

# Prevention in the first 2000 days

## Synthesis of knowledge from The Australian Prevention Partnership Centre and CERI

August 2022



The Collaboration for Enhanced Research Impact (CERI) is a joint initiative between The Australian Prevention Partnership Centre and a diverse group of related NHMRC Centres of Research Excellence. We are working together to find alignment in the policy and practice implications of our work and to develop shared communications and early career capacity support across our participating centres.

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**Suggested citation:** Chung A, Hall A, Brown V, Kuswara K, Howse E, Stickney B, Signy H, Rychetnik L. The first 2000 days: Synthesis of knowledge from the Australian Prevention Partnership Centre and CERI. Sydney, Australia: The Australian Prevention Partnership Centre, 2022.

Disclaimer: The evidence and knowledge included in this synthesis has been selectively drawn from Prevention Centre and CERI member CRE research programs. This evidence review does not claim to be nor is it meant to be a review of all available evidence.

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## Summary of findings

**The first 2000 days (conception to age five) is a critical window to give children the best possible start in life.**

- Acting early reduces risk of disease in later life
- Prevention at this age is effective and cost-effective
- The public support government action to protect children's health

### Key messages

- We asked our policy partners how our research on the first 2000 days could support them in their work
- We identified answers from research across members of the Collaboration for Enhanced Research Impact
- We found strong evidence to support the benefits of prevention in the first 2000 days
- We identified a number of interventions that are effective (and cost-effective) to give children the best start in life
- We found that implementation and scale-up of effective interventions in the first 2000 days requires collaboration between researchers, policy makers, health and social care practitioners, and consumers

### What is the issue?

The first 2000 days is a window of opportunity in early life to establish and support healthy behaviours among parents and their children to reduce the likelihood of poor health outcomes and associated economic impacts in the short and long term.

This knowledge synthesis aimed to combine the expertise of research, policy and communications experts to draw out policy relevant lessons from research conducted by the Prevention Centre and the NHMRC Centres of Research Excellence within the Collaboration for Enhanced Research Impact (CERI), as relevant to the first 2000 days of life.

Our findings are based on evidence drawn from 60 peer reviewed articles, synthesised and interpreted with guiding input from 12 prevention policy makers from eight jurisdictions convened over two national roundtables.

### What did we find?

Our policy partners indicated there are four key questions for which they need evidence to guide their work. The key answers from our knowledge synthesis are below.

#### **1. What is the evidence for the benefits of prevention in the first 2000 days?**

Prevention improves health for infants through to later life, and reduces pregnancy complications for women. Prevention is cost-saving (healthy children mean reduced hospitalisation costs and reduced parent productivity due to reduced student absenteeism), and there is considerable public support for the government to take action that protects children's health.

## 2. What prevention interventions are effective (and cost-effective) to give children the best start in life?

Women do not necessarily consider the importance of **preconception health** before they fall pregnant, yet evidence indicates that preconception health influences the health of mothers and their babies. Population-wide interventions and targeted interventions from practice nurses, in workplaces or online may effectively reach this group of women to support preconception health.

During **pregnancy**, combined targeted interventions (diet and physical activity-based lifestyle interventions) are effective, cost-saving and cost-effective.

**After the birth**, interventions delivered by health professionals and that combine diet and physical activity are effective. Women are particularly open to receiving support, including web-based support programs in the first 12 months after birth.

**In early childhood**, interventions commenced during pregnancy or early infancy have widespread benefits for obesity prevention. There is evidence for effectiveness of interventions including: a novel infant sleep intervention; scaling up Romp and Chomp to all Australian children; digital interventions in early childhood education and care settings; removing sugary drinks from sports and recreation settings; and delivering health promotion messages via telephone calls or text messages.

## 3. How do we support implementation and scale-up of effective interventions?

Evidence from research on the first 2000 days confirms that co-design and collaboration between researchers, policy makers and health service delivery practitioners is important in planning and implementing effective interventions. It is necessary to balance maintenance of the fidelity of an evidence-based program while making necessary adaptations to fit local circumstances.

## 4. How can we tailor, implement and scale-up prevention interventions to meet the needs of priority population groups including Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse people, and people experiencing socioeconomic disadvantage?

While there is a lack of evidence in relation to the first 2000 days in this area, the knowledge synthesis found interventions must be tailored to address unique circumstances, and underlying structural factors that influence health behaviour must be considered and addressed.

## Opportunities for further research

We identified areas for further research as follows:

- Further evidence is required to support the design, implementation, and evaluation of prevention interventions in the first 2000 days that meet the needs of priority population groups such as Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people who experience socioeconomic disadvantage.
- There is a need for increased monitoring of risk factors across the first 2000 days, to ensure future prevention efforts can be designed to address ongoing and emerging health risks.
- Discussions during our two policy dialogues revealed key areas of further interest for policy partners, including how to address specific risk factors such as food insecurity and parents' mental health across the first 2000 days.

# Introduction

The Australian Prevention Partnership Centre is a national initiative, bringing together academic researchers, policy partners and prevention practitioners to build an effective, efficient and equitable system for the prevention of chronic disease.

The Collaboration for Enhanced Research Impact (CERI) is a joint initiative between the Prevention Centre and National Health and Medical Research Council (NHMRC) Centres of Research Excellence (10 at the time of writing). Established in June 2020, the goal of CERI is to enhance the impact of prevention research by finding alignment in the policy and practice implications of members' work and developing shared advocacy for prevention. The Centres of Research Excellence involved in CERI are listed on the [CERI web page](#).

This knowledge synthesis contributes to the Prevention Centre's objective to effectively mobilise knowledge and translate policy relevant prevention research. The focus of this particular synthesis is **prevention across the first 2000 days**, guided by the policy priorities and questions of our policy partners as identified in two research-policy dialogues. Drawing upon evidence and knowledge from past and currently funded Prevention Centre and CERI member CRE projects, combined with the content expertise of research, policy and communications experts, this project aims to provide accessible, synthesised knowledge to policy and practice audiences.

The evidence and knowledge included in this synthesis has been drawn from research and expertise of the Prevention Centre and relevant CERI member CREs. It does not claim to be nor is it meant to be a review of all the evidence in any particular area. The emphasis is on identifying and synthesising findings to date and drawing on expertise from across our programs of work to generate a synthesis of our shared learnings and insights, both to inform further policy deliberations and guide future research.

# Background

## The first 2000 days

The first 2000 days of a child's life represents a critical window of opportunity to give children the best possible start in life. The early life period is a time when children's biology is most amenable to change, and parents and children are receptive to learning and establishing behaviours that support healthier living.

The first 2000 days, the period from conception to age five years, is a foundational time for lifelong health and wellbeing and a critical opportunity for action to promote health and health equity (Skouteris, Bergmeier et al. 2021). Key opportunities to influence health in the first 2000 days occur during preconception, pregnancy, postpartum and early childhood (Figure 1). This knowledge synthesis therefore focuses on these key periods, from preconception through to early childhood, as they represent opportunities for action to prevent ill health and promote optimal health and wellbeing throughout the first 2000 days and beyond.

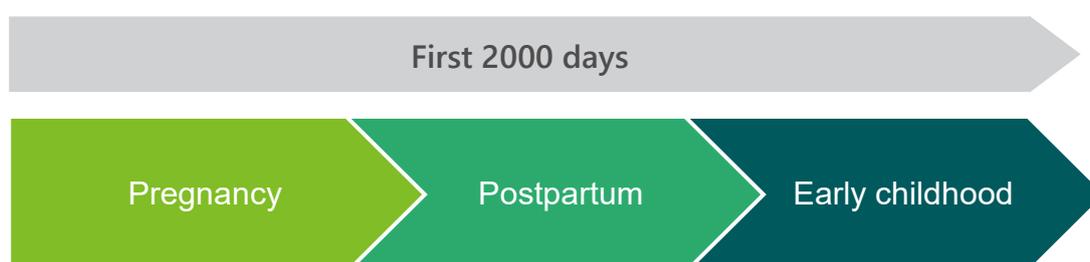


Figure 1. Life stages of the first 2000 days

## Global context

Prevention in the first 2000 days aligns with a global agenda to support children's health and development from early life. Recent years have seen concerted efforts to improve the health and wellbeing of young children, with peak health and development organisations including the United Nations and World Health Organization leading the development of global guidelines and recommendations. Key documents are listed in Box 1.

| <b>United Nations</b>   | <b>World Health Organization</b>  |
|---|---|
| <ul style="list-style-type: none"><li>• Sustainable Development Goals, 2015</li></ul>   | <ul style="list-style-type: none"><li>• Nurturing Care Framework, 2018</li></ul>  |
| <b>Lancet Series</b>  | <ul style="list-style-type: none"><li>• Report of the Commission on Ending Childhood Obesity, 2016</li></ul>  |
| <ul style="list-style-type: none"><li>• Double Burden of Malnutrition Series, 2020</li><li>• Preconception Health Series, 2018</li><li>• Breastfeeding Series, 2016</li><li>• Early Childhood Development Series, 2016</li><li>• Obesity Series, 2015</li></ul> | <ul style="list-style-type: none"><li>• Global Action Plan for the Prevention and Control of Non-Communicable Diseases, 2013</li><li>• Closing the gap in a generation: health equity through action on the social determinants of health - Final report of the Commission on Social Determinants of Health, 2008</li></ul> |

Box 1. Key documents for prevention in the first 2000 days

## The importance of prevention

Prevention aims to protect and promote health and reduce the risk of poor health, illness, injury and early death. Prevention includes a broad range of strategies such as government policies and regulation, social marketing and mass media campaigns, settings-based approaches, and individual behaviour change strategies. Different types of prevention interventions have different effects. For instance, a government policy to restrict unhealthy food advertising on television reduces everyone's exposure to unhealthy food advertising, while providing nutrition information on food labels relies on individuals taking action to interpret that information and use it to guide their food choices.

