OVID and Scopus databases. Data extraction involved mapping article characteristics and reviewing public health capacity building framework domains.

Results. The search yielded 5731 records. A total of 43 articles met the study eligibility criteria. Articles were published in English, Spanish, French and Russian including diverse perspectives and experiences emanating from more than 20 countries in Africa, Europe, North America and South America. Most articles were formatted as commentaries. Only three reported methods or collected primary data. Articles topics included organizational structure, networks, research, funding, and governance.

Conclusion. Findings reveal a longstanding international interest in leveraging NPHIs to address complex public health challenges. Lack of studies reporting methods reveals the need for future research to utilize quantitative and qualitative methods. The NPHI literature addresses topics concerning public health capacity building which underscores NPHIs' ability to tackle global and national public health threats. Many articles in this review recommend investment in NPHIs as a strategy to respond to crises and strengthen countries' public health systems.

Background

During the last century, many national public health institutes (NPHIs) around the world emerged to address urgent health threats or enduring public health challenges. While many NPHIs originated from infectious disease, laboratory, and hygiene traditions, their missions and scope gradually expanded to include complex, multidisciplinary and multisectorial health challenges. Recognition of the role and contribution of NPHIs has often followed public health crises. Recent outbreaks, (e.g., SARS, 2003 and Ebola virus disease, 2014), for example, led countries such as Canada, Hong Kong, Liberia and Sierra Leone, to merge or establish a NPHI to provide better guidance, coordination, and leadership. Similarly, the Covid-19 pandemic may re-invigorate country interest in creating or merging agencies to establish a NPHI.

To date, 214 countries and territories around the world are beset by the Covid-19 pandemic underscoring the importance of reliable public health systems, infrastructure, and institutions (1). Less than half (94 of the 214) have a dedicated NPHI or its equivalent according to membership in the International Association of Public Health Institutes (IANPHI) (2). Given that there are currently no reviews or syntheses of the NPHI literature, this study conducted a scoping review to provide an overview of the published literature focusing on NPHIs during the past two decades. The study also reviewed whether the NPHI literature addresses public health capacity building domains and identified gaps in the literature as areas for future research.

According to IANPHI, an NPHI is defined as "a government agency, or closely networked group of agencies, that provides science-based leadership, expertise, and coordination for a country's public health activities" (3). There are many different variations of this definition at the country level which is evident from the broad diversity of nomenclature. NPHIs have many different names such as an institute of public health, public health institute, public health agency, public health center, center for disease control and prevention or health protection, to name a few. NPHIs are typically designated as politically neutral, semi-autonomous governmental agencies subordinate and supportive of Ministries of Health (MoH) that are science-based (i.e., data driven) and undergirded by a legal framework (4). Although NPHIs around the world differ in name, structure, size, and scope, their focus on core public health functions is their unifying commonality (3).

Methods

Study approach

The study was designed as an exploratory scoping review which is a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area by systematically searching, selecting and synthesizing existing knowledge (5). Scoping reviews are often conducted for the following reasons: to examine the current breadth of research in a specific field; to investigate readiness for conducting a systematic review; to summarize and disseminate findings; and, to identify gaps in the existing body of literature. Given that no review of the NPHI literature exists, conducting a scoping review was deemed appropriate in order to understand the breadth and depth of literature in this field. To standardize reporting of this review, we utilized the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist (6).

Search strategy. Three search sources were utilized: 1) electronic database searches (Ovid Medline, Scopus) 2) bibliographic review of reference lists from included articles; 3) Google Scholar review of citations. To inform the search strategy, an initial subset of 20 articles was identified. A review of the MeSH terms and key words from these articles were used to design the search strategies for Ovid Medline and SCOPUS in consultation with a Cochrane information specialist. These two databases were selected given that they include a broad range of health, medical, policy, and social science sources and journals.

Inclusion criteria. The inclusion criteria did not impose limitations with regard to publication type or language. All articles published in scientific journals on this subject including editorials, letters, reviews, commentaries, and research studies. Only articles published after the year 2000 were included to capture contemporary views. Table 1 provides an overview of the literature search criteria.

Table 1
Literature search strategy

Databases	Inclusion criteria	Exclusion criteria
Medline	Thematic focus on NPHIs, public health agencies (PHA) and centers for disease and prevention (CDC)	Articles published before 2000
Scopus	All languages	Conference proceedings, workshops, news briefs, books, excerpts from encyclopedias, and dissertations

Literature search. The search log consisted of search strategies conducted in Medline and Scopus databases. The search strategy with Scopus, Elsevier (searched 26.05.2020) used the following terms: TITLE-ABS-KEY ("public health institute" OR "public health institutes" OR "public health agency" OR "public health agencies") AND PUBYEAR > 1999 AND NOT INDEX (Medline). Appendix 1 and 2 contain additional details of the search strategy and Medline results. The search was completed in May 26, 2020 (26.05.20). The title and abstract screening process and full text review was conducted independently by two authors (SM and SF) using the Covidence systematic review software program (7).

Data extraction

The analysis followed an approach described by Arksey and O'Malley as: "a 'descriptive-analytical' method within the narrative tradition, which involves applying a common analytical framework to all the primary research reports and collecting standard information on each study, stands more chance of being useful." (8). Based on scoping review data extraction methods (9), key information was charted for each article. Descriptive information included: author(s), year of publication, country of origin of first author, language, geographic focus, study methods, country focus, and primary focus were recorded. Thematic content of articles was assessed using NVivo 12 Plus, a qualitative data analysis software (10).

