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RESEARCH ARTICLE

Enriching the evidence base of co-creation research in public health with methodological principles of critical realism

K. Messiha[a], T. M. Altenburg[a], M. Schreier[b], G. R. Longworth[c], N. Thomas[d], S. Chastin[e,f] and M. J. M. Chinapaw[a]

[a]Department of Public and Occupational Health, Amsterdam Public Health Research Institute, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands; [b]School of Business, Social & Decision Sciences, Constructor University, Bremen, Germany; [c]Faculty of Psychology, Education and Sport Sciences Blanquerna, Universitat Ramon Llull, barcelona, Spain; [d]Cambridge Public Health, Department of Psychiatry, University of Cambridge, Cambridge, UK; [e]School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK; [f]Department of Movement and Sports Science, Ghent University, Glasgow, Belgium

ABSTRACT

With the popularity of co-creation research in public health and other fields, there is a need to strengthen its evidence-base by developing a framework based on meta-theoretical principles. The lack of applying meta-theoretical principles in co-creation research impedes the theory- and evidence building. Critical realism seems a promising candidate for providing meta-theoretical principles to enrich the evidence base of co-creation research in public health. To this purpose we searched for relevant papers on critical realism methodological principles, clarified and subsequently applied such principles to a co-creation public health case study. We provide explanatory steps to apply five principles; 1) focusing on understanding an event, like childhood overweight, 2) exploring the broader structure and context surrounding the event, 3) constructing hypotheses about the underlying mechanism(s) of an event, 4) empirical testing to corroborate those hypotheses, and 5) using multiple methods and triangulation. Further, this study shows that critical realism can enrich co-creation research in public health by iteratively building theory and evidence following the five proposed principles.

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Introduction

Meta-theory is the philosophical underpinning of theory or theories and concerns the foundational set of notions about how the phenomena of a research field ought to be conceived of and researched (Brodie et al., 2019). In a key way, meta-theory can broadly offer the possibility to not only integrate a process of theory-building, but also allow the researcher to contemplate their research from the start, with a certain frame of mind in considering critical questions about the nature of reality (ontology) and what counts as knowledge (epistemology) (Frauley, 2017). Therefore, meta-theory offers a framework for researchers to consider how reality may have been shaped by knowledge, and knowledge shaped by reality. By identifying and employing meta-theory explicitly from the outset of research, researchers could enrich their understanding of particular phenomena, and develop more rigorous, theory-informed research designs and protocols.

CONTACT K. Messiha k.m.messiha@amsterdamumc.nl

With co-creation practices gaining popularity in research, co-creation is a term encompassing many different methods (Jones, 2018). In this paper, co-creation research refers to active collaboration of researchers with diverse stakeholders towards creative problem-solving covering all phases of an initiative, from the problem identification to evaluation of the developed solution (Messiha, 2021, 2023; Vargas et al., 2022). To the best of our knowledge no meta-theoretical principles exist for co-creation research. We posit that meta-theoretical principles could promote a well-defined and robust approach or methodology for co-creation research, thereby enhancing the evidence base for co-creation. Meta-theory can allow for increased coherence and alignment among diverse theoretical constructs while also enabling the validation of knowledge (Love, 2000). The EC-funded Health CASCADE project aims to develop such a coherent methodology for co-creation research in public health (Verloigne et al., 2023). This study, as part of the overarching Health CASCADE project, contributes to developing an underlying meta-theoretical lens for co-creation research.

Originating from the work of Roy Bhaskar in the 1970's, 'critical realism' allows us to discern between the real and the observable world (Bhaskar et al., 1998; Koopmans & Schiller, 2022). Explicitly, critical realism gives us the ability to reconcile the objective reality (realism) of the natural world with the subjective and socially constructed (relativist) nature of human experience. Further, critical realism cautions us into recognising that our human knowledge and perception about reality is limited. In this way, critical realism recognises independent structures influencing stakeholders' actions within specific contexts, alongside the impact of subjective knowledge and reasoning. Consequently, the perspectives and contributions of stakeholders involved in the phenomenon of interest are important for constructing theories that approximate reality.

Various epistemological and ontological viewpoints, including critical realism, offer avenues for examining concepts of knowledge and reality (Moon & Blackman, 2014). These perspectives range from naïve realism, advocating a singular objective reality, to relativism, acknowledging multiple realities. Critical realism acts as a middle-ground theory, facilitating the integration of aspects from both extremes. While naïve realism tends to favour quantitative methods and relativism leans towards qualitative methods, critical realism combines both in recognising an independent reality yet acknowledging our perceptions are shaped by social constructs – promoting the use of mixed methods to understand complex phenomena. Co-creation research can be appropriate for exploring complex phenomena, which calls for a meta-theoretical perspective that combines various methods and methodologies – a combination that critical realism allows for.

Critical realism focuses on understanding causation, encouraging researchers to examine complex phenomena (Byers et al., 2022; Bygstad & Munkvold, 2011; Clegg, 2005). It involves examining why and how a phenomenon has occurred, from the perspective of different stakeholders (cf. Clark et al., 2008; Fletcher, 2017; Jeppesen, 2005). Starting the process of co-creation research, activities focus on forming a deep and shared understanding of a specific phenomenon and seeking to go beyond merely stakeholder consultation (Darlington et al., 2022). In favour of this, critical realism is recognised as the least restrictive meta-theory, as it is inclusive of all potential sources of causal evidence, embracing a wide-range of methodologies for investigating complex phenomena (Easton, 2010; McEvoy & Richards, 2003; Schiller, 2016). Knowledge production derived from lived experiences, perspectives and expertise can be seen as pluralism, as advocated for by critical realism. Utilising diverse knowledge sources may enhance our understanding about phenomena (Kurki, 2007). Besides, pluralism in knowledge production aligns with co-creation research by incorporating a range of diverse and relevant perspectives from various stakeholders throughout the research process (Payne et al., 2008). Hence, critical realism can suit a specific 'research mindset' towards stakeholder involvement, even in highly ambiguous and abstract contexts (Bammer, 2019; Stieler, 2018; Sturgiss & Clark, 2020).

