Chapter 4. Developing and using logic models

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Key points

- Logic models are conceptual diagrams that can be used to define and articulate the relationships between key concepts within a review (e.g. intervention, health condition, context).
- They can be used for 'practical theorising' about the intervention or phenomenon of interest at the protocol stage as well as during and after synthesis.
- Logic models may be particularly useful in a qualitative evidence synthesis (QES) to help develop and communicate emergent theories about interventions or phenomena that are based on the findings of a review.
- They can be used in a stand-alone qualitative evidence synthesis (QES), a mixed-methods review with a qualitative component, or shared across a QES and linked intervention effect review.
- Logic models cut across disciplinary boundaries and can incorporate different sets of expertise drawn from lived and professional experience.
- Involving stakeholders in the development of a logic model is a recommended approach to help develop a logic model that is salient and interpretable to beneficiaries and users of review evidence.

4.1 Introduction

Theory takes many different forms (see chapter 3). This chapter focuses on review-specific theories in the form of logic models. Logic models represent a way of supporting theorising at an intervention- and review-specific level. As well as providing a framework for theorising how interventions work, and how well they are implemented, logic models can be mobilised for decisions throughout the systematic review process (Kneale, Thomas and Harris 2015). Logic models can be used to inform, strengthen and communicate the findings of a qualitative evidence synthesis (QES).

This chapter is important given increasing interest in using logic models in specific review types such as intervention effect reviews, realist reviews (chapter 16) and narrative syntheses (chapter 19). Logic models can also be considered an additional visual method to support synthesis (see also chapter 12). Logic models are particularly helpful when exploring complexity and in understanding complex interventions and their implementation (chapter 17). In a QES, review authors may be familiar with using theory (see chapter 3) and yet may not realise the added value of using logic models when exploring, for example, the factors involved in implementation of interventions in specific contexts (chapter 17). Logic models are particularly helpful when the intervention is a policy, strategy, or initiative that is implemented within a complex system such as a health service, police service, education or community setting. Concerns persist around the lack of documentation on the use of logic models and the difference they make to QES and evidence synthesis more broadly (Kneale, Thomas and Harris 2015). Better reporting of the use and contribution of logic models not only enhances the transparency of the review process but also facilitates further methodological developments.

The following sections offer guidance on: (i) the elements contained within logic models and particular considerations for logic models in QES; (ii) how logic models can be used to theorise different forms of causal relationship and how different types of logic model can support different questions that may be posed within the review; (iii) how logic models can be used at different stages of a review; (iv) how logic models are constructed and how to choose the appropriate type of logic model for a review; and (v) the challenges of developing and using logic models. Finally, logic models are considered in relation to stakeholder engagement and involvement, equity, diversity and inclusion, and review author reflexivity.

4.2 What is a logic model?

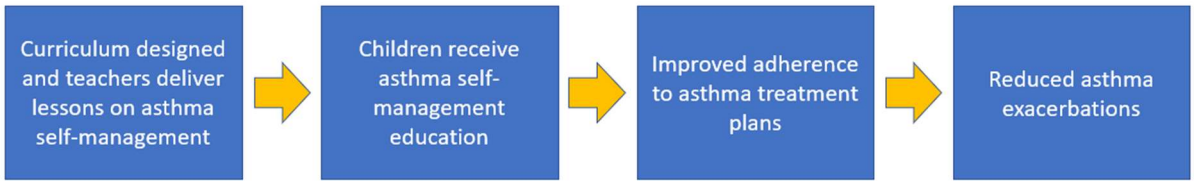
Logic models are pragmatic and graphical tools used to design interventions, create strategies for the evaluation of interventions, monitor programmes of work, conduct research, and communicate the findings of research (Kneale, Thomas and Harris 2015). The focus here is on the use of logic models as a tool to help design, plan, structure and present the findings of a systematic review through development and communication of programme theory (Rehfuess, et al. 2018). Programme theory refers to an explicit theory of how an intervention activates a series of processes and results that may change outcomes for participants and lead to wider impact (Funnell and Rogers 2011). A logic model represents one configuration of programme theory. When used within a systematic review, it allows reviewers to develop and communicate their understanding of how an intervention is theorised to influence outcomes, and the core pathways and moderators to achieving these outcomes.

Logic models can represent sequential chains of events or processes; and in interpreting most logic models these can be read as a series of 'if… then….' statements (McLaughlin and Jordan 2015). In the simple model in Figure 1, the logic can be read as follows: 'if a curriculum is designed and teachers deliver lessons on asthma self-management, then

greater numbers of children receive asthma self-management education'; 'if children receive asthma self-management education, then their adherence to asthma medication improves'; and finally 'if adherence to asthma medication improves, then asthma exacerbations decrease'. These 'if…then' statements represent assumptions of what is expected to happen during the intervention. Collectively, they can form the basis of programme theory that can underpin intervention implementation and evaluation (see also Chapter 16 for how if-then statements about interventions are used to develop programme theory within realist reviews).

Logic models are highly flexible and variable: they can depict systems or processes, interventions or naturally occurring phenomena, and simple or complex relationships. No set criteria exist on what is, and what is not, a logic model. However, in the next section (4.3) we outline some of the core components of a process-orientated logic model for interventions; QESs of interventions being the most frequently encountered type of QES within Cochrane and Campbell systematic reviews. Despite this flexibility, all logic models share the properties of being: (i) visual theories; that (ii) represent not only concepts but the relationship between concepts; and that (iii) are developed with a cogent set of explanations around how/why the relationship occur between concepts that are based on established theories, empirical evidence, and/or professional and lived expertise.

Figure 1: Simplified logic model of school-based asthma self-management intervention



4.3 Elements of a logic model and considerations for qualitative evidence syntheses

Although logic models offer substantial flexibility in design and included elements – a key attraction of logic models – the features below are common to logic models supporting many types of reviews evaluating interventions and their implementation (Anderson, et al. 2011, Kneale, Thomas and Harris 2015, Thomas, et al. 2019):

1. **Intervention inputs:** for example, the resources needed to deliver the intervention and the components and activities that are included within the intervention and the function they play.
2. **Outputs**: descriptive indicators of changes generated by the intervention activities that are directly within the investigators' control (see example in Figure 2 below: numbers of children receiving asthma self-management education).
3. **Outcomes**: outcomes are theorised to follow the implementation of an intervention; although outcomes are theorised to be conditional on outputs occurring, they are usually not directly within the investigators' control.

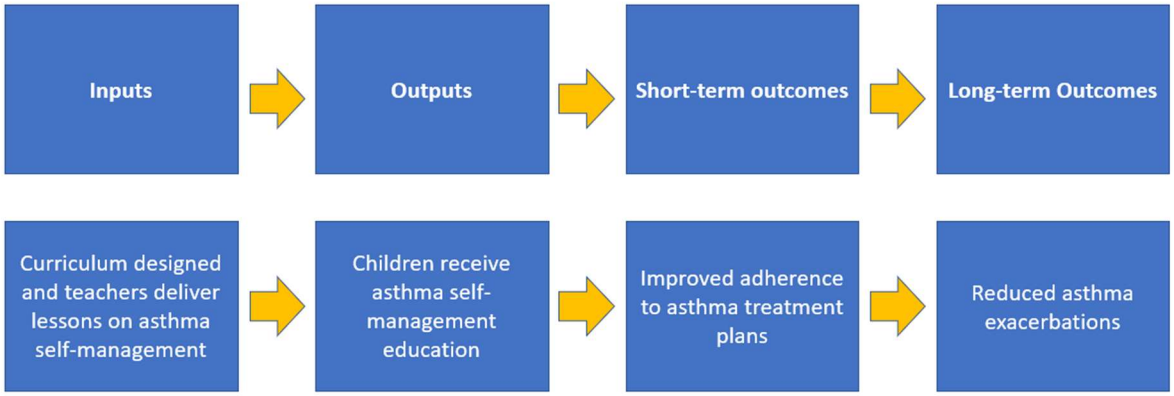


Figure 2: Simplified logic model of school-based asthma self-management intervention

Despite sharing many of the components described above, a logic model for a QES may need to include some specific characteristics that reflect the foci of a QES:

1. ***Recognition that logic models are useful tools to communicate review findings and emergent theory***: Logic models are increasingly recommended for inclusion within systematic review protocols to represent the review team's pre-existing assumptions about the intervention and how it works, and to support decisions made within systematic reviews (Thomas, et al. 2019). That is, they are typically used in systematic reviews before the synthesis to inform and structure the analysis.