Conceptual framework

A conceptual model on country level public health capacities developed by Aluttis and colleagues was used to categorize themes and focal areas of the literature (11). Their model was developed from a review of frameworks focusing on public health capacity building at the country level. The synthesis of findings from eleven frameworks identified domains clustered around seven dimensions theorized to influence public health capacity building (11). These dimensions, shown in Fig. 1, include: country specific context with relevance for public health, organizational structure, governance and leadership, knowledge development, partnerships and networks, workforce, and financial resources. Country specific context was considered a dimension influencing all domains.

The rationale for focusing on dimensions of public health capacity building emanates from the perspective that investment in health system capacity (i.e., organizational structures, resources, and skills) at the country level will result in amplified and sustainable impact in contrast to efforts aimed solely at influencing the health status of a population directly (12). Although this framework was developed to address country level public health capacity building on a macrolevel, one can argue that these dimensions are equally relevant at the institutional level of public health infrastructure development. In other words, we considered these domains to be useful categories to assess the NPHI literature. Hence, we explored the extent to which NPHI literature considers these focal topics in order to inform the knowledge base of how NPHIs contribute to public health capacity building. Insert Fig. 1 here.

Results

Search and selection process

Completed in May 2020, the search yielded 5827 potentially relevant records. Of these, 121 full text records were retrieved and reviewed independently by two reviewers. All discrepancies in the review process were adjudicated by two reviewers. Appendix 3 includes a PRISMA flow diagram of the screening results. A total of 43 publications met the eligibility criteria and were included in the final collection.

Article characteristics

Key attributes from each article include author, year of publication, first author's country of origin, primary focus, type of article, methods, language, and geographic focus. Article characteristics are summarized in Table 2.

Publication year. Approximately half of the articles (n = 21) were published in from 2011–2020 while the other half (n = 22) were published in 2000–2010. A spike in articles was noted in 2008 due to a special journal issue dedicated to NPHIs. No other temporal trends were noted.

First author affiliation. First author country affiliation included North America (USA, Mexico, Canada) (22), Europe (France, United Kingdom, Czech Republic, Slovenia, Switzerland, Sweden) (9), Africa (South Africa, Burkina Faso, Nigeria, and Guinea Bissau) (5), South America (Brazil, Columbia) (3), and India (1).

Article type and study design. Most articles were classified as commentaries (25), followed by editorials/letters to the editor (10), historic profiles (3), empirical studies (3) and technical papers (2). Interestingly, few articles collected original data, either qualitative or quantitative. Only three articles include a methods section describing the type of research methods that were used in the study design. Of the three including a methods section, the methodology included document review (legal and country documents), survey data analysis, and case study design. Comparative analysis of country level experiences was described in a few articles.

Primary topic. The primary topic of articles varied although several themes emerged. Some articles described the historic legacy of NPHIs (13–17) while others focused on the mandate and or scope by exploring NPHIs' engagement with public health core functions (18–21), health infrastructure (22), and One Health (23). The role of NPHIs in national and global health security was discussed in several articles (24–27). The potential of NPHI partnerships, collaborations, and regional and global networks such as the IANPHI was addressed in several articles (28–30). Governance challenges (31, 32), leadership (33), legal frameworks (34), and organizational structure (35) were discussed in several papers. Finally, technical tools to assist in NPHI development were also presented (34, 36).

Language. Most articles were published in English (n = 38) although two were in Spanish, two in French, and one in Russian. All foreign language articles included English abstracts explaining how they were captured in our search.

Geographic focus. The geographic focus of the articles included more than 20 countries in North America (Canada, Mexico, USA), Europe (Czech Republic, France, Slovenia, Sweden, the United Kingdom), South America (Brazil, Columbia), Africa (Ethiopia, Guinea Bissau, Liberia, Mozambique, Nigeria, South Africa) and the Eastern Mediterranean region (Morocco). Relatively few articles focus on countries in Asia with the exception of articles referring to China, Hong Kong, and India. Fifteen articles discussed NPHIs from an international perspective many of which focused on the global and regional potential of NPHI networks and collaboration.

Table 2

NPHI literature findings: authorship, year, origin of first author, topic, article type, methods, language and geographic focus

