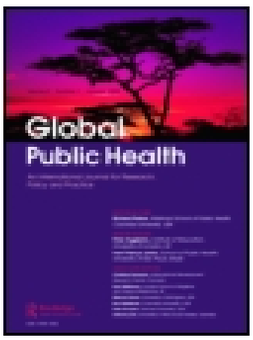

Taylor & Francis
Taylor & Francis Group

Global Public Health

An International Journal for Research, Policy and Practice

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rgph20

National public health institutes: A scoping review

Sonja L. Myhre, Steve D. French & Anne Bergh

To cite this article: Sonja L. Myhre, Steve D. French & Anne Bergh (2021): National public health institutes: A scoping review, Global Public Health, DOI: 10.1080/17441692.2021.1910966

To link to this article: https://doi.org/10.1080/17441692.2021.1910966

GLOBAL PUBLIC HEALTH
https://doi.org/10.1080/17441692.2021.1910966

Routledge
Taylor & Francis Group

National public health institutes: A scoping review

Sonja L. Myhre, Steve D. French and Anne Bergh

Division of Health Services, Global Health, Norwegian Institute of Public Health, Oslo, Norway

ABSTRACT

During the last century, national public health institutes emerged to address enduring and emergency public health challenges. Previous outbreaks often compelled countries to establish national institutes of public health. Despite historic legacies and contributions to public health, no review of this literature has been published. The aim of this scoping review is to provide an overview of this literature and map characteristics including format, authorship, geographic focus, methods, language, focal topic and public health capacity building domains. The scoping review was guided the Arksey and O'Malley methodological framework and utilised the PRISMA-ScR checklist. A systematic search of Medline OVID and Scopus databases yielded 5731 records. In total, 43 articles met the eligibility criteria. Articles were published in English, Spanish, French and Russian and included perspectives from over 20 countries in Africa, Europe, North America and South America. Three reported methods or collected primary data. Findings reveal a longstanding international interest in leveraging national institutes to address complex public health challenges. Lack of studies reporting methods reveals the need for future research utilising robust methodology. Several articles recommend investment in national public health institutes as a strategy to respond to crises and strengthen countries' public health systems.

ARTICLE HISTORY
Received 30 November 2020
Accepted 14 March 2021

KEYWORDS
National public health institute; national public health agency; center for disease control

Introduction

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 other complex, multidisciplinary and multisectoral health challenges such as non-communicable disease, climate change, and antimicrobial resistance, to name a few. 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 create a NPHI to provide better guidance, coordination, and leadership. Similarly, the Covid-19 pandemic may re-invigorate country interest in establishing 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 (De Ceukelaire & Bodini, 2020). 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

CONTACT Sonja Myhre sonjalynn.myhre@fhi.no; sonja.myhre@fhi.no Division of Health Services, Global Health, Norwegian Institute of Public Health, P.O. Box 222 Skøyen, Oslo 0213, Norway

Supplemental data for this article can be accessed https://doi.org/10.1080/17441692.2021.1910966.

(IANPHI) (IANPHI, Retrieved on October 16, 2020). Given that there are currently no reviews 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 identifed 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' (IANPHI, 2020). 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 (IANPHI, 2007). Although NPHIs around the world differ in name, structure, size, and scope, their focus on core public health functions is their unifying commonality (IANPHI, 2020).

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 synthesising existing knowledge (Colquhoun et al., 2014). Scoping reviews are often conducted to: examine the current breadth of research in a specific field; investigate readiness for conducting a systematic review; summarise and disseminate findings; and, identify gaps in the existing literature. Given that no review of the NPHI literature exists, conducting a scoping review was deemed appropriate to understand the breadth and depth of literature in this field. To standardise reporting of this review, we utilised the PRISMA-ScR (Preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews) checklist (Tricco et al., 2018).

Search strategy

Two search sources were utilised: (1) electronic database searches (Ovid Medline, Scopus) and (2) bibliographic review of reference lists from included articles. 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. 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.

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). Appendices 1 and 2 (see online supplemental data) contain 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 (Veritas Health Innovation).

Data extraction

The analysis followed an approach described by Arksey and O'Malley (2005) 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'. Based on scoping review data extraction methods (Joanna Briggs Institute, 2020), 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. Thematic content of articles was assesed using NVivo 12 Plus, a qualitative data analysis software (QSR International, 1999).

Conceptual framework

A conceptual model on country level public health capacities developed by Aluttis and colleagues was used to categorise themes and focal areas of the literature (Aluttis et al., 2014). 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 theorised to influence public health capacity building (Aluttis et al., 2014). These dimensions, shown in Figure 1, include: country specific context with relevance for public health, organisational structure, governance and leadership, knowledge development, partnerships and

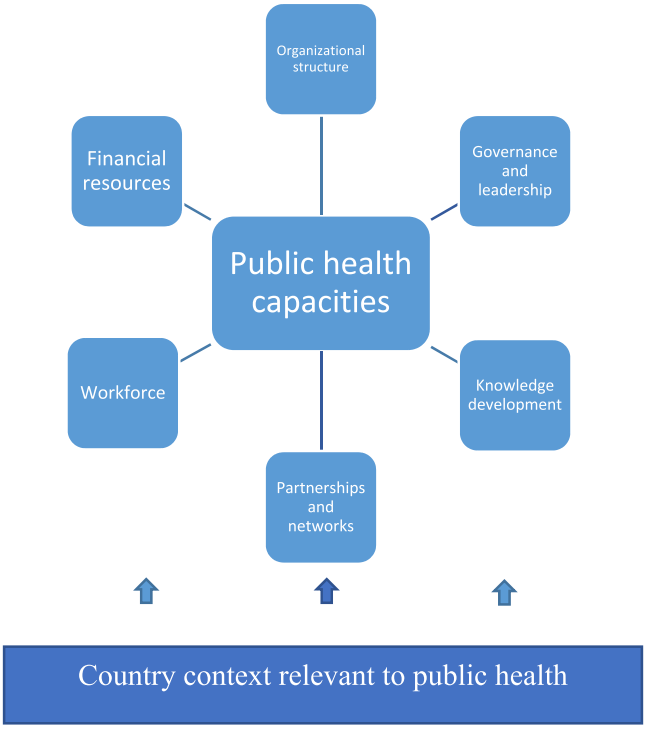

Figure 1. Modified version of conceptual framework of public health capacity. Note. This figure was adapted with permission from Dr. C. Aluttis (Aluttis et al., 2014).

