4.13 Addressing complexity through mixed methods

Authors

Tracey O'Sullivan, Faculty of Health Sciences, University of Ottawa, Ontario, Canada.

Yasmin Khan, Public Health Ontario and the University of Toronto, Ontario, Canada.

4.13.1 Learning objectives

To understand key factors to consider when developing a mixed methods study for research in health emergency and disaster risk management (Health EDRM) , including:

1. The basic principles of mixed methods research.
2. The relevance of mixed methods design for disaster research.
3. Systems thinking for use in disaster research.
4. The basic tenets of complexity theory and their relevance for disaster research.

4.13.2 Introduction

The timing, characteristics and non-linear impacts of different types of disasters contribute to the complexity of prevention, preparedness, response and recovery – as well as to the challenges for designing research relevant to disaster health and Health EDRM more generally. Although warning systems make it possible to anticipate some weather-related events, other types of disasters such as wildfires, tornadoes and pandemics typically provide little warning. For disaster health research, it is rare to see a simple, single research design that can capture the complexity needed for disaster studies, given the dynamic nature of the context around risks, hazards and events leading to a disaster. Mixed methods and a systems approach provide additional options to address some of these issues.

While mixed methods research is typically described in terms of its evolution over the past 30 years, some argue that this approach has been around for at least a century *(1)*. Nevertheless, it is recognized as a third methodology, with its own set of assumptions and criteria for quality *(2–3)* and not surprisingly, its own set of critiques *(1)*.

Mixed methods research combines qualitative and quantitative methods, and grew from the recognition that some research questions require both quantitative and qualitative methods to provide comprehensive answers. This approach is often used with complex problems, when quantitative or

qualitative methods are not sufficient on their own *(3)*. Given the challenges of defining mixed methods research, and the historical evolution of this approach, Johnson et al *(4)* asked leaders in research methods to provide a definition. Integrating the 19 definitions they received, they presented this definition:

"Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (such as the use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration."

While mixed methods research is common, it is not without critique and practical considerations. Flick *(1)* provides an excellent overview of the myths and mantras, and perhaps the most salient critique is that mixed methods research is somehow regarded as superior to quantitative and qualitative methodologies, despite the limited scope of methods used in mixed methods research (surveys, interviews, for example). Other challenges include defining what is meant by mixed methods research, and how to manage conflicting assumptions, paradigms and values. Criticisms of these studies often include lack of integration of the findings from the quantitative and qualitative arms of the design *(4)* and the need for more comprehensive triangulation *(1)*.

4.13.3 Mixed Methods Research Designs

When deciding whether or not to use a mixed methods research design, the first step is to consider the research question *(1)*, which as with all studies should drive the methodological approach (Chapter 3.5). Generally, complex questions require more complex methods. Simple research questions are characterized by having one concept or variable of interest, and one type of data needed to answer it. Complex questions have multiple concepts or groups, and changing trajectories. More than one type of data is needed to answer the question *(5)*. Once the research questions are in place, the most appropriate and feasible methodologies can be identified. In doing so, it is essential to be aware of theoretical and epistemological differences between the quantitative and qualitative methods being considered *(1)*.

In developing the design, researchers must decide whether the main method needed is quantitative or qualitative and how the supplementary method will support their analyses *(6)*. Palinkas and colleagues *(7)* and Creswell and Plano Clark *(8)* provide excellent overviews of different types of designs. They use capital letters (QUAN or QUAL) to indicate the weighting of the main method, and lower case letters to indicate the weighting of the other method (quan or qual), and the → or + symbols to indicate whether the methods will be implemented sequentially or simultaneously *(8)*. Table 4.13.1 summarizes different types of designs using this notation, and provides examples relevant to Health EDRM research.

