**Webisode 8 - How to determine which interventions work best:**

**Qualitative Comparative Analysis (QCA) – A method for**

**understanding complex interventions**

Presenters: Katy Sutcliffe and Dylan Kneale (EPPI-Centre, UCL)

YouTube: <https://youtu.be/Q193cAT41HI>

JOANN STARKS: Welcome to another session from EPP-Centre Evidence Tools, Products, and Projects. This series of nine brief webisodes will introduce the audience to several tools, products, and projects of the Evidence for Policy and Practice Information and Coordinating Center or EPPI-Centre. Based at University College London's Institute of Education, the EPPI-Centre focuses on the development of systematic review and studies the use of research evidence.

I'm Joann Starks from the Center on Knowledge Translation for Disability and Rehabilitation Research, or KTDRR, at American Institutes for Research. The Center on KTDRR is sponsoring these webisodes with support received from the National Institute on Disability, Independent Living, and Rehabilitation Research, or NIDILRR, in the US Department of Health and Human Services.

This session is how to determine which interventions work best: Qualitative Comparative Analysis (QCA), a method for understanding complex interventions. Our presenters are Katy Sutcliffe and Dylan Kneale, both research officers with the EPP-Centre.

Katy's interests include children's participation in their health care, approaches for integrating different types of research evidence in systematic reviews, and approaches for supporting the implementation of review findings.

Dylan's interests include exploring methods and practice in evidence-based policy making, policy analysis, longitudinal analysis, neighborhood and contextual effects, transitions to adulthood, housing and health, and aging and aging policy. Welcome, Katy and Dylan. I'll now hand things over to you, Dylan.

DYLAN KNEALE: OK. Thank you very much for the introduction. OK. So we're here today on this webinar to talk about qualitative comparative analysis. This session is a bit of a whistle stop tour across a complex method that can be used to understand how interventions work. The session is going to be split into the first half, which will cover the theoretical basis and underpinnings for qualitative comparative analysis, or QCA. And the second half we'll be talking through a real life experience of applying this method to understand how an intervention works.

So I'm going to be presenting with my colleague Katy here. And we'd also like to acknowledge our colleague James Thomas who was one of the first people to apply QCA in the field of systematic reviewing.

OK. So we thought we would begin with thinking through why we need to address complexity within systematic review. So Within systematic reviewing, and specifically systematic reviewing for public health, we cannot escape complexity. Complex interventions mean that there are often multi-componenets, that they have lots of different ways and pathways to intervention success, and can mean that there are multiple interacting components and multiple potential moderators.

Within social interventions, the context of delivery, as well as the nature of the intervention design as well, can add in further complexity. So we can have complex interventions taking place within complex contextual and a complex context. OK. So this is a well known model of a complex intervention or a complex set of circumstances that lead to an outcome within the UK. This is a model of causes and determinants of obesity within the UK.

As you can tell, there are multiple pathways and multiple interacting components between these conditions that do lead to obesity. Some of these conditions will be switched off and some of them will be switched on. They form complex configurations of conditions. This idea of getting toward complexity is one that we can't escape within systematic reviews. And also, they make systematic reviews and the findings of systematic reviews more useful for decision makers.

So decision makers need assurance, both that an intervention is going to work, and we have many and synthesis techniques that can assist us with this, most notably in the form of meta-analysis, but also they need to know how things work in order to know whether an intervention is suitable for their own locality. The type of evidence that we can generate through QCA, or qualitative comparative analysis, can help illuminate to decision makers what about an intervention, what are the key components of an intervention that can trigger a successful outcome?

So what is QCA? The aim of QCA is to identify the mechanisms through which interventions impact, and move us beyond the questions of effectiveness, so beyond the question of whether something works but to understand what about how it works. What configuration of intervention components or contextual components can trigger successful outcomes?

It can identify the combination of contextual features that are present or absent when an intervention is successful or not in the desired outcome. QCA requires us to develop or adopt a logic that may be unfamiliar to some people. QCA aligns on set theory. So by set theory we mean that we have an outcome set of successful interventions, and then we also have an outcome set of different combinations of conditions. And the purpose of QCA is to explore the degree of overlap between these two sets.

So the underpinnings of QCA and are very much within set theoretic logic. So you almost have to cast your mind back to some of the Venn diagrams that you may have been interacting with during high school to try and think through the logic of QCA. It has a case oriented approach rather than a variable orientated approach, which this group distinguishes it from meta-analysis and allows for a deep understanding of the complex configurations of conditions that trigger a successful outcome.