In QES however, logic models are also presented as a product that has been developed through the synthesis, to communicate the emergent theory derived from the synthesis. Depending on the synthesis method, it may be desirable for detailed understanding of the processes, perceptions and experiences to develop from the data inductively during the QES (Barnett-Page and Thomas 2009). QES synthesis methods such as thematic synthesis (chapter 10) combine elements of meta-ethnographic (chapter 11) as well as grounded theory approaches (Barnett-Page and Thomas 2009, Thomas and Harden 2008). For some reviews therefore, a detailed logic model proves useful both as a tool for synthesis and/or in communicating the intervention theory that is developed through synthesising the evidence. For example, in their review exploring housing improvements for health and socioeconomic outcomes, Thomson, et al. (2013) used a logic model to map out the qualitative evidence on impacts and the links between impacts of housing improvements on the outcomes; this did not draw on the logic model prepared for the protocol (Thomson, et al. 2011). Figure 3, below, also provides an example of where a logic model is used to communicate an emergent theory; in this case the model illustrates an emergent theory of the determinants of engagement with antenatal care (see Downe, et al. 2016).

One approach that optimises the utility of a logic model in making decisions that frame a review *and* an inductive approach to synthesis, is to develop a concept-based logic model initially at the protocol stage, based around the PICO criteria for example (or SPICE/SPIDER criteria in QES – chapter 2). This is followed by a granular account based on the evidence

uncovered within the review. Similarly, some review teams have used abstract social science theories or models as the foundation of the logic model at the protocol stage, before developing granular and specific models based on the evidence in the full review (see the example discussed below).

The utility of logic models as tools for *directly* creating impact and engaging policy-makers and practitioners in the findings of QES is relatively unexplored (as is the case for systematic reviews and research more broadly). However, logic models do help to communicate evidence to decision-makers on 'how' interventions 'do good' (or not) that can help form policies on scaling up interventions (Weiss 1995), and correspond with decision-makers' preferences for evidence in visually compelling formats (Feldman, Nadash and Gursen 2001, Sonderegger, et al. 2021). Similarly, increasing numbers of examples where public involvement has supported the development of a logic model within the systematic review literature and beyond (for example O'Mara-Eves, et al. 2022a), indicate their potential as an impactful engagement tool among diverse audiences. Their further usefulness may be enhanced through software and strategies that make the logic model interactive.

2. ***Emphasis on patient/public perceptions and experiences:*** reviews drawing on QES may emphasise the perceptions and experiences of participants involved in interventions, or even of routine care.

A recent relevant example is a Cochrane review focussed on women's experiences of attending routine antenatal care and the factors that influenced women's uptake (Downe, et al. 2019). Initially, the authors included a logic model in the protocol (Downe, et al. 2016) based directly on the theory of reasoned action (Fishbein and Ajzen 2011). This well-established model of human behaviour was used in the protocol to depict how different forms of belief shape attitudes towards behaviours, perceived norms, and the perceived ability to control behaviour; these in turn shaped intentions and ultimately behaviours regarding engagement with antenatal care (Downe, et al. 2016, Fishbein and Ajzen 2011). The review team then used the review findings to evaluate the explanatory power of the initial logic model seeking to confirm, challenge and/or amend it. Three logic models were created representing how different belief systems impact intentions and, ultimately, behavioural choices, to determine full, partial or no engagement with antenatal services, with each logic model representing evidence from the synthesis of studies from high and low and middle income settings (Downe, et al. 2019).

The model is shown in Figure 3 with its interpretation following the if-then statement logic of earlier examples. These logic models demonstrate the flexibility and capacity of logic models to convey large amounts of information succinctly - certainly more succinctly than when in textual form. Figure 3 shows the results of the synthesis for women (in standard text) and healthcare providers (in bold text); it also shows conjunctural relationships (where a combination of different factors come together to bring about an effect – in this case attitudes to behaviours, perceived norms and perceived control – can all shape intentions

simultaneously); and illustrates the capacity of logic models to represent theories for specific groups of stakeholders (patients and healthcare providers).

Figure 3: Logic Model of full antenatal care uptake using findings relating to beliefs reproduced from Downe, et al. (2019) (superscript letters and numbers refer to a summary of qualitative findings table presented within the review – see source material)

3. ***Emphasis on the influence of broad social forces:*** Logic models supporting or deriving from a QES may need to represent complex processes and phenomena that are less prominent within logic models supporting effectiveness reviews. While logic models for a QES are not alone in depicting, or attempting to understand, the parameters and complexities of a system (Hong, et al. 2022), they offer scope for acknowledging the complex social, political, economic and psychological processes and contextual features that shape systems. In their review of the views and experiences of community members of mass drug administration programmes for a parasitic disease endemic in several low and middle income countries, Taylor et al (2022) revised their earlier logic model in favour of a visual model akin to the social ecological model. This allowed the review team to capture and theorise interrelationships between the historic forces representing inequalities and oppression, such as colonialism and the perceptions of international organisations based on their past actions, viewed as interacting within different levels of the model.

4. ***Emphasis on aspects of intervention complexity:*** A QES may offer insight on intervention complexity, the role of context, the implementation of interventions, and perceptions and experiences of recipients and stakeholders (Noyes, et al. 2019). Consequently, a logic model that supports a QES may address distinct types of questions and represent specific concepts and relationships. For example, the logic model may offer granularity around specific components of processes, and how these are moderated.

A review of lay health worker interventions (Glenton, et al. (2013) used logic models to synthesise and communicate findings from a QES and an effectiveness review. The review team focussed on how participants viewed specific intervention components, and how these individual components were theorised to lead to shorter-term intermediate outcomes as well as longer-term outcomes. Their logic model also showed positive and negative moderators that facilitate or hinder specific intervention components in activating a change in outcomes. While such a component-specific approach can also be taken within a quantitative effectiveness review, limitations in synthesis methods and the limited availability of data often make it challenging to develop and evidence theories about specific components. By focusing on intervention moderators, the same logic model (Glenton, et al. (2013) helps in conceptualising factors identified in a QES that impact on the effectiveness of interventions. Several Cochrane QESs have used a logic model to link findings to outcomes identified in effectiveness reviews as a strategy (Bohren, et al. 2019, Jordan, et al. 2016).

5. **Understanding implementation of complex interventions and whether the theory and implementation strategies have worked or not**. A QES can be used to explore why interventions are successful (or unsuccessful), with evidence mapped against the logic model to better distinguish between theory and implementation failure. In Figure 4, if teachers deliver lessons on asthma self-management, but children tend to be absent from these lessons, then the short-term and long-term outcomes are not observed, and this is regarded as an example of engagement or adherence failure (see also chapter X).

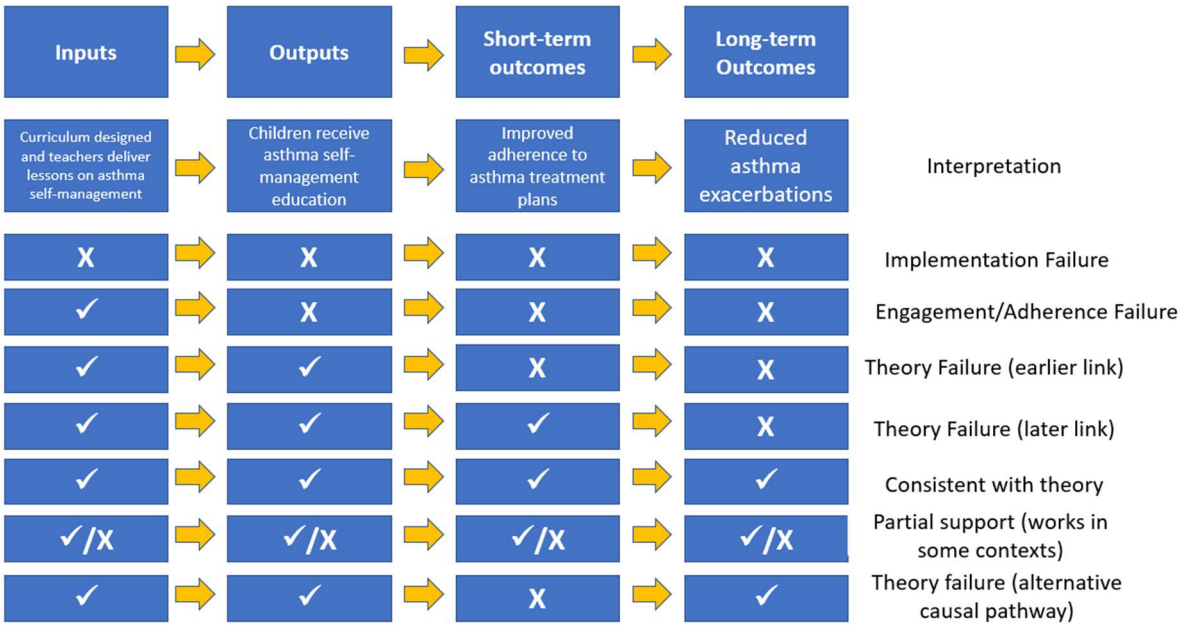


Figure 4: Using a logic model to distinguish between theory and implementation failure (based on example from Funnell and Rogers (2011)

Not only do logic models supporting a QES need to represent complex factors or phenomena, they may also need to represent complex relationships between these factors. The next sections demonstrate different approaches to understanding and representing complexity within logic models. This chapter then examines how systematic reviewers can harness logic models to inform decision-making within a review, before providing guidance on how to develop a logic model.

