




Article

Addressing Complexity in Chronic Disease Prevention Research

Melanie Pescud^{1,2,*,†}, Lucie Rychetnik^{2,3,†}, Sharon Friel¹, Michelle J. Irving^{2,3,4}, Therese Riley^{5,6}, Diane T. Finegood⁷, Harry Rutter⁸, Ray Ison⁹ and Steven Allender¹⁰

¹ Menzies Centre for Health Governance, School of Regulation and Global Governance (RegNet), Australian National University, Canberra, ACT 0200, Australia; sharon.friel@anu.edu.au

² The Australian Prevention Partnership Centre, The Sax Institute, Glebe, NSW 2037, Australia; lucie.rychetnik@saxinstitute.org.au (L.R.)

³ Menzies Centre for Health Policy, Faculty of Medicine and Health, School of Public Health, University of Sydney, Camperdown, NSW 2006, Australia

⁴ Centre for Evidence and Implementation, 33 Lincoln Square South, Carlton, VIC 3053, Australia

⁵ Therese Riley Consulting, Melbourne, VIC 3191, Australia; therese@thereserileyconsulting.com.au

⁶ Mitchell Institute for Education and Health Policy, Victoria University, Queen Street, Melbourne, VIC 3000, Australia

⁷ Morris J. Wosk Centre for Dialogue, Simon Fraser University, Vancouver, BC V6B 5K3, Canada; finegood@sfu.ca

⁸ Department of Social & Policy Sciences, University of Bath, Bath BA2 7AY, UK; hr526@bath.ac.uk

⁹ Faculty of Science, Technology, Engineering and Mathematics, School of Engineering and Innovation, Open University, Milton Keynes MK7 6AA, UK; ray.ison@open.ac.uk

¹⁰ Faculty of Health, School of Health and Social Development, Deakin University, Geelong, VIC 3125, Australia; steven.allender@deakin.edu.au

* Correspondence: melanie.pescud@uwa.edu.au; Tel.: +61-8-6488-6000

† These authors contributed equally to this work.



Citation: Pescud, M.; Rychetnik, L.; Friel, S.; Irving, M.J.; Riley, T.; Finegood, D.T.; Rutter, H.; Ison, R.; Allender, S. Addressing Complexity in Chronic Disease Prevention Research. *Systems* **2023**, *11*, 332. <https://doi.org/10.3390/systems11070332>

Academic Editors: Ivana Stankov and Pamela A. Matson

Received: 8 May 2023

Revised: 14 June 2023

Accepted: 25 June 2023

Published: 27 June 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: There is wide agreement on the need for systems thinking to address complexity in chronic disease prevention but there is insufficient understanding of how such approaches are operationalised in prevention research. Ison and Straw propose that to address complexity, the right balance must be struck between ‘systemic’ and ‘systematic’ paradigms. We examined the nature and characteristics of this relationship in a series of six qualitative case studies of prevention research. Data comprised 29 semi-structured interviews with 16 participants, and online documents. The analysis combined inductive methods from grounded theory with a theoretically informed framework analysis. *Systemic* and *systematic* ways of working varied across each case as a whole, and within the dimensions of each case. Further, the interplay of *systemic* and *systematic* approaches was described along a dynamic continuum of variable proportions, with greater emphasis on *systemic* aspects balanced by less focus on the *systematic*, and vice versa. By expanding the boundaries for exploring prevention research, we gained empirical understanding of the potential and scope of *systemic* and *systematic* paradigms for addressing complexity in prevention research. There is inherent value in being more explicitly conscious and bilingual in both *systemic* and *systematic* paradigms so that their respective value and strengths may be utilised. Our findings propose a coherent theoretical frame to better understand existing approaches for addressing complexity in prevention research.

Keywords: complexity; systems thinking; systems; systematic; systemic; prevention research; chronic disease prevention

1. Introduction

In the past decade, there have been calls for systems-based approaches to study and address chronic disease. This shift is a response to the understanding that chronic disease can be understood as a result of the complex interactions between social, economic, and

environmental forces [1–5]. The evidence demonstrating the likely value of systems-based responses for tackling population-level chronic disease continues to grow [6–8].

Yet despite wide agreement in public health literature on the importance of addressing complexity, the lack of working examples of how research does address complexity is an important gap in knowledge, and more understanding is needed of the operationalisation and impact of different approaches [9]. Systems theories, methods, and tools are not yet universally adopted, nor embedded at scale in public health research and practice, although some notable examples exist, e.g., [10–13], including the Australian Prevention Partnership Centre [14] that applies and funds systems approaches to the study of chronic disease prevention.

In this paper we present an empirical analysis from the Prevention Centre’s Systems Case Studies project, spanning cases related to food and nutrition policy, obesity prevention, liveability, and health services research. We sought to explore different ways in which complexity is addressed in chronic disease prevention research, and whether and how systems-based approaches were used to inform or guide that work. The goals of the research were to (1) draw on a series of empirical case studies undertaken under the auspices of, or aligned with, the Prevention Centre to explore and understand how research teams address complexity in prevention research; and (2) contribute knowledge about operationalising systems-based approaches in chronic disease prevention research to empirically inform the reflective practice, capacity building, and future planning of researchers and policy partners.

We propose that understanding existing approaches from the common vantage point of a coherent theoretical frame offers a basis to better understand the existing approaches to complexity in prevention research, and empirically advance our efforts in the prevention of chronic disease. Ison and Straw [15] proposed that to address complexity, the right balance must be struck between ‘systemic’ and ‘systematic’ paradigms and approaches. *Systemic* broadly refers to approaches that explore the bigger picture, with a focus on whole systems comprising dynamic relationships between interconnected parts, while *systematic* broadly refers to a focus on step-by-step, linear processes, details, and examining selected parts within a system [15]. We draw on the work of Ison and Straw [15] to examine the relationship between *systemic* and *systematic* ways of working in the case studies, and present how this was operationalised across different forms of prevention research. We also present an expansion of Ison and Straw’s heuristic to further describe and illustrate the multi-layered interplay that was observed.

2. Materials and Methods

2.1. Research Context and Design

This research was conducted under the auspices of the Australian Prevention Partnership Centre [14] which was established in 2013 to apply systems thinking and systems science to the study of chronic disease prevention [16–19]. There was also provision to learn from the growing experience of those affiliated with the Centre by conducting a process of empirically derived reflexive learning based on a series of prevention research systems case studies [20]. This research applied a comparative case study design using semi-structured qualitative interviews to explore similarities, differences, and patterns with respect to *systemic* and *systematic* approaches across six cases [21]. See Table 1 for an overview of the study stages, processes, and analytical decisions.

Table 1. Methodological pathway.




Recruitment 	Case selection
	Selected a convenience sample of known chronic disease prevention projects that addressed complexity on a range of prevention research topics and study designs.

Table 1. Cont.

Data collection		Conducted qualitative semi-structured interviews using two-part interview schedule, plus analysis of case study documents available online
		Interview 1 explored the background, context, and purpose of the work in each case study, while Interview 2 explored further details of working with complexity and the role of systems approaches. Questions informed by Foster-Fishman et al. [22].
Data analysis		Developed codes and categories with analysis combined with deductive and inductive processes
		Open coding analysis in Word using the comments function and memo writing; drew on systems literatures to inform theoretical sensitivity, and inductive methodology informed by grounded theory for empirically derived concepts.
		Structured framework analysis used to develop higher order categories and their relationships . Data managed in Google sheets. All categories further explored in relation to the core social process of ‘addressing complexity’ as identified in the research question.
		Explored the operationalisation of systems approaches within each case study
		Described elements of systems approaches for addressing complexity within each case study articulated across a range of dimensions. The dimensions were derived from the framework analysis above. These identified explicit uses of systems science, methods, and tools, plus examples of implicit <i>systemic</i> approaches. Analysis explored how these were operationalised.
		Identified systematic methods embedded in <i>systemic</i> work, and <i>systemic</i> approaches incorporated into systematic work; described how these relationships played out in varying forms and proportions.
		Incorporated the systematic paradigm to represent the whole (Ison and Straw [15])
		Comparative descriptive synthesis conducted for each case study to identify how <i>systemic</i> and systematic aspects were operationalised within the core dimensions.
		Building on Ison and Straw’s [15] work contrasting <i>systemic</i> and systematic paradigms, further analysis explored their relational properties as a continuum with variable proportions.
		Key considerations:
		<ul style="list-style-type: none"> • All case studies had operationalised both <i>systemic</i> and systematic paradigms; • The Ison and Straw [15] relational paradigms could be further explored through a number of different dimensions; • The relative proportions of these <i>systemic</i> and systematic paradigms varied between case studies, and between the dimensions within the case studies; • Some of the dimensions identified as <i>systemic</i> were not explicitly described as such by the participants; • Even work that did not explicitly apply systems science or theory was often found to be <i>systemic</i> in how it was conceived and operationalised; • The dimension of ‘data and evidence’ was the most consistently difficult to delineate into <i>systemic</i> and systematic dimensions.

Reflexive practice

The core team on this project were LR and MP; LR was also the Co-Director of the Prevention Centre and MP a Senior Research Fellow supported through the Centre at the Australian National University (ANU). Throughout the project, our analysis, interpretations, and writing were also guided by our co-authors in conversations (in person and virtually) and via feedback on working documents and draft manuscripts. We convened bi-monthly Chief Investigator meetings (SA, SF, MJI); and a quarterly Systems Advisory Group (RI, DTF, TR, HR). Our data collection and analysis were also informed through wider reading of the systems literature, but particularly the following: [8,15,22–25].

The study was conducted in the context of a Prevention Centre project, itself conceived as reflexive practice (i.e., to explore what can be learned from research case studies affiliated with the Centre that seek to address the complexity of chronic disease prevention). We acknowledge that our data and interpretations are partly formed by our research question and study design; our team’s worldviews, assumptions, and beliefs; and the overall goals of the Prevention Centre. We have, however, sought to provide an explicit audit trail to maximise the replicability of our methods, and propose that the concepts and theory emerging from our analysis will likely hold true for many examples of prevention research seeking address complexity.

Our overarching research question was: how do prevention researchers address complexity in their work? The intention was to produce generalisable lessons from the cases as they pertain to their common goal of chronic disease prevention [26]. Case study research is appropriate when “a how or why question is being asked about a contemporary

set of events over which the investigator has little or no control” (p. 9) [27]. Cases are also useful when the implementation of methods or techniques are being explored and events are complex, involving change over time [26].

Ethical clearance for the study was granted from the Australian National University human research ethics committee—ref no. 2019/653.

2.2. Recruitment

2.2.1. Case Selection

A convenience sample was selected of known chronic disease prevention projects actively addressing complexity and covering a range of prevention research topics and study designs. In total, we examined six case studies using qualitative interviews and related materials available online. The case studies comprised three projects and one program of work that had been fully or partly funded through the Prevention Centre, and two other affiliated programs of work (i.e., related prevention research led by chief investigators within the Centre).

2.2.2. Data Collection

Data collection comprised two sets of semi-structured interviews and gathering of online data sources. All study participants were recruited via personalised email invitations with an attached participant information letter and consent form. Interviews were conducted via Zoom video calls or phone and transcribed verbatim by a professional transcription service. The interviews were conducted approximately 4–6 weeks apart and involved 29 interviews with 16 participants. The online data collection pertaining to the case studies included project information on the Prevention Centre and/or other websites, study findings briefs, reports, and peer-reviewed publications. To assist with triangulation, these data were used to complement the interview data and compile a fuller picture of the program of work relating to each case study.