Table 4.13.1 Overview of mixed methods designs and applications to Health EDRM research

Design	Structural description	Applied example	Data collection and analysis
QUAN + QUAL	Quantitative and qualitative methods are implemented simultaneously and have the same weighting	Randomized trial measuring behavioural outcomes following a disaster preparedness campaign using a community survey and telephone interviews with a subset of the survey sample	QUAN: Analysis of numerical survey responses on a Likert scale QUAL: Thematic analysis of interview data
QUAL + quan	Main method is qualitative, implemented simultaneously with quantitative method which is weighted less	Focus groups with citizens who have experienced flooding of their homes, supplemented with a short survey related to accessing mental health services	QUAL: Iterative content analysis of focus group data quan: Analysis of binary responses (for example, yes and no).
QUAN + qual	Main method is quantitative, implemented simultaneously with qualitative method which is weighted less	Exit survey with citizens attending influenza vaccination clinics, supplemented with field observations of crowd control and dynamics of the flow of service delivery	QUAN: Analysis of Likert scale ratings from survey qual: thematic analysis from 2 observers field notes
quan → QUAL	Supplemental method is quantitative, implemented before the main qualitative method	Questionnaire sent to participants before a table top exercise to identify priority topics for discussion, followed by field observations and thematic analysis of the discussions during the exercise and debriefing sessions	quan: Analysis of ranking of topics. QUAL: Thematic analysis and triangulation of field notes taken by observers with transcripts of discussions.
qual → QUAN	Supplemental method is qualitative, implemented before the main quantitative method	Key informant interviews to pilot test items for a health risk perception survey being administered to first responders following a prolonged response to wildfires	Interview data analysed deductively according to a coding grid based on topics from the risk perception survey
QUAL → QUAN	Quantitative and qualitative methods are weighted equally, but the qualitative method is implemented first	Community consultation focus groups followed by a community survey to set priorities for a public health action plan	Inductive thematic analysis of focus group data to identify priorities, followed by ranking of priorities

Design	Structural description	Applied example	Data collection and analysis
QUAN → QUAL	Quantitative and qualitative methods are weighted equally, but the quantitative method is implemented first	Rapid needs assessment survey distributed to households impacted by a chemical spill, followed by focus groups with a subset of the population who are at heightened risk	Standardized post-disaster survey analysed to identify neighbourhoods disproportionately impacted using GIS mapping; subsequent outreach and exploratory data collection and analysis to understand short-term health impacts

In the case of intervention research, Minary et al *(9)* provide a framework to guide evaluation design for complex interventions, as well as considerations for evaluating effect, implementation and how mechanisms and context interact to determine intervention outcomes. Further information on the practical considerations for designing mixed methods research studies is available elsewhere *(7, 10–11)*. An important decision to consider in the design stage is how best to ensure comprehensive triangulation, which goes beyond integration of different types of data *(1)*.

4.13.4 Considerations for design and implementation

When combining qualitative and quantitative methods, it is important to consider how the different paradigms will be reconciled *(2)*, and to be certain of the rationale for using mixed methods research to answer the research questions. The mixed methods research design is often methods-centric, with the focus on combining specific methods (for example, quantitative surveys with qualitative interviews) at different timepoints in the project *(1)*. Typical design decisions include determining whether the data will be collected and analysed at the same time, or separately and integrated later.

The decision to do mixed methods research should come after the research questions are identified. It is often described as the obvious choice, under the assumption that two methods are better than a single method *(1)*. This assumption has infiltrated funding programs where mixed methods research projects are deemed more comprehensive. However, as Flick *(1)* emphasizes, most such studies use limited qualitative methods (such as interviews) and don't explore the range of qualitative methods. When applied to a disaster health research context, this can limit creativity in addressing complex issues.

It is important to consider how theory and epistemological differences will be managed in mixed methods research *(1)*. Morgan *(12)* defined research paradigms as "systems of beliefs and practices that influence how researchers select both the questions they study and methods that they use to study them". Paradigms are guides for researchers to determine how to approach a research topic, including the research questions, design, methods and analyses. A pragmatic paradigm is most widely used

in mixed methods research *(13)*. When doing multiple methods (separate studies not mixed), this task is simpler because the paradigms are acknowledged for each method and presented separately.