4.4 Depicting causality and intervention complexity within logic models supporting qualitative evidence synthesis

A review team may develop sequential chains of intervention inputs, activities/processes, outputs, and outcomes to form chains of events that are theorised to occur as part of, and following the implementation of, an intervention. Such logic models represent mechanistic accounts of (causal) theory that aim to elucidate how the components of the intervention and activities are organised to effect a change (mechanism) in the outcome(s) (Illari and Russo 2014, Maxwell 2004b). For logic models supporting and particularly emerging from QES, the logic model becomes a general interpretive framework, presented graphically, of how the evidence is understood to 'fit together' to show how a particular outcome

occurred. In some cases, the relationships between the components are theorised as causal. However, in many other cases relationships are tentative reflecting influences or connections yet to be explored within the review. This contrasts with demonstration that a (statistical) relationship exists between particular variables (Maxwell 2004b), typical of an effectiveness review.

The processes represented within a logic model may be measured directly within the studies included in a QES, unlike studies included within an effectiveness reviews where processes are assumed mechanisms or are interpreted through proxy variables (Maxwell 2004b). 'Meanings, beliefs, and volitional actions' within a QES are not easily converted to variables or neat labels 'without fundamentally concealing and misrepresenting the nature of the processes' (Maxwell 2004a), p7. Logic models supporting QES should avoid oversimplification; sometimes short qualitative statements offer the best way to represent such processes. Figure 5 shows a logic model (adapted from Popay, et al. 2006 guidance on Narrative Synthesis chapter 19) and based on Weiss 1998), which demonstrates how qualitative statements representing meanings, beliefs and actions can be developed into a logic model of the expected impacts of increasing teachers' salaries (note that this is described as a programme theory model in Popay's guidance on Narrative Synthesis-chapter 19).

Figure 5: Adapted Logic Model of the link between increasing teachers' salaries and improved student achievement (Popay, et al. 2006, Weiss 1998)

The relationships depicted within the logic model are usually highly context-dependent. The longer the causal chain, the greater the influence of context on these processes is likely to be (Kneale, et al. 2018). Within a QES, separating context and representing contextual features as anything but intrinsic to the processes, risks misrepresenting the causal mechanism itself (Maxwell 2004a, Maxwell 2012). The lack of standard notation for the design of logic models, as well as their inherent flexibility, allows systematic reviewers to represent many forms of complexity. This includes representations of relationships between interventions and contexts and context-dependent processes, even if this requires reviewers to be creative in their visualisation (see systems-based logic models below).

Logic models supporting QES for Cochrane and Campbell intervention reviews often represent causal theories of why and how an intervention is activating a change in outcomes, with scope for logic models to help to theorise and communicate how the causal system is understood. Mirroring variance-theory approaches, logic models can be used to depict interventions and comparisons (Maxwell 2004b); for example in theorising how an intervention is understood to change or disrupt existing practice or systems relative to the control or usual care. They can also represent changes and understandings of what happened before the intervention and/or outside the intervention, and what participants perceive as a counterfactual outcome in the absence of an intervention. However, logic models are probably more useful in supporting the theorisation and analysis of connections between events and processes. Review teams may need to consider whole events,

decomposing them into smaller fragments (causal chains or parts of causal chains), and recomposing them where needed to once again represent sequentially connected actions (Maxwell 2004b). Logic models are also useful in developing and assessing alternative explanations (Maxwell 2004b); for example the practice of 'dark logic' modelling, where potential unintended consequences of an intervention are theorised and/or represented (Bonell, et al. 2015), evokes the practice of understanding discrepant or negative cases that takes place when evaluating causal accounts within qualitative primary research. Dark logic models also have parallels with dys-logic models; described as models of factors that prevent a system from functioning effectively (Garside, et al. 2020). Garside and colleagues (2020) use a dys-logic model, which integrated evidence from a mixed-methods review of nature-based social prescribing interventions for people with mental health conditions, as well as key informant interviews, to depict key implementation barriers, the points at which patients drop out of the intervention, and the key interrupters to the flow of the intervention.

Further relationships that can be represented within a logic model

Logic models commonly represent complexity in the form of 'equifinality' and 'conjunctural causation'. Equifinality refers to the principle that an outcome (or output) is reached through multiple routes; systematic reviews can be used to explore the strength of evidence surrounding these pathways. Figure 5 shows how multiple pathways are followed to reach improvements in student morale; Figure 5 also depicts a degree of 'conjunctural causation', where a factor (e.g. an intervention component or output or process) is only influential in the presence of another. For example, it might be assumed that from looking at the pathways in the middle of the logic model in Figure 5, that students merely working harder may not activate improvements in student achievement unless teachers also teach more effectively; both need to occur for improvements in student achievement to occur. Equifinality and conjunctural causation are frequently explored in syntheses using Qualitative Comparative Analysis (QCA) (see chapter 18).

Logic models can also support complexity when considering the nature of the lines connecting elements. For example, feedback loops are activated when initial changes in the outcome create the conditions for further self-reinforcing changes earlier in the chain of outputs/outcomes (Rogers 2008). Returning to Figure 4, where it is further theorised/evidenced that students become more motivated with increased achievement, this might produce a 'virtuous cycle' where the effect of students working harder is sustained (or even amplified; see Figure 6 below). Equally, a vicious cycle might occur where a dampening of intervention impacts occurs as social systems adapt and absorb the impacts of the intervention (Noyes, et al. 2013).

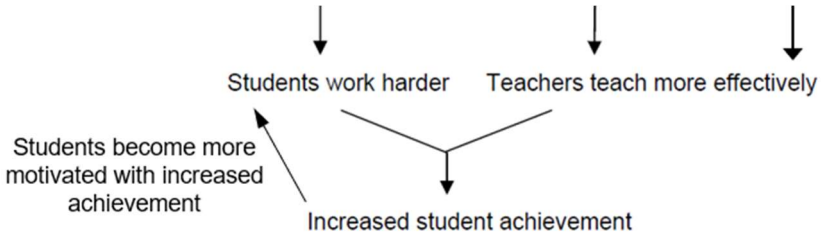


Figure 6: Depiction of virtuous cycle (based on logic model in Figure 3)

Logic models could help in theorising other aspects of complexity (e.g. threshold effects or delayed effects) or complex network structures, although few worked examples exist (Davies 2018). Additional notation and alternative colour schemes are proposed for representing complex relationships in logic models and other forms of programme theory, supplemented by use of clickable explanations in interactive logic models hosted on websites (Davies 2018). Frameworks and decision-aids that support reviewers to consider different aspects of complexity are useful when theorising which forms of complex relationship should be represented within logic models (see Lewin, et al. 2017, Movsisyan, Rehfuess and Norris 2020).