The purpose of the first set of interviews was to sensitise participants to the study, take a deep dive into the background and context of their work, and explore how they approached and conducted their research. These interviews made limited reference to systems language or theory, unless raised by the participants themselves. The second set of interviews delved deeper into how the participants and their team responded to complexity within their project, or program of work, and explored whether and how the case studies applied a *systemic* lens. The guide for the second interviews was informed by Foster-Fishman et al.’s [22] framework for understanding and changing organisational and community systems. Foster-Fishman et al.’s framework was selected for its theoretical breadth and depth, spanning literature from the organisational change field, systems thinking, and community change, and its previous practical applications to enable a deeper understanding of how complexity was being addressed. The framework was adapted to our context to explore how teams respond to complexity in prevention research [13,22].

2.3. Data Analysis

Data analysis took place in an iterative manner over an 18-month period. A staged series of in-depth analyses were conducted within and across case studies to identify the approaches and explanations of how each project, or program of work, responded to complexity, as per our research question [21]. Both deductive and inductive processes were used throughout; we drew upon our wide reading of systems literatures to inform theoretical sensitivity and used inductive principles to allow for new empirically derived concepts to arise [27]. The core analytical steps are summarised as a methodological pathway (Table 1).

2.3.1. Open Coding and Framework Analysis

Every interview transcript was individually coded by at least two authors (i.e., MP, and LR or MJI) using the comments function in Word, followed by detailed memo writing.

Memos were written about each interview, each case (first and second interviews, plus online data), and as reflections across cases. We then conducted a structured framework analysis in Google sheets comprising categories along the vertical and horizontal axes. These were empirically derived as pertinent to the research question of addressing complexity in prevention research. The vertical framework categories were as follows: case study goals, case study narrative, addressing complexity, achieving impact, change making, systems approaches, systems thinking worldview, use of theories, soft systems practices, and systems science methods. Additional vertical categories added during the synthesis process were for our reflections and developing ideas to inform reporting/writing up. The horizontal framework categories pertained to each case and the interview participants within each case. An additional horizontal category for synthesising key learnings from each vertical column was also added. This stage of the analysis was primarily conducted by MP and LR in an iterative series of online dialogues to review, discuss, and generate joint reflections on the empirical data.

2.3.2. Exploring How Systemic Approaches Were Operationalised

To synthesise the findings from the framework analysis in relation to the core social process of addressing complexity, two authors (MP and LR) distilled the key dimensions of each case study into further memos and summary tables. This stage of the analysis also focused on identifying whether, where, and how systems approaches, theories, and methods were used—and how these interacted and aligned with other aspects of the research. The analysis examined instances of systems thinking, methods, and tools that were explicitly reported, as well as our own interpretations of a systems-based approach based on the representations in the data. A brief summary of our own roles and reflexive practice in the context of this research are outlined within Table 1. We described some of the core dimensions of systems-based approaches, including some that were implicit as well as others that were explicit (e.g., systems science and systems methods and tools). There were also core systematic components within the systems-led work (e.g., methodological protocols used within *systemic* community workshops).

2.3.3. Representing the Whole

We drew on Ison and Straw's [15] *systemic*–*systematic* duality to more explicitly incorporate and explore both the *systemic* and *systematic* paradigms to represent the whole. Ison and Straw [15] suggest the two paradigms exist in complement rather than opposition to one another and that one cannot exist without the other [15]. We describe and contrast *systemic* and *systematic* approaches, and consider their relative proportions within our case studies and the dimensions (empirically derived from the open coding and framework analysis) within each case study. *Systemic* and *systematic* paradigms as identified by the work of Ison and Straw [15] and Swinburn et al. [1] are defined in Table 2.

Table 2. *Systemic* and *systematic* paradigms.

<i>Systemic</i>	<i>Systematic</i>
<ul style="list-style-type: none"> • Exploring the bigger picture; • Focus on whole systems composed of interconnected parts; • Natural experiments; • A non-linear focus; • Supporting change and change-agents in leveraging systems; • Non-dualistic thinking (embracing the continuum); • “What works for what systems in what contexts?”; • A focus on strengthening existing systems. 	<ul style="list-style-type: none"> • A focus on details; • Methodical; • Examining the parts within a system; • A more linear focus; • Duality (black and white, night and day, inhale and exhale, yin and yang, etc.); • Randomised controlled trials and cluster randomised controlled trials; • “What intervention works?”; • A focus on fidelity in program delivery.

Overall, our intention was not to evaluate or rate projects on the degree to which they incorporated and adopted a *systemic* paradigm, but rather to explore how the two paradigms manifested within these case studies, and what we could learn from exploring empirically their various dimensions and interactions.

3. Results

3.1. Addressing Complexity through Systemic and Systematic Paradigms—Case Study Summaries The Systemic and Systematic Paradigms Took Different Forms and Played out in Different Proportions within the Cases of Prevention Research

Our study found significant diversity in how the *systemic* and *systematic* paradigms are embodied and operationalised within and across different types of prevention research, and the case studies illustrate varying combinations of these paradigms within their work. The *systematic* paradigm was embraced most obviously via controlled study designs and highly methodical means such as randomised controlled trials, systematic reviews, and other strict replicable research processes and an adherence to fidelity. Overall systems thinking and *systemic* approaches were also valued and sometimes applied through explicit adoption of systems theories, methods, and tools. However, the *systemic* paradigm was also embraced to address complexity through other means such as governance models, relationship-based process and infrastructure, co-design approaches, a focus on systems change, and the ‘soft systems’ approaches embodied in the way that people work. Significantly, these *systemic* dimensions were identifiable even when the use of systems approaches was not explicitly reported by the study participants.

We present below a brief summary of each case study, with the key manifestations of both the *systemic* and *systematic* paradigms observed within that work, e.g., problem framing, ways of working, or adoption of methods and tools. Also provided are tables with further illustrative details. Table 3 describes what each case entailed as a piece of research. Appendix A is a more detailed summary of how each case addressed complexity overall (the overview), and delineation of how *systemic* and *systematic* approaches were operationalised within eight dimensions, i.e., Theory, Methods, Data and Evidence, Relationships, Capacity Building, Learning Orientation, Multi-perspectivity, and Knowledge Mobilisation/Translation. Note: it was not logical to delineate the two paradigms for the dimension of ‘Data and Evidence’ and so the columns are combined.

Table 3. Case study descriptions.

Case Study 1—The Healthy and Equitable Eating (HE ²) Study Case Study	
Data	Two interviewees, two interviews each
Study link	https://preventioncentre.org.au/our-work/research-projects/healthy-public-policy-to-support-healthy-and-equitable-eating/ (accessed on 26 April 2023).
Focus	Structural/policy level
Project	Discrete project
Academic/Policy/Practice	Academic-led with policy focus genesis, academic-led and policy research implementation
The study: what happened?	The team explored what is required to create a healthy and equitable system of eating in Australia. A key piece of work was a causal loop diagram developed as a collaborative effort between academics and policy makers, and depicting the drivers of inequities in healthy-eating—spanning domains—including housing and the built environment, health literacy, transport, employment, food supply and environment, food taste preferences, and social protection. A systems-based policy framework was also developed suggesting plausible policy actions that could be implemented across each of the domains. An additional piece of work used an existing Australian policy case study to explore the potential value of public policy attention given to inequities in obesity.
Rationale	When working to address the complex problem that is addressing inequities in healthy eating, a typical response has been to oversimplify both the problem and the solution instead of paying attention to the multiple interacting variables affecting the consumption of a healthy diet across social groups. Evidence was required to guide coherent policy development and implementation spanning a broad range of policy areas which affect nutrition-related inequities.

Table 3. Cont.

Case Study 1—The Healthy and Equitable Eating (HE²) Study Case Study	
Outcome	An evidence base was produced showing what can be done to improve healthy and equitable eating (HE ²) in Australia via federal and state cross-government policies and programs.
Case study 2—Food environment policy index (Food-EPI) study case study	
Data	Four interviewees, two interviews with two participants and one paired interview where only one interview was conducted
Study link	https://preventioncentre.org.au/our-work/research-projects/benchmarking-obesity-policies-in-australia/ (accessed on 26 April 2023).
Focus	Structural/policy level
Project	Program of work
Academic/Policy/Practice	Academic-led with policy focus genesis, academic-led and policy research implementation, for public policy advocacy
The study: what happened?	The Healthy Food Environment Policy Index (Food-EPI) was developed by INFORMAS (International Network for Food and Obesity/NCDs Research, Monitoring and Action Support) to assess government policy across 14 areas for action in relation to food environments. This approach was replicated and applied in this Australian case study in which diet-related aspects of obesity prevention policies at state, territory, and federal level were assessed and compared to international best practice. There was extensive engagement between researchers and policy makers, including in the extensive process of collating government policy data, verifying it, and reviewing and prioritising recommendations. Government also had input into the way in which results were presented as part of final reports. An important goal of the project was to increase accountability of governments around obesity prevention. The ratings were conducted in workshops engaging all of the participating policy agencies.
Rationale	While it is recognised that in order to address obesity a comprehensive approach is required, the development and implementation of recommended policies has not moved quickly within Australia and elsewhere. Australia's performance when it comes to obesity prevention had not been systematically benchmarked and monitored. The study design was also informed by former successful campaigns establishing competition and accountability, i.e., the Dirty Ashtray and Couch Potato Awards benchmarking the States and Territories against best practice and each other.
Outcome	An assessment was made as to the degree to which policies in Australian met best practice for creating healthy food environments and priority areas for action to improve food environments were identified. The findings were published in and published in public reports.
Case study 3—NSW childhood obesity modelling project addressing complexity	
Data	Five interviewees, two interviews each
Study link	https://preventioncentre.org.au/wp-content/uploads/2017/03/1702_FB_ATKINSON_PremObesity.pdf (accessed on 26 April 2023).
Focus	Structural/policy level
Project	Discrete project, but it has produced spin-off projects
Academic/Policy/Practice	Primarily policy-led genesis, academic-led and policy research implementation, for local policy decision making
The study: what happened?	In NSW, as part of the Premier's Priorities, the Ministry of Health approached the Prevention Centre to test how different interventions and combinations of interventions could help achieve a 5% reduction in child overweight and obesity over a 10-year period. A dynamic simulation model was used to provide insights into what combination of interventions would be required to meet the target.

Table 3. Cont.

Case study 3—NSW childhood obesity modelling project addressing complexity	
Rationale	When it comes to addressing overweight and obesity in Australian children, population-level interventions that create sustained change have been lacking. The impact of these interventions being implemented simultaneously has also been unclear.
Outcome	A participatory approach was employed to build and test the model. This engaged multiple stakeholders central to decision making in relation to addressing overweight and obesity in NSW children. The combination of interventions required to meet the target included actions to improve the built environment, food policy interventions, school and childcare interventions, and clinical service delivery.
Case study 4—Hunter New England region program of work addressing complexity	
Data	Three interviewees, two interviews each
Study link	https://preventioncentre.org.au/blog/youve-heard-of-clinician-scientists-were-applying-the-same-model-to-public-health/ (accessed on 26 April 2023).
Timeframe	Ongoing
Focus	Structural/policy/community level
Project	Program of work
Academic/Policy/Practice	Practice-based genesis, practice-led and academic research implementation, for quality improvement of service delivery
The study: what happened?	This case relates to the research–practice partnership set up between Hunter New England Population Health (a population health service delivery unit in Australia) and the University of Newcastle and was included as a case study of an embedded model for prevention and health services research. A single-integrated governance structure means that researchers are embedded within the health service delivery unit. Senior leadership roles are filled by staff holding appointments at both the health service and university.
Rationale	Health research is much more likely to be used if the research questions are derived from the proximal service delivery needs of the end users.
Outcome	Research and service delivery work is co-conceived, co-designed, co-evaluated, and co-disseminated by both practitioners and researchers. This optimises research co-production via greater knowledge exchange and alignment of research with the needs of the health service. Thus, research and evaluation findings are readily available to end users. Both academic and health service resources are simultaneously leveraged to meet scientific and service delivery goals.
Case study 5—Liveability program of work addressing complexity	
Data	Two interviewees, two interviews each
Study links	https://preventioncentre.org.au/our-work/research-projects/creating-liveable-and-healthy-communities/ (accessed on 24 June 2023). https://preventioncentre.org.au/our-work/research-projects/developing-the-tools-to-map-and-measure-urban-liveability-across-australia/ (accessed on 26 April 2023). https://preventioncentre.org.au/our-work/research-projects/benchmarking-monitoring-modelling-and-valuing-the-healthy-liveable-city/ (accessed on 26 April 2023).
Focus	Structural/policy level
Project	Program of work
Academic/Policy/Practice	Academic-led with policy focus genesis, academic and policy-led research implementation, for public policy decision making and system change
The study: what happened?	A range of policies related to the liveability domains have been validated to provide evidence for how they contribute to chronic disease risk factors. These have also been benchmarked and are being monitored to track the progress of communities towards healthier and more equitable living. Furthermore, agent-based modelling is being used to explore the efficacy and economic benefits of possible interventions relating to the indicators to improve walking, cycling, and public and private transport usage.
Rationale	Eleven domains of liveability have been identified by Billie Giles-Corti’s research team relating to the social determinants of health. Neighbourhoods have huge impacts on many aspects of health and wellbeing.