Critical realism also highlights the importance of comprehending how power and inequality (social structures) influence phenomena, such as allocation of resources and recognising different group interests (De Souza, 2014). This has implications for co-creation research around being more considerate of the power dynamics among diverse stakeholders included in the co-creation process

and ensuring the voices of stakeholders from underrepresented populations are not only included, but also valued.

As we seek to explore the meta-theoretical lens of critical realism in empirical research, it is important to draw upon its methodological principles. However, translating meta-theory into methodological principles presents considerable challenges. This study aims to address this endeavour by clarifying critical realism methodological principles and exploring how such principles can enrich co-creation research in public health.

Methods

We conducted a literature review on methodological principles for conducting and evaluating research from a critical realism perspective. We used a two-step approach: first, we explored and clarified critical realism methodological principles through a literature review; second, we applied these principles to co-creation research within a public health case study led by two co-authors: the 'Kids in Action' project.

Search strategy

Google Scholar was used as considered appropriate for a broader interdisciplinary approach to search for relevant studies and ranks search results based on relevance. Google Scholar is a widely utilised online academic search engine, indexes between 2 and 100 million records encompassing academic and grey literature – and has attracted significant interest for literature searches, especially for grey literature (Haddaway et al., 2015). We used the search query 'critical realism AND Method AND principles' in March 2023. The paper of Wynn and Williams (2012) was identified as the first reference result on Google Scholar using the search query. Additionally, the search result identified papers referring to and exploring the critical realism methodological principles proposed by Wynn and Williams. A second relevant paper by Bygstad et al. (2016), elaborated on Wynn and Williams's (2012) principles, providing a comprehensive step-wise analytical approach to these principles.

The two pivotal papers of Wynn and Williams's (2012) and Bygstad et al. (2016) were selected as 'seed papers' for the identification of further relevant publications in order to gain a more comprehensive and nuanced understanding of the critical realism methodological principles outlined by Wynn and Williams (2012). Both papers were fed into Litmaps (https://www.litmaps.com/) a tool that constructs visual maps of seed papers in a specific research domain, suggesting strongly connected papers, useful for mapping and uncovering relevant content (Kaur et al., 2022; Mercadé et al., 2023). Litmaps employs open access metadata from various data providers, such as Crossref, Semantic Scholar and OpenAlex, to expand the coverage of literature papers, with data providers including PubMed, arXiv, bioRxiv, medRxiv and Microsoft Academic Graph. We used the open access version of Litmaps which generates the 20 most relevant papers that relate to the seed papers. Specifically, the tool examines all the seed papers' citations and references, and for each of those papers, analyses their citations and references. Subsequently, Litmaps identifies the 20 papers, that are most interconnected.

Following this, the lead author (K.M.) plus one co-author (G.L.) independently read through the 20 full-text papers identified by Litmaps. We included papers if at least one of the reviewers (i.e. either K. M. or G.L.) determined that the concerned paper clarified the methodological principles of critical realism, as outlined by Wynn and Williams (2012). We also checked the reference lists of the 20 retrieved papers for potential additional relevant papers.

Data extraction

We elicited relevant data from the included papers using a manual and an Excel spreadsheet that provided instructions for extracting relevant information from the included papers. Two authors (K.

M. and G.L.) independently extracted data from the included papers with respect to any ideas, concepts and quotes that were deemed relevant to clarifying Wynn and Williams' proposed critical realism methodological principles. Extracted data was summarised using distinct approaches, such as creating tables, mind-maps and other formative outputs (such as bullet-point lists) which we added to Mural, a visual work platform (see *Appendix A*).

Subsequently, we compared our extractions and came to agreed descriptions of the critical realism methodological principles before sharing them among the complete authoring team, initiating collaborative deliberations to assess clarity, coherence and completeness. Through these deliberations, checks were undertaken and adjustments were made to refine the synthesised content related to the description of the critical realism methodological principles. Specifically, we convened a hybrid meeting to gather feedback regarding the merits of each principle synthesis along with our authoring teams' perceptions of its potential benefits to co-creation research (shown in *Appendix A*). Moreover, we encouraged suggestions for ideas around how to define and describe each principle, how we envisaged building upon the existing work and identifying any untapped potential within the principles. We also allocated a section for unanswered questions, prompting discussions on lingering uncertainties, areas of confusion and perceived omissions. Following the meeting, we carefully addressed all feedback points, engaging in iterative exchanges via email until reaching a consensus on our contribution to clarify Wynn and William's principles. Thereafter, we checked the clarity of the description of the principles among $n = 7$ PhD fellows and $n = 3$ PhD supervisors conducting co-creation in public health within the Health CASCADE project. Table 1 (first three columns) presents the final summative output with respect to clarifications of the critical realism methodological principles.

Application of CR principles to case study

Two co-authors (T.A. and M.C.) retrospectively applied the principles using the descriptions in Table 1, to one of their co-creation projects, 'Kids In Action' (Anselma et al., 2019,b).

