





Understanding the importance of the early-life period for adult health: a systematic review

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Review

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Abstract

Evidence clearly indicates that the nutritional and non-nutritional environment and level of physical activity during the early-life period from preconception through infancy has a lifelong impact on the child's health. However this message must be communicated effectively to parents and other stakeholders such as grandparents, health professionals, policymakers and the wider community in order for positive change to occur. This systematic review explores how both awareness and understanding of the long-term effects of the early-life environment have been measured in various populations and whether any patterns are evident. Ten articles were retrieved via a search of Embase, Medline and Scopus databases for peer-reviewed studies designed to assess participants' knowledge of the links between early-life exposures and adult health. Eligible articles spanned a wide range of countries, population groups and research methods. Three common themes were identified using thematic analysis: 1. a tendency for researchers to conflate participant understanding of the issue (the WHY) with a knowledge of key phrases and nutrition guidelines (the WHAT); 2. bias in both researchers and participants towards short-term thinking due to difficulty conceptualising long-term risk; and 3. challenges in comprehending the complexity of the evidence resulting in oversimplification and the overemphasis of maternal factors. Taken together these findings underscore the importance of a multi-level, whole-of-society approach to communicating the evidence, with the goal of influencing policy decisions as well as building a foundation of community support for parents and prospective parents to create a healthy early-life environment for the long-term wellbeing of all.

Introduction

Research in the field of Developmental Origins of Health and Disease (DOHaD) contributes to a growing body of evidence that the early life environment, particularly the period of pregnancy through to the first two years of life (commonly termed “The First Thousand Days”), plays a significant role in determining health and disease outcomes in later life.^{1,2} Factors influencing the developmental environment, such as parental metabolic health and gestational nutrient intake have been linked with the risk of developing non-communicable diseases (NCDs) in adulthood – in particular cardiovascular disease, type 2 diabetes, respiratory diseases and some cancers – via epigenetic regulation of gene expression in the earliest stages of life.^{3,4} As these NCDs are now responsible for the vast majority of morbidity and premature mortality globally, identifying risk factors and communicating this knowledge in a way that enables risk reduction strategies to be effectively put into practice will be key for future NCD prevention.⁵⁻⁷

The interactive process of synthesis, dissemination, exchange and ultimately application of knowledge in healthcare decision-making is known as knowledge translation.^{8,9} This process differs from research translation in that it is aimed at a broader audience than the clinicians and health practitioners who are traditionally tasked with integrating biomedical research into everyday practice. Knowledge translation also involves a greater focus on the recipients' context, recognising a wide range of stakeholders, each incorporating different perspectives, prior experience and existing wisdom into their own practical adaptation of the evidence.^{10,11} DOHaD knowledge translation interventions to date have tended to be small in scale and typically aimed at improving the awareness of parents with the goal of prompting behaviour change to promote a healthy early-life environment during pregnancy and infancy; more recently the focus has shifted somewhat to adolescents, as the impact of preconception health comes under the spotlight.¹²⁻¹⁴

As more and more compelling data regarding the developmental period and its significance for later adult health emerges, it becomes increasingly critical for this research to be understood not just by new and future parents, but by decision-makers in the public health system, politicians, health practitioners, community leaders, educators and extended family support networks.^{15,16} Achieving widespread recognition and understanding of the ways in which

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different environmental exposures may be either beneficial or detrimental in shaping an individual's lifelong health trajectory has the potential to reframe the way society views health behaviours, replacing the judgment of individual choices with attention to the broader structural determinants of health.¹⁷ However, in shifting the focus from individuals to wider society, there is a risk of DOHaD health promotion messaging being viewed as a top-down approach "imposed" by experts onto the public with little interaction or true engagement with affected communities.¹⁸ Therefore, when designing knowledge translation interventions, consideration must be given to the degree of scientific and health literacy in the target population – as the attitudes, values, knowledge and skills of each individual and group, alongside agency freedoms associated with the potential to take actions, will determine their ability to make evidence-based health and policy decisions.¹⁹ Baseline awareness and understanding of DOHaD concepts must also be established to enable an intervention to be structured in a way that effectively meets stakeholders at their existing level of knowledge. In this review, we explore the methods implemented by researchers to assess DOHaD knowledge in a variety of contexts, and identify patterns in the resulting reports which may in some way serve to improve the process of DOHaD knowledge translation.

Methods

Eligibility criteria

The aim of this review was to systematically analyse any peer-reviewed research investigating the extent of public knowledge regarding the associations between early-life environment and adult health. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement was used to guide the review process.²⁰ Due to the open-ended nature of the review objectives, the eligibility criteria were broad, encompassing research across a range of disciplinary fields, irrespective of whether or not the study included an intervention.

