

Public health recommendations and strategies focused on future parents and young children to improve life course health trajectories from early life onwards

LifeCycle report D10.3

Authors:

Mark Hanson (UOS)

Chandni Jacob (UOS)

Ivan Ochoa- Moreno (UOS)

Version 1.0

Delivery date: Month 66

Document Information

Grant Agreement No.	733206
Project Title	Early-life stressors and LifeCycle health (The LifeCycle Project)
Project Start Date	01 January 2017
Work package title	WP10 - Economic, public, and individual impact of early-life stressors
Related task(s)	10.3 - Public health recommendations and strategies focused on future parents and young children to improve life course health trajectories from early life onwards
Lead Organisation	UOS
Submission date	19 September 2022
Dissemination Level	Public

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List of Abbreviations

BMI: Body Mass Index

DHSC: Department of Health and Social Care

DOHaD: Developmental Origins of Health and Disease

FIGO: International Federation of Gynaecology and Obstetrics

GDM: Gestational diabetes Mellitus

GP: General Practitioner

HCPs: Healthcare Practitioners

LMICs: Low- and middle-income countries

MNCH: Maternal, Newborn and Child Health

NCDs: Non-communicable Diseases

PA: Physical Activity

PCC: Preconception Care

PCOS: Polycystic Ovarian Syndrome

PMNCH: Partnership for Maternal Newborn and Child Health

SDGs: Sustainable Development Goals

UN: United Nations

WHO: World Health Organisation

WP: Work package

Executive summary

The life course approach and developmental origins of health and disease (DOHaD) concept suggest that risks for developing non-communicable diseases (NCDs) such as diabetes could begin before a person is born, and can also be transferred from one generation to the next. More recently, studies in the period before pregnancy (the preconception period) have shown that improving the health status of parents before pregnancy with the support of clinical and policy interventions could help reduce the level of NCDs such as heart disease and diabetes in Europe and globally. To support the development of such interventions, in task 10.3 we undertook several studies to develop recommendations for policymakers and clinicians discussed below. The studies conducted included a review of existing research exploring how the period before pregnancy can be used to prevent NCDs, a survey of attitudes of women and healthcare professionals and interviews with healthcare professionals. We also conducted workshops and a review of policy documents to understand how a life course approach could be adopted in order to intervene in early life for later benefits on health. Overall, the findings from our papers contribute to the understanding of how opportunities before and during pregnancy can be harnessed to prevent NCDs, improve women's health and wellbeing and provide a better start to life for the next generation.

Policy Recommendations

- There is a need to focus on priority areas for policymaking such as planning obesity and NCD prevention interventions together with structural interventions e.g., targeted food taxes, subsidies, food labelling and linked with the United Nations (UN) sustainable development goals (SDGs) and climate change agenda, supporting services for maternal mental health (before, during and after pregnancy);
- Targeted interventions for addressing the inequalities in nutrition and childhood obesity which include social determinants of health such as housing, transport;
- Better workplace policies for maternal health, parental leave and breastfeeding friendly environments;
- There is good quality evidence for early childhood development and school readiness, and stress in pregnancy affecting executive function in the next generation and hence programmes to support a good start in life are needed;
- Implementation of nurturing care framework;
- Increased leadership and commitment from political agencies to develop monitoring and reporting mechanisms for these initiatives and to increase accountability;
- Development of mechanisms to collect good quality data from routine systems;
- Develop novel measures for 'value' e.g., health capital and capacity across the life-course, measures of community resilience.

Recommendations for general population health

- Embedding prevention in policies beyond maternal and child health e.g., environment, education, economic stress and climate change, pollution, environmental toxicants;
- Public engagement through wider campaigns using media: Engaging wider public in population-level programmes and generating demand for action on NCDs through campaigns using carefully framed messages. This will also need further research efforts to clarify language to be used in the preconception period to engage with prospective parents;
- In LMICs and low resource settings effective measures before conception will have added benefits due to lower rates of attendance for antenatal care.