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. organisational 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 (Hawe et al., 1997). 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.

Results

Search and selection process

Completed in May 2020, the search yielded 5731 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 (see online supplemental data) 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.

Overview of 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 summarised in Table 1.

Publication year. Approximately half of the articles ($n = 21$) were published from 2011 to 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 (U.S.A., Mexico, Canada) (22), Europe (France, United Kingdom, Czech Republic, Slovenia, Switzerland, Sweden and Finland) (9), Africa (South Africa, Burkina Faso, Nigeria, Morocco, 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). 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 (Hogstedt et al., 2004; Klavs et al., 2003; Kriz, 2005; Rodriguez-Lopez, 2008; Rubin, 2017) while others focused on the mandate and or scope by exploring NPHIs' engagement with public health core functions (Binder, Adigun, Dusenbury, et al., 2008; Frieden & Koplan, 2010; Koplan et al., 2005; Verrecchia et al., 2019), health infrastructure (Koplan et al., 2007), and One Health (Beer, 2013). The role of NPHIs in national and global health security was discussed in several articles (Buss et al., 2009; Heymann, 2008; Koplan et al., 2013; Rodier et al., 2007). The potential of NPHI partnerships, collaborations, and regional and global networks such as the IANPHI was addressed in several articles (Ihekweazu et al., 2015; Meda

Table 1. NPHI literature findings.

#	Authorship	Year	Origin of 1st author	Primary topic	Article type	Method section	Study method	Language	Geographic focus
1	Rosenfeld et al	2020	U.S.A.	Comparative analysis of NPHI legal frameworks	Legal review	Yes	Document review	English	Nigeria, Ethiopia, Guinea Bissau, Mozambique, Liberia
2	Verracchia et al	2019	U.K.	NPHI networks, global health	Commentary	No	–	English	International
3	Campos-Matos et al	2019	U.K.	NPHI and health inequalities	Commentary	No	–	English	United Kingdom
4	Barzilay et al	2018	U.S.A.	Development tool for NPHIs	Technical	No	–	English	International
5	Njidda et al	2018	Nigeria	Nigeria CDC	Commentary	No	–	English	Nigeria
6	Puska et al	2017	Finland	NPHIs and IANPHI	Editorial	No	–	English	International
7	Rubin	2017	U.S.A.	Mexico's INSP	Editorial	No	–	English	Mexico
8	Meda et al	2016	Burkina Faso	African NPHI network	Letter	No	–	English	West Africa
9	Bourdillon	2016	France	Santé Publique France	Commentary	No	–	French	France
10	Faford et al	2016	Canada	PHA Canada	Commentary	No	–	English	Canada
11	Spahic et al	2016	Canada	Governance of PHA Canada	Commentary	No	–	French	Canada
12	Ihekweazu et al	2015	South Africa	Collaboration of NICD (South Africa) and PHE (U.K.)	Commentary	No	–	English	South Africa, U.K.
13	Roa et al	2015	Brazil	Fiocruz NPHI network	Commentary	No	–	English	Brazil, Mozambique
14	Lahariya	2015	India	Lack of NPHI capacity in India	Commentary	No	–	English	India
15	Valladares et al	2015	Mexico	Graduate education	Commentary	No		English	Mexico
16	Beer	2013	U.S.A.	NPHIs and ecohealth	Letter	No	–	English	U.S.A., Canada
17	Koplan et al	2013	U.S.A.	NPHIs and health security	Commentary	No	–	English	Canada, China, Hong Kong, U.S.A.
18	Bloland et al	2012	U.S.A.	U.S. CDC and health system strengthening	Technical	No	–	English	International
19	Lopez	2012	Columbia	Columbia's NPHI	Editorial	No	–	Spanish	Columbia
20	Schepin et al	2012	Unknown	NPHI models	Commentary	No	–	Russian	International
21	Magana-Valladares et al	2011	Mexico	Mexico's NPHI and policy	Commentary	No	–	English	Mexico
22	Frieden et al	2010	U.S.A.	NPHI core functions	Commentary	No	–	English	International
23	Fierlbeck	2010	Canada	NPHI governance	Commentary	No	–	English	Canada
24	Binder et al	2009	U.S.A.	NPHI overview	Letter	No	–	English	International
25	Buss et al	2009	Brazil	NPHI Latin American network and health security	Commentary	No	–	Spanish	Latin America, Caribbean and international
26	Hassar	2008	Morocco	Morocco's 3 NPHI agencies	Commentary	No	–	English	Morocco
27	Heymann	2008	Switzerland	NPHIs and health security	Letter	No	–	English	International
28	Rodriguez-Lopez	2008	Mexico	Profile of Mexico INSP	Commentary	No	–	English	Mexico
29	Binder, Adigun, & Dusenbury	2008	U.S.A.	Survey data on NPHIs	Survey data	Yes	Survey of NPHIs	English	International
30	Binder, Adigun, Greenspan et al	2008	U.S.A.	Canada PHA, Morocco, Nigeria CDC, South Africa NICD, U.S. CDC	Case study	Yes	Document review, Interviews	English	Canada, Nigeria, U.S.A., Morocco, South Africa

(*Continued*)

Table 1. Continued.

