More than a decade has passed since a conceptual framework was introduced to guide public health services and systems research (PHSSR) and elucidate the relationships associated with system performance. Since then, research has primarily focused on performance, standards, and key processes, with less emphasis on identification of measures or methods. Capacity lies at one end of the conceptual framework, although little emphasis has been placed on measuring and defining “capacity” of the public health system. This is striking, given organizational capacity is a critical determinant of performance and is necessary for understanding systematic effectiveness, sustainability, or generalizability. As a nascent field, PHSSR needs to develop a definition of organizational capacity and elucidate its relationship within a research framework. Evidence must be developed on the temporal and causal relationships between capacity, process/performance, and outcomes. The purpose of this article was to review research frameworks and capacity measures in various disciplines to expand the existing PHSSR conceptual framework.

KEY WORDS: measurement, methods, organizational capacity, PHSSR

Public health services and systems research (PHSSR) examines the complex and dynamic mechanisms behind disease prevention and health promotion efforts of the public health system. This research helps quantify the effectiveness of public health services at multiple levels but has been limited by the lack of measures and methods. Much of the research effort has focused on performance, standards, and key processes, whereas little work has been done on methodologies or to identify constructs for measurement. In order for “public health practice to move toward an evidence-based science-driven basis for decision-making,” measurement and methods for PHSSR need to be better elucidated.

Measuring and defining the “capacity” of a public health system are areas of PHSSR that have received relatively little emphasis. This is surprising considering that capacity is a critical determinant of system performance. As such, capacity is a key element of evaluation or improvement efforts in many other fields. However, in a not-for-profit culture such as public health, capacity assessment is often neglected in favor of program development or evaluated within very narrow perspectives. This is problematic because focusing solely on performance indicators ignores the temporal or causal relationships of the system and offers little insight into understanding systematic effectiveness, sustainability, or generalizability.

Public health performance relative to the capacity of the system or organization is perhaps a more useful concept to guide PHSSR. It enables us to ask: “How well did you do (process/performance), given what you had...”

Author Affiliations: Lineberger Comprehensive Cancer Center (Dr Meyer), Cecil G. Sheps Center for Health Services Research (Dr Meyer), and Center for Public Health Preparedness (Ms Davis), University of North Carolina, Chapel Hill; and Department of Health Services Management, Center for Public Health Services and Systems Research, University of Kentucky, Lexington (Dr Mays).

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Correspondence: Anne-Marie Meyer, PhD, Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, NC 27599 (meyer-er@email.unc.edu).

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to work with (capacity)?” Adequate performance alone tells us little about what types of capacity contribute to the effectiveness of the system. It does not tell us about the capacities used or identify the specific resources required for a given level of performance. Similarly, performance assessment independent of capacity limits the ability to determine sustainability. However, if capacity is included in performance assessment, then the variation, necessary components, and optimal configurations of resources associated with effective and efficient performance can be identified. For systems research, capacity is a necessary part of the equation.

The purpose of this article was to outline the importance of developing a construct for measuring and defining “capacity” within PHSSR. First, we briefly describe the myriad capacity constructs within public health and other research fields. Second, we propose an expanded conceptual model for PHSSR that emphasizes capacity within a systems framework. Finally, we highlight a list of measures to begin developing a capacity construct specifically for PHSSR.

**Existing Frameworks and Capacity Constructs Within Public Health**

The contemporary framework for PHSSR created by Handler et al. in 2001 highlights the importance of systematically assessing public health services. It was heavily influenced by the Donabedian framework of “structure-process-outcomes” to study quality of care and health outcomes in health services research.31

The first component of the Handler model is defined as “structural capacity,” which includes informational, organizational, physical, human, and fiscal resources.5 To date, PHSSR has focused on a small subset of these constructs, specifically human or fiscal resources, and a small number of organizational or geographic attributes.32,33 The broader informational, organizational, and physical constructs of the model have remained largely undefined and unmeasured. Without considering other constructs, the total capacity of a public health organization cannot be quantified, presenting a barrier for PHSSR research.