Included for analysis were any English language, peer-reviewed studies involving any human subjects in any location, setting or timeframe, which were designed to assess individuals' awareness or knowledge of links between parental health and/or a child's environmental exposures during the periods of preconception, pregnancy and infancy, and the child's health as an adult. We excluded studies designed solely to explore knowledge of genetic or congenital conditions, or determine participants' awareness of maternal nutrition, physical activity or other health guidelines (for example gestational weight gain) without explicit reference to the potential impact on the health of the child into later life. Intervention studies (for example those targeting a reduction in childhood obesity) were considered only if they included a component measuring participants' understanding of DOHaD concepts. Qualitative or mixed-methods studies that did not explicitly set out to explore participants' knowledge of the relationship between early-life exposures and adult health were excluded. Although we recognise that (lack of) awareness of long-term impacts is sometimes identified as a theme in qualitative maternal health research, it is not usually the main focus, making it difficult to reliably locate such studies via a systematic search process.

Data sources and search strategy

Database searches were undertaken in September 2021 and included all articles published prior to this time. Three databases

– Scopus, Embase and PubMed – were used to retrieve articles for consideration. Each search involved two components, linked using boolean logic operators: 1. A search term relating to DOHaD present in the article's title, abstract or keywords; and 2. A search term synonymous with "knowledge" in the article's title. This combination was shown to return the most relevant articles without an overwhelming quantity of unrelated research resulting from the generic nature of the terminology. A full list of search terms used is presented in Table 1. Search results were then narrowed down using the database filters provided in order to exclude non-human studies and articles that did not qualify as peer-reviewed original research studies.

Study selection and verification

Following refinement of the search results, the articles from all three databases were combined by importing into EndNote reference management software, where duplicates were identified and removed. The titles of the remaining studies were manually screened for eligibility and excluded if they were obviously unrelated to the review criteria. Abstracts were then retrieved and reviewed by J.R.H. for possible inclusion. A pre-screen of titles and abstracts was undertaken by J.R.H., J.L.B. and M.H.V. before the final list of studies was consolidated and independently screened by J.R.H. and J.L.B. via review of the full article text. Reference lists from these articles were also checked by J.R.H. for further possible contenders. Where conflicts regarding inclusion occurred, input was sought from M.H.V., T.B. and members of the wider research team until consensus was reached.

Data analysis

Due to the wide range of population characteristics and methods used in the papers under review, it was determined that quantitative analysis and comparison of statistical data would not be practical or meaningful, therefore a qualitative approach was taken to provide an overview of the eligible literature. Thematic analysis was used to identify and highlight recurring themes in the data. Following a full reading of all eligible articles for familiarisation, patterns were identified and coded by J.R.H. into candidate themes. The themes were reviewed by J.B. and M.V. for consistency with the data then summarised, defined and named prior to final analysis.²¹

Results

The PRISMA diagram for this review (Fig. 1) shows that, from an original 3261 search results, ten articles were identified which met the eligibility criteria – nine directly from keyword searches of the listed databases, plus one additional article identified via reference checks of the 25 final candidates screened for full-text review. Key characteristics of each study included are outlined in Table 2.

The articles included for review span the years 2011–2021 and encompass a broad range of geographical locations – UK, Europe, Canada, Australasia, Japan, Iran, South Africa – and participant demographics, ranging from adolescents and undergraduate students to parents and caregivers to healthcare professionals and the general public. No patterns could be identified regarding the relationship between geographical location and participant characteristics. Sample sizes also varied widely, from a small qualitative sample of 12 first-time mothers in a low-income South African community, to a questionnaire administered to 2071 first-time mothers across five European countries.

