Speaker Notes: Qualitative Comparative Analysis (QCA) in Implementation Studies

PART 1: OVERVIEW

Slide 1: Overview

Welcome to "Qualitative Comparative Analysis in Implementation Studies. This narrated powerpoint is the first in a series of presentations and provides an overview of QCA. These presentations are offered to you by the North Carolina Translational and Clinical Sciences Institute, which is the academic home of the Clinical and Translational Sciences Award at UNC Chapel Hill.

Slide 2: Learning Objectives

These are the learning objectives for the presentation. By the end you should be able to define what QCA is, and how to apply this method to dissemination or implementation research. You should also be able to identify the differences between crisp set QCA and fuzzy set QCA, and the various software packages that are available to analyze your data. Finally, you should be able to understand how to interpret research findings that are generated using QCA.

Slide 3: What is Qualitative Comparative Analysis (QCA)?

What exactly is qualitative comparative analysis and how do research scientists use it? The goal of QCA is an analytic technique used to explain how factors or sets of factors work together to contribute to a "successful" outcome of interest.

In conventional regression analysis, the researcher puts causal factors in competition with each other to determine which can independently explain the most "variance" in a given outcome. In QCA, the researcher explores how causal factors combine or work together to produce an outcome of interest. For D & I researchers, the outcome of interest is usually successful dissemination or successful implementation.

At its core, QCA recognizes that real world outcomes are usually caused by a set of complex factors, rather than a single, decisive cause. Effective implementation of evidence-based programs, for example, often results from a combination of visible leadership from senior managers, strong buy-in from providers and staff, high-quality training and technical assistance, and adequate resources for implementation. Rarely is any one factor sufficient on its own to produce successful implementation. Rather, these factors work together to produce the desired outcome.

QCA also recognizes that causes and conditions can combine in multiple ways to produce the same results. This principle is known in systems theory as "equifinality," which means "many paths, same outcome." Imagine you want to implement a highly effective, but technically demanding health care practice. Imagine that there is a gap between the level of knowledge and skill required to effectively perform the practice and the level of knowledge and skill that current providers possess. There are at least three ways to close the gap. You could use high-quality training and technical assistance to bring providers' knowledge and skills up to the level demanded by the practice. Or you could simplify the practice to match providers' current knowledge and skills. Or, as a third option, you could hire providers who already possess the requisite knowledge and skills. All three paths will get you to the same outcome.

The name, QCA, can be misleading because data do not come exclusively come from qualitative research. They can come from a variety of sources, including comparative research and mixed methods research. QCA can be used with binary data; for example, data that are coded "yes" or "no". Or it can be used with continuous data such as time or weight.

Slide 4: What is Qualitative Comparative Analysis (QCA)? (2)

QCA is based on set theory rather than on the general linear model. Set theory is a branch of mathematics that studies sets, which are simply collections of objects. Objects can be members of sets and set themselves can be members of other sets. QCA seeks to describe the relationship between causal conditions and outcomes in terms of the relationships between sets. Common mathematical operations to describe set relationships include intersection, union, negation, and inclusion.

By focusing on set relations, QCA allows investigators to examine the explicit connections between causal conditions and outcomes rather than just general associations or tendencies. For example, an investigator can examine whether a causal condition is sufficient, necessary but not sufficient, sufficient but not necessary, or neither necessary nor sufficient for an outcome to occur. In regression, we typically examine whether an causal condition is sufficient to produce an outcome. This is expressed as "If X, then Y." In QCA, we can examine a wider range of possible relationships, such as: "If X, then Y," "Only if X, then Y," "If and only if X, then Y," and so forth.

QCA employs Boolean algebra and algorithms that allow the logical reduction of multiple, complex combinations of causal conditions into a reduced set of causal-condition combinations that lead to an outcome. Researchers code cases or assign values to variables and this information is then summarized in something called a "truth table" which will be explained later in the presentation.