#	Authorship	Year	Origin of 1st author	Primary topic	Article type	Method section	Study method	Language	Geographic focus
1	Rosenfeld et al (34)	2020	USA	Comparative analysis of NPHI legal frameworks	Legal review	Yes	Document review	English	Nigeria, Ethiopia, Guinea Bissau, Mozambique, Liberia
2	Verracchia et al (21)	2019	UK	NPHI networks, global health	Commentary	No	-	English	International
3	Campos-Matos et al (37)	2019	UK	NPHI and health inequalities	Commentary	No	-	English	United Kingdom
4	Barzilay et al (36)	2018	USA	Development tool for NPHIs	Technical	No	-	English	International
5	Njidda et al (38)	2018	Nigeria	Nigeria CDC	Commentary	No	-	English	Nigeria
6	Puska et al (29)	2017	Finland	NPHIs and IANPHI	Editorial	No	-	English	International
7	Rubin (17)	2017	USA	Mexico's INSP	Editorial	No	-	English	Mexico
8	Meda et al (30)	2016	Burkina Faso	African NPHI network	Letter	No	-	English	West Africa
9	Bourdillon (39)	2016	France	Santé Publique France	Commentary	No	-	French	France
10	Faford et al(32)	2016	Canada	PHA Canada	Commentary	No	-	English	Canada
11	Spahic et al (40)	2016	Canada	Governance of PHA Canada	Commentary	No	-	French	Canada
12	Ihekweazu et al (28)	2015	South Africa	Collaboration of NICD (South Africa) and PHE (UK)	Commentary	No	-	English	South Africa, UK
13	Roa et al (41)	2015	Brazil	Fiocruz NPHI network	Commentary	No	-	English	Brazil, Mozambique
14	Lahariya (42)	2015	India	Lack of NPHI capacity in India	Commentary	No	-	English	India
15	Valladares LM et al (43)	2015	Mexico	Graduate education	Commentary	No	-	English	Mexico
16	Beer (23)	2013	USA	NPHIs and ecohealth	Letter	No	-	English	USA, Canada
17	Koplan et al (27)	2013	USA	NPHIs and health security	Commentary	No	-	English	Canada, China, Hong Kong, USA

#	Authorship	Year	Origin of 1st author	Primary topic	Article type	Method section	Study method	Language	Geographic focus
18	Bloland et al (44)	2012	USA	US CDC and health system strengthening	Technical	No	-	English	International
19	Lopez (45)	2012	Columbia	Columbia's NPHI	Editorial	No	-	Spanish	Columbia
20	Anonymous (46)	2012	Unknown	NPHI models	Commentary	No	-	Russian	International
21	Magana-Valladares et al (47)	2011	Mexico	Mexico's NPHI and policy	Commentary	No	-	English	Mexico
22	Frieden et al (18)	2010	USA	NPHI core functions	Commentary	No	-	English	International
23	Fierlbeck (31)	2010	Canada	NPHI governance	Commentary	No	-	English	Canada
24	Binder et al (48)	2009	USA	NPHI overview	Letter	No	-	English	International
25	Buss et al (26)	2009	Brazil	NPHI Latin American network and health security	Commentary	No	-	Spanish	Latin America, Caribbean and international
26	Hassar (49)	2008	Morocco	Morocco's 3 NPHI agencies	Commentary	No	-	English	Morocco
27	Heymann (24)	2008	Switzerland	NPHIs and health security	Letter	No	-	English	International
28	Rodriguez-Lopez (16)	2008	Mexico	Profile of Mexico INSP	Commentary	No	-	English	Mexico
29	Binder et al (20)	2008	USA	Survey data on NPHIs	Survey data	Yes	Survey of NPHIs	English	International
30	Binder et al (35)	2008	USA	Canada PHA, Morocco, Nigeria CDC, South Africa NICD, US CDC	Case study	Yes	Document review, interviews	English	Canada, Nigeria, USA Morocco, South Africa
31	Silva (50)	2008	Guinea Bissau	Guinea Bissau NPHI	Letter	No	-	English	Guinea Bissau
32	Anonymous (51)	2008	NA	NPHI potential	Editorial	No	-	English	International
33	Frenk et al (52)	2008	Mexico	NPHI building	Commentary	No	-	English	International
34	Wilson et al (33)	2008	Canada	NPHI leadership models in US, UK, and Canada	Commentary	No	-	English	Canada
35	Butler-Jones (53)	2007	Canada	PHA Canada	Commentary	No	-	English	Canada
36	Koplan et al (22)	2007	USA	NPHIs and public health infrastructure	Commentary	No	-	English	International

#	Authorship	Year	Origin of 1st author	Primary topic	Article type	Method section	Study method	Language	Geographic focus
37	Adigun et al (54)	2007	USA	NPHI development	Commentary	No	-	English	Africa
38	Rodier et al (25)	2007	Switzerland	NPHIs and health security	Commentary	No	-	English	International
39	Jousilahti (55)	2006	Finland	NPHI overview	Commentary	No	-	English	International
40	Koplan et al (19)	2005	USA	NPHI core functions	Commentary	No	-	English	International
41	Kriz (13)	2005	Czech Republic	Prague NPHI historic review	Narrative - historic	No	-	English	Czech Republic
42	Hogstedt et al (15)	2004	Sweden	Sweden NIPH historic review	Narrative - historic	No	-	English	Sweden
43	Klavs et al (14)	2003	Slovenia	Slovenia NIPH historic review	Narrative - historic	No	-	English	Slovenia

Public health capacity building domains

Articles identified in the scoping review were assessed using the domains of the public health capacity building framework developed by Allutis and colleagues (11). Table 3 presents a summary of the public health building capacity domains, description, and examples from the NPHI literature.