Preventive action includes universal strategies that are aimed at an entire population regardless of risk, as well as targeted strategies that are designed to address particular risk factors among at-risk groups. Universal approaches have a wide population reach, but unless they address the causes of ill health, or if they are only effective in improving health for some groups, they may widen health inequities. For example, information-based strategies have been found to be more beneficial for people from higher socioeconomic backgrounds, and less effective among people experiencing socioeconomic disadvantage. On the other hand, universal approaches that address structural determinants are more likely to have equal or greater benefit for people in lower socioeconomic groups. In contrast, targeted approaches can be tailored to address specific needs among at-risk groups and can be helpful to reduce the health inequities gap. This knowledge synthesis - along with the wider evidence - suggests that both universal and targeted approaches to prevention are needed (Marmot, Allen et al. 2010). Rigorous evidence on the costs and benefits of each approach are also needed, so that society's scarce resources can be allocated efficiently.

Prevention has many benefits including better physical and mental health outcomes for individuals. This translates to benefits for communities and society more broadly. The economic benefits of prevention include lower healthcare costs, and reduced costs associated with ill health and premature death. Prevention interventions are an investment in future health and wellbeing.

## Social determinants of health

The social determinants of health are the conditions in which people are born, live, grow, work and age. They include education, employment, income and social protection, housing, food insecurity and access to health care. These factors are fundamental to a person's opportunity to achieve and maintain good health.

## Health inequities

Health risks are not distributed equally across the population, with children's experience of risk closely linked to socioeconomic position. People living with socioeconomic disadvantage are at greater risk of poor health, and experience higher rates of illness, disability and premature death than people from higher socioeconomic groups. For instance, in Australia, lower socioeconomic position is associated with a higher prevalence of a number of child health risk factors, including childhood obesity, poor dietary intake and exposure to passive smoke. Socioeconomic differences in children's health emerge in early life, and, once established, can be difficult to remedy. Preventive health in early life therefore presents an important opportunity to reduce health inequities.

## Priority populations

There are groups within society who are at greater risk of experiencing health inequities. The increased burden of disease experienced by some groups is not solely due to people's behaviour, but arises from circumstances beyond individual control. These circumstances include the social determinants of health such as education, employment, income, housing, and access to health care, all of which are shaped by economic, social and political mechanisms. Priority groups identified in this knowledge synthesis include Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people who experience socioeconomic disadvantage. Although there are a number of groups of people at increased risk of health inequities, the approaches required to reduce risks and improve health will be different for different groups. Approaches to prevention need to take into account individual circumstances and build upon existing strengths of individuals and communities.

## Prevention in the first 2000 days

Prevention targeted in the first 2000 days not only minimises health risks to children in early life, but provides lifelong benefits. Opportunities for promoting equity and preventing ill health exist at each life stage of the first 2000 days.

### *Preconception*

A healthy start to life begins before conception. Health during preconception is important for favourable maternal and infant health outcomes (Hill, Hall et al. 2020). Because not all pregnancies are planned, it is helpful from a public health perspective to take a broader view of preconception that includes all people of reproductive age. There are a few risks factors that are important to address during preconception, as they contribute to poor health outcomes for both mother and child. Some of the more common risks include overweight and obesity, poor nutrition, insufficient physical activity, alcohol and drug use, and smoking (Walker, Drakeley et al. 2021).

### *Pregnancy*

A healthy pregnancy can reduce the risk of short- and long-term health problems for mother and child. Healthy weight gain during pregnancy, ensuring optimal nutrition and regular physical activity, and avoiding tobacco, alcohol and other drugs are important preventive health measures during pregnancy.

### *Early childhood*

During early childhood, targeting children's health behaviours is important in the prevention of future chronic diseases. Key health behaviours instilled in childhood influence health and health-related behaviours throughout later life. These include good nutrition, including breastmilk for at least the first six months, followed by appropriate introduction of foods, healthy dietary intake, regular physical activity, and healthy sleep routines. Addressing these health behaviours early is key to achieving effective and sustained chronic disease prevention.

### *Settings and supportive environments*

The settings where children learn, such as school and childcare, provide an important platform for the delivery of prevention interventions (Jackson, Jones et al. 2021). The policies and practices within these settings can support engagement with healthy behaviours, for instance by providing and promoting healthy food and drinks and creating opportunities for regular physical activity.

## Australia's National Preventive Health Strategy

Australia's [National Preventive Health Strategy](#) (Commonwealth of Australia 2021) presents an opportunity to build a sustainable prevention system for the future. The Strategy outlines an approach to prevention that aims to provide the best possible health outcomes for all Australians. A key focus is to ensure children grow up in communities that nurture healthy development. The Strategy states that investing in prevention and early intervention during the first 2000 days will deliver significant health gains and healthcare expenditure savings with immediate and long-lasting benefits.

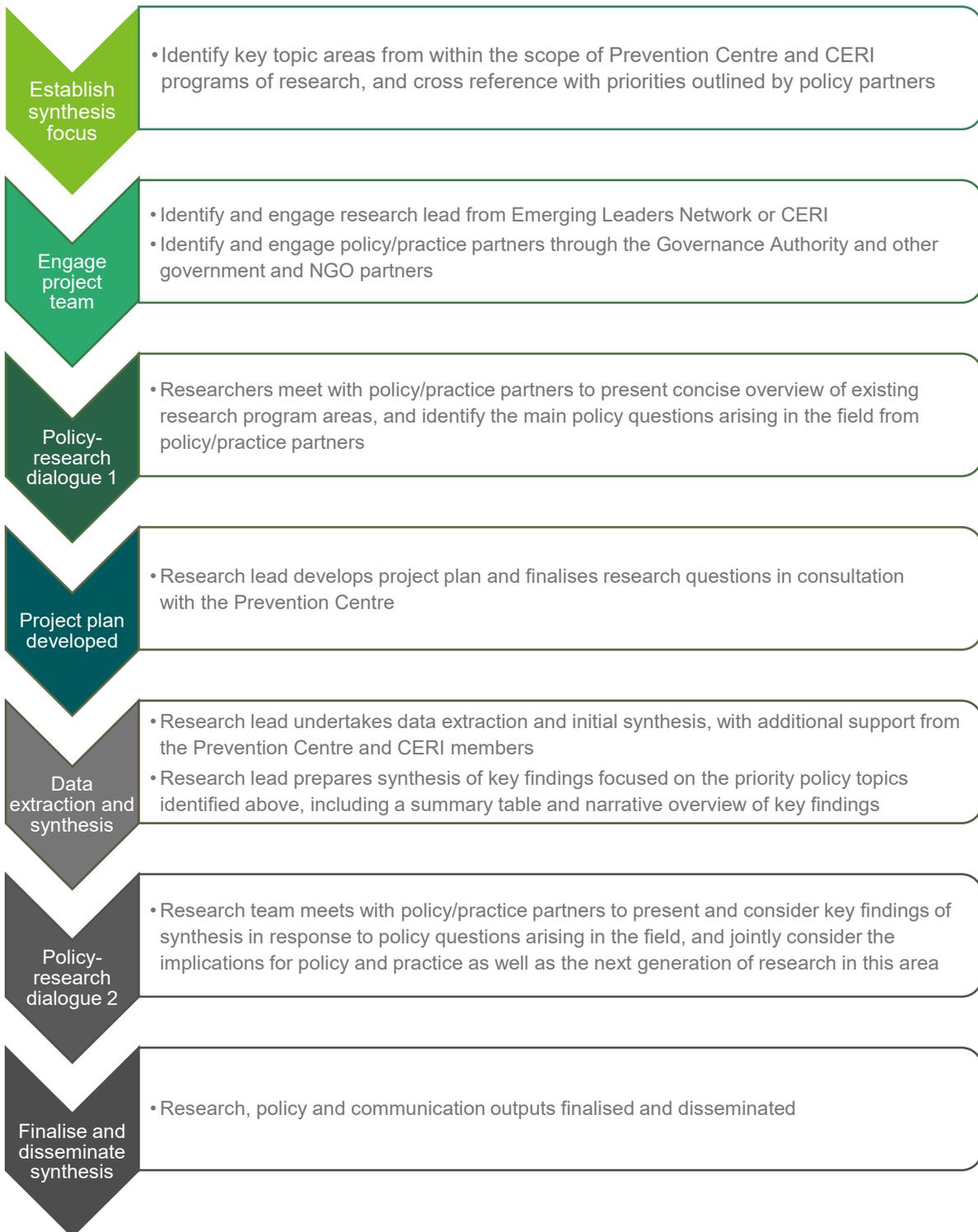
The Strategy also places an emphasis on health equity, bringing an equity focus to prevention that ensures populations with poorer health outcomes experience greater improvements in health. The Strategy recognises that inequities in health are shaped by the environments and conditions in which people go about their lives. The Strategy also acknowledges that ongoing racism and discrimination including intergenerational trauma experienced by Aboriginal and Torres Strait Islander peoples impacts health and wellbeing and requires a trauma-informed approach to prevention.