Several areas of public health research and other fields offer examples of how to define or assess capacity for research and evaluation purposes. However, systematic reviews of capacity measurement within different fields have highlighted the lack of consensus on definitions or research frameworks.9,10,29,34-37

Defining capacity for systems research is complicated for many reasons. First, capacity is a dynamic construct that incorporates multiple levels including system, organization, community, and personnel/individual.9,10,12,14,35,37-39 Second, capacity is multidimensional and includes things such as capabilities, knowledge, resources.9,12,14,22,29,36,39 Finally, measuring capacity is often defined very differently depending on the perspective or goal (ie, research vs practice).10,22,35,40

There are a number of examples of capacity frameworks or tools within specific public health areas including health promotion, disease prevention (HIV, chronic disease), and community/capacity building.9,11,41-48 However, these examples are specific to one practice area and identify a relatively small number of capacity constructs.

Capacity for a PHSSR needs to be defined more broadly. It must include both tangible and intangible assets and influences (eg, mission, values, legal authority, governance and decision-making structures, information flows).10,49 Capacity measures must be assessed at different levels of the system (individual, organization, system), be multidimensional, and must encompass the processes, knowledge, and resources of a public health system. The recent taxonomy introduced by Merrill and colleagues50 identifies many essential elements of capacity under both “knowledge” and “resources.” However, these elements of capacity still require a systematic framework for measurement. Above all, PHSSR must be conducted within transdisciplinary and multidisciplinary teams applying a “systems thinking” approach and must leverage tools and methods outside of the traditional public health domain.51,52

One way to build a multidisciplinary approach is to look to analogous fields of systems research. Many of these fields include broader capacity constructs such as operating structure, networks, leadership, and mission or strategy. Not surprisingly, these capacity measures have recently been identified as vital and important research priorities for PHSSR.1,3-5,53,54 To develop a relevant capacity framework for PHSSR, it is necessary to review and synthesize definitions, models, and constructs from other fields of research.

**Examples External to Public Health**

Fields of study outside of public health offer other examples of how to define or assess capacity for research and evaluation purposes. Some relevant fields include economics, public administration, manufacturing, nonprofit/service, economics, and operations research.15,16,21,22,46,55-57 Most of these fields use the term “organizational capacity” and emphasize the importance of quantifying capacity measures as the first step in systems research or evaluation. For-profit and business sectors have well-established systems for deciding where and how to invest in capacity.13 There are a myriad of models or frameworks from these fields specifically designed to guide assessment and evaluation of capacity. Many of these efforts include a systems perspective that may be beneficial to PHSSR. The most
relevant to PHSSR may be examples and research from service organizations in the capacity development and nonprofit sector.

Lessons from service organizations

Service and nonprofit organizations have spent a great deal of time and effort to define and assess capacity for systematic evaluation and to maximize social impact and cost-effectiveness. The similarities in structure and function between these organizations and public health make them a useful model. First, the greatest assets identified by both public health and service organizations are their human resources (eg, people and knowledge). Similarly, the number and diversity of partners are identified as vital resources. Success in these fields depends on an organization’s ability to maximize its human resources and use partners to deliver services. For example, many public health programs (eg, education, prevention, intervention) are more successfully delivered and sustained through community partners (eg, churches, schools). These programs are often repackaged for multiple, diverse populations, settings, or purposes. Consequently, service organizations and public health often prioritize program work and practice over institutional functions or capacity.

Next, the beneficiaries of service organizations do not usually provide directives or directly influence organizational policies. Similarly, in public health, it is rare for individual consumers to make direct requests to public health organizations. In both types of organizations, there are governing, political, or supervisory bodies (eg, Centers for Disease Control and Prevention, World Health Organization, United Nations, USAID) that define program objectives and thus serve to mediate public values and preferences for services. Perhaps, as a result, there is an indirect line of accountability between organizations and the populations they serve.