Slide 5: History of QCA

QCA is a relatively new method, developed in the late 1980s by Charles Ragin. QCA was initially developed for applications in political science and historical sociology. Ragin, a sociologist, was interested in developing an analytic approach that specifically focused on moderate sized samples in social research. Generally, statistical researchers prefer to examine thousands of cases. By contrast, most case-study researchers examine just a handful of cases, often one or two. QCA was developed to work with data from 5-50 cases of which many social phenomena are bound. For example, the number of coup d'etats in Latin America since 1972, members of the EU, major cities in the United States that have had African American mayors, and so on (Ragin, et al 2003).

Today, there are highly developed computer software programs to run QCA. They are inexpensive (sometimes free), and we have included a web-link to some of them at the end of this slide presentation.

Slide 6: When to use QCA

In general, QCA can be used when researchers are working with small or medium sized sets. Sample sizes in QCA are quantitatively too small for inferential analysis and too large for qualitative analysis, and can range from 12-200 cases.

QCA is suitable when researchers are examining cases at the macro level, such as organizations and communities, whole populations or economies, or even entire countries or societies.

QCA can also be useful when researchers anticipate that the causal structure of a specific outcome will be complex, equifinal, and conjunctural. Equifinal means that there are different pathways to an outcome and conjunctural means that conditions are often sufficient only in combination.

Lastly, QCA is helpful when a researcher in interested in knowing when the conditions for predicting an outcome are necessary or sufficient or both.

Slide 7: Crisp vs. Fuzzy Set QCA

Crisp set QCA is designed for causal conditions that are coded as simply absent or present. With crisp data sets, each case is assigned one of two possible membership scores *in a single set.* Cases can belong to multiple sets, and sets can be subsets of each other, or supersets. So a condition may be coded as a 1 (membership in the set) or 0 (non-membership in the set). For example, we may be interested in primary care practices that implement brief screening and counseling for alcohol misuse. One set might be physician practices that use non-physicians to deliver the intervention, and the practice is coded as either in or out. This set reflects a causal condition. Another set might be practices that *successfully* implement an alcohol misuse intervention, and a practice is coded as either in or out. This set reflects the outcome of interest. Crisp sets establish distinctions among cases that are wholly qualitative in nature (for example, membership versus non-membership in the successful implementation set).

However, many of the causal conditions that interest social scientists vary by level or degree. For example, while it is often clear that some organizations successfully implement evidence-based programs and some do not, there are many in-between cases that are not fully in the set of successful implementers, nor are they fully out of the set of successful implementers. Fuzzy sets extend crisp sets by permitting membership scores in the interval between 0 and 1. Fuzzy set QCA is especially powerful because it allows researchers to calibrate partial membership in sets without abandoning core set theoretic principles (Ragin 2005).

Slide 8: How to use QCA: A Six step Process

Procedurally, QCA involves six steps. First, you have to identify the outcome that you are interested in describing or explaining. This outcome defines the target set. If a researcher is interested, for example, in explaining why some primary care practices and not others effectively implemented brief screening and counseling for alcohol misuse, then the outcome of interest is effective implementation, and the target set consists of those primary care practices that exhibit the outcome of interest.

Second, the researcher must identify a set of causal conditions expected to contribute to the outcome of interest. Selection of causal conditions is based on theory, prior research, and knowledge of the cases. A researcher might consult the Consolidated Framework for Implementation Research, which synthesizes 19 conceptual frameworks, to identify causal factors that contribute to successful implementation of brief screening and counseling for alcohol misuse.

Third, the researcher must calibrate measures of the outcome and the causal conditions into either crisp or fuzzy sets. If using a crisp set, the causal conditions are transformed into binary variables. If using a fuzzy set, a process called calibration is used where the researcher transforms measures from a continuous or interval-scale variable into a score indicating the degree of membership in a set, which is called a "set membership score". The researcher must employ theoretical and substantive knowledge to specify three values: full membership in the set of interest, full non-membership, and a crossover point of maximum ambiguity. Maximum ambiguity means that you can't say with full confidence that the case is clearly in or clearly out. With these three values established, the research uses one of several algorithms for transforming the variables measuring the outcome and causal conditions into set membership scores that range from 1.0, indicating full membership in the set, to 0.0, indicating full non-membership in the set.