Using process-orientated logic models to theorise how interactions between intervention components influence an outcome

In guidance on the use of logic models in systematic reviews of complex interventions, Rehfuess, et al. (2018) provide a useful distinction between models that focus on theorising complex interactions and processes within an intervention (process-oriented models) and those that focus on theorising interactions between an intervention and the system within which it is implemented (system-based models). The former focus on 'unpacking' an intervention's components and processes and theorising how interactions between these components could produce a change in the intended outcome. This aligns with the observation, analysis and synthesis of actions and events and their connecting processes that can be developed into a causal theory or explanation in qualitative research (Maxwell 2004b). Process-oriented logic models therefore support theorising linear and non-linear relationships and typically feature an account of temporality that enables the sequence of events to be theorised (Rehfuess, et al. 2018). A process-oriented model offers a basis for an analytical framework (in contrast to a system-based model which provides the basis for a conceptual framework (Rowher, et al. 2016, p18)), reflecting the granular approach used to theorise sequences and the nature of connections across a causal chain. Process-oriented logic models are thought to resemble the logic models used by investigators and evaluators of primary interventions (Funnell and Rogers 2011), typically building upon the basic structure shown in Figures 1 and 2. A process-oriented approach counters historic critiques that systematic reviews treat interventions as 'black boxes', with little attempt to understand the mechanisms surrounding why an intervention did or did not 'work', or with minimal critical engagement with the complexity of concepts and processes under study (e.g. community mobilisation) (Cornish 2015, Negrini 2019).

Using system-based logic models to theorise interactions between intervention and its context

In a system(s)-based logic model, theorising focuses on interactions between the intervention, its participants, and its context (Rehfuess, et al. 2018, Rohwer, et al. 2017). System-based logic models can support reviewers to understand and prioritise elements of complexity around, for example, intervention implementation and/or which wider (systemic) impacts result from an intervention (Movsisyan, Rehfuess and Norris 2020). The system-based logic model tends to represent the PICO criteria as core elements, with supplemental information included on context and implementation (Rohwer, et al. 2017), and uses 'system-based approaches to unpick the complexity of a policy or programme' (Rowher, et al. 2016).

However, system-based logic models frequently do not provide granular detail on interactions between the intervention and the wider context, and many examples tend not depict causal or sequential chains in detail. This often results in a missed opportunity to consider the role of context and integrating contextual factors into the representation of processes, as expected from causal explanation in qualitative research more generally (Maxwell 2004b). Instead, system-based logic models have been used to depict a broad conceptual framework that comprehensively describes intervention and contextual factors that may explain the effectiveness or patterns of implementation (Rehfuess, et al. 2018, Rohwer, et al. 2017).

However, a strength of a system-based logic model is its capacity to depict conditions of 'usual care'. Inadequate consideration of 'usual care' is described as the 'black hole' within the 'black box', signifying a poorly described but important feature of context, crucial to the interpretation of evidence from complex interventions (Negrini, et al. 2019).

4.5 The role of logic models at different stages of systematic reviews

Anderson and colleagues (2011, p35) were among the first to illuminate how logic models might support systematic review stages including those in Figure 7 blow.

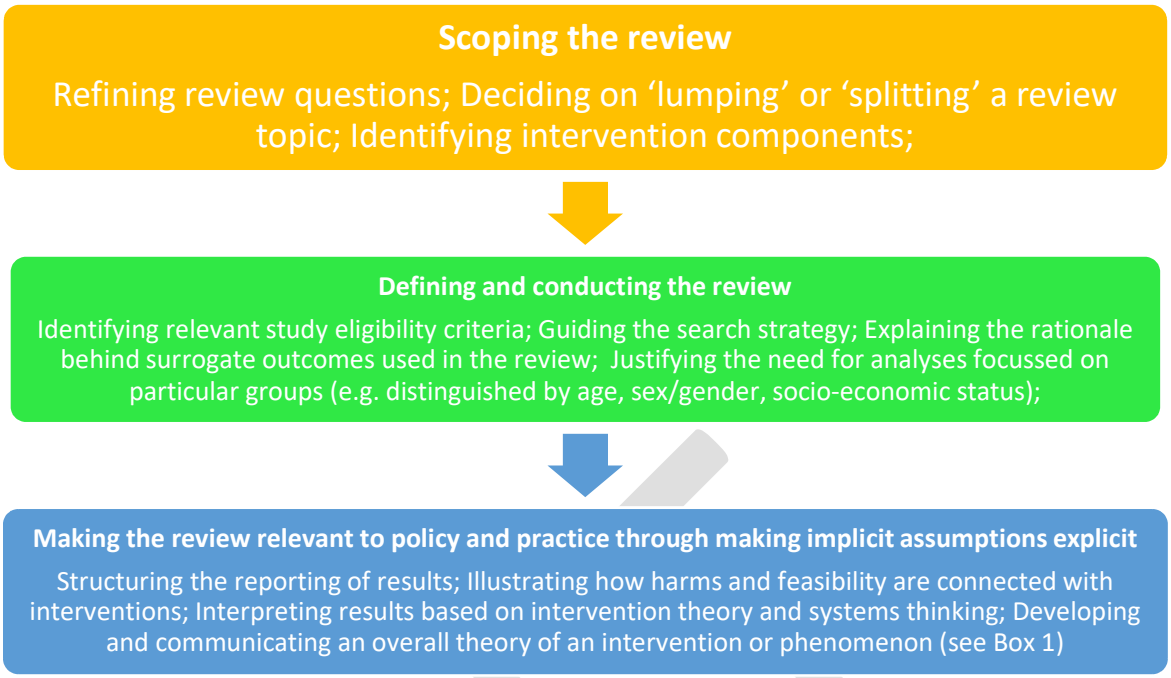


Figure 7: The stages of a review in which a logic model can contribute Anderson and colleagues (2011, p35)

Logic models are important in helping reviewers to think conceptually about the intervention and in identifying the optimal way of addressing the review questions (Kneale, Thomas and Harris 2015). Where logic models are developed with stakeholder input, such conceptual thinking can also translate into a systematic review that addresses questions of salience to decision-makers and other stakeholders (Anderson, et al. 2011, Baxter, et al. 2014). Although review authors used to include logic models as static and somewhat redundant figures in the introduction to protocols/reviews, with little explanation of their use or contribution (Kneale, Thomas and Harris 2015); examples now exist where the logic model has been used to inform multiple stages of the review (Rehfuess, et al. 2018). Further examples of how logic models support a QES are considered in Box 1.

Box 1 – The use of logic models to support qualitative evidence synthesis

Developing and changing the focus of the review: Logic models are increasingly used to articulate issues that surround the intervention or phenomena under study, and as tools to help develop the review questions and sub-questions (Booth, et al. 2019).

Informing the search/eligibility criteria: A realist review of recovery-orientated mental health interventions and their contribution to personal recovery featured a logic model within a central role when considering study eligibility. Eligible studies were required both to inform a pathway within the draft logic model and to provide evidence on the mechanism between intervention and outcome (Winsper, et al. 2020).

Informing the analysis of findings - see example of theory and implementation success and failure in fig 4.

Informing the conduct of synthesis: A QES examining companionship during childbirth used a logic model to further organise findings from a thematic synthesis and to link findings with the results of an earlier intervention review (Bohren, et al. 2019). Others have outlined how reviewers could purposively select different synthesis methods based on the relationships depicted within the logic model (Kneale, et al. 2018).

Strengthening the quality of QES: Logic models can be useful in strengthening the conduct of QES in multiple ways including:

- Challenging reviewers to develop evidence-based mechanistic and processual explanations for how change happens.
- Providing a framework for integrating diverse evidence including different forms of qualitative evidence as well as evidence from mixed-methods studies.
- While logic models are likely to provide a generalised theory for a phenomenon or intervention, they can also support decisions around the contextualisation of evidence. For example, logic models could help reviewers to ensure that concepts emerging from the synthesis are not translated and applied to a context or group where they do not belong (Thomas and Harden 2008).
- A logic model can also help to identify gaps in the evidence, particularly when a logic model simultaneously summarises both theory and the strength of evidence supporting different pathways or mechanisms within the theory. This can help to inform decisions about conceptual saturation and purposive sampling of literature (Ames, Glenton and Lewin 2019 and chapter X), which may be particularly relevant in developing realist reviews (see Chapter 15).
- Logic models can also help reviewers to be reflexive and to consider how the evidence synthesised during a review challenges their own assumptions, and in doing so can help reviewers consider their positionality (see Schucan Bird, et al. (2023) and later section on reflexivity).

Updating logic models to communicate theory development: Logic models can show the assumptions held by review authors at the start of the review on how interventions are theorised to work. They can also show how the theory develops with the evidence synthesised during the review, either opportunistically or at planned stages (Booth, et al. 2019, Rehfuess, et al. 2018). Examples exist of both process-oriented models (Harris, et al. 2019) and system-based models (Krishnaratne, et al. 2020) where logic models have been updated to reflect learning acquired during the review.