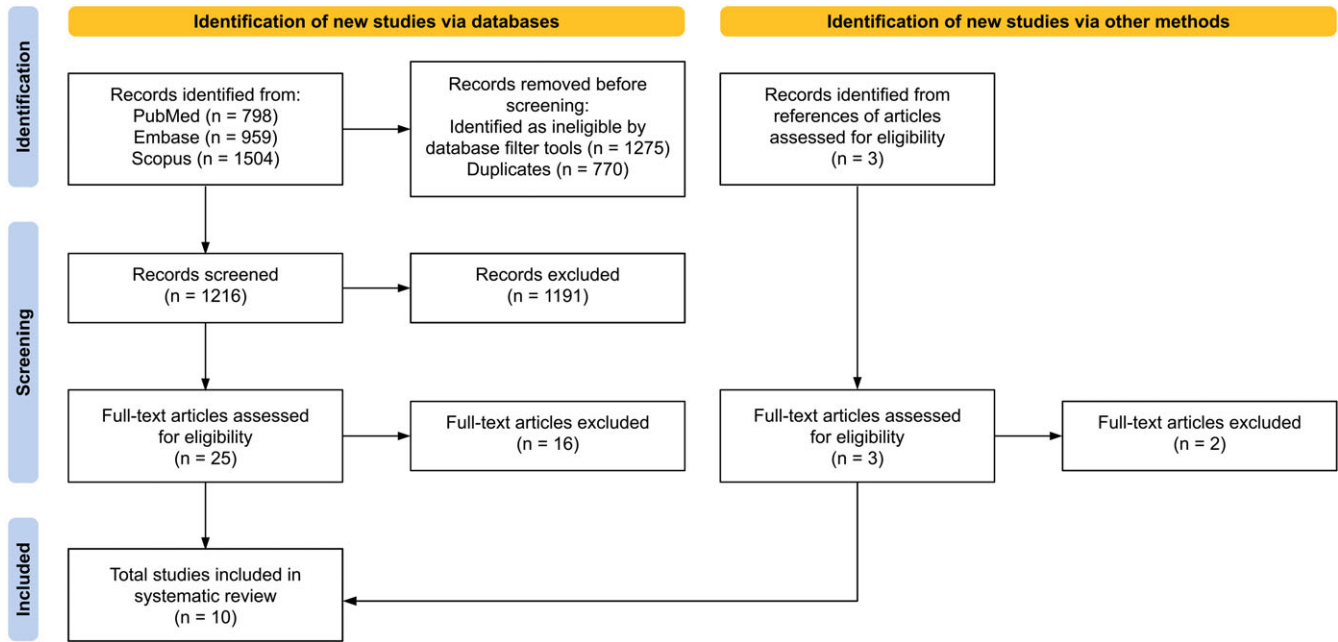


Fig. 1. PRISMA flow diagram for the selection of studies.

Table 1. Database search terms

Title/Abstract/Keywords include:	AND Title includes:
"DOHaD" OR	"know*" OR
"developmental origins" OR	"aware*" OR
"developmental programming" OR	"importan*" OR
"FOaD" OR	"understand*" OR
"fetal origins" OR	"belie*" OR
"first 1000 days" OR	"attitude*" OR
"first thousand days" OR	"communicat*" OR
"early life" OR	"translat*" OR
"early-life" OR	
"life course" OR	
"life-course" OR	
"lifecourse"	

Of the ten studies, seven used a questionnaire tool to assess participants’ understanding of DOHaD concepts. Five of these featured Likert-style responses asking participants to indicate how strongly they agreed or disagreed with statements such as “the food a woman eats when she is pregnant affects the health of her baby when it is grown up”²²⁻²⁶ and one asked similar questions giving participants the option of yes/no answers combined with an open-ended response field to explain their reasoning.²⁷ The seventh quantitative study utilised multiple-choice questions, scoring participants for “correct” or “incorrect” answers.²⁸

The three qualitative studies included for review explored participants’ understanding of the importance of the early-life period via interviews and discussions. While the participant groups in these studies were significantly different demographically (Canadian specialist healthcare professionals versus mothers and grandmothers raising children in poverty in South Africa), researchers in both contexts highlighted the immediate demands of competing priorities and caregivers’ difficulty conceptualising long-term risk as major barriers to communicating DOHaD knowledge.²⁹⁻³¹

Three themes (a focus on the WHAT versus the WHY; a focus on the short term versus the long term; a need for complex

understanding) were identified from the eligible studies. Together these themes illustrate some of the challenges inherent in promoting understanding of this complex topic and provide insight for future knowledge translation activities to help pave the way for improvements to lifelong health.

A focus on the WHAT versus the WHY

While all of the studies selected for review were focused on assessing participants’ understanding of the link between early-life environment and adult health, a range of different survey tools were used. Many of the later approaches build on questions developed by earlier research, with work by Bay et al., Oyamada et al., McKerracher et al. and Lynch et al. utilising similarly-worded 5-point Likert scales to score participants’ level of agreement with questions relating to life-style impacts at various stages of development.²²⁻²⁵ In addition to these questions, participants in multiple studies were questioned regarding their familiarity with the terms “first 1000 days” and “developmental origins of health and disease”. In most instances the likely reasoning behind this was to evaluate the effectiveness of prior messaging around the DOHaD concept rather than participants’ understanding of the evidence, but this was not always clear. In any case, knowledge of terminology (the WHAT) should not be viewed as a reliable indicator of participant understanding (the WHY), as Lynch et al. reveal that only a small minority of participants (3.7% and 12.9%, respectively) who claimed familiarity with the terms “first 1000 days” and “developmental origins of health and disease” were able to provide a full explanation of their meaning according to criteria set by researchers.²³