Australia's National Preventive Health Strategy is complemented by the [National Obesity Strategy](#), which has a strong focus on prevention. These strategies outline an approach to prevention that addresses Australia's burden of chronic disease, reduces health inequities and protects and promotes health in early life.

# Methods

The knowledge synthesis presented in this report is not a typical systematic review, but rather follows an iterative process developed to review and synthesise, in consultation with our policy partners, the research carried out by the Prevention Centre and its affiliated research groups. Thus, the evidence and knowledge included in this synthesis has drawn on research from the Prevention Centre and CERI member CREs, as well as policy partners' expertise and priorities. The knowledge synthesis process is outlined below.

## The knowledge synthesis process



## Establishing synthesis focus and engaging project team

Prevention in the first 2000 days has been identified by Prevention Centre policy partners as a priority area. During regular CERI meetings in 2021, the first 2000 days was also identified as a cross-cutting theme relevant to the work of several member CREs. Representatives from the Centre of Research Excellence in the Early Prevention of Obesity in Childhood (EPOCH CRE) (Victoria Brown and Konsita Kuswara), Centre of Research Excellence Health in Preconception & Pregnancy (CRE HiPP) (Alexandra Chung) and the National Centre of Implementation Science (NCOIS) (Alix Hall) joined together to establish the CERI first 2000 days working group with support from the Prevention Centre. The initial aim of the group was to develop a joint position statement on prevention in the first 2000 days. The working group subsequently agreed to expand this work to a knowledge synthesis with methods guided by the Prevention Centre's knowledge synthesis process. Policy partners were identified through established Prevention Centre networks and invited to contribute to the process by participating in the policy-research dialogues.

### Policy-research dialogue 1

The first policy-research dialogue took place in October 2021, during a 75-minute Zoom meeting. This meeting was attended by three Prevention Centre representatives, four CERI members representing their respective CREs, two CRE Chief Investigators, and seven policy partners from the NSW Ministry of Health, Tasmanian Department of Health, Wellbeing South Australia, Western Australia Department of Health, and Queensland Health. The aim of this meeting was to introduce the knowledge synthesis process to policy partners, develop a shared understanding of definitions of the first 2000 days and map priority areas for the knowledge synthesis.

Key themes emerging from this meeting:

- The first 2000 days is a priority area for prevention policy
- There is a need to take a broad view of child health and wellbeing, not just obesity
- It is necessary to break down silos across settings, and across professions
- It is important to build an argument for prevention
- Policy makers need evidence of what interventions work
- Specific risk factors need to be addressed, e.g. smoking, food insecurity, mental health
- The synthesis should consider how to meet the unique needs of families experiencing socioeconomic disadvantage, or from culturally and linguistically diverse backgrounds, or Aboriginal and Torres Strait Islander descent, with targeted interventions
- Scalability and implementation of effective interventions are important
- Translating evidence into practice is important.

### Developing the project plan and research questions

Drawing on the outcomes of the priority mapping exercise during the first policy-research dialogue, four research questions were developed to inform the data extraction and knowledge synthesis (Box 2).

#### Research questions for knowledge synthesis

1. What is the evidence for the benefits of prevention in the first 2000 days?
2. What prevention interventions are effective (and cost-effective) to give children the best start in life?
3. How do we support implementation and scale-up of effective interventions?
4. How can we tailor, implement and scale-up prevention interventions to meet the needs of priority population groups including Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people experiencing socioeconomic disadvantage?

Box 2. Research questions

## Data extraction and initial synthesis

Potentially relevant articles from Prevention Centre and CERI member research programs were identified in two ways. First, representatives from the Prevention Centre and CERI members were invited to provide details of relevant studies from their respective research programs that addressed prevention in the first 2000 days. Second, a manual search of Prevention Centre and CERI member websites was conducted to identify additional relevant research outputs.

Peer reviewed journal articles including primary research, modelling studies and reviews were all eligible for inclusion in the knowledge synthesis. Articles reporting on projects outside the scope of the first 2000 days, not conducted by Prevention Centre or CERI member CREs, letters and opinion pieces, conference abstracts, research protocols and methods papers were all excluded.

The data extraction and initial synthesis were led by the first author (AC), with iterative feedback and guidance from the Prevention Centre. Articles were read in full by this author to determine eligibility. Data from included articles were extracted into a Microsoft Excel form. Data extraction items included: lead author, title of the article, publication year, country/countries studied, aim, methods, results, authors conclusions. Articles were subsequently assigned to one of four categories, determined by the primary focus of the article, to correspond with each of the research questions: 1) evidence for prevention 2) interventions 3) scale-up 4) priority populations. The allocation of categories was based on the primary focus of the article.

A narrative summary was conducted to examine evidence from Prevention Centre and CERI member CRE research that addressed prevention in the first 2000 days. The overall synthesis was guided by the research questions outlined in Box 2. Included articles were reviewed and summarised, and key themes were identified in response to each of the research questions.

## Policy-research dialogue 2

The second policy-research dialogue was held in March 2022, during a 90-minute Zoom meeting. This meeting was attended by four Prevention Centre representatives, four CERI members representing their respective CREs, four CRE Chief Investigators, and nine policy partners from the Australian Government Department of Health, NSW Ministry of Health, Hunter New England LHD, Victorian Department of Health, Wellbeing South Australia, Western Australia Department of Health, and Queensland Health. The aim of this meeting was to present key findings from the knowledge synthesis to policy partners, identify implications for policy and practice, and discuss the types of research dissemination outputs that would be useful to policy partners.

Key themes emerging from this second meeting:

- Economic evidence is compelling for decision making
- Public support for prevention is useful, but we also need to build political support
- There is an opportunity to use COVID-19 recovery framing as a conduit to promote the importance of investment in prevention
- There is an ongoing need to break down silos between disciplines and sectors
- Interventions targeting specific phases / populations are helpful, but there is a need to complement this with universal and environmental strategies that have broad population reach
- We should consider new modes of intervention delivery e.g. commissioning intervention delivery
- It is important to consider equity and continue ongoing discussions about defining priority populations
- Suggested useful outputs include a live website that can be updated and easily accessed, and one-page targeted policy briefs.

# Findings

## Synthesis of research

The lead author of this report (AC) reviewed a total of 78 potentially relevant articles for eligibility for inclusion in the knowledge synthesis. Of these, we deemed 60 articles eligible for inclusion. We excluded 18 articles including articles outside the scope of the first 2000 days, not conducted by Prevention Centre or CERI member CREs, letters/commentaries, and research protocols. Publication dates of included articles ranged from 2016 to March 2022.

Below is a narrative synthesis of the key findings, summarising major themes from the research under each of the four research questions.

### What is the evidence for benefits of prevention in the first 2000 days?

#### ACTING EARLY REDUCES RISK

**Prevention reduces the risks of excess weight and weight-related complications at key stages of the first 2000 days including during pregnancy and early childhood. Much of the research presented here focuses on excess weight and weight-related risk factors. This is not to say that other risks do not exist, rather that this has been the focus of work published to date from the Prevention Centre and CERI member CREs. Findings presented here help build a case for investment in prevention in the first 2000 days, to reduce the incidence of poor health and adverse outcomes in the short and long term.**

Systematic review evidence indicates that reducing maternal weight gain improves infant weight-related outcomes at birth. Interventions designed to reduce excessive gestational weight gain were found to lead to a small reduction in infant birthweight and risk of macrosomia and infants being large-for-gestational age, without influencing the risk of adverse outcomes including low birth weight and small-for-gestational age (Bennett, Walker et al. 2019).

Review evidence demonstrates associations between pregnancy complications (including gestational diabetes mellitus, gestational hypertension, pre-eclampsia and delivery of a preterm or growth restricted baby) and maternal overweight and obesity and excess weight during pregnancy. These risks place women at increased risk of cardiometabolic disease in later life. Authors concluded early detection and intervention to reduce preconception overweight and obesity and gestational weight gain in women will reduce pregnancy-related complications and attenuate risk for cardiovascular disease (Grieger, Hutchesson et al. 2021).

Analysis of almost 10,000 children participating in the Longitudinal Study of Australian Children provided evidence that demonstrates the persistence of childhood overweight and obesity into adolescence. Natural resolution of overweight was more commonly observed in children under seven years, compared to older children, suggesting that early childhood is an opportune period for interventions to reduce excess weight in the short and long term (Hayes, Carrello et al. 2021).

Socioeconomic and gender differences in weight trajectories have also been observed. Children with lower socioeconomic position, children from culturally and linguistically diverse backgrounds, and girls are more likely to move from healthy weight into overweight and are less likely to experience resolution of overweight during childhood (Hayes, Carrello et al. 2021). Acting early to reduce these disparities may help reduce persistent inequities in excess weight.

