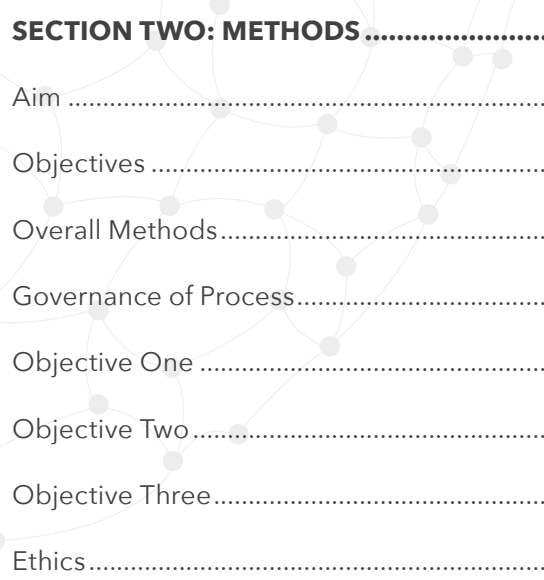

ACCELERATING PROMOTION OF EARLY CHILD DEVELOPMENT THROUGH SYSTEMS:

Mixed-method evidence review of the potential applications of systems thinking in scaled efforts to enable every child to thrive.



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EXECUTIVE SUMMARY



Introduction

A great deal is already known about how to effectively promote healthy child development through interventions in health, education, and other sectors (1). The pre-eminent global framework for promotion of ECD at scale is the WHO, UNICEF and World Bank's Nurturing Care Framework for Helping Children Survive & Thrive to Transform Health and Human Potential (NCF). Within the NCF, based on evidence, five key domains of nurturing care are identified as well as strategic actions to promote ECD at scale (2). However, in spite of what is known, few interventions promoting early child development (ECD) have been equitably and sustainably scaled and even prior to the COVID-19 pandemic substantial inequities existed in child development indicators between and within countries (3, 4).

The pandemic and other major disruptions to child health and development including conflict, natural disasters and the climate crisis make the challenge of progressing towards the Sustainable Development Goal 4.2.1 vision of enabling all children to reach their developmental potential immense. However, these disruptions also present a timely opportunity to address longstanding challenges in ECD and think differently about how to better promote child development at scale moving forwards.

Systems thinking describes a way of conceptualising real-world phenomena which aims to improve understanding of a whole, its component parts and the interconnections between them (5). It explicitly acknowledges complexity and recognises that context in which systems exist is dynamic and change over time (5). While systems thinking has a long history in some sectors (e.g. information technology, finance, agriculture), its application in many other social sectors is relatively new and in the global child development agenda is under-developed.

For this project we suggest that systems thinking might offer new insights into longstanding challenges in promotion of ECD at scale, including sustainability and equity. Right now, the COVID-19 pandemic and other major system disruptors (e.g., the climate crisis, economic crises, conflict), offer a relatively unique window of opportunity to investigate whether applied systems approaches could promote system resilience and accelerate progress in regaining lost ground for children. This evidence review has harnessed the lessons learned from failures and successes in applying systems thinking across sectors, to suggest a number of potential ways forward for an accelerated ECD equity ecosystem.

Within this report we use the following definitions of systems related key terms;

Key term	Definition
Systems thinking	A broadly inclusive, cross-disciplinary conceptual framework and way of conceptualising real-world phenomena as systems which aim to improve understanding of a whole, its parts and interconnectedness between components or factors, acknowledging that the context in which this exists is dynamic and changes over time 5,6
Applied systems thinking	The application of a broad array of qualitative and quantitative methods and tools designed to better understand system behaviours and intervene in the context of complexity and uncertainty 7
Complex Intervention	An intervention which has a number of interacting components within the experimental and control interventions; having a number and difficulty of behaviours required by those delivering and receiving the intervention; having a number of groups or organisational levels targeted by the intervention; having a number and variability of outcomes; a high degree of flexibility or tailoring of the intervention permitted 8
Early Child Development	Children's cognitive, physical, language, motor, and social and emotional development, between conception and age eight years 2

Aim & Objectives

This evidence review aimed to explore the potential application of systems thinking in accelerating progress in equitable and sustainable promotion and implementation of ECD at scale.

The three main objectives of our evidence review were to:

1. Systematically review the evidence of impact for complex systems interventions on outcomes at scale across sectors through published and grey literature review.
2. Qualitatively explore multi-sectoral stakeholder experiences, perspectives, and examples in implementing complex systems interventions at scale in diverse settings.
3. Synthesize the results of Objectives 1 and 2 to consider future directions and implications for practitioners, researchers, policy makers and funders regarding the potential application of systems thinking in ECD.

Methods

Mixed-methods evidence synthesis including an intersectoral systematic review of published and grey literature, combined with qualitative analysis of interviews and focus group discussions to explore key informant perceptions and experiences of applied systems thinking. This project was approved by the Royal Children's Hospital Melbourne Human Research Ethics Committee Reference number 788894.

KEY FINDINGS

Systematic literature review

We conducted an interdisciplinary systematic literature review designed to rigorously answer the question ***'What is the evidence of impact for complex systems interventions on outcomes at scale across sectors?'***

We searched three databases (Pubmed, SCOPUS and Econlit) from 2010 to 2021 to capture published literature across a range of disciplines (e.g. economics, agriculture, health and social sciences) and included studies with an experimental or quasi-experimental study design, a priori determination of outcomes of interest and/or inclusion of a comparator group. We included studies from high and low-and middle-income countries although restricted to English literature.

Of the 42,660 papers initially identified and screened, most (n=42,550) were excluded because they were duplicates, not relevant to the primary research question or otherwise did not meet inclusion criteria. Of papers included in full-text review (n=110) there were n=105 excluded. Reasons for exclusion related to study design (i.e. historical analysis or lack of comparator) (72%), lack of relevance to research question (i.e. intervention or outcome not related to a complex system) (10%), or interventions that were not at scale (16%) or being a duplicate (1%). A secondary search was completed by searching through the reference lists and citations of the included studies, but no additional studies met the criteria for inclusion. Therefore from 42,660 screened abstracts there were 5 papers included.



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Summary of five included studies

References	Sector	Country	Population	Intervention	Comparator	Outcome
Abdallah et al, 2020 (9)	Health (Reproductive, maternal, newborn and child health and nutrition (RMNCHN))	India, Bihar	8 districts	Household and community-level interventions to improve RMNCHN	30 non-focus districts in the state of Bihar	Significant improvements in indicators during first phase where intensive support was provided
Ashish KC et al, 2019 (10)	Health (Newborn)	Nepal	12 hospitals, (n=89,014 women-infant pairs)	Neonatal resuscitation quality improvement package	Hospitals not yet enrolled	Improved neonatal resuscitation practices and decreased intrapartum related deaths
Patel et al, 2016 (11)	Health (Community)	Northern Ghana	3 districts (n=184,000 people)	Community-Engaged Emergency Referral System	Unexposed subdistricts in Upper East and West regions	Improved referral practices, overall facility-based maternal mortality as well as accident-related deaths decreased relative to non-intervention areas
Rawat et al, 2017 (12)	Health (Nutrition)	Vietnam	15 provinces (n=340,000 mothers of children aged 2yo)	Social franchising with a mass media campaign and community mobilisation	Counselling with less intensive mass media and non-intensive community mobilisation	Improvements in feeding practices (dietary diversity and minimum acceptable diet) but not growth were observed in the intervention group Significant declines in stunting were seen in both intervention and comparison groups over time
Waiswa et al, 2021 (13)	Health (Child)	Uganda	16 districts	Community and District-management Empowerment for Scale-up (CODES)	Unexposed districts	Improved treatment of malaria, diarrhoea, pneumonia, improved stool disposal, improved coverage of immunisation and Vitamin A supplementation

Characteristics of included studies

The five included papers showed positive impact of multi-faceted interventions within pre-existing government health systems. They described interventions applied at subnational scale in five countries (Nepal, Vietnam, Ghana, Uganda, India). Interventions varied in the way they applied systems thinking tools and methods. Notable features of these successful interventions include:

- Clearly defined goals and aims
- Deep understanding of local context, in some cases with a history of embedded implementation research
- Targeting of multiple system levels, beyond a focus on front-line worker alone (e.g. hospital leadership, district level management)
- Use of pre-existing services as units for scaling (e.g. hospitals, districts, communities)
- Co-design and implementation incorporating both 'top-down' and 'bottom-up' elements with a strong focus on stakeholder engagement, especially community (e.g. traditional social groups) as well as health leadership
- Data and indicators for monitoring and evaluation and embedded continuous learning processes
- Monitoring and evaluation incorporating mixed methods

Included papers also described enablers and challenges to ongoing scaling and a need to include measurement of intervention sustainability.

Qualitative interviews

We interviewed 22 key informants (KIs) who came from the ECD community as well as experts in systems thinking from other sectors (i.e. health, food systems, agronomy, ecology, social policy, international development). They represented academic institutions and non-government organisations (international and domestic, for-profit, and not-for-profit) and UN agencies. While half of KIs were based in academic institutions, many had dual roles and experience and expertise across sectors and disciplines. KIs were from six countries although many worked in diverse settings. Online interviews/focus groups were conducted via Zoom between November 2021 and February 2022 using a semi-structured approach and question guide. Qualitative content analysis explored KI experiences and perspectives of systems thinking. Five key themes emerging from qualitative analysis:

Theme 1: Why use systems thinking?

Applied systems thinking has a variable history across sectors, often driven by the need for innovative approaches to tackle complex problems where traditional approaches are perceived to fall short. These drivers include limitations of an empirical evidence base to inform public policy coupled with challenges related to complexity, scaling, sustainability, and equity.

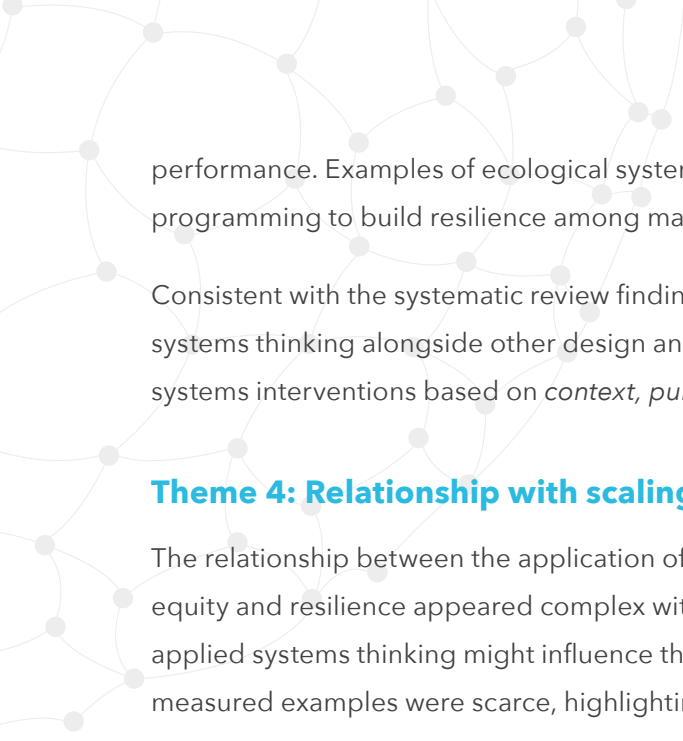
Theme 2: What is systems thinking?

Terminology was recognised as important with challenges related to lack of clarity and multiple definitions of terms related to systems thinking. However, defining features of systems thinking approaches, consistent with previous literature, were noted including explicit acknowledgement of complexity, a focus on connections between systems components, emergence and non-linearity.

Theme 3: Systems thinking in practice

Systems thinking was described in different stages of its evolution and application across different sectors although its history spans many decades. KIs highlighted that practitioners in different fields may already apply elements of systems thinking without naming this approach. In some sectors (e.g., private consulting), applied systems thinking was described as being in an early stage of emergence with efforts to apply systems thinking approaches, tools and methods like *"building a plane while flying"* (KI2). In other sectors (e.g., health, agriculture, ecology) a long history of systems thinking application was described, with well-developed application of approaches, tools and methods.

Differences in underlying definitions of systems thinking were also noted to have practical implications. Most notably a difference between mechanistic and ecological approaches was highlighted. Mechanistic approaches were described to be hierarchically structured and focused on improving system performance (i.e. outputs or outcomes), whereas ecological approaches were explained as framed around learning networks with a specific purpose and focused on process and participation rather than



performance. Examples of ecological systems informed program design included strengths-based programming to build resilience among marginalised communities.

Consistent with the systematic review findings, KIs described (1) examples of incorporating applied systems thinking alongside other design and implementation approaches, and (2) features of successful systems interventions based on *context, purpose, process and collaboration*.

Theme 4: Relationship with scaling, sustainability, equity and resilience

The relationship between the application of systems thinking approaches with scaling, sustainability, equity and resilience appeared complex with mixed KI perceptions. Whilst some KIs described how applied systems thinking might influence these aspects of ECD program design and implementation, measured examples were scarce, highlighting an important area for further evaluation and research.

Theme 5: Measurement - data, indicators, monitoring and evaluation

Data and measurement were seen as crucial, with a real focus on the importance of what is measured and why. However, measurement at many levels was highlighted as a challenging area, due to a number of factors, including the inherent difficulty, in systems interventions, in establishing a comparator control group, as is often required in traditional experimental research design. Identified successful systems interventions within health which employed mixed methods approaches to monitoring and evaluation, together with process indicators and feedback loops to facilitate rapid, continual learning were instructive. These and other measurement approaches, tools and methods highlighted by KIs warrant further exploration and development in the application of systems thinking moving forwards. KIs highlighted a range of innovative approaches, methods, and tools they were aware of being used to address measurement challenges in the field.

These and other resource links suggested by KIs and detailed in the full report, provide an opportunity for further exploration of monitoring and evaluation approaches and development of related indicators, potentially relevant to ECD.



Overall key findings

Key findings are based on the systematic review and qualitative thematic analysis of KI interviews and focus groups. These provide insights into the potential application of systems thinking for addressing commonly experienced challenges to equitable and sustainable promotion of ECD at scale. Five overall key findings are described below.

1. There are compelling drivers towards systems thinking in ECD.

KIs described an increased focus on systems across multiple sectors over variable periods of time. Often this was described as arising from the need for innovative approaches to tackle complex problems where traditional (single intervention) approaches were perceived to fall short. Especially when addressing complexity and in the context of challenges with sustainable and equitable implementation and scaling. These resonated with similar identified challenges in promotion of ECD at scale.

2. Terminology is important but also a challenge.

The multiple related, overlapping and sometimes highly technical definitions of systems thinking may be a barrier to engaging practitioners and policymakers. This is despite the fact that many stakeholders may already be using applied systems thinking without defining their work as such.

3. There is an evidence gap between systems thinking and measuring impact at scale.

There are very few documented examples in the published literature describing measured impact of applied systems thinking on prospectively defined population outcomes at scale. This is potentially due both to challenges in systems terminology as well as measuring impact in systems interventions. In our extensive systematic literature review, only five studies were identified, all within the health sector.

4. Successfully applied systems thinking interventions have common elements.

- Purpose: clearly defined and shared goals and aims for multiple stakeholder groups.
- Context: deep understanding of local context, in some cases with a long history of embedded implementation research.
- Process: codesign and implementation that incorporates both 'top-down' and 'bottom-up' elements and a strong focus on stakeholder engagement, especially at community level. In all examples program design targeted multiple system levels, beyond a focus on front-line workers alone.

- Continual learning: using data and indicators for monitoring, adaptation and feedback as well as mixed methods approaches for monitoring and evaluation.
- Collaboration and networking: is key to intervention design and implementation.

5. Innovation is required to address measurement challenges.

The iterative, multifaceted nature of complex systems interventions makes application of traditional research, program monitoring and evaluation methods challenging. However, existing implementation frameworks, with an emphasis on context and process, may provide an opportunity for integrating relevant indicators to measure and evaluate systems thinking approaches. To do this, data and development of indicators which allow for comparison of applied systems thinking approaches across contexts are needed.

Implications and future directions

Now is a crucial moment in time for ECD. Challenges such as the COVID-19 pandemic, climate crisis and conflicts present major set-backs in international efforts to enable all young children to thrive and reach their full developmental potential. However, systems disruptions also present opportunities to change and explore innovative approaches to address longstanding challenges in efforts of the ECD community to promote child development at scale.

Building on key findings, the following implications and future directions are proposed for further consideration of practitioners, policymakers, funders, researchers and other stakeholders within and beyond the ECD community.

For practitioners

Reframing common challenges from a systems lens and building capacity within the ECD community related to application of tools and methods will be required. Opportunities to consider include development of;

- **Learning networks**, engaging ECD stakeholders as well as systems thinking experts and practitioners from other sectors to continue to share learnings and experiences related to applied systems thinking.
- **Strategies to document application of systems thinking** approaches more clearly and in ways which are comparable across settings.
- **Data and indicators** to measure systems thinking processes and impact as well as innovations in program monitoring and evaluation, to better capture systems change. This requires motivation and data literacy.

For policymakers

Systems disruptions associated with the pandemic and the urgency of emerging challenges such as the climate crisis provide an opportunity to consider;

- **Innovative policy scaffolding** to drive system change (e.g. alter policy regulatory environment, change and incentivise different funding mechanisms linked to practice). Such scaffolding needs to address the underlying social determinants of child health and development.
- **Creation of capacity building infrastructure** (including data and learning system capacity and capability) that can accelerate system changes.

For researchers

To address evidence gaps in systems thinking related to ECD will require research that;

- Is embedded into existing implementation research platforms.
- Engages with innovative approaches for research co-design, mixed methods evaluation and processes which embed continual participatory learning.
- Considers where applied systems thinking tools and methods can be drawn from other sectors into existing ECD intervention design and implementation research frameworks.
- Develops and tests indicators which allow comparability of both applied systems thinking implementation processes and impact across settings.

For funders

- To explore the potential of applied systems thinking in strengthening promotion of ECD at scale, long-term investment in partnerships which support program co-design and implementation within existing systems is needed.
- Accountability in investment is crucial but will require consideration of innovative approaches for monitoring and evaluation as well as development and testing of relevant data and indicators to ensure that progress can be measured, tracked and compared across settings.
- Investment in networks which focus on capacity building, knowledge sharing and ongoing learning related to application of systems thinking across sectors, with a focus on community and primary stakeholders may also be beneficial.