Using logic models to communicate new theory: Examples exist where the logic model itself is the main output and contribution of the review. Here the logic model is developed inductively, sometimes taking a broad social science theory as a basis for developing a granular programme theory, and sometimes developing a logic model solely from the review findings. A review of positive psychology interventions produced an evidence-based logic model as a main output to communicate evidence underlying positive psychology interventions, contrasting findings from the logic model with the prevailing theory of positive psychology (Kletter, Harris and Brown 2021).

4.5.1 Reporting and creating/updating logic models

As we outline above, in addition to being tools for framing a review and strengthening the synthesis, logic models hold potential as tools for communicating findings and theory. However, little guidance exists for the reporting of logic models. Instead, we offer principles for shaping decisions on presenting and report a logic model:

- **Interpretability:** Logic models are graphical representations of complex relationships; where this summary becomes unintelligible to others outside the direct review team, then logic models are failing to fulfil their intended purpose.
- **Interactivity:** Good logic models are visually stimulating and ideally have some interactive component that allows stakeholders to explore further details around particular components or relationships.
- **Independence:** A good logic model should be interpretable, even if it's a stand-alone model taken out of context of any accompanying text. Ideally the model can be viewed on a single page (although this is less of a consideration for interactive models), with text that is legible, a key for any meaningful use of colours or fonts, and consideration around accessibility.
- **Informative:** While the model should stand alone, an accompanying narrative should also address questions including: what does the model show?; how was the model developed?; what were the preconceptions of the review team/stakeholders?; how does the evidence in the review challenge or confirm preconceptions?; how was the model used?; how were stakeholders involved in the construction of the model?; what are the reflexivity considerations?
- **Integrated:** The reporting of the logic model should be integrated into the review, and its role should also be reported in the protocol – be this a copy of the 'a priori' logic model or a description of plans to develop a logic model as a synthesis tool.

The decision about when to create and/or update a logic model is very much tied to the underlying review question – its breadth and whether it involves testing or developing theory - as well as pragmatic constraints (see Rehfuess, et al. 2018 for further guidance). A review question involving an inductive approach to synthesising the literature could mean that the logic model is only developed at the end of the review based on the evidence uncovered. Alternatively, a staged approach to creating and then updating the logic model may be preferred when a review team plans to synthesise specific types of literature sequentially and/or to engage with stakeholders at planned points in the review. While this choice depends on the reviewers' focus; where a logic model is published in a protocol, it would generally be expected that an updated version is published in the review that shows confirmation or changes to the expected relationships, as well as an indication of the strength of evidence supporting these changes.

4.6 Developing and using logic models for systematic reviews

4.6.1 Getting started with developing a logic model for a review

Given the complexity of many social and health interventions, the development of logic models to support theorising how these interventions are intended to 'work' can also be challenging (Noyes, et al. 2016, Wolfenden, et al. 2021); the steps in Figure 8 below are intended to support reviewers in identifying or developing logic models for a systematic review. Detail on exactly what each step entails is included in guidance published elsewhere

(Kneale, et al. 2020a, Kneale, Thomas and Harris 2015, Rowher, et al. 2016), and there also exist useful templates to get started with process and systems-based logic models with worked examples published elsewhere (Rohwer, et al. 2017, Rowher, et al. 2016).

Figure 8 was drawn using Miro, software that is used across the literature to develop interactive logic models, and an interactive version of this model can be accessed here with accompanying notes: https://miro.com/app/board/uXjVMbWj-TQ=/. These steps are most likely followed in supporting the development of a process-based logic model at a protocol stage, although many steps could help in developing a logic model as a tool for synthesis or for communicating the review findings. While this logic model was created through software, many (if not most) logic models may be created initially through more participatory methods (e.g. simple post-it notes (see section 4.6.3 and Figure 10)).

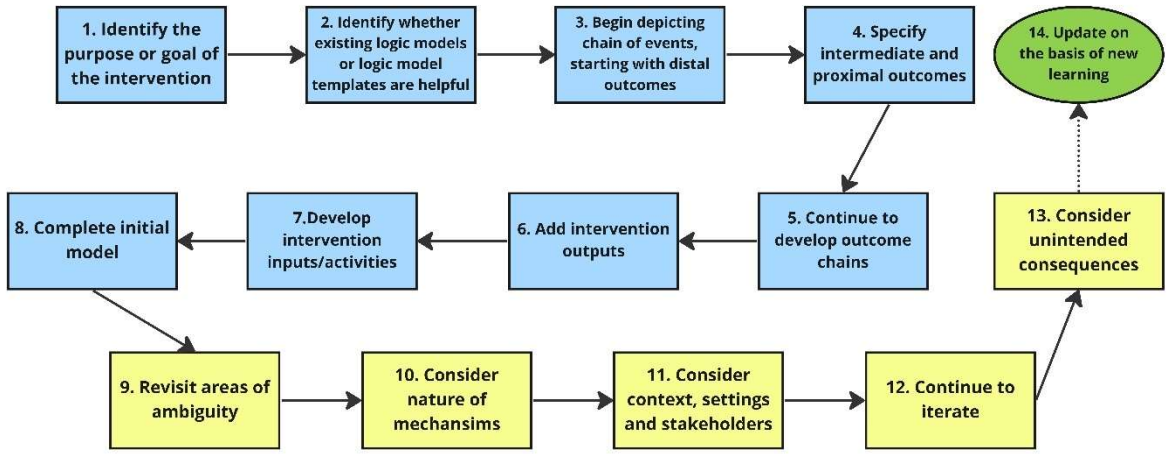


Figure 8: Steps taken in constructing a logic model; an interactive version of this model can be accessed here with accompanying notes: https://miro.com/app/board/uXjVMbWj-TQ=/

4.6.2 Choosing between different forms of logic model or between a logic model and other forms of programme theory

Choosing between process oriented and system-based approaches

Clearly process-oriented and system-based logic models overlap and are interrelated (Rehfuess, et al. 2018), with possibilities of incorporating process-oriented thinking within a system-based framework (and vice versa). Some recommend that reviewers should start with a system-based model, holding a process-oriented model in reserve until they reach a better perceived understanding of the intervention (Rehfuess, et al. 2018). However, incorporating stakeholders in the design of the model, particularly if undertaking in-depth engagement through co-production, may help develop sufficient early understanding to develop a process-oriented model.

Those that distinguish between process-oriented and system-based logic models stress that the distinction is not a 'straitjacket', and that the distinction serves to prompt reviewers with important questions surrounding the intervention and the review (Rehfuess, et al. 2018). In reality, logic models may contain both process-oriented and system-based thinking, and for logic models that are used to guide QES and/or are the product of QES, elements of both process-orientated and systems-orientated thinking may be needed to develop a theory of causal explanation. Examples of hybrid models appear across the literature. For example, in developing a system-based model of the impacts of school closures during the pandemic, a logic model was created that focussed on broad system-level impacts across different socioecological levels (invoking system-based thinking) but that also considered some of the nature, direction and sequencing of these processes (usually associated with process-oriented logic models). Created within the first month of the pandemic, the logic model was used to display impacts evidenced from previous pandemics, as well as impacts that were theorised but unevidenced (Kneale, et al. 2020b). A snapshot in Figure 9 shows impacts on children's health and wellbeing, evidenced in the literature through purple connections, and those theorised to occur but were unevidenced through green connections.

Figure 9: Part of a systems-based logic model of the impact of pandemic related school closures on children's health and wellbeing (Kneale, et al. 2020b)

Choosing between a logic model and other forms of programme theory

To date the focus in this chapter has been on how logic models are used as review-specific theory. Multiple overlapping terms exist for forms of programme theory that only differ subtly from logic models. One frequently encountered term is 'Theory of Change', long established in the evaluation literature (Funnell and Rogers 2011). While any distinction between a theory of change and a logic model is 'fuzzy', the former is usually an explanatory form of programme theory with the expectation that all underlying assumptions in the model are explicated (Clark and Anderson 2004). Given that this depth of knowledge may not always be accessible to review authors at the outset of a review, and indeed at the end of a review questions may remain, 'logic models' are preferred here. Similarly, 'logical frameworks' or 'logframe' approaches are used by evaluators, particularly those working on complex international development interventions, as project management tools (Floate, Durham and Marks 2018). Although their construction may involve theorising, their utility in either (i) qualitative evidence synthesis; or (ii) theorising of complex mechanisms within interventions, remains uncertain.