To illustrate, a researcher interested in examining successful implementation has to specify what counts as "successful implementation." Suppose a researcher is measuring the extent of implementation in terms of the percentage of physicians in a primary care practice that are screening and counseling for alcohol misuse. The researcher has to specify what counts as successful implementation. Using prior knowledge and research, she might decide that successful implementation means that 70% of physicians in a primary care practice are consistently screening and counseling for alcohol misuse. This means that primary care practices that meet or exceed 70% are members of the "successful implementation" set. In crisp-set QCA, primary care practices that do not meet or exceed 70% are not members of the "successful implementation" set. In fuzzy-set QCA, the researcher could decide, again based on prior knowledge and research, that practices where 30% or fewer physicians are consistently screening and counseling are definitely not in the "successful implementation" set, whereas practices where only 50% of physicians are consistently screening and counseling are neither fully in nor fully out of the "successful implementation" set. In fuzzy-set QCA, these three values (70%, 30%, and 50%) are used to assign each practice a score that ranges from 1 to 0 that indicates their membership in the fuzzy set of "successful implementation." They are used in a computer-generated algorithm that assigns a score from 1-0.

Slide 9: How to use QCA: A Six Step Process

Fourth, the researcher must construct a data matrix known as a truth table where each row indicates a specific combination of causal conditions, with the full table listing all logically possible combinations.

For example, suppose a researcher wanted to examine four causal conditions. The truth table would have 16 rows representing all logically possible combinations of these four causal conditions. Note that some of these logically possible combinations might not be observed empirically. Some combinations might be observed frequently, while others might be observed rarely or not at all. In QCA, specific combinations of causal conditions are called recipes, configurations, or solutions. We refer to them as solutions in this presentation.

Fifth, the investigator reduces the number of rows in the truth table based on two decisions: (1) the minimum number of cases required for a solution to be considered further, and (2) the minimum consistency level of a solution. For small sample studies, a researcher might decide that a solution has to exhibit at least one case for the solution to be considered for further analysis. In medium- to large-samples, a researcher might decide that a solution needs to exhibit 10 or more cases. Consistency simply means that cases exhibiting a given combination of causal conditions also exhibit the outcome of interest. Typically, researchers set the minimum consistency at .75 or .80. A simple way of calculating consistency is the proportion of cases exhibiting a solution that also exhibit the outcome of interest. If 90 percent of the cases exhibiting a solution also exhibit the outcome of interest, we can say that the solution consistently produces the outcome. By comparison, if only 50 percent of the cases exhibiting a solution also exhibit the outcome of interest, the best we can say is that sometimes the solution produces the outcome and sometimes it doesn't. QCA uses a more sophisticated formula that assigns small penalties for minor inconsistencies and large penalties for major inconsistencies.

Lastly, the researcher uses an algorithm based on Boolean algebra to reduce the truth table into simplified solutions through the elimination of logically or arithmetically redundant causal combinations. For example, imagine you find that the solution ABC consistently results in effective implementation. Imagine further that the solution AB and not-C also consistently results in effective implementation. These two solutions can be logically simplified to AB since the same outcome results whether C is present or not. The narrated PowerPoint presentations that accompany this introduction illustrate how this process works.

Slide 10: How to Interpret and Present Findings from QCA

To interpret the results of QCA, one looks at both consistency and coverage.

As already noted, consistency refers to the degree to which cases displaying a given solution also display the outcome of interest. Another way to think about consistency is that it indicates how closely a perfect subset relation is approximated. In order words, consistency indicate the degree to which the cases that exhibit the solution are a subset of the cases that exhibit the outcome of interest. By establishing a benchmark for consistency scores, probabilistic tests can be employed to assess whether the degree of consistency is greater than could be expected by chance.