Abbreviations

Abbreviations	
ECD	Early Child Development
ECDAN	Early Childhood Development Action Network
FGD	Focus group discussion
KI	Key informants
KII	Key informant interviews
LMIC	Low and middle-income countries
MCRI	Murdoch Children’s Research Institute
NCF	WHO, UNICEF and World Bank Nurturing Care Framework for Helping Children Survive & Thrive to Transform Health and Human Potential (NCF)
WASH	Water, sanitation and hygiene
WHO	World Health Organization
UNICEF	United Nations Children’s Fund
SDG	Sustainable Development Goals
ST	Systems thinking
STCS	Systems thinking and complexity science
SWS	Sustainable WASH Systems
USAID	The United States Aid & International
PROSPERO	Prospective Register of Systematic Reviews Development
CAS	Complex Adaptive Systems Framework
MNCH	Maternal, Newborn and Child Health
QI	Quality Improvement
GEHIP	Ghana Essential Health Intervention Program
SERC	Sustainable Emergency Referral Care Initiative
IYCF	Infant and young child feeding
CF	Complimentary feeding
A&T	Alive and Thrive, a Save the Children Fund supported initiative
EC-LINC	Early Childhood Learning and Innovation Network for Communities
CSSP	The Center for the Study of Social Policy
PCF	Brazil’s Programa Crianca Feliz
LT	The Lili’uokalani Trust

Glossary

Key term	Definition
Applied systems thinking	The application of a broad array of qualitative and quantitative methods and tools designed to better understand system behaviours and intervene in the context of complexity and uncertainty (7)
Adaptation	Adjustments in a system behaviour in response to intervention (15, 16)
Boundaries	A conceptual border defined for the purpose of identifying factors within a system structure are thought to be most influential. Boundaries can be physical, geopolitical, organisational or abstract (15, 16)
Complex Intervention	An intervention which has a number of interacting components within the experimental and control interventions; having a number and difficulty of behaviours required by those delivering and receiving the intervention; having a number of groups or organisational levels targeted by the intervention; having a number and variability of outcomes; the degree of flexibility or tailoring of the intervention permitted (8)
Complexity science	Analyzes and models dynamic systems, often using computer simulation, to determine how systems might behave over time (15)
Complex systems	Systems that are comprised of many variables interacting with each other, yet functioning as a whole, that produces their own set of behaviour over time (15, 17)
Dynamics	The changes observed over time in a factor and/or its interactions with other factors (16)
Early childhood development	Children's cognitive, physical, language, motor, and social and emotional development, between conception and age eight years (2)
Emergence	Properties of a complex system that cannot be directly predicted from the elements within it and are more than just the sum of its parts (15)
Factors	Any aspect, element or component of the system which can be tangible or abstract (15, 16)
Feedback loop	The return of material or information about the status of a factor or process that results in a change in the factor to which the information is returned (16)
Flows	Elements in a system that can increase or decrease a stock (15)
Interactions	The effect that one factor has on another, which can be direct or indirect (via interaction with a third factor) (15, 16)

Key term	Definition
Non-linear relationship	Relationships within a system that do not follow a simple, constant input-output gradient, noting that cause and effect relationships within a system are frequently disproportionate (i.e. bigger or smaller than the initial intervention) (15)
Nurturing care	A stable environment, sensitive to children's health and nutritional needs, with protection from threats, opportunities for early learning and interactions that are responsive, emotionally supportive and developmentally stimulating (1)
Primary actors	People most immersed in the context of a (social) issue, often with lived experience of the issue itself
Scale	In this review, based on the above definition, scale-up was defined geographically as an intervention that was conducted at city, province, or national level in health systems or equivalent scale in other sectors
Scaling-up	Expanding coverage or quality for example of a service or intervention and can refer to expansion in any of several domains (e.g. geographic, population, service) (18). Typically, in ECD this refers to "expanding coverage and quality of a specific service to larger populations or broader geographical areas aiming at maximizing the reach and effectiveness of an intervention, leading to sustained impact on outcomes"(19)
Stocks	Factors in a system that can be accumulated or depleted (15)
Supporting actors	Professional managers, funders, policy makers and advisors who work in partnership with primary actors to support (social) change (17)
Sustainability	Variably refers to at least one of; continuation of activities, on continuation of benefits, on capacity building, on adaptations or cost recovery (20)
System	A set of two or more factors (e.g. people, organisations, resources) and their interconnections (5)
Systems thinking	A broadly inclusive, cross-disciplinary conceptual framework and way of conceptualising real-world phenomena as systems which aim to improve understanding of a whole, its parts and interconnectedness between components or factors, acknowledging that the context in which this exists is dynamic and changes over time (5, 6)
Systems work	Day to day principles and practices that guide the actions of organisations and individuals as they undertake to change systems; emphasizes process over outcomes (17)
Whole system intervention	A complex intervention that explicitly seeks to change several different points in a particular system (15)

Audience and Scope

The primary audience for this evidence review is stakeholders in the ECD community including practitioners, policy makers, researchers and funders. Within the ECD community, we hope that it is not only of interest to stakeholders in health and education, but also nutrition and social protection.

This review also engaged experts in systems thinking from diverse fields beyond ECD. We hope that this report is of interest to these colleagues across sectors, as part of an ongoing process of shared learning about applications of systems thinking to address complex challenges at scale, sustainably and equitably.

The work described in this report was undertaken over a 12-month period between February 2021 and February 2022.

Within what was feasible in this time frame, our evidence synthesis provides an overview of existing published evidence related to application of complex systems interventions at scale as well as a snapshot of multiple stakeholder perspectives. It does not attempt to provide a comprehensive summary of all available systems thinking tools and methods or systematically sample representative views within the ECD community.

Nevertheless, we hope that the evidence synthesis described in this report is an informative early moment in ongoing learning, collaboration and networking to strengthen understanding of the potential for application of systems thinking to address challenges in scaling promotion of ECD.

SECTION ONE: BACKGROUND





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BACKGROUND

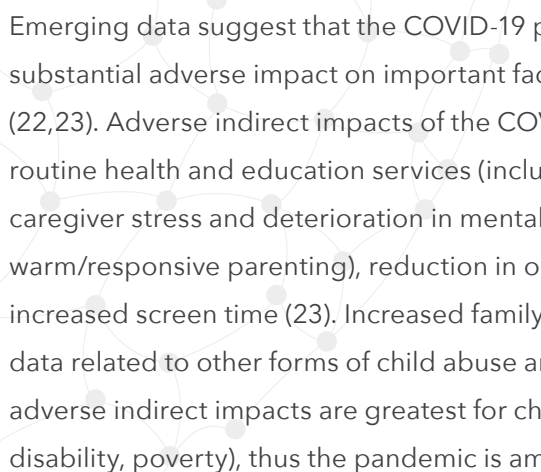
Rationale for applying a systems thinking lens to challenges in ECD

The importance of investing in early child development (ECD) for the benefit of children themselves as well as from a whole-of population perspective has been clearly articulated. ECD refers to a child's cognitive, physical, language, motor, and social and emotional development between conception and age 8 years (2). A large body of evidence has been amassed that demonstrates the importance of investing in early childhood to improve long-term health, development, educational outcomes and opportunities in adult life (1). The investment case is also clear, with the potential for scaled investment in promotion of ECD to reap substantial economic returns for society at large and reduce inequities (21). A great deal is also known about how to effectively promote healthy child development through interventions in health, education and other sectors (4).

At a global level, the Sustainable Development Goal 4.2.1 vision of enabling every child to thrive or reach their developmental potential has been supported by the WHO, UNICEF and World Bank 'Nurturing care framework for early child development' (2). The Nurturing Care Framework (NCF) is intended as an inclusive strategy to ensure children receive holistic inputs related to health, nutrition, responsive caregiving, safety and security and opportunities for early learning in order to promote their development (2). The NCF recognises the inherently complex and intersectoral nature of ECD and that for relevant inputs to be successfully implemented, enabling policy environments and accountability within systems are needed.

However, in spite of what is already known, and the increasing momentum within global ECD networks, few interventions promoting ECD have been equitably and sustainably scaled (4). Further, substantial inequities existed in child development indicators between and within countries, even prior to the pandemic (3).





Emerging data suggest that the COVID-19 pandemic and its related control measures are having a substantial adverse impact on important factors related to early child development in diverse settings (22,23). Adverse indirect impacts of the COVID-19 pandemic relevant to ECD include; disruption to routine health and education services (including closures in school and early learning), increased caregiver stress and deterioration in mental health impacting on caregiving (harsher parenting and less warm/responsive parenting), reduction in outdoor play, physical activity and interaction with peers and increased screen time (23). Increased family violence has also occurred across many settings although data related to other forms of child abuse and neglect are complex to interpret (24). Overall, these adverse indirect impacts are greatest for children and families with pre-existing vulnerabilities (e.g., disability, poverty), thus the pandemic is amplifying inequities in ECD (23).

The challenge of progressing towards the SDGs for ECD, in spite of the set-back of the pandemic, is immense.

However, we suggest that policy disruptions created by the pandemic also present a unique opportunity to think differently about how to better support children and families and promote ECD at scale moving forwards. In particular, we consider that it is both timely and urgent to explore how systems thinking approaches may help us to address long-standing and emerging challenges in scaling and sustainably embedding ECD interventions in the policy, service and social fabric of countries.

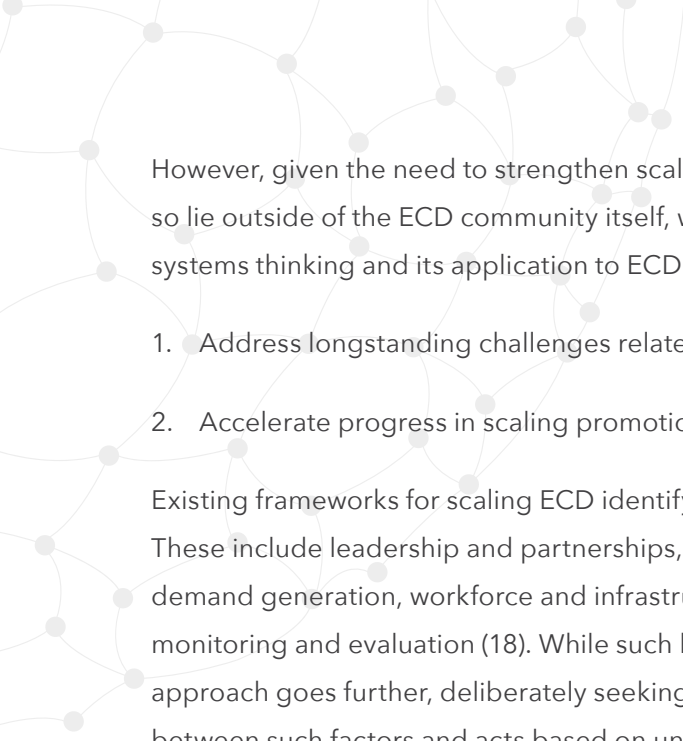
At its core, systems thinking describes a way of conceptualising real-world phenomena as systems which aims to improve understanding of a whole, its parts and interconnectedness between components (5). Systems thinking also acknowledges that the context in which systems exist are dynamic and change over time (5).

Historically, systems thinking has been used within developmental psychology, to improve understanding of infant and early child development (25, 26). However, curiously, within global child development more broadly it has not been operationally applied to implementing or scaling interventions which promote ECD. Across sectors most directly relevant to scaled promotion of ECD (e.g. health, nutrition, education, social protection) the use of systems thinking approaches has been highly variable and these approaches are not yet harnessed within pre-eminent frameworks for promotion of ECD at scale.

We suggest that further exploration of the potential application of systems thinking in scaling ECD may offer new insights for regaining lost ground for child development due to the pandemic, and addressing future challenges from disease, conflict, climate change and other natural disasters. We also consider whether progress in addressing pre-existing challenges in scaled promotion of ECD can be accelerated across diverse contexts.

ECD interventions are often acknowledged as complex, intersectoral and typically framed ecologically. As such, systems thinking approaches seem, in some ways, a natural fit for implementation and scaling of ECD. Indeed, arguably systems thinking approaches may already be implicit in approaches used by practitioners and other stakeholders to implement ECD interventions in some settings.





However, given the need to strengthen scaling of ECD and the fact that many identified barriers to doing so lie outside of the ECD community itself, we hypothesise that more explicit exploration of the role of systems thinking and its application to ECD has potential to yield new insights to;

1. Address longstanding challenges related to equity and sustainability and,
2. Accelerate progress in scaling promotion of ECD moving forwards

Existing frameworks for scaling ECD identify a range of potential barriers and enablers across sectors. These include leadership and partnerships, policy and legislative context, economics and financing, demand generation, workforce and infrastructure, intersectoral planning and coordination, feedback, monitoring and evaluation (18). While such barriers and enablers are well recognised, a systems thinking approach goes further, deliberately seeking to understand the interactions and interdependencies between such factors and acts based on understanding of these interconnections, regularly adapting to feedback and changing conditions (16).

Application of systems thinking approaches have led to wholesale changes in a number of fields traditionally not associated with ECD (e.g. business, finance, agriculture). Our challenge is to understand what lessons have been learned from failures and successes in applying systems thinking across diverse sectors, and to consider how these apply to present challenges in sustainably scaling ECD. Exploring these will require mixed methods approaches including qualitative methods to capture both practitioner and other stakeholder perspectives and published literature describing systems methodologies, process and where they exist, impact evaluations to ensure that most rigorous available evidence informs application of these approaches to ECD (15).

Systems thinking - what do we mean?

Systems perspectives have been applied in efforts to tackle complex challenges across a number of fields for decades. In ECD, systems approaches have more recently emerged within stakeholder discussions and the associated terminology is often poorly defined. While there are many potential definitions for related terms, as a starting point within this review we use commonly accepted terms from academic literature related to systems thinking and complexity science (STCS), to consider the systems in which ECD is promoted and what can be learned from systems approaches applied in other fields. (Table 1 below)

Systems thinking and complexity science arose from different traditions but are loosely related and often used together in evaluation of public health interventions (27). Systems thinking typically refers to an interdisciplinary approach to considering real-world phenomena based on core systems concepts (15, 16, 27). Systems thinking focuses on its understanding the overall structure of a system, defining



and understanding its component parts or factors and the relationships between these and the wider system (15, 16, 27). Complexity science typically refers to a set of ideas, theories, approaches and methods used to study complex systems (27). Since the terms are used together within the field of public health evaluation, we also chose to collapse them together within our review in order to capture wide perspectives on systems approaches potentially relevant to ECD, although acknowledging their distinct origins (15, 27). See Glossary and Table 1 Definition of frequently used terms, below.

Table 1 Definitions of frequently used terms

Key term	Definition
Applied systems thinking	The application of a broad array of qualitative and quantitative methods and tools designed to better understand system behaviours and intervene in the context of complexity and uncertainty (7)
Complex Intervention	An intervention which has a number of interacting components within the experimental and control interventions; having a number and difficulty of behaviours required by those delivering and receiving the intervention; having a number of groups or organisational levels targeted by the intervention; having a number and variability of outcomes; the degree of flexibility or tailoring of the intervention permitted (8)
Early Child Development	Children’s cognitive, physical, language, motor, and social and emotional development, between conception and age eight years (2)
Complex systems	Systems that are comprised of many variables interacting with each other, yet functioning as a whole, that produces their own set of behaviour over time (15, 17)
Scale	In this review, based on the above definition, scale-up was defined geographically as an intervention that was conducted at city, province, or national level in health systems or equivalent scale in other sectors.
Scaling-up	Expanding coverage or quality for example of a service or intervention and can refer to expansion in any of several domains (e.g. geographic, population, service) (18). Typically, in ECD this refers to “expanding coverage and quality of a specific service to larger populations or broader geographical areas aiming at maximizing the reach and effectiveness of an intervention, leading to sustained impact on outcomes.” (19)
Sustainability	Variably refers to at least one of; continuation of activities, on continuation of benefits, on capacity building, on adaptations or cost recovery (20)
System	A set of two or more factors (e.g. people, organisations, resources) and their interconnections (5)

Key term	Definition
Systems thinking	A broadly inclusive, cross-disciplinary conceptual framework and way of conceptualising real-world phenomena as systems which aim to improve understanding of a whole, its parts and interconnectedness between components or factors, acknowledging that the context in which this exists is dynamic and changes over time (5, 6)
Whole system intervention	A complex intervention that explicitly seeks to change several different points in a particular system (15)

While defining what we mean by these terms is crucial we also recognise upfront that practitioners and other stakeholders in ECD and other fields may be deeply engaged in systems work, without using this lexicon. This created a challenge in evidence synthesis using traditional methods for review of published literature (See also 'Methods' below) and was part of the rationale for using a mixed methods approach, including qualitative interviews with diverse stakeholders and experts in SCTS in other fields to ensure that broader perspectives were captured.

Similarly, we acknowledge that we are part of the systems we seek to change and bring strengths as well as particular individual and institutional positioning to underlying questions driving this review. As an academic team, we utilise our technical expertise and tools of critical appraisal to review available scientific evidence. However, in doing so, we were also keen to avoid a potential dichotomy highlighted by Rayner and Bonnici between technical and transformational approaches to systems change (17). In particular, we do not want to imply that solutions to identified challenges in promotion of ECD are primarily technical and therefore able to be addressed if 'solutions' are identified and adopted by the relevant stakeholders. Rather, we recognise that many challenges in sustainable scaling of ECD reflect deep underlying social inequities unreachable with a traditional academic toolkit. Thus, while our review centres around a systematic review of published literature, we also hope to touch on broader transformative approaches through engagement of broader networks beyond academic collaborators and the traditional ECD community.

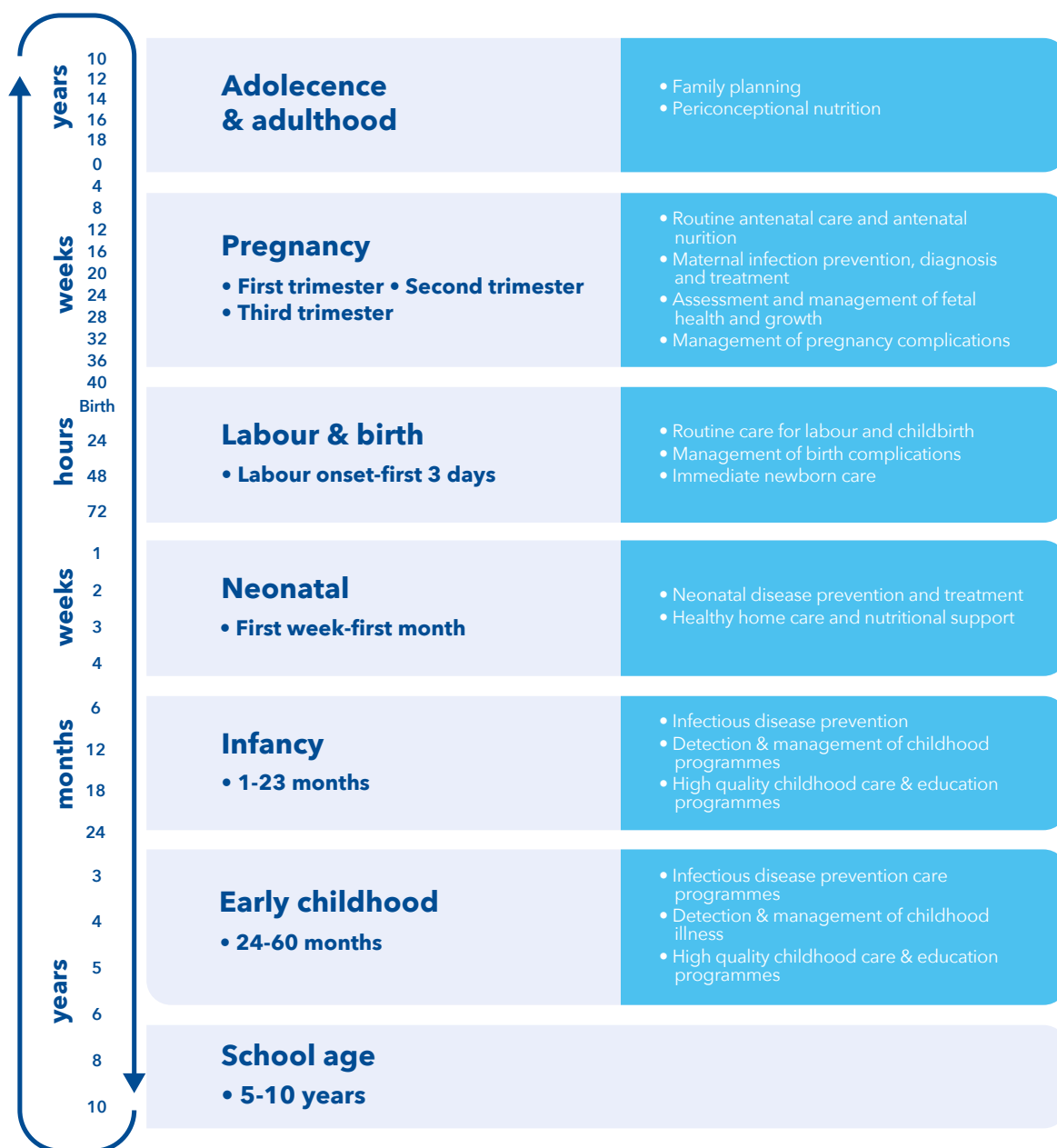
Systems for scaled promotion of ECD - what do we already know?