#	Authorship	Year	Origin of 1st author	Primary topic	Article type	Method section	Study method	Language	Geographic focus
31	Silva	2008	Guinea Bissau	Guinea Bissau NPHI	Letter	No	–	English	Guinea Bissau
32	Anonymous	2008	NA	NPHI potential	Editorial	No	–	English	International
33	Frenk et al	2008	Mexico	NPHI building	Commentary	No	–	English	International
34	Wilson et al	2008	Canada	NPHI leadership models in U.S., U.K., and Canada	Commentary	No	–	English	Canada
35	Butler-Jones	2007	Canada	PHA Canada	Commentary	No	–	English	Canada
36	Koplan et al	2007	U.S.A.	NPHIs and public health infrastructure	Commentary	No	–	English	International
37	Adigun et al	2007	U.S.A.	NPHI development	Commentary	No	–	English	Africa
38	Rodier et al	2007	Switzerland	NPHIs and health security	Commentary	No	–	English	International
39	Jousilahti	2006	Finland	NPHI overview	Commentary	No	–	English	International
40	Koplan et al	2005	U.S.A.	NPHI core functions	Commentary	No	–	English	International
41	Kriz	2005	Czech Republic	Prague NPHI history	Narrative – historic	No	–	English	Czech Republic
42	Hogstedt et al	2004	Sweden	Swedish NIPH history	Narrative – historic	No	–	English	Sweden
43	Klavs et al	2003	Slovenia	Slovenia NIPH history	Narrative – historic	No	–	English	Slovenia

et al., 2016; Puska & Koplan, 2017). Governance challenges (Fafard & Forest, 2016; Fierlbeck, 2010), leadership (Wilson & Keelan, 2008), legal frameworks (Rosenfeld et al., 2020), and organisational structure (Binder, Adigun, and Greenspan, 2008) were discussed in several papers. Finally, technical tools to assist in NPHI development were also presented (Barzilay et al., 2018; Rosenfeld et al., 2020).

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, U.S.A.), 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.

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 (Aluttis et al., 2014). Table 2 presents a summary of the public health building capacity domains, descriptions, and examples from the NPHI literature.

Organisational structure

The concept of organisational 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. Moreover, organisational structure in many countries is often not static but rather subject to changes in government, administrations, and leadership (i.e. ministers, directors, etc.).

Organisational models. Several articles describe organisational models operationalised in different countries underscoring the diversity of how countries choose to structure NPHIs within the overall institutional architecture of a nation (Hassar, 2008; Jousilahti, 2006; Koplan et al., 2007, 2013). 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) (Buss et al., 2009). Similarly, other articles describe how European institutes originated in laboratory settings, hygiene efforts, and communicable disease traditions transitioning to NPHIs as evidenced by Germany's Robert Koch Institute initially the Royal Prussian Institute of Infectious Disease (1891) (Verrecchia et al., 2019), Prague's NPHI (1925) (Kriz, 2005) and the Republic of Slovenia's NPHI (1923) (Klavs et al., 2003).

Many articles describe different models of organising the work of NPHIs into either a network of closely coordinated agencies or institutes concentrating resources and expertise in one single entity (Binder, Adigun, Dusenbury, et al., 2008; Bloland et al., 2012; Hassar, 2008; Koplan et al., 2013). Several articles discuss the process and perceived advantages of organising NPHIs into one agency (Bourdillon, 2016; Hassar, 2008; Silva, 2008; Spahic et al., 2016). Advantages of consolidating public health functions under one roof are described as: optimising scarce resources (i.e. financial, personnel, technical); reducing costs, fragmentation, and duplication; increasing efficiency; and acquiring a critical mass of research and technical expertise.

Table 2. Public health capacity building domains.

Domain	Description	Examples from the literature
1. Organisational 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 (Hassar, 2008) Mergers (Binder, Adigun, & Greenspan, 2008; Bourdillon, 2016; Spahic et al., 2016) Public health core functions (Binder, Adigun, Dusenbury, et al., 2008; Frieden & Koplan, 2010; Koplan et al., 2005) Spectrum of NPHI scope (Adigun et al., 2007) IHR focal point (Heymann, 2008; Rodier et al., 2007)
2. Governance and leadership	Legal foundation and authority, autonomy, regulatory mechanisms, policies, oversight and advisory boards, and leadership models	Legal frameworks (Rosenfeld et al., 2020) Governance and autonomy (Fierlbeck, 2010; Wilson & Keelan, 2008) Oversight and advisory boards (Frenk & González-Block, 2008) NPHI leadership models (Fafard & Forest, 2016; Wilson & Keelan, 2008)
3. 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 (Magaña-Valladares & Cooper, 2011) NPHI surveys and studies (Frenk & González-Block, 2008; Rodriguez-Lopez, 2008) One Health (Beer, 2013) Applied research (Binder, Adigun, Dusenbury, et al., 2008; Heymann, 2008)
4. Partnerships and networks	NPHI partnerships, regional or international NPHI networks that enhance capacity by pooling or sharing resources or expertise	Collaborative partnerships (Ihekweazu et al., 2015) Regional networks (Meda et al., 2016; Verrecchia et al., 2019) International cooperation (Roa & Baptista e Silva, 2015) International network, i.e. IANPHI (Binder, Adigun, Dusenbury, et al., 2008; Puska & Koplan, 2017)
5. Workforce	Higher graduate and postgraduate education, continuing education, field epidemiology training programs, technical training, and workforce development activities	Graduate education/training (Rubin, 2017; Valladares & Ávila, 2015) Field epidemiology, laboratory training programs (Njidda et al., 2018) Technical exchange and training (Ihekweazu et al., 2015) Workforce development (Frenk & González-Block, 2008)
6. Financial resources	Domestic funding, core budgets, external funds supporting NPHIs (i.e. IANPHI, donors, external grants)	Domestic budgets/funding (Binder, Adigun, & Greenspan, 2008) IANPHI support (Rodier et al., 2007; Silva, 2008; Verrecchia et al., 2019) Donor investment (Koplan et al., 2005)
7. Country specific context	Social, cultural, environmental, and political features influencing public health institutes	Country engagement in development assessment tool (Barzilay et al., 2018) Contextual lessons (Buss et al., 2009; Koplan et al., 2013)

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 (Buss et al., 2009; Koplan et al., 2013). Maintaining institutional continuity during political fluctuations or instability was also considered an advantage (Jousilahti, 2006). One study investigating the initial formation of NPHIs found that merging 'precursor' organisations is common (Binder, Adigun, & Greenspan, 2008). Moreover, mergers were often the result of leaders leveraging opportunities to broaden their mandates through consolidation or reorganisation.