Most public health programs do not directly come from the program recipients or beneficiaries. Therefore, the culture of public health and service organizations emphasizes economic theories of “collective action” or “public good.” In these models, the whole population receives benefits from the system, although individuals primarily contribute or participate indirectly. As a result, it is challenging to quantify the broader benefit or calculate a per person charge or payment.

Because the recipients do not pay directly, an important feedback mechanism or impetus for evaluation may be missing. This mechanism, seen in for-profit organizations can be described as, “fee for service = feedback for service.” However, unlike manufacturing, there may not be feedback or communication between service organizations and their clients or constituents. Because this feedback mechanism is largely absent, the importance or sustainability of a specific program may not be understood. Consequently, the financing of service organizations is not focused on development or maintenance of infrastructure for continuation of programs and services. Financing is highly variable and heavily influenced by external and macro-level variables (eg, political environment, emerging threats) rather than internal need or structure. In service organizations, there are often significant challenges to securing funding for general administration costs versus more tangible campaigns or programs.

Finally, public health and service organizations have highly variable, nonstandardized governance structures. This lack of standardization presents major challenges for systematic measurement of essential elements of organizational capacity such as mission, governance structure, statutory powers, and interorganizational relationships.

Despite the inherent challenges of capacity assessment, several service organizations have capacity models and tools that translate well to PHSSR. There are published reviews of different tools and models, including from renowned foundations and consulting companies. Many of these models include relevant constructs or methodologies that are useful in defining organizational capacity for PHSSR. These models are multidimensional and include system capacity, organizational capacity, and personnel capacity. The vast majority of the models also use a Donabedian-like approach of structure, process, and outcomes to evaluate effectiveness.

Conceptual Model

To illustrate the importance of understanding organizational capacity within a public health system, we developed a new PHSSR conceptual model (Figure). This model borrows heavily from the literature on nonprofit and service organizations and builds upon the framework of Handler et al and macro and system constructs recently identified by Mays et al. It places the Donabedian components within a framework amenable to research and outlines constructs for measuring organizational capacity.

Organizational capacity is conceptualized as a predictor of process and performance and resultant health outcomes. For example, advanced organizational capacity in the form of electronic surveillance systems will impact awareness of an outbreak and timing of response (process/performance) that may prevent additional morbidity and mortality (outcomes). The model illustrates how the 3 components influence each other within a broader macro-level environment of
system-level determinants. A key aspect of the model is that measuring capacity is the primary step for system research or evaluation.

**Organizational Capacity for PHSSR**

After reviewing capacity frameworks internal and external to public health, we synthesized 8 fundamental constructs from existing models (Table). The first 3 constructs were included as components in the framework of Handler et al. The remaining constructs were identified in a recent article by Mays et al and from our review. These additions to the PHSSR model allow a more thorough assessment of organizational capacity and describe the complicated milieu in which public health organizations operate.

While not an exhaustive list, we propose a list of potential measures within each of the 8 constructs with which to begin a broader discussion. Although these measures capture fundamental aspects of the constructs, each can be operationalized into a range of possible variables for research purposes. The choice of specific variables is largely dependent on the level of the public health system under study (eg, public health program, local health department, state health department). The following 8 constructs provide a systematic beginning to begin measuring organizational capacity in PHSSR.

**Construct 1: Fiscal and economic resources**

Many studies have used economic and financial predictors to explore public health performance and health outcomes. Existing PHSSR studies indicate wide variation in sources of funding and its allocation. This variation must be captured to fully understand the fiscal and economic capacity of a public health system. In addition, the broader organizational capacity literature has emphasized the inclusion of alternative sources of finance, operating budgets, and capital. These measures can often be defined as both absolute and relative (per capita) variables. Some examples of variables that could be included are total number, type, and diversity of the revenue sources or funding mechanisms (ie, number of funding streams). Although potentially time consuming to collect, much of these data already exist and are readily accessible.