While there is an identified gap in application of systems thinking, there is already a substantial literature related to scaled promotion of ECD. Therefore, as background to our exploratory review of the role of systems thinking in scaled promotion of ECD, we completed a background review of existing literature related to scaling in ECD (Appendix 1), describe factors that might constitute a 'system' for promotion of ECD at scale as well what is already known about barriers and enabler to scaling.

The pre-eminent global framework for promotion of ECD at scale is the WHO, UNICEF and World Bank's Nurturing Care Framework for Helping Children Survive & Thrive to Transform Health and Human

Potential (NCF) (2). Following the 2016 Lancet series and an international, multi-stakeholder consultation process, it was launched at the United Nations General Assembly in 2018. The framework is based on a life-course and rights-based approach to child development through a universal progressive model with universal promotion of child development as well as targeted or indicated support, proportionate to need for children with additional risk factors or vulnerabilities for poorer developmental outcomes. The NCF also emphasises from science to scaling up and innovating multi-level action with a whole-of-government and whole-of-society approach.

Based on evidence, five key domains of nurturing care are identified in order to promote ECD at scale. These include; health, nutrition, responsive caregiving, early learning and safety and security. Within the NCF five key strategic actions are also identified including; leading and investing, focusing on families and communities, strengthening and services, monitoring progress and using scale-up and innovation. The emphasis on these strategies largely reflects previous evidence reviews which have highlighted the importance of these elements promoting ECD at large-scale (4).



(Reproduced with permission, Britto, P.R. et al, Lancet 2017) (1)

Evidence gaps to address

However, in spite of what is known, there remain many evidence gaps about how to implement nurturing care interventions, at large (national or sub-national scale), sustainably and equitably. Particular identified gaps to address include the need for evidence to understand how to;

- Adapt program design and implementation approaches to context
- Integrate and scale effective interventions within real-world systems and service delivery structures
- Develop and support capacity of front-line workers and other stakeholders
- Strengthen leadership and partnerships across sectors
- Integrate or coordinate approaches across sectors
- Generate political will, funding and policy support for nurturing care
- Program design, implementation and impact across contexts to improve comparability of data

Since many of these challenges are interconnected and extend beyond the traditional scope of ECD practice, we proposed that a focus on systems thinking approaches, their application and impact in other sectors might lead to new insights and opportunities to address these challenges in ECD moving forwards (18, 4, 28).

SECTION TWO: METHODS



Aim

We aimed to explore the potential application of systems thinking in addressing long-standing challenges and accelerating progress in equitable and sustainable promotion of ECD at scale.

To achieve this, we completed a mixed method evidence review and synthesis regarding the impact of systems interventions on outcomes at scale across diverse sectors.

Objectives

The three main objectives of our evidence review and synthesis were to;

1. Systematically review the evidence of impact for complex systems interventions on outcomes at scale across sectors through published and grey literature review.
2. Qualitatively explore multi-sectoral stakeholder experiences, perspectives and examples in implementing complex systems interventions at scale in diverse settings.
3. Synthesize the results of Objectives 1 and 2 to explore and consider the potential application of systems thinking for accelerating promotion of ECD at scale.

Overall methods

This evidence synthesis used a mixed-methods approach, including an intersectoral systematic review of published and grey literature complemented by phenomenological content analysis of qualitative interviews and focus group discussions with key informants in the ECD community and field of systems thinking.

By taking a mixed method and intersectoral approach, we endeavoured to be maximally inclusive of relevant data sources and a diverse multi-stakeholder group as part of the process of building networks regarding this knowledge gap.

Governance of process

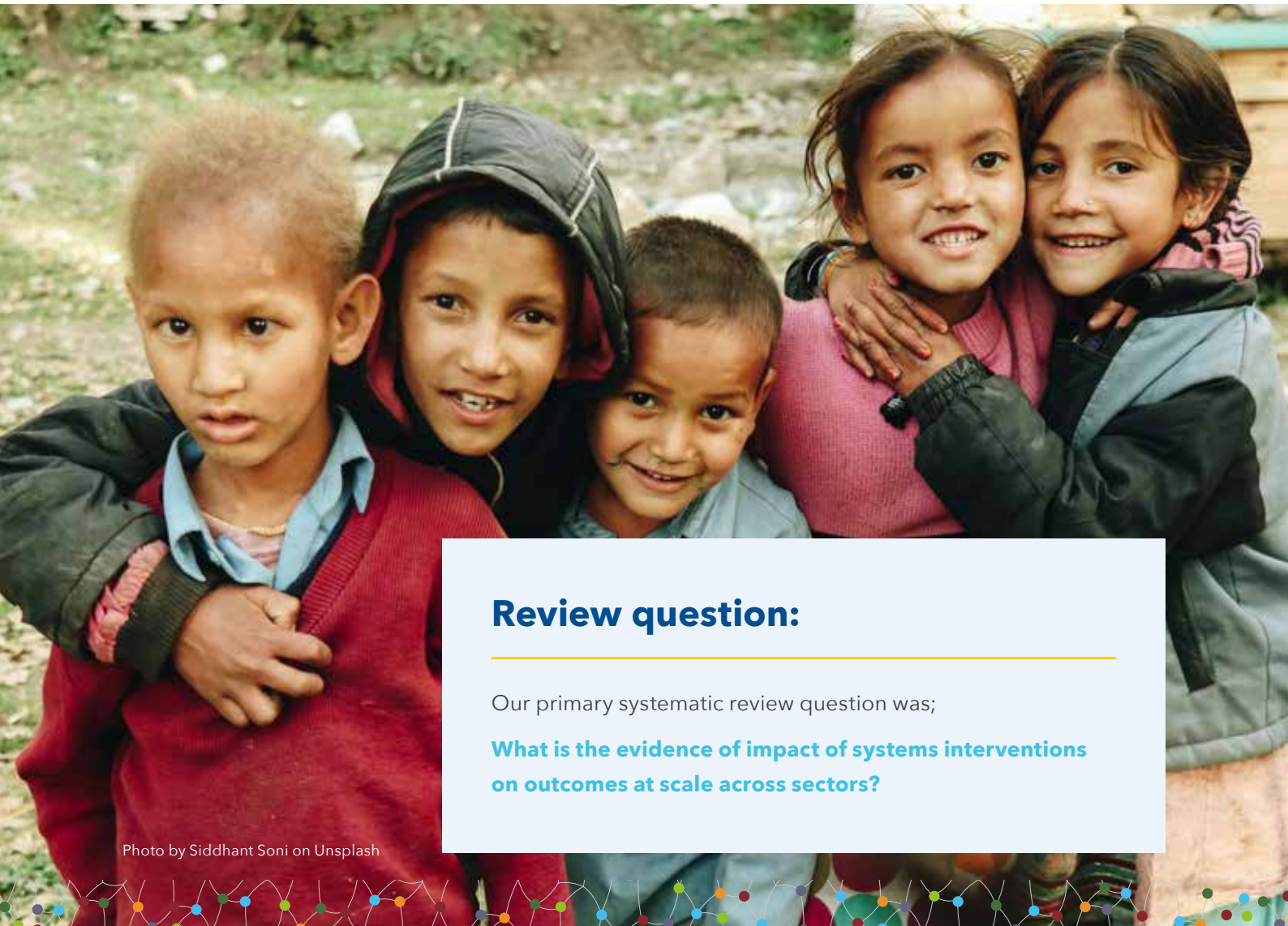
To guide the process of evidence synthesis, an Expert Advisory Group was established that included experts from within the ECD and systems thinking communities. We met as a group twice over the period of this review. The purpose of Expert Advisory Group meetings was to inform our evidence synthesis processes, ensure that this work built on rather than replicated work in other sectors and provide feedback regarding the relevance of our findings and suggested implications to the target audience.

Details of our methods are outlined per objective below.

OBJECTIVE ONE

Systematic review of published and grey literature - what is the evidence of impact for complex systems interventions on outcomes at scale across sectors?

The literature review was limited to English but included literature from countries with diverse income levels and from all regions, where possible drawing out best practice examples to highlight practical lessons for the field. It included not only grey and published literature related to ECD, but also considered systems literature from other fields where relevant (e.g. social protection, maternal new-born and child health), and a range of disciplines beyond ECD such as agriculture, business and manufacturing, where system change has been integral to success. This review was also designed to capture evidence from countries with diverse income levels and across regions.



Review question:

Our primary systematic review question was;

What is the evidence of impact of systems interventions on outcomes at scale across sectors?

Photo by Siddhant Soni on Unsplash

Search strategy

Our methods for systematic review of the published literature are outlined in Textbox 1 below.

Text Box 1: Search strategy for systematic review of published literature

We searched Pubmed, SCOPUS and Econlit databases from 2010 to 2021 inclusive. Searches were re-run just before the final analysis and further studies retrieved for inclusion. For feasibility, searches were limited to those published in English. Databases were searched using the following search terms and syntax:

Search terms:

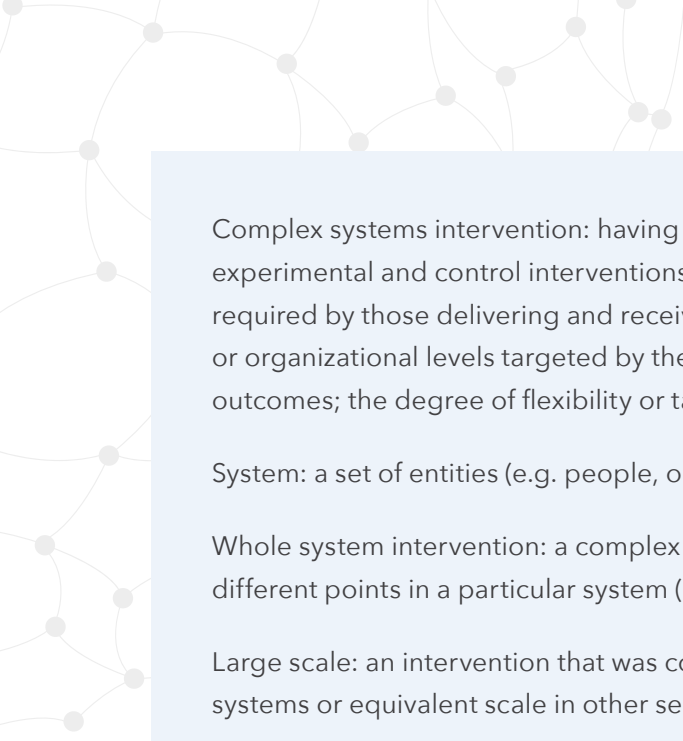
("systems strengthening") OR ("systems thinking") OR ("complex adaptive systems") OR ("system dynamics") OR ("system models") OR ("strategic options development analysis") OR ("critical systems heuristics") OR ("soft system methodologies") OR ("feedback factors") OR ("causal loop diagramming") OR ("service delivery") OR ("complexity science") OR ("systems change") OR (transformation)) OR ("large-scale change") OR ("transformational change"))

(large-scale) OR (scale)) OR (scaled)) OR (at scale)) OR (large setting)) OR (large companies)) OR (large company)) OR (organisation-wide)) OR (organization-wide)) OR (mega project)) OR (mega system)) OR (rollout)) OR (regional scale)) OR (multi scale))

The following inclusion and exclusion criteria were applied;

Inclusion Criteria	Exclusion Criteria
<ol style="list-style-type: none">1. Fields in healthcare, economics, finance and agriculture due to their implementation and evaluation of large scale complex whole system intervention,2. Large scale studies defined as city, province, national or sub-national level3. Any experimental study design with a priori determination of outcomes of interest4. Studies with an inclusion of a comparator group	<ol style="list-style-type: none">1. Fields in arts, biochemistry, dental, humanities, allergy or immunology, pathology, pharmacology and veterinary science2. Small scale studies defined as at a sub-organizational level such as department, division and team3. Non-experimental designs such as commentaries, editorials, systematic reviews4. Studies including a pre- and post-intervention

Thus our review focused on **studies in which complex whole system interventions conducted on a large scale were evaluated for impact on the target population.** We used the following definitions;



Complex systems intervention: having a number of interacting components within the experimental and control interventions; having a number and difficulty of behaviours required by those delivering and receiving the intervention; having a number of groups or organizational levels targeted by the intervention; having a number and variability of outcomes; the degree of flexibility or tailoring of the intervention permitted.

System: a set of entities (e.g. people, organisations, resources) and their interconnections (5))

Whole system intervention: a complex intervention that explicitly seeks to change several different points in a particular system (14).

Large scale: an intervention that was conducted at city, province, or national level in health systems or equivalent scale in other sectors.

We included studies in health care and specific fields beyond, including economics, finance, agriculture and others with a history of implementation and evaluation of large scale complex whole system interventions.

We excluded studies conducted in the following fields: arts, biochemistry, dental, humanities, allergy or immunology, pathology, pharmacology, veterinary science due to limited perceived relevance and substantial additional volume of publication in this area. Studies that were small scale (e.g. at sub-organization level such as department, division, etc.) were also excluded.

Of note, **included studies were required to have an experimental study design with a prior determination of outcomes of interest and inclusion of a comparator.**

Case studies, pre-and-post design without a comparator group and retrospective analyses were excluded as were commentaries and editorials.

Grey literature searches of related non-government and governmental organizational websites were undertaken to retrieve related white papers and non-published evaluations. Grey literature sources searched were centred around think-tanks and government funded institutions namely UNICEF, the National Bureau of Economic Research and Overseas Development Institute. For the grey literature search, the following search terms were used: large scale, systems thinking, at scale systems, systems models, large scale systems.



Screening and data extraction

Titles and abstracts were screened by the author team in Covidence (www.covidence.org). Title and abstract rules were set so that all studies were screened by two reviewers. Any conflicts were resolved by a third author or discussed for inclusion/exclusion amongst two or more authors. Studies that did not meet inclusion criteria were excluded. Full-text articles were assessed for eligibility using the same inclusion and exclusion criteria included in the final review.

Full text of potentially eligible studies were retrieved and independently assessed for eligibility by two review team members. Any disagreement between team members over the eligibility of studies was resolved through discussion with a third reviewer.

We created a template in Covidence to extract data from the included studies. Extracted information included: intervention sector; study design; study setting; study population and participant demographics and baseline characteristics; details of the intervention and control conditions; outcomes and times of measurement; suggested mechanisms of intervention action; information for assessment of the risk of bias. Two review authors extracted data independently, discrepancies were identified and resolved through discussion, with a third author where necessary. To minimize missing data, attempts were made to contact study authors to gather missing data or clarify details.

Data analysis

Included studies were analyzed descriptively, with a focus on key indicators included data extraction. We also synthesized findings across studies and triangulated findings of published and grey literature review with findings of qualitative data collection (see Objective 2 below). Findings were discussed as a research group with engagement of our interdisciplinary Expert Advisory Group as part of an iterative process of reflective feedback as the review progressed.



Objective two

Qualitative exploration - Multistakeholder experiences and perspectives in implementing complex systems interventions at scale in diverse settings

In order to capture evidence not included in our systematic literature review we also used qualitative methods to explore stakeholder experiences and program examples related to implementation of complex systems interventions at scale in diverse fields and geographic regions. Qualitative methods also iteratively informed systematic review methods and interpretation of results.

Participants

Key informants (KI) from diverse sectors with expertise and experience in child development and/or systems thinking were purposively selected and invited to participate in interviews and focus groups. Participants included practitioners, academics and other individuals with specific expertise and experience related to systems thinking across diverse sectors. (See Table 3 below)

Experts were identified through professional networks (e.g., professional contacts in the global ECD community including through the Early Child Development Action Network) as well as through the systematic literature review and establishment of our Expert Advisory Group. Snowballing recruitment during interviews or focus groups with other participants was also used. For feasibility, only English proficient participants were included within the timeframe for this review.

Data collection

Data was collected through online interviews / focus groups and February 2022 by SZ and KM. Interviews took between 45-90min and were recorded via Zoom where possible. Interviews were semi-structured using a question guide (See Appendix 2) transcripts were obtained by Outscribe. In total we conducted interviews/focus groups with 22 key informants.

Data reporting and analysis

Data was analyzed using phenomenological thematic content analysis. Interviews were coded separately by two members of the research team discussion and comparison of emergent themes. Text description of emergent themes and subthemes relevant to the primary research description was provided.





Objective three

Synthesize the results of Objectives 1 and 2 to explore and consider the potential application of systems thinking for accelerating promotion of ECD at scale

Results from both the systematic literature review and qualitative data collection were synthesized to describe potential implications for accelerating scaling of ECD promotion including policy, programming, research and funding in diverse settings.

Ethics

This project was approved by the Royal Children's Hospital Melbourne Human Research Ethics Committee (Reference number 788894/RCHM-2021 and governance authorisation at the Melbourne Children's Campus (incorporating the Royal Children's Hospital, Murdoch Children's Research Institute and the University of Melbourne Department of Paediatrics).



SECTION THREE: SYSTEMIC REVIEW KEY FINDINGS



Systematic review key findings

We identified 42,660 studies from three databases, of which, five met the inclusion criteria (Figure 2 Prisma flow chart)(29). 4,611 studies were removed as duplicates, and after reviewing abstracts, 37,939 studies were excluded due to not meeting inclusion criteria. 110 studies underwent full-text review. Of these, a further 105 were excluded. Reasons for exclusion related to study design (i.e. historical analysis or lack of comparator) (72%), lack of relevance to research question (i.e. intervention or outcome not related to a complex system) (10%), or interventions that were not at scale (16%) or being a duplicate (1%). A secondary search was completed by searching through the reference lists and citations of the included studies but no additional studies met the criteria for inclusion. Therefore from 42,660 screened abstracts there were 5 papers included.

Figure 2: PRISMA flow diagram for study selection (29)



Grey and additional published literature

Additional grey and published literature review did not provide empirical examples of measured impact for systems thinking interventions at scale. However, it did provide a rich picture of intersectoral evolution in systems of thinking and its application across multiple sectors over variable time periods. Some of the program examples highlighted by grey literature review and key informants are further described below (See Section Five: Exemplars).