Table 3. Cont.

Case study 5—Liveability program of work addressing complexity	
Outcome	The liveability indicators are being used by a range of stakeholders to inform the creation of healthier built environments.
Case study 6—Community-based childhood obesity strategies case study addressing complexity	
Data	One interviewee, two interviews
Study link	https://iht.deakin.edu.au/global-centre-for-preventive-health-and-nutrition/stream/community-collaboration/ (accessed on 26 April 2023).
Focus	Community level
Project	Discrete projects across many communities as part of broad program of work
Academic/Policy/Practice	Academic-led with community focus genesis, community-led and academic research implementation, for local community action
The study: what happened?	Informed by system dynamics theory, communities are empowered to create informal maps as well as contribute to formal simulation models to understand, address, and communicate dynamic complexity. Systems science methods including Agent Based modelling, System Dynamics, Social Network Analysis and Causal Loop Diagrams are used in this program of work spanning numerous and diverse communities in Australia and internationally.
Rationale	Successful population-level interventions for addressing child obesity and other non-communicable diseases require a shared understanding of the <i>systemic</i> drivers of these problems and an understanding of how to strengthen existing systems to promote good health and reduce disease burden. The ability of communities to apply systems thinking is crucial to the success of such interventions.
Outcome	Capacity is built within communities and communities are empowered to solve their problems as a collective and engage in sustainable change.

Summary of *systemic* and *systematic* dimensions in case study 1: Healthy and equitable eating (HE2) project

This case study examined a project [28] focused on expanding the conceptualisation and understanding, including among prevention researchers and policy partners, of the system-wide drivers of healthy and equitable eating (Table 3). How the *systemic* paradigm was operationalised in this work included a participatory systems-based methodology (collaborative conceptual modelling [29]) used to develop a comprehensive causal loop diagram of the Australian food system [10]. This systems diagram was co-produced through a series of collaborative workshops of researchers and health sector-based policy and program partners. There was an explicit goal to develop shared understanding and language to support future collaboration on addressing the leverage points within the system. The *systematic*, process-driven qualities within the work included the strict adherence to a structured methodology for developing the CLD. The project also included a discrete qualitative evaluation conducted through semi-structured interviews (Appendix A).

The way the *systemic* paradigm was operationalised in this work included the focus on food environments (rather than dietary behaviours) and an analysis of state and federal government policy systems (comprising food composition, food labelling, food promotion, food provision, food prices, food retail, leadership, governance, monitoring and intelligence, funding and resources, and support for communities) (Appendix A). There was also an emphasis on both internal and external capacity building and reflexive learning. The investigators also prioritised establishing and maintaining trusting relationships with government officials/policy participants. The highly *systematic* qualities in this work included the focus on fidelity to the rigorous and clearly prescribed methodology, with strict policy rating criteria, an emphasis on the independence of the researchers and the reporting of findings, and reference to competitive benchmarking as part of the strategy to effect change (note this strategy also had an explicit focus on knowledge development and enhancing collaboration which reflected more *systemic* work).

Summary of *systemic* and systematic dimensions in case study 2: Food environment policy index (Food-EPI) project

This case study examined a project [30] that replicated an existing methodology developed by INFORMAS (International Network for Food and Obesity/NCDs Research, Monitoring and Action Support) in the Australian context to assess government policies related to the food environment (Table 3). How the *systemic* paradigm was operationalised in this work included the focus on food environments (rather than dietary behaviours) and an analysis of state and federal government policy systems (comprising food composition, food labelling, food promotion, food provision, food prices, food retail, leadership, governance, monitoring and intelligence, funding and resources, and support for communities) (Appendix A). There was also an emphasis on both internal and external capacity building and reflexive learning. The investigators also prioritised establishing and maintaining trusting relationships with government officials/policy participants. The highly systematic qualities in this work included the focus on fidelity to the rigorous and clearly prescribed methodology, with strict policy rating criteria, an emphasis on the independence of the researchers and the reporting of findings, and reference to competitive benchmarking as part of the strategy to effect change (note this strategy also had an explicit focus on knowledge development and enhancing collaboration which reflected more *systemic* work).

Summary of *systemic* and systematic dimensions in case study 3: State-level childhood obesity prevention modelling project

This case study examined a policy-driven dynamic simulation modelling project [31] that was used to forecast what combination of interventions would be required to achieve a state-level target of a 5% reduction in child overweight and obesity over a specified time period (Table 3). The *systemic* paradigm was operationalised in this work through a whole-of-system, state-wide focus; how the research was policy-led and embedded within the government system that it sought to inform; and system dynamic theory, methods, and tools were explicitly applied to interact with the end-users and develop the model (Appendix A). For example, these included participatory group model building (qualitative) with clinical, program, and policy partners; dynamic simulation modelling (quantitative); and the development of an interactive interface to support engagement and knowledge mobilisation. The relational aspects of the work were emphasised throughout, prioritising deliberative methods that incorporated multiple perspectives, empowerment and capacity building, and priority research questions arising from real-world policy decisions. The systematic aspects of the work included the rigorous synthesis, appraisal, and incorporation of systematic reviews; international and local data and other forms of evidence; and validation of the model outputs against historical data.

Summary of *systemic* and systematic dimensions in case study 4: Embedding prevention research within health services—program of work

This case study examined an embedded model of health services led prevention research through a long-term partnership between the Local Health District's (LHD) population health service and the local University [32]—a partnership built over several decades (Table 3). The *systemic* paradigm is reflected in this work through its organisational structures, governance and relational aspects, and prioritising research to inform systems change (Appendix A). All of these aspects support an integrated program of work comprising research, research translation and program implementation across the population health service, and the wider LHD prevention system. Research questions are regularly derived from the program delivery needs of the LHD and/or its affiliated government, non-government, and community partners. Other *systemic* qualities were the focus on understanding and changing the prevention system, and capacity building and quality improvement across that system. There were also strong systematic dimensions to this case study, including the methodological focus on evidence-based practice, intervention effectiveness and routine use of randomised controlled trials (RCTs), and other epidemiological and qualitative study designs and methods.

Summary of *systemic* and systematic dimensions in case study 5: Liveability—program of work

This case study examined a program of work [33] that focused on developing and evaluating a series of indicators to measure the liveability of neighbourhoods and the association between these indicators and health outcomes (see Table 3). The operationalisation of the *systemic* paradigm in this work included examining the interacting dimensions of liveability within the system of a local neighbourhood (or city) that combine and impact on health (Appendix A). Research-policy relationships have been key to framing the research, and it is underpinned by the long-term partnerships between the lead investigators and their urban planning policy partners. The embedded relationships between prevention researchers and policy partners outside the health sector are relatively novel—they focus on the co-benefits of health and planning—and have been strategically developed to ensure relevance to those most able to influence *systemic* changes within the system being studied. The systematic, detail-driven dimensions in this case study include the focus on fidelity, generating replicable indicators for benchmarking and monitoring liveability, and statistical modelling.

Summary of *systemic* and systematic dimensions in case study 6: Community-based childhood obesity prevention—program of work

This case study examined a growing body of work [34] that applies systems science theories and methods to develop, implement, and study childhood obesity prevention initiatives in partnership with communities and/or governments at local, regional, and state-levels (Table 3). The explicitly *systemic* aspects of this work include the application of system dynamics theory to conceptualise, understand, and address complex problems, and implementing co-designed solutions focused on creating sustainable systems change (Appendix A). The community-based interventions seek to communicate complexity in digestible forms and empower local agents for change. The STICKE software platform used for group model building [35] and to support communities to develop their own causal loop diagrams (CLDs) is widely available through a low-cost licence. Other research methods employed throughout include an integrated network of local, national, and international projects include social network analysis, agent-based modelling, and dynamic simulation modelling. The systematic dimensions of the work include the CLD group model building workshops; these follow clearly defined guidelines, with strict rules about governance mechanisms, group process, as well as precise scripts to guide facilitation. The projects also routinely employ RCTs to evaluate intervention effectiveness.

3.2. Expanding the Boundary: Comparing the Relative Proportions of Systemic and Systematic Paradigms

The Balance between the Systemic and Systematic Paradigms Appears to Vary When One Considers a Case as a Whole, When Examining the Individual Dimensions within That Work, and When Comparing across Case Studies

As outlined above and in Appendix A, there was variability in the relative proportions of *systemic* and systematic paradigms within and across the different case studies and their dimensions. For example, both the obesity modelling project (#3) and the community-based childhood obesity program (#6) may be holistically described as highly *systemic* due to the explicit use of systems science theory and methods. However, each case study also demonstrated a core dimension of more systematic, process-driven, and detail-focused public health research methodologies, including the principles of evidence-based practice, a highly systematic collection and synthesis of evidence reviews and other data, and using an RCT design to demonstrate intervention effectiveness.

Conversely, when considering the food policy environment project (#2) or the prevention in health services program (#4), both could be described as highly systematic in their use of underpinning theories, research designs, and data collection methods. Yet such a categorisation alone would not be a true reflection of the overall program of work as there are other dimensions that are also clearly *systemic*, including a focus on systems change, multi-perspectivity, systems leadership, and their approaches to capacity building.

To understand how *systemic* and systematic dimensions manifested within a case study, it was necessary to explore each of its composite dimensions.

A key finding from this research is the importance of avoiding surface-level judgements about the paradigms operating within different types of prevention research projects and programs of work. For example, within the health services case study #4, the methods were viewed as primarily systematic while their knowledge mobilisation efforts were primarily *systemic* in nature. Other dimensions were a combination of *systemic* and systematic aspects such as the use of theory dimension. Furthermore, within the methods dimension of the community-based childhood obesity strategies (#6), both *systemic* and systematic tools were utilised, i.e., a systems science method stemming from Hovmand [25] was used to understand and mobilise community systems change, while systematic RCTs were used to evaluate intervention effectiveness. Collectively, the distribution across each dimension determined the overall balance of *systemic*–systematic dimensions making up the case as a whole. Therefore, unless we expand our boundaries, most notably beyond theory and methods, we may not notice if we are making surface-level judgements and we may not notice the true degree to which something is *systemic* or systematic. Thus, by expanding the boundary, our perception of each case study will change.