Likewise, measures of participants’ knowledge and recall of dietary guidelines during pregnancy was in some cases conflated with knowledge of the reasons for the guidelines. The questionnaire tool used by Bagheri et al. consisted of a series of multiple-choice questions such as “Do you know to which period of life the ‘first 1000 days of life’ is referred to?”*, “What is the role

*Original questionnaire in Persian; English translation is provided by the authors.

Table 2. Characteristics of studies included in review

Year	Authors	Location	Participants	Method	Intervention
2021	Lynch et al.	Australia	Adults ($n = 391$)	Questionnaire (quantitative)	No
2021	Pedro et al.	South Africa	First-time mothers ($n = 12$)	Interviews (qualitative)	No
2021	Bagheri et al.	Iran	Parents, prospective parents ($n = 135$)	Questionnaire (quantitative)	No
2020	McKerracher et al.	Canada	Pregnant women ($n = 330$)	Questionnaire (quantitative)	No
2020	Molinaro et al.	Canada	Maternal & paediatric healthcare providers ($n = 23$)	Interviews (qualitative)	No
2018	Oyamada et al.	Japan, New Zealand	Undergraduate health students ($n = 460$)	Questionnaire (quantitative)	Yes
2016	Worthman et al.	South Africa	Mothers, grandmothers as primary caregivers ($n = 38$)	Written survey, discussion (qualitative)	No
2012	Bay et al.	New Zealand	Adolescents ($n = 235$) and their parents ($n = 99$)	Questionnaire (quantitative)	Yes
2012	Grace et al.	England	Adolescents ($n = 802$)	Questionnaire (quantitative)	Yes
2011	Gage et al.	England, Finland, Germany, Hungary, Spain	First-time mothers ($n = 2071$)	Questionnaire (mixed-methods)	No

of parents in the ‘first 1000 days of life?’”, “Which of the following supplements is not common during pregnancy?”, “When does a child become interested in high-fat and salty foods?” and “Which of the following does not increase the risk of obesity in adulthood?”. The answers to these questions were assessed as being correct or incorrect against a pre-determined answer sheet and the scores were then combined prior to analysis as a measure of “parents’ awareness about the first 1000 days of life” – therefore making it impossible to separate participants’ understanding of DOHaD concepts (the WHY) from their knowledge of best practice approaches to mitigate risk (the WHAT).²⁸ Participant scores for similarly-themed questions were also combined by McKerracher et al., however in this case DOHaD knowledge was grouped separately from dietary guideline knowledge, allowing these researchers to conclude that participants with a better understanding of the WHY were more likely to do the WHAT.²⁴

Of the 10 studies, only two queried participants’ sources of DOHaD knowledge, with Bagheri et al. reporting that almost 60% of the participants who were familiar with the phrase “first thousand days of life” ($n = 23$) had heard it from friends and relatives, while their counterparts surveyed by Lynch et al. ($n = 121$) either could not remember where they had heard the phrase (31.4%) or attributed their awareness to the internet (27.3%) or a health professional (25.6%) being the source of their information.^{23,28}

A focus on the short term versus the long term

The timescale involved in linking early-life exposures to adult health is one that is difficult for many – if not most – people to conceptualise. Five of the eligible studies clearly illustrated a theme of short-term thinking, as did a number of articles which were excluded at the final stage of screening for precisely this reason (as discussed below). Despite being well-educated and familiar with DOHaD terminology, more participants in the survey by Lynch et al. of Australian adults indicated a strong belief that maternal nutrition affects the child’s health in the short term than in the long term.²³ Gage et al. report that when asked to rank a list

of factors that have the greatest influence on adult health, the European first-time mothers they surveyed placed infant diet in equal second-lowest position alongside environmental pollution. Family income was the only factor ranked lower. When asked to link health conditions with infant diet, genetics, environmental and lifestyle factors, food allergy was the disease or condition most likely to be attributed to infant diet.²⁷