Table 2: Summary of included studies

Reference	Sector	Country	Population	Research Design	Intervention	Comparator	Outcome
Abdallah et al, 2020 (9)	Health (Reproductive, maternal, newborn and child health and nutrition (RMNCHN))	India, Bihar	8 districts	Cross-sectional survey (9 rounds across program length 2012 - 2017). A Lot Quality Assurance Sampling (LQAS) methodology for Phase 1, and modified LQAS+ for Phase 2	Household and community-level interventions to improve RMNCHN. Phase 1 - intensive ancillary support to government in 8 districts; Phase 2 - techno-managerial assistance to state-wide government-led implementation	30 non-focus districts in the state of Bihar	Significant improvements in indicators during first phase where intensive support was provided; significant decrease across 33 of 52 indicators during phase 2, indicating that improvement in indicators depended on a level of intensity of support that could not be achieved at scale
Ashish KC et al, 2019 (10)	Health (Newborn)	Nepal	12 hospitals, (n=89,014 women-infant pairs)	Stepped-wedge cluster-randomised controlled trial)	Neonatal resuscitation quality improvement package	Hospitals not yet enrolled	Improved neonatal resuscitation practices and decreased intrapartum related deaths
Patel et al, 2016 (11)	Health (Community)	Northern Ghana	3 districts (n=184,000 people)	Quasi-experimental study using an iterative systems development approach with time series analysis of key indicators	Community-Engaged Emergency Referral System	Unexposed subdistricts in Upper East and West regions	Improved referral practices, overall facility-based maternal mortality as well as accident-related deaths decreased relative to non-intervention areas

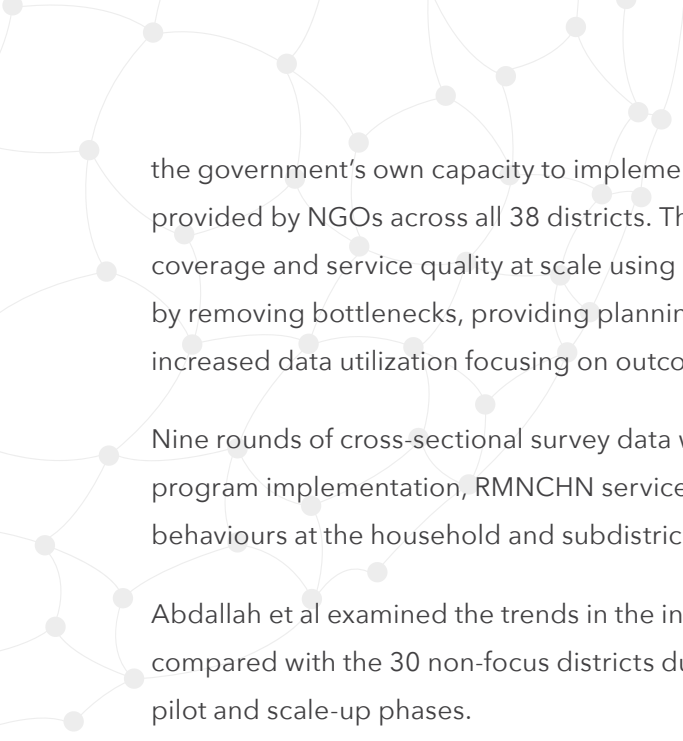
Reference	Sector	Country	Population	Research Design	Intervention	Comparator	Outcome
Rawat et al, 2017 (12)	Health (Nutrition)	Vietnam	15 provinces (n=340,000 mothers of children aged 2yo)	Cluster-randomised nonblinded evaluation design with cross-sectional surveys (baseline 2010 and endline 2014)	Social franchising within government health system to improve counselling combined with a mass media campaign and community mobilisation	Counselling with less intensive mass media and non-intensive community mobilisation	Improvements in feeding practices (dietary diversity and minimum acceptable diet) but not growth were observed in the intervention group. Significant declines in stunting were seen in both intervention and comparison groups over time
Waiswa et al, 2021 (13)	Health (Child)	Uganda	16 districts	Randomised controlled trial	Community and District-management Empowerment for Scale-up (CODES)	Unexposed districts	Improved treatment of malaria, diarrhoea, pneumonia, improved stool disposal, improved coverage of immunisation and Vitamin A supplementation

Description of included studies

Reproductive, maternal, newborn and child health and nutrition (RMNCHN) in Bihar, India (Abdalla S et al) (9)

In 2010, the Bill and Melinda Gates Foundation (BMGF) formed a partnership with the Government of Bihar, India to accelerate the achievement of Bihar's RMNCHN goals through the Ananya program. The program included a range of household, community, and facility-level interventions delivered across multiple government platforms in partnership with Non-Governmental Organizations (NGOs) with the aim to identify the most effective interventions for scale-up. Interventions addressed a range of RMNCHN issues at different levels of the system including poor coverage and quality of services in family planning, skilled birth attendance, newborn care, prevention and management of neonatal sepsis, nutrition, and immunization; improvement of frontline worker effectiveness; Quality improvement across RMNCHN services in public health facilities; media campaigns and health messaging to increase demand for and adoption of priority health behaviours; and integrating RMNCHN messaging and behaviour change campaigns into self-help groups for community mobilization to advocate for better quality of local RMNCHN services.

During the first phase of the program (2011 - 2013), NGOs provided intensive support to governmental implementation of RMNCHN initiatives in eight focus districts and successful interventions were identified to be scaled across the rest of the state during the second phase (2014 - 2017). The second phase was characterized by a reduction in external NGO implementation support and instead relied on



the government's own capacity to implement and sustain interventions with techno-managerial support provided by NGOs across all 38 districts. The aim was to increase government ownership and improve coverage and service quality at scale using health system strengthening and performance management by removing bottlenecks, providing planning and policy technical support, and building capacity via increased data utilization focusing on outcomes.

Nine rounds of cross-sectional survey data were collected assessing changes in RMNCHN indicators, program implementation, RMNCHN service coverage, quality, utilization, and beneficiary health behaviours at the household and subdistrict levels across all 38 districts.

Abdallah et al examined the trends in the indicators in the focus districts in phase 1 compared to phase 2, compared with the 30 non-focus districts during both phases, as well as the transition period between the pilot and scale-up phases.

Results showed a significant improvement in 34 out of 52 indicators during the pilot phase with intensive support in the focus districts, especially as related to postnatal front-line worker performance. During the transition between pilot and scale-up phases however, there was a relative decrease in 33 out of the 52 indicators in the focus districts, even though they were still higher than non-focus districts. During the scale-up phase, there was little change in indicators in the focus and non-focus districts, with some indicators improving, while others declining significantly.

The authors concluded that it was possible to improve RMNCHN outcomes if sufficient investment is made in the intensity of implementation support, like in the first phase of the program. These gains were mostly lost, however, in the transition to scale. The authors suggested that these outcomes could potentially be explained by: challenges with sustaining interventions within government systems at scale compared to NGO systems which have different organizational cultures that cannot be replicated within government systems; insufficient time during the scale-up phase (3 years) for the government system to overcome chronic weaknesses and sufficiently integrate the complexity and range of interventions at scale; insufficient funding to implement at the same intensity as the first phase of the program.

Neonatal resuscitation in Nepal (Ashish KC et al) (10)

Ashish KC et al explored the effect of a neonatal resuscitation quality improvement package on intra-partum-related mortality in Nepal when trialled in 12 hospitals over 18 months (April 2017-October 2018).

The authors identified that most previous literature related to neonatal quality improvement (QI) interventions focused on microlevel intervention to improve health-worker performance and in their package, sought to target a mix of microlevel and meso-level interventions.

Building on formative research and their review of the QI literature, they designed an intervention which focused on four levers of change: improved leadership accountability; mechanisms for continuous QI; standards and techniques for improving care and metrics for change related to process and outcomes



of care. Whilst also noting the importance of macro (national level) interventions as suggested in the Lancet Commission on High Quality Health Systems (14), they chose to focus more directly on systems level where they considered that their team could have most impact due to decentralized governance of health care services in Nepal. They specifically noted a lack of QI packages for intervention at different levels of governance to improve quality of care.

The QI package included interventions should be to improve hospital leadership and governance related to intrapartum care and neonatal resuscitation, continuous facilitated QI processes in clinical units and an independent data collection system set-up at each hospital to gather data on mortality.

The intervention - called Nepal Perinatal Quality Improvement Package (NePeriQIP) was delivered within the government hospital system in a combination of high and low-volume facilities. During the baseline period, intra-partum related mortality ranged from 9-31/1000 births with a mean of 13/1000 births.

Results showed a significant reduction in intrapartum related deaths in the intervention period (adjusted OR 0.79; 95% CI, 0.69-0.92). The incidence of intrapartum-related mortality during the intervention control period was 10.7/1000 live births and during the intervention period was 7.8/1000 live births. Both intrapartum still births and first day neonatal mortality decreased.

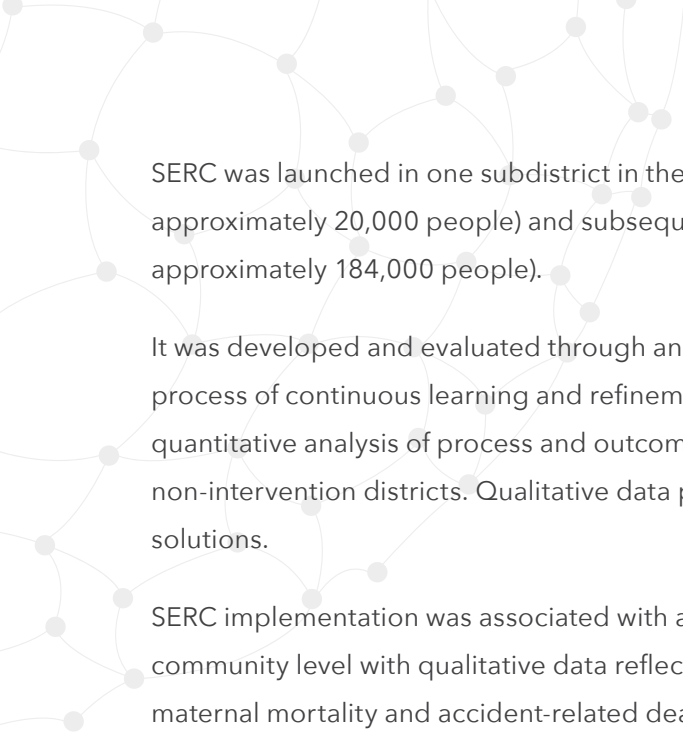
The authors concluded that scaling a set of micro- and meso level neonatal QI interventions was feasible and when implemented adequately (not perfectly) improved the quality of neonatal resuscitation and reduced intrapartum related mortality.

However, they also noted that both process and outcomes varied across hospital within the trial and suggested that more research was needed to assess contextual implications and the sustainability of the intervention and its impact.

Emergency referral systems in Ghana (Patel S et al) (11)

Ghana has a well organized primary health care system and at the time of the study by Patel et al, had a large scale systems strengthening and capacity building project known as the Ghana Essential Health Intervention Program. GEHIP identified an urgent need to improve emergency referrals in the Upper East region of the county and a lack of policies and guidelines to support emergency referral. In response to this, the Ghana Health Service and community stakeholders collaboratively designed and launched the Sustainable Emergency Referral Care Initiative (SERC) (2012).

SERC aims to 'develop a community and subdistrict-level emergency referral system that would improve survival in impoverished rural Ghanaian communities.' It was developed using a participatory planning approach and included; low-cost emergency transport and communication systems; community education activities; adequately resourced referral centres; collaboration between referral levels and across sectors; referral and receiver protocols; mechanisms for supervision, monitoring and evaluation and policy support. Ghanaian cultural groups called Durbars were engaged as a platform for community engagement.



SERC was launched in one subdistrict in the Upper East Region of Ghana in 2012 (population approximately 20,000 people) and subsequently scaled to 12 subdistricts (2013-15) (population approximately 184,000 people).

It was developed and evaluated through an iterative systems development approach as part of a process of continuous learning and refinement. SERC was evaluated using mixed methods including quantitative analysis of process and outcome indicators in 12 intervention subdistricts compared with non-intervention districts. Qualitative data provided information related to challenges and potential solutions.

SERC implementation was associated with an increased volume and more appropriate referrals from community level with qualitative data reflecting strong community support. In SERC areas, facility based maternal mortality and accident-related deaths decreased relative to facility mortality in comparison areas.

In their discussion of the SERC initiative Patel et al highlight several key lessons including; importance of people centred-planning for obtaining and sustaining community support; intersectoral collaboration (e.g. with transportation authorities and manufacturers); impact of resource limitations on both implementation and evaluation; importance of evidence-based supervision and refresher training; importance of monitoring and feedback to support systems improvements.

Complementary feeding in Vietnam (Rawat R et al) (12)

In Vietnam, during the period when this study by Rawat et al was conducted (2014), prevalence of childhood stunting was 25% and wasting 6.8% with substantial direct and indirect potential impacts on child health, development and well-being. Poor infant and young child feeding (IYCF) practice is one factor contributing to the challenge of child undernutrition, including early introduction and poor quality of complementary feeding (CF).

The authors of this study noted that whilst small scale efficacy trials to improve CF have shown positive impact on maternal IYCF knowledge and feeding practices, impacts on growth are inconsistent. They also noted limited local evidence in Vietnam at the time of this study and that programmatic examples of CF interventions, delivered in large scale programs or national health systems were lacking. They also noted that while social-behaviour change communication interventions have previously been shown to improve the availability, quality and use of health services in other disciplines (e.g. reproductive health), less is known about their application in nutrition.

Alive & Thrive (A&T) was a Save the Children Fund supported initiative evaluated across three countries - Bangladesh, Ethiopia and Vietnam which demonstrated positive impact on breast feeding in all contexts and on CF in Bangladesh and Ethiopia. The paper by Rawat et al describes implementation of the Alive & Thrive initiative in 15 of 63 provinces in Vietnam at commune, district and provincial level to improve quality of IYCF counselling.





The intervention was multi-pronged and was established within the existing government health system structure. It included a range of strategies aimed at improving IYCF including: health worker training and supervision; incentives to health facilities; applying social franchising (the use of commercial franchising concepts so that a brand identity is equated with quality services) to delivery of individual and group counselling; monitoring tools and mass media activities. Mass media activities included promotional print materials and television advertising to generate demand across implementation areas. In some areas more intensive mass media campaigns were used and also included billboards and broadcasts on village loud-speakers as well as home visiting by village health workers for households of women with children <24 months old.

The initiative was implemented across 40 communes in 10 districts in 4 provinces of Vietnam between 2011-2014. 20 communes were allocated to the more intensive intervention and 20 to non-intensive intervention. It occurred alongside advocacy at national and provincial levels to increase paid maternity leave and strengthen legislation around marketing of breast milk substitutes.

Impact evaluation comparing intensive and non-intensive intervention implementation used a cluster-randomised, non-blinded evaluation design with cross-sectional pre- and post surveys.

Evaluation demonstrated that child feeding and growth improved in both intensive and non-intensive areas but improvements between groups were not different, with the exception of more timely introduction of water and other foods between 6-8.9 months. Differential impacts were noted related to key feeding practices including dietary diversity and minimum acceptable diet.

Rawat et al surmised that the lack of more substantial improvement potentially reflected the lack of a 'full control' which could result in an under-estimate of impact of the more intensive intervention arm. They also noted that it was unclear from the evaluation whether improvements in growth in both groups reflected secular trend or were due to impact of the non-intensive intervention also.

Community and District-management Empowerment for Scale-up (CODES) (Waiswa et al) (13)

In establishing CODES in Uganda, Waiswa et al identified that limited managerial capacity at district level negatively affected decentralized child health system performance in Uganda.

Community and District Empowerment for Scale-up (CODES) was a multi-year initiative which involved a district level health management strategy informed by community engagement and local data. It aimed to strengthen government health service capacity to tackle three major causes of childhood mortality; pneumonia, diarrhoea, malaria. Using an analytic framework to explore system bottlenecks CODES identified four determinants of effective health system coverage; enabling environments, supply, demand and quality of health services. It aimed to enable managers to generate local data, diagnose health system bottlenecks and target resources to context-appropriate solutions.

Three pillars of the intervention were enunciated including 1) data - collating, analyzing and applying program and survey data, 2) regular review and support for implementation of district work plans and 3) stimulation of demand for services through community engagement.

The intervention was implemented in eight high mortality districts and evaluated through a randomised controlled trial involving the eight intervention and eight comparison districts.

Results demonstrated clinically significant positive impact on management of common childhood illness. Specifically, intervention districts reported increases in treatment of common childhood illness - pneumonia, malaria and diarrhoea. Coverage rates for protective and preventive child health interventions (i.e. immunization and Vitamin A supplementation) were also increased.

Variation in management and implementation was observed across districts and constraints in policy and financial support were identified as constraints to implementation.

Waiswa et al concluded that CODES warrants ongoing consideration for scale-up of child health services in Uganda and potentially other decentralized, resource-limited settings as a model for health systems strengthening.

Summary of key findings: systematic literature review

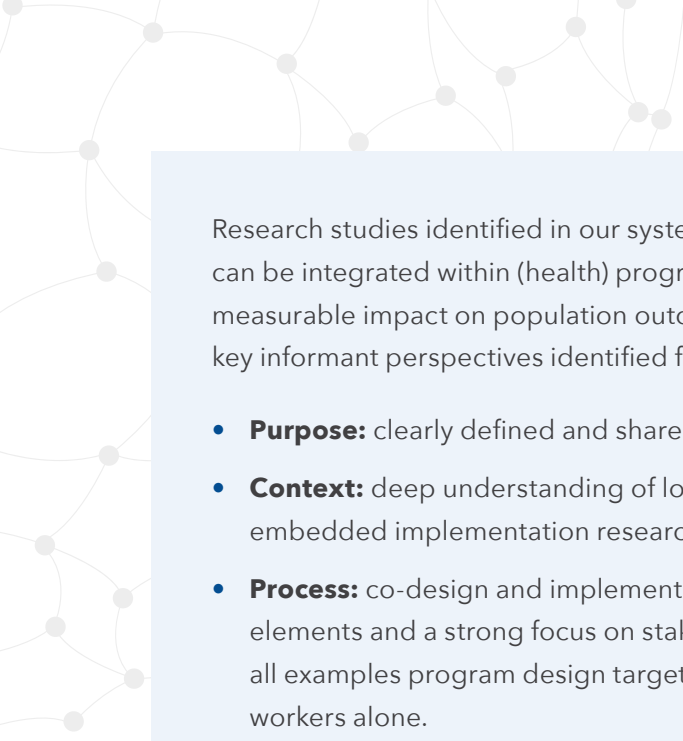
Text Box 2: Summary of key findings from the systematic literature review

Question - What is the evidence of impact for complex systems interventions on outcomes at scale across sectors?

We have conducted what is to our knowledge, the first interdisciplinary systematic literature review designed to rigorously answer the question 'What is the evidence of impact for complex systems interventions on outcomes at scale across sectors?'

We searched three databases (Pubmed, SCOPUS and Econlit) from 2010 to 2021 to capture published literature across a range of disciplines (e.g. economics, agriculture, health and social sciences) and included studies with an experimental study design, a priori determination of outcomes of interest and inclusion of a comparator group.

Of an initial screen of 42,660 papers most (n=42,550) were excluded because they were duplicates, not relevant to the primary research question or otherwise did not meet inclusion criteria. Of papers included in full-text review (n=110), reasons for exclusion (n=105) related to study design (72%), lack of relevance to research question (i.e. 'wrong' study population, intervention or outcome) (10%), including interventions that were not at scale (16%) or being a duplicate (1%).