Adoption of *systemic* vs. systematic approaches, and their relative balance, were influenced by many variables. Reported factors underpinning enhanced *systemic* dimensions (explicit or implicit) included at least one (or more) of the following: strong orientation towards achieving real-world impact and creating systems change; professional training and personal belief in the value of systems thinking and systems science; sociological, structural orientations to public health; or inherent valuing of relational and other soft systems practices. Meanwhile, factors enhancing the systematic paradigm included methodological training, and/or expectations and requirements of funding bodies; requirements to articulate strict study timeframes and milestones; and siloed structures, expectations, or hierarchies within health and other partnering organisations. Furthermore, some discomfort with overt use of systems science methods and/or terminology was also reported by some, although this had diminished over time as it mainly related to initial unfamiliarity with methods or theories.

3.3. The Continuum: Changing the Relative Proportions of Systemic and Systematic Paradigms in Prevention Research

3.3.1. The Proportional Interplay between the Systemic and Systematic Paradigms Is not Fixed, and Variations Can Be Described along on a Continuum (see Figure 1)

Our analysis led us to conclude that the interplay between the *systemic* and systematic qualities coded in the data was most appropriately described as manifesting at points along a continuum (Figure 1) rather than as distinct categories. For example, there was much variability along the continuum of whether and how participants self-identified with a systems thinking worldview and practice, i.e., ranging from extensive to partial applications of systems theory, systems science, and systems methods. There were also degrees of *systemic* approaches embedded within knowledge mobilisation from dissemination of descriptive analyses to more interventionist framing oriented to creating system change. All of the case study dimensions had dynamic qualities that may evolve over time.

We anticipate that most prevention research projects and programs of work are inherently dynamic and thus will evolve over time based on contextual factors such as funding, team members, skillsets, and learning opportunities. Notably, the relative balance between *systemic*–systematic dimensions of the case studies is an analytical interpretation of the data, not directly reported by the study participants. Further, the perception of a dynamic interplay between *systemic* and systematic paradigms along a continuum, and analytical placement of a case study along that continuum, is dependent on what dimensions are taken into account. The movement along the continuum may occur through boundary expansion (or contraction) in terms of which dimensions are (or not) taken into account. We propose that all prevention research is likely to change over time in terms of the relative distribution of *systemic* and systematic dimensions.

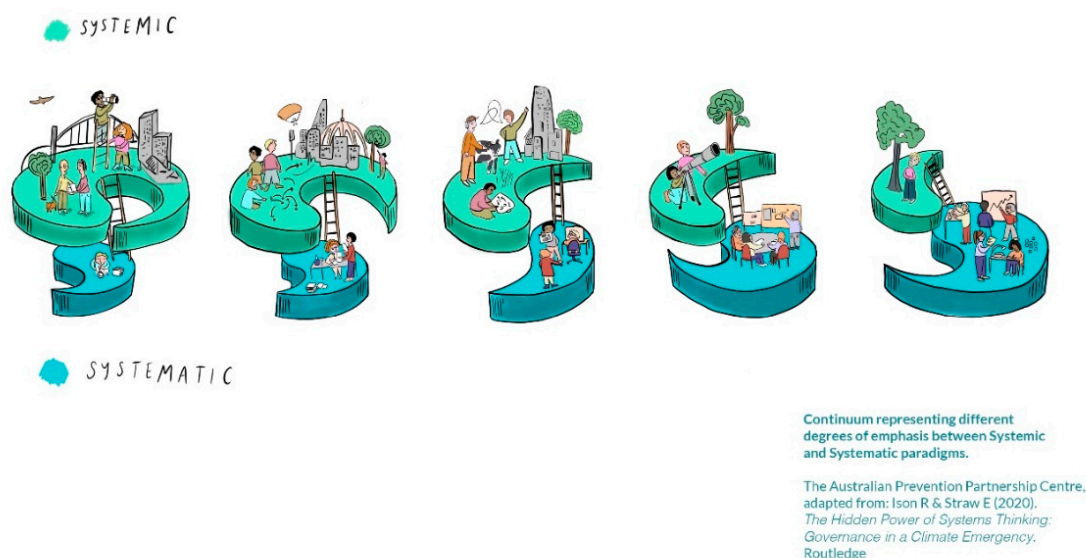


Figure 1. Continuum representing different degrees of emphasis between systemic and systematic paradigms [15].

3.3.2. The Concept of a (Dynamic) Continuum of Systemic–Systematic Paradigms in Prevention Research Can Be Conceived as a Repeating Pattern Occurring on Different Scales (i.e., the Case as a Whole and within Cases Explored along Different Dimensions) (Figures 1 and 2)

To visually represent these findings as a heuristic tool, we commissioned an artist to adapt and expand the original diagram from Ison and Straw [15]. Our goal was to illustrate how the differing proportional distributions between the *systemic* and *systematic* paradigms can be represented along a spectrum (Figure 1). Thus, Figure 1 depicts a graphic illustration of the following points:

- The relative proportions of *systemic* and *systematic* dimensions play out along a continuum of variable proportions.
- There is potential for movement (up and down via the ladder) between the *systemic* and *systematic* dimensions, which results in movement (left to right) along the sliding scale of the continuum. Of note, however, is that position along the continuum can be supported or constrained by contextual factors and what dimensions are included in the assessment.
- The detailed images on the two levels illustrate the descriptive characteristics of the two paradigms (as articulated in the methods Table 1); they do not have deeper meanings other than for illustration.

Figure 2, a hypothetical case study of prevention research, depicts the increasing boundary scope moving from looking at the case as a whole to looking at the case in terms of its component dimensions. Looking at Figure 2, we can see that if we judge a case by its theory and methods alone then we will see it as more *systematic* in nature. However, if we bring in the additional dimensions, we can see that it is overall more *systemic*. By widening our perspective of each prevention research case, we can deepen our understanding of the range of *systemic* and *systematic* dimensions comprising the work.

Case study overview as a whole	
Case study component dimensions	
Theory	
Methods	
Data and evidence	NA
Relationships	
Capacity building	
Learning orientation	
Multi-perspectivity	
Knowledge mobilisation/translation	

Figure 2. Example of research responses to complexity as a repeating pattern and the importance of boundary scope for ascertaining *systemic* and systematic paradigms.

4. Discussion

In this paper, we present findings from a series of prevention research case studies that offer insights into how the study of complex problems may be operationalised through a duality of *systemic* and systematic paradigms. We highlight the diversity of how prevention research embodies both *systemic* and systematic ways of working; describe how that duality is enacted along a continuum; and how it plays out across different dimensions, i.e., Theory, Methods, Relationships, Capacity Building, Learning Orientation, Multi-perspectivity, and Knowledge Mobilisation/Translation. We note that one category for which it is difficult to distil and articulate these relationships is ‘Data and Evidence’, and surmise that this is

because these are primarily determined by the purpose for what it was collected and how it was to be used. We illustrate the many ways that systems approaches are embedded in prevention research and identify how a *systemic* lens is both explicitly and implicitly employed. Finally, we propose a coherent theoretical frame (Figures 1 and 2) to inform conversations about the nature and value of understanding both *systemic* and systematic paradigms in prevention research. To operationalise systems-based approaches in chronic disease prevention research, it is important for researchers to be able to describe how they are working to address complexity and be explicit about where their work sits along the dynamic continuum of the relative proportions of *systemic* and systematic paradigms.

Traditionally in public health research, the systematic paradigm has predominated, with limited attention paid to enhancing and operationalising the *systemic* paradigm—including in health care and public health research [15,26]. Typically, systems-based approaches have been adopted implicitly without clear reference to their *systemic* nature [36]. Strengthening *systemic* approaches in prevention research will also enhance the broader public health goals of enabling and supporting systems change [4,20]. This has implications for addressing chronic disease yet, as several authors on this paper have previously proposed, when research teams seek to incorporate *systemic* dimensions into their work, they often experience constraints such as restrictive funding arrangements and unsupportive contextual factors including a lack of management support [15,37,38].

Further, previous empirical studies of systems thinking in public health have commonly assessed and rated intervention research to determine how much, and/or how well, it had applied the systems theories and methods of complexity science, e.g., [39]. Some have further explored the relationship between such normative ratings of a systems-based approach and intervention effectiveness, e.g., [8]. We recognise the importance of such work for generating evidence of the value-add of a *systemic* lens. While also drawing on existing systems frameworks, our study adopted a notably different and more inductive and exploratory approach. Thus, rather than apply a normative stance, we sought to explore how prevention research addressed complexity—and if a *systemic* lens was applied, where and how this occurred—irrespective of an explicit use of systems theory, methods, and language. We propose that this theoretically sensitive and grounded theory approach enabled us to observe and elaborate upon a broad range of *systemic* dimensions of prevention research, as outlined in the results and Tables. Jebb and colleagues [37] conceptualise systems-based approaches as existing on a continuum that moves from a low-to-high consideration of complex systems principles. As the consideration of complex systems principles increases, so does the application of systems thinking. We extend this work by adding in the systematic paradigm to the *systemic* (systems-based approaches) and demonstrate how the two paradigms exist as a duality.

We found a relatively even balance between the *systemic* and systematic paradigms in the case studies examined, but with substantial variability across different dimensions. This balance may partly reflect the fact that the work was conducted under the auspice of the Prevention Centre, with its explicit focus on capacity building in systems approaches, or by affiliated researchers who purposefully apply systems science to inform their work. Other examples of prevention research may look quite different, and on the surface appear more systematic than *systemic* in its approach. As demonstrated in this study, however, such work may also reflect implicit *systemic* approaches across multiple domains.

Our study also suggests that if prevention research is examined primarily on its theories and methods, then unless these are explicitly derived from systems science the work may be judged as *systemically* deficient or lacking. However, different forms of prevention research embodies both *systemic* and systematic paradigms across a number of other important dimensions. Thus, rating projects, programs of work, or researchers on the degree to which they do, or do not, use systems methods may be counterproductive if there is an assumption that there is a 'correct' balance. By elaborating on the duality proposed by Ison and Straw [15], and by describing how that is operationalised in prevention research along a continuum across many dimensions and as a whole, our results broaden and

deepen understanding of the range of options in how prevention research does, and can, address complexity through a *systemic* lens. We propose that as long as it is fit-for-purpose, prevention research may legitimately sit anywhere along the *systemic*–*systematic* continuum and still be ‘right’. Further research is however required to assess the practical application of this work as well as the roles and impact of the interplay between *systemic* and *systematic* dimensions within prevention research. By exploring intervention effectiveness, researchers may also build the empirical evidence base required to support or challenge the need for a balanced approach. Future research may identify new important dimensions and assess the relative proportions of the *systemic* and *systematic* approaches, both overall and within their dimensions, and understand the impact of any interplay between those approaches. Our heuristic is important for ensuring the boundary is broad enough to capture all of the *systemic* and *systematic* dimensions, or as many as possible, especially when quantifying or rating prevention research case studies.

It is our intention that application of this tool should enable teams to consider and explore prevention research along our proposed continuum. This may be conducted both for a case or program of work overall and also as a more detailed, and potentially cumulative assessment, within each of the related dimensions. That is, Figure 1 is to be applied to explore a repeating pattern that is self-similar across different scales, and thus may be conceived as ‘fractal’ [40]; a simple example of an object in nature with fractal features is a fern whereby the same shape is repeated in its leaves (including the veins inside each leaf), fronds, and branches. Figure 2 presents a visual example of the fractal concept as applied to a hypothetical case study of prevention research. The heuristic can also be used as a synthesis tool whereby multiple *systemic* and *systematic* dimensions are considered at once, analysed, and then synthesised as a collective ‘whole’ case study.

In using our heuristic, we propose that researchers will be better able to:

- Gain a deeper understanding of the paradigm from which they predominantly work;
- Describe how they are working both *systemically* and *systematically* and to what extent (this is important for articulating given our field has called for more *systemic* approaches to addressing complex problems (see [2]));
- Produce better evidence about the value of *systemic* and *systematic* dimensions through the expansion of the boundaries within which these dimensions exist;
- Identify opportunities for how to become more *systemic* in their practice, especially if this paradigm is lacking beyond the application of *systemic* theories and methods.