#### PREVENTION OFFERS ECONOMIC BENEFITS

**Healthcare costs are high in early childhood. Early childhood obesity adds to these already high costs. Costs associated with obesity in early childhood include increased healthcare costs and loss of carer productivity due to increased school absenteeism. Findings demonstrate economic benefits of preventing early onset obesity.**

A study of healthcare costs in early childhood showed that healthcare costs are high during this period of life, especially in the first two years (Hayes, Brown et al. 2019). Evidence indicates that obesity adds to healthcare costs in early childhood. For example, one study of Australian children aged two to five years found direct healthcare

costs of children with obesity aged two to four years were 1.6 times those of healthy weight children. The largest category of costs was for hospital treatment, with children with obesity more than twice as likely to be hospitalised compared to healthy weight children. Based on these findings and the prevalence of obesity in this age group, the study authors estimated the annual direct costs to the Australian healthcare system to be around \$17 million AUD (valued in 2016 AUD) (Hayes, Chevalier et al. 2016, Brown, Moodie et al. 2017).

Another economic analysis found a small but significant association between school absenteeism and obesity among Australian children. Analysis of data from the nationally representative Longitudinal Study of Australian Children found children aged six to 13 years with obesity missed on average an extra day of school annually compared to children of a healthy weight, while adolescents aged 14 to 17 years with obesity missed on average an extra 0.69 days of school annually. The estimated national cost for children with obesity aged six to 13 years was approximately \$64 million AUD (\$43 million USD) through lost productivity of caregivers (Carrello, Lung et al. 2021) highlighting the importance of early prevention to avoid economic costs in later childhood.

Economic modelling identified the potential for significant long-term health benefits and healthcare cost savings from effective and sustainable obesity prevention interventions in preschool aged children (Brown, Ananthapavan et al. 2019). These savings were based on conservative estimates of intervention effectiveness on body mass index (BMI), with evidence from other studies suggesting that intervention effectiveness (and therefore cost-effectiveness) could be even greater than estimated (Waters, de Silva-Sanigorski et al. 2011). Given that these health benefits and healthcare cost savings arose from the prevention of chronic diseases that most commonly present much later in life than in childhood (for example, heart disease, stroke, type 2 diabetes mellitus), the authors note that healthy weight needs to be achieved and maintained over relatively long periods of time. This highlights the importance of adopting a lifecourse approach to prevention, starting from an early age (Brown, Ananthapavan et al. 2019).

## PEOPLE VALUE PREVENTION

**The Australian population supports prevention, especially policy actions that protect children's health. Prevention policies with high levels of support include restricting unhealthy food and drink advertising, using local planning to promote health such as through fast food density zoning laws and improved walking and cycling infrastructure, and implementation of prevention interventions in childcare and health service settings.**

Several studies examined public opinion, finding that the Australian population supports prevention policies, especially those that protect children. For example, a study of 1,155 mothers of infants in NSW examined the level of support for six potential state government health promotion policies to help prevent childhood obesity (Esdaile, Owen et al. 2021). Overall, there was very high support for policy options including 1) fast food density zoning laws 2) restricting unhealthy food advertising on public transport 3) building a network of connected walkways and bike paths 4) requirements for childcare services to have policies around nutrition, play, screen time and sleep 5) support programs for healthy eating and active living 6) child height and weight to be routinely taken at health appointments, and feedback on child growth provided to parents. Approval for each of these policies ranged between 89% and 95%, indicating very strong support for public health approaches to prevent childhood obesity (Esdaile, Owen et al. 2021). Similar findings were reported in a review of public opinion on regulatory nutrition policies in Australia that found overall support for government-led prevention of obesity and diet-related disease, and high levels of support for regulatory action to protect children such as regulation of unhealthy food marketing targeted towards children (Cullerton, Baker et al. 2021).

Analysis of data from the nationally representative AUStralian Perceptions Of Prevention Survey (AUSPOPS) provides insight into the Australian population views of government intervention for prevention. Findings indicated increasing support for the role of government in maintaining people's health. This support was uniform across gender, age and socioeconomic status (Grunseit, Howse et al. 2021). AUSPOPS data also demonstrated strong support for prevention framed as a shared responsibility between governments and individuals. More than 92% of participants agreed that maintaining the community's health was a shared responsibility between government and individuals (92.7%). A majority of respondents also indicated that governments had not gone far enough to implement preventive health policies such as restrictions on unhealthy food advertising for children and setting salt limits on processed food. In this sample, younger adults, compared with older adults, and women compared to men, were more likely to respond that Australia does not have enough government regulation and policies for people to be healthy (Howse, Bohn-Goldbaum et al. 2020).

Further analysis of AUSPOPS data demonstrated high levels of community engagement with prevention policy. Focus group and survey data revealed thoughtful and complex interpretations of preventive actions and policies among community members, suggesting that a 'nanny state' conceptualisation of prevention is overly simplistic. Authors argued that advocates and legislators must not allow the prevention debate to be restricted to the nanny state–libertarian continuum. Rather, there is a need to engage the community in collectivist considerations of future health costs, equity, and likely outcomes of action and inaction in order to garner community support for prevention (Grunseit, Rowbotham et al. 2019).

## **POLICY FRAMEWORKS ARE NEEDED TO SUPPORT PREVENTION**

**A systems-wide approach to obesity prevention in early childhood, supported by broader national plans for food, nutrition and physical activity, is needed to ensure a comprehensive approach to obesity prevention policy.**

A mapping review of policy options to prevent obesity in early childhood examined policies across six high-income countries including Australia, New Zealand, England, Ireland, Scotland and Canada. The authors observed that policy actions were most often focused on individual behaviour and that upstream policies to address underlying determinants of health were more likely in countries that had invested in system-wide approaches to obesity such as developing a national obesity strategy, having separate food/nutrition and physical activity plans, and a dedicated preventive health agency (Esdaile, Thow et al. 2019). At the time of publication of the study by Esdaile and colleagues (2019), Australia was the only one of the six countries studied to have neither a national obesity strategy, nor a national preventive health agency. Of note, Australia has since published a National Preventive Health Strategy, and National Obesity Strategy (Commonwealth of Australia 2021, Commonwealth of Australia 2022). Further recommendations to strengthen the prevention of obesity in early childhood in Australia include prioritising the development of a national food and nutrition strategy (Esdaile, Thow et al. 2019).

## **What prevention interventions are effective (and cost-effective) to give children the best start in life?**

### **FOR SPECIFIC STAGES OF THE FIRST 2000 DAYS**

**Prevention interventions are important at each stage of the first 2000 days. Healthy lifestyle interventions in the workplace can improve preconception health among women. Lifestyle interventions during pregnancy can improve outcomes including gestational weight gain, gestational diabetes, preterm delivery, large-for-gestational age neonate, and neonatal intensive care admission. In early childhood, obesity prevention interventions promote the development of healthy eating, activity and sleep behaviours, and reduced BMI z-scores. Many of these interventions have been found to be cost-effective.**

#### **Preconception**

A systematic review of workplace lifestyle programs on diet, physical activity, and weight-related outcomes for working women reported that group programs may improve physical activity and weight-related outcomes. Group-based physical activity interventions in the workplace making use of already established employee relationships were cost-effective compared to interventions targeted to the individual (Madden, Cordon et al. 2020). In contrast, focus groups with working women in Australia identified a number of barriers to achieving healthy lifestyle behaviours during preconception and pregnancy including high workloads, sedentary jobs and unhealthy food environments in and around the workplace (Madden, Skouteris et al. 2020). Another study reported barriers to healthy lifestyle behaviours during preconception included lack of knowledge around the importance of preconception health and limited opportunities to engage in healthy lifestyle behaviours due to lack of resources including financial constraints and limited access to healthy food (Kandel, Lim et al. 2021). Consideration of the barriers to achieving healthy lifestyles will be important to future interventions to improve preconception health.

## **Pregnancy**

### *Effectiveness of maternal lifestyle interventions in pregnancy*

A systematic review of randomised trials of antenatal lifestyle interventions found antenatal structured diet and physical activity-based lifestyle interventions were associated with reduced gestational weight gain and lower risk of adverse maternal and neonatal outcomes (including gestational diabetes, preterm delivery, total adverse maternal outcomes, large-for-gestational age neonate, NICU admission, and total adverse neonatal outcomes) (Teede, Bailey et al. 2022).

Advanced dynamic simulation modelling was used to explore the impact of maternal weight interventions on the incidence of hyperglycemia in pregnancy (HIP, including gestational diabetes and pre-existing type 1 and type 2 diabetes). Combining targeted interventions for high-risk groups with population health promotion support was shown to be the most effective scenario for reducing the incidence of hyperglycaemia in pregnancy. Scaling up childhood healthy weight interventions to ensure healthy weight among all female children entering adulthood also achieved a significant improvement in insulin sensitivity in the short term and decreased HIP in the long term (Freebairn, Atkinson et al. 2020).

The 10,000 Lives smoking cessation initiative comprises a coordinated health promotion program to increase uptake of smoking cessation services in Central Queensland. The target is 20,000 fewer smokers in Central Queensland, resulting in 10,000 fewer premature deaths due to smoking-related diseases (Khan, Green et al. 2021). This program has focused on pregnant women as a priority group, however, evaluations of the program's impact for these women have not yet been published.