Research studies identified in our systematic review (n=5) demonstrate how systems thinking can be integrated within (health) program design, implementation and evaluation with measurable impact on population outcomes at scale. Our systematic review triangulated with key informant perspectives identified five common features of successful interventions:

- **Purpose:** clearly defined and shared goals and aims for multiple stakeholder groups
- **Context:** deep understanding of local context, in some cases with a long history of embedded implementation research
- **Process:** co-design and implementation that incorporates both 'top-down' and 'bottom-up' elements and a strong focus on stakeholder engagement, especially at community level. In all examples program design targeted multiple system levels, beyond a focus on front-line workers alone.
- **Continual learning:** using data and indicators for monitoring, adaptation and feedback as well as mixed methods approaches for monitoring and evaluation
- **Collaboration and networking:** is key to intervention design and implementation

Identified enablers and challenges to ongoing scaling and a need to measure intervention sustainability were also described. Grey and published literature provided a narrative of the evolution in systems thinking across sectors as well as practice examples, descriptions of how systems thinking was codified in some sectors, tools and other useful resources (e.g. description of innovations in monitoring and evaluation).



SECTION FOUR: QUALITATIVE PERSPECTIVE KEY FINDINGS



Qualitative perspective key findings

We interviewed 22 key informants (KI) who had with expertise and experience in child development and/or systems thinking and were from diverse sectors (i.e. health, early child development, early childhood education, food systems, agronomy, ecology, social policy, international development). They represented academic institutions and non-government organisations (international and domestic, for-profit and not-for-profit) and UN organisations. While half of KIs were based in academic institutions, many had dual roles and experience and expertise across sectors and disciplines. KIs were from six countries although many worked in diverse settings. (See Table 3)

Table 3: Summary of key informants interviewed

	Organization Type	Country	Sector/Field
1	Academic	USA	Health systems
2	Academic	USA	Health systems
3	Academic/consulting	Australia	Public health policy
4	Academic/consulting	USA	ECD
5	International NGO	Italy	Social policy
6	Academic	USA	Health systems
7	Academic	USA	Public health
8	NGO	India	Education (ECCE)
9	Academic/consulting	USA	Evaluation, ecology, systems
10	Academic	USA	Health, social policy
11	NGO	USA	Health equity
12	NGO	Bangladesh	Food systems
13	Academic	USA	Health
14	Academic	USA	Health, evaluation
15	Academic	India	Education (ECCE)

	Organization Type	Country	Sector/Field
16	NGO	India	Social development
17	NGO	India	Education (ECCE)
18	International NGO	India	Education
19	NGO	India	Economics, education
20	NGO	India	International development
21	NGO	India	Education
22	NGO	India	Systems, international development

Our systematic review, described in the preceding section, provided important examples regarding the process and impact of applied systems thinking at scale in diverse settings.

However, KIs emphasised the importance of including other sources of evidence to fully understand the potential applications and impact of systems interventions at scale.

As such, findings of qualitative components of our evidence review, described in this section, provide unique insights from both research and practitioner perspectives related to practical experiences in applying systems thinking across sectors. This section outlines themes which emerged through phenomenological thematic content analysis of KIIs and FGDs. Converging themes provide a broader context for understanding results of the systematic review and a more holistic understanding of the potential application of systems thinking within global efforts to more effectively promote ECD at scale, sustainably and equitably, in diverse settings.

Text Box 3: Summary of qualitative themes and subthemes

Theme 1: Why systems thinking? [Drivers towards and value-add of applied systems thinking]

- Limitations of empirical evidence base to inform policy
- Complexity
- Sustainability and equity challenges
- Efforts to scale
- Technology

Theme 2: What is systems thinking? [Definitions]

- Challenges with definitions
- Pragmatic approaches vs. technical definitions
- Defining features of complex systems thinking approaches
- Complexity
- Interconnectedness
- Emergence and non-linearity

Theme 3: Systems thinking in practice

- Many practitioners already do systems work
- Variability in development across sectors and disciplines
- Mechanistic vs ecological approaches
- Elements of systems of applied systems thinking approaches in practice
 - » Context
 - » Purpose
 - » Participatory processes
 - » Collaboration
 - » Learning
- Progression in use
- Incorporation within existing approaches

Theme 4: Relationship with scaling, sustainability, equity, resilience and acceleration

- Complex with mixed perceptions
- Practice examples (scaling, equity and resilience) but under-explored in evaluation and research

Theme 5: Measurement - data, indicators, monitoring & evaluation

- Crucial but complex
- Innovative tools and approaches to mixed methods monitoring and evaluation
- Further exploration of data and indicators required

Theme 1: Why systems thinking? [Drivers towards and value-add of applied systems thinking]

KIs in different fields described the evolution of systems thinking across sectors, sometimes over decades. Progress incorporating systems thinking into intervention design, implementation, scaling and research was described to be at different stages in different fields. However, there appeared to be some common drivers across fields and sectors. Specifically, several KIs described increased focus on systems thinking arising from the need for new approaches to tackle complex problems where traditional approaches were perceived to fall short, especially when addressing challenges like sustainable and equitable implementation and scaling.

Within this overall theme several sub-themes were also identified. These were;

- Limitations of the empirical evidence base to inform public policy
- Complexity
- Sustainability and equity challenges
- Efforts to scale
- Technology

A number of key informants highlighted gaps between evidence needed by policy makers and that generated by linear approaches to evidence generation as a driver towards systems thinking design, implementation and evaluation approaches.

Similarly, several key informants highlighted the perceived utility of systems thinking approaches in tackling complex “real-world” challenges in health and other sectors. That is several KIs identified the complexity of the problem as the starting point for bringing systems thinking approaches into traditional modes of operation within a sector, suggesting that it was well suited to tackling underlying drivers of complex challenges.

The need to ensure sustainability in interventions was also cited as an important driver towards the uptake of systems thinking in different fields. Key informants commonly also expressed that another driver towards systems thinking informed approaches was a desire to improve scaling of an intervention or program, although our systematic review results and other points of qualitative data suggested a complex relationship between applied systems thinking and scaling (See also Theme 4 below).

While systems thinking was acknowledged as having a long history across sectors and in diverse fields, in some fields, recent emergence or acceleration of interest was perceived to be related to changes in technology.

Theme 1 KI Quotes - why systems thinking? [Drivers towards and value-add of applied systems thinking]



It is my growing perspective over years in research, and certainly also driven by my experience in the practice and policy worlds before academia, that meaningful change at scale almost always involves systems thinking."



I think that looking at systems approaches is particularly appropriate for those key problems related to sustainability, equity, and scaling, because they are all features of... complex systems that require adaptation, that are dynamic, that ... should have a lot of intra-dependence."

Emergence of new technology that supports systems approaches



Systems thinking is not a new idea, right? It's been around for 100 years... from the 1950s, till about the 1980s, the methodological thinking was pretty stagnant... I think part of that lull, or stasis, was because of a stasis in computational power. So I think the development of more and better computers, more and better models, more user friendly ways to do this work, almost a democratization of being able to do a systems map...has probably contributed, as well."

Theme 2: What is systems thinking? [Definitions]

Key informants commented on several aspects of definitions in relation to systems thinking. These included challenges with definitions, differences between pragmatic versus more technical definitions and core accepted elements of systems related definitions.

A number of KIs reported taking a pragmatic approach to addressing definitional challenges in practice, such that they had a broad conceptualisation of what they considered to be systems thinking.

In spite of complexities, several core features of systems thinking approaches were highlighted, consistent with a traditional definition of systems thinking i.e. an approach which is *'broadly inclusive, cross-disciplinary conceptual framework and way of conceptualizing real-world phenomena as systems which aim to improve understanding of a whole, its parts and interconnectedness between components or factors, acknowledging that the context in which this exists is dynamic and changes over time'* (5).

Theme 2 KI Quotes – What is systems thinking? [Definitions]

Challenges with definitions



I think the systems is one of those words that just has way too many understandings.”



Lack of consensus or alignment in what is meant by that term [systems thinking], and how it translates into practical differences in program or policy design and implementation.”



I think there’s a really fundamental definitional question there. What do you mean? And I’ve been through this quite recently with government organisation X we could mean 17 different things. There’s probably an overlap, in the middle of that Venn diagram, where there’s a core, there’s an essence, to what we mean when we say a systems approach ...But there are lots of different permutations that inevitably take the conversation in slightly different directions.”

Pragmatic vs. technical definitions



So there’s a lot of language around systems thinking which I think unfortunately alienates... people who are making big decisions, it makes it seem extremely complicated. So while I’m a huge fan of the approach of complex adaptive systems, I try to keep it on the down low when I’m working in the field or I’m working on communications and persuading. I think it’s fine for us academics and others to kind of think through like those elements and it’s a complete motivator and a source of my intellectual base... but I don’t consider it essential, or that important... to popularise this notion.”



If you go to the average member of Parliament or legislator and say, “Are you doing systems thinking,” They will not relate to this. ...The people we’re trying to move, that is not what moves them. What moves them is, “Are you worried about the three-year-old who is already starving and that will impact to them?” Yes. If you start with that problem, the malnourished kid, ... you talk them through, ... we have to solve that in a couple of places and really help to have food support for their whole family.”

Defining features of systems thinking approaches

Complexity

“ The thing that's beneficial about labelling something as a complex system, is it acknowledges the complexity. A complex system has a pretty established definition and the complexity is that it arises from connections and has all these aspects of emergence, self-organization, tipping points, etc...”

Interconnectedness

“ When people try to understand systems they'll look at the parts - but a system is really defined by the relation between those things...”

“ If you're thinking about all the parts of a problem, that's holistic thinking. ...trying to wrap your head around all the pieces, but it's systems thinking approach is something where you are focusing on how those parts are connected.”

Theme 3: Systems thinking in practice

KIs highlighted the importance of recognising that many practitioners and policy makers are already deeply engaged in systems work whether or not they explicitly identify this.

KIs in different fields also described the evolution of systems thinking across sectors over decades although progress incorporating systems thinking in intervention design, implementation and scaling was described at different stages in different fields.

One KI with expertise in social sciences and ecology, highlighted a distinction between a mechanistic approach to systems thinking and more ecological approach. An example of an application of an ecological systems thinking approach in program design and implementation is outlined below. (See Section Five, Exemplar 3)

More generally, KIs and FGDs revealed several elements of applied systems thinking approaches in practice, including; context, purpose, participatory processes, collaboration and an emphasis on ongoing learning.

Key informants described a variable progression in application of systems thinking across sectors, from an evolving interest in the overall approach, driven by factors described above (See Theme 1: Why Systems thinking?) to more developed application of related frameworks and tools.

One KI, engaged in private sector consulting stated that application of systems thinking in their field was "...like building a plane while flying." By comparison, KIs within health described more developed application of systems thinking in their sectors with more specific sectoral definition/s of the "system", frameworks for systems strengthening and implementation science related to this.

Key informants expressed a variety of opinions about how applied systems thinking worked or might work alongside existing policy and program design and implementation approaches highlighted in quotes presented below. Several KIs highlighted both the feasibility and value of systems thinking approaches being incorporated within or alongside other policy, design and implementation approaches.

Theme 3 KI Quotes - Systems thinking in practice

Many practitioners already do systems work



I doubt that ECD programmes are not using systems thinking, they just might not call it systems thinking."



I think somebody who's working in a hospital setting might not think about their work as being part of a social network. But my goodness, they are exchanging different types of information with different types of people and they're all working together towards a common goal in a very complex and dynamic environment. I mean, that is a system but they may not see it that way..."

Variable development of systems thinking across sectors and disciplines



75% of the emphasis, both in practice and research in management science around systems thinking...driven to the question of how we build more systemic leaders? So it's very focused on leadership development."



One of the reasons that systems thinking is more popular...is because the outcome, at least in theory, is the public good... In the private sector, it's really much more simple right? The goal is profit. ... So in many ways, I think those applications share methods, they share theoretical histories, often, the communities that are discussing them are aligned. But in practice, they're very, very different questions."

Different approaches to systems thinking (e.g. mechanistic vs. ecological)

“ One of the most remarkable differences between these two systems is that in the ecological system there is no waste. The waste of one species is the food of another and so on and plants and animals and all are so intertwined...the mechanistic ones that are full of waste. Look at what's happening to our planet in terms of waste. Think of all the waste of people. People's capacities. It's because we just want them to do this certain thing and so you don't get creativity... But over in the organic and the ecological model there is much more capacity by its very structure for creativity.

“ Then the other thing, and this to me is just so fundamental, is that the structure is not a hierarchy; it's a network. It's a network that is self-organising and it's evolving... interdependence, diversity, flexibility - and those to come together in ways which create resilience - and then there's cycles.... There's not a linear path.”

Common elements of applied systems thinking approaches

Context

“ Implementation science at least contains the space for some of this. I don't think necessarily all of it or that well defined. But there's a lot of discussion about the context ... the organisational context and then the broader context in which things work.”

“ It's also very difficult when you're doing interventions that are very culturally specific, and where things in the environment change, ...you often need the internal comparisons to see how you're progressing over time... what's a meaningful comparison in that context? There may well be large cultural or context-dependent components... what matters more is what happens within your own group...in that case it's the processes that matter for continued learning.”

Purpose

“ A successful system, whether it's like a company or a hospital or a health system, needs to have simple aims ...that everybody gets across the system...people talk about vision...this notion...is actually much more concrete than vision...”

Participatory processes

“ Participatory co-design is important. The premise of this work in the corporate and governance space is the participation principle. If people are able to have a hand in designing a future context then there is a greater stickiness to it.”

“ The keys for system change are power, resource flows, relationships, & purpose. To disrupt the way that the system functions today you need to think 1) Where does the power sit? Does the power sit with hospitals? With government ministers that dictate policy? Can you give more power to families and young people...? 2) Resource flows, for example, information or funding. Could moving information around the system differently help? If parents had access to better info around the development of kids, would that lead to different choices? Is that a way to disrupt? Change different part of system?”

“ ...the population that they're supposed to serve...those that are being left out, the marginalised, what's important to them. ...their metrics might, well, they might be more qualitative, but they might be very different. Bringing them together... in non-threatening ways that... [is] a useful approach ...to building that kind of double loop learning.”

Collaboration

“ Well, commonly, there's three things: the interdependence, which basically says, “You need to collaborate, or at least deal with the other, are you going to look at stakeholders or agents in ... a framework?”...once you collaborate and bring in other stakeholders... [you] may need to break down and rebuild mental models...you need to be able to learn and adapt, well, it's best to do that with data than without.”

Learning

“ The key to these kind of interventions is learning, ... the explicit learning that you do and make, ...that you adapt from learnings as well as ... inherent learning ... that happens in response to things that you don't anticipate that's not necessarily intentional, but you learn anyways...”

“ Now, X would argue that the only thing that should scale, if we take systems thinking seriously, is learning. Because the nature of complexity, and one of the reasons we lean into systems thinking, is because there's no best practice. It's one of the reasons it's challenging to develop an evidence base for systems approaches. There's only good practice, and we need to be constantly iterating and learning based on the results of parallel experiments that are happening in place.”

Progression in use

“ I think we are not that developed as a policy sector globally... I think the vast majority of people who are using or are interested in the application of a systems approach, my assessment would be that they're in years zero to three of the work.”

“ I think healthcare delivery has always kind of thought about hardware and software together a lot more than other sectors have... so like a healthcare system is a widely understood concept I think”

“ For the work I do in health systems I always just go back to what we call the foundation. ...framework for kind of health system performance and the bottom of it is called the foundations... the building planks of the system. So population and governance and platforms and providers and tools are ...some of the things. ...when I look at a break in performance I kind of go back to those things. So I say is this about the population not getting it? Is this about regulation not being sufficient? I go back to the foundations and say which of these things are aimed in the wrong direction.”

“ I think most of the at scale solutions that have tried to be systems approaches have failed and that's because policy change and national government change doesn't work that way. Let's have a national statement on early childhood policy... They get a beautiful statement that people spend a long time getting everybody to agree on but that is not implemented in legislation, policy or budgets because those aren't implemented that way. What gets implemented are single programs or single laws that tend to be much more narrow that work within the ministry... So I think fundamentally you have to have a strategy for moving all the parts to scale and the parts understanding that children live in families and communities and societies ...”

“ If you start with that problem, the malnourished kid, can you talk them through... we have to solve that in a couple of places and really help to have food support for their whole family. There's good evidence that the following four things work: better minimum wage, food support and mums being able to take leave for breastfeeding. They know how to operate all that. It's very concrete, they can sell them, they can legislate them, they can budget them, they can make them happen. But if you say... the kid is malnourished because we're not thinking well about early childhood systems, they're off to the next person talking to them about air pollution. That is way too academic and unrelatable and impractical for most policymakers.”



I advocate that systems thinking is a really important part of our arsenal for solving problems. But there are more traditional methods of thinking and methods of analysis, that are absolutely non-systemic but that we rely upon for the proper functioning of society... a really good example of that is the rollout of COVID vaccines...on the one hand, we need randomised control trials in order to build up an evidence base for vaccines that work and are safe and effective to roll out across the population at scale. A lot of systems thinkers would tell you that RCTs are not an effective vehicle to demonstrate what works and what doesn't, in social and other contexts. But at the same time, when we need to develop evidence about how policymakers combat vaccine hesitancy in large populations, we probably want to be thinking more systemically about the causes, barriers, enablers, drivers of that challenge. So any good policy response to COVID-19, or ... to the question, how do governments increase vaccination rates, or develop a vaccine program for COVID-19, is inevitably going to involve systems thinking and non-systemic thinking. ...Systems thinking might well be the right tool. It will almost always need to be used in combination with other tools."

Theme 4: Relationship with scaling, sustainability, equity, resilience and acceleration

Scaling

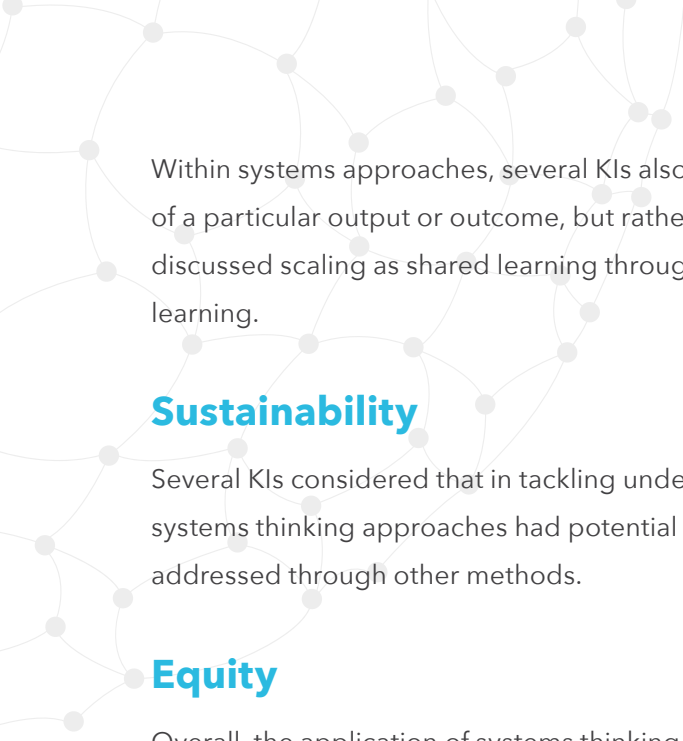
Key informants described a somewhat complex relationship between systems thinking and scaling, as defined earlier (See Glossary). Specifically, some KIs described a tension between the contextual and person-centred approaches of applied systems thinking and more mechanistic approaches to scaling interventions or programs.

However, one KI working in agronomy argued that systems thinking approaches were essential to scaling and described that systems thinking was embedded in scaling in their sector stating,



When you look at, particularly with these issues of scaling up or scaling out...that's where the systems thinking approach can be very useful, because as you try to do things at a broader level, you tend to encounter more obstacles and challenges to things that... confront the work that you might have done in a pilot."