Thus, a key aspect of addressing complexity is the capacity to practice being conscious of the paradigms that are guiding your research efforts and what these paradigms bring to the research. While there are many tools to help research to be *systematic* and appraisal tools to assess rigour and quality based on *systematic* principles (e.g., the CONSORT checklist for randomised trials or the PRISMA checklist for *systematic* reviews), there are fewer tools for guiding the application of a *systemic* approach within prevention research. Some exceptions include the Prevention Systems Change Framework [20] and a systems thinking mindset guide for enhancing knowledge mobilisation in prevention research [41]. Other examples include the Intervention Level Framework [24] and the iceberg model [42].

Our conclusion derived from the empirical literature and these case studies is that prevention research does address complexity using both *systemic* and *systematic* dimensions, and the manifestation of these proportions are themselves highly dependent on individual, contextual, structural, and *systemic* factors. We propose therefore, that there is inherent value in researchers being explicitly ‘bilingual’ in both *systemic* and *systematic* ways of thinking and terminology in order to ensure that the relative value and strengths of these paradigms may be utilised. Our overall goal is to support and inform conversations about where and how prevention research could and should manifest the *systemic*–*systematic* duality across different dimensions. We also propose that that the balance between these paradigms may be modified through reflexivity. Explicit reviews of prevention research, utilising the key summary points in our findings and employing Figures 1 and 2 will help to

ensure that the *systemic*–systematic duality of a study or program of research is purposeful relative to the goals, priorities, and context of that work.

In summary, we endorse the importance and value of *systemic* and systematic theories, methods, and tools in addressing complexity in prevention research. Our goal is to support more explicit reflexive practice to ensure that choices about the adoption of *systemic* and systematic paradigms are consciously made and clearly described, and so that the nature and balance of the adopted duality is well-informed, transparent, and truly fit for purpose.

Author Contributions: Conceptualization, M.P. and L.R.; formal analysis, M.P., L.R. and M.J.I.; funding acquisition, M.P., L.R., S.A. and S.F.; investigation, M.J.I., D.T.F., T.R., R.I. and H.R.; methodology, M.P. and L.R.; project administration, M.P. and L.R.; supervision, L.R. and S.F.; writing—original draft, M.P., L.R. and M.J.I.; writing—review and editing, M.P., L.R., S.A., M.J.I., D.T.F., T.R., R.I., H.R. and S.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by The Australian Prevention Partnership Centre, which is supported through the NHMRC partnership centre grant scheme (Grant ID: GNT9100003) with the Australian Government Department of Health, ACT Health, Cancer Council Australia, NSW Ministry of Health, Wellbeing SA, Tasmanian Department of Health, and VicHealth. It is administered by the Sax Institute.

Institutional Review Board Statement: The study was approved by the Ethics Committee of the Australian National University (protocol code 2019/653 on 1 October 2019).

Data Availability Statement: The data supporting this study are available on The Australian Prevention Partnership Centre website in the form of peer-reviewed publications, reports, findings briefs, and project pages. See The Australian Prevention Partnership Centre. Available online: <https://preventioncentre.org.au/> (accessed 7 May 2023). Interview transcripts are not available due to ethical approval conditions.

Acknowledgments: Sincere gratitude to our case study participants for volunteering their time to take part in this research project.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

Appendix A Overview of How Each Case Study Addressed Complexity

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 1—The healthy and equitable eating (HE2) study responding to complexity		
Overview	Systems thinking was applied throughout this project with an explicit focus within the causal loop diagramming work. There was primarily a focus on explaining and describing complexity as a first step in a longer program of work to create change. The purpose was to create a shared understanding and shared language around addressing nutrition-related inequities and mapping the healthy and equitable eating system. This helped to build a case for the need for intersectoral and whole of government working to address the structural drivers of HE ² .	There were systematic approaches applied including recruitment of qualitative interviews, conduct and analysis of interviews. The process of creating the CLDs was systematic, e.g., first drawing individual diagrams, then pair blending, then expanding out to the whole group to create one large diagram. The Prevention Centre required a systematic work plan detailing research aims and timelines.

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 1—The healthy and equitable eating (HE2) study responding to complexity		
Theory	<p>The Ottawa Charter and the social determinants of health literature was used to underpin this program of work and these frameworks are inherently <i>systemic</i>.</p> <p>While systems theory (namely applied systems and system dynamics) underpinned the diagramming work and was known and understood by the facilitator of this process, and it was the first time it was experienced by the broader team.</p>	<p>Durlak and DuPre’s implementation framework was used to analyse some of the qualitative data in a systematic fashion.</p>
Methods	<p>Collaborative conceptual modelling (a systems science method) was used to produce the causal loop diagrams of the drivers of nutrition-related inequities. This systems science methodology enabled a holistic picture of the drivers of inequities in healthy eating to be built and understood. A <i>systemic</i> lens was applied to the range of calls to action relating to the healthy and equitable eating framework.</p>	<p>Systematic semi-structured interviews were used to conduct the research to address the question of the extent to which the whole of government strategy focused upon inequities relating to obesity/nutrition. Systematic approach to creating the healthy and equitable eating framework.</p>
Data and evidence	<p>The HE² diagram was informed by the literature and expert opinion, the HE² framework was informed by the HE² diagram and expert opinion, and the interviews were informed by the lived experience of the interviewees.</p>	
Relationships	<p>In terms of collaborative relationships, the focus was predominantly on the core research team and those involved in developing the main CLD, which was conducted in a participatory manner, so as to facilitate research–policy collaboration. This worked to create a shared understanding around the drivers of HE² across multiple domains of influence which could be used by others to advocate for change.</p> <p><i>I think also the role of an academic, the researcher, is not always been the direct change, direct influencer. But the sort of evidence that we generated through our project gets referred to by others in policy or in other—you know, the Public Health Association of Australia use that. They’ve got strong policy guiding to government. So we might not have a strong voice directly with government, but we’ve got a strong voice into the Public Health Association. So that’s our responsibility to really work that relationship.</i></p>	<p>Policy and practice partners and stakeholders were chosen in a systematic way based on experience and expertise relating to HE².</p>
Capacity building	<p>The focus on capacity building within the research team and broader stakeholder group was informed by a <i>systemic</i> perspective.</p>	<p>Capacity was built in a number of ways within those involved in this piece of work. For example, those who were yet to be exposed to causal loop diagramming had the opportunity to upskill in this methodology through direct experience, and those less versed in the social determinants of health or systems thinking had the opportunity to deepen their understanding of the many interconnections across the HE² system driving inequities in healthy eating.</p>

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 1—The healthy and equitable eating (HE2) study responding to complexity		
Learning orientation	There was a strong learning orientation within the CLD workshops for most of the participants. Much of the learning emerging from this piece of work was around the value of systems science methods for conveying the complexity of addressing inequities in healthy eating.	
Multiperspectivity	The participatory approach employed in this piece of work took the CLD diagramming participants along a journey of developing a model of HE ² together which fostered receptivity to the method. There was a recognition of the need for multiple and diverse perspectives to inform this piece of work and build capacity of others to understand different viewpoints.	
Knowledge mobilisation/translation	A participatory approach engaged key policy makers from strategic government and NGO partners.	The project developed a number of dissemination products including publications, findings briefs, newsletters, and conference presentations.
Case study 2—Food environment policy index (Food-EPI) study addressing complexity		
Overview	The team used systems thinking implicitly. Language around systems thinking or approaches was purposefully avoided in the work because it was perceived as alienating to study participants/partners. The research team was however well versed in systems concepts. In this project, complexity was described as being addressed by working with the food environment policy system, as a whole, and setting up an accountability process to engage stakeholders and influence the way that system works. The Food-EPI work is described as a “cog” within a broader system; the team worked within the boundaries of their remit to seek to influence change through accountability mechanisms.	Application of the Food-EPI rating and benchmarking tool to the food environment policies to monitor and evaluate jurisdictional policies. This was applied in a consistent and standardised way across jurisdictions. The Prevention Centre required a systematic work plan detailing research aims and timelines.
Theory	There was an expressed program logic around accountability.	The Food-EPI tool was used as a theoretical framework to rate and benchmark food environment policies, articulating the processes, impacts, and outcomes of public and private sector policies and actions. This in itself provides a systematic theory of change of the components required for effective action to improve population diets, risk factors, and health outcomes.
Methods	Those rating the policies comprised multiple perspectives from academics and NGO experts. Policy representatives from state and commonwealth jurisdictions around Australia helped refine some of the priorities and the way information was presented; they did not, however, contribute to the ratings.	The methodological approach involved a formal process of rating and benchmarking policies for comparison purposes, as well as many other purposes such as knowledge sharing and building relationships.