The function of the mixed method study will determine how the qualitative and quantitative methods are combined at the interface point *(3, 6)*. When determining function, it is important to consider whether the methods need to be combined to answer the same research question, or whether a series of research questions related to the topic require mixed methods. The need for triangulation is a common reason for choosing mixed method design. Flick *(1)* provides a good overview of how triangulation has evolved in recent decades, beyond confirming, disconfirming and expanding findings.

The findings of mixed methods research can be integrated in different ways and at different times. O'Cathain and colleagues *(14)* provide practical suggestions for how to follow a thread and move back and forth between the quantitative and qualitative datasets to confirm or expand the analyses. Use of a mixed method matrix is another option for identifying patterns in the different datasets. Publication of triangulation protocols is an important contribution for the literature, because these enable readers to understand at what points the datasets were integrated and what steps were followed.

Johnson and Schoonenboom *(11)* present a series of tables suggesting different ways qualitative methods can be combined with quantitative methods to enhance randomized trials (Chapters 4.1 and 4.3). In the early stages of designing a randomized trial, qualitative approaches can be used to establish the fit of a conceptual framework or theory (Chapter 4.10) for the intervention. They can also be used to gather information about the context in which the intervention will be implemented and engage stakeholders. For complex interventions, mixed methods research can be used to evaluate outcomes and implementation *(9, 14)*. Qualitative methods are often used in the process of constructing or piloting surveys or other data collection instruments. They are also frequently used to add depth to quantitative designs, such as the example in Case Study 4.13.1 where interviews supplemented survey responses following an earthquake to provide more in-depth understanding of survivor perceptions.

Case Study 4.13.1
Perceptions of earthquake survivors in Amatrice, Italy *(15)*

A series of devastating earthquakes occurred in Central Italy in 2015-2016. In the town of Amatrice, 238 people died out of a population of 2500 people. Massazza et al. *(15)* conducted a mixed methods research study with earthquake survivors in the town, publishing their results in 2019. They explored how survivors perceived the damage from the earthquake and how those perceptions aligned with the concept of natural versus human-made disasters.

Massazza and colleagues *(15)* used a mixed methods, longitudinal design which included quantitative surveys and interviews conducted at two time points, 16 months apart. At the first time point, they received 127 responses to the survey and recruited 52 of the survey respondents to participate in one-to-one interviews. The follow-up survey was completed by 112 of the original respondents. The mixed method design allowed the

researchers to triangulate the findings from the quantitative data with narrative data from the qualitative interviews. The qualitative data was also used to corroborate and expand the analyses for indepth understanding of the complexity of perceptions and understandings of natural versus human-made disasters.

As an excellent example of how mixed methods can be presented together, Massazza and colleagues *(15)* present a summary of the quantitative results in text, tables and graphs, followed by a detailed explanation of the emergent themes from the qualitative data. The discussion includes points of convergence, divergence and how the indepth thematic analysis expanded understanding of the quantitative results.

As an intervention is rolled out, qualitative methods can be used to assess fidelity of the implementation, to determine the extent to which the protocol is being completed as intended *(11)*. Context is important for understanding the mechanisms of why an intervention works and in what circumstances *(16)*. Qualitative approaches provide distinct options for generating process-related data, which can be used in the interpretation of the success of an intervention.

4.13.5 Systems thinking and complexity

Most disasters are complex and involve collaboration across different sectors, organizations and jurisdictional boundaries. The type of disaster will determine which organizations and jurisdictions must be involved in planning for Health EDRM, including prevention, preparedness, response and recovery, and, therefore, in disaster research. For example, in research related to influenza pandemics, it is essential to consider the roles and impacts on the health and social services sectors, and also on essential services sectors (for example, hydro, transportation) which are likely to experience operational disruptions when absenteeism is high *(17)*. With this in mind, it is useful to look at disaster health research questions through a systems lens, and to acknowledge the complexity in the design of research projects, particularly the interventions (Chapter 3.3).

Systems are made up of different interdependent components and actors or stakeholders. They can be complex, depending on how tightly-coupled the interdependencies are *(18)*. Systems thinking has gained recognition in various fields, because it can be used to understand context, mechanisms and outcomes. It is a way of examining how things are connected within a whole and how the parts within the whole interact in complex ways *(19)*.