### *Cost-effectiveness of maternal lifestyle interventions in pregnancy*

Cost-effectiveness of maternal lifestyle interventions has also been examined. Structured antenatal diet and physical activity lifestyle interventions in pregnancy appear cost-saving or cost-effective. These interventions have previously been shown to prevent adverse maternal outcomes including gestational diabetes and hypertension in pregnancy. Economic analysis showed physical activity interventions reduced adverse maternal events by 4.2% in the intervention group compared with standard care and could be cost-saving. Diet and diet with physical activity interventions reduced events by 3.5% and 2.9% respectively (with potential to be cost-effective). Unstructured interventions did not reduce events and were dominated by standard care (Bailey, Skouteris et al. 2022). The study authors noted that not all potential neonatal and longer-term benefits were included in the model, suggesting that cost-effectiveness was likely to have been underestimated. The findings from this analysis suggest governments can expect a good return on investment when implementing effective lifestyle interventions in pregnancy. A separate analysis found that lifestyle interventions are cost-effective for reducing adverse maternal outcomes in pregnancy, and that interventions for mothers in higher weight categories are cost-saving (Bailey, Skouteris et al. 2020), demonstrating the benefit of targeted approaches for at-risk populations alongside universal interventions.

## **Postpartum**

A systematic review and meta-analysis of interventions to support postpartum weight management found interventions delivered by health professionals produced significantly greater weight loss compared to those delivered by non-health professionals, and interventions that combined diet and physical activity led to significantly greater weight loss compared with physical activity-only interventions (Lim, Liang et al. 2019).

Analysis of data obtained from an Australian web-based support forum for women before and after birth showed engagement to seek help and support during the postpartum period was common among mothers with infants aged under 12 months. Web-based platforms provide an opportunity to engage with and support mothers during the postpartum period, and further research may illuminate how healthcare professionals can use these platforms to provide targeted and personalised support to women in postpartum period (Chivers, Garad et al. 2021). Systematic review evidence supports these findings, demonstrating support for digital health interventions to promote healthy lifestyle behaviours among postpartum women (Lim, Tan et al. 2019).

## **Early childhood**

### *Effectiveness of early childhood obesity prevention interventions*

Early childhood obesity prevention interventions commenced during pregnancy or early infancy have demonstrated positive health outcomes for young children across multiple domains. A meta-analysis of data from participants in the EPOCH trial interventions (four early obesity prevention interventions delivered in Australia and

New Zealand) showed lower BMI z-scores at age 18 to 24 months among children participating in the interventions. This finding indicates the potential for early obesity prevention programs to have widespread benefits for obesity prevention, if implemented at scale. Early intervention was also associated with increased breastfeeding duration, less television viewing and healthier feeding practices (Askie, Espinoza et al. 2020). This suggests wider scale implementation of parent-focused obesity prevention interventions commenced by early infancy may produce public health benefits (Askie, Espinoza et al. 2020).

#### *The cost of early childhood obesity prevention interventions*

An analysis of the costs of five early childhood obesity prevention interventions conducted in Australia and New Zealand (InFANT, Healthy Beginnings, Nourish, POI, Communicating Healthy Beginnings Advice by Telephone Randomised Controlled Trial (CHAT)) found that interventions varied widely in their resource use. The total cost per participant varied according to delivery mode and setting, and intensity of the intervention, with time costs of personnel delivering the interventions contributing more than 50% of total intervention costs (Brown, Tan et al. 2020). While cost is an important factor in deciding what interventions to adopt, the authors of this analysis point out other important factors must also be considered in decision making, such as the overarching aims and target population of each intervention and factors such as intervention acceptability, feasibility and equity impact.

#### *Cost-effectiveness of early childhood obesity prevention interventions*

Cost-effectiveness analyses of a novel infant sleep intervention to prevent childhood overweight (POI) examined whether a sleep intervention, either alone or in combination with food, activity, and breastfeeding advice was cost-effective compared with usual care. While both interventions led to similar health gains, only the sleep-only intervention was regarded as cost-effective. The more resource intensive (and more costly) intervention of sleep combined with food, activity, and breastfeeding advice was not considered cost-effective (Tan, Taylor et al. 2020).

Cost-effectiveness of scaling up Romp and Chomp, a whole-of-community obesity prevention intervention, identified fair probability of cost-effectiveness if scaled up for delivery to all Australian children aged under five years (Tran, Killedar et al. 2022). Romp and Chomp was a community-wide obesity prevention intervention that effectively reduced weight and BMI measures in children aged under five years. Romp and Chomp had lower modelled intervention effects on BMI at age 15 years compared to other early obesity prevention interventions (including those in the EPOCH trials), however, Romp and Chomp was also less costly given its less intensive mode of delivery (Tan, Taylor et al. 2020, Tran, Killedar et al. 2022). Authors of the analysis concluded that scale-up of the Romp and Chomp program should be considered as part of a package of interventions to reduce the prevalence of obesity in children (Tran, Killedar et al. 2022).

## **SETTINGS AND SUPPORTIVE ENVIRONMENTS FOR PREVENTION**

**Prevention interventions in early childhood education and care settings have a positive impact on children's physical activity behaviours. Interventions in food retail environments lead to reduced purchases of unhealthy food and drinks and encourage and support healthy food and drink choices for children and families.**

### **Early childhood education and care settings**

An umbrella review of systematic review evidence of the effectiveness of interventions in the early childhood education and care settings on the physical activity levels of children from birth to age six reported that interventions delivered in early childhood education and care demonstrated a positive impact on child physical activity outcomes, including total physical activity and duration of sedentary behaviour (Lum, Wolfenden et al. 2022).

A systematic review of dietary behaviour and physical activity policies and guidelines found guidelines focused on the physical environment, making recommendations such as providing healthy food within settings, not providing sugar-sweetened beverages, and providing opportunities for physical activity. On the other hand, guidelines scarcely addressed the policy and economic environments within the care centres (Jackson, Jones et al. 2021). A study looking at digital health interventions in Australian early childhood education and care centres found high levels of intention to adopt digital health interventions to support dietary guideline implementation. Given evidence of the effectiveness of digital health interventions, these findings highlight an opportunity for improving early childhood nutrition through digital interventions in early childhood education and care settings (Grady, Barnes et al. 2020).

## Food environments

Evaluation studies have demonstrated the positive impacts of initiatives to improve retail food environments. Evaluation of an intervention to reduce the availability of sugary drinks in sports and recreation centres within the context of adopting healthy food and beverage policies showed removing sugary drinks from sports and recreation settings had clear public health benefits. Sports and recreation settings are an important environment for public health interventions given their frequent use by children and families for swimming classes and recreation. Moderate financial impacts were observed, and study authors suggest these could be mitigated with increased promotion of healthier alternatives (Boelsen-Robinson, Orellana et al. 2020). Evaluation of customer acceptability demonstrated strong support from patrons for the sugary drink removal initiative, with many reporting that the intervention would likely support healthier dietary choices for children (Boelsen-Robinson, Jerebine et al. 2021).

Evaluation using a randomised trial restricting the promotion of unhealthy food in retail stores in remote Australia showed a reduction in free sugar sales through reduced sales of sugary drinks and confectionary in intervention stores. Gross profit of intervention stores was not adversely impacted. This demonstrates benefits of restricting the promotion of unhealthy foods and beverages in retail stores, with complementary merchandising of healthier foods and beverages (Brimblecombe, McMahon et al. 2020).

## HEALTH-RELATED QUALITY OF LIFE

**Health-related quality of life may be impacted by obesity among older children and adolescents. The evidence examined in this synthesis finds no significant association between weight status in early childhood and health-related quality of life at age five years.**

Measuring health-related quality of life (HRQoL) in very young children is challenging, given the need for parent-proxy reports and that fact that existing tools may not be well-calibrated to this very young age group. The relatively limited evidence on the impact of prevention interventions on HRQoL in this age group is mixed or inconclusive, and more investigation is required in this area. For example, a study examining the association between weight status in the preschool years and HRQoL at age five years found no significant association between weight status in preschool (age two to five years) and health-related quality of life at age five (Tan, Brown et al. 2018). This is not to say that obesity in childhood does not influence quality of life, but rather that it has not been demonstrated in this study of young children. It has been suggested that HRQoL is more likely to be impacted by overweight and obesity among older children and adolescents compared to preschool aged children (Canaway and Frew 2014).

## PARTICIPANT EXPERIENCES

**Participant experiences of program and health service participation during preconception and early childhood demonstrate the need for flexible modes of intervention delivery to ensure ease of access and optimal participation and engagement.**

### Preconception

Three studies looked at women's perceptions of health and healthcare provision in the preconception period. A Victorian study exploring women's awareness and uptake of healthy lifestyle behaviours in the preconception period found that while women perceive preconception health to be important, it is not considered a high priority if they are not planning a pregnancy. Participants suggested a range of interventions to engage women in preventive health and promote preconception health. These included having access to reputable and easily accessible online sources of preconception health information, education in secondary schools, and public health campaigns. The authors concluded that a multi-level approach with a range of interventions across this model is crucial to improve patient engagement and health literacy in preconception health (Walker, Drakeley et al. 2021).