Recommendations for healthcare workers and clinicians

- Consider the whole family and early childhood development;
- Focus on missed opportunities in the healthcare system for a continuum of care. These include women seeking fertility advice, approaching endocrinologists, GPs, cardiologists etc. nurses, pharmacists, community midwives and post-natal health visiting teams;
- Better detection and management of NCDs through clinical pathways;
- Particular attention to maternal mental health and stress;
- Developing tools to enable the discussion of nutrition by healthcare professionals;
- Focus of consultation on fitness and nutrition and not weight loss;
- Increase the focus on collective (e.g., family, communities) and not only individual-level advice for balanced diets in pregnancy, avoidance of alcohol, smoking, unsafe foods, violence and drugs in pregnancy, managing GDM, supporting breastfeeding and care of the newborn;
- Involvement of missing actors – midwives, community health workers in LMICs and low resource settings along with community-based programmes.

1. Introduction

The way an embryo and fetus obtains and allocates nutritional resources has profound consequences for the individual's lifelong health. Influences in early life on risk factors such as obesity and later NCDs fall into biological, behavioural and contextual domains (1). The biological factors affecting fetal development include maternal nutrition (under and overnutrition) and hyperglycaemia, and recent studies have shown that prenatal exposure to gestational diabetes mellitus could lead to epigenetic alterations that increase the risk for type 2 diabetes later in life for the offspring (2). Intrauterine growth retardation (including low birth weight), premature delivery, over-nutrition in utero and intergenerational transmission of risk are all known risk factors for chronic diseases such as ischemic heart disease, stroke and diabetes (3). A recent umbrella review by Daly *et al.* (2022) (4) looked at exposure-outcome associations in the preconception period. The study found high quality evidence linking maternal folate supplementation and the reduced risk of neural tube defects. For risk factors such as obesity/ high BMI and interpregnancy weight change, moderate grade evidence was seen for outcomes such as fetal distress, miscarriage and maternal hypertension respectively. For paternal risk factors such as higher paternal age (more than 40 years), moderate evidence suggested an increased risk of miscarriage. Associations were also seen for short interpregnancy intervals and outcomes such as low birthweight, but they were of low quality. DOHaD research has shown that multiple developmental factors operate from preconception through early life to affect the risk for later NCDs. **Table 1** presents common risk factors in the preconception period and their impact on immediate outcomes during pregnancy, and potential long-term outcomes for the baby and mother.

Considering the evidence for intervening in the preconception period, and results from recent studies suggesting that intervening during pregnancy in the mother and offspring may be too late to prevent outcomes such as preterm birth, macrosomia, and childhood obesity (5, 6), for this task, the preconception period was considered the key critical period in the life course for non-communicable disease (NCD) prevention.

Table 1. Risk factors related to nutrition in parents in the preconception period and possible outcomes during pregnancy, childbirth and childhood

Preconceptional risk factors for future NCDs	Increased risk of complications during pregnancy and childbirth	Risk to babies
Overweight and obesity	<ul style="list-style-type: none"> Before pregnancy: reduced fertility, polycystic ovarian syndrome (PCOS) During pregnancy: pregnancy loss, GDM, pre-eclampsia, gestational hypertension, higher risk of Caesarean or instrumental delivery, induction of labour, thromboembolic disorders, preterm birth Post-partum: Unsuccessful breastfeeding	Low birthweight ¹ , small for gestational age (SGA), macrosomia, congenital anomalies (e.g., neural tube and cardiac defects), childhood obesity, and higher risk of adult chronic disease. Allergy and immune dysfunction in offspring (e.g., atopic dermatitis)
Underweight/ undernutrition	Complications during pregnancy and delivery, associated nutrient deficiencies	Preterm birth, low birth weight, stillbirth, type 2 diabetes, neurodevelopmental issues, and cardiovascular disease in later life
Pre-existing conditions e.g., Diabetes mellitus High blood pressure	Spontaneous abortion, preterm labour, caesarean section, hypertension in pregnancy, preeclampsia, GDM	Birth defects, stillbirth, macrosomia with shoulder dystocia/nerve palsy if delivered vaginally, hypoglycaemia after birth, type 2 diabetes in later life
Micronutrient deficiencies e.g., Iron, Folic acid, Vitamin D, Calcium, Iodine	Eclampsia/ Pre-eclampsia, Preterm birth, Pregnancy loss, stillbirth, increased risk of maternal morbidity and mortality	Neural tube defects and other birth defects, Increases risk of neonatal/ infant mortality, Low birth weight, Low child cognition (intelligence quotient)
Risky behaviours e.g., Smoking, alcohol	Poor fetal growth, Preterm birth	Low birthweight, fetal alcohol syndrome, childhood obesity, impaired neurodevelopment
Paternal factors such as suboptimal nutrition and obesity, smoking, advanced paternal age	Reduced fertility, greater risk of pregnancy loss	Cardiometabolic disease risk