Rather than ranking pre-determined factors, South African primary caregivers (young mothers and grandmothers raising their grandchildren) surveyed by Worthman et al. were asked at what stage of life parents have the most influence over their child’s development. Most respondents identified early adolescence as the critical window of opportunity with only one of 12 study participants preferring the early-life period, with the reasoning that parental monitoring was necessary to prevent injury during the toddler phase. Overall, actions with practical, visible short-term consequences were seen as the primary focus for parental influence. This view surprised the researchers as the women had just completed a series of questions related to child development and parenting in the early-life period. Despite this, participants felt that teaching and guiding children through the challenges of adolescence required greater parental consideration and involvement, articulating a commonly held belief amongst these women that young children simply “develop naturally” in the presence of sufficient parental love, food and care.³⁰

An exploration by Molinaro et al. into Canadian maternal and paediatric healthcare providers’ experiences of communicating DOHaD messaging to their patients raised the issue of conflicting priorities and reactive rather than proactive responses to the needs of both mothers and children. One particular insight regarding intimate partner violence highlighted the difficulties inherent in promoting a long-term view of health when concrete, short-term needs are clearly more pressing:

I had one patient who didn't have a lock on her door. That was all we worked on. We didn't do sugar screening 'cause we just had to keep her safe . . . she was not worried about what was gonna happen to her adult child. We were just focused on her not getting beat up in the pregnancy.²⁹

Likewise, structural barriers and unmet basic needs made a long-term focus unrealistic for the 12 first-time mothers surveyed by Pedro *et al.* in South Africa, few of whom were familiar with the concept of the “first 1000 days” as they were understandably pre-occupied with day-to-day survival in a population burdened by financial hardship and infant malnutrition.³¹

A need for complex understanding

Three of the quantitative studies incorporated an intervention component, in one case measuring participants’ post-intervention understanding of DOHaD principles against a pre-intervention baseline,²² and in the other two cases against a control group of participants who did not experience the intervention.^{25,26} In all three studies, participant awareness of the link between early-life environment and later health increased, although the questions used to assess this differed between studies, with Grace *et al.* asking adolescents “At what age do you think lifestyle starts to affect your future health?”, Bay *et al.* measuring adolescents’ agreement with the statement “The food a woman eats when she is pregnant affects the health of her baby when it is grown up” and Oyamada *et al.* probing more specifically into undergraduate health students’ understanding of maternal, paternal and environmental factors at different stages of development.^{22,25,26} While the young age of participants in the Grace *et al.* and Bay *et al.* studies presumably precluded discussion of some of the more complex mechanistic aspects of epigenetic inheritance such as paternal and transgenerational effects, the third- and fourth-year New Zealand nursing and Japanese nutrition students surveyed by Oyamada *et al.* were expected to have encountered these concepts as part of their coursework. As such it is interesting to note that these students’ knowledge of the effect of paternal factors on fetal health was not measurably different from that of their first- and second-year counterparts, a finding which may have implications for future intervention design. In this case it is acknowledged that the purpose of the study was to evaluate the suitability of the questionnaire tool for future use rather than to assess student awareness, so care should be taken not to read too much into this result.²⁵ Health practitioners interviewed by Molinaro *et al.* were also in agreement that DOHaD is a very complex concept to introduce to patients, and feared that attempts to address it may result in additional stress when structural barriers and non-modifiable factors mean that lifestyle changes aimed at reducing risk may either come too late or be unachievable for many. However, despite the challenges, practitioners felt that DOHaD understanding could be life-changing and lead to better health outcomes for all involved and were interested in more training in how to communicate the evidence effectively to patients.²⁹

Discussion

A focus on the WHAT versus the WHY

While many interventions have been carried out with the aim of improving long-term health via changes to the early-life environment, these typically take place in the absence of any discussion or education of participants regarding their benefits.³² Despite this, evidence suggests that women who display knowledge of basic DOHaD principles show greater adherence to pregnancy nutrition guidelines than those who lack awareness of the impact on the long-term health of their child.²⁴ Women who identify the health of their child as motivation for eating well during pregnancy are also more likely to make nutrition a priority than those whose

primary motivations concern their own health or the expectations of society, at least in the earlier stages of pregnancy.³³

Knowledge of both the WHY and the WHAT are related to sociodemographic factors, indicating that both a lower level of educational attainment and a lower income play a role in determining women’s nutrition decisions.^{24,33} This of course presupposes that mothers have both access to a healthy diet and the ability to tolerate a variety of nutritious foods during pregnancy. For many women this is clearly not the case, and even armed with the most up-to-date evidence and best of intentions, mothers may struggle to follow pregnancy nutrition and infant feeding guidelines, leading to increased anxiety and feelings of inadequacy and guilt.^{29,34}