The same key informant then described a range of technology based tools, more suited to products than people or process, which had been recently developed to improve system diagnostics and next steps for scaling in their sector.



Within systems approaches, several KIs also suggested that the emphasis is not on scaling production of a particular output or outcome, but rather learning itself (See also Theme 3 above). With this lens, KIs discussed scaling as shared learning through networks and creation of environments which enabled learning.

Sustainability

Several KIs considered that in tackling underlying determinants of health (or other complex challenges), systems thinking approaches had potential to sustainably address issues which could not be adequately addressed through other methods.

Equity

Overall, the application of systems thinking approaches, with an emphasis on collaboration and participation of primary actors and the community, seemed aligned with efforts to improve equity. Indeed, a number of exemplars provided by KIs highlighted this through their focus and reach of marginalised populations. (See Section Five: Exemplars below). One KI who generally expressed scepticism about the impact of complex systems interventions at scale, considered that this was a particular potential role for systems thinking informed approaches. They gave the specific example of inclusive education as illustrative of how systems thinking informed approaches might improve reach to marginalised populations, in this example, children with disabilities (See Quotes below)

However, KIs also highlighted that to realise the potential of systems thinking approaches to address inequities, attention to processes which are participatory and engage primary actors and community is important.

Resilience

Key informants gave examples of ways in which applied systems thinking can promote resilience, including in crisis situations and with vulnerable communities. For example, one KI working in health systems described how experiences using systems thinking approaches in crisis situations in a low-income setting had informed their response to challenges of the COVID-19 pandemic in a high-income setting.

Another KI described how the application of ecological systems thinking approaches was associated with a focus on strengths, rather than vulnerabilities in marginalised populations, and hence promoted resilience. This was elaborated in discussion of the application of systems thinking within Hawaiian indigenous communities (See also Section 5: Exemplars below).

One element of our underlying research question that remained relatively under-explored in qualitative data collected was the relationship between applied systems thinking and acceleration of progress in implementation, scaling or impact interventions. Although we asked specifically about this, no examples were forthcoming.



Theme 4 KI Quotes - relationship with scaling, sustainability, equity, resilience and acceleration

Scaling

Contextual and place-based

“...if a systems approach has to recognize the importance of context, how could it ever be scalable? Okay, but if it's not scalable what's the point of taking a systems approach? I don't know if systems approaches are not scalable.”

“You have to know your environment...the whole mentality of people in different ecological situations is different... So when you're thinking of trying to scale... bringing that knowledge together and saying, okay, now how do we work in this setting with this group of people...”

“So I think part of the challenge is we're just not far enough along the developmental pathway to show those scaled benefits. I think on scale, I think it works a lot, I think works very well in a place-based local setting, like a local authority, thinking about a collective impact initiative... I think the policy evidence, and ... the anecdotal evidence from people that are doing that work on the ground shows thinking about it and working it through systemically helps.”

Scaling through learning networks

“In the context of intervention, whether that's a community, or a district, bring them together to share how they learn. It seems to be part of that scaling experience and productive ways so that you get...better learning.”

“Now, X would argue that the only thing that should scale, if we take systems thinking seriously, is learning. ...if you think about a hierarchy, and you've got your local delivery units, and you've got a local authority, and a state authority, and a national authority, and ministers, his argument is that each scale should be enabling the scale below itself to learn, and engaged in learning activities to scale those up... we need to be constantly iterating and learning based on the results of parallel experiments that are happening in place.”

Hierarchies vs learning organisations and networks

“You don't want something to scale up the organisation, you want the organisation to be designed in a way where scale is almost flat, or it's almost scale free. It's more about thinking about it as a network and transferring learnings across the network.”

“ The role of health policy decision makers, if they were taking systems thinking seriously...how do they create the conditions for the other actors in the system to think and work in systemic ways? How do they make it easy for them to do those things? And how do they make it hard for them not to? And so that’s probably the scaling narrative...And it assumes a central decision maker, but I think there are ways around that.”

Sustainability

“ Health systems in countries that I care a lot about are performing at 40% of what they ought to be doing... in terms of the quality of care that they give. Almost nothing can move that needle without ... tackling the deep underlying structures and thinking about how they interact and thinking about how to set up the foundations of that system, rejig them, such that over time they will nudge the performance in the direction that we hope. I’m convinced of that. ...you hear a lot about leap frogging and work arounds and we can just skip this step and move onto this one, ...maybe we don’t need all these doctors and nurses seeing people in person, we can just do it all on Zoom, it’s so great right. These sort of simplistic solutions are so baked into our nature of... seeking the lowest hanging fruit that I think they’re really diverting us from the real attention of how do we organize work in the system.”

Equity

“ Do the teachers understand inclusive education? Do they know how to do it? Do they have the facilities? What kinds of kids with special needs are being included? There are a million detailed questions where systems thinking, I believe, really would benefit inclusive education. ...I think I can solve parental leave without systems thinking but I don’t think you can solve inclusive education without systems thinking.”

“ Participatory learning approaches are extremely valuable to be able to do that. I think that’s needed for sustainability, but definitely for equity issues...You can still do it wrong if you do participatory approaches with the elite, you’re still going to have the equity issues although you still can improve the program...You need those kind of approaches that break down mental models and that build collaborations, and that collect data from the right places.”

“ I’ve seen time and time again, when that top down implementation [of a systems approach] occurs, staff at the coalface inevitably ask two questions. “But what do you mean?”, being the first question, and then the second question is, “And how is it different from what we always do?”

Resilience

“ I learned firsthand during the Ebola outbreaks, and then anticipated it here... You have that kind of shock, you need to first of all think of things like, “Well, where do you start?” and understanding that you need to work with communities, and engage communities in these kind of shocks is critical... in Liberia we had had riots, literally riots about Ebola, and then learned the hard way that no, you need to engage communities. And once you had traditional speakers understanding and being the messengers, that was important.”

“ We learned early that mental health and stigma are going to be a big part of this, that became really critical in dealing with the social aspects of a crisis. And we should have learned that from other disasters, because it's common, and it's not measured.....Not that you prevent them, for instance, the mental health shock, but we were prepared and understood that all of that was coming...”

“ Often when you look at so-called vulnerable groups, the intervention you want to take is actually a strength-based approach and often it's building on whatever that strength is, ... whether it's ...culture or social capital, or traditional knowledge, ... it's something I've been learning a lot from Indigenous peoples....”

Theme 5: Measurement - data, indicators, monitoring and evaluation

Data and measurement were seen as crucial within application of systems thinking approaches, but also challenging. Firstly, data itself was acknowledged as a potential systems intervention as one KI noted, “Data itself can be a systems intervention which is deeply catalytic”

Secondly, a number of KIs highlighted how systems thinking approaches raised important questions about what is measured and why. However, measurement at many levels was highlighted as a challenging area, requiring further exploration and development in application of systems thinking moving forwards.

A number of KIs highlighted different approaches, methods and tools they were aware of being used to try and address measurement challenges in the field. (See KI Quotes below).

These and other resource links suggested by KIs provide an opportunity for further exploration of monitoring and evaluation approaches and development of related indicators, potentially relevant to ECD, moving forwards.

Theme 5 KI Quotes - Measurement - data, indicators, monitoring and evaluation



Data itself can be a systems intervention which is deeply catalytic"



Measurement for what. That's the first question I ask... we've done a lot of thinking about this internally and... there are three reasons to measure...one is accountability right. You measure because somebody wants to know whether the money's well spent. The second is improvement. You're measuring because you're trying to see what's going on under the hood and you want to tweak it. And the third one is sort of advocacy. Like you want to be able to use some of these data to make a case, you know."



Statistics is not necessarily consistent with management... Health statistics is more epidemiological than management. Economists have to work with situations that are not experimental. They have to make inferences about countries and trends and situations that defy epidemiological think. We're much more comfortable with econometrics, than biometrics. And using designs that are not randomized but are consistent with the way a program manager thinks... results that emerge, are convergent with strategic considerations about how to change the way things work. We optimise for systems thinking rather than optimising for statistical inference."



I collaborated with a system scientist from the computing field. They go about evaluating things quite differently than, health scientists do. They need immediate, continuous appraisal of whether something is optimal, or improves upon some way of doing things. And this optimization thinking has the buzzword or term agile science. An agile scientist, doesn't look at a project, they look at a process. They look at science as if it's management itself. They integrate their code into management thinking. They try to improve the way things work in response to management criteria and prerogatives. They respond to user needs and then continuously develop code. They never end."

Summary of qualitative perspective key findings

Text Box 4: Summary of key findings from the qualitative exploration

Question - What are stakeholder experiences and perspectives in implementing complex systems interventions at scale in diverse settings?

Key themes emerging from qualitative analysis were as described below:

Theme 1: Why systems thinking?

Applied systems thinking has a variable history across sectors, often driven by the need for innovative approaches to tackle complex problems where traditional approaches are perceived to fall short. Described drivers towards systems thinking approaches included limitations of empirical evidence base to inform public policy coupled with challenges related to complexity, scaling, sustainability and equity.

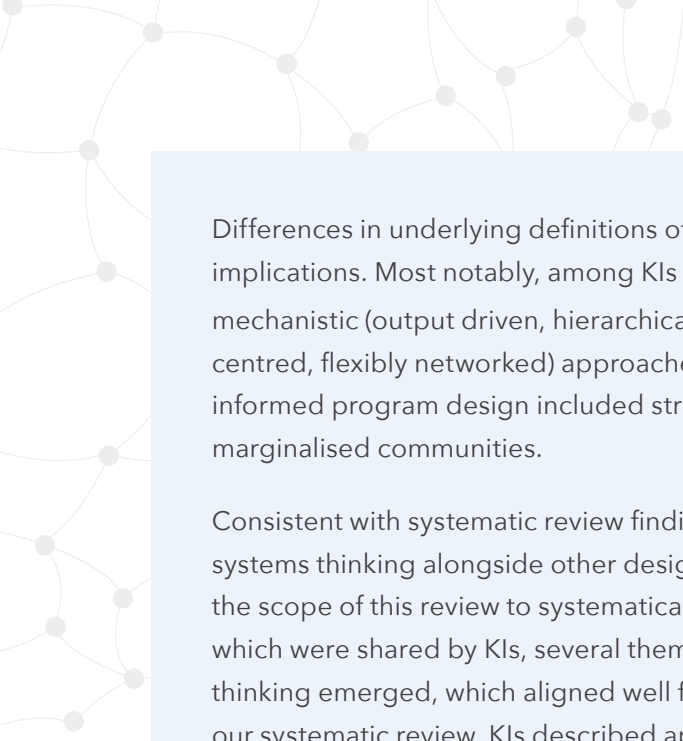
Theme 2: What is systems thinking?

Terminology was recognised as important although challenges with lack of clarity and multiple definitions of terms related to systems thinking were also broadly acknowledged. While explicit use of systems related terms (e.g. complexity) were considered to be beneficial, concerns were raised about the potential for highly technical terminology to alienate policy makers and practitioners.

However, in spite of this complexity defining features of systems thinking approaches, consistent with previous literature were noted including explicit acknowledgement of complexity, a focus on connections between systems components, emergence and non-linearity.

Theme 3: Systems thinking in practice

Systems thinking was described in different stages of its evolution and application across different sectors although its history overall spans many decades. KIs highlighted that practitioners in different fields may already apply elements of systems thinking without naming this approach. In some sectors applied systems thinking was described as being in an early stage of emergence with efforts to apply systems thinking approaches, tools and methods being like “building a plane while flying”. In other sectors (e.g. health, agriculture, ecology) a long-history of systems thinking application was described, with well-developed application of systems thinking approaches, tools and methods.



Differences in underlying definitions of systems thinking were also noted to have practical implications. Most notably, among KIs with a grounding in ecology, a difference between mechanistic (output driven, hierarchically structured) and ecological (purpose and process centred, flexibly networked) approaches was highlighted. Examples of ecological systems informed program design included strengths-based programming to build resilience among marginalised communities.

Consistent with systematic review findings, KIs described examples of incorporating applied systems thinking alongside other design and implementation approaches. While it was beyond the scope of this review to systematically describe specifics of related tools and methods which were shared by KIs, several themes related to core elements of applied systems thinking emerged, which aligned well features of successful systems interventions noted in our systematic review. KIs described applied systems thinking approaches as focused on the following elements;

- Context
- Purpose
- Process
- Collaboration
- Learning

Theme 4: Relationship with scaling, sustainability, equity, resilience and acceleration

The relationship between application of systems thinking approaches with scaling, sustainability, equity and resilience appeared complex with mixed KI perceptions. Practice examples related to applied systems thinking to support scaling, promote equity and resilience were given but under-explored in evaluation and research.

Theme 5: Measurement - data, indicators, monitoring & evaluation

Data and measurement were seen as crucial within application of systems thinking approaches, but also challenging, requiring further exploration and development in application of systems thinking moving forwards. KIs highlighted a range of innovative approaches, methods and tools they were aware of being used to try and address measurement challenges in the field. These and other resource links suggested by KIs provide an opportunity for further exploration of monitoring and evaluation approaches and development of related indicators, potentially relevant to ECD, moving forwards.





SECTION FIVE: EXEMPLARS



Exemplar 1: Water, Sanitation and Hygiene (WASH) (16)

Text Box 5: Learning from systems thinking evolutions in health (Ethiopia, Kenya, Uganda)

It is estimated that 2.3 billion people worldwide still lack access to adequate water, sanitation and hygiene (WASH). Although a clear set of technologies and approaches to the provision of WASH, sustainable service delivery is a major challenge.

Inadequate access to appropriate WASH services, predominantly affects the rural poor in low and middle income countries (LMIC). Acknowledging the need for fresh approaches to this equity and sustainability challenge, over time an increased emphasis on the potential role of applied system thinking has emerged within the WASH sector.

One example of this, is the \$15,300,000 USD investment of USAID in the Sustainable WASH Systems (SWS) learning partnerships (2016 - 2021). In this program of work USAID partnered with the University of Colorado, Environmental incentives, IRC WASH, Tetra Tech, LINC, WaterSHED, Whave and Oxford University with the aim of testing new ideas, approaches and tools to strengthen local WASH systems and improve sustainability over 5 years in Cambodia, Ethiopia, Kenya and Uganda. The premise underlying SWS was that sustainable change in WASH required strengthened understanding of WASH systems to improve problem definition and more effective solutions.

The approach included a focus on WASH system technical components as well as less tangible system dynamics. Interventions focused on professionalized maintenance for rural water services, collective action approaches and improving systems understanding and engagement using a range of tools, methods and resources. Partners developed, tested, and documented “high-potential systems approaches for local WASH service delivery” with an equal emphasis on both improving service delivery and sustainability as well as building the knowledge and evidence for the global WASH sector on “how systems approaches can be applied, adapted, and scaled in different contexts.”

The project generated lessons learned that were published in peer-reviewed journals on topics like “pathways for collaboratively strengthening water and sanitation systems”, “adapting collaborative approaches for services provision to low-income countries”, “understanding rural water services as a complex system”, technical and thematic briefs and blogs learned from the countries around the key themes of collective and collaborative approaches, professionalized maintenance of WASH services, and systems understanding and engagement.

SWS made important contributions to both the local and global WASH sector, including: identifying system assessments relevant for WASH; implementing a range of assessments with

SWS partners; indicators of improved sustainability of WASH services; and improvement in WASH networks.

Relevance to thinking about the potential role of systems approaches, tools and methods in ECD?

This exemplar highlights how, systems thinking approaches apply even in single sector interventions at large scale and how, over time within the WASH sector, systems thinking has evolved from a conceptual approach to larger scale prospective applied systems thinking supported by operational research to explore innovative potential strategies to overcome entrenched, complex challenges of equitable and sustainable implementation at scale. In the example of SWS, this evolution was supported by a medium term (5 year) multistakeholder funded partnership with specific geographic focus.

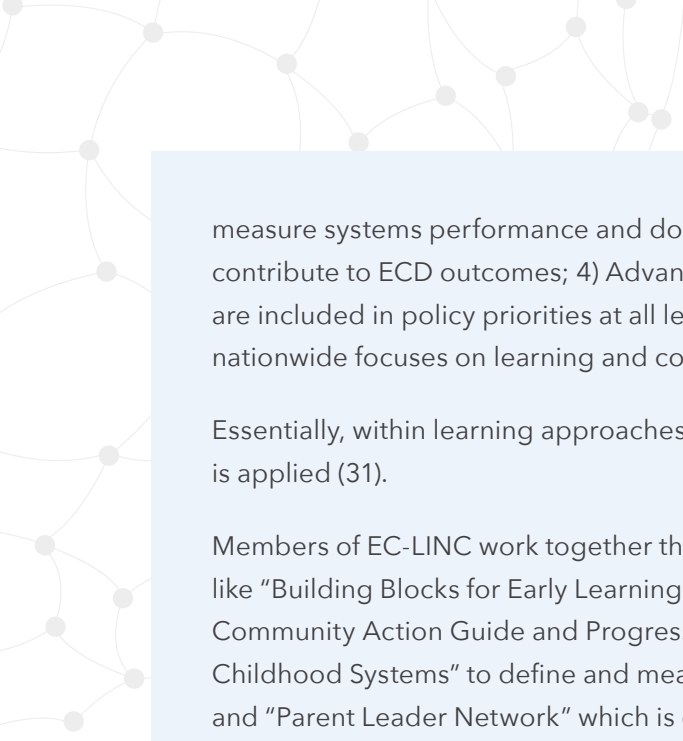
In ECD, how can we learn from these types of experiences in other sectors, to map a path from systems thinking concepts, to more rigorous exploration with applications of systems thinking approaches, methods and tools in areas where scaled promotion of ECD is urgently needed?

Exemplar 2: Early childhood learning and innovation network for communities (EC-LINC), USA

Text Box 6: Early childhood learning and innovation network for communities (EC-LINC), USA

The Center for the Study of Social Policy (CSSP) is a US-based national, non-profit policy organization focused on connecting community action with public system and policy change. CSSP established the “Early Childhood Learning and Innovation Network for Communities” (EC-LINC) formed of partners across 14 local communities in the United States who collectively contribute to services, supports, policies, and practices for young children and their families from birth to age eight (30).

Their key areas of action and learning for the EC-LINC include: 1) Integrating family voice, leadership, and equity, where partners implement and document how local ECD systems produce more equitable outcomes when parent leadership is included; 2) Transforming practice and systems which focuses on supporting direct service providers and reforming the systems they operate within; 3) Building evidence focused on innovating and testing tools to



measure systems performance and document how improvements in systems performance contribute to ECD outcomes; 4) Advancing policy focuses on ensuring community voices are included in policy priorities at all levels; and 5) Advancing local early childhood systems nationwide focuses on learning and coordination across networks for better ECD outcomes.

Essentially, within learning approaches a systems approach to continuous quality improvement is applied (31).

Members of EC-LINC work together through various systems-level collaborative initiatives like “Building Blocks for Early Learning Communities” where they pilot test an Early Learning Community Action Guide and Progress Rating Tool; “Outcomes and Metrics for Early Childhood Systems” to define and measure well-functioning local early childhood systems; and “Parent Leader Network” which is community of practice to strengthen family engagement in early childhood as a way to achieve equity and community empowerment among a number of other innovation and learning collaborations.

EC-LINC concluded that “a well-functioning early childhood system reaches families with the help they need, improves the coordination of services and supports, promotes a climate of support for early childhood, and increases parent engagement and equity.” This formed the building blocks of their systems measurement framework which included indicators across key systems-level contributions including: foundations, reach, coordination, commitment and equity.