Another Victorian study examined the acceptability of expanding the role of practice nurses to provide preconception care. Participants in this study considered preconception to be when a woman is planning a pregnancy. Women reported wanting personalised preconception care and considered practice nurses to be acceptable providers of preconception care. Other resources in the wider community, such as schools, were also identified as important aspects of a coordinated approach to providing preconception health care (Walker, Kandel et al. 2021).

Evaluation of a virtual patient advocate providing preconception health advice to women living in Victoria was found to be an acceptable provider of health information. A virtual patient advocate is a computer-generated character, often a health professional, who simulates face-to-face conversations with patients to communicate key health messages. The virtual patient advocate in this study was considered trustworthy and was able to develop rapport with participants in a relatively short time. Findings demonstrated the potential to increase women's access to general and preconception health advice via virtual patient advocates. The authors concluded that this may be particularly useful in overcoming barriers to the provision of healthcare such as low levels of patient access and health literacy and as an alternate source of health information and patient education in contexts where human resources are limited (Walker, Drakeley et al. 2021).

### Early childhood

The Communicating Healthy Beginnings Advice by Telephone Randomised Controlled Trial (CHAT RCT) (n=947) was an infant obesity prevention program delivered via telephone calls or text messages, with supporting information booklets. Interventions were provided at six time points following key developmental milestones from the antenatal period (third trimester) until the end of first year of the infant's life. Evaluation of participant experiences found many participants reported positive experiences. Participants appreciated flexibility particularly in relation to intervention delivery via telephone calls or text messages. Individual preferences varied according to information needs and time constraints on new mothers, and authors concluded that information provision via multiple modes is ideal to reach a wider population and for better engagement. Authors also concluded that delivering health promotion messages via telephone calls or text messages has the potential to provide equitable access to information by women from various socioeconomic and culturally diverse backgrounds (Ekambareshwar, Taki et al. 2020).

Factors enabling parents' engagement in the Victorian InFANT early childhood obesity prevention program included parents' heightened need for knowledge, affirmation and social support. On the other hand, program attendance reduced as parents acquired knowledge and confidence, and early cessation of the program was associated with parents returning to work. Overall, it appears that the InFANT program catered to the needs of parents in the transition to parenthood, providing information and social support (Love, Laws et al. 2018).

## How do we support implementation and scale-up of effective interventions?

**Collaboration and partnerships between researchers, policy makers, health service delivery practitioners and consumers are central to the design, implementation and scale-up of prevention interventions in the first 2000 days. Implementation and scale-up of effective interventions also requires a careful balance of maintaining program fidelity and tailoring to meet local need.**

Evaluation of four EPOCH trials highlighted the importance of collaboration between researchers, policy makers and health service delivery practitioners in the planning and implementation of effective interventions to ensure both scalability and sustainability (Seidler, Hunter et al. 2020). Other key features of scale-up include alignment of interventions with organisational values and priorities, and embedding interventions within existing services and systems.

A case study of the scale-up of Victoria's InFANT program identified several key factors for success, highlighting a balance between two critical components – maintaining the fidelity of an evidence-based program while making necessary adaptations to fit local circumstances. Alignment of the InFANT program's goals with existing policies and services was seen as a success factor. However, workforce capacity for program delivery and administration was a challenge, largely overcome by embedding the program into existing roles. Authors of the case study concluded that policy makers, researchers and practitioners have important and complementary roles to play in supporting the translation of effective research interventions into practice, and recommended funding for research translation activities and partnerships between researchers and end-users needs to be built into existing research funding schemes (Laws, Hesketh et al. 2016).

Co-design also emerged as an important feature of interventions to ensure translation into practice. For example, one study looked at the potential to enhance current provision of preconception and pregnancy care using co-design, reporting that input is required from multiple stakeholders including women, nurses, midwives, obstetricians, allied health and administration and management staff. The authors also identified the diverse needs of culturally and linguistically diverse women, Aboriginal and Torres Strait Islander women and women who have experienced socioeconomic disadvantage, highlighting that co-design is likely to have even greater application

with these priority population groups (Walker, Morris et al. 2020). Co-design was also identified as contributing to the success of the Healthy Stores 2020 intervention to reduce promotion and sales of unhealthy food in remote stores (Brimblecombe, McMahon et al. 2020).

A mixed method systematic review of 20 studies identified key barriers and facilitators impacting the implementation of healthy eating, physical activity and obesity prevention policies and programs in the family day care setting. This review identified barriers and facilitators of implementation that related to the following key domain areas: 'environmental context and resources' (e.g. physical resources, weather conditions); 'social influences' (e.g. attitudes and preferences); and 'skills' (Grady, Jackson et al. 2022).

## How can we tailor implementation and scale-up of prevention interventions for priority populations?

### TAILOR INTERVENTIONS TO UNIQUE CIRCUMSTANCES

**Population groups including Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people experiencing socioeconomic disadvantage were all identified as important during policy dialogue discussions. Evidence indicates that engagement with and efficacy of healthy lifestyle interventions is impacted by participant circumstances such as educational attainment and cultural background. These findings highlight the need for interventions in the first 2000 days to be tailored to meet the unique needs of culturally diverse populations and families experiencing socioeconomic disadvantage.**

A meta-analysis of randomised controlled trials on diet and physical activity-based interventions in pregnancy demonstrated positive associations between antenatal dietary interventions and clinically significant reductions in excess gestational weight gain and reduced risk of inadequate weight gain among women with low educational attainment. The analysis also found associations between dietary interventions and reduced risk of inadequate weight gain among women with low educational attainment. Physical activity interventions, however, were not associated with gestational weight gain (O'Brien, Segurado et al. 2019). These are important findings, identifying particular intervention components that led to positive outcomes in a priority population group.

Engagement, retention, and behavioural outcomes from the Healthy Beginnings trial were less favourable among families who spoke a language other than English at home, compared to families with English as their main language. This evidence demonstrates the need to tailor early obesity prevention interventions to improve engagement and effectiveness among culturally and linguistically diverse families (Marshall, Xu et al. 2021). There is some further proposed research that will contribute to this area. Healthy Beginnings is developing a web-based platform to extend the reach of its program with a focus on culturally and linguistically diverse populations. The focus of EPOCH-Translate CRE (2022-2026) is to look at how effective and cost-effective interventions can be scaled up and tailored to various policy and practice contexts, including for priority population groups. A review of the InFANT program is underway to examine the evidence on approaches to tailor the intervention to vulnerable population groups in Victoria.

### STRUCTURAL FACTORS CONTRIBUTE TO HEALTH BEHAVIOUR

**Studies examining food consumption patterns according to socioeconomic position and food security in remote Aboriginal communities reveal the underlying issues that influence dietary behaviour. There is a clear need for structural change to address the social determinants of health including income and housing, as these factors constitute the underlying drivers of health behaviour and health outcomes.**

Analysis of Australia's National Nutrition and Physical Activity Survey found households with low socioeconomic position reported significantly lower intakes of healthy food and drinks and similarly high intakes of unhealthy food and drinks compared to households with high socioeconomic position. The habitual diets of households with low socioeconomic position cost significantly less than the diets consumed by households with high socioeconomic position. Diets recommended for health were unaffordable for the lowest socioeconomic households, and stressful to afford for the second lowest, indicating that families with lower socioeconomic position cannot afford a healthy diet (Lewis, McNaughton et al. 2021).

Insights from an ethnographic study of food practices of households in remote Australian Aboriginal communities identified several underlying issues contributing to food insecurity including poverty, overcrowding, food budgets,

food availability and affordability. The study also illustrated the resourcefulness of Aboriginal people living in remote communities in securing food despite experiencing poverty and adversity (Bryce, Scales et al. 2020). The study authors concluded that drawing on the strengths of communities and respecting Aboriginal leadership will be necessary complements to structural reform to improve food security in remote communities.

Analysis of smoking behaviours among Indigenous students found they were significantly more likely than non-Indigenous students to have used tobacco. These findings illustrate the need for universal tobacco prevention interventions that address common determinants of tobacco use, as well as targeted initiatives that address underlying issues that are unique to Indigenous adolescents, including community smoking prevalence and the influence of unique social, economic, cultural and historical factors on smoking behaviour (Heris, Guerin et al. 2021).

Beyond these findings, evidence was limited with regards to scaling up interventions to meet the needs of Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people experiencing socioeconomic disadvantage. This is also reflected in the broader evidence that suggests a lack of focus on priority populations, pointing to the need for greater investment in research to support the design, implementation and evaluation of effective interventions to improve outcomes for priority population groups (Renzaho, Polonsky et al. 2016).

## Discussion

Drawing together findings from Prevention Centre and CERl member CREs research programs over the past six years and insights from policy partners and public health experts, this synthesis highlights benefits, cost-effectiveness, key interventions, equity considerations, and implementation and scale-up lessons for prevention in the first 2000 days.