Scope. Several articles state that the scope of NPHI tasks varies reflecting level of maturity, resources, and staff (Adigun et al., 2007; Binder, Adigun, & Greenspan, 2008; Verrecchia et al., 2019). Adigun et al. (2007) describe NPHI development as evolving along a continuum of

institutional maturity from countries with little to no public health infrastructure to fledgling organisations and mature agencies managing comprehensive mandates. Similarly, Koplan et al. (2007) note that while, historically, many NPHIs emerged to address infectious disease and environmental issues affecting the public's health, twenty-first century public health challenges (i.e. noncommunicable disease, antimicrobial resistance, climate change and traffic injuries) have redirected and expanded their mandates. Verrecchia et al. (2019) note, however, that the scope of NPHIs in LMICs may be limited by resource constraints and fragmented health systems.

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 ($n = 28$). Binder, Adigun, Dusenbury, et al. (2008) reveal that NPHIs often engage in a set of core public health functions. The scope of these core functions are often delineated in legal documentation as reported by Rosenfeld and colleagues (Rosenfeld et al., 2020).

Acknowledging limited national public heath 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 (Meda et al., 2016). Given that many core public health functions involve health security, increased attention to adherence and compliance with the International Health Regulations (IHR) has recognised NPHIs as natural focal points for IHR implementation and communication (Heymann, 2008; Rodier et al., 2007)

Institutional development. A concept of NPHI building emerged with the establishment of IANPHI and was further developed by Frenk and González-Block (2008) calling for a global movement to support the establishment, expansion, and strengthening of NPHIs worldwide. The premise was 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 NPHI contributions to health infrastructure (Koplan et al., 2005, 2007), public health capacity (Verrecchia et al., 2019) and IANPHI's efforts to strengthen NPHIs (Puska & Koplan, 2017).

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 (Rosenfeld et al., 2020). Countries also vary in terms of formal and informal administrative links with other agencies and their positioning within the broader health portfolio (Fierlbeck, 2010).

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 (Fafard & Forest, 2016; Wilson & Keelan, 2008) can 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 not aligned with agendas of those in power. Various mechanisms that protect scientific independence and autonomy of the chief official responsible for public health such as providing protection of this position from dismissal without cause, ensuring open communication with the public, and ensuring that recommendations are supported by science, have been discussed by Canadian researchers (Wilson & Keelan, 2008). Several other articles also briefly mention this topic (Fafard & Forest, 2016; Fierlbeck, 2010; Frenk & González-Block, 2008; Puska & Koplan, 2017; Rosenfeld et al., 2020; Verrecchia et al., 2019).

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 (Binder, Adigun, & Greenspan, 2008; Bloland et al., 2012; Frieden & Koplan, 2010; Rosenfeld et al., 2020). 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 (Fafard & Forest, 2016; Wilson & Keelan, 2008).

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 (Rosenfeld et al., 2020). 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 (Frenk & González-Block, 2008).

Knowledge development

As science-based organisations, 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 assessment, 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 and needs.

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 (Binder, Adigun, Dusenbury, et al., 2008; Frieden & Koplan, 2010). 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 (Hogstedt et al., 2004) 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 (Klavs et al., 2003; Kriz, 2005). In sum, a vital contribution of a NPHI is to share scientific knowledge, offer ongoing advice to the MoH and national government, and influence private and nonprofit stakeholders in order to benefit the public's health.

Partnerships and networks

Partnerships and networks were discussed in terms of benefits derived from collaborations between countries as well as regional and international networks that facilitate sharing of resources and expertise (Buss et al., 2009; Jousilahti, 2006; Koplan et al., 2007; Meda et al., 2016; Roa & Baptista e Silva, 2015; Verrecchia et al., 2019).

Partnerships. NPHIs work collaboratively with international organisations, academia, NGOs, and engage in collaborative relationships with sister institutes on research projects, implementation, or technical issues. Ihekweazu and colleagues (2015), for example, describe a North South technical exchange program between the United Kingdom and South Africa that benefitted both organisations by promoting a reciprocal exchange of information, skills, and advice.

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 (Meda et al., 2016) and the activities of the Mesoamerican Institute of Public Health are two examples of regional initiatives (Magaña-Valladares & Cooper, 2011). Africa CDC, for example, established five Regional Collaborating Centres strategically situated in five regions of Africa (Njidda et al., 2018) 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 utilising a unique structural cooperation approach that prioritises partnerships and states' endogenous resources and capacity (Roa & Baptista e Silva, 2015).

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 (Jousilahti, 2006; Koplan et al., 2005). With more than a decade of experience, IANPHI has demonstrated value by supporting members through leadership mentoring, resource sharing, guidance, peer support and has been instrumental in organisational development and establishment processes (Puska & Koplan, 2017).

Workforce

Many articles described the need for a competent public health workforce (Bloland et al., 2012; Frieden & Koplan, 2010; Jousilahti, 2006; Koplan et al., 2005) and direct NPHI engagement with workforce development, training, and higher educational opportunities (Frenk & González-Block, 2008; Hogstedt et al., 2004; Klavs et al., 2003; Kriz, 2005; Magaña-Valladares & Cooper, 2011; Rubin, 2017; Valladares & Ávila, 2015).