Table 3
Public health capacity building domains and NPHI literature examples

Domain	Description	Examples from the literature
Organizational structure	Institutional model of NPHI (single versus network of agencies), mergers, mandate, scope of work, essential core public health functions, and role as IHR focal point	Single vs multiple agency model (49) Mergers (35, 39, 40) Public health core functions (18–20) Spectrum of NPHI scope (54) IHR focal point (24, 25)
Governance and leadership	Legal foundation and authority, autonomy, regulatory mechanisms, policies, oversight and advisory boards, and leadership models	Legal frameworks (34) Governance and autonomy (31, 33) Oversight and advisory boards (52) NPHI leadership models (32, 33)
Knowledge development	Development of knowledge products including routine data collection (e.g., surveillance, registries) and research (e.g., reports, reviews, briefs, etc.)	Research informing policy (47) NPHI surveys and studies (16, 52) One Health (23) Applied research (20, 24, 44)
Partnerships and networks	NPHI partnerships, regional or international NPHI networks that enhance capacity by pooling or sharing resources or expertise	Collaborative partnerships (28) Regional networks (21, 30) International cooperation (41) International network, i.e., IANPHI (20, 29)
Workforce	Higher graduate and postgraduate education, continuing education, field epidemiology training programs, technical training, and workforce development activities	Graduate education/training (17, 43) Field epidemiology, laboratory training programs (38) Technical exchange and training (28) Workforce development (52)
Financial resources	Domestic funding, core budgets, external funds supporting NPHIs (i.e., IANPHI, donors, external grants)	Domestic budgets/funding (35) IANPHI support (21, 25, 50) Donor investment (19)

Domain	Description	Examples from the literature
Country specific context	Social, cultural, environmental, and political features influencing public health institutes	Country engagement in development assessment tool (36) Contextual lessons (26, 27)

Organizational structure

The concept of organizational structure is clearly relevant to NPHIs given that how national agencies are designed (i.e., institutional model), their designated scope, and role in performing core public health functions, may influence their overall impact and effectiveness.

Organizational models. Several articles describe organizational models operationalized in different countries underscoring the diversity of how countries choose to structure NPHIs within the overall institutional architecture of a nation (22, 27, 49, 55). Latin American and Caribbean countries', for example, have a longstanding legacy of infectious disease agencies evolving into NPHIs as evidenced by Chile's Institute of Public Health (1892), Peru's National Institute of Health (1896), Brazil's Oswaldo Cruz Institute (1900), Argentina's National Administration of Laboratories and Health Institutes (1916), Columbia's National Institute of Public Health of Colombia (1917), Panama's Gorgas Institute (1921), Cuba's Pedro Kouri Tropical Medicine Institute (1937), and Mexico's National Institute of Public Health (1987) (26). Similarly, other articles acknowledge the transformation of European institutes originating in laboratory settings, hygiene efforts, and communicable disease traditions into NPHIs as evidenced by Germany's Robert Koch Institute (initially the Royal Prussian Institute of Infectious Disease (1891) (21), Prague's NPHI (1925) (13) and the NIPH of the Republic of Slovenia (1923) (14).

Many articles describe different models of organizing the work of NPHIs into either a network of closely coordinated agencies or institutes concentrating resources and expertise in one single entity (20, 27, 44, 49). Several articles discuss the process and perceived advantages of organizing NPHIs into one agency (39, 40, 49, 50). Advantages of consolidating public health functions under one roof are described as: optimizing scarce resources (i.e., financial, personnel, technical); reducing costs, fragmentation, and duplication; increasing efficiency; and acquiring a critical mass of research and technical expertise (49).

A consolidated model, with regard to emergency response, may also confer benefits such as generating evidence to inform public health decisions and facilitating coordinated and quick responses (26, 27). Maintaining institutional continuity during political fluctuations or instability was also considered an advantage (55). One study investigating the initial formation NPHIs found that merging 'precursor' organizations is common (35). Moreover, mergers were often the result of leaders leveraging opportunities to broaden their mandates through consolidation or reorganization (35).

Scope. Several articles state that the scope of NPHI tasks varies reflecting level of maturity, resources, and staff (21, 35, 54). Adigun and colleagues describe NPHI development as evolving along a continuum of institutional maturity from countries with little to no public health infrastructure to fledgling organizations and mature agencies managing comprehensive mandates (54). Similarly, Koplan and colleagues note that while, historically, many NPHIs emerged to address infectious disease and environmental issues affecting the public's health, 21st century public health challenges (i.e., noncommunicable disease, antimicrobial resistance, climate change and traffic injury) have redirected and expanded their mandates (22). Verracchia and colleagues note, however, that the scope of NPHIs in LMICs may be limited by resource constraints and fragmented health systems (21).

Essential public health functions. The extent to which NPHIs engage and contribute to essential public health functions is discussed in more than half of the articles (n = 28). NPHI survey data collected in 2008 reveals that NPHIs often engage in a set of core public health functions (20). The scope of these core functions are often delineated in legal documentation as reported by Rosenfeld and colleagues (34).

Acknowledging limited national public health capacity in some countries, however, Meda and colleagues recommend that NPHIs initially focus on five essential "axes" (i.e., disease surveillance and monitoring of health trends, field research, field investigation of acute health events, laboratory support, and field training) and rely on regional collaboration for other functions (30). Given that many

core public health functions involve health security, increased attention to adherence and compliance with the International Health Regulations (IHR) has recognized NPHIs as natural focal points for IHR implementation and communication (24, 25).

Institutional development. The concept of NPHI building was introduced more than a decade ago by Frenk and González-Block in their article that called for a global movement to support the establishment, expansion, and strengthening of NPHIs worldwide (52). Their premise was that investment in NPHIs as a strategic capacity building approach would contribute to achieving equity and global health goals. This theme has also been discussed in the context of NPHIs' contributions to health infrastructure (19, 22), public health capacity (21) and IANPHI's efforts to strengthen NPHIs (29).