Berry and colleagues *(16)* defined systems thinking as “a set of ‘synergistic analytic skills’ used to help describe a complex set of interacting factors that produce outcomes, to predict their behaviour and to formulate interventions to achieve desired (and avoid pernicious) results”. It enables disaster researchers to examine an issue in terms of a dynamic, interconnected collection of components; recognizing how macro, meso and micro level factors influence its operation *(20-22)*. Micro level factors are associated with individuals or households, whereas meso and macro levels refer to factors at the organizational or community and societal levels, respectively (Figure 4.13.1).

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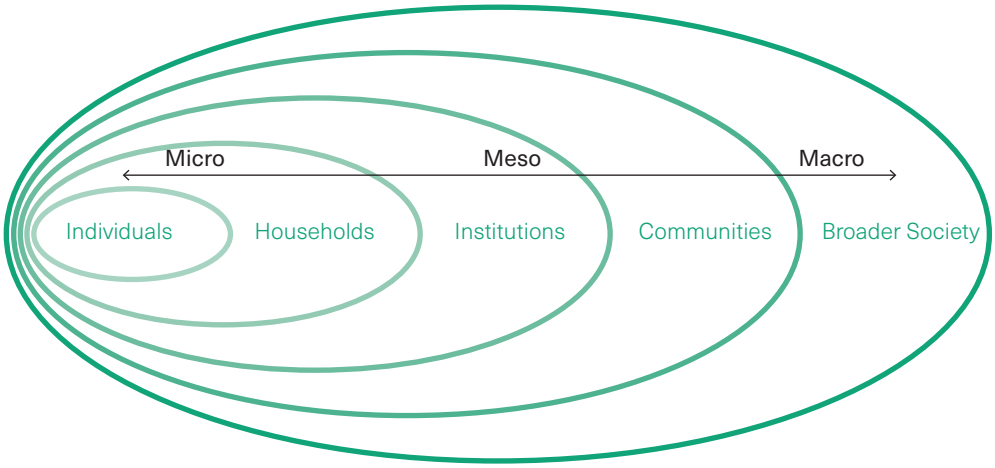
Figure 4.13.1 Multiple Levels for a Systems Approach



Complex research questions require methods that will unpack various influences that interact across multiple levels of society. For example, to achieve a comprehensive understanding of how intervention strategies promote influenza vaccine uptake, it is necessary to have knowledge about people, organizations, communities, health care policy and media; and how different variables intersect across micro, meso and macro levels. The complexity of vaccine uptake across a population includes how messaging influences preventive health behaviours, how social factors influence access and awareness, how mass vaccination is coordinated at the organizational level to increase accessibility, political climate, availability of subsidized health care, and social media threads circulating at the macro societal level *(17)*. The complexity of interdependencies across different levels of the system is the essence of why this problem requires systems thinking.

Complexity has been discussed in the literature for many fields. Cilliers *(18)* outlines different tenets of complexity that are characteristic of complex adaptive systems, including dynamic context, interconnectivity, emergence, self-organization, adaptability, feedback loops and non-linearity. Because complex adaptive systems are open and interact with their environments, the environmental context is inherently dynamic. Systems are composed of different parts and actors which are interconnected, meaning that actions within individual components of a system lead to changes which emerge in other components and the whole system *(19)*. The changes at different levels of the system are non-linear and are, therefore, unpredictable and it is difficult to trace the original causes *(23)*. Nonlinearity is one of the reasons that mixed methods research is important for Health EDRM.

As described by Cilliers *(18)*, complex systems have the capacity for self-organization "... which enables them to develop or change internal structure spontaneously and adaptively in order to cope with, or manipulate, their environment". In the absence of structure or protocols, self-organization naturally follows change in social systems, with people within the system creating structure or strategies to adapt and preserve system functioning. The impacts of changing context within a system are non-linear and feedback loops provide important information about operational functioning *(18)*. In the example of pandemic vaccines, social

media provides a salient example of how self-organizing works. When accurate, timely information is missing, people will look for information and share what they find. This has implications for the rapid spread of misinformation, which can influence beliefs and vaccine uptake.