Graduate education. Articles discussing experiences from Mexico (Frenk & González-Block, 2008; Rodriguez-Lopez, 2008; Rubin, 2017; Valladares & Ávila, 2015) and Brazil (Roa & Baptista e Silva, 2015) are unique in that their mandates includes accredited educational opportunities in public health disciplines, training, and workforce development. This may also result in 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, the value of continuing education and graduate level programmes (Valladares & Ávila, 2015), and increasing potential for distance learning (Frieden & Koplan, 2010) was also highlighted.

Field training. Several articles mentioned opportunities for public health training and support for field epidemiology and laboratory training programmes (Njidda et al., 2018) often modelled after the U.S. CDC Epidemic Intelligence Service program (Bloland et al., 2012; Verrecchia et al., 2019). 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 (Bloland et al., 2012).

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 (Ihekweazu et al., 2015). Peer learning was also mentioned as a way to facilitate knowledge exchange (Verrecchia et al., 2019).

Financial resources

Domestic and external funding. Financial resources were also discussed in several articles. A few articles recommended investment in public health infrastructure, specifically for strengthening NPHIs (Adigun et al., 2007; Koplan et al., 2007). 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 (Frenk & González-Block, 2008). Several articles discuss external funding opportunities available from IANPHI (Binder, Adigun, & Greenspan, 2008; Puska & Koplan, 2017; Silva, 2008; Verrecchia et al., 2019) while others suggested external donors invest in national infrastructure such as NPHIs (Koplan et al., 2007). One article compared the NPHI budgets in three different countries (Binder, Adigun, & Greenspan, 2008). Relatively few articles, however, discuss the breakdown of NPHIs' budgets (domestic, external sources) or available financial resources. This issue is of particular importance given that funding may influence how NPHIs work.

Country level context

Examples from the literature suggest that historical, situational and political factors impact the development and direction of NPHIs (Binder, Adigun, & Greenspan, 2008). NPHI historic narratives (Anonymous, 2012; Hogstedt et al., 2004; Klavs et al., 2003; Kriz, 2005) discuss the impact of events and trends while public health emergencies may reflect situational, political, cultural, and environmental factors (Koplan et al., 2013; Wilson & Keelan, 2008) 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 (Rosenfeld et al., 2020), leadership models (Wilson & Keelan, 2008), and organisational structures (Binder, Adigun, & Greenspan, 2008) 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 (Barzilay et al., 2018).

Discussion

This scoping review provides an overview of NPHI literature that is highly relevant to the global health community in lieu of the Covid-19 pandemic. Increasingly, NPHIs are being recognised for their capacity to respond to public health emergencies. In a 2019 *Nature* article discussing health challenges of the twenty-first century, for example, public health leaders highlighted to the unique ability of NPHIs to respond to epidemics (Bedford et al., 2019). 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' (Pierre-Louis et al., 2012). More recently, Shamasunder and colleagues (2020) assert that this pandemic provides the opportunity and obligation to redesign stronger public health infrastructure and capacity. In sum, lessons accumulated from past outbreaks have repeatedly acknowledged the importance of national entities with designated authority and responsibility to respond (Koplan et al., 2013). The case for functional NPHIs in every country is based on the understanding 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 behaviours 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 transitioning 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 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 organisational 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 organisational structure and institutional design has received limited attention in the field of public health despite research recognising that public health organisations and other actors are potential drivers for implementing public health visions, policies, and

transformations (Jakubowski et al., 2018). The review also reveals the paucity of research dedicated to investigating the scientific independence and autonomy of NPHIs.

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 main organisation 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. A report on building MoH capacity considered strengthening NPHIs a strategic investment given their role as a 'health resource partner institution' (Omaswa & Boufford, 2010). This report underscores the value of investing in national institutions (e.g. NPHIs, schools of public health) that build capacity, leverage local knowledge and resources, and instill country ownership.

Approaches to national development have highlighted the potential of strengthening health systems by investing in a country's local organisational capacity (Swanson et al., 2015). 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) is an effective means of improving health system outcomes (Ferreira & Fonseca, 2017). 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 (Onyebujoh et al., 2016) as well as the potential for integrating health management information systems (Bogaert & Van Oyen, 2017). 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 (Kirigia & Wambebe, 2006) that could be areas for NPHIs to support. Recent findings suggest that local capacity building efforts supporting research may have important dividends (Kasprowicz et al., 2020). 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 (González-Block, 2009) and policy reform (Knaul et al., 2006).

On the topic of partnerships and networks, the literature recognises 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 (Cadée et al., 2016). Similarly, several successful regional networks are evidenced by the launch of Africa CDC in 2017, NPHI networks in Europe (World Health Organization/International Association of National Public Health Institutes, 2018) and South American NPHI networks (Roa & Baptista e Silva, 2015). 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 (Nkengasong, 2019).

Health workforce, particularly in low and middle income countries, is essential to achieving universal health coverage (Reid et al., 2020). 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 (Ihekweazu et al., 2005). Thus, NPHIs may serve as magnet organisations 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. 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 (Bedford et al., 2019; Jousilahti, 2006; Koplan et al., 2005, 2007; Nkengasong, 2019; Nkengasong et al., 2017). Given that few articles examine NPHIs funded, this is a topic worthy of further research.

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 apolitical, 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. debunking rumours) (Wilkinson et al., 2020). NPHIs serve at national level but are also internationally linked with IANPHI and WHO. As such, NPHIs bridge global level initiatives with national level response. Collectively, all of these dimensions contribute to public health capacity which can be understood as manpower, infrastructure, and resources.

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 utilise 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
- Mechanisms and processes through which NPHIs influence national public health
- Impact of training and human resource development provided by NPHIs
- Contributions of global and regional NPHI networks
- NPHI experiences in maintaining scientific independence during the Covid-19 pandemic

Strengths and limitations

Strengths

To our knowledge, this is the first scoping review to systematically search, map, and synthesise 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 findings all show clear gaps on topics such as scientific independence, autonomy, and financial resources that deserve further attention. Existing and emerging public health challenges (e.g. non-communicable diseases, climate change, antimicrobial resistance, and future potential epidemics) all underscore the importance and need for investment in NPHI-focused research.