Finally, causal loop diagrams are used to understand and visualise systems, sharing parallels with logic models. They contain elements including the 'variables', the links between the variables, and an indication of the polarity of the relationship (whether a vicious or virtuous cycle connects variables or whether they operate within a balancing relationship). Although originally employed to 'qualitatively' map systems for later (quantitative) modelling, these diagrams are increasingly used to support qualitative

research (Baugh Littlejohns, Hill and Neudorf 2021) including narrative literature reviews (Brereton and Jagals 2021) and qualitative syntheses (Gaveikaite, et al. 2020). The well-known example of the Foresight obesity systems map demonstrates their capacity to represent highly complex systems (see Finegood, Merth and Rutter 2010); Knai, et al. (2018) present an alternative example where an initial linear model of the commercial determinants of non-communicable disease was transformed into a complex systems model using a causal loop approach. Causal loop diagrams are said to help to identify potential key leverage points for change and action in a system by helping the reader to understand potential feedback mechanisms (Brereton and Jagals 2021). Causal loop diagrams are thought by some to extend logic models beyond the confines of theorising linear cause and effect mechanisms (Baugh Littlejohns, Hill and Neudorf 2021). However, this an erroneous assumption is demonstrated in Figure 6 and throughout this chapter. While the full utility of causal loop diagrams for QES may become increasingly apparent in the future, some considerations for those interested in the approach are the extent to which causal loop diagrams (i) support representations of meaning or perception, given their focus on representations of (quantitatively) increasable or decreasable states; (ii) support representations and theorisation of the detailed processual activities and events; (iii) focus on the polarity of relationships which may limit the type of factors represented; (iv) are based on, or incorporate elements of, broad social science theory; (v) adequately capture the temporal order of relationships; and (vi) identify and represent broad social and historical forces, for example colonialism or racism.

4.6.3 Challenges of developing and using logic models

Logic models are a flexible approach to developing a working theory of what may happen during an intervention. One concern articulated around the use of logic models is ‘what if the initial theory is wrong?’ such that the review pursues an irrelevant or incorrect tangent. This is a legitimate concern. However, strategies for stakeholder involvement and drawing on logic models to build on existing theory, may help to mitigate this concern. Logic models that draw on broader social and other theories in informing their design may also mitigate the risk of developing an irrelevant or incorrect theory. Furthermore, the approaches around planned iteration of the logic model to reflect changing understanding around the intervention (and documenting this process) means that theory is explored, revised, and improved as a result of the review. Finally, as discussed earlier, logic models for QES are often used to support and communicate the findings of the synthesis, and for some forms of QES, logic models may suggest, rather than ‘test’, a theory.

Logic models can quickly become complex, losing their coherence and becoming too complex to provide a detailed framework for analysis, (Davies 2018). This criticism is well-founded, and while the principle of equifinality is likely to hold for many complex interventions, high numbers of different combinations of potential routes can become unmanageable for analytical or communication purposes. Again, stakeholder involvement may help to prioritise pathways within a logic model; furthermore, reviewers should consider a logic model as a simplified representation of a complex intervention system.

Creation of a logic model entails grappling with this complexity in ensuring that it represents those pathways theorised as most important.

Choosing appropriate software represents a further pragmatic challenge. Software options include specialist software purposefully designed for creating logic models and theories of change (for a recent list see BetterEvaluation (2020)), software for graphic visualisation (for example Miro), and familiar software for visualising simple models (for example PowerPoint). Often, particularly when using participatory approaches, paper-based approaches may suffice, proving effective in stimulating engagement; paper-based approaches may also represent a useful initial step in advance of software (see Figure 10 for an example and chapter 12). However, no consensus exists on the most appropriate software, and very complex models pose a challenge to most types of software, further justifying that reviewers keep models as simple as possible.

Figure 10: Initial paper-based approach to a logic model of Cognitive Behavioural Therapy interventions (see Shaw, et al. (2019))

A final challenge to the use of logic models is the absence of quality standards– while recommendations exist for developing a logic model, no agreed consensus exists for what a 'good' logic model looks like. Conversely, this freedom facilitates logic models that are tailored to the evidence gaps that reviewers are addressing, the types of intervention, and the perspectives of the stakeholders involved.

4.7 Stakeholder engagement and patient and public involvement in developing a logic model is essential

It is critically important to identify and involve appropriate stakeholders from the outset in developing a logic model, particularly to strengthen the salience of the model and to create a model that makes sense and is of value across different stakeholders. Stakeholders could

bring lived expertise of a given health condition (e.g. patient, carer, parent, or relative), may advocate for those with lived expertise (e.g. patient groups), or may contribute professional or learnt expertise (e.g. practitioners, clinicians, researchers and policy-makers). Among other benefits, stakeholder involvement can challenge assumptions about the intervention or the condition under study (Kneale, et al. 2021); ensure a diversity of views are incorporated; and help to identify how contextual factors facilitate or hinder the delivery of the intervention (Kneale, et al. 2020a). Several resources and tools are useful in helping reviewers to engage with stakeholders (Oliver, et al. 2021).

Given that logic models can be visually engaging and interactive, both during their development as well as in the output itself, they are conducive to the involvement of diverse stakeholders. Furthermore, given the significance that logic models can hold in framing the review, making decisions during the review, and in communicating the findings, involving stakeholders in the construction of logic models could be a means of avoiding tokenistic approaches to stakeholder involvement in reviews (although clearly reviewers should attempt to maximize opportunities for stakeholder involvement across all review stages (see Haddaway, et al. (2017)). Adopting co-production in developing logic models can go further to ensure that the logic model is developed in a way that is inclusive, human and that challenges reviewer world views (O'Mara-Eves, et al. 2022a, O'Mara-Eves, et al. 2022b).

Regardless of approach, involving stakeholders in developing logic models should avoid the need for one model that supports decisions and communication within the team conducting the review, and a separate public-facing model aimed at stakeholders - and beyond. A single model serves a dual purpose as a tool for conducting the review and a medium for transparently conveying assumptions and evidence beyond the review team. This should optimise the reach of the review findings, add transparency and democratise the review process.

4.8 Equity, Diversity and Inclusion

Logic models offer potential as tools to support further consideration of equity issues. A review of the use of programme theory in relation to socioeconomic status found that reviewers could do more to optimise logic models as tools to consider differential intervention effects (Maden, et al. 2017), with the same being likely across different groups of interest and across PROGRESS-Plus characteristics (see chapter 1 and Oliver, et al. 2008 for a description of PROGRESS-Plus). Current logic model practice often “lumps together” equity considerations as potential effect modifiers, but the prospect for a greater role for logic models to support theorising about these distributional impacts remains. General- and intervention-specific equity logic models have been proposed structured around Recruitment, Intervention and Outcome Evaluation for an intervention or programme (Lehne, et al. 2019).

Cochrane and Campbell reviews can (and should) help us to understand how effects are distributed within populations and across population groups (Welch, et al. 2019); use of logic models to articulate how the intervention impacts different groups is, as yet, largely unrealised.

Writing this chapter has also crystallised the need and potential for reviews drawing on QES to further develop the potential of logic models in visualising complex context dependent relationships and, for example, theorise whether interventions or phenomena are likely to take a similar form in high vs low income context. Within many existing logic models, there is a tendency to represent context as exogenous and potentially extraneous to intervention processes and systems. We would hope that future iterations of this chapter will identify examples where contextual factors (and potentially other factors representing equity), are represented as integral to the processes depicted within the model**.**

4.9 Reflexivity

Review authors and stakeholder biases could influence the development and evolution of logic models. We have noted earlier that logic models can support reflexivity and provide a framework for reviewers to consider their own assumptions and positionality. Given the importance that logic models can play in the review, the role of review author and stakeholder perspectives and potential conflicts of interest needs to be made transparent, as these can influence the direction of the review and interpretation and communication of findings. For example, professionals often privilege specific outcomes over others and consider their selected clinical outcomes to be more important than outcomes as prioritised by patients or intervention recipients. To help understand how author and stakeholder perspectives shape a review, their role in the creation of the logic model and the role that the logic model has in the interpretation of evidence, needs to be made transparent. This could include, for example, ensuring that conflict of Interest statements are managed and declared in developing and publishing a logic model. In addition, transparent reporting of how stakeholders contributed to the development of the logic model, as well as transparent reporting of how the logic model contributed to the direction of the review, could help to understand how such conflicts of interest could influence the findings. Where clear conflicts of interest or divergent perspectives exist among particular groups who contribute to the development of the logic model, there is a case for publishing a separate logic model that clearly shows these distinctions.