Table 4.13.2 shows an example of how complexity theory can be applied to understand or map out issues within a pandemic context. Social networks are used as an example, but the same table could be created to examine other issues related to the complexity of pandemics (for example, vaccination or supply chain management). This technique can be used for integration in the analysis phase of mixed methods studies, to understand how complexity manifests within a given research topic and needs to be considered in intervention design (see Case Study 4.13.2).

Table 4.13.2 Application of complexity theory to social networks in pandemic prevention, preparedness, response and recovery

Tenet of complexity	Application
Interconnectivity	Interconnectivity is inherent in relationships, partnerships and strong social networks. Effective pandemic response is dependent on actors from different parts of the health system working together; communication, which is a connective activity is central in pandemic prevention, preparedness, response and recovery.
Dynamic context	Social networks are dynamic. People change positions, retire or meet new people, and the relationships within the network change. People also develop new expertise and experience, which contributes to the dynamic nature of the entire system.
Emergence	Knowledge and ideas emerge within social networks. Behaviours also emerge and influence social norms within networks – both positive and counter-productive. Emergence can spark innovation and contribute to different intervention strategies.
Feedback loops	Social networks provide opportunities for feedback from different parts of the system. This feedback loop creates opportunities for networking, relationship building, and co-learning.
Self-organization	Networks contribute to self-organization in the absence of clear policies or plans which outline roles and responsibilities. When structure and information are needed, but missing, people self-organize to create structure and fill the gaps. Self-organization can support pandemic response and recovery, but in vaccination campaigns, it can also hinder formal processes and awareness campaigns if not managed.
Non-linearity	Social networks are non-linear. Social media is a good example of how social networks do not develop in linear patterns. Communication and influence within social networks are dependent on the relationships and connections of each actor. Non-linearity prohibits cause-effect relationships from being established.
Adaptability	Networks contribute to adaptability. They create opportunities for learning and innovation. Actors within social networks provide different sources of information to enhance situational awareness.

4.13

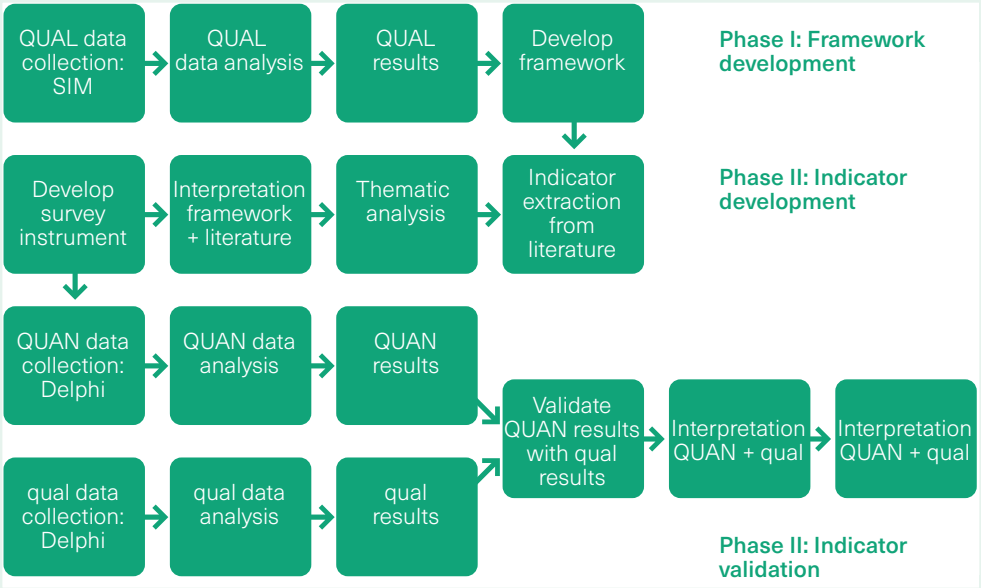
Case Study 4.13.2
Advancing performance measurement for public health emergency preparedness (24–25)