'Kids In Action' involved 9- to 12-year-old children as co-researchers throughout the development, implementation and evaluation of actions (i.e. interventions) targeting healthy physical activity and dietary behaviour (Anselma et al., 2018, 2019a; b; Anselma et al., 2020, 2023). 'Kids In Action' was included based on the project's applicability and relevance to co-creation in public health and the co-authors' (T.A. and M.C.) insider knowledge about this project. This project has published work on their participatory needs assessment (Anselma et al., 2018), process (Anselma et al., 2020) and outcome evaluation (Anselma et al., 2023). Although 'Kids In Action' is a participatory action research project, no explicit meta-theoretical position was adopted, therefore we sought to retrospectively explore the value of applying the methodological principles of critical realism in empirical research adopting a co-creation approach in public health. The co-authors (T.A. and M.C.) discussed possible parallels between the critical realism methodological principles and aspects of 'Kids In Action'. The lead author (K.M.) then reviewed these examples to ensure clarity and coherence.

Findings

A total of 22 papers (including the 2 seed papers) were included for the data extraction and synthesis on critical realism methodological principles. While we excluded 12 papers identified by Litmaps with reasons, such as not offering insights into the practical implementation of critical realism principles (for details see *Appendix B*) – we included an additional 12 papers via reference checking of the 22 selected papers. Figure 1 presents the flow chart of our screening process.

Table 1 presents the clarified critical realism methodological principles by providing a definition per principle, accompanied by a summary of suggested steps for each principle as well as examples drawing on the 'Kids In Action' project.

Table 1. The definition and explanation of Wynn and William's (2012) critical realism methodological principles, including examples drawing on the 'Kids in Action' project (Anselma et al., 2019a, 2019b, 2018, 2020, 2023.).

Wynn and Williams (2012) Critical Realism methodological principles	Proposed Definition	Suggested Explanatory Steps	Example based on "Kids In Action" (henceforward 'KiA') papers (M. Anselma, Altenburg, et al., 2019; M. Anselma, T. M. Altenburg, et al., 2019; Anselma et al., 2018, 2020, 2023)
Principle 1: Explication of Events	Identification of and detailing the critical/important events as a set of related actions or changes that occur over time and have a particular outcome or goal.	• Identify the outcome/event of the research • Perform a preliminary exploration of the literature to identify: existing concepts and arguments, empirical studies and historical evidence; • Provide a narrative description from a chronological viewpoint; • Explore existing viewpoints data to consider co-creators' understandings of what they are doing and their reasons, possible objects of interest and tentative relationships, connections, concepts and categories; • Compile information about the key components of Actors (stakeholders/individuals or entities that participate in the event); Actions (the specific behaviours or actions performed by the actors); Objects (the physical or abstract entities that are involved in the event); Outcome/event.	Event: childhood overweight. Literature is explored as well as local data (i.e. neighbourhood in which KiA is conducted); findings from both explorations underpin the event. A participatory needs assessment was conducted: 3–4 participatory group meetings with three groups of 9–12-year-old children (n=20) and (group) interviews and informal meetings with parents (n=27) and professionals working with children (n=9) in the selected neighbourhood. Three professionals worked for a school program stimulating healthy school environments; two worked for the municipality in sports and/or child development; one was a physical education teacher; one was the manager of a community centre; one was a youth mentor; and one was a social worker. Results confirmed that childhood overweight/obesity was considered as the main issue in the neighbourhood and that a lack of physical activity and unhealthy dietary behaviour were identified as the main risk factors. Actors = children, parents, professionals Actions = unhealthy lifestyle behaviours, insufficient physical activity and unhealthy dietary behaviours Objects = physical and social characteristics of different settings: school, home, neighbourhood environment Outcome = overweight/obesity
Principle 2: Explication of structure and context	Identification of social (norms) and physical structure, contextual environment and their relationships as linked to the event(s) which occurred. This includes power relations,	• Identify and analyse the components of the contextual environment that influence the event. This could include cultural, social, physical	The participatory needs assessment with children and the (group) interviews with parents and professionals showed that perceived determinants of children's

(*Continued*)

Table 1. (Continued).

Wynn and Williams (2012) Critical Realism methodological principles	Proposed Definition	Suggested Explanatory Steps	Example based on "Kids In Action" (henceforward 'KiA') papers (M. Anselma, Altenburg, et al., 2019; M. Anselma, T. M. Altenburg, et al., 2019; Anselma et al., 2018, 2020, 2023)
	cultural values, economic factors etc.	environmental and economic factors. Clarify their connections in order to understand how such event is influenced.	unhealthy behaviours included neighbourhood characteristics (safety, distance), culture, habits, finances, social norms, knowledge and marketing of unhealthy foods. (Details in manuscript on needs assessment: Anselma et al., IJERPH, 2018)
Principle 3: Retroduction	Identification and explanation of underlying mechanisms that caused the observed events	• Redescribe the potential theoretical explanations of the event, suggesting (relevant) mechanisms at play which are believed to have better explanatory power than alternatives; • Identify the social and physical entities such as the affordances which enable specific actions and behaviours. The affordances are part of the contextual conditions; • Note that retroduction is characteristic of a creative and intuitive process. There are four main types of retroduction: overcoded (meaning mechanisms are taken directly from the literature), undercoded (using current body of knowledge to make suggestions), creative (i.e. to invent a mechanism as existing solutions are not found in the available literature) and meta-retroduction (i.e. where observations do not fit current conceptual schema, resulting in a paradigm shift in terms of how we perceive the hypothesised theories or mechanisms).	The academic researchers developed a logic model of the problem based on a needs assessment conducted over two school years in collaboration with the YPAR groups and a community project group (See Anselma et al., IJBNPA 2019)
Principle 4: Empirical corroboration	About the validation/'confirmation' of proposed causal mechanisms through empirical testing	• Identify the hypothesis that needs to be tested based on prior knowledge and observations about the social structures, conditions, agency and events; • Develop a means of testing the hypothesis,	The academic researchers developed a logic model of change – based on the results of the needs assessment, including: input children | community | academia > activities > outputs > behavioural determinants > intermediate

(*Continued*)

Table 1. (Continued).