Governance and leadership

Governance and leadership issues concerning NPHIs are discussed in the literature in terms of legal authority, autonomy, leadership models, oversight mechanisms and advisory boards.

Legal authority. Commonly established as legal parastatal entities, many NPHIs have institutional ties with the Ministry of Health (MoH) although some are situated in settings such as universities. A review of five countries' NPHI legal frameworks illustrates variability with respect to autonomy, accountability, leadership structure, reporting requirements, oversight mechanisms (i.e. advisory boards), core functions and operations, and financial resources (34). Countries also vary in terms of formal and informal administrative links with other agencies and their positioning within the broader health portfolio (31).

Scientific independence and autonomy. Maintaining scientific integrity in public health advice, recommendations, and communication is dependent on ensuring the scientific independence of NPHIs. Loss of autonomy described in several articles (32, 33) may compromise the independence of public health authority and underscores the importance of preserving public health leadership particularly in emergency situations that may result in downplaying, silencing or altering public health advice that is not aligned with agendas of those with political power.

Leadership. Several articles discuss the role of leadership in setting priorities, promoting research agendas, developing guidelines and recommendations, and engaging in policy analysis and implementation (18, 34, 35, 44). Diminished power of NPHI leadership, on the other hand, is discussed by some authors revealing the vulnerability of NPHIs losing influence when leadership roles are weakened (32, 33).

Oversight and advisory boards. The role of advisory boards to support NPHIs was mentioned in several articles. Analysis of five NPHI laws observed that all included legal provisions for NPHI oversight or advisory boards or a board of directors (34). One case in the literature, for example, described the value of an international advisory committee composed of prestigious public health leaders that provided mentoring and guidance thereby shielding the NPHI from external threats. The advisory board also facilitated valuable institutional networks, funding streams, and talent recruitment (52).

Knowledge development

As science-based organizations, knowledge development is at the core of NPHIs' identity. Knowledge production may assume many different forms such as disease surveillance and registry data, and scientific research (i.e., original studies, systematic reviews, Health Technology assessments, reports, etc.) that provide information necessary for policy and decision-making. One aim of dedicating resources to research conducted by NPHIs is to develop a knowledge base capable of managing public health issues and anticipating future public health trends, needs, and challenges.

Knowledge-generation. Nearly three-fourths of the articles (n = 32) mentioned NPHIs' engagement in knowledge production and research to give the best evidence base to inform recommendations, guidelines, and policy decision-making. Several articles cited this as a vital NPHI function (18, 20). Routine disease surveillance systems and health information management systems are other examples of data that is essential to the public health community. Hogstedt and colleagues (15) described the role of NPHIs as a "knowledge go-between" conveying information from the research community to public health practitioners. NPHI historical narratives also mentioned the role of research in their legacies (13, 14).

Research. Many articles discuss how NPHI-initiated research has been instrumental in driving public policy decisions in the implementation and development of social programs as well as influencing health care practices (17, 47). The emerging importance of interdisciplinary approaches (e.g., One Health) (23), mission-oriented research (47), country-led public health research agendas (18)

and cultivating research environments that address health inequities (37) was also discussed. The science-based nature of NPHI institutes is considered fundamental to the credibility and public trust in NPHIs.

Partnerships and networks

Partnerships and networks was discussed in terms of benefits derived from collaborations between countries as well as regional and international networks that facilitate sharing of resources and expertise (21, 22, 26, 30, 41, 55).

Partnerships. NPHIs work collaboratively with international organizations, academia, NGOs, and engage in collaborative relationships with sister institutes on research projects, implementation, or technical issues. Ihekweazu and colleagues, for example, describe a North South technical exchange program between the United Kingdom and South Africa that benefitted both organizations by promoting a reciprocal exchange of information, skills, and advice (28).

Regional networks. Recognition that public health crises, such as infectious disease and natural disasters, may cross borders indiscriminately demonstrates the necessity of regional and global responses. The launch of Africa CDC in 2016 (30) and the activities of the Mesoamerican Institute of Public Health are two examples of regional initiatives (47). Several articles discuss the value of leveraging regional networks. Africa CDC, for example, established five Regional Collaborating Centres strategically situated in the north, south, east, west and central regions of Africa (30, 38) that serve as hubs for surveillance, preparedness, and emergency response. Similarly, the Network of National Institutes of Public Health of the Community of Portuguese-Speaking Countries (RINSP-CPLP) facilitated by Brazil's NPHI (Fiocruz) illustrates how regional networks can strengthen NPHIs (41). Moreover, the RINSP-CPLP utilizes a unique structural cooperation approach that prioritizes partnerships and states' endogenous resources and capacity (41).

International networks. The launch of the international NPHI consortium – the International Association of National Public Health Institutes (IANPHI) – brought global attention to the potential of peer assistance, advocacy, and networking opportunities (18–20, 22, 55). With more than a decade of experience, IANPHI has demonstrated value by providing support to members through leadership mentoring, resource sharing, guidance, peer-to-peer support and has been instrumental in organizational development and establishment processes (29).

NPHI creation. While many articles in this literature focus on discussions around the functions, mission, and challenges of NPHIs, two articles published in Russian and Indian journals advocated for the establishment of a public health institute in their specific country (42, 46).