While the articles in this review did span a range of populations such as adolescents, tertiary students and health professionals in addition to parents, it is telling that all of those studies assessing parental awareness of DOHaD were heavily biased towards mothers with very limited participation from fathers.^{24,27,28,30,31} This appears primarily due to selected avenues of recruitment being focused towards antenatal and maternal healthcare clinics and is problematic in that it reflects a disproportionate focus on the role of the individual woman as the provider of a nurturing early-life environment, at the exclusion of myriad other influences outside her ability to control.³⁵⁻³⁷ Attributing primary responsibility for the lifelong health of a child to its mother only serves to add an additional burden of stress to the early-life environment, paradoxically introducing another potential risk factor for later disease.³⁸ Furthermore, despite growing acknowledgment of the role of paternal health in the developmental programming of offspring,³⁹ a myopic focus on the role of mothers in DOHaD research contributes to a continued imbalance in research findings, leading to policies and further interventions targeting mothers as well as girls and women of reproductive age, which reinforces and perpetuates this bias.⁴⁰ While knowledge translation efforts must naturally shadow the evolution of the evidence over time, in order to be truly effective, DOHaD research and knowledge translation must occur at the level of community and wider society, including fathers, grandparents and extended families, health and education providers and especially policymakers.^{17,41}

As illustrated by the brief glimpses into the lives of participants in the reviewed studies, many families may not have the capacity to prioritise or enact the lifestyle changes necessary to promote healthier long-term outcomes for their children – a situation that will ultimately lead to increasingly ingrained multi-generational inequity if preventive messaging is targeted solely at the family or maternal level, with the ability to access and act on DOHaD evidence a luxury available only to those possessing strong financial and social support.^{42,43} Therefore a major consideration in effective translation of DOHaD knowledge is the need to emphasise the societal benefits of raising healthy children into healthy adults, establishing a strong connection between individual and collective achievement.^{32,44} Educating policymakers and politicians as well as key stakeholders in education, health and community leadership as well as women and their families should be viewed as a strategic investment in the future of a healthy and productive society.⁴⁵

A focus on the short term versus the long term

By definition, the biological processes described by DOHaD evidence take many decades to play out, and the risks apparent in the developmental stages may never be realised in adulthood. Unfortunately, this plays into a decision-making bias known as temporal discounting, in which increasing future uncertainty