Wynn and Williams (2012) Critical Realism methodological principles	Proposed Definition	Suggested Explanatory Steps	Example based on "Kids In Action" (henceforward 'KiA') papers (M. Anselma, Altenburg, et al., 2019; M. Anselma, T. M. Altenburg, et al., 2019; Anselma et al., 2018, 2020, 2023)
		through the use of available empirical methods and gather the data using empirical methods, advisably in a longitudinal way; • Analyse data using appropriate methods to determine the relationship between the variables; • Evaluate the results in terms of empirical scrutiny, comparing this with competing explanations to achieve empirical 'adequacy'. To do this, you can use the causal test questions from Wynn and Williams (2012, p. 802): are the causal factors of the phenomenon actually manifest in the context? If the causal factors were part of the context, were those factors causally effective? Do the causal powers provide a satisfactory explanation to the intended audience? Does the proposed mechanism provide causal depth?; • Conduct further evaluation to corroborate or refute the refined theories.	behavioural outcomes on the child's level (> influenced by intermediate behavioural outcomes on other levels) > long-term outcomes > overall aim (Anselma et al., IJBNPA; 2019). Next, the YPAR groups developed, implemented and evaluated actions; for the effect evaluation a controlled design with 3 measurements (longitudinal data) was used; for the process evaluation focus groups with children (n=40) and interviews with community partners (n=11) were conducted. (Details in manuscripts on outcome evaluation (Anselma et al., Health Education and Behaviour) and process evaluation (Anselma et al., 2020)).
Principle 5: Triangulation and multi-methods	About using (i.e. combining and integrating) a variety of data types and sources, relevant theories, analytical methods and observers in a research study to identify causal relationships	• Use multiple data sources, theories, investigators and methods to capture diverse perspectives and experiences and to identify patterns and themes across the data and to support causality; • Use triangulation to consider whether the event analysis is significant (but caveated as not definitively determined); • Think about the timing, prioritisation and combination of methods, ensuring matters of feasibility and practicality.	KiA applied both quantitative and qualitative methods. Qualitative data: Focus groups with the action teams and interviews with community partners to evaluate: 1) how children and community partners experienced the participatory process and how it would be taken forward; 2) how children and community partners experienced the developed actions; 3) if and how the involvement of children in decision-making and community change influenced children's health behaviour and empowerment; and 4) the essential preconditions and

(*Continued*)

Table 1. (Continued).

Wynn and Williams (2012) Critical Realism methodological principles	Proposed Definition	Suggested Explanatory Steps	Example based on "Kids In Action" (henceforward 'KiA') papers (M. Anselma, Altenburg, et al., 2019; M. Anselma, T. M. Altenburg, et al., 2019; Anselma et al., 2018, 2020, 2023)
			challenges of YPAR. Quantitative data: Using a controlled design, data was collected through: (1) a questionnaire, consisting of nine sections: Demographic and Family characteristics, Soft drinks consumption, Energy and sport drinks consumption, Sweets consumption, Snack consumption, Playing outdoor, Sports participation, Screen viewing behaviour and Perceived health; (2) a Neuromotor fitness test (group level); and (3) Accelerometers. Triangulation – analyses of various qualitative data sources were combined; similarly, analyses of various quantitative data sources were combined. Multiple investigators (i.e. stakeholders/co-researchers) were involved. See 'Actors' part of Principle 1 for more information. (Details in manuscripts on outcome evaluation (Anselma et al., Health Education and Behaviour) and process evaluation (Anselma et al., 2020).

In the following, we focus on articulating how the clarified five critical realism methodological principles could enrich the evidence base of the 'Kids in Action' project as co-creation case study.

Principle 1: Explication of events

This principle forms the basis for phenomenological understanding, via the identification and abstraction of events, typically drawn from experiences (Albert & Salam, 2013; Mukumbang, 2023). In the context of critical realism within public health, our understanding of an event is such that it emerges as the outcome of underlying structures and mechanisms that cause it, which is reinforced by the idea 'that events should be investigated in terms of generative mechanisms that cause those events' (Armstrong, 2019; Mungai, 2018, p. 3). Events are important indicators of change and form the basis for understanding the observed phenomenon (Bygstad et al., 2016; Shi, 2019).