Workforce

Many articles described the need for a competent public health workforce (18, 19, 44, 55) and direct NPHI engagement with workforce development, training, and higher educational opportunities (13–15, 17, 43, 47, 52).

Graduate education. Articles discussing experiences from Mexico (16, 17, 43, 52) and Brazil (41) are unique in that their mandates includes accredited educational opportunities in public health disciplines, training, and workforce development. The result of engagement with education and training is the increased potential for repatriating individuals that may stem 'brain drain' that depletes countries of skilled, trained individuals. The importance of a competent public health workforce (20) the value of continuing education and graduate level programs (34), and increasing potential for distance learning (18) was also highlighted.

Field Training. Several articles mentioned opportunities for public health training and support for field epidemiology and laboratory training programmes (38) often modelled after the US CDC Epidemic Intelligence Service program (21, 44). NPHIs may also address health care worker performance and patient care which has been exemplified by the Integrated Management of Childhood Illness (IMCI) strategy that focuses on frontline health care workers (44).

Exchanges and peer learning. Training exchanges among NPHIs that facilitate secondments is another avenue to enhance capacity building, skills development, and competence with mutual benefit to participating NPHIs (28). Peer learning was also mentioned as a way to facilitate knowledge exchange (21).

Financial resources

Domestic and external funding. Financial resources were also discussed in the literature. A few articles recommended investment in public health infrastructure, specifically for strengthening NPHIs (22, 54). Similarly, Frenk and Block called on the global community to support the establishment and strengthening of NPHIs in developing countries with the aim of improving health system performance (52). Several articles discuss external funding opportunities available from IANPHI (21, 29, 35, 50) while others suggested external donors invest in national infrastructure such as NPHIs (22).

Country level context

Examples from the literature suggest that historical, situational and political factors impact the development and direction of NPHIs (35). NPHI historic narratives (13–15, 46) discuss the impact of events and trends while public health emergencies may reflect situational, political, cultural, and environmental factors (27, 33) influencing the emergence, institutional design and strategic direction of NPHIs. Comparative analyses highlight the unique context at the country level with regard to legal frameworks (34), leadership models (33), and organizational structures (35) illustrating diversity among NPHIs at the country level. Each country's unique approach to the institutional structure, leadership, and legal footing reflect political, legal, and cultural mores. NPHI development tools also emphasize the importance of incorporating country context by encouraging country-owned and led assessments (36).

Discussion

This scoping review provides an overview of NPHI literature that is relevant to the global health community in lieu of the Covid-19 pandemic. Increasingly, NPHIs are being recognized for their capacity to respond to public health emergencies. In a 2019 *Nature* article discussing health challenges of the 21st century, for example, public health leaders highlighted the unique ability of NPHIs to respond to epidemics (56). Similarly, a World Bank report stated that, “[o]ne critical investment countries can make to assist MoHs in their new role is the development and strengthening of national public health institutes” (57). More recently, Shamasunder and colleagues assert that this pandemic provides the opportunity and obligation to redesign stronger public health infrastructure and capacity (58). In sum, lessons accumulated from past outbreaks have repeatedly acknowledged the importance of national entities with designated authority and responsibility to respond (27).

The case for functional NPHIs in every country is based on the understanding and appreciation of the need for coordinated and collective action and solidarity to combat pandemics as well as enduring public health challenges. Long and uncertain development timelines for vaccines further highlights the necessity and importance of identifying, promoting, and enforcing effective preventive and protective health behaviors to combat infectious disease transmission.

Strengthening collaborations with WHO and IANPHI may further broaden the possibilities for leveraging NPHIs' contributions around the world. While NPHIs are rooted in addressing infectious disease, they have demonstrated capacity to evolve and adapt to the changing landscape of public health that has transitioned from a focus on clean water and hygiene to climate change, non-communicable disease, antimicrobial resistance and other highly complex health issues. Covid-19 has also demonstrated the importance of data and research to our understanding that is essential for informing appropriate policy decisions. The importance of evidence-based policies assumes even greater significance given the adverse spillover health effects on routine health services.

The findings of this scoping review suggest broad support in promoting and leveraging NPHIs to address public health challenges as expressed by many public health leaders. This review highlights the diversity in range of content, article format, and focus during the past two decades. Further, using a public health capacity building framework facilitated exploration of the literature in terms of organizational structure, governance and leadership, knowledge development, partnerships and networks, workforce, financial resources, and country context – all acknowledged as factors contributing to public health capacity building.

To date, the study of organizational structure and institutional design has received limited attention in the field of public health despite research recognizing that public health organizations and other actors are potential drivers for implementing public health visions, policies, and transformations (59). The findings provide several descriptions of how NPHIs are positioned within a country's public health institutional architecture.

Broadly speaking, NPHIs are typically subordinate to Ministries of Health - the primary organization responsible for driving the health sector at country level. Externally funded and implemented programs, however, often circumvent MoHs opting instead to create parallel systems that result in duplication, waste, and siphoned staff. Moreover, a report on building MoH capacity considered strengthening NPHIs a strategic investment given their role as ‘health resource partner institution’ (60). Approaches to national

development have highlighted the potential of strengthening health systems by investing in a country's local organizational capacity (61). Similarly, the concept of 'structural cooperation,' coined and implemented by Fiocruz, has documented how investment in the 'structuring pillars' of the health system (i.e., NPHIs, schools of public health, technical health schools, etc.) is an effective means of improving health system outcomes (62, 63). The findings offers several perspectives on challenges of effective governance and leadership models to ensure effective functioning. These lessons are particularly relevant to countries engaged in NPHI development as they offer lessons in the weaknesses of some models.