Key lessons learned by EC-LINC through this process included the value of community-led systems efforts, measurement of systems performance and the importance of a focus on equity, in spite of challenges. Lessons related to outcomes, indicators and systems performance measures were also described. Overall, the approach to evaluation used by the initiative was one of ‘visionary evaluation’ based on iteration or repeated trial and error, and embedding learning within the system than a more linear, traditional evaluation approach.

What are the reflections from this collaborative for applied systems thinking in ECD?

EC-LINC provides an example of learning collaboratives at scale, with a focus on children and active participation of families which invested in processes, data and indicators to measure and track progress. It provides an example of how systems thinking approaches can be progressed, from application of an overall approach, to more explicit application or codification of systems thinking related tools and methods.



Exemplar 3: Learning about the potential of systems thinking for ECD through retrospective analysis of programs at scale

Text Box 7: Learning about the potential of systems thinking for ECD through retrospective analysis of programs at scale

Brazil's Programa Crianca Feliz (PCF)


Programa Criança Feliz (PCF - 'Happy Child' ECD program) is a program in Brazil a country with over 207million people, 11% of whom are children less than 6 years old.

PCF is a parenting and home visiting program based on the WHO/UNICEF Care for Child Development. It includes pregnant women and their children up to the age of 36months with targeting of socially vulnerable or at-risk families and children under the age of 6 years with disabilities. It is supported by intersectoral approaches to strengthen family and community networks and a multi-level government implementation strategy.

PCF was launched in 2016 in response to national legislation which aimed to address endemic financial and racial inequities including in children. Specifically, in a supportive legislative context, Buccini et al (19) report that the program was launched on a 'large scale by passing both efficacy testing and real world trials'. By 2020 it was implemented in 2934 of 5570 municipalities nationally and therefore represents one of the largest home visiting programs in the world. To explore barriers and enablers for PCF emergence, scaling-up and sustainability, Buccini et al (19) completed a qualitative case study in which they combined the use of an implementation science framework (RE-AIM) and complex adaptive systems (CAS) constructs to qualitatively analyse perspectives of key informants at national and federal levels. CAS constructs applied included; path dependence, positive and negative feedback loops, emergence behaviour and phase transitions.

At the time of program emergence, political instability and budget cuts to social assistance were viewed as negative feedback loops for PCF implementation. Nevertheless, an enabling national political environment through individual championship and a related presidential decree, parliamentary support, high level partnerships and a supportive legislative framework were considered key factors in program emergence in spite of these challenges. However, a top-down approach generated negative feedback loops for adoption, reach and effectiveness. Similarly, rushed scale-up generated negative feedback loops in terms of program implementation, coverage and quality.

Chile Crece Contigo, India's Integrated Child Development Services, Grade R in South Africa and Bangladesh's Child Development Centres



In one of few published papers exploring the relevance of systems thinking to ECD, Pérez-Escamilla et al. used a complex adaptive systems framework to retrospectively evaluate large-scale ECD programs in four low-and middle-income countries (Bangladesh, India, South Africa and Chile)(32). The authors found that analysis using a complex systems framework was relevant and improved understanding of how programs had been scaled, as well as systems factors which promoted successful implementation and scaling (32). Further exploration of how such methods could be prospectively applied, drawing in expertise and experiences from other sectors where their use is more commonplace, may yield further insights into approaches for strengthening scaled promotion of ECD.

They noted a number of ways in which program emergence, scaling and sustainability behaved like complex systems and several system features associated with successful scaling (32). These included positive feedback and tipping points related to political support (both international and domestic), international partnerships, evidence-informed program design, monitoring and evaluation systems and workforce development.

Technical and social networks related to referral pathways, leveraging parent and carer engagement to facilitate demand generation and innovation spread and local contextualisation were also observed to be positive for scaling (32). By contrast, negative feedback loops stemming from complexity due to the multi-sectoral nature of ECD and an over-burdened workforce were seen as detrimental to programme implementation and scaling (32).

Implications for understanding the potential role of applied systems thinking in scaling ECD

This case study and similar retrospective CAS analyses of scaling ECD programmes by Pérez-Escamilla et al (32) demonstrate how systems thinking methods can be successfully applied to increase nuanced, contextual understanding of barriers and enablers to effective design, implementation and sustainable scaling of ECD programs in diverse settings.

Arguably, the retrospective, rather than prospective application of CAS methods and tools to scaling challenges in ECD in these case studies also reflect an earlier stage in the application of systems thinking approaches and methods within ECD compared with other disciplines.

In ECD, perhaps a relevant question is therefore, how can systems thinking approaches and methods be prospectively applied to inform scaling of ECD in diverse settings?



Exemplar 4: Lili'uokalani Trust

Text Box 8: Systems mapping and culturally-appropriate evaluation frameworks

Summary of program

The Lili'uokalani Trust (LT) is a private foundation, based on the mission of Queen Lili'uokalani to ensure wellbeing of Native Hawaiian children and 'Ohana (families), to provide opportunities for Hawaiian children to realise their greatest potential (33).

LT utilises a systems approach to creating sustainable change, driven by the belief that sustainable solutions require root causes of poorer outcomes to be tackled. LT recognises that change at the scale needed to break the cycle of poverty requires addressing all levels of the system around the individual. In order to achieve the end goal, a systems map has been developed to examine and better understand the system. The map highlights negative patterns and identifies leverage points for generating change. The LT systems map, developed by over 300 contributors is a 'living document' that evolves and changes over time and is utilized to inform their strategic vision (34).

LT recognizes the need for a 'focussed and expansionary working theory of change'. Delivering social work services to children in need at the micro level, focussing on particular challenges identified within the community such as teen pregnancy, youth incarceration and homelessness. LT also invests in work at the meso level, by collaborating with and supporting other organizations' efforts in improving education, physical and mental health in low resourced, predominantly Hawaiian communities, with the aim of strengthening the networks surrounding families to drive greater collective impact. At the macro level, LT works to increase equitable outcomes for Hawaiian children across systems through research, advocacy and education about poverty and wellbeing (33).

LT aims to measure thriving by wellbeing outcomes that are grounded in a Hawaiian culture-based perspective on wellbeing. The Trust utilizes an Aloha Framework (35), which emerged from this context to strengthen evaluation processes through authentically and holistically reflecting the lives, values and experiences of the Hawaiian people.

Implications for understanding the potential role of applied systems thinking in scaling ECD

This exemplar demonstrates the importance of systems mapping as an important step in understanding the system. Utilising this approach to map ECD systems and highlight the strengths and weaknesses will facilitate identification of leverage points for intervention. LT also illustrates how evaluation of impact can be achieved through a contextually and culturally appropriate framework. The tools and resources used by the LT to implement their mission i.e. the Aloha Framework and their systems map along with a detailed explainer have very generously been made available and could be drawn upon for inspiration and to stimulate the development of systems-informed approaches to ECD in diverse contexts.

SECTION SIX: LIMITATIONS AND OVERALL KEY FINDINGS



Limitations

Our systematic review was designed, in combination with qualitative methods, to rigorously answer our underlying research question. However, there are a number of limitations of our systematic review. Our search required that studies be associated with search terms related to systems. As we have described in this report, much research and program work that is informed by systems thinking approaches may not be identified by this terminology. As such, while this creates a bias in literature captured within our search strategy, it is perhaps unavoidable.

Similarly, by requiring studies to have an experimental study design with a priori determination of outcomes of interest and a comparator group, we automatically excluded research or program evaluations that used other methods such as time series, cohort data or case series. Many dynamic systems or complexity-theory-oriented studies do not use experimental designs but use more descriptive approaches to both qualitative and quantitative documentation of systems change. Such studies would not have been captured in our systematic literature review.

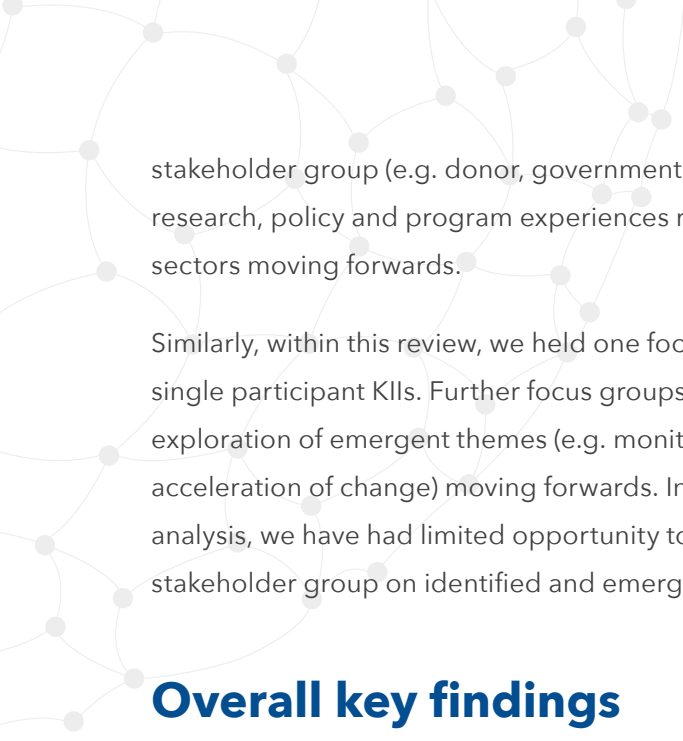
While these restrictions inevitably excluded some relevant literature, we consider a literature review of this scope would have been unmanageable without these restrictions. Further, we consider that the restrictions used were most appropriate to our research question, which sought best available evidence related to impact of systems thinking approaches, rather than seeking to describe the expansive broader literature related to this topic.

Additionally, during our systematic review, where we identified papers that were of broad interest or relevance, these were read so that they contributed to our team's broader understanding of the literature. Similarly, where our EAG or KIs highlighted research that was not captured by our review, we ran these through our search strategy to understand whether these had been missed due to human error. One paper was identified through this checking process.

While other methods of review such as network or bibliometric analyses of the literature may have made the review more manageable, we did not consider that these methods were best suited to answer our underlying research question.

Further, while our use of systematic review methods and the limited number of studies retrieved through this approach raises important questions about how we measure evidence related to systems thinking, we do not consider this a limitation of our methods, but rather a reflection of important questions related to this field, as discussed further below.

Within the timeframe available for this review, we were limited in the number of key informant interviews and focus groups undertaken. While our KI sample included stakeholders from a number of countries and diverse sectors, there was limited representation from some geographic regions and stakeholder groups (e.g. government). Similarly, our representation from some sectors specifically relevant to ECD (e.g. nutrition, social protection, mental health) was also limited. Further exploration with a broader



stakeholder group (e.g. donor, government) remains an important opportunity to consider further research, policy and program experiences related to the application of systems thinking, in diverse sectors moving forwards.

Similarly, within this review, we held one focus group, with the rest of qualitative data collection being by single participant KIs. Further focus groups may also provide additional perspectives and more in-depth exploration of emergent themes (e.g. monitoring and evaluation, systems resilience and sustainability, acceleration of change) moving forwards. In the same way, within the time frame for qualitative data analysis, we have had limited opportunity to date, to seek reflective feedback from our EAG and broader stakeholder group on identified and emergent themes.

Overall key findings

Key findings are based on the systematic review and qualitative thematic analysis of KI interviews and focus groups. These provide insights into the potential application of systems thinking for addressing commonly experienced challenges to equitable and sustainable promotion of ECD at scale. Five overall key finds are described below.

Text Box 9: Overall key findings

1. There are compelling drivers towards systems thinking in ECD.

KIs described an increased focus on systems across multiple sectors over variable periods of time. Often this was described as arising from the need for innovative approaches to tackle complex problems where traditional approaches were perceived to fall short, especially when addressing complexity and in the context of challenges with sustainable and equitable implementation and scaling. These resonated with similar identified challenges in promotion of ECD at scale.

2. Terminology is important but also a challenge.

The multiple related, overlapping and sometimes highly technical definitions of systems thinking may be a barrier to engaging practitioners and policymakers. This is despite the fact that many stakeholders may already be using applied systems thinking without defining their work as such.

3. There is an evidence gap regarding measured impact at scale.

Whilst much is written about complex systems interventions in general, there are very few documented examples in the published literature describing measured impact of applied systems thinking on prospectively defined population outcomes at scale. In our extensive systematic literature review, only five studies were identified, all within the health sector.



4. Successfully applied systems thinking interventions have common elements.

Research studies identified in our systematic review (n=5) demonstrate how systems thinking can be integrated within (health) program design, implementation and evaluation with measurable impact on population outcomes at scale. Our systematic review and triangulated with key informant perspectives identified five common features of successful interventions:

- **Purpose:** clearly defined and shared goals and aims for multiple stakeholder groups.
- **Context:** deep understanding of local context, in some cases with a long history of embedded implementation research.
- **Process:** codesign and implementation that incorporates both 'top-down' and 'bottom-up' elements and a strong focus on stakeholder engagement, especially at community level. In all examples program design targeted multiple system levels, beyond a focus on front-line workers alone.
- **Continual learning:** using data and indicators for monitoring, adaptation and feedback as well as mixed methods approaches for monitoring and evaluation
- **Collaboration and networking:** is key to intervention design and implementation

5. Innovation is required to address measurement challenges.

The iterative, multifaceted nature of complex systems interventions makes application of traditional research and program monitoring and evaluation methods challenging. However, existing implementation frameworks, with an emphasis on context and process, may provide an opportunity for integrating relevant indicators to measure and evaluate systems thinking approaches. To do this, data and development of indicators which allow for comparison of applied systems thinking approaches across contexts are needed. Innovations in mixed-methods monitoring and evaluation, learning from experiences, resources and tools used in other sectors may provide an opportunity to strengthen measurement of process and outcomes are also needed.

DISCUSSION



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Discussion

This evidence synthesis aimed to explore the potential application of systems thinking in addressing long-standing challenges and accelerating progress in equitable and sustainable promotion of ECD at scale. To achieve this, we completed what is to our knowledge, the first intersectoral mixed method evidence review and synthesis regarding the impact of systems interventions on outcomes at scale across diverse sectors. The results provide a unique contribution to an evolving discussion about the potential application of systems thinking within ECD, building on what has been learned through the increasing application of systems thinking approaches, tools and methods in other sectors.

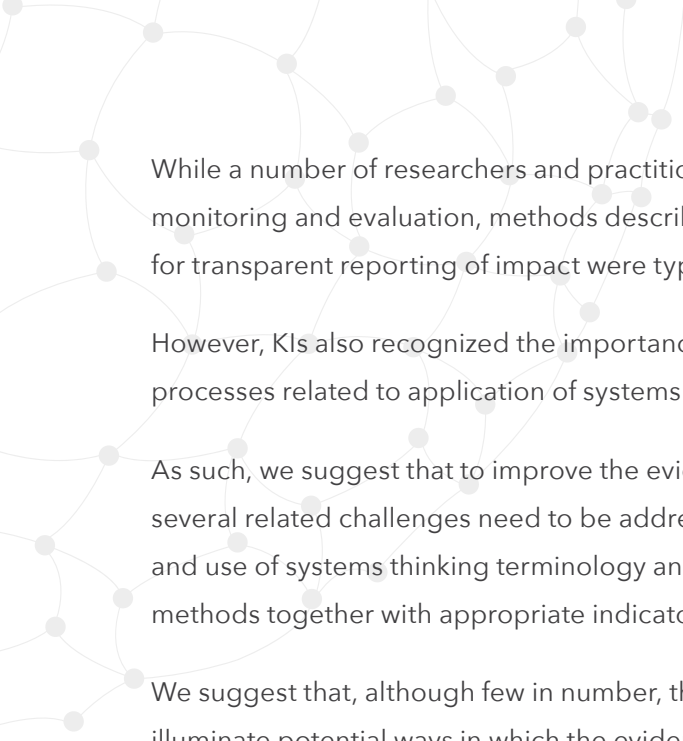
In our review, KI perspectives highlighted the broad appeal of systems thinking approaches to address challenges commonly experienced in designing and implementing a wide range of interventions at scale, across diverse sectors. Multiple KIs described how a shift towards systems thinking had occurred in their discipline, driven by a recognition that innovative approaches were needed to address complex challenges and support more sustainable and equitable solutions at scale.

This shift towards systems thinking was observed, in both published literature and within our qualitative data, to have occurred at different paces in different sectors. For example, complex adaptive systems approaches, methodologies and tools developed over many decades with contributions from multiple disciplines (36). In more recent decades, in health and several other sectors, an evolution has occurred with application of these systems thinking approaches and tools to address specific sectoral implementation challenges (36).

Previous literature reviews have also observed an increase in applications of systems thinking over time. For example, systematic literature reviews related to systems thinking within health have described an exponential increase in the number of published papers related to this topic from the 1990's onwards (6, 37, 38). Similar to our evidence synthesis, Chughtai et al completed a mixed methods review of systems thinking literature in public health which provided an 'over-arching storyline' for the application of systems thinking in that field and demonstrated that of all related papers published between 1994 and 2014 (n=557 papers), half were published after 2010 (6).

However, also consistent with previous published literature, our findings indicate that while there is much interest and exploration in the application of systems thinking across sectors, much of the discussion and literature is conceptual, not well-documented or evaluated through non-experimental methods (6, 37 - 40).

KIs highlighted several important reflections related to this observation. Firstly, KIs indicated that many researchers and practitioners working within complex systems do not identify with or use related systems thinking terminology. Thus, published literature searches related to systems thinking, that rely on identifying related search terms, as our search strategy did, may not capture all relevant literature. Secondly, KIs described systems interventions as being inherently difficult to test using traditional experimental research methods due to their interconnectedness, dynamic and non-linear features.



While a number of researchers and practitioners highlighted emerging and innovative approaches to monitoring and evaluation, methods described were predominantly qualitative and data and indicators for transparent reporting of impact were typically lacking.

However, KIs also recognized the importance of strengthening the evidence base for impact and processes related to application of systems thinking, to further understand its utility moving forwards.

As such, we suggest that to improve the evidence base related to application of systems thinking in ECD, several related challenges need to be addressed. These include both strengthening understanding and use of systems thinking terminology and further exploration of innovative research and evaluation methods together with appropriate indicators to measure and track progress.

We suggest that, although few in number, the five published studies identified through our review illuminate potential ways in which the evidence base related to application of systems thinking in ECD might be strengthened moving forwards.

All five identified studies occurred in low- and middle-income countries, within existing health services and typically occurred in the context of a pre-established structure for large-scale implementation research. Studies used mixed research designs including randomized control trials, quasi-experimental designs and stepped-wedged cluster randomized trials with mixed qualitative and quantitative methods for monitoring and evaluation.

All studies also used existing managerial structures (e.g. hospitals, districts, communities) to establish comparator groups. Additionally, while all applied complex systems interventions, systems-specific terminology, approaches and tools were applied within existing public health program design, implementation, evaluation and research frameworks.