Definitions of the Preconception period

The period is commonly defined as “3 months prior to pregnancy”. Dean *et al.* propose that ‘the preconception period should be defined as a minimum of 1-2 years prior to the initiation of any unprotected sexual intercourse that could possibly result in a pregnancy (7). This would extend through the care provided in early pregnancy (peri-conception care) and the postnatal period until the next pregnancy. Other authors have used the first trimester (<12 weeks of gestation) to select their target populations as part of preconception care (PCC) programmes and highlighted this as a pragmatic critical period to access women from LMICs who often do not seek antenatal care before 12 weeks (8).

¹ For the purpose of this study the following accepted definitions have been used: Low birthweight defined as weight at birth < 2500g. A Small for Gestational Age (SGA) infant is an infant born with a birth weight less than the 10th centile and Large-for-Gestational-Age (LGA) infant is an infant whose weight is > the 90th centile, for gestational age. Macrosomia is birth weight > 4000g, irrespective of gestational age.

More recently, *The Lancet* series on preconception health called for a new definition that considers multiple perspectives – biological (days to weeks before embryo development), individual (weeks to months before pregnancy) and public health (months to years) (5). Hill *et al.* 2020 additionally included the life course perspective which encompasses the public health perspective defined by Stephenson *et al* (2018) (5,9). Thus, improving the health of women in the reproductive age group acts as a cross-cutting theme to achieve good health across multiple life stages and generations. Healthcare professionals often meet women with different perspectives on pregnancy (9) - ‘potential’ (sexually active individuals without effective contraception or contraceptive failure); ‘intentional’ (men and women making a conscious decision to conceive); and ‘public health’ (a wider range of individuals and couples not sexually active). With the growing realisation that efforts to optimise the health of women and children should begin before conception, healthcare practitioners (HCPs) need to be aware of these perspectives.

Preconception care is defined as -

“a set of interventions that aim to identify and modify biomedical, behavioural, and social risks to a woman's health or pregnancy outcome through prevention and management, emphasizing those factors that must be acted on before conception or early in pregnancy to have maximal impact.”(10)

This includes care provided regardless of pregnancy status or intention (11). A limitation in delivering PCC has been the focus on women and couples motivated to conceive. For example, early marriage and early age at childbirth are common in LMICs such as India (12). In addition, even in high-income countries (HICs), a significant proportion of pregnancies are unplanned: 45% of pregnancies in the UK, similar to the global rates discussed earlier (13). Studies often include the post-partum period, early pregnancy and peri-conceptional periods as part of PCC. The post-partum period in particular (also called the interconception period) provides the potential for interventions aiming to support recent mothers with issues such as excess weight gain to have positive outcomes in the next pregnancy (14-16). So the overarching aim of PCC is to improve short and long-term maternal and child health outcomes by intervening before pregnancy. It also includes interconception care which is delivered between the end of a women’s pregnancy to the start of her next pregnancy or in the first 24 months postpartum to improve outcomes for potential future pregnancies (17, 18).

Studies have also highlighted the adolescent period as part of the preconception period, as health during adolescence can have a tremendous impact on health as future parents (19, 20). Major transitions and developmental changes make this a time of immense potential for preventive interventions and provide opportunities to address risk factors that exist since childhood (21, 22).

1.2 Objectives

To develop public health recommendations and strategies focused on future parents and young children for improving life course health trajectories from early life onwards.

1.3 Methods

Multiple studies (discussed below) were conducted to inform the recommendations of this deliverable. Both qualitative and quantitative methods were employed in the studies along with scoping reviews. Reviews were conducted for three life stages discussed above (adolescents, preconception and interconception). In addition, to explore how the concept of life course approach has been implemented in practice, a review of policies on how these were measured and monitored was also conducted. Finally, a document analysis of meeting minutes for five key interdisciplinary coalitions and networks from the field of DOHaD was conducted.