Chapter information

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References

Ames, H., Glenton, C. and Lewin, S. (2019). Purposive sampling in a qualitative evidence synthesis: A worked example from a synthesis on parental perceptions of vaccination communication. *BMC medical research methodology*, 19, 1-9.

Anderson, L.M., Petticrew, M., Rehfuess, E., Armstrong, R., Ueffing, E., Baker, P., Francis, D. and Tugwell, P. (2011). Using logic models to capture complexity in systematic reviews. *Research synthesis methods*, 2, 33-42.

Barnett-Page, E. and Thomas, J. (2009). Methods for the synthesis of qualitative research: a critical review. *BMC medical research methodology*, 9, 1.

Baugh Littlejohns, L., Hill, C. and Neudorf, C. (2021). Diverse approaches to creating and using causal loop diagrams in public health research: recommendations from a scoping review. *Public health reviews*, 24.

Baxter, S.K., Blank, L., Woods, H.B., Payne, N., Melanie, R. and Elizabeth, G. (2014). Using logic model methods in systematic review synthesis: describing complex pathways in referral management interventions. *BMC Medical Research Methodology*, 14, 62.

BetterEvaluation. (2020). Theory of Change Software. In Better Evaluation.

Bohren, M.A., Berger, B.O., Munthe-Kaas, H. and Tunçalp, Ö. (2019). Perceptions and experiences of labour companionship: a qualitative evidence synthesis. *Cochrane Database of Systematic Reviews*.

Bonell, C., Jamal, F., Melendez-Torres, G.J. and Cummins, S. (2015). 'Dark logic': theorising the harmful consequences of public health interventions. *Journal of Epidemiology and Community Health*, 69, 95-98.

Booth, A., Noyes, J., Flemming, K., Moore, G., Tunçalp, Ö. and Shakibazadeh, E. (2019). Formulating questions to explore complex interventions within qualitative evidence synthesis. *BMJ global health*, 4, e001107.

Brereton, C.F. and Jagals, P. (2021). Applications of Systems Science to Understand and Manage Multiple Influences within Children's Environmental Health in Least Developed Countries: A Causal Loop Diagram Approach. *International journal of environmental research and public health*, 18, 3010.

Clark, H. and Anderson, A.A. (2004). Theories of Change and Logic Models: Telling Them Apart. In *American Evaluation Association*. Atlanta, Georgia.

Cornish, F. (2015). Evidence synthesis in international development: a critique of systematic reviews and a pragmatist alternative. *Anthropology & medicine*, 22, 263-277.

Davies, R. (2018). Representing theories of change: technical challenges with evaluation consequences. *Journal of Development Effectiveness*, 10, 438-461.

Downe, S., Finlayson, K., Tunçalp, Ö. and Gülmezoglu, A.M. (2016). Factors that influence the uptake of routine antenatal services by pregnant women: a qualitative evidence synthesis. *The Cochrane Database of Systematic Reviews*, 2016.

Downe, S., Finlayson, K., Tunçalp, Ö. and Gülmezoglu, A.M. (2019). Provision and uptake of routine antenatal services: a qualitative evidence synthesis. *Cochrane Database of Systematic Reviews*.

Feldman, P.H., Nadash, P. and Gursen, M. (2001). Improving communication between researchers and policy makers in long-term care: or, researchers are from Mars; policy makers are from Venus. *The Gerontologist*, 41, 312-321.
Finegood, D.T., Merth, T.D. and Rutter, H. (2010). Implications of the foresight obesity system map for solutions to childhood obesity. *Obesity*, 18, S13.
Fishbein, M. and Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach*. Psychology press.
Floate, H., Durham, J. and Marks, G.C. (2018). Moving on from logical frameworks to find the 'missing middle'in international development programmes. *Journal of Development Effectiveness*, 1-15.
Funnell, S.C. and Rogers, P.J. (2011). *Purposeful program theory: effective use of theories of change and logic models*. John Wiley & Sons, San Francisco, CA.
Garside, R., Orr, N., Short, R., Lovell, R., Husk, K., McEachan, R., Rashid, R. and Dickie, I. (2020). Therapeutic Nature: nature-based social prescribing for diagnosed mental health conditions in the UK. In *Final Report for DEFRA*. Department for Environment, Food and Rural Affairs, London.
Gaveikaite, V., Grundstrom, C., Lourida, K., Winter, S., Priori, R., Chouvarda, I. and Maglaveras, N. (2020). Developing a strategic understanding of telehealth service adoption for COPD care management: A causal loop analysis of healthcare professionals. *PloS one*, 15, e0229619.
Glenton, C., Colvin, C.J., Carlsen, B., Swartz, A., Lewin, S., Noyes, J. and Rashidian, A. (2013). Barriers and facilitators to the implementation of lay health worker programmes to improve access to maternal and child health: qualitative evidence synthesis. *Cochrane Database Syst Rev*, 10.
Haddaway, N.R., Kohl, C., Rebelo da Silva, N., Schiemann, J., Spök, A., Stewart, R., Sweet, J.B. and Wilhelm, R. (2017). A framework for stakeholder engagement during systematic reviews and maps in environmental management. *Environmental evidence*, 6, 1-14.
Harris, K., Kneale, D., Lasserson, T.J., McDonald, V.M., Grigg, J. and Thomas, J. (2019). School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review. *Cochrane Database of Systematic Reviews*.
Hong, Q.N., Bangpan, M., Stansfield, C., Kneale, D., O'Mara-Eves, A., van Grootel, L. and Thomas, J. (2022). Using systems perspectives in evidence synthesis: A methodological mapping review. *Research Synthesis Methods*, 13, 667-680.
Illari, P. and Russo, F. (2014). *Causality: Philosophical theory meets scientific practice*. OUP Oxford.
Jordan, J., Rose, L., Dainty, K.N., Noyes, J. and Blackwood, B. (2016). Factors that impact on the use of mechanical ventilation weaning protocols in critically ill adults and children: a qualitative evidence-synthesis. *Cochrane Database of Systematic Reviews*.
Kletter, M., Harris, B. and Brown, C. (2021). Outcomes, mechanisms and contextual factors of positive psychology interventions for health workers: a systematic review of global evidence. *Human resources for health*, 19, 1-14.
Knai, C., Petticrew, M., Mays, N., Capewell, S., Cassidy, R., Cummins, S., Eastmure, E., Fafard, P., Hawkins, B. and Jensen, J.D. (2018). Systems thinking as a framework for analyzing commercial determinants of health. *The Milbank Quarterly*, 96, 472-498.
Kneale, D., Bangpan, M., Thomas, J. and Sharma Waddington, H. (2020a). Using logic models in research and evaluation of Health EDRM interventions. In World Health Organization, Kobe.
Kneale, D., O'Mara-Eves, A., Rees, R. and Thomas, J. (2020b). School closure in response to epidemic outbreaks: Systems-based logic model of downstream impacts *F1000Research*, 9, 352-352.
Kneale, D., O'Mara-Eves, A., Sutcliffe, K., Oliver, S., Thomas, J., Hutchinson Pascal, N. and Co-Production Collective. (2021). Handling Complexity in Evidence from systematic reviews and meta-analyses of Public Health Interventions (CEPHI project) – Protocol for a mixed methods and mixed synthesis project. In National Institute of Health Research, London.
Kneale, D., Thomas, J., Bangpan, M., Waddington, H. and Gough, D. (2018). Conceptualising causal pathways in systematic reviews of international development interventions through adopting a causal chain analysis approach. *Journal of Development Effectiveness*, 10, 422-437.

Kneale, D., Thomas, J. and Harris, K. (2015). Developing and Optimising the Use of Logic Models in Systematic Reviews: Exploring Practice and Good Practice in the Use of Programme Theory in Reviews. *PloS one*.

Krishnaratne, S., Pfadenhauer, L.M., Coenen, M., Geffert, K., Jung-Sievers, C., Klinger, C., Kratzer, S., Littlecott, H., Movsisyan, A. and Rabe, J.E. (2020). Measures implemented in the school setting to contain the COVID-19 pandemic: a rapid scoping review. *Cochrane Database of Systematic Reviews*.

Lehne, G., Voelcker-Rehage, C., Meyer, J., Bammann, K., Gansefort, D., Brüchert, T. and Bolte, G. (2019). Equity impact assessment of interventions to promote physical activity among older adults: a logic model framework. *International journal of environmental research and public health*, 16, 420.