Acknowledgements

We wish to thank Marit Johansen, Cochrane information specialist, for her guidance throughout the process of designing and finetuning the search protocol. We also wish to thank the following for their insights on preliminary drafts of this manuscript: Heather Ames, Katrine Frønsdal, Susan Kyomuhendo Munabi-Babigumira, Heather Munte-Kaas, Trygve Ottersen, Elizabeth Peacocke, and Ingvil Sæterdal. Norad was not involved in the study design, collection, analysis, interpretation of data, or writing of this manuscript. SM conceptualised 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.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The study received funding from the Norwegian Agency for Development Cooperation (Norad).

ORCID

Sonja L. Myhre http://orcid.org/0000-0002-6290-9311

References

Adigun, L., Dusenbury, C., & Schoub, B. D. (2007). Public health in Africa – The role of national public health institutes. *South African Medical Journal*, *97*(11), 1036–1039. PMID: 18254195.

Aluttis, C., den Broucke, S. V., Chiotan, C., Costongs, C., & Michelsen, K. (2014). Public health and health promotion capacity at national and regional level: A review of conceptual frameworks. *Journal of Public Health Research*, *3*(1), 199. https://doi.org/10.4081/jphr.2014.199

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(*1*), 19–32. https://doi.org/10.1080/1364557032000119616

Barzilay, E. J., Vandi, H., Binder, S., Udo, I., Ospina, M., Ihekweazu, C., & Bratton, S. (2018). Use of the staged development tool for assessing, planning, and measuring progress in the development of National Public Health Institutes. *Health Security*, *16*(S1), S18–S24. https://doi.org/10.1089/hs.2018.0044

Bedford, J., Farrar, J., Ihekweazu, C., Kang, G., Koopmans, M., & Nkengasong, J. (2019). A new twenty-first century science for effective epidemic response. *Nature*, *575*(7781), 130–136. https://doi.org/10.1038/s41586-019-1717-y

Beer, K. (2013). News from the IAEH. Discussion on the role of national public health agencies in the implementation of ecohealth strategies for infectious disease prevention. *Ecohealth*, *10*(2), 111–114. https://doi.org/10.1007/s10393-013-0840-8

Binder, S., Adigun, L., Dusenbury, C., Greenspan, A., & Tanhuanpaa, P. (2008). National Public Health Institutes: Contributing to the public good. *Journal of Public Health Policy*, *29*(1), 3–21. https://doi.org/10.1057/palgrave.jphp.3200167

Binder, S., Adigun, L. E., & Greenspan, A. L. (2008). NPHI creation: Lessons learned and future directions. *Journal of Public Health Policy*, *29*(4), 459–466. https://doi.org/10.1057/jphp.2008.33

Bloland, P., Simone, P., Burkholder, B., Slutsker, L., & De Cock, K. M. (2012). The role of public health institutions in global health system strengthening efforts: The US CDC's perspective. *PLoS Medicine*, *9*(4), e1001199. https://doi.org/10.1371/journal.pmed.1001199

Bogaert, P., & Van Oyen, H. (2017). An integrated and sustainable EU health information system: National public health institutes' needs and possible benefits. *Archives of Public Health*, *75*(1), 3. https://doi.org/10.1186/s13690-016-0171-7

Bourdillon, F. (2016). France creates a national public health agency. Illustrations of its main missions and challenges. *Bulletin de L'Académie Nationale de Médecine*, *200*(3), 639–650. https://doi.org/10.1016/s0001-4079(19)30738-1

Buss, P., Koplan, J. P., Dusenbury, C., Binder, S., & Rosenberg, F. (2009). National public health institutes: A coordinated and comprehensive approach toward influenza A H1N1 and other threats to public health. *Pan American Journal of Public Health*, *26*(2), 184–188. https://doi.org/10.1590/S1020-49892009000800012

Cadée, F., Nieuwenhuijze, M. J., Lagro-Janssen, A. L. M., & De Vries, R. (2016). The state of the art of twinning, a concept analysis of twinning in healthcare. *Globalization and Health*, *12*(1), 66. https://doi.org/10.1186/s12992-016-0205-5

Colquhoun, H., Levac, D., O'Brien, K., Straus, S., Tricco, A., Perrier, L., & Moher, D. (2014). Scoping reviews: Time for clarity in definition, methods, and reporting. *Journal of Clinical Epidemiology*, *12*(12), 1291–1294. https://doi.org/10.1016/j.jclinepi.2014.03.013

De Ceukelaire, W., & Bodini, C. (2020). We need strong public health care to contain the global corona pandemic. *International Journal of Health Services*, *50*(3), 3. https://doi.org/10.1177/0020731420916725

Fafard, P., & Forest, P.-G. (2016). The loss of that which never was: Evaluating changes to the senior management of the Public Health Agency of Canada. *Canadian Public Administration*, *59*(3), 448–466. https://doi.org/10.1111/capa.12174

Ferreira, J. R., & Fonseca, L. E. (2017). Cooperação estruturante, a experiência da Fiocruz Structural Cooperation, the Fiocruz experience. *Ciência & Saúde Coletiva*, *22*(7), 2129–2133. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-81232017002702129&nrm=iso. https://doi.org/10.1590/1413-81232017227.04412017

Fierlbeck, K. (2010). Public health and collaborative governance. *Canadian Public Administration*, *53*(1), 1–19. https://doi.org/10.1111/j.1754-7121.2010.00110.x

Frenk, J., & González-Block, M. (2008). Institutional development for public health: Learning the lessons, renewing the commitment. *Journal of Public Health Policy*, *29*(4), 449. https://doi.org/10.1057/jphp.2008.35

Frieden, T. R., & Koplan, J. P. (2010). Stronger national public health institutes for global health. *The Lancet*, *376*(9754), 1721–1722. https://doi.org/10.1016/S0140-6736(10)62007-7