2. Summary of studies conducted

2.1 Review of preconception interventions and clinical guidelines

Two reviews were conducted to explore the existing evidence for interventions in the preconception period, and clinical guidelines for preconception care which focused on NCD prevention.

Summary Review 1

The primary aim of review 1 was to prepare a narrative review of existing evidence for preconception interventions to prevent risk factors for non-communicable diseases in children, based on previous reviews.

A search was conducted in January 2018 on PubMed, Medline and CINAHL, and the Cochrane Library, including the Cochrane Database of Systematic Reviews and the Database of Abstracts of Reviews of Effects to identify pertinent systematic reviews published between 2006 and 2018. Four search strings were developed for each of the sites, with a limit applied for identifying review articles only (in English). The main search terms were “preconception”, “preconception care”, “systematic”, “pregnancy outcome”, “behaviour”, “lifestyle”, “obesity”, “gestational diabetes” and “offspring”. Reference lists of relevant articles were manually searched for potential articles not identified by the database search, experts in the field were contacted and an additional search on google scholar was performed in 2018. Studies reporting outcomes such as a change in maternal weight and body composition, gestational weight gain, birth weight and others which were associated with a risk of NCDs in the future for the baby and the mother were included. Reviews that evaluated observational and experimental studies, focusing on prevention of maternal risk factors such as GDM, and management of type 1 and 2 diabetes in the preconception period maternal malnutrition (under- and over-nutrition), maternal weight and pregnancy outcomes such as birth weight, were also included. Reviews with a primary focus on the prevention of congenital anomalies were excluded, however, if data on folic acid supplementation was reported in the included review, they were extracted.

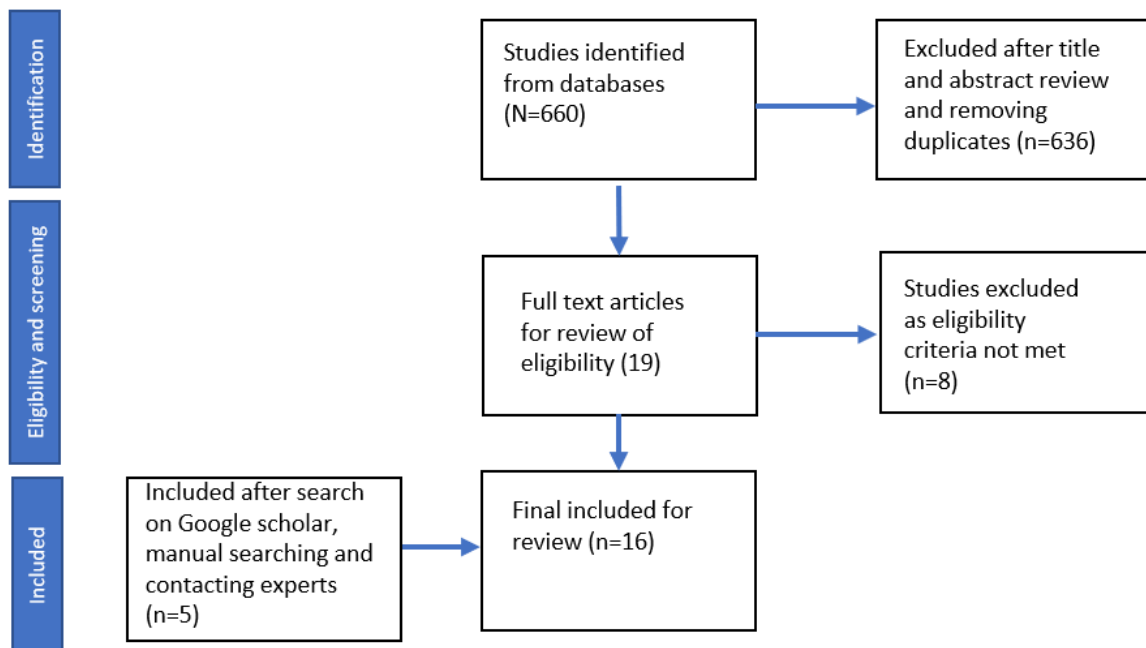


Figure 1. Flow chart depicting results of the search strategy

Of the potential articles found from the databases (**Figure 1**), 16 reviews were identified (8, 15, 16, 23-35) and two of the papers (7, 25) were part of the same systematic review.