Experience is a subset of an event, highlighting the need for useful data to comprehend co-creators' perceptions through their experiences of the identified event. Such data can give insights into their intentions and motivations for engaging in a co-creation process, as well as reveal points of

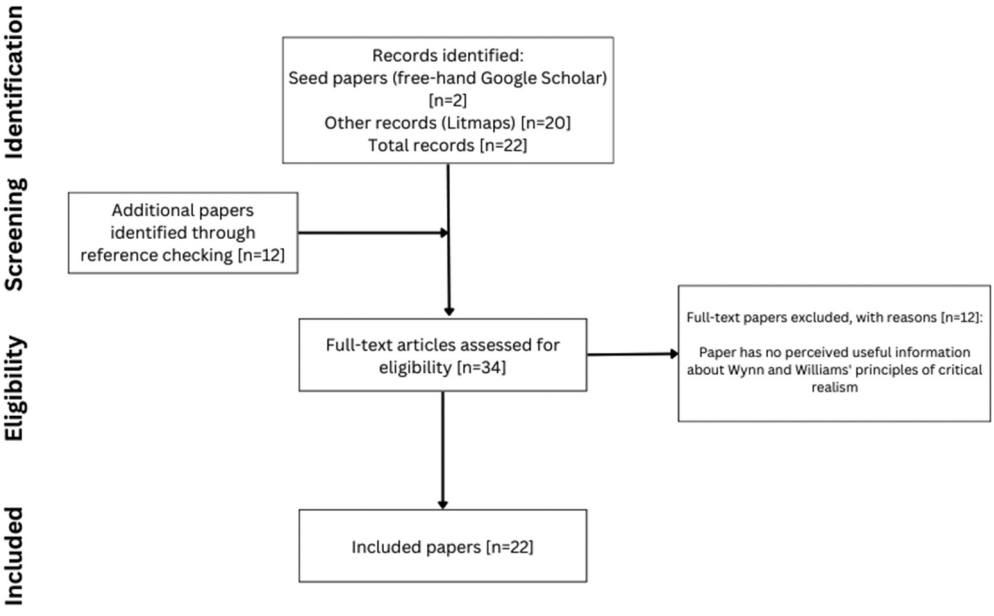

Figure 1. Information flow chart of paper selection.

interest, relationships, connections, concepts and categories. The principle recommends a two-fold strategy of literature exploration alongside the use of empirical methods, with the aim of generating more comprehensive data and insights into the challenges and facilitating factors related to the identified event. By emphasising the exploration of direct causes as opposed to mere symptoms, the principle aligns with addressing the underlying factors associated with an observed event (Bygstad & Munkvold, 2011). This principle also posits the recognition of the following key elements when explicating an identified event: the participants (co-creators engaged in the event), actions (specific behaviours by participating stakeholders), objects (physical and social characteristics of different settings linked to the event) and outcome (framed as the event).

In the case of the 'Kids in Action' project, principle 1 is addressed through a participatory needs assessment and literature study, where childhood overweight could be cast as the event. Yet, after the first cycle of a needs assessment and developing, implementing and evaluating co-created interventions – in a second cycle, the events could be further clarified, based on the evidence from empirical data. Hence, this principle could have been applied in order to update the understanding of the identified event obtained by the needs assessment, particularly where evidence or support from empirical data is lacking (see principle 4).

Principle 2: Explication of structure and context

Principle 2 reinforces that a public health event is influenced by causal tendencies in a social structure as well as contextual conditions (Hu, 2018; Wynn & Williams, 2012; Frederiksen and Kringelum, 2021; Baptista, 2022). Importantly, this principle advocates for an event to be uncovered through a thorough analysis of influential factors (e.g., via engaging various stakeholders in the research process, employing an ecological model approach, acquiring detailed context-specific insights and segmenting environments). Such an analysis should be a continuous and ongoing process, which is important as a critical realist perspective on structure and agency reinforces iteration over an extended time period (Hoddy, 2019). Further, the critical realist perspective is

about striving towards 'more detailed causal explanations' of a given event, in relation to both stakeholders' interpretations as well as structures and mechanisms interacting to result in the outcomes over time (Wynn & Williams, 2012, p. 788).

The 'Kids in Action' project could be enriched by this second principle to obtain an even more detailed and clarified explanation of the structure and context of the event, where evidence or support from empirical data is lacking (see principle 4). This could comprise updating the researchers' and co-creators' knowledge as well as the evidence base with new information by challenging assumptions, considering alternative explanations and re-evaluating approaches previously taken.

Principle 3: Retroduction

This principle encourages uncovering generative mechanisms to understand the underlying processes that can explain the occurrence of events, to gain a deeper understanding of causal relationships (Wynn & Williams, 2012; Zachariadis et al., 2013). This principle is helpful as it is about seeking to formulate the strongest explanation about an event using pluralistic approaches (Brönnimann, 2022) (see principle 4 on empirical corroboration and principle 5 on triangulation and multimethods). In this way, the focus is on 'theory building and possibilistic explanation' (Iannacci et al., 2022, p. 472). Further, this principle involves extrapolating from empirical observations and coming up with a hypothesis regarding a potential mechanism or set of mechanisms that could account for a public health event as an outcome (Bygstad & Munkvold, 2011).

In public health research, identifying and analysing main risk factors and determinants to produce hypotheses about an event is important as this in turn can lead to solution generation related to the event. In particular, retroduction can ensure that goals and interventions in public health are aligned with identified causal factors underpinning an event. The 'Kids in Action' project demonstrates this in building a logic model informing the development and implementation of interventions. By applying this principle in a second cycle, the researchers could have refined and revised their logic model based on the evidence from their empirical data (see principle 4).

Principle 4: Empirical corroboration

This principle emphasises the importance of continuously testing hypothesised mechanisms and exploring alternative means until validation is achieved (Wynn & Williams, 2012). As such, a valuable use of empirical corroboration means demonstrating the effectiveness of the logical underpinning of the causal explanation (Mahmud, 2018). According to this principle, hypotheses may need to be rejected or revised, requiring further testing to confirm or refute refined theorised mechanisms (Wynn & Williams, 2012).