Lewin, S., Hendry, M., Chandler, J., Oxman, A.D., Michie, S., Shepperd, S., Reeves, B.C., Tugwell, P., Hannes, K. and Rehfuess, E.A. (2017). Assessing the complexity of interventions within systematic reviews: development, content and use of a new tool (iCAT_SR). *BMC medical research methodology*, 17, 1-13.

Maden, M., Cunliffe, A., McMahon, N., Booth, A., Carey, G.M., Paisley, S., Dickson, R. and Gabbay, M. (2017). Use of programme theory to understand the differential effects of interventions across socio-economic groups in systematic reviews—a systematic methodology review. *Systematic reviews*, 6, 1-23.

Maxwell, J.A. (2004a). Causal explanation, qualitative research, and scientific inquiry in education. *Educational researcher*, 33, 3-11.

Maxwell, J.A. (2004b). Using qualitative methods for causal explanation. *Field methods*, 16, 243-264.

Maxwell, J.A. (2012). The importance of qualitative research for causal explanation in education. *Qualitative Inquiry*, 18, 655-661.

McLaughlin, J.A. and Jordan, G.B. (2015). Using logic models. *Handbook of practical program evaluation*, 2, 7-32.

Movsisyan, A., Rehfuess, E. and Norris, S. (2020). When complexity matters: a step-by-step guide to incorporating a complexity perspective in guideline development for public health and health system interventions. *BMC medical research methodology*, 20, 1-13.

Negrini, S. (2019). Evidence in rehabilitation medicine: between facts and prejudices. *American Journal of Physical Medicine & Rehabilitation*, 98, 88-96.

Negrini, S., Chiara, A., Riccardo, B., Joel, P. and Massimiliano, G. (2019). The black hole within the black box: a numerical systematic review on “usual care” control groups in stroke rehabilitation RCTs. In *Cochrane Colloquium*.

Noyes, J., Booth, A., Cargo, M., Flemming, K., Harden, A., Harris, J., Garside, R., Hannes, K., Pantoja, T. and Thomas, J. (2019). Qualitative evidence. In Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. and Welch, V. (eds), *Cochrane Handbook for systematic reviews of interventions*. 525-545.

Noyes, J., Gough, D., Lewin, S., Mayhew, A., Michie, S., Pantoja, T., Petticrew, M., Pottie, K., Rehfuess, E. and Shemilt, I. (2013). A research and development agenda for systematic reviews that ask complex questions about complex interventions. *Journal of clinical epidemiology*, 66, 1262-1270.

Noyes, J., Hendry, M., Booth, A., Chandler, J., Lewin, S., Glenton, C. and Garside, R. (2016). Current use was established and Cochrane guidance on selection of social theories for systematic reviews of complex interventions was developed. *Journal of clinical epidemiology*, 75, 78-92.

O'Mara-Eves, A., Kneale, D., Oliver, S., Cain, L., Hutchinson Pascal, N., Catchpole, J., Chesworth, A., Candy, B., Sutcliffe, K. and Thomas, J. (2022a). How co-production underpinned the development of a logic model and testing of novel statistical methods for evidence synthesis.

O'Mara-Eves, A., Laidlaw, L., Candy, B., Vigurs, C., Collis, A. and Kneale, D. (2022b). The Value of Co-Production Research Project: A Rapid Critical Review of the Evidence. In Co-production Collective, UCL, London.

Oliver, S., Kavanagh, J., Caird, J., Lorenc, T., Oliver, K., Harden, A., Thomas, J., Greaves, A. and Oakley, A. (2008). Health promotion, inequalities and young people's health: a systematic review of research.

Oliver, S., Langer, L., Nduku, P., Umayam, H., Conroy, K., Maugham, C., Bradley, T., Bangpan, M., Kneale, D. and Roche, C. (2021). Engaging Stakeholders with Evidence and Uncertainty: Developing a Toolkit.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K. and Duffy, S. (2006). Guidance on the conduct of narrative synthesis in systematic reviews. In *A product from the ESRC methods programme* b92.

Rehfuess, E.A., Booth, A., Brereton, L., Burns, J., Gerhardus, A., Mozygemba, K., Oortwijn, W., Pfadenhauer, L.M., Tummers, M. and van der Wilt, G.J. (2018). Towards a taxonomy of logic models in systematic reviews and health technology assessments: a priori, staged, and iterative approaches. *Research synthesis methods*, 9, 13-24.

Rogers, P.J. (2008). Using Programme Theory to Evaluate Complicated and Complex Aspects of Interventions. *Evaluation*, 14, 29-48.

Rohwer, A., Pfadenhauer, L., Burns, J., Brereton, L., Gerhardus, A., Booth, A., Oortwijn, W. and Rehfuess, E. (2017). Series: Clinical Epidemiology in South Africa. Paper 3: Logic models help make sense of complexity in systematic reviews and health technology assessments. *Journal of Clinical Epidemiology*, 83, 37-47.

Rowher, A., Booth, A., Pfadenhauer, L., Brereton, L., Gerdhardus, J., Mozygemba, K., Oortwijn, W., Tummers, M., van der Wilt, G.J. and Rehfuess, E. (2016). Guidance on the use of logic models in health technology assessments of complex interventions. *International Journal of Technology Assessment in Health Care*.

Schucan Bird, K., Stokes, N., Tomlinson, M. and Rivas, C. (2023). Ethically Driven and Methodologically Tailored: Setting the Agenda for Systematic Reviews in Domestic Violence and Abuse. *Journal of Family Violence*, 1-15.

Shaw, L., Moore, D., Nunns, M., Thompson Coon, J., Ford, T., Berry, V., Walker, E., Heyman, I., Dickens, C. and Bennett, S. (2019). Experiences of interventions aiming to improve the mental health and well-being of children and young people with a long-term physical condition: a systematic review and meta-ethnography. *Child: care, health and development*, 45, 832-849.

Sonderegger, S., Bennett, S., Sriram, V., Lalani, U., Hariyani, S. and Roberton, T. (2021). Visualizing the drivers of an effective health workforce: a detailed, interactive logic model. *Human resources for health*, 19, 1-15.

Taylor, M., Thomas, R., Oliver, S. and Garner, P. (2022). Community views on mass drug administration for filariasis: a qualitative evidence synthesis. *Cochrane Database of Systematic Reviews*.

Thomas, J. and Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC medical research methodology*, 8, 45.

Thomas, J., Kneale, D., McKenzie, J.E., Brennan, S.E. and Bhaumik, S. (2019). Determining the scope of the review and the questions it will address. In Thomas, J. and Higgins, J.P.T. (eds), *Cochrane Handbook for Systematic Reviews of Interventions*. John Wiley & Sons, Hoboken, NJ, USA, 13-31.

Thomson, H., Thomas, S., Sellstrom, E. and Petticrew, M. (2011). PROTOCOL: Housing improvements for health and associated socio-economic outcomes. *Campbell Systematic Reviews*, 7, 1-38.

Thomson, H., Thomas, S., Sellstrom, E. and Petticrew, M. (2013). Housing improvements for health and associated socio-economic outcomes. *Cochrane database of systematic reviews*.

Weiss, C.H. (1995). Nothing as practical as good theory: Exploring theory-based evaluation for comprehensive community initiatives for children and families. *New approaches to evaluating community initiatives: Concepts, methods, and contexts*, 1, 65-92.

Weiss, C.H. (1998). *Methods for studying programs and policies*. Prentice Hall, Upper Saddle River, New Jersey.
Welch, V., Petkovic, J., Jull, J., Hartling, L., Klassen, T., Kristjansson, E., Pardo Pardo, J., Petticrew, M., Stott, D. and Thomson, D. (2019). Chapter 16: Equity and specific populations. In Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M.J. and Welch, V.A. (eds), *Cochrane Handbook for Systematic Reviews of Interventions version*.
Winsper, C., Crawford-Docherty, A., Weich, S., Fenton, S.-J. and Singh, S.P. (2020). How do recovery-oriented interventions contribute to personal mental health recovery? A systematic review and logic model. *Clinical psychology review*, 76, 101815.
Wolfenden, L., Movsisyan, A., McCrabb, S., Stratil, J.M. and Yoong, S.L. (2021). Selecting review outcomes for systematic reviews of public health interventions. *American Journal of Public Health*, 111, 465-470.