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 2—Food environment policy index (Food-EPI) study addressing complexity		
Data and evidence	<p>A <i>systemic</i> look across the whole food system was facilitated by the components of the Food-EPI tool developed by INFORMAS: food composition, food labelling, food promotion, food provision, food prices, food retail, leadership, governance, monitoring and intelligence, funding and resources, and support for communities.</p> <p>Data and evidence generated from Food-EPI (benchmarked against best practice internationally) were seen as key for supporting researchers and policy makers to take advantage of policy windows opening in the future.</p> <p>Policy makers were heavily involved in helping collate policy details in order to be assessed. The investigators also consulted with them on best ways to present the findings. They also worked with them on which policies to focus on in the executive summaries of each report.</p> <p>The way the data was collected was systematic in its application of a pre-existing framework.</p> <p>Since the original study was collected, another has been conducted; longitudinal data are required to capture changes in policy over an extended period of time. Note, this type of research could be considered as both systematic and systemic as the work implicitly considers changes over time across a whole system.</p>	
Relationships	<p>There was a strong focus on the research team developing collaborative relationships with the study participants involved in the scoring process. Trust building between the researchers and those whose policies were being scored was considered an essential part of this program of work and it was actively fostered. Thus, the importance of relationships was emphasised, especially in working with and across government departments; with a lot of work put into managing relationships via formal and informal means.</p> <p>The influence of the methods used on the relationships between those conducting and participating in the study was explicitly recognised and discussed.</p>	<p>In trying to change the system and because of the intended ‘independent’ nature of the rating and benchmarking activities, the team was working from outside the policymaking “tent”.</p> <p>To maintain objectivity, the research team facilitated the rating and benchmarking process, but the researchers themselves were not participating in the scoring process.</p> <p>This project needed to retain a degree of objectivity and thus distance from the health, education, finance, trade, sport and recreational, etc., systems it was comparing, and thus the work was described as ‘participatory’ as opposed to co-production. Without a focus on co-production, however, the policy stakeholders felt the rating and comparison across jurisdiction was a risky process that they needed to engage in but also manage fallout from potential negative ratings.</p> <p>The research team had very good relationships with the policy participants, but the pre-defined systematic scoring process of the Food-EPI tool created barriers to real co-production and set up a type of power differential between the research team and those whose policies were being rated and scored. The team also conducted a very thorough formal evaluation to inform future iterations of the tool and as such made several fundamental changes to the process, in response to feedback received.</p>
Capacity building	<p>Within this project there was an emphasis on reflexive learning within the research team and mentoring by a senior team member with a deep understanding of the media, communications, and advocacy to ensure skills were enhanced within the research team to ensure knowledge mobilisation was amplified. Capacity building in this project also deliberately extended beyond just the research team; it was one of the key aims of the project to increase knowledge and build relationships.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 2—Food environment policy index (Food-EPI) study addressing complexity		
Learning orientation	<p>The research team was very aware of the need to reflect on the pre-determined systematic rating methods of their work as outlined in by Food-EPI—and the degree to which it was influencing or changing policy. It was noted that in future iterations of the program of work, it would be beneficial to shift to a more fair and reliable assessment for the end-users, to improve chances of uptake of the findings of the work and its recommendations.</p>	<p>The project provided jurisdictions with opportunities to learn about the presence, strengths, and limitations of their policies process relative to others.</p>
Multiperspectivity	<p>Within the team’s broader program of work as part of Food-EPI, there was an emphasis on bringing in multiple perspectives. For example, in another piece of work there was a commitment to including industry, and thus seeking to understand the perspectives of those involved in industry, which is often over-looked in the prevention research space. The team also had parallel pieces of work exploring the nature of policy processes for obesity prevention at both state and federal levels with a view to understanding levers for change.</p>	
Knowledge mobilisation/translation	<p>A keen focus was placed upon who were the key food environmental policy system decision makers and influencers within the system and then ensuring they were provided with the information and support they needed to understand and use the findings. By working closely with stakeholders, the team sought to contribute to real-world problems.</p>	<p>The project developed a number of dissemination products including publications, conference presentations, findings briefs, reports, mixed media coverage, and videos.</p>
Case study 3—NSW childhood obesity modelling project addressing complexity		
Overview	<p>The need for this project was identified from within the NSW Ministry of Health. Systems thinking was described as both an implicit and explicit component of this work. <i>Systemic</i> world view was identified as a necessary precondition to working using dynamic simulation modelling. Systems approaches were reported to enable the team to work beyond departmental and sector-based silos. Systems thinking was also reinforced through the modelling process itself, which identified and made explicit the complexity of the interactive variables driving child overweight and obesity in NSW. Participatory model development workshops were structured but allowed to evolve organically.</p>	<p>Evidence reviews and other data were systematically collected and used to inform the model quantification/calculations. The Prevention Centre required a systematic work plan detailing research aims and timelines.</p>
Theory	<p>System dynamics theory was used, drawing on the lessons from infectious disease modelling. Other frameworks used were the Ottawa Charter, the social determinants of health, the Foresight obesity diagram, and NSW’s Healthy Eating and Active Living strategy.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 3—NSW childhood obesity modelling project addressing complexity		
Methods	<p>Group model building and dynamic simulation modelling was used, combined with a participatory process to map all relevant variables and quantify them in order to devise solutions to child overweight and obesity.</p> <p>User-friendly interfaces allowed decision makers to have direct contact and interactions with the models, thus allowing them to understand the assumptions underlying the modelling and what it meant.</p>	<p>The project adopted a ‘glass box’ model where relationships and assumptions are made visible, as opposed to a black box in which they are hidden. This explicit visibility was seen as important to account for all aspects of the system that impact on human behaviour and allow them to be accounted for in the modelling.</p> <p>Dynamic simulation modelling brought those aspects to the surface and made them explicit. Other traditional modelling methods, e.g., epidemiology or economics, tend to exclude those variables.</p>
Data and evidence	<p>The published literature, and local data, and local real-world experience of those involved were used as evidence in the development of the model, and models were validated based on historical data.</p> <p>The model outputs gave legitimacy to, and provided evidence for, what was already anticipated about the limitations of the existing NSW HEAL policy. It provided a stronger case for expansion of the existing investment and prevention policy program of work.</p> <p><i>You can't control whether governments decide to intervene or not in particular areas but we produced the evidence that was needed to argue for the case and that's what we did.</i></p>	
Relationships	<p>The dynamic simulation modelling was underpinned and led by a participatory approach which fostered the way of working and the strong relationships with decision makers and was reported as key to achieving impact.</p> <p>An organic approach was applied in the workshops for developing the models, allowing important dimensions to emerge, grounded in the experience and preferences of the participants. This process allowed for dialogue and disagreement which provided a level of freedom to diverge, before converging towards agreement and, where possible, degrees of consensus. The process allowed underlying assumptions to be surfaced as part of the participatory process which was a key aspect of the work.</p> <p>Interpersonal skills have been key for carrying out this piece of work, including the ability to be open and receptive to all perspectives and being adamant about bringing them into the work. For example, debate was welcomed when the model was being built so that participants could share all of their information.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 3—NSW childhood obesity modelling project addressing complexity		
Capacity building	<p>Within the unit at the Ministry of Health, there was an emphasis placed upon upskilling people and embedding new capabilities. There was a focus on empowering those involved in building CLD (qualitative system diagrams) to ensure they understood what was going on, key terms, and they learnt technical systems language which was seen as empowering and a way of levelling the playing field. The language and jargon of dynamic simulation modelling was used, but all terms were explained. This was used as a means of empowering people and placing them all on the same playing field. The language of dynamic simulation modelling was interpreted and translated into jargon that is familiar to stakeholders, which may be plain English for lay people, or epidemiological jargon for public health researchers. A contrasting view was shared, however, by another interviewee who explained that they did not adopt new language so as to avoid alienating people.</p>	
Learning orientation	<p>Learning was emphasised in this work in relation to the modelling method itself and what it could and could not do. Overall, there was curiosity, interest, and good will in the modelling work which helped with buy-in. People were receptive because their experiences were heard and adjustments were made to the model in accordance with their feedback, leading to a very respectful process.</p> <p><i>I learned so much, definitely about the modelling side of things, what it can do, what it probably can't do so well. I've learned sort of how something like this politically can give us some really strong representation, like the importance of actually, yeah like embedding, you know, someone but I guess more broadly building capability and capacity. I've learned that yeah, like actually the importance of the translator role in making sure that something like this doesn't just end up sitting on the shelf.</i></p> <p>The work emphasised and valued deliberative methods, participatory methods, and the importance of developing shared understanding of a system and shared goals in order to leverage change. Creating shared understanding and shared intent were key aspects of the participatory process; the models help to create the shared understanding of problem, communicate the problem, and create shared intent. Collaboration and the participatory process enabled more interventions to be entered into model than would have occurred without the modelling methods.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 3—NSW childhood obesity modelling project addressing complexity		
Multiperspectivity	<p>Policy, practice and content experts contributed different perspectives informing the dialogue and creating the model.</p> <p><i>So there was the technical experts and there was a core group from the Ministry and the Office of Preventive Health that sort of had oversight or active involvement, for either implementing or evaluating the Premier's priority, from a Ministry point of view. Then the public workshops were designed to include a whole bunch of content experts and other stakeholders, so that was a much broader group, to seek input and validate the whole process by a series of workshops and involvement with all these different stakeholders.</i></p>	
Knowledge mobilisation/translation	<p>There was focus on the importance, politically, of embedding key stakeholders and decision makers into the process of building a model in a participatory manner. Ensuring there were personnel in translator/boundary spanner roles was a key aspect for supporting the ongoing use of the model.</p>	
Case study 4—Hunter New England region program of work addressing complexity		
Overview	<p>The HNE way of working seems to replicate Ray Ison's <i>systemic</i> and systematic yin yang diagram whereby they have an overarching paradigm of looking at the bigger picture and yet they also work within the details with respect to service delivery and health promotion needs. This program of work is very <i>systemic</i> in its governance and relational aspects, but more systematic in its research design and data collection methods.</p>	
Theory	<p>Many of those in leadership roles within the LHD have been exposed to systems thinking in one way or another, formally or informally, but systems theories were not explicitly applied.</p> <p>Complexity was understood and addressed from the viewpoint of sociology and psychology theories, thus providing a deep structural understanding of systems as well as human behaviour. The role of intuition and understanding the local context were highlighted, which was generated through experience in the field.</p>	<p>Other theories used were implementation science theory, RE-AIM, and behaviour change theory.</p>
Methods		<p>While the team described the complexity of chronic disease and the nature of interacting variables within the local context, many were not trained in systems science methods and mostly adhered to the study designs and methods of population health epidemiology, and/or qualitative. Theories and methods were chosen to meet the pragmatic goals of answering practical implementable questions. Randomised controlled trials were the main research method used to evaluate intervention effectiveness. The research team identified themselves as trialists, i.e., generating evidence within the EBM paradigm. <i>Context influences impact, but you can only, as a health service control what you can control, and you need to know in that circumstance are these things that I can manipulate worth manipulating. So are they beneficial? So you know, a randomised control trial is actually a really useful and powerful tool to let you do that.</i></p>