The analysis should always be informed by, or underpinned by, existing theories. So we're not looking for any old sets of conditions and the degree of overlap with the successful outcome or the outcome sets. They have to be theory based.

Within QCA, we have to know about two key set-theoretic relationships. So the first one here is necessity. By necessity, we're saying that a condition has to be there for an outcome to occur. There is no way that that outcome can occur without the presence of that condition. So the condition is necessary for the outcome to occur.

So for example, having a lottery ticket is necessary to winning the lottery. So you can't win the lottery without purchasing a ticket. The second key set-theoretic relationship that we have to be aware of within QCA is sufficiency. So within sufficiency, what we're thinking of is that when we observe a condition, it does trigger that outcome. But we're also aware that that condition is not the only pathway to that outcome.

So for example, having a son is a sufficient condition for being a parent, but we also know that having a daughter is sufficient to being a parent. So when we see this kind of relationship we're saying that it's a relationship of sufficiency.

Within systematic reviewing, our focus is more on identifying sufficient relationships than necessary relationships. And within QCA, within systematic reviewing, there are three different ways of using it within the review. I'll start with the first method. So the first method is to use QCA to explore the results of meta-analysis.

So it's implemented within a mixed message framework. And the meta-analysis will have been conducted already and configural questions will be asked of that meta-analysis to understand what it is about intervention components that trigger a successful outcome. Within the second group of systematic reviews that use QCA, QCA is used to almost help us design meta-analysis, say QCA is undertaken before the meta-analysis in order to develop theories of configural questions that can be explored within the meta-analysis.

A third group of studies use QCA as the sole basis of the synthesis. And on this slide, we have a cross next to the group three, because this is not necessarily an advised way of using QCA. Within systematic reviews, the advice is to use QCA within a mixed methods framework.

Within QCA as well, we start to talk with a different language than we would necessarily within meta-analysis, for example. So here we have a QCA glossary. And so within the world of QCA, variables are known as conditions. So we don't talk about variables. We talk about conditions. We also talk about configurations of conditions, which are a combination or collection of conditions.

Cases are studies. We've also covered sufficient conditions, so where the condition is enough to trigger the outcome, but there are other routes to achieving that outcome, and necessary conditions, where the outcome is only triggered in the presence of that condition. A truth table is one of the most important analytical tools within QCA. This will be something that Katy is covering in the second half of this presentation, but it's the first set of results and it displays that logically possible combinations of conditions and the extent to which they map on to the outcome set.

So what do we mean by asking configurable questions? In this slide we try to summarize some of the questions and example questions of real life reviews that are taking place that make best use of QCA. So as a generic question, we got what combination of conditions are found among cases to trigger that outcome?

And so some of the examples that we have here are what combinations of behavioral change techniques are found among interventions that demonstrate improved medication adherence? What are the key processes and design features associated with successful implementation of school asthma programs? And this is an interesting example because, here successful interventions are defined through implementation not through effectiveness.

A third question here is what are the key components of quality improvement strategies to improve mental health care for children and adolescents. And the final question is what are the critical features of successful adult weight management programs? And this is a question that Katy is going to be exploring in the second half of this presentation.

KATY SUTCLIFFE: Thank you, Dylan. Yes. So just thinking through a work example that we addressed that very question about what are the key critical ingredients of successful adult weight management programs. And what we mean in terms of these weight management programs are either commercial programs that you might have heard of such as Slimming World or Weight Watchers. But also in the UK, these kind of programs may be delivered by health services.

And there's much existing evidence in systematic reviews in this area already. And they have fairly comprehensively shown that multi-component weight management program, so those address both diets and exercise, are, on average, more effective than those that address either diet or exercise alone. But more fine grained evidence about what the key ingredients pf those interventions is currently, or were currently, not available when we came to begin this review.

In the UK, that National Institute for Care and Excellence had already attempted to answer this question by undertaking the meta-aggression. But they ended up concluding that the key ingredients that differentiates more effective from less effective interventions remain largely unknown. So we were asked and commissioned by the Department of Health in England to try an alternative method to try to answer this question.

And we built on the work of colleagues here at the EPPI-Centre, James Thomas, Allison O'Mara-Eves, and Ginny Brunton, who have published a paper on this, which we'll provide yo with the details at the end of the webinar. So once you have developed your configural question, there are six analytical stages within the conduct of a qualitative comparative analysis.