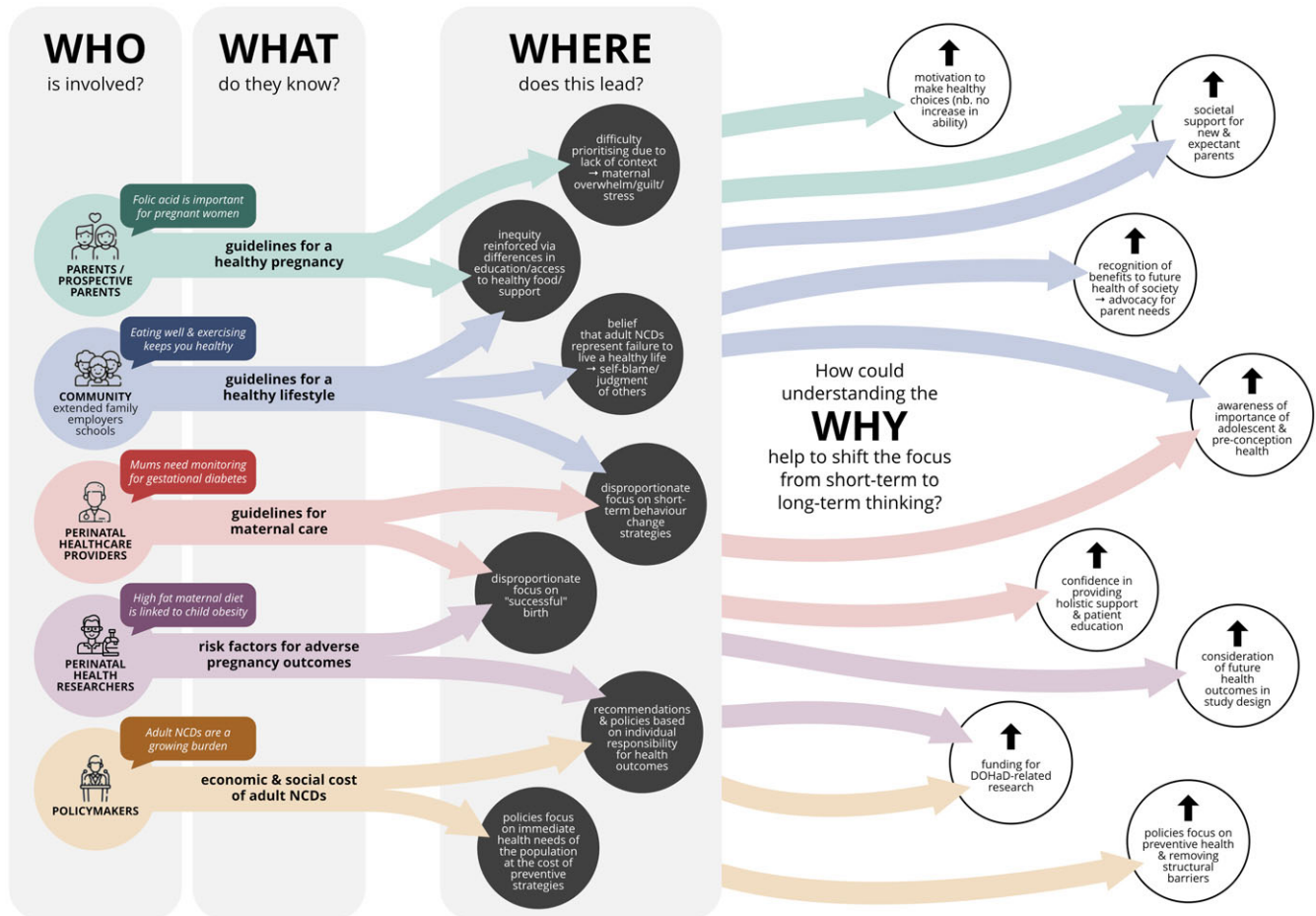


Fig. 2. An exploration of the relationship between themes shows that improving stakeholder understanding of DOHaD evidence could lead to a greater emphasis on long-term outcomes.

favours a tendency towards overvaluing short-term payoffs, leading to poor long-term decision-making and little motivation for change, especially in the arenas of personal health and finance.⁴⁶⁻⁴⁸ This difficulty is compounded by the fact that those who bear the burden of implementing change are not the ones who benefit most from the resulting reduction in health risk, an additional level of abstraction that makes it even harder to conceptualise the necessity for action.⁴⁹

Fig. 2 encapsulates the results of these patterns of short-term thinking, and suggests alternate long-term health outcomes that could potentially be reached via an increase in various stakeholders’ understanding of the WHY. We propose that improving knowledge of DOHaD principles is key to shifting the balance away from short-term, reactive decision-making to a more powerful mindset of supporting health throughout the life course at both individual and structural levels. In other words, a clear understanding of the WHY may provide a critical foundation not only for the WHAT, but also the WHEN – by focusing attention on the larger picture and promoting actions and policies that lead to beneficial consequences in the long term.

In practice, DOHaD knowledge translation shares many of the same challenges as climate change science in motivating people to traverse the psychological distance between the tangible here-and-now and the hypothetical future in order to guide choices and actions that will benefit generations to come.^{50,51} In both cases, the solution is far more complex than simply communicating

the evidence and expecting people to act on it rationally, as there are many cognitive, psychological and social barriers which impede meaningful engagement and action.⁵² In addition to an adequate understanding of the issue and its potential consequences, environmental researchers show that emotional connection is also important for motivating change, and consideration must also be given to economic factors, social norms and habitual behaviours, with engagement of personal values and experiences of climate change more likely to improve people’s environmental habits than persuasion by climate experts.^{53,54} For this reason, any act of communication with the goal of changing perceptions and behaviours should be framed in such a way as to promote opportunities for discussion in order for real transformative learning to occur.⁵⁵

A need for complex understanding

When communicating the WHY and laying the foundations for the WHAT, there is no avoiding the fact that the role of epigenetic modification in NCD is a new and unfamiliar concept for most people and careful scaffolding will be required to convey understanding without the risk of oversimplification.⁴⁵ To “dumb down” the evidence for ease of communication places a disproportionate burden on the choices and actions of mothers, and increases stigma associated with overweight and obesity without reference to the wider social context in which health behaviours occur.¹⁸ This is

in complete contrast to the DOHaD evidence itself, which clearly illustrates that the environment plays a much greater role in individual health than is commonly understood.^{4,35} The degree of complexity within the DOHaD paradigm presents a significant challenge for researchers who may be keenly aware of the social determinants of health but find themselves cornered into a reductionist approach by the practicalities of study design and participant comfort.⁵⁶

That the nutrition and nursing students surveyed by Oyamada *et al.* demonstrated increased awareness of maternal but not paternal factors contributing to lifelong health following their undergraduate coursework is an understandable outcome, but one that future interventions, especially at the level of health practitioner training, should ideally be designed to mitigate as much as possible.²⁵ Likewise, while the maternal and paediatric healthcare providers interviewed by Molinaro *et al.* expressed enthusiasm for the possibilities afforded by application of DOHaD principles, many of them did not feel secure enough in their own understanding of the evidence to broach the topic with their patients.²⁹