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 4—Hunter New England region program of work addressing complexity		
Data and evidence	<p>All data and evidence are generated through high quality RCTs within specific contexts and settings and incorporate qualitative research into process evaluations.</p> <p>However, this case study challenges the binary reductionist view of intervention trials in that RCTs are used to evaluate systems-level interventions, and these interventions themselves are designed taking a systems approach.</p>	
Relationships	<p>The research is conducted within and by the health service for the purposes of adaptation and implementation of local service delivery. There was also a lot of focus on generating shared intent, alignment of values, and consideration of co-benefits as a way of working together when values or priorities did not align.</p> <p>Because of the focus on addressing the needs of those they sought to help through their health service-based work, the use of language was tailored to the needs of end-users to ensure clear communications.</p>	
Capacity building	<p>There was a strong focus on building capacity across the health service and this was reflected through the governance arrangements which allowed, for example, those with research training to also manage health services. Those working within the health service had the opportunity to rotate around roles and upskill across a number of areas.</p>	
Learning orientation	<p>There was strong emphasis of the importance of adaptation within the work so that while there are key principles that they work to, it is essential that they avoid getting bogged down in rigidly adhering to any one method, framework, or theory. There was a recognition that systems can be unpredictable and thus no trial or program of work will always go smoothly.</p> <p>There were examples of reflection and ongoing active learning through the more formalised continual quality improvement processes built into the way they work. Cycles of learning involved testing, reflecting, learning, implementing, and testing again.</p>	
Multiperspectivity	<p>Within the team, there is a strong focus on deep listening, compassion, and understanding the system in which they work.</p> <p>There is a high level of engagement with those who work in the system, and an emphasis on listening to their points of view, issues, concerns, and pressures and then picking out the ‘gems’ that are going to point the way to the solution.</p> <p>There was also an awareness of and engagement with the multiple perspectives of those involved in the work which include, for example, NGOs and industry; from this, there is attention paid to understanding what co-benefits can emerge from various pieces of work.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 4—Hunter New England region program of work addressing complexity		
Knowledge mobilisation/translation	<p>They use an embedded systems approach facilitated through governance structures to create the right environment for co-production to occur. This means that the system is receptive and able to incorporate the changes that the research identifies as needed. There is an emphasis on rigour in the research methods, but the framing of the questions is always focused on the end user.</p> <p><i>One of the good things about working in the organisation that I am in is that you have to move past the theorising and into the practical really quickly, and unless the theory becomes practical from a service perspective, then there is actually not a lot of value in it for practitioners.</i></p> <p>Impact is thus achieved through the organisational structure whereby dual roles are held so that researchers are also practitioners, coupled with the co-location of practitioners and researchers within the health service teams. As a result, there are minimal difficulties with translation of research for the purposes of generating impact because the evidence is generated locally for the purpose of answering questions that the service needs to answer.</p> <p><i>The service is often thought of synonymously with intervention so we, and research and service is also it's hard to distinguish at times because the research process is so ingrained with the service delivery and quality improvement process of the health promotion unit that we are working in.</i></p> <p>Guiding principles for effective research translation and creating change, are derived locally as from the evidence of systematic reviews. Four key principles that are used include the following: understand the system in which you are seeking change, ensure appropriate training, implement performance monitoring and feedback, and obtain support from leaders within the system.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 5—Liveability program of work addressing complexity		
<p>Overview</p>	<p>The liveability team explicitly used the language of complex adaptive systems, and aimed to develop a thorough understanding of the planning and transport systems that they were working with, and the interdependent nature of their dimensions. They have a multidisciplinary team with complementary skills (e.g., relational, data analysts, economists, GIS and other modelling). Within the team, members adopt different roles in terms of both big picture thinking and focused analysis of the finer details.</p> <p><i>You keep adding colour, but when you step back you can actually see that there is a picture there that there is actually something to be seen. So, if you look at Monet’s Gardens, it just looks like splotches of colour, but then if you stand back, then you realise it’s a bridge with lily pads. So, I think our research is a bit like that. Every time we do something, we’re adding a dab of colour and it just gives clarity to the picture but only when you stand back because our work is meant to be more strategic and more of a higher level, it’s meant to draw attention to the problem, at which point you start to dig in a lot deeper to say, well.</i></p>	<p>The work focused on careful and rigorous identification, development, testing, and evaluation of liveability indicators across a broad range of domains. These were developed for applied planning policy and practice contexts. The Prevention Centre required a systematic work plan detailing research aims and timelines.</p>
<p>Theory</p>	<p>The Ottawa Charter and Social Determinants of Health frameworks strongly informed this work, encouraging a big picture, sociological, and structural world view.</p>	<p>Diffusion of innovation theory was applied to the work with the goal to targets key innovators and those who support change among the decision makers and influencers. The Results-Based Accountability Framework, which relies on using data for continuous learning and improvement, was also used; this can, however, also be considered <i>systemic</i> in nature given its focus on continuous learning.</p>
<p>Methods</p>	<p>Over time, the team has incorporated the use of systems science modelling methods to complement their use of natural experiments.</p>	<p>Rigorous identification, development, benchmarking, testing, monitoring, and evaluation of liveability indicators.</p>
<p>Data and evidence</p>	<p>There were strong focuses on both data and evidence in combination with politics, structure, power, or influence. Qualitative information gained from relational interactions and informal discussions with decision makers was valued as an important source of knowledge to inform and guide the program of research. Data mapping methods and quantitative agent-based modelling were used to further explore and understand complexity.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 5—Liveability program of work addressing complexity		
Relationships	<p>Much of the working relationships are longstanding, having been nurtured through this program of work over an extended period of time. As such, the research team has a deep and intimate understanding of the policy makers’ worldviews, problems, and ways of working which has served to build up high levels of trust resulting in several working partnerships.</p> <p>The close partnerships built up between policy and research actors served as a relational form of embedding the work within the system it was seeking to influence. A jargon-free and thus accessible shared language was an important dimension of the liveability work. This linked into the need to build strong relationships and engage in a meaningful way with key stakeholders by refraining from highly academic language that would have served to alienate and create power differentials.</p> <p><i>So, in our project, you could think of it as two fuzzy spots, the edges of the circles are not closed at all and are very open to what the other is trying to teach us so that we can create something that’s joint and in partnership, so together, not a collaborator, someone who sits next to you, but someone who is literally holding your hand, a partner. So, it’s quite—that language, I think, for us is quite strong. Partner is the word that we’re using, we’re conscious of using that word, it’s not in collaboration with, they’re not sitting next to us, they’re actually, you know, it’s much more, forgive the word but intimate, it’s meant to be.</i></p>	
Capacity building	<p>A key aspect of this work was building capacity in partners outside the health sector to draw on and use the available evidence and identify the gaps in knowledge.</p>	<p>Capacity building was achieved through understanding policy concerns, educating people to be able to ask questions that could be answered through empirical research; and helping them to reframe their questions to address the gaps in the evidence from the liveability research.</p>
Learning orientation	<p>Within the body of work there was a strong focus on quality improvement within the team itself, and well as an externally focused learning orientation. This was facilitated by reflection at the end of each project to see what worked well, what did not, and to learn from these reflections. Partners were asked what their needs were and whether these had been met within their policy and practice context.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 5—Liveability program of work addressing complexity		
Multiperspectivity	<p>The research program has a strong focus on responding to the priorities and needs of sectors outside of health. Thus, while focused on health impacts, many key stakeholder relationships are based outside the Department of Health and relationships have been fostered with partners in the Department of Transport and the Department of Environment, Land, Water and Planning. Shared intent was fostered using framing around co-benefits across sectors whereby health was considered an integral part of the value equation when it comes to producing societal benefits through environmental changes.</p> <p><i>If you're looking at the Department of Environment, Land, Water and Planning, again it's sort of planning focus, it's not focussing on health per se but what we're now finding is that there's a greater recognition that the conduit for great change comes from the valuing of things more holistically, so understanding societal benefit, health benefit, benefits that comes from intangibles. What happens in terms of the environment, so environmental sustainability as a benefit? Looking at using sustainable development goals as a way of measuring the true impact that comes from making decisions that are related to planning and infrastructure. So, I think, that the assumption might be and I don't know if it's really an assumption, but in the past it's let's just ignore health or we assume that health is taking care of itself but actually that's not how it works at all, we have to, that first step is to assume that health is part of that value equation and you need to factor it in and you need to create systems that help to measure it.</i></p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 5—Liveability program of work addressing complexity		
Knowledge mobilisation/translation	<p>The work is highly embedded in strong working relationships with policy partners outside the health sector. Relationship building, as well as formal knowledge generation and evidence, were key to understanding the complexity inherent in the system. These were key dimensions in the change-making process because they were generated as part of a close partnership approach in which researchers and decision makers worked together. Much time was spent listening to policy partners, understanding their needs, and then working alongside them to help address their goals. This served to meet both research and change making agendas, by providing practical solutions for policy partners.</p> <p>Through an embedded research partnership, all parties work to achieve their goals relating to changing non-health systems as a way of improving health. This represents a win-win partnership. <i>But it's like a developer, you know, what they want to do is maximise profit, but what researchers want to do is maximise good evidence and that translation of evidence into practice. So, we're all coming at it, from a different angle in the sense that we don't actually have shared objectives at all, we have different things that we're responsible for and different things that we want to get out of our project. But there is a bit like a Venn diagram, if you draw the circles of what everyone is trying to do, yes, they have their own objectives but they also have a point where they cross over and for me that knowledge translation space is that bit where we're acknowledging that we are in partnership together, we're in this together and we cross over somewhere and it's just about finding, you know, how strong that crossover is and whether we're just touching each other on our circles or whether it's a bit crossover.</i></p>	<p>Benchmarking and monitoring indicators for liveability were helpful for describing a system, but also for fostering change though establishing methods for greater accountability and by allowing actors within the system to observe how liveability indicators changed over time.</p>
Case study 6—Community-based childhood obesity strategies case study addressing complexity		
Overview	<p>This work embodies three dimensions in responding to complexity, i.e., the understanding, addressing, and communicating of complexity are key within this body of work.</p> <p>Understanding relates to describing systems in a way that fundamentally embodies a systems approach and relates to the features of a complex adaptive system.</p> <p>Addressing relates to creating change within systems (whereas a focus on program implementation and fidelity, while ignoring context and the need to adapt, was given as an example of not adequately addressing complexity). Communicating relates to the need to speak the language of those communities that research teams are working within to help understand complexity or create change.</p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 6—Community-based childhood obesity strategies case study addressing complexity		
Theory	System dynamics is the predominant theoretical lens through which this program of work is conducted. Other theories from the broad systems science field are also known (e.g., Cynefin).	
Methods	The team is very explicitly applying systems science methods to the diagnosis of systems and their readiness for change. Systems approaches are also applied to planning and implementation of local community-based interventions. Social network analysis, agent-based modelling, group model building, and dynamic simulation modelling are the main methods used. AI is also being explored. STICK-E software has been developed to meet the needs of the researchers and communities.	The <i>systemic</i> CLD group model building workshops had systematic, clearly defined, and articulated guidelines, rules, governance mechanisms, and strictly applied scripts to guide facilitation. RCT designs are used to evaluate the effectiveness of interventions.
Data and evidence	Data and evidence are used to create rigour around the process of using systems science methods. Evaluations are supported by traditional methods such as RCTs for generating evidence of intervention effectiveness. The use of RCT designs also assists this type of work getting published in mainstream public health journals. Data and evidence are co-created between researchers and community members in real time using the causal loop diagram methods and implemented through visualisations using the STICK-E software.	
Relationships	Strong relationships based on trust were key to the success of the work within communities. Participatory approaches were key to helping people understand complexity and then act to address it. In terms of informal feedback, this is received from communities and stakeholders based on strong trusting relationships. In terms of formal feedback, there is a process of leaving the building and sitting in a circle where the least experienced researcher speaks first to break down power differences. Formal processes also include feedback from communities, with those who are recently recruited and those who are well experienced, and, in the middle, those who are currently working on a project, thus building the networks and relationships between those communities. Power structures are broken down between research team members and those working within the community, and within the communities themselves. Sometimes communities then continue to apply what they have learnt to new problems and concerns (e.g., COVID-19 response).	
Capacity building	Communities are empowered by giving them the direct experience of understanding, addressing, and communicating complexity for the first time. The right tools are provided to the right people at the right time. Communities are enabled to learn skills and develop relationships and networks to then progress to addressing their local problems for themselves, while the GLOBE team provides ongoing backup and support. Shared language was a key feature as part of this work and one of the three pillars for creating change, namely, communicating complexity.	

Dimensions	Systemic Paradigm	Systematic Paradigm
Learning orientation	Case study 6—Community-based childhood obesity strategies case study addressing complexity	
	<p>Formal and informal mechanisms for reflection and feedback were a key part of this research group's practice.</p> <p>This applied to the research process itself where community participants were empowered to share their hopes, fears, and feedback (i.e., group model building process), as well as formal internal research team-focused reflection sessions.</p> <p>The feedback sessions were aimed at addressing power imbalanced <i>systemic</i> through a formal systematic process. (The goal is <i>systemic</i>, but the process is systematic.)</p> <p><i>There's huge amounts of informal feedback that's built on relationships where in all of our major trials, I can think of probably across 10 different countries where this happens—the key community person in any one of those communities can ring me on my mobile any time and say we just had one of your crew present such and such, and it went over like a lead balloon, what are we going to do? Or "We just ran a session and they got really excited—what do we do next?" Or "That was okay, but this bit sucked." Or "Was surprised you didn't mention the Mayor, because the Mayor was in the room. You better do something about that." So there's a whole bunch of informal relationship-based feedback which is more powerful even I think than the other sought.</i></p>	
	<p><i>And it's a pretty basic process, but it's just good drills, right...There's little things like you never discuss the session until you're out of the building and just little things like that, that don't seem to mean anything . . . You need someone to be able to say, all right. Well, we're going to do feedback. We're going to sit in a circle and do it and we're going to do it from the youngest to oldest, or from least experience and this is the framing of the feedback. This is how we're going to use it, and we're going to wait until we know that the room is empty before we start. We'd also have in that group of people, the sponsors for that local community, so we're immediately building a network of people that are last community, next community, this community. And the idea, because I'm probably most experienced in most things, I don't have to say anything—it deliberately builds relationships between them. Because, they're, "This really sucked." And the last community says, "Yeah, that happened to us too, but stick with it, it will be all right." Or, "Yeah, we overcame that," or the Captain of the golf club looked really grumpy. You're going to have to call them separately, this is what we did, or whatever it is.</i></p>	

Dimensions	Systemic Paradigm	Systematic Paradigm
Case study 6—Community-based childhood obesity strategies case study addressing complexity		
Multiperspectivity	<p>The GMB process is strategic in recruiting local community leaders, those who can take action, and those who are able to provide lived experience to inform the development of the models.</p> <p>Because of the emphasis on empowerment and capacity building, as well as the way the GMB workshops were run, there had to be a keen focus on listening in order to work collectively with communities to understanding and address problems.</p> <p>There is an explicit consideration of whose voice is included, and why/why not, and how to address power imbalances to ensure that multiple perspectives are heard.</p>	
Knowledge mobilisation/translation	<p>Understanding complexity in public health is seen as a strategic step in addressing it, i.e., creating change.</p> <p>Understanding complexity can only happen if systems thinking is made accessible via avenues such as language, participatory approaches, and user-friendly software (e.g., STICKE).</p> <p>Communities must be empowered to understand and then create their own changes. Thus, there is a strong focus on communicating complexity to those with the power to enable the work to happen.</p>	