The very first stage is what we call building a data table. This is where you essentially map out, using a matrix, your cases, that is your interventions within studies, in the rows, and your condition, which is the components of features of the intervention, in columns. And the presence of a particular condition within a case is indicated in the cell by the presence of a one. If the condition is absent within that particular case, you indicate it by putting a zero. And I'll show you an example of such a table.

We then move from individual conditions and cases to looking at those configurations or collections of conditions in our truth table, which are key in the escort tool. So we look. The rows then become a summary of the different possible configurations of conditions that we're interested in looking at and the columns indicate not individual cases but our sets of cases, so this is where our set theory is coming in. We're looking to see whether our set of cases with a successful outcome are represented in those configurations or whether we've got our sets of studies with an unsuccessful outcome are represented there.

And in this example on weight management, how we identified our successful and unsuccessful studies was to use that existing systematic review undertaken by NICE, the National Institute for Care and Excellent, and they've identified 40 possible interventions. And we selected the 10 most successful in terms of weight loss up to 12 months and compared them against the 10 least successful in terms to weight loss at 12 months.

So once you've prepared and constructed your truth table and you can begin to check the quality or integrity of that truth table, first of all, you look to see, for each configuration of conditions, whether you have a contradiction, whether you have both positive and negative cases that represent that configuration. And if you do, that indicates that your configuration is not distinguishing between your positive and negative cases and you need to do some more work.

Satisfactory spread refers to simply whether or not you've got enough examples of the different possible configurations of conditions. The fourth stage is Boolean minimization. Essentially, what we're trying to do at this stage is look for the most simplified configurations. We use Boolean logic to reduce our configurations to the essential components. And again, we'll take you through an example of that.

Fifth stage is consideration of logical remainders, which simply mean you hypothesize what you think would happen in configurations for which you have no cases or no evidence to test that configuration. And the final stage is interpretation where you consider your findings in the light of your original theory that's underpinning your work. And in essence that theory that underpins your work should work and inform all of those previous stages, but it's just a point in which you're really checking that your findings are grounded in that theory and you're not fishing for results.

So here's our data table, stage 1, So this is where we're looking at individual cases and individual intervention conditions. Over on the left hand side of the screen, you can see, for example, in the first row we have the intervention evaluated by Burkes and colleagues in 2012. And it's highlighted in yellow as are the top 10 cases listed there. And those are the most successful interventions. And below that in green are indicated those ten least successful interventions.

And in the columns, you can see the first three there indicated in gray are elements of the intervention relating to diet, so whether or not practical information was given, for example. In the next set of columns indicated in white, they focus on diet monitoring elements of the intervention. And I'll take your attention to that third set of columns, and the first one within that which is notated as direct provision.

And what that's referring to, all of these columns relate to issues around the provision for physical activity elements within the program. And direct provision is an intervention component that, from our theory, which we developed by looking and undertaking a qualitative synthesis and evidence of the views of people either receiving or delivering weight management programs.

And one of the key factors that they raised as enabling them to self-regulate their own healthy lifestyle was having direct provision of exercise within the program. They felt that it helped them a, to realize that they could partake in exercise, that they enjoyed it, and begin to see benefits from it. That was a really important factor.

Another really important factor in the interventions, perhaps our key finding, which we'll continue to demonstrate in the following slides, a critical factor that emerged was having a strong relationship, and positive relationship between people in the service and the service provider. I'll just draw your attention to the direct provision of exercise here. And you can see, for example, that study has a warning that's indicating that direct provision was provided as part of that intervention.

So moving on to our truth table. So this is where we're moving from looking at individual conditions and individual cases to looking at configurations of conditions and our sets, our most effective set and our least effective sets. So you can say in the first row here that we have a configuration, which involves direct provision of exercise, and it also involves having those opportunities to develop good relationships with providers.

The third is a graduated exit, so where intentionally built into the program, you start off having regular sessions and then stretch further and further apart. As you go through the program, kind of tapering off towards the end and higher intensity really reflects just the amount of contact time that's offered as part of the intervention.

So when all four of those conditions in our configuration are present, we see that we had five interventions with all four present. And all of those were most effective interventions. If you look down at the bottom of the table where all four of those conditions in our configuration are absent, we only had two interventions representing that configuration and both were least effective interventions.

And you can see in between that there are other configurations with either most effective or least effective interventions populating them. But at the stage of checking the quality of this table, we can see that there are no contradictions. There are no configurations which have both most effective and least effective interventions there. And we judge that we had a reasonable spread in that we had quite a number of possible configurations represented.