**Construct 2: Workforce and human resources**

Human resources have been identified as the most vital component of public health capacity. This construct has attracted considerable attention in PHSSR,
### TABLE Eight Constructs of Organizational Capacity for Public Health

<table>
<thead>
<tr>
<th>Main Construct</th>
<th>Subconstructs and Potential Variables for Measurement</th>
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</thead>
<tbody>
<tr>
<td>Construct 1: Fiscal and economic resources</td>
<td>Budget, Sources of revenue, Funding mechanisms, In-kind assets, Expenditures, Public health spending per capita, Cost per service/program or health outcome</td>
</tr>
<tr>
<td>Construct 2: Workforce and human resources</td>
<td>Number of full-time employees, Staff knowledge/skills/expertise, Education, Experience, Training, Staffing configuration/availability/deployment, Demographics, Diversity, Tenure/recruitment/retention, Morale/motivation, Compensation</td>
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<tr>
<td>Construct 3: Physical infrastructure</td>
<td>Operating space, Office space and equipment, Transportation, Telecommunications equipment (mobile phones, radios), Communication tools and software (Skype etc), Computer and IT equipment, Computing software (operating systems/office software, statistical packages, GIS/mapping, etc), Mobile data collection devices (PDA, GPS, etc), Medical equipment, Laboratory collection/testing equipment, Response/disaster resources (emergency kits, tents, trailers, etc)</td>
</tr>
<tr>
<td>Construct 4: Interorganizational relationships</td>
<td>Number and network of partners, Breadth/diversity of partners, Density and strength of relationships, Status of relationship, Direction of benefit or degree of reciprocity, Collaboration, Competition, Current contact information, Mechanisms for contact/communication (workgroups, coalitions, LISTSERV, etc), Access to policy makers and leaders</td>
</tr>
<tr>
<td>Construct 5: Data and informational resources</td>
<td>E-mail/Internet access, IT support, Data and information sources, HAN (health alert network)/HIN (health information network)</td>
</tr>
<tr>
<td>Construct 6: System boundaries and size (externally controlled, static)</td>
<td>Geopolitical jurisdiction, Structure within the broader system (eg, federal, state, local), Community attributes, Municipalities/size, Population density, Geography, Distances to travel, Urban/rural, Population and demographics (ethnicity, poverty, insured/uninsured)</td>
</tr>
<tr>
<td>Construct 7: Governance and decision-making structure</td>
<td>Legal authorities, Governance structure, Centralization/decentralization, Local board of health, Type of jurisdiction, Standard operating procedures/guidelines, Reporting relationships, Chain of command/delegation, Performance evaluations, Decision making structure/spatial complexity (breadth and depth of decision makers)</td>
</tr>
<tr>
<td>Construct 8: Organizational culture</td>
<td>Mission, Climate, Values/munificence, Preferences, Planning and development, Strategy/strategic plan, Fit (goals, norms, needs), Leadership, Adaptation/proactiveness/innovation, Human resources management, Internal communication (ease, transparency), Team learning/training, Continuing education, Employee sense of safety and enjoyment, Multicultural tolerance/human rights principles</td>
</tr>
</tbody>
</table>

Abbreviations: GIS, Geographic Information System; GPS, Global Positioning System; IT, information technology; PDA, personal digital assistant.
and several capacity measures already exist. The most common measures are the number and educational attainment of public health workers; other measures include important predictors such as staff demographics, retention, and compensation. However, there has been little exploration of other aspects of human resources such as staffing configuration, allocation of knowledge/expertise, and staff motivation or morale. The capacity literature from service organizations argues that these broader measures are vital characteristics of human resource capacity and directly affect system performance.12,13,61

Construct 3: Physical infrastructure

Physical resources are often overlooked in organizational capacity assessment. Although frequently identified as an important construct, we found few measures for quantifying physical infrastructure (even among service organizations). Perhaps, an audit or accounting of goods, equipment, and supplies is perceived as an onerous process. Or, perhaps, physical infrastructure is highly specific to each field and cannot be systematically defined across organizations (ie, health vs environmental vs humanitarian organizations). Regardless of the challenges, it is increasingly obvious that physical infrastructure measurement is vital in considering the capacity of public health systems. The recent taxonomy developed by Merrill and colleagues50 includes several physical infrastructure measures in the top-ranked essential resources reported by their sample of public health employees.