González-Block, M. A. (2009). Leadership, institution building and pay-back of health systems research in Mexico. *Health Research Policy and Systems*, *7*(1), 22–22. https://doi.org/10.1186/1478-4505-7-22

Hassar, M. (2008). NPHIs and public goods: A perspective from Morocco. *Journal of Public Health Policy*, *29*(1), 22–25. https://doi.org/10.1057/palgrave.jphp.3200166

Hawe, P., Noort, M., King, L., & J, C. (1997). Multiplying health gains: The critical role of capacity-building within public health programs. *Health Policy*, *39*(1), 29–42. https://doi.org/10.1016/S0168-8510(96)00847-0

Heymann, D. L. (2008). NPHIs as focal points for leadership in prevention and control of infectious diseases. *Journal of Public Health Policy*, *29*(3), 374–376. https://doi.org/10.1057/jphp.2008.19

Hogstedt, C., Lundgren, B., Moberg, H., Pettersson, B., & Agren, G. (2004). The Swedish public health policy and the National Institute of Public Health. *Scandinavian Journal of Public Health. Supplement*, *64*, 6–64. PMID: 15768522.

IANPHI. (2007). *Framework for the creation and development of National Public Health Institutes.* National Public Health Institutes: Core functions and attributes. Retrieved February 3, 2020 from http://www.ianphi.org/_includes/documents/core-functions.pdf, accessed February 3, 2020

IANPHI. (2020). Retrieved October 16, 2020 from https://ianphi.org/about/index.html

Ihekweazu, C., Anya, I., & Anosike, E. (2005). Nigerian medical graduates: Where are they now? *Lancet*, *365*(9474), 1847–1848. https://doi.org/10.1016/s0140-6736(05)66612-3

Ihekweazu, C., Ncube, F., Schoub, B., Blumberg, L., Ruggles, R., Salter, M., Madhi, S., & Kessel, A. (2015). A North/South collaboration between two national public health institutes–a model for global health protection. *Journal of Public Health Policy*, *36*(2), 181–193. https://doi.org/10.1057/jphp.2014.52

Jakubowski, E., Kluge, H., & Rechel, B. (2018). Organization of public health services. In Rechel B, Jakubowski E, and E. A. McKee (Eds.), Organization and financing of public health services in Europe [Internet] (Vol. Health Policy Series, No. 50.). European Observatory on Health Systems and Policies. https://www.ncbi.nlm.nih.gov/books/NBK535720/

Joanna Briggs Institute. (2020). *JBI reviewer's manual*. https://reviewersmanual.joannabriggs.org/

Jousilahti, P. (2006). Improving the world's health – The role of National Public Health Institutes. *Central European Journal of Public Health*, *14*(1), 3–5. https://doi.org/10.21101/cejph.b0052

Kasprowicz, V. O., Chopera, D., Waddilove, K. D., Brockman, M. A., Gilmour, J., Hunter, E., Kilembe, W., Karita, E., Gaseitsiwe, S., Sanders, E. J., & Ndung'u, T. (2020). African-led health research and capacity building- is it working? *BMC Public Health*, *20*(1), 1104. https://doi.org/10.1186/s12889-020-08875-3

Kirigia, J. M., & Wambebe, C. (2006). Status of national health research systems in ten countries of the WHO African region. *BMC Health Services Research*, *6*(1), 135. https://doi.org/10.1186/1472-6963-6-135

Klavs, I., Albreht, T., Berger, T., Drev, A., Kraigher, A., Moravec Berger, D., Otorepec, P., Rogac, M., Seljak, M., Stergar, E., Svab, I., & Marusic, A. (2003). Eighty years of the Slovenian Institute of Public Health: Challenges for the future. *Croatian Medical Journal*, *44*(5), 511–519. PMID: 14515406.

Knaul, F. M., Arreola-Ornelas, H., Méndez-Carniado, O., Bryson-Cahn, C., Barofsky, J., Maguire, R., Miranda, M., & Sesma, S. (2006). Evidence is good for your health system: Policy reform to remedy catastrophic and impoverishing health spending in Mexico. *The Lancet*, *368*(9549), 1828–1841. https://doi.org/10.1016/S0140-6736(06)69565-2

Koplan, J. P., Butler-Jones, D., Tsang, T., & Yu, W. (2013). Public health lessons from severe acute respiratory syndrome a decade later. *Emerging Infectious Diseases*, *19*(6), 861–863. https://doi.org/10.3201/eid1906.121426

Koplan, J. P., Dusenbury, C., Jousilahti, P., & Puska, P. (2007). The role of national public health institutes in health infrastructure development. *BMJ*, *335*(7625), 834–835. https://doi.org/10.1136/bmj.39356.406377.BE

Koplan, J. P., Puska, P., Jousilahti, P., Cahill, K., & Huttunen, J. (2005). Improving the world's health through national public health institutes. *Bulletin of the World Health Organization*, *83*(2), 154–157. https://doi.org/17

Kriz, J. (2005). Eighty years of the National Institute of Public Health in Prague. *Central European Journal of Public Health*, *13*(1), 3–5. PMID: 15859172.

Magaña-Valladares, L., & Cooper, K. (2011). The National Institute of Public Health: Shaping public policy to advance population health in Mexico. *Public Health Reviews*, *33*(1), 331–338. https://doi.org/10.1007/BF03391638

Meda, N., Dabis, F., Desenclos, J. C., Crespin, X., & Delfraissy, J. F. (2016). Network for strong, national, public health institutes in Africa. *The Lancet*, *387*(10034). https://doi.org/10.1016/S0140-6736(16)30015-0

Njidda, A. M., Oyebanji, O., Obasanya, J., Ojo, O., Adedeji, A., Mba, N., Oladejo, J., & Ihekweazu, C. (2018). The Nigeria centre for disease control. *BMJ Global Health*, *3*(2), e000712. https://doi.org/10.1136/bmjgh-2018-000712

Nkengasong, J. N. (2019). How Africa can quell the next disease outbreaks. *Nature*, *567*(7747). https://doi.org/10.1038/d41586-019-00789-4

Nkengasong, J. N., Maiyegun, O., & Moeti, M. (2017). Establishing the Africa Centres for Disease Control and Prevention: Responding to Africa's health threats. *The Lancet Global Health*, *5*(3), e246–e247. https://doi.org/10.1016/s2214-109x(17)30025-6

Omaswa, F., & Boufford, J. (2010). *Strong ministries for strong health systems*.