The 'Kids In Action' project could have been enriched by iteratively testing and adjusting theorised mechanisms until successful empirical corroboration was achieved, which can mean revisiting retroduction (principle 3). This is since, despite positive findings on children's empowerment and increased awareness of healthy behaviours in the 'Kids In Action' project process evaluation – the effect evaluation did not consistently show improvements in the assessed health behaviours.

In the 'Kids in Action' project, a single theory of change (hypothesis), incorporates multiple behaviours and determinants. This single theory of change was tested and while it only demonstrated partial success – there could have been an opportunity to explore various hypotheses. By applying an iterative process (Leidner et al., 2018; Saxena, 2019) involving implementation, evaluation, adaptation, re-implementation and re-testing, a more comprehensive understanding of the event could have been obtained. For instance, after suggesting plausible mechanisms behind the causes of the public health event (see principle 3 on retroduction), the project could have progressed by eliminating less probable explanations and consistently confirming the most probable explanations through ongoing empirical validation (Armstrong, 2019; Wynn & Williams, 2012). Therefore, it

may be necessary to return to the previous principles (i.e. 1–3) to collate even more evidence regarding the factors contributing to the public health event and to then build potential hypotheses.

It is also worth noting that while lack of empirical corroboration related to retroduction (see principle 3) does not necessarily disprove the plausibility of a hypothesis, it can explain the inadequacy of the co-created intervention in affecting change in a public health event.

Principle 5: Triangulation and multi-methods

To address the rigour-relevance gap in research, critical realism advocates for a causal analysis through this principle, meaning that critical realism is not confined to a singular approach or design, but rather supports several types of methods and approaches within a single study (Mungai, 2018; Priharsari et al., 2019). For instance, critical realism endorses both qualitative and quantitative methods (Dissanayake & Pavlovich, 2019). This is important as a single data source does not necessary provide a reliable portrayal of a public health event (Spagnoletti et al., 2021). Indeed, through this principle, mechanism(s) are eventually identified as the most plausible (Masiero, 2018).

According to this principle, the 'Kids In Action' project included a diverse range of stakeholders (i.e. investigators) including the Action Teams comprised of children acting as co-researchers. It was documented that a variety of methods and data sources were utilised. The effect evaluation collected quantitative data by accelerometers, self-reporting and motor fitness tests, with the aim of evaluating the effect on both physical activity and sedentary behaviour. Additionally, for the qualitative process evaluation, the empowerment of children and the perception of children and other relevant stakeholders on the participatory process, actions and outcomes was analysed using data from focus groups and participatory meetings.

Yet, the 'Kids In Action' project could have been enriched by revisiting this principle to incorporate multiple theories in their empirical research, given the limitations and biases' inherent to the use of singular or individual theories. Hence, this project could have incorporated useful theories to afford the empirical research more conceptual richness, complementarity etc. For example, a recent systematic review on theories used for co-approaches (i.e. co-creation, co-design and co-production) in public health research by Messiha et al. (2023) shows that Social Learning Theory may have been used to provide the evidence-base for the developed actions, since action ideas generated by stakeholders need to be informed by evidence-based behaviour change strategies. Since Social Learning Theory focuses on how stakeholders learn from observing others, this theory may have enriched the evidence base to result from the intervention design – specifically in how social dynamics can influence health-related behaviours.

Discussion

This study aimed to apply critical realism methodological principles to co-creation research within public health, and explore how such principles can enrich the co-creation approach. To do this, we employed the critical realism methodological principles proposed by Wynn and Williams (2012), clarified these principles and retrospectively applied them to a case study to explore the added value of such principles to co-creation research in public health. This is important not only to fill the gap in the existing literature on applied critical realism (Fletcher, 2017), but also due to the paucity of theory in co-creation approaches within public health research (Messiha et al., 2023). While not originally designed as a prescriptive step-by-step approach (Wynn & Williams, 2012), the proposed critical realist methodological principles can serve as meta-theoretical guidance for applying co-creation research in the context of public health.

Applying the principles can (re-)position co-creation research in public health in a salient way, such that they: underscore the empirical relevance of identifying and comprehending the complexity of public health events (Principle 1), explicate such events further by closely investigating both their social and physical structures and contexts (Principle 2), prioritise theorisation of generative mechanisms to explain the occurrence of events for a deeper scrutiny of causal relationships (Principle 3), inspire continuous empirical testing of hypothesised mechanisms for validating causal

explanations (Principle 4) and encourage multi-methods and triangulation within study designs (Principle 5).

It is important to reinforce the critical realist ontological and epistemological basis informing methodological principles, as outlined by Mukumbang et al. (2023). According to this perspective, the three levels of reality – real, actual and empirical – demonstrate the interaction between observable phenomena and underlying structures. The world functions as an open system directed by various structures and mechanisms, giving rise to observable patterns of events influenced by contextual factors and generative powers (i.e. inherent mechanisms within a structure or system causing observable events). Critical realism asserts that independent structures shape stakeholders' actions while acknowledging subjective knowledge and reasoning. The existence and structure of the world remain independent of human cognition. Scientific theories, viewed through this lens, provide credible approximations of reality consistent with critical realism.

In the case of applying these principles to the 'Kids in Action' project, we recommend that researchers iterate between the five principles in order to enhance understanding of and the ability to address a critical public health event. This means that Principle 1 is further leveraged for a more detailed understanding of such an event where empirical support is lacking. Similarly, Principle 2 is applied for a richer explanation of the structure and context surrounding the event. Principle 3 promotes the identification of potential theGoretical explanations of the event, suggesting mechanisms underlying the public health event with valuable explanatory power – which also allows for the scalability of the results of co-creation research. We further posit that it is key to revise/change hypotheses where empirical corroboration is lacking, to explore and test multiple hypotheses continually (Principle 4). Finally, we suggest that conceptual richness can be further enhanced by using multi-methods and triangulation (Principle 5).