As rapid advances occur in communication technology and disease surveillance, so do the requirements for physical resources (eg, computers, handheld technologies, cell phones). In addition, public health preparedness has recently invested a great deal in the physical infrastructure of the public health system to prepare for and improve disaster response (eg, Strategic National Stockpile, CHEMPACK).1 Future efforts to quantify measures within the physical infrastructure construct may help explain variation in public health response and performance. The sparse service organization contributions and recent work by Merrill and colleagues62 provide several measures from which to start systematic measurement of this construct.13,61

Construct 4: Interorganizational relationships

Public health is a system of multiple organizations and agencies embedded within an “environment of other organizations as well as a complex web of norms, values and collectivities of the society at large.”63 This broad environment includes partners and relationships that are vital components of the system. In some systems research fields, these networks or relationships are quantified within the construct of human resources or organizational structure. However, in the service organization literature, they are often prioritized and categorized separately. The success of service organizations is highly dependent on their ability to build, maintain, and leverage relationships with partners.12 A diverse network can provide greater interorganizational collaboration and communication and can influence system performance.64 In addition, public health organizations often find themselves in both collaborative and competing roles with their partners. These relationships may be adversarial about competition for funding but collaborative because of the collective need for information or response.

This construct is relatively new to PHSSR; however, the field of interorganizational relations has compiled numerous measures and methods over the past 40 years from which PHSSR can borrow.57,63,65 This body of research provides many important measures such as number, diversity, density, and strength of relationships as well as direction of communication. Recent application of novel analytic tools and methods such as graph theory or social network analysis can help quantify and describe this construct.66,67

Construct 5: Informational resources

Parallel to the human aspects of a public health network are the networks of information resources available to an organization. Information technology (IT) resources for rapidly assessing and communicating information are increasingly available to all public health organizations. Electronic disease reporting and syndromic surveillance have revolutionized public health surveillance and have become vital information resources. On an even larger scale, electronic health records and health information exchange platforms are poised to transform public health informatics practice. Broader IT tools for health or community assessment, data analysis and computing, and information dissemination are helping public health workers within all levels of the system.

Despite the ready adoption of these new technologies, few capacity measures have been operationalized by PHSSR or service organizations to quantify the impact of IT on their respective systems. Luckily, other fields, especially IT itself, have explored these measures and developed frameworks and measures for quantifying impact.68-70 This body of literature emphasizes the importance of broad system context when defining measures or variables to describe informational capacity. In this context, merely the existence or availability of an IT resource (ie, electronic surveillance) does
not indicate capacity. The essential measures for understanding capacity must also include aspects such as user satisfaction, degree of integration, and adoption of the tool into the system.\textsuperscript{68,69,71,72} For example, a local health department may have electronic disease reporting software but lack staff with adequate technical training or time to use it. These additional measures must be considered because they indicate whether the IT capacity is being fully realized.

**Construct 6: System boundaries and size**

System boundaries and size consist primarily of measures that are largely static or change slowly. For the most part, these attributes are beyond the direct control of the organization such as the relative position of the organization within the broader system. Other aspects include geographic and demographic measures. Several measures under this construct have been explored in PHSSR.\textsuperscript{3,73-75} However, inconsistent associations have been observed between variables such as size or community characteristics and performance.\textsuperscript{3} These inconsistent associations may be a consequence of the heterogeneity among public health organizations. They may also be a result of the lack of systematic, comparable measures for use in PHSSR. To determine the effect of these ecological and system-level measures, transparent and consistent methods must be applied within PHSSR.