A key finding of this review is the paucity of interventions in the preconception period in contrast to the myriad of interventions during pregnancy for NCD risk reduction. There is substantial evidence for maternal underweight and overweight, diabetes and smoking in the preconception period leading to negative outcomes such as low birthweight, macrosomia and congenital anomalies. Weight gain during pregnancy is an important risk factor for future NCDs in the mother and child, and this review provides moderate evidence supporting the effectiveness of diet and exercise-based interventions in the preconception period for weight-related outcomes.

Adopting a life course approach by providing simple interventions before pregnancy can prevent a significant proportion of adverse birth outcomes such as low birthweight, preterm labour and congenital anomalies. It also provides the potential to prevent the risk of obesity in children, which further affects their health, and physical and mental development. Ways to sustain preconception interventions through pregnancy, postpartum, infancy and childhood need to be explored further. The remit of PCC also includes interventions to promote adolescent health and prevent teenage pregnancies, encourage contraceptive use, optimise weight and micronutrient status, and screen for and manage NCDs – all of which have been effective in multiple settings. HCPs are key stakeholders in implementing these activities and understanding the knowledge attitude and barriers and facilitators to deliver these services among these stakeholders is essential. Most of the evidence for the effectiveness of preconception interventions in this review comes from the primary care setting. It is possible that much of this learning can be transferred to other settings (such as

community settings). Existing platforms such as family planning services can be utilised to identify women preparing for pregnancy and to provide health education and counselling related to healthy diet and lifestyle, and to optimise maternal, neonatal and child health outcomes (36). This is especially relevant in LMICs and should include young mothers and newlywed couples. This also further highlights the opportunity HCPs have in providing PCC in a range of settings. However, whether these messages are communicated to clinicians through clinical guidelines or curriculum is unknown. The findings from this review were published in *Obesity Reviews* (37).

Summary Review 2 Clinical guidelines

Addressing maternal obesity before pregnancy is challenging and calls for a greater emphasis on prevention and providing support for weight loss before pregnancy. This can have added benefits for women with subfertility who are trying to conceive, and those with co-morbidities such as PCOS or pre-existing diabetes.

Preconception interventions and counselling during clinical visits have shown a very clear benefit in the prevention of neural tube defects and reducing the risk of fetal alcohol syndrome (38, 39). Increasing evidence discussed in the review above suggests that PCC can help modify dietary and physical activity behaviours and control medical conditions, e.g., diabetes, and reduce sequelae such as congenital anomalies. Despite this, dedicated preconception clinics are rare in most countries. In addition, as a significant proportion of pregnancies are unplanned, experts and healthcare organisations have called for maximising routine contact between HCPs and young women (40). In many cases, the onus for PCC is on HCPs who see women in their routine practice, for reasons other than pregnancy planning. Elements of PCC can occur whenever a clinician meets a woman of childbearing age (41) and this would include offering support for pregnancy planning and addressing nutritional and weight management.

A scoping review of clinical guidelines that have directly addressed NCD prevention for women and their future offspring in the preconception period was conducted for this review. A literature review of published articles and grey literature for clinical guidelines was conducted on PubMed along with a web-based search of international health organisations. Overall, 24 documents were included in the review, including seven review articles (39, 42-47).

Based on the findings of the review, the key recommendations for PCC and NCD risk prevention in routine care that HCPs can consider supporting women in improving nutrition, weight management and lifestyle before pregnancy are listed below in **Table 2**.

Table 2. Recommendations for clinicians to support the prevention of NCD risk factors in the preconception period