So moving on to stage 4 and Boolean minimization, going to step outside of our worked example just to use a hypothetical example here. And our configural question here is what are the key elements that make a good restaurant? We hypothesize that one element might be happening locally sourced food. Another would be having a good wine list. A third element might be having a Michelin starred restaurant. And our outcome therefore would be whether it's a good restaurant or not.

So we come down towards the bottom of the screen. We can indicate our hypothetical configurations here. In these hypothetical configurations, an uppercase letter denotes that the condition is present, and a lowercase letter-- a condition is present, sorry-- and a lowercase letter indicates that a condition is absent within that configuration.

So we have two possible configurations leading to our outcome. In the first, we have a locally sourced food, a good wine list, and a Michelin star all present. But in the second configuration, we only have locally sourced food and a good wine list, but the Michelin star is absent. But we're still finding that we're getting the outcome of a good restaurant. Therefore, our minimized solution suggests that locally sourced food and a good wine list is sufficient for leading to the outcome of the restaurant.

So back to the worked example on weight management and stage 5, where we consider what we think would happen in the case where we don't have any cases Representing configurations. So you can see on the right hand side, we didn't have any cases representing any of these configurations. And I should note that the top configuration is slightly misrepresented. The high intensity box should be grayed out if that component was absent in that configuration.

But what we judged in this example was that as the provider relationship, which is indicated in the first column, was so central to good outcomes from our theory, generated from our qualitative synthesis, that all of those configurations without provider relationships present would lead to a less effective intervention.

And then in our final stage interpretation, this slide is just to kind of indicate how we come back to our initial theory. And what we've given here, in the second column here, is some examples from our view synthesis. We give you a flavor of how emotive people were about the importance of positive relationship with the program provider.

One of the participants in one of, the studies said you feel that someone is batting for you. This is a really strong feeling that came across a large number of studies that we looked at. And one of the authors of one of the studies that we included in that synthesis suggested that the personality and approach of the advisor is likely to determine the success or failure of the service.

In the following columns we describe our most effective and least effective interventions. So all 10 of the most effective interventions had provider-user relationships emphasized and supported as well as characteristics perceived seek to foster self-regulation, such as the directly provided exercise sessions. And all of the least effective interventions either had no emphasis on provider relationships or some emphasis on that, but none of the conditions that were theorized to support self-regulation. So you can see that we came back to and discussed and discussed in force about does the logic of our configuration still match and tie up with our initial theory.

The last slide I have here is just to indicate a feeling I alluded to earlier that one of the key benefits of QCA is that it enables us to deal with those complex interventions and the complex context in which you see them in which there may be more than one possible pathway to an outcome. So even within configurations, we're saying that these provider relationships are absolutely critical.

But you can see our minimized pathways allow us two possible pathways, one where provider relationships is emphasized alongside a high intensity program with that graduated exit or a provider relationship is emphasized the program, but there is that direct provision of exercise.

So in terms of the strength of QCA, it has an ability to identify critical features where other approaches may be unsuccessful. It works particularly well with a small number of heterogeneous studies, which is often what we find when we are doing systematic reviews and it's not conducive to doing meta-aggression. But QCA manages, and in fact it works particularly well in this situation.

As I was saying on the last slide, it has the ability to reflect the complexity that we often find in public health interventions and other, at times, social interventions, being able to demonstrate the multiple pathways to effectiveness, and the grounding in theory structures analysis and avoids data dredging. I'd also argue that grounding in the theory not just provides justification but the explanation of not just what works but why it works.

And finally, thinking about the limitations of QCA. The analytical approach is abductive, which means that our conclusions must be there for more tentative than from deductive approaches. It's also often hampered by poor intervention reporting that is common in trials. What we're trying to get at with QCA is the really holistic, deep understanding of our cases.

So there are some challenges there, but QCA is an explicit and systematic approach and provides useful information for decision making where otherwise there is nothing on which to base decisions and, as Dylan suggested before, we would recommend its use in combination with other methods in the mixed method systematic review.

And just on this last slide is the reference to the paper by James Thomas and Ginny Brunton. But we also have listed our email addresses in case you have any questions or anything you'd like to share with us. Thank you very much.

JOANN STARKS: Well, thank you very much, Katy and Dylan for this presentation about the theory of QCA and an example of its application. And of course, we want to thank our funding agent NIDILRR for supporting this and other webcast activities. Please look for the other sessions in this series on the EPPI-Centre Evidence Tools, Products, and Projects.