References

1. Swinburn, B.A.; Kraak, V.I.; Allender, S.; Atkins, V.J.; Baker, P.I.; Bogard, J.R.; Brinsden, H.; Calvillo, A.; De Schutter, O.; Devarajan, R.; et al. The global syndemic of obesity, undernutrition, and climate change: The Lancet Commission report. *Lancet* **2019**, *393*, 791–846. [[CrossRef](#)] [[PubMed](#)]
2. Diez Roux, A.V. Complex systems thinking and current impasses in health disparities research. *Am. J. Public Health* **2011**, *101*, 1627–1634. [[CrossRef](#)] [[PubMed](#)]
3. Salway, S.; Green, J. Towards a critical complex systems approach to public health. *Crit. Public Health* **2017**, *27*, 523–524. [[CrossRef](#)]
4. Midgley, G. Systemic Intervention for Public Health. *Am. J. Public Health* **2006**, *96*, 466–472. [[CrossRef](#)] [[PubMed](#)]
5. Leischow, S.J.; Milstein, B. Systems Thinking and Modeling for Public Health Practice. *Am. J. Public Health* **2006**, *96*, 403–405. [[CrossRef](#)]
6. Allender, S.; Millar, L.; Hovmand, P.; Bell, C.; Moodie, M.; Carter, R.; Swinburn, B.; Strugnell, C.; Lowe, J.; de la Haye, K.; et al. Whole of systems trial of prevention strategies for childhood obesity: WHO STOPS childhood obesity. *Int. J. Environ. Res. Public Health* **2016**, *13*, 1143. [[CrossRef](#)]
7. den Hertog, K.; Busch, V. The Amsterdam Healthy Weight Approach: A whole systems approach for tackling child obesity in cities. *Eur. J. Public Health* **2020**, *30* (Suppl. 5), ckaa165-516. [[CrossRef](#)]
8. Leykum, L.K.; Pugh, J.; Lawrence, V.; Parchman, M.; Noël, P.H.; Cornell, J.; McDaniel, R.R. Organizational interventions employing principles of complexity science have improved outcomes for patients with Type II diabetes. *Implement. Sci.* **2007**, *2*, 28. [[CrossRef](#)]
9. Carey, G.; Malbon, E.; Carey, N.; Joyce, A.; Crammond, B.; Carey, A. Systems science and systems thinking for public health: A systematic review of the field. *BMJ Open* **2015**, *5*, e009002. [[CrossRef](#)]
10. Friel, S.; Pescud, M.; Malbon, E.; Lee, A.; Carter, R.; Greenfield, J.; Cobcroft, M.; Potter, J.; Rychetnik, L.; Meertens, B. Using systems science to understand the determinants of inequities in healthy eating. *PLoS ONE* **2017**, *12*, e0188872. [[CrossRef](#)]
11. Mavoa, S.; Boulangé, C.; Eagleson, S.; Stewart, J.; Badland, H.M.; Giles-Corti, B. Identifying appropriate land-use mix measures for use in a national walkability index. *J. Transp. Land Use* **2018**, *11*, 681–700. [[CrossRef](#)]
12. Vandevijvere, S.; Barquera, S.; Caceres, G.; Corvalan, C.; Karupaiah, T.; Kroker-Lobos, M.F.; L'Abbé, M.; Ng, S.H.; Phulkerd, S.; Ramirez-Zea, M.; et al. An 11-country study to benchmark the implementation of recommended nutrition policies by national governments using the Healthy Food Environment Policy Index, 2015–2018. *Obes. Rev.* **2019**, *20*, 57–66. [[CrossRef](#)]
13. Allender, S.; Brown, A.D.; Bolton, K.A.; Fraser, P.; Lowe, J.; Hovmand, P. Translating systems thinking into practice for community action on childhood obesity. *Obes. Rev.* **2019**, *20*, 179–184. [[CrossRef](#)]
14. Prevention Centre. The Australian Prevention Partnership Centre website. Available online: <https://preventioncentre.org.au> (accessed on 24 June 2023).

15. Ison, R.; Straw, E. *The Hidden Power of Systems Thinking: Governance in a Climate Emergency*; Routledge: Oxfordshire, UK, 2020.
16. Haynes, A.; Rowbotham, S.; Grunseit, A.; Bohn-Goldbaum, E.; Slaytor, E.; Wilson, A.; Lee, K.; Davidson, S.; Wutzke, S. Knowledge mobilisation in practice: An evaluation of the Australian Prevention Partnership Centre. *Health Res. Policy Syst.* **2020**, *18*, 1–17. [[CrossRef](#)]
17. Slaytor, E.; Wilson, A.; Rowbotham, S.; Signy, H.; Burgess, A.; Wutzke, S. Partnering to prevent chronic disease: Reflections and achievements from The Australian Prevention Partnership Centre. *Public Health Res. Pr.* **2018**, *28*, e2831821. [[CrossRef](#)]
18. Wutske, S.; Redman, S.; Bauman, A.; Hawe, P.; Shiell, A.; Thackway, S.; Wilson, A. A new model of collaborative research: Experiences from one of Australia's NHMRC Partnership Centres for Better Health. *Public Health Res. Pr.* **2017**, *27*, e2711706. [[CrossRef](#)]
19. Wutzke, S.; Rowbotham, S.; Haynes, A.; Hawe, P.; Kelly, P.; Redman, S.; Davidson, S.; Stephenson, J.; Overs, M.; Wilson, A. Knowledge mobilisation for chronic disease prevention: The case of the Australian Prevention Partnership Centre. *Health Res. Policy Syst.* **2018**, *16*, 1–16. [[CrossRef](#)]
20. Pescud, M.; Rychetnik, L.; Allender, S.; Irving, M.J.; Finegood, D.T.; Riley, T.; Ison, R.; Rutter, H.; Friel, S. From Understanding to Impactful Action: Systems Thinking for Systems Change in Chronic Disease Prevention Research. *Systems* **2021**, *9*, 61. [[CrossRef](#)]
21. Mills, M.; Van de Bunt, G.G.; De Bruijn, J. Comparative research: Persistent problems and promising solutions. *Int. Sociol.* **2006**, *21*, 619–631. [[CrossRef](#)]
22. Foster-Fishman, P.G.; Nowell, B.; Yang, H. Putting the system back into systems change: A framework for understanding and changing organizational and community systems. *Am. J. Community Psychol.* **2007**, *39*, 197–215. [[CrossRef](#)]
23. Foster-Fishman, P.G.; Watson, E.R. The ABL Change Framework: A Conceptual and Methodological Tool for Promoting Systems Change. *Am. J. Community Psychol.* **2012**, *49*, 503–516. [[CrossRef](#)] [[PubMed](#)]
24. Johnston, L.M.; Matteson, C.L.; Finegood, D.T. Systems Science and Obesity Policy: A Novel Framework for Analyzing and Rethinking Population-Level Planning. *Am. J. Public Health* **2014**, *104*, 1270–1278. [[CrossRef](#)] [[PubMed](#)]
25. Hovmand, P.S. Group model building and community-based system dynamics process. In *Community Based System Dynamics*; Springer: New York, NY, USA, 2014; pp. 17–30.
26. Tharenou, P.; Donohue, R.; Cooper, B. *Management Research Methods*; Cambridge University Press: Cambridge, UK, 2007.
27. Glaser, B.G.; Strauss, A.L. *The Discovery of Grounded Theory: Strategies for Qualitative Research*; Routledge: Oxfordshire, UK, 2017.
28. Partnership Centre. Healthy Public Policy to Support Healthy and Equitable Eating. Available online: <https://preventioncentre.org.au/our-work/research-projects/healthy-public-policy-to-support-healthy-and-equitable-eating/> (accessed on 24 June 2023).
29. Newell, B.; Proust, K.; Dyball, R.; McManus, P. Seeing obesity as a systems problem. *New South Wales Public Health Bull.* **2007**, *18*, 214–218. [[CrossRef](#)] [[PubMed](#)]
30. Partnership Centre. Benchmarking Obesity Policies in Australia. Available online: <https://preventioncentre.org.au/our-work/research-projects/benchmarking-obesity-policies-in-australia/> (accessed on 24 June 2023).
31. Partnership Centre. Partnering to Develop a Decision Tool to Reduce Childhood Overweight and Obesity. Available online: https://preventioncentre.org.au/wp-content/uploads/2017/03/1702_FB_ATKINSON_PremObesity.pdf (accessed on 24 June 2023).
32. Wolfenden, L. You've Heard of Clinician Scientists. We're Applying the Same Model to Public Health. Prevention Centre Blog. Available online: <https://preventioncentre.org.au/blog/youve-heard-of-clinician-scientists-were-applying-the-same-model-to-public-health/> (accessed on 24 June 2023).
33. Partnership Centre. Creating Liveable and Healthy Communities. 2021. Available online: <https://preventioncentre.org.au/our-work/research-projects/creating-liveable-and-healthy-communities/> (accessed on 24 June 2023).
34. Global Obesity Centre. Community Based Systems Interventions. Available online: <https://iht.deakin.edu.au/global-centre-for-preventive-health-and-nutrition/stream/community-collaboration/> (accessed on 24 June 2023).
35. Hayward, J.; Morton, S.; Johnstone, M.; Creighton, D.; Allender, S. Tools and analytic techniques to synthesise community knowledge in CBPR using computer-mediated participatory system modelling. *Npj Digit. Med.* **2020**, *3*, 1–6. [[CrossRef](#)]
36. Greenhalgh, T.; Papoutsis, C. Studying complexity in health services research: Desperately seeking an overdue paradigm shift. *BMC Med.* **2018**, *16*, 1–6. [[CrossRef](#)]
37. Jebb, S.A.; Finegood, D.T.; Roux, A.D.; Rutter, H.; Clarkson, J.; Frank, J.; Roos, N.; Bonell, C.; Michie, S.; Hawe, P. Systems-based approaches in public health: Where next? *Acad. Med. Sci.* 2021. Available online: <https://researchportal.bath.ac.uk/en/publications/systems-based-approaches-in-public-health-where-next> (accessed on 26 April 2023).
38. Rutter, H.; Savona, N.; Glonti, K.; Bibby, J.; Cummins, S.; Finegood, D.T.; Greaves, F.; Harper, L.; Hawe, P.; Moore, L.; et al. The need for a complex systems model of evidence for public health. *Lancet* **2017**, *390*, 2602–2604. [[CrossRef](#)]
39. McGill, E.; Marks, D.; Er, V.; Penney, T.; Petticrew, M.; Egan, M. Qualitative process evaluation from a complex systems perspective: A systematic review and framework for public health evaluators. *PLoS Med.* **2020**, *17*, e1003368. [[CrossRef](#)]
40. Mandelbrot, B.B.; Mandelbrot, B.B. *The Fractal Geometry of Nature*; WH Freeman: New York, NY, USA, 1982.

41. Irving, M.J.; Pescud, M.; Howse, E.; Haynes, A.; Rychetnik, L. Developing a 'systems thinking' guide for enhancing knowledge mobilisation in prevention research. *Public Health Res. Pract.* **2022**, *in press*. [[CrossRef](#)]
42. Sheffield, J.; Sankaran, S.; Haslett, T. Systems thinking: Taming complexity in project management. *Horizon* **2012**, *20*, 126–136. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.