Coverage refers to the degree of overlap or intersection among two or more sets. Coverage scores indicate the percentage of cases that exhibit the outcome that also exhibit a specific solution. Coverage is analogous to variance explained or R-square in regression analysis. It allows you to assess the empirical relevance of a solution.

One can also interpret the results of QCA in terms of necessity and suffiicency.

A necessary condition is one in which all or almost all of the cases exhibiting the outcome also exhibit a specific solution. A necessary condition does **no**t imply that all or almost all of the cases exhibiting a solution also exhibit the outcome. For example, a researcher might find that all of the primary care practices that successfully implemented screening and counseling for alcohol misuse had a physician champion present. Based on theory and substantive knowledge of the cases, the researcher could argue that this pattern indicates that physicians champions are a necessary condition for successful implementation. Note that the researcher might have also found primary care practices where a physician champion was present, but successful implementation did not occur. This would indicate that physician champions are a necessary but not sufficient condition for implementation success.

A sufficient condition is one which all or almost all cases exhibiting a solution also exhibit the outcome. A sufficient condition might not be a necessary for the outcome to occur. There might be other solutions that also produce the outcome. For example, a researcher might find that all of the primary care practices that had a physician champion successfully implemented the screening and counseling intervention. Note that the researcher might also have found cases where successful implementation occurred in the absence of a physician champion. This would indicate that physician champions are sufficient but not necessary for implementation success.

Slide 11: Consistency

Because QCA is grounded in set theory, it is easy to illustrate the idea of consistency using Venn Diagrams.

Low consistency indicates that many cases that exhibit a causal condition are **not** members of the set of cases that exhibit the outcome.

High consistency indicates that many cases that exhibit a causal condition are **also** members of the set of cases that exhibit the outcome.

Although this illustration focuses on a single causal condition, the logic of consistency applies to combinations of causal conditions, or solutions.

Slide 12: Coverage

Low coverage indicates that the cases that exhibit causal condition do **not** represent a large proportion of the cases that exhibit the outcome.

High coverage indicates that the cases that exhibit a causal condition **do** represent a large proportion of the cases that exhibit the outcome.

As the illustration on the left-hand portion of the slide indicates, it is possible for a causal condition to exhibit high consistency but low coverage.

Slide 13: Necessary vs. Sufficient

Venn diagrams also make it easy to understand the distinction between necessary vs. sufficient conditions.

As mentioned earlier, a necessary condition is one in which all or almost all instances of an outcome also exhibit a causal condition or set of causal conditions. However, not all instances of a causal condition or set of conditions also exhibit the outcome. This is illustrated in the Venn Diagram by the part of the blue circle that is not covered by the green circle.

By comparison, a sufficient condition is one which all or almost all instances of a causal condition or set of causal conditions also exhibit the outcome. A sufficient condition might not be a necessary for the outcome to occur. There might be other causal conditions that give rise to the outcome. This is illustrated in the Venn Diagram by the part of the green circle that is not covered by the blue circle.

It's worth noting that a causal condition (or set of causal conditions) can be: necessary but not sufficient, sufficient but not necessary, necessary and sufficient, or neither necessary nor sufficient. QCA allows researchers to explore causal complexity in ways that are difficult to do with regression analysis.

Slide 14: Resources for using QCA

You can learn more about QCA by referring to the Ragin book listed above. You can find software and instructions for conducting QCA by following these four links.

Slide 15: Thank You!

This concludes the introductory section of Qualitative Comparative Analysis. In the next section, we will be discussing an example implementation research that used QCA principles with crisp set analysis.

Staff from the TraCs Institute are available for consultations. In order to become a member and request a consultation, please call us at 919-966-6022, email us at nctracs@unc.edu, or visit our website at tracs.unc.edu.