We found that the critical realism lens accommodates complexity and uncertainties in embracing alternative explanations and pluralism, more generally – and in this way, this lens is valuable for advancing scientific knowledge (Miller & Tsang, 2011). It may enable researchers to focus on the key interacting factors that are causing a public health event, as critical realism insists on continual, rigorous testing and validation to meaningfully facilitate the development of more comprehensive explanations (hypotheses) about the causes of such an event. As such, applying these five critical realism methodological principles has potential to improve the theory and evidence-base of co-creation research in public health.

Critical realism can assist in finding a more complete understanding of the public health event. This relates to acknowledging clear boundaries for knowledge whilst encouraging a deep exploration of a phenomenon and/or event by multiple stakeholders. Further, leveraging these principles can mitigate the risks associated with inadequate research practices of co-creation, such as tokenism (Connelly, 2001), since it reinforces that stakeholder involvement is not merely symbolic but genuinely contributes to the quality and integrity of the research process. Also, iterative research plans can prevent rushed co-creation processes and avoid limitations such as a small number of workshops leading to a superficial understanding of the problem and a rushed solution. Overall, critical realism may help position co-creation research in a balanced manner, preventing the co-creation approach from being overly idealised or regarded as a universal solution (Brandsen et al., 2018; Jackson & Greenhalgh, 2015).

Overall, these critical realism methodological principles can contribute to 'emancipatory social practice', aligning with Bhaskar's proposition (Corson, 1991, p. 223). Such a proposition maintains that in order to transform the world in a meaningful way, we must initially understand it well. In critical realism, this relates to being careful when making sense of causal processes in terms of broad, universal statements about how social structures can affect emancipation processes (Modell, 2017). Researchers ought to acknowledge the challenge of staying neutral in their work and, instead, adopt an open-minded approach when identifying theories and hypothesised mechanisms. Critical realism methodological principles are potentially best suited to participatory action research that engages stakeholders as co-researchers in collaborative inquiry to address real-world issues based on their experiences. We believe that both critical realism methodological principles as well as participatory

action research methodology can support the development of sound theory and evidence in co-creation research.

Study strengths and limitations

Our study makes novel contributions to the field in its endeavour to bring meta-theoretical principles into a format applicable to public health and other fields. Further, we not only demonstrated the empirical parallels, and hence relevance, of these principles with a case study but reinforced the value of such principles. Doing so advances the theoretical salience and understanding as well as the potential for real-world applications of these principles, in enhancing co-creation research and practice.

This study did not specifically examine and compare different meta-theoretical perspectives. That said, critical realism may be critiqued for allowing multiple theories without clear guidance on selecting one based on data consistency (Cruickshank, 2011). A study limitation extends to our search and paper selection, as although our emphasis was on the quality of understanding rather than a systematic review of existing literature, the lack of an exhaustive search may have resulted in overlooking potentially other valuable methodological principles. Further, we acknowledge that there may be biases in the coverage and ranking of results in Google Scholar, which not include all relevant articles from specialised databases. Also, we retrospectively applied the principles to one case study and propose application of the principles from the start of future co-creation research.

Conclusion

This study addresses a key research gap by exploring the application of a meta-theory, specifically critical realism and its methodological principles to enrich the evidence base for co-creation research in public health. We conclude that the five principles of critical realism, put forward by Wynn and Williams (2012), seem well-suited as a meta-theoretical framework for evidence-based co-creation – by demonstrating their value in enriching the evidence base of co-creation research within the field of public health. We recommend that future empirical research further explores the value of these principles.

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ORCID

K. Messiha http://orcid.org/0000-0002-3383-0719

Author's contributions

This study was conceived by K.M., T.A. and M.C. and led by K.M.
K.M. and G.L. performed the screening steps, literature synthesis of included papers and produced the formative outputs.
K.M. facilitated the meetings to source feedback from T.A., M.S., N.T., G.L., S.C. and M.C. on the formative outputs and developed a substantive summary based on that.
The manuscript was written by K.M. and M.C.
The manuscript was edited by T.A., M.S., N.T., G.L. and S.C.
The manuscript was reviewed and approved by all authors.

Availability of data and materials

A pre-print of this work is to be submitted to Zenodo, under the community page of Health CASCADE. The dissemination outputs can be provided to the Health CASCADE network members as a means of raising awareness and promoting critical realism as our nominated meta-theory for enriching the evidence base of co-creation for public health research.

Data availability statement

The authors agree to make the data and materials supporting the results or analyses presented in this paper available upon reasonable request, unless unable to do so due to ethical, privacy or security concerns. Researchers interested in accessing such data and materials may contact the corresponding author at k.m.messiha@amsterdamumc.nl.

Originality

This article is an original piece of work which has not been published before.

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Appendices

Appendix A

Mural visual work platform showing display of four "exhibitions" and feedback grid in reference to our deliberation of the formative outputs.

Information flow chart of paper selection.