Investments made to protect and promote health in the first 2000 days yield benefits that can last a child's entire lifetime (Heckman and Masterov 2007), and have extensive population level benefits, such as the potential to reduce morbidity, mortality and economic, and social costs. The economic burden of preventable disease comprises costs associated with healthcare expenditure, and with lost productivity due to school absenteeism, impacting governments, businesses and individuals (Hayes, Chevalier et al. 2016, Crosland, Ananthapavan et al. 2019, Carrello, Lung et al. 2021).

There is evidence of strong public support for prevention policies, particularly those that protect children's health. Policies with high levels of support include restricting unhealthy food and drink advertising, local planning laws to reduce the density of fast food outlets, investments in improved walking and cycling infrastructure, and implementation of prevention interventions in early childhood education and care settings. These policies align with focus areas of the National Preventive Health Strategy (Commonwealth of Australia 2021) including improving access to and consumption of a healthy diet, and improving physical activity, as well as the Strategy's aim to ensure all children have the best start in life.

The synthesis demonstrates evidence of effective interventions at each stage of the first 2000 days, from preconception to pregnancy, the postpartum period and throughout early childhood. For example, healthy lifestyle interventions improve pregnancy-related outcomes including gestational weight gain, gestational diabetes, preterm delivery, large-for-gestational age neonate, and neonatal intensive care admission (Bennett, Walker et al. 2019, Teede, Bailey et al. 2022). Early childhood obesity prevention interventions promote the development of healthy eating, activity and sleep behaviours in young children, and reduced BMI z-scores (Askie, Espinoza et al. 2020).

A comprehensive approach to prevention requires a range of individual and population-based interventions that support healthy behaviours among individuals, promote and support health in settings (including education, workplace and healthcare settings), and create healthy and supportive environments. The need for multi-component interventions is echoed in leading evidence including the Nurturing Care Framework (World Health Organization, United Nations Children's Fund et al. 2018), and the Report of the Commission on Ending Childhood Obesity (World Health Organization 2016).

Barriers to engagement with prevention interventions have been identified in research presented in this synthesis, and ongoing evaluation of barriers and facilitators to successful participation will be necessary to ensure interventions can be responsive to participant needs. At the same time, ongoing work is required to ensure that the benefits of prevention interventions can be sustained over time. Regular monitoring and surveillance of health-related behaviours and health outcomes is necessary to understanding the extent to which these needs are met.

This synthesis presents evidence of inequities in health, and describes the influence of socioeconomic position, race and culture on the efficacy of preventive health programs. These inequities reveal the impact of social determinants of health, a finding that is verified in the broader literature. Early life is a critical time in which to address health inequities. Socioeconomic differences in children's health emerge in early life, and the gap increases over time (Moore, McDonald et al. 2014). This points to the need for action to address underlying structural determinants of health with social and economic policies that improve basic conditions for a healthy life including income, opportunities for education, housing, and access to health care (Commission on Social Determinants of Health 2008).

Decisions around where and how to act can be complex. When implementing and scaling up effective interventions, considerations of program fidelity and tailoring to local need must be carefully balanced. Additional factors for successful intervention scale-up include costing and economic modelling of intervention approaches, the use of evidence-based approaches, participatory methods and engagement with the target community, strong leadership and champions, political will, and infrastructure to support implementation (Milat, Bauman et al. 2015). Resources to support scale-up are available, including those published by the Prevention Centre (Milat, Lee et al.

2020), and the World Health Organization (World Health Organization and ExpandNet 2010). There are other considerations in deciding how to act, such as whether to implement universal or targeted prevention interventions. Universal approaches have wide population reach, while targeted approaches are designed to meet the needs of a particular, often at-risk, population groups. This knowledge synthesis - along the wider evidence - suggests that both universal and targeted approaches to prevention are needed (Marmot, Allen et al. 2010). Rigorous evidence on the costs and benefits of each approach are needed, so that society's scarce resources can be allocated efficiently.

Limitations of this synthesis include the focused nature of the search to include only work undertaken by Prevention Centre and CERI member research teams. This decision was made for two reasons. Firstly, to draw together research findings from across the Prevention Centre and CERI network, and, secondly, to allow close engagement between our network of research experts working in the first 2000 days and policy and practice partners through the policy dialogues. To date, work undertaken by the Prevention Centre and CERI member CREs has focused predominantly on lifestyle behaviours in preconception and pregnancy, programs to support prevention of early childhood obesity and the economic impacts of these, healthy food retail interventions and physical activity interventions in early childhood education and care settings. As work across the first 2000 days progresses, further evidence on each of these topics and more will be generated.

Discussions during each of the two policy roundtables revealed several areas of interest for policy partners. Some of these have been addressed in this knowledge synthesis, others have not. Areas for further exploration include specific risk factors such as food insecurity and parents' mental health across the first 2000 days, breaking down silos between services and sectors, and generating political support for prevention across the first 2000 days. This synthesis has also identified some gaps in the evidence. For example, further evidence is required to support the design, implementation, and evaluation of prevention interventions that meet the needs of priority population groups including Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities, and people experiencing socioeconomic disadvantage. There is also a need for increased monitoring of modifiable risk factors across the first 2000 days, to ensure future prevention efforts can be designed to address ongoing and emerging health risks.

## Conclusions

This knowledge synthesis combines findings from Prevention Centre and CERl member CREs research programs that have focused on prevention in the first 2000 days with insight from policy partners and public health experts. Collectively, these findings build a strong case for prevention in the first 2000 days.

- **There is a window of opportunity to establish and support healthy behaviours in the formative first 2000 days of life.** Health behaviours in the first 2000 days influence health throughout childhood, adolescence and adulthood.
- **There are economic benefits from investing in prevention in the first 2000 days,** before chronic diseases emerge.
- **Interventions in the first 2000 days are effective and cost-effective.** Healthy lifestyle interventions during preconception and pregnancy and family-based early childhood obesity prevention interventions have demonstrated evidence of effectiveness and cost-effectiveness.
- **Prevention in the first 2000 days requires a comprehensive approach** that combines individual and population-based interventions to support healthy behaviours among individuals, promote and support health in settings (including education, workplace and healthcare settings), and create healthy and supportive environments.
- **Taking action in the first 2000 days will reduce health inequities.** Socioeconomic differences in children's health emerge in early life and are difficult to remedy once established.
- **There is strong public support for prevention interventions in the first 2000 days,** particularly for interventions that protect children's health.
- **Implementation and scale-up of effective interventions requires collaboration** between researchers, policy makers, practitioners and consumers, and a careful balance of program fidelity and tailoring to local need.

This project demonstrates the utility of a collaborative approach to knowledge synthesis that combines the expertise of research, policy and communications experts to draw out policy relevant lessons for prevention in the first 2000 days. The synthesised knowledge will be shared in a range of diverse and accessible formats via the Prevention Centre.

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## Appendix: Included studies

| Research group | Author and year of publication | Title  | Article type                             |
|----------------|--------------------------------|--|--|
| EPOCH          | Askie et al. (2020)            | Interventions commenced by early infancy to prevent childhood obesity—The EPOCH Collaboration: An individual participant data prospective meta-analysis of four randomized controlled trials | Intervention evaluation<br>Meta-analysis |
| EPOCH          | Brown et al. (2019)            | The potential for long-term cost-effectiveness of obesity prevention interventions in the early years of life  | Cost-effectiveness study                 |
| EPOCH          | Brown et al. (2017)            | The high cost of obesity in Australian pre-schoolers   | Cost of obesity in early childhood       |
| EPOCH          | Brown et al. (2020)            | Cost comparison of five Australasian obesity prevention interventions for children aged from birth to two years  | Cost of interventions                    |
| EPOCH          | Brown et al. (2018)            | Utility values for childhood obesity interventions: a systematic review and meta-analysis of the evidence for use in economic evaluation   | Systematic review and meta-analysis      |
| EPOCH          | Carrello et al. (2021)         | Relationship between obesity and school absenteeism in Australian children: Implications for carer productivity  | Cost of obesity in early childhood       |
| EPOCH          | Ekambaraesha et al. (2020)     | Participant experiences of an infant obesity prevention program delivered via telephone calls or text messages   | Intervention evaluation                  |
| EPOCH          | Esdaile et al. (2021)          | Strong support for broad policies to prevent childhood obesity among mothers in New South Wales, Australia   | Community opinion study                  |
| EPOCH          | Esdaile et al. (2019)          | National policies to prevent obesity in early childhood: Using policy mapping to compare policy lessons for Australia with six developed countries   | Prevention policy mapping                |
| EPOCH          | Hayes et al. (2016)            | Early childhood obesity: Association with healthcare expenditure in Australia  | Cost of obesity in early childhood       |
| EPOCH          | Hayes et al. (2014)            | Economic evaluation of “healthy beginnings” an early childhood intervention to prevent obesity   | Intervention economic evaluation         |
| EPOCH          | Hayes et al. (2019)            | A New Model for Evaluation of Interventions to Prevent Obesity in Early Childhood  | Intervention evaluation                  |
| EPOCH          | Hayes et al. (2019)            | Patterns and costs of health-care utilisation in Australian children: The first 5 years  | Cost of healthcare in early childhood    |
| EPOCH          | Hayes et al. (2021)            | Looking backwards and forwards: tracking and persistence of weight status between early childhood and adolescence  | Cohort study                             |