Findings on knowledge development demonstrate broad interest in country level information, data, and research. Several other studies have documented the potential of regional integration of health surveillance systems (64) as well as the potential for integrating health management information systems (65). Overall, the literature considers knowledge generation as a core function of NPHIs. Producing knowledge, however, requires infrastructure such as access to information and data, health information systems, and skilled researchers. A study exploring research infrastructure in Africa reported significant resource constraints in terms of supportive policies, legislation, infrastructure, human capacity, and funding (66) that could be areas for NPHIs to support. Recent findings suggest that local capacity building efforts supporting research may have important dividends (67). Articles focused on how NPHI-led research informed policy decisions has been corroborated by studies demonstrating the return of research investments in the form of increased MoH budgets (68) and policy reform (69).

On the topic of partnerships and networks, the literature recognizes that the value of NPHIs extends beyond the national level but may be leveraged through collaborative partnerships and regional and global networking opportunities. Like partnerships, twinning is a similar approach that has been successfully applied to NPHI collaborations (70). Similarly, several successful regional networks are evidenced by the launch of Africa CDC in 2017 (71, 72), NPHI networks in Europe (73) and South American NPHI networks (41). This finding also resonates with literature on NPHI networks and partnerships discussing the added value of facilitating reciprocity through sharing capacity and supplies such as laboratory networks (72).

Health workforce, particularly in low and middle income countries, is essential to achieving universal health coverage (74). Several articles point out that NPHI training, education, and hiring practices may inspire repatriation and retention of talent that would reduce brain drain - a well-documented detrimental phenomenon (75). Thus, NPHIs may serve as magnet organizations to attract workers studying abroad to return to their home country. Training has also been supported by regional NPHI organisations such as the European Centre for Disease Prevention and Control that coordinates field epidemiology and microbiology fellowship programmes (EPIET/EUPHEM). Regarding financial resources, some authors highlight the need for domestic investment and support for NPHIs while others discuss opportunities for investment from external funders. Several articles explicitly recommend funding allocated to NPHIs and infrastructure development (19, 22, 55, 56, 71, 72).

Finally, in terms of country context, the findings reveal that NPHIs reflect historical, cultural, social, linguistic, educational, political, and environmental dimensions unique to each country. Country ownership is fundamental given the necessity of understanding national traditions, values, and habits influencing health behaviour. The uniqueness of each NPHI further underscores the value of non-political, country owned and operated enterprises given the links between environment, culture, and health. Successful solutions addressing the Ebola outbreak in West Africa illustrate the importance of acquiring a community's trust, understanding cultural traditions, (i.e., burial traditions) and coordinating messaging and communication (i.e., addressing rumors) (76). NPHIs serve at national level but are also internationally linked with IANPHI and WHO. As such, NPHIs may provide a bridge between global level initiatives and national level response.

Research gaps. The scarcity of systematic quantitative or qualitative research, as evidenced by only three articles with dedicated methods sections, reveals the need for more rigorous research to inform future institutional development and design. Future studies could utilize survey, case study, or qualitative methodological approaches. Well-documented case studies of successful NPHIs could provide valuable information on best practices to inform creating new NPHIs. Another noted gap was the paucity of publications emanating from Asia relative to other regions of the world. Potential research areas that could add to the existing literature include:

- Success factors for established or strengthening newly emerging NPHIs
- NPHIs as data stewards and providers of national research infrastructure
- Impact of training and human resource development provided by NPHIs, how they fit in the wider educational system, and impact on retainment of qualified staff at national level
- NPHI experiences in maintaining scientific independence during the Covid-19 pandemic

- The role and contributions of global and regional NPHI networks
- Finally, did NPHI scientific leadership play a central role during the Covid pandemic or was it sidelined or scapegoated by politics?

Strengths and limitations

Strengths. To our knowledge, this is the first scoping review to systematically search, map, and synthesize the NPHI literature. This collection provides the first comprehensive overview of NPHI literature published in the last two decades. The iterative and exhaustive search strategy provides assurance that the final collection captured all relevant articles.

Limitations. All search terms were in English which may have limited the findings. While the results included several articles in other languages, some publications may have been missed. The search was limited to two databases: Medline and Scopus. Other databases may have included articles that were not discoverable in Medline and Scopus.

Conclusion

This scoping review demonstrates that public health leaders and authors from many different regions around the world have published articles on the historical legacies, experiences, contributions, and benefits of NPHIs. The findings illustrate that domains related to public health capacity building have been interlaced throughout the NPHI literature. The paucity of empirical qualitative or quantitative studies, however, points to the need for more robust research on NPHIs going forward. The weaknesses in public health systems in developed and developing countries exposed by the Covid pandemic further underscores the importance and need for investment in NPHI-focused research.

Abbreviations

CDC Center(s) for Disease Control

IANPHI International Association of Public Health Institutes

IHR International Health Regulations

MoH Ministry of Health

NPHI National public health institute

PHA Public health agency

SDG Sustainable Development Goals

WHO World Health Organization

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

SM, SF, and AB declare no competing interests or conflicts of interest.