Template
Feedback grid
This framework is designed to enable some constructive input.
Share template feedback
Get thoughtful feedback
Now that KM has presented in-progress work, use this in conjunction with viewing each Exhibition (1-4).
Please thoughtfully reflect on was shared, and write feedback in each of the quadrants below. Similar feedback can be clustered into themes.
Positive feedback
What do you like about each principle (correspond each principle per sticky note)
How do you think it will benefit our research? (correspond each principle per sticky note)
TOPIC
Formative output related to Critical Realism Methodological Principles
Constructive feedback
What is not working very well related to each principle? (correspond each principle per sticky note)
What concerns you? (correspond each principle per sticky note)
What do you wish was different? (correspond each principle per sticky note)
Events can be understood as a sort of needs assessment
The only principle that scores specific is retroduction yet even he is there may be overlaps (with other principles)
Principle 1 and 2 work well together in getting layers of understanding.
Principle 1: Great breaking complex events like this
Principle 3: great in general to pay attention to mechanisms
Observers can be equated to the co-creators
Procedure may need to adjust due to the empirical questions of these principles
Principle 1: Using events as a basic unit could be a good way to engage people/co-creators in collective intelligence around a problem. In a very pragmatic way.
We must ensure not to have our ideas tainted by our own research as to avoid some degree of bias
Need to balance the semantics - the philosophical yet salient ideas per principle
The principle about explication of events (P1)
How to incorporate the longitudinal aspect of empirical corroboration (P4)
How prototyping within the co-creation process would fit - perhaps with the iterative nature of the principles of retroduction and empirical corroboration?
Ideas
What new ideas do you have? (correspond each principle per sticky note)
How would you build upon the work done so far? (correspond each principle per sticky note)
What has untapped potential? (correspond each principle per sticky note)
Unanswered questions
What is still unclear? (correspond each principle per sticky note)
In what ways do you feel confused? (correspond each principle per sticky note)
What seems missing? (correspond each principle per sticky note)

Appendix B

Excluded Papers with Reasons

Table showing list of papers excluded at full text screening with principal reason for exclusion.

Excluded paper generated by Litmaps	Principal reason for exclusion
Heeks 2018 [Heeks, R., Thapa, D. and Wall, P.J., 2018. Critical realism and ICT4D: editorial introduction to the special issue of EJISDC. The Electronic Journal of Information Systems in Developing Countries, 84(6), p.e12050.]	Editorial introduction to a special issue, which does not offer insights into the practical implementation of critical realism principles.
Heeks et al., 2019 [Heeks, R., Ospina, A.V. and Wall, P.J., 2019. Combining pragmatism and critical realism in ICT4D research: an e-Resilience Case Example. In Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D: 15th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2019, Dar es Salaam, Tanzania, May 1–3, 2019, Proceedings, Part II 15 (pp. 14–25). Springer International Publishing.]	Combines pragmatism with critical realism principles ('Application of a Pragmatist-Critical Realist Methodology') in the realm of ICT4D research. Pragmatism is a distinct philosophical perspective that our study is not concerned with per se. Moreover, this paper was considered inadequate in illustrating the synergy or distinction between these (i.e. pragmatism and critical realism) philosophical perspectives within the context of ICT4D research.
Huser 2020 [Huser, D., 2020. Generative mechanisms of information use for project monitoring in humanitarian health management information systems (Doctoral dissertation, Vrije Universiteit Amsterdam).]	A master's thesis which focuses on a data analysis methodology based on the underpinnings of critical realism but does not detail the critical realism principles of Wynn and Williams in a coherent way.
Iliya and Ononiwu, 2021 [Iliya, A.A. and Ononiwu, C., 2021. Mechanisms for mobile phone use in empowerment: A critical realist study of people with disabilities in Nigeria. The Electronic Journal of Information Systems in Developing Countries, 87(2), p.e12158.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.
Mukumbang etal., 2021 [Mukumbang, F.C., Kabongo, E.M. and Eastwood, J.G., 2021. Examining the application of retroductive theorizing in realist-informed studies. International Journal of Qualitative Methods, 20, p.16094069211053516.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.
Namisango et al., 2021 [Namisango, F., Kang, K. and Rehman, J., 2021. Service co-creation on social media: varieties and measures among nonprofit organizations. Journal of Service Theory and Practice, 31(5), pp.783–820.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.
Øvrelid and Bygstad, 2019 [Øvrelid, E. and Bygstad, B., 2019. The role of discourse in transforming digital infrastructures. Journal of Information Technology, 34(3), pp.221–242.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.
Preko and Boateng, 2020 [Preko, M. and Boateng, R., 2020. Assessing healthcare digitalisation in Ghana: A critical realist's approach. Health Policy and Technology, 9(2), pp.255–262.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.
Rizk, 2020 [Rizk, A., 2020. Data-driven innovation: an exploration of outcomes and processes within federated networks (Doctoral dissertation, Luleå University of Technology).]	Rendered to be of no or little relevance to Wynn and William's critical realism methodological principles.
Waizenegger et al., 2020 [Waizenegger, L., Seeber, I., Dawson, G. and Desouza, K., 2020. Conversational agents-exploring generative mechanisms and second-hand effects of actualized technology affordances.]	Rendered to be of no or little relevance to Wynn and William's critical realism methodological principles.
Weisshuhn, 2019 [Weisshuhn, O., 2019. Platform Business Modelling for Enhancing the Efficiency of Freight Logistics in the Maritime Supply Chain (Doctoral dissertation).]	Rendered to hold no new information that could be considered informative about Wynn and William's critical realism principles.
Buchana, 2018 [Buchana, Y., Garbutt, M. and Seymour, L.F., 2018. Identifying micro-level generative mechanisms of ICT-enabled performance improvement in resource-constrained healthcare organisations: A critical realist perspective. The Electronic Journal of Information Systems in Developing Countries, 84(6), p.e12057.]	Despite the fact that the paper cites Wynn and Williams's work, it gives superficial mention of such work devoid of clearly engaging with the critical realism methodological principles.