**Construct 7: Governance and decision-making structure**

Efforts have been made to enumerate the effect of different types of organizational structure in public health systems.\textsuperscript{74,76-79} However, there has been little systematic research on the effect of governance structure on public health processes and outcomes.\textsuperscript{3} There is also little understanding of how statutory authority or autonomy affects public health performance and services provided.\textsuperscript{86} Fortunately, there are many examples from service organizations and health services research that may provide a starting point for PHSSR.\textsuperscript{80-82} Recent works\textsuperscript{3,76} identify several potential measures, some of which are summarized in Table, and include things such as governing structure and statutory authority. Nevertheless, these measures have not been systematically quantified and applied to public health organizations.

**Construct 8: Culture**

Organizational culture is closely related, yet distinct from, governance and decision making. Few measures of culture have been included in PHSSR, and those that have been used were included together with governance and structure measures. The measures contained in this final construct deviate from governance and decision making in that they are largely controlled internally. Many of the culture measures such as planning and human resources management are difficult to conceptualize or quantify. Most are within the direct control of organizational leadership and staff but are often unconsciously defined and applied. As a result, their direct influence on capacity is underestimated or not well understood.

Cultural measures such as climate, mission, values, and preferences may be the most challenging and unfamiliar capacity measures for PHSSR. But these measures can significantly influence capacity and impact a public health system.\textsuperscript{83} In service organizations, items such as mission, leadership, and strategic planning have been identified as highly influential and predictive of success.\textsuperscript{10,13,24} Many of these measures have been identified in the service organization literature from which PHSSR can borrow lessons and tools.\textsuperscript{10,24}

**Discussion**

Over a decade has passed since Handler et al used the Donabedian model to create a conceptual framework for PHSSR. Their framework was introduced as a method for assessing public health system performance. At that time, the authors concluded that public health research needed to create consensus on further measures and methods for research. While great strides have been made in development and use of performance measures, little has occurred to systematically and thoroughly define capacity.

Performance of a public health organization will be more readily understood, sustained, and replicated if there is a clearer understanding of capacity relative to performance. To obtain a clearer understanding of public health systems capacity and performance, more thorough measures and methods need to be developed and tested. Through PHSSR, measurement tools to assess capacity can be developed, tested, and hopefully adapted into practice-based tools for public health organizations.

Toward this end, we have synthesized capacity literature in several disciplines to propose a roadmap for capacity assessment in PHSSR. By borrowing from existing frameworks and analogies from the well-established nonprofit/service literature, we have identified 8 constructs of organizational capacity for PHSSR.

While this article is not an exhaustive review of all possible fields, systematic reviews of organizational capacity within other fields currently exist. The research
model and 8 constructs outlined in this article are a starting point from which PHSSR can begin to discuss developing measures of organizational capacity. A comprehensive assessment of organizational capacity will likely require both quantitative and qualitative methods and be a daunting task. Input at all levels of the organization is required (eg, volunteers, partners, staff, leadership). Some capacity constructs are easily defined counts, others are more difficult to define and quantify. Many of the suggested measures contained within each construct may be superfluous or nested within another measure. Until we have developed and validated assessment tools, it is unclear which of the measures under each construct are necessary. It is also likely that the required measures will depend on the question we want to ask. Developing a framework to measure organization capacity within a broader public health systems model will lead to a better understanding of organizational and system performance.\(^1,3\) Additional work is needed throughout the proposed PHSSR conceptual model. To truly assess the effect of public health systems, it is vital that capacity, performance, and outcomes begin to be systematically operationalized.

Public health organizations are increasingly faced with constraints in funding and available expertise. In light of diminishing resources, it is imperative that we develop a better understanding of capacity as a determinant of performance. A better understanding of this relationship will help determine how to maximally allocate resources in order for the public health impact to be efficient, effective, and sustained.

Public health systems and services research can significantly impact a better understanding of the relationship between capacity, performance, and outcomes by developing and validating systematic measures of public health systems capacity. It is a burgeoning science that must quickly respond to practice needs while applying the best possible science. To do this effectively, public health systems and services researchers need to work in multidisciplinary teams to systematically review measures, assessment tools, and methods from other fields. It is vital that a “systems” approach be applied and consensus reached on important issues such as conceptual models, taxonomy, standardized and validated measures, and analytic methods.

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