An important knowledge gap in Health EDRM is understanding levels of preparedness or readiness in advance of a disaster. This is a challenging topic, but one of important policy relevance, given the increasing frequency of emergencies and the value of defining and measuring preparedness to guide improvement. This topic was well-suited to a two phase mixed methods study to address the dual objectives: "how do we know if we are prepared?" and "how do we measure it?". Furthermore, using mixed methods enables a consideration for complexity, which is seen as increasingly important for public health systems research *(22)*.

The initial exploration aimed at defining emergency preparedness for the public health system in Canada was achieved using a qualitative study design. Rich qualitative data was analysed using a complex adaptive systems lens to develop a framework defining the essential elements of a resilient public health system *(24)*. The framework reflects the complexity of the role of the public health sector in emergencies and was used to ensure that the approach to measurement considered what the system is aiming to do.

The framework elements informed a mixed methods Delphi survey to develop indicators for public health emergency preparedness (PHEP) *(25)*. The Delphi is a mixed methods research technique well-suited to fields where there is a paucity of evidence, such as PHEP research, and is a structured and rigorous approach to collecting data on expert opinion *(26)*. Its use for developing indicators for clinical contexts such as cancer care also rendered it appropriate for developing PHEP performance indicators *(27)*. In the Delphi process, the combination of deductive thematic analysis of the literature, open ended questions for comments on indicators and suggestions for new indicators, and quantitative rating of indicators enabled the development of a list of preparedness indicators *(25)*. The sequence and combination of mixed methods approaches for the two phases is displayed in Figure 4.13.2.

Figure 4.13.2 Mixed methods used in defining a framework and developing performance indicators for public health emergency preparedness (24–25)



Interdependencies are the norm in modern society and are the reason systems thinking is useful for disaster health research. Lechner and colleagues *(28)* provide a salient example of the interdependencies between the digital society and financial institutions, which has substantial implications in a disaster context. A digital crisis can trigger a financial disaster as the cascading impacts jump between sectors. This complexity underscores the need for collaboration across disciplines and sectors to support situational awareness *(24)*. Expansive, diverse expertise on collaborative teams can also support integrated knowledge translation, which facilitates diffusion and uptake of research findings *(11, 24)*.

The need to understand context is widely acknowledged in the evaluation literature. In fact, the literature base on realist evaluation underscores the importance of understanding context and how it interacts with a mechanism to influence particular outcomes *(29)*. In supporting this point, Johnson and Schoonenboom *(11)* emphasize the utility of qualitative methods to support quantitative methods in process evaluation, with context being a critical consideration. The integration of concepts of complexity, disaster health research and mixed methods approaches are described in the above example of Case Study 4.13.2.

4.13.6 Conclusions

This chapter has introduced mixed methods research design, systems thinking, and shown how complexity can be addressed in Health EDRM research. When conducting mixed method research, it is essential to consider the theoretical and epistemological differences of the methodologies being combined. It is also important to develop the research questions before making the assumption that mixed methods research is the most appropriate methodology for the study.

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When the decision has been taken to use mixed method research as a methodology, careful planning must be done to plan how best to ensure there is comprehensive triangulation, which includes (but is not limited to) integration of data from different methods. Examples provided in this chapter illustrate some of the different strategies that can be used to approach complex questions with mixed methods.

4.13.7 Key messages

- **Mixed methods, which combines quantitative and qualitative methods, has evolved into a third type of methodology which can provide a more comprehensive explanation for the complexity inherent in disaster research.**
- **Systems thinking in disaster health research focuses on the interactions of factors across macro, meso and micro levels of society.**
- **Integration of data, analysis and findings in mixed methods studies is central to the methodology. Many mixed methods studies fall short in the integration process, but this is one of the defining features of mixed methods.**
- **Challenges and practical considerations for designing and implementing mixed method research include theoretical and epistemological differences between methodologies.**

4.13.8 Further reading

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