Onyebujoh, P. C., Thirumala, A. K., & Ndihokubwayo, J. B. (2016). Integrating laboratory networks, surveillance systems and public health institutes in Africa. *African Journal of Laboratory Medicine*, *5*(3), 431. https://doi.org/10.4102/ajlm.v5i3.431

Pierre-Louis, A., El-Saharty, S., Stanciole, A., Jonas, O., Pascual, F., Oelrichs, R., Lorenzo, M., Villafana, T., Lavadenz, F., & Rock, M. (2012). *Connecting sectors and systems for health results*.

Puska, P., & Koplan, J. P. (2017). IANPHI-10 years of collaboration for institutional public health. *European Journal of Public Health*, *27*(2), 192–193. https://doi.org/10.1093/eurpub/ckw241

QSR International. (1999). *NVivo Qualitative data analysis software [Software]* (Version 12). https://qsrinternational.com/nvivo/nvivo-products/

Reid, M., Gupta, R., Roberts, G., Goosby, E., & Wesson, P. (2020). Achieving Universal Health Coverage (UHC): Dominance analysis across 183 countries highlights importance of strengthening health workforce. *PLoS One*, *15*(3), e0229666. https://doi.org/10.1371/journal.pone.0229666

Roa, A. C., & Baptista e Silva, F. R. (2015). Fiocruz as an actor in Brazilian foreign relations in the context of the Community of Portuguese-Speaking Countries: An untold story. *História, Ciências, Saúde-Manguinhos*, *22*(1), 153–169. https://doi.org/10.1590/s0104-59702015000100009

Rodier, G., Greenspan, A. L., Hughes, J. M., & Heymann, D. L. (2007). Global public health security. *Emerging Infectious Diseases*, *13*(10), 1447–1452. https://doi.org/10.3201/eid1310.070732

Rodriguez-Lopez, M. H. (2008). Commentary: A perspective from Mexico. *Journal of Public Health Policy*, *29*(1), 26–31. https://doi.org/10.1057/palgrave.jphp.3200168

Rosenfeld, E. L., Binder, S., Brush, C. A., Whitney, E. A. S., Jarvis, D., Seib, K., Verani, A. R., Flores, M. A., & Menon, A. N. (2020). National Public Health Institute legal framework: A tool to build public health capacity. *Health Security*, *18*(S1), S43–S52. https://doi.org/10.1089/hs.2019.0093

Rubin, R. (2017). Profile: Mexico's National Institute of Public Health at 30. *Lancet*, *389*(10071), 787. https://doi.org/10.1016/s0140-6736(17)30582-2

Schepin, O, Nechaev, V, & Jyliyaeva, Y. (2012). [The national institutes of public health in the contemporary world]. *Problemy Sotsialnoi Gigieny i Istoriia Meditsiny*, *20*(1), 3–5.

Shamasunder, S., Holmes, S. M., Goronga, T., Carrasco, H., Katz, E., Frankfurter, R., & Keshavjee, S. (2020). COVID-19 reveals weak health systems by design: Why we must re-make global health in this historic moment. *Global Public Health*, *15*(7), 1083–1089. https://doi.org/10.1080/17441692.2020.1760915

Silva, A. (2008). Letter from Guinea Bissau. *Journal of Public Health Policy*, *29*(3), 377–378. https://doi.org/10.1057/jphp.2008.18

Spahic, M., Mettendorff, M., & Bourdillon, F. (2016). Flashback to the reform experience: The Creation of Santé publique France, the National Public Health Agency. *Les Tribunes de la Santé*, *53*(4), 35–47. https://www.cairn.info/journal-les-tribunes-de-la-sante1-2016-4-page-35.htm. https://doi.org/10.3917/seve.053.0035

Swanson, R. C., Atun, R., Best, A., Betigeri, A., de Campos, F., Chunharas, S., Collins, T., Currie, G., Jan, S., McCoy, D., Omaswa, F., Sanders, D., Sundararaman, T., & Van Damme, W. (2015). Strengthening health systems in low-income countries by enhancing organizational capacities and improving institutions. *Globalization and Health*, *11*(1), 5. https://doi.org/10.1186/s12992-015-0090-3

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/m18-0850

Valladares, L. M., & Ávila, M. H. (2015). Innovations in graduate public health education: The Instituto Nacional de Salud Pública. *American Journal of Public Health*, *105*(Suppl. 1), S88–S91. https://doi.org/10.2105/ajph.2014.302478

Veritas Health Innovation. Covidence systematic review software.

Verrecchia, R., Dar, O., Mohamed-Ahmed, O., & Squires, N. (2019). Building operational public health capacity through collaborative networks of National Public Health Institutes. *BMJ Global Health*, *4*(5), e001868. https://doi.org/10.1136/bmjgh-2019-001868

Wilkinson, A., Parker, M., Martineau, F., & Leach, M. (2020). Engaging 'communities': Anthropological insights from the West African Ebola epidemic. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences*, *372*(1721), 26. https://doi.org/10.1080/17441692.2020.1760915

Wilson, K., & Keelan, J. (2008). Learning from listeria: The autonomy of the Public Health Agency of Canada. *Canadian Medical Association Journal*, *179*(9), 877–879. https://doi.org/10.1503/cmaj.081441

World Health Organization/International Association of National Public Health Institutes. (2018). *Establishing National Public Health Institutes through mergers – What does it take?* Joint WHO Regional Office for Europe and International Association of National Public Health Institutes Technical Seminar, Poland.