| Research group | Author and year of publication | Title  | Article type                             |
|----------------|--------------------------------|--|--|
| EPOCH          | Killedar et al. (2020)         | Estimating Age- and Sex-Specific Utility Values from the CHU9D Associated with Child and Adolescent BMI z-Score  | Health-related quality of life           |
| EPOCH          | Killedar et al. (2020)         | Weight status and health-related quality of life during childhood and adolescence: effects of age and socioeconomic position   | Health-related quality of life           |
| EPOCH          | Laws et al. (2016)             | Translating an early childhood obesity prevention program for local community implementation: a case study of the Melbourne InFANT Program                               | Intervention implementation and scale-up |
| EPOCH          | Love et al. (2019)             | Lessons on early childhood obesity prevention interventions from the Victorian Infant Program  | Intervention implementation and scale-up |
| EPOCH          | Love et al. (2018)             | Factors Influencing Parental Engagement in an Early Childhood Obesity Prevention Program Implemented at Scale: The Infant Program  | Intervention evaluation                  |
| EPOCH          | Marshall et al. (2022)         | Engagement, satisfaction, retention and behavioural outcomes of linguistically diverse mothers and infants participating in an Australian early obesity prevention trial | Intervention evaluation                  |
| EPOCH          | Seidler et al. (2020)          | Understanding, comparing and learning from the four EPOCH early childhood obesity prevention interventions: A multi-methods study  | Intervention evaluation                  |
| EPOCH          | Tan et al. (2018)              | Is there an association between early weight status and utility-based health-related quality of life in young children?  | Health-related quality of life           |
| EPOCH          | Tan et al. (2020)              | Cost-effectiveness of a novel sleep intervention in infancy to prevent overweight in childhood   | Cost-effectiveness study                 |
| HiPP           | Chivers et al. (2021)          | Support Seeking in the Postpartum Period: Content Analysis of Posts in Web-Based Parenting Discussion Groups   | Qualitative study                        |
| HiPP           | Harrison et al. (2021)         | Weight management across preconception, pregnancy, and postpartum: A systematic review and quality appraisal of international clinical practice guidelines               | Systematic review                        |
| HiPP           | Kandel et al. (2021)           | Enablers and barriers to women's lifestyle behavior change during the preconception period: A systematic review  | Systematic review                        |
| HiPP           | Madden et al. (2021)           | Workplace healthy lifestyle determinants and wellbeing needs across the preconception and pregnancy periods: A qualitative study informed by the COM-B model             | Qualitative study                        |
| HiPP           | Madden et al. (2020)           | The effect of workplace lifestyle programs on diet, physical activity and weight-related outcomes for working women: A systematic review using the TIDieR checklist      | Systematic review                        |

| Research group    | Author and year of publication | Title   | Article type                             |
|-------------------|--------------------------------|---|--|
| HiPP              | Walker et al. (2020)           | Preconception women's views of promoting preconception women's health in Australia  | Qualitative study                        |
| HiPP              | Walker et al. (2020)           | Assessing the potential of a Virtual Patient Advocate to provide preconception care and health advice to women living in Australia  | Qualitative study                        |
| HiPP              | Walker et al. (2021)           | Practice nurses and providing preconception care to women in Australia: a qualitative study   | Qualitative study                        |
| WHiRL             | Grieger et al. (2021)          | A review of maternal overweight and obesity and its impact on cardiometabolic outcomes during pregnancy and postpartum  | Narrative review                         |
| WHiRL             | McAninch et al. (2020)         | The metabolic syndrome in pregnancy and its association with child telomere length  | Cohort study                             |
| NCOIS             | Grady et al. (2020)            | Barriers and enablers to adoption of digital health interventions to support the implementation of dietary guidelines in early childhood education and care: Cross-sectional study                            | Intervention implementation and scale-up |
| NCOIS             | Jackson et al. (2021)          | Obesity Prevention within the Early Childhood Education and Care Setting: A Systematic Review of Dietary Behavior and Physical Activity Policies and Guidelines in High Income Countries                      | Systematic review                        |
| NCOIS             | Wolfenden et al. (2017)        | Strategies for enhancing the implementation of school-based policies or practices targeting risk factors for chronic disease  | Cochrane review                          |
| Tobacco Endgame   | Khan et al. (2021)             | How can a coordinated regional smoking cessation initiative be developed and implemented? A programme logic model to evaluate the '10,000 Lives' health promotion initiative in Central Queensland, Australia | Intervention evaluation                  |
| RE-FRESH          | Boelsen-Robinson et al. (2020) | Change in drink purchases in 16 Australian recreation centres following a sugar-sweetened beverage reduction initiative: an observational study   | Intervention evaluation                  |
| RE-FRESH          | Boelsen-Robinson et al. (2021) | Evaluating the implementation and customer acceptability of a sugar-sweetened beverage reduction initiative in thirty Australian aquatic and recreation centres   | Intervention evaluation                  |
| RE-FRESH          | Brimblecombe et al. (2020)     | Effect of restricted retail merchandising of discretionary food and beverages on population diet: a pragmatic randomised controlled trial   | Intervention evaluation                  |
| Prevention Centre | Bailey et al. (2020)           | Cost-Effectiveness of Antenatal Lifestyle Interventions for Preventing Gestational Diabetes and Hypertensive Disease in Pregnancy   | Cost-effectiveness of interventions      |
| Prevention Centre | Bailey et al. (2022)           | A Comparison of the Cost-Effectiveness of Lifestyle Interventions in Pregnancy  | Cost-effectiveness of interventions      |

| Research group    | Author and year of publication | Title   | Article type                                 |
|-------------------|--------------------------------|---|--|
| Prevention Centre | Bailey et al. (2021)           | Economic evaluation methods used in home-visiting interventions: A systematic search and review   | Systematic review                            |
| Prevention Centre | Bennett et al. (2019)          | Attenuation of maternal weight gain impacts infant birthweight: systematic review and meta-analysis   | Systematic review and meta-analysis          |
| Prevention Centre | Bryce et al. (2020)            | Ngaanyatjarra Pitjantjatjara Yankunytjatjara Women's Council. Maitjara Wangkanyi: Insights from an Ethnographic Study of Food Practices of Households in Remote Australian Aboriginal Communities | Ethnographic study<br>Priority population    |
| Prevention Centre | Cullerton et al. (2020)        | What do the Australian public think of regulatory nutrition policies A scoping review   | Scoping review                               |
| Prevention Centre | Freebairn et al. (2020)        | 'Turning the tide' on hyperglycemia in pregnancy: insights from multiscale dynamic simulation modeling  | Modeling study                               |
| Prevention Centre | Goldstein et al. (2020)        | The Healthy Pregnancy Service to Optimise Excess Gestational Weight Gain for Women with Obesity: A Qualitative Study of Health Professionals' Perspectives  | Qualitative study                            |
| Prevention Centre | Grunseit et al. (2021)         | Changes in Australian community perceptions of non-communicable disease prevention: a greater role for government?  | Community opinion study                      |
| Prevention Centre | Grunseti et al. (2019)         | Nanny or canny? Community perceptions of government intervention for preventive health  | Community opinion study                      |
| Prevention Centre | Heris et al. (2017)            | Smoking behaviours and other substance use among Indigenous and non-Indigenous Australian secondary students, 2017  | Cross-sectional study<br>Priority population |
| Prevention Centre | Hill et al. (2020)             | Defining preconception: exploring the concept of a preconception population   | Rapid review                                 |
| Prevention Centre | Howse et al. (2020)            | Are perceptions of government intervention for prevention different by gender and age? Results from the AUStralian Perceptions Of Prevention Survey (AUSPOPS)                                     | Community opinion study                      |
| Prevention Centre | Lee et al. (2021)              | Review of nutrition among Aboriginal and Torres Strait Islander people  | Review<br>Priority population                |
| Prevention Centre | Lewis et al. (2021)            | Dietary Intake, Cost, and Affordability by Socioeconomic Group in Australia   | Cross-sectional study<br>Priority population |
| Prevention Centre | Lim et al. (2020)              | An evaluation of the impact of lifestyle interventions on body weight in postpartum women: A systematic review and meta-analysis  | Systematic review and meta-analysis          |

| Research group    | Author and year of publication | Title   | Article type                                   |
|-------------------|--------------------------------|---|--|
| Prevention Centre | Lim et al. (2019)              | A systematic review and meta-analysis of intervention characteristics in postpartum weight management using the TiDieR framework: A summary of evidence to inform implementation        | Systematic review and meta-analysis            |
| Prevention Centre | Lim et al. (2019)              | Health Professionals' and Postpartum Women's Perspectives on Digital Health Interventions for Lifestyle Management in the Postpartum Period: A Systematic Review of Qualitative Studies | Systematic review                              |
| Prevention Centre | O'Brien et al. (2019)          | Impact of maternal education on response to lifestyle interventions to reduce gestational weight gain: individual participant data meta-analysis  | Intervention evaluation<br>Priority population |
| Prevention Centre | Teede et al. (2022)            | Association of Antenatal Diet and Physical Activity-Based Interventions With Gestational Weight Gain and Pregnancy Outcomes: A Systematic Review and Meta-analysis                      | Systematic review and meta-analysis            |