This uncertainty is not restricted to health professionals, either. In screening the final candidates for inclusion in this review, limited DOHaD understanding amongst researchers themselves resulted in several studies not meeting the eligibility criteria as adult health was not considered an outcome of interest. Although the abstracts and keyword-matching of search terms, and in many cases the article introductions, suggested that the authors understood the concept of early-life programming affecting adult health, the methods and analysis of findings did not reflect this understanding, and the studies therefore could not be considered eligible. Examples include an exploration of UK adults' beliefs, knowledge and attitudes regarding preconception health which considered only short-term outcomes related to conception, pregnancy and health at birth;⁵⁷ a survey of college students' understanding of type 2 diabetes risk factors across the life course in which early-life or epigenetic factors were not presented as potential risks,⁵⁸ and at least two studies discussing the implications of overweight and obesity during pregnancy where the long-term health of the offspring was never mentioned by either participants or researchers.^{59,60}

WHAT, WHY, WHEN and WHO – but HOW?

The themes identified by this review and outlined above have emphasised the importance of augmenting existing practical knowledge (WHAT) with an understanding of the evidence (WHY), and ensuring the responsibility for health is shared by all (WHO) with a view to more beneficial outcomes in the long-term (WHEN). It is clear from the results of the included studies that awareness of DOHaD principles is lacking not only in the general population but also amongst health professionals and researchers. All of which leads to the question: HOW should the situation be addressed?

While the purpose of this review is to explore measures of DOHaD knowledge rather than investigate potential interventions, some basic guidance can be gleaned from the studies discussed – the key observation being that any intervention aimed at improving knowledge must be context-specific; as with any complex issue, there is no one-size-fits-all solution. We have briefly mentioned the importance of allowing stakeholders to engage with the evidence in ways that support them to discuss and fully explore the information, enabling them to position it within their existing frame of reference.⁶¹ The process of incorporating complex new ideas into

one's worldview is consolidated not only by engaging in critical self-reflection but also by seeking to understand the perspectives of others, considering preferences, values and possible trade-offs and weighing up the evidence with a view to its practical application.⁶² For this reason, the use of community-based participatory action research initiatives which incorporate a deliberation component such as the increasingly popular World Café method may be an effective way to engage the wider community in examining DOHaD principles via group interaction and problem-solving alongside their peers.^{61,63,64}

Strengths and Limitations

The broad nature of this systematic review meant that a wide range of studies encompassing a variety of population groups could be explored to give a comprehensive overview of the current state of DOHaD understanding worldwide. However, the use of database search terms targeting “knowledge”, “understanding” and “awareness” in article titles made it difficult to strike a balance between identifying eligible studies without surfacing an overwhelming number of unrelated results. In addition to this, the search terms used to locate potential articles for inclusion meant some candidates were possibly missed due to the lack of explicitly DOHaD-related terminology in their title or abstract. This was evident in the article by Grace *et al.*, which was located through a supplementary reference check of the final articles and subsequently found to meet the inclusion criteria, however no specific keywords or phrases could be identified from the title or abstract which would have resulted in this article appearing via database query.²⁶

Conclusion

This review set out to analyse studies of DOHaD knowledge in various populations, using the systematic search terms “awareness” and “understanding” (among others). The key finding from this investigation is that awareness of DOHaD terminology is not equivalent to understanding of DOHaD concepts, and that understanding of DOHaD concepts does not necessarily translate into application of evidence – whether as a parent working to provide a healthy developmental environment, as a health practitioner working to provide care to patients, or as a researcher working to explore issues of early-life health. This is reflected in the three themes identified, which outline three challenges for effective DOHaD knowledge translation going forward: greater focus on communicating the WHY, overcoming short-term thinking, and accurately presenting the evidence in its full complexity.

While promoting understanding of the importance of a healthy early-life environment for prevention of chronic disease in later life is in itself a major public health challenge, immediate pragmatic concerns such as comfort, cost and convenience must also be accounted for. Structural, social and psychological barriers often impede the translation of knowledge into practice even amongst those who do have a good understanding of DOHaD science, highlighting the need for a multi-level, society-wide approach aimed at influencing policy and both formal and informal social support networks to reinforce the efforts made by parents during the early-life period. Communicating a clear and consistent message which promotes interpersonal discussion and exploration without oversimplifying the issues will help to reinforce to all members of society that working to ensure good health at the very earliest stages of life is beneficial for everyone in the long run.

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