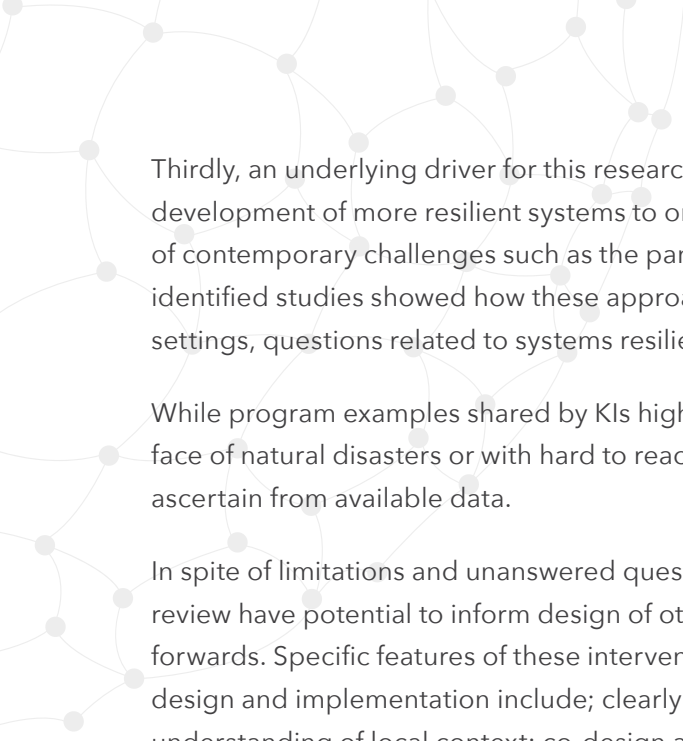
Thus, whilst challenging, we argue that the small number of studies identified in our systematic review are stand out examples which highlight how systems approaches might be applied and tested within existing ECD program design and implementation frameworks, to strengthen the evidence based related to this moving forwards.

We also note that, in answer to our primary research question, all studies demonstrated positive impact on target population health outcomes at scale, in their various contexts. Thus, while evidence is limited, these studies in health systems demonstrate the potential for complex systems interventions to positively impact a number of health outcomes, implemented at scale in diverse settings.

However, our literature review also highlighted a number of gaps relevant to consideration for ECD. Firstly, a number of key informants highlighted the intersectoral nature of ECD interventions as an aspect of ECD systems requiring particular attention within application of systems thinking moving forwards.

Secondly, whilst all studies showed impact at scale, this impact was demonstrated at subnational scale, in the short term. Further research at even larger scale and with longer-follow-up will be required, particularly in child development, to ascertain both short term impacts and sustainability of demonstrated results.





Thirdly, an underlying driver for this research was whether systems approaches could support development of more resilient systems to or accelerate change, to moderate child development impacts of contemporary challenges such as the pandemic, conflict natural disasters and the climate crisis. While identified studies showed how these approaches could be successfully applied in resource-limited settings, questions related to systems resilience and accelerators remain under-explored.

While program examples shared by KIs highlight ways in which they may promote resilience (e.g. in the face of natural disasters or with hard to reach populations), the impact of these programs was difficult to ascertain from available data.

In spite of limitations and unanswered questions, successful programs identified by our systematic review have potential to inform design of other complex systems interventions, including in ECD moving forwards. Specific features of these interventions which are noteworthy with regards to ECD intervention design and implementation include; clearly defined and shared goals across stakeholder groups; deep understanding of local context; co-design and implementation which is both 'top-down' and 'bottom-up' and moves well beyond a focus on front-line workers; emphasis on continual learning and quality improvement approaches and collaboration and networking.

Building on these findings, what can we say then for ECD? Our review suggests that in ECD as in other sectors, there is demand for further exploration of applied systems to tackle common challenges in equitable and sustainable scaling of promotion of ECD in diverse settings. We know from other sectors, especially health, that these interventions can be impactful at large-scale on population outcomes, although challenges remain and there are many unanswered questions requiring further research.

However, in terms of direct application in ECD, the published literature reflects limited explicit exploration of the application of systems thinking approaches, methods and tools to date. In one of few published papers specifically exploring the relevance of systems thinking to ECD, Pérez-Escamilla et al. used a complex adaptive systems framework to retrospectively evaluate large-scale ECD programs in Bangladesh, India, South Africa and Chile (32). The authors found that analysis using a complex systems framework was relevant and improved understanding of how programs had been scaled, as well as systems factors which promoted successful implementation and scaling (32). Pérez-Escamilla et al. also applied a complex adaptive systems approach to retrospectively analyze barriers and enablers to scaling Brazil's Programa Criança Feliz (19, 32). In their analysis, the use of complex adaptive systems approaches for this analysis increase nuanced, contextual understanding of the political economy, barriers and enablers to effective design, implementation and sustainable scaling of ECD programs in diverse settings (19, 32).

Moving forwards then, a challenge in ECD, is to consider how systems thinking approaches, tools and methods can be prospectively applied within program design and implementation, building on what is already known about applied systems thinking from its use in other sectors.

To capture findings of emerging work in this area, we suggest that learning which continues to engage ECD stakeholders and systems thinking experts and practitioners from other sectors may be useful to continue to increase shared language, learnings and experiences related to application of systems thinking approaches within the ECD community. As well as emphasizing innovation, our review also supports further consideration of where systems thinking approaches and methods can be integrated into existing program design and implementation frameworks in ECD.

In the near term, we suggest a particular focus on sectors and systems most directly relevant to ECD where systems thinking has already been explored in some detail. For example, we note previous work on education systems by the Research on Improving Systems in Education Group which provides a useful framework for accountability frameworks to promote systems coherence, albeit in a single sector (41). This framework, which has been applied in programs in several low- and middle-income countries (e.g. Malawi and Vietnam) warrants further consideration for its application to building more coherent systems for ECD although additional focus on governance across multiple sectors will be required (42, 43).

However, given the substantial gaps in evidence, investment in research and careful consideration of monitoring and evaluation approaches is also required to build the knowledge base to ensure that investment in systems thinking in ECD is maximally impactful.

Currently, lack of relevant data and indicators and monitoring and evaluation frameworks for systems thinking approaches limit comparability of implementation and impact across settings. Therefore, in applying these approaches in ECD, there is a need to develop and test indicators and innovative approaches to monitoring and evaluation, which allow for comparability of process and impact across settings.

Further research to explore the relationship between systems thinking, both short and long-term outcomes, systems accelerators, resilience and equity is also required. Exploration of the influences of social norms and sociocultural processes on application of approaches such as networking across contexts is also required since these are known to be powerful determinants of variation in implementation processes in other sectors (e.g. education) (44).

Finally, in considering future directions related to systems thinking in ECD, we are mindful that one of the key findings of our review is that systems thinking approaches emphasise collaborative continual learning and participatory processes. As such, extension of collaborative networks engaging families, communities and even more diverse stakeholders will be crucial to ongoing exploration of the role of systems thinking in strengthening systems to promote and support every child's development.



SECTION EIGHT: IMPLICATIONS & FUTURE DIRECTIONS



Implications & future directions

Building on key findings, the following implications and future directions are proposed for further consideration of practitioners, policymakers, funders, researchers and other stakeholders within and beyond the ECD community.

Text Box 10: Implications and future direction

For practitioners and policymakers

Now is a unique moment in time for policymakers and practitioners to harness lessons from systems thinking evidence and experiences in other sectors, to innovate and explore applications of systems thinking in scaled promotion of ECD.

For practitioners

Reframing common challenges from a systems lens and building capacity within the ECD community related to application of systems thinking approaches, tools and methods will be required. Opportunities to consider include development of;

- **Learning networks**, engaging ECD stakeholders as well as systems thinking experts and practitioners from other sectors to continue to share learnings and experiences related to applied systems thinking
- **Strategies to document application of systems thinking** approaches more clearly and in ways which are comparable across settings
- **Data and indicators** to measure systems thinking processes and impact as well as innovations in program monitoring and evaluation, to better capture systems change

For policymakers

Systems disruptions associated with the pandemic and the urgency of emerging challenges such as the climate crisis provide an opportunity to consider;

- **Innovative policy scaffolding** to drive system change (e.g. alter policy regulatory environment, change and incentivize different funding mechanisms linked to practice). Such scaffolding needs to address the underlying social determinants of child health and development
- **Creation of capacity building infrastructure** (including data and learning systems capacity and capability) that can accelerate system changes

For researchers

To address evidence gaps in systems thinking related to ECD will require research that;

- Is embedded into existing implementation research platforms
- Engages with innovative approaches for research co-design, mixed methods evaluation and processes which embed continual participatory learning
- Considers where applied systems thinking tools and methods can be drawn from other sectors into existing ECD intervention design and implementation research frameworks
- Develops and tests indicators which allow comparability of both applied systems thinking implementation processes and impact across settings

Specific research questions to address include;

- How can systems thinking approaches be applied prospectively within ECD program design and implementation?
- What is the impact of incorporating systems thinking approaches into existing approaches for ECD program design and implementation?
- What is the relationship between applied systems thinking interventions, sustainability, equity?
- Can systems thinking approaches promote system resilience and can positive systems change be accelerated, under what conditions and how?
- How do sociocultural processes affect the implementation of systems thinking approaches across contexts?

For funders

- To explore the potential of applied systems thinking in strengthening promotion of ECD at scale, long-term investment in partnerships which support program co-design and implementation within existing systems is needed.
- Accountability in investment is crucial but will require consideration of innovative approaches for monitoring and evaluation as well as development and testing of relevant data and indicators to ensure that progress can be measured, tracked and compared across settings.
- Investment in networks which focus on capacity building, knowledge sharing and ongoing learning related to application of systems thinking across sectors, with a focus on community and primary stakeholders may also be beneficial.

Conclusion

In response to unaddressed and emerging challenges in efforts to scale-up promotion of ECD, this evidence synthesis aimed to explore an area of increasing interest in the global ECD agenda, namely the potential role of applied systems thinking in accelerating progress in the field. To achieve this, we applied rigorous systematic review methodology combined with qualitative methods to be inclusive of scientific literature and multiple stakeholder expertise and experiences. A particular strength of our review was its intersectoral design.

We found major gaps in existing published evidence as well as five stand-out examples of how complex systems interventions have been applied across diverse low-and middle-income settings within existing health services with positive impact on population health at scale. Common elements of intervention design and implementation approaches used in these studies were clear purpose, close attention to context, co-design, continual learning processes, collaboration and networking.

Major opportunities identified through published literature and qualitative data sources included challenges with terminology, measurement and unaddressed research questions. Addressing these and other challenges will require reframing and capacity building in systems thinking for policy makers and practitioners, innovative funding approaches and research to address emerging questions. Research questions include: how to incorporate systems thinking approaches, tools and methods within existing ECD design and implementation frameworks; whether systems thinking approaches can promote resilience and accelerated systems change in the face of major systems disruptors; and how to measure and track change through development and testing related indicators and innovative approaches to monitoring and evaluation.

To further delineate next steps, systems approaches such as continual learning networks and participatory co-design processes present an exciting opportunity to collaboratively explore how we can harness this unique moment in time to build back better for children's development.

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Appendices

Appendix 1- Background literature review of ECD scaling frameworks (methods)

Aim and objectives:

The aim of this background literature review was to existing frameworks for promotion of ECD at scale to 1) understand factors constituting a 'system' for promotion of ECD at scale and 2) describe what is already known about barriers and enablers to scaling.

Methods:

To identify relevant initial search terms, seminal papers related to early childhood development policy and programming at scale were identified, in discussion with ECD technical experts, and analysed using the Yale MeSH analyser. Derived search terms were as follows

PMID	30885965	27717610	29791741
Title	Scaling early child development: what are the barriers and enablers	Investing in the foundation of sustainable development: pathway...	Diffusing and scaling evidence-based interventions: eight lessons...
Author Year	Cavallera (2019)	Ritcher LM (2017)	Tomlinson M (2018)
MeSH Headings	Child	Child Development	Child
	Child Development*	Child Health Services/ economics	Child Development*
	Child Health	Child Health Services/ organization & administration	Child, Preschool
	Child Health Services/ organization & administration	Child Protective Services/ economics	
		Child Protective Services/ organization & administration	
		Child, Preschool	
	Developing Countries	Developing Countries*	
		Early Intervention, Educational/ economics	Evidence-Based Practice*
		Early Intervention, Educational/ organization & administration	
		Financing, Government	
	"Health Policy Humans"	Humans	"House Calls* Humans"
			Infant
	Leadership		Leadership
		Maternal Health Services/ economics	Maternal-Child Health Services/ organization & administration*
		Maternal Health Services/ organization & administration	
		Nutritional Status	
Program Development Program Evaluation	Politics Poverty	Perinatal Care/ organization & administration* Problem Solving	
		Social Support	
		South Africa	
Author Keywords	Early Child Development		Diffusing Interventions
	Health Policy		Early Child Development
	Interantional Child Health		Home Visiting
	Low and Middle-income Earners		Implementation Science
	Scaling-up Implementation		Perinatal Health
			Scaling Up

Inclusion Criteria:

These were as follows:

1. Written in the English language
2. Literature from published between 2011-2021
3. Peer reviewed
4. Providing a clear description and/or evaluation of an approach to scaling evidence-based ECD interventions or programs

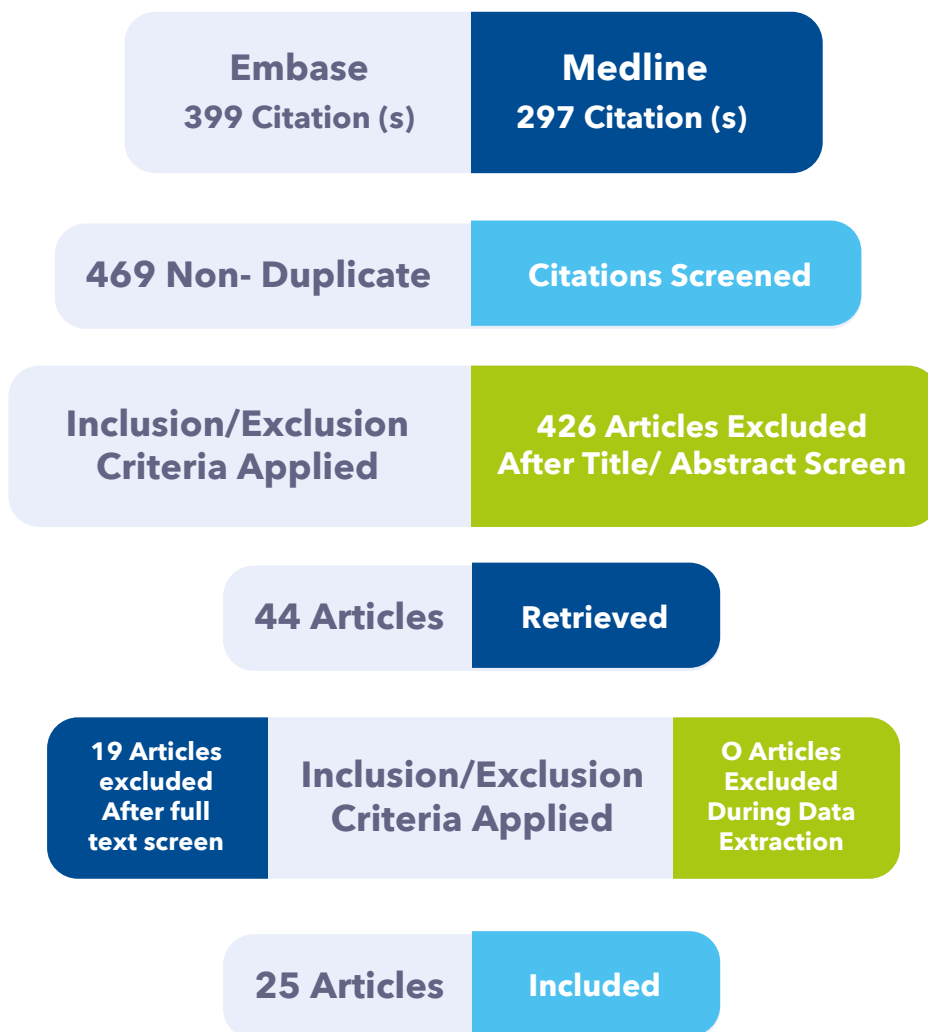
Methods:

These included papers that focused on:

5. Prenatal, antenatal or child health but not specifically ECD
6. Child morbidity and mortality as the primary outcome instead of ECD
7. Maternal health
8. ECD pilot or smaller scale programs without following those programs to scale

469 papers were initially identified. Of these 425 were excluded based following title and abstract screen. Of the 44 remaining papers, 19 were excluded following full text screen. Relevant papers or reports identified through reference lists of included papers were also included. 25 papers were included in descriptive analysis and narrative review related to search aims and objectives, namely key factors within ECD systems and common barriers and enablers of scaling.

PRISMA diagram - literature review of requirements for scaled promotion of ECD



Appendix 2 Key informant question guide

1. What does systems thinking mean to you?
2. What are your perspectives on the role of systems thinking in your sector?
3. What do you consider to be the key practical difference in systems thinking informed design and implementation compared with other approaches?
4. Are you aware of examples of systems thinking informed interventions which have successfully achieved impact at scale and if so, how has this been measured?
5. Are you aware of examples where a systems thinking informed approach has accelerated the pace of change and if so, how has this been measured?
6. What do you perceive to be the limitations and/or challenges in implementing systems thinking approaches to program design and implementation?
7. How do you think systems thinking based interventions should be measured? How does this differ from monitoring and evaluation in interventions/program implementation at scale which are not informed by systems thinking?
8. Is there anything else you would like to tell us related to your experience or perspectives related to systems thinking and its potential application to ECD?
9. Is there anyone else you think would be helpful for us to talk to, related to this area of enquiry?

Appendix 3 Key Informants

We would like to thank and acknowledge the key informants who so generously offered their time and expertise to participate in interviews and or focus groups and contribute to this research. Those who have provided consent to be named are listed below.

John Atkinson, 4SD

Sourav Banerjee, Room to Read

Dan Berelowitz, Spring Impact

Kimberley Boller, The Nicholson Foundation

Heather Britt, NORC

Richard Chivaka, Spark Health Africa

Luke Craven, Collaboration for Impact

Jordan Fabyanske, Dalberg Advisors

Chittaranjan Kaul, Centre of Learning Resources

Margaret Kruk, Harvard T.H. Chan School of Public Health

Tim Krupnik, International Maize and Wheat Improvement Center (CIMMYT)

Hema Magge, Bill and Melinda Gates Foundation

Arif Neki, United Nations

Beverley Parsons, InSites

Rafael Perez-Escamilla, Yale School of Public Health

James Phillips, Columbia University Medical Center

Angelica Ponguta, Child Study Centre, Yale Institute for Global Health

Cynthia Rayner, Bertha Centre for Social Innovation

Dominic Richardson, UNICEF office of Research, Innocenti

Tinni Sawhney, Aga Khan Foundation

Jay Weatherill, Minderoo Foundation

Bob Williams, Systems Thinking Consultant

Hirokazu Yoshikawa, New York University Steinhardt

Appendix 4 Expert Advisory Group

We would like to thank and acknowledge the members of our Expert Advisory Group, listed below for being a core part of this work in bringing new ideas, providing feedback throughout the research process and providing strategic perspectives on next steps.

Dan Berelowitz, Spring Impact

Kimberly Boller, The Nicholson Foundation

Richard Chivaka, Spark Health Africa

Jordan Fabyanske, Dalberg Advisors

Liana Ghent, International Step by Step Association

Margaret Hargreaves, NORC

Jessica Hjarrand, Porticus

Mihaela Ionescu, International Step by Step Association

Chittaranjan Kaul, Centre of Learning Resources

Margaret Kruk, Harvard T. H. Chan School of Public Health

Dieuwerke Luiten, Porticus

Lynette Okengo, Africa Early Childhood Network

Angelica Ponguta, Child Study Centre, Yale Institute for Global Health

Katharine Shelley, PATH

Manpreet Singh, Bill and Melinda Gates Foundation

Nicholas Valcourt, Open Water Systems

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