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Authors' contributions

SM conceptualized the study design. SM and SF conducted the literature search, screening, and data extraction. SM, SF and AB contributed to the analysis and writing. All authors read and approved the final manuscript.

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Figures

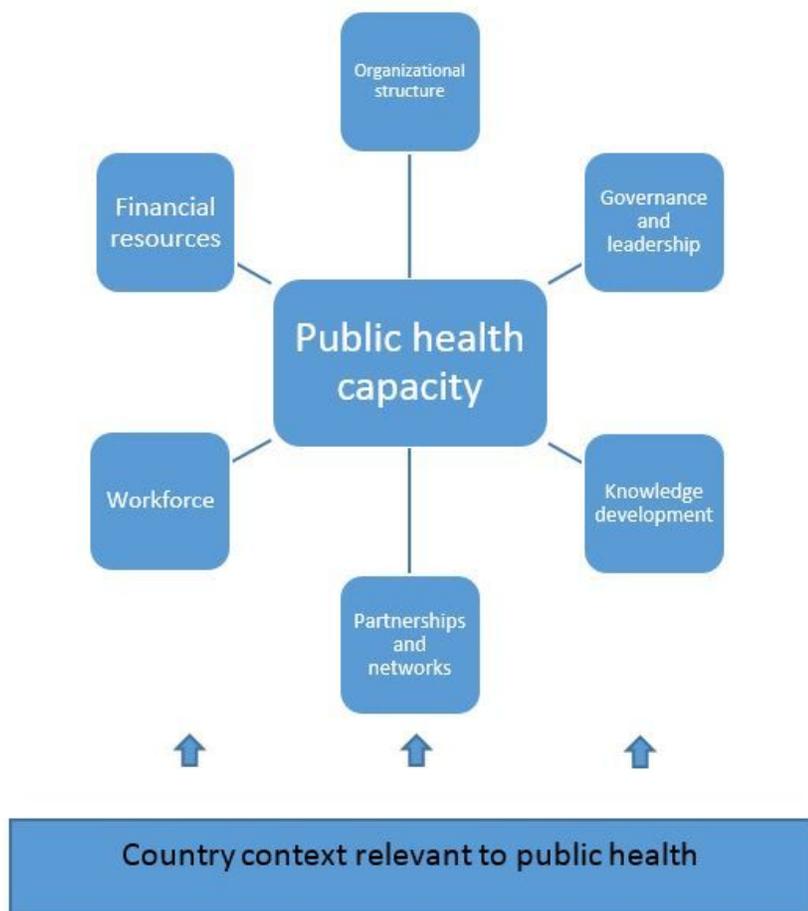


Figure 1

Modified version of Public health capacity conceptual framework (Aluttis et al, 2014)

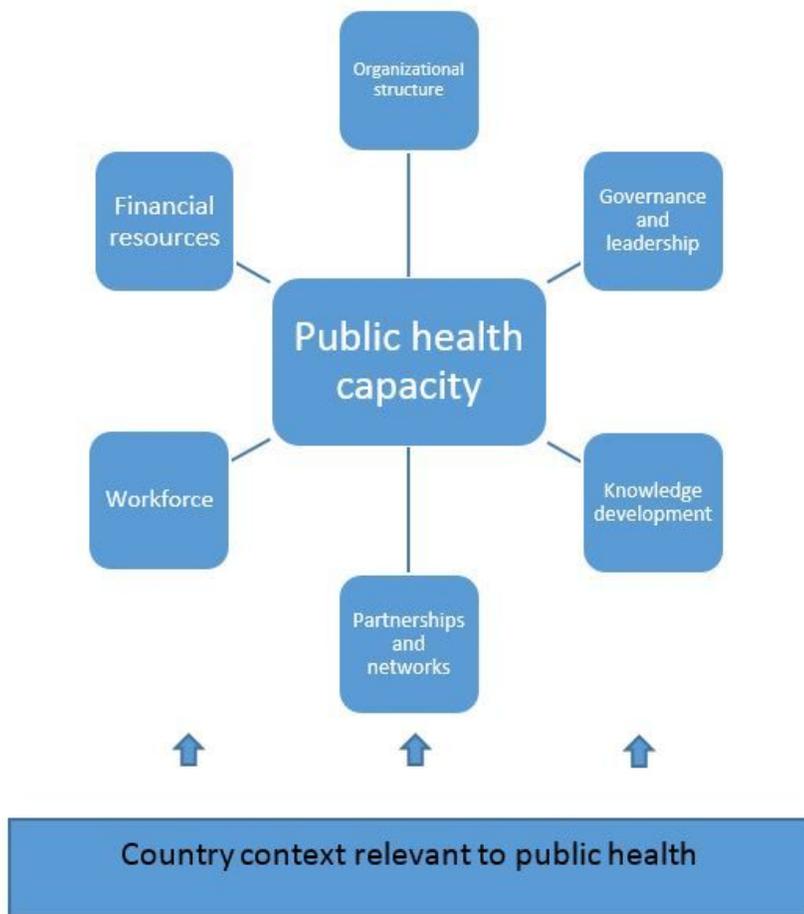


Figure 1

Modified version of Public health capacity conceptual framework (Aluttis et al, 2014)

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