1.	Preconception consultations should include the measurement of height and weight and the calculation of body mass index (BMI). Where appropriate, all women should be encouraged to attain a BMI as close to the normal range (BMI 18.5–24.9 kg/m ²) as possible before conceiving.
2.	All women who have a BMI greater than 30 kg/m ² should be counselled about the risks of obesity for their health and that of their baby.
3.	Women who are underweight before pregnancy (BMI less than 18.5 kg.m ²) should be counselled about the risk of being underweight during pregnancy along with the benefits of good nutrition as relevant to their socioeconomic status. Where relevant, women who are underweight should be screened for suspected eating disorders and treated as needed
4.	Counselling for physical activity should be provided when required. Pre-pregnancy, during pregnancy, and post-partum – where possible, women should exercise moderately for at least 30 minutes a day, 5 days a week, or achieve a minimum of 150 minutes of moderate exercise per week.
5.	Clinicians should support women with known pre-existing diabetes to achieve glycaemic control (HbA1c <6.5%) before pregnancy along with optimal weight management and dietary advice. When feasible and indicated (e.g., Type 1 DM), screening for thyroid dysfunction and coeliac disease should be performed.
6.	Chronic conditions such as high blood pressure and polycystic ovarian syndrome (PCOS) should be optimally managed with medication appropriate for pregnancy as required before conception. Women should be counselled regarding the risk of cardiometabolic co-morbidities during pregnancy.
7.	Folic acid: to ensure protection against neural tube defects, all women of reproductive age are advised to consume 0.4 mg (400 mcg) of synthetic folic acid daily, obtained from fortified foods and/or supplements. For all women planning a pregnancy, a dietary supplement of at least 0.4 mg (400 mcg) of folic acid per day is recommended at least 1 month before conception and continuing during the first trimester of pregnancy.
8.	Women at a higher risk of neural tube defects – e.g., on anticonvulsant medication, with pre-pregnancy diabetes mellitus, a previous child or family history of neural tube defects, and women with a BMI of 30 kg/m ² or greater wishing to become pregnant should be advised to take at least 4 mg folic acid as a dietary supplement daily, starting at least 1-3 months before conception and continuing during the first trimester of pregnancy.
9.	Nutritional deficiencies (e.g., of Iron, Iodine and Vitamin D) should be assessed and treated and advice given as appropriate
10.	Where applicable, discussion on nutritional risks should include the diet and health of the partner too.

Findings from this review were published as a position paper with the International Federation of Gynaecology and Obstetrics (FIGO) (48).

2.3 Review of school-based interventions for adolescents

Adolescence is a transitional period marked by critical changes that place adolescents at an increased risk of becoming overweight and obese due to changes in food choices, physical activity levels and exposure to an obesogenic environment. Health education in school may improve health literacy by encouraging critical thinking about these issues. To develop effective interventions, it is necessary to understand which intervention elements are effective. This review aimed to synthesize the literature investigating the effectiveness of health education interventions delivered in school settings to prevent overweight and obesity and/ or reduce BMI in adolescents, and to explore the key features of effectiveness

A systematic search of electronic databases including MEDLINE, CINAHL, PsychINFO and ERIC for papers published from Jan 2006 was carried out in 2020, following PRISMA guidelines. Studies that evaluated health education interventions in 10-19-year-olds delivered in schools in high-income countries, with a control group and reported BMI/BMI z-

score were selected. Three researchers screened titles and abstracts, conducted data extraction and assessed quality of the full-text publications. A third of the papers from each set were cross-checked by another reviewer. A meta-analysis of a sub-set of studies was conducted for BMI z-score

Thirty-three interventions were included in the review. Most studies evaluated multi-component interventions using health education to improve behaviours related to diet, physical activity and body composition measures. Fourteen interventions were associated with reduced BMI/BMI z-score. Most interventions (n=22) were delivered by teachers in classroom settings, 19 of which trained teachers before the intervention. The multi-component interventions (n=26) included strategies such as environment modifications (n=10), digital interventions (n=15) and parent involvement (n=16). Fourteen studies had a low risk of bias, followed by 10 with medium and nine with a high risk of bias. Fourteen studies were included in a random-effects meta-analysis for BMI z-score. The pooled estimate of this meta-analysis showed a small difference between intervention and control in change in BMI z-score (-0.06 [95% CI -0.10, -0.03]). A funnel plot indicated that some degree of publication bias was operating, and hence the effect size might be inflated.

Findings from our review suggest that school-based educational interventions have the public health potential to lower BMI towards a healthier range in adolescents. This systematic review of school-based educational interventions demonstrates the features associated with effectiveness in improving diet, PA, and BMI outcomes. Multicomponent interventions involving key stakeholders such as teachers and parents and digital components are a promising strategy. There is evidence for the use of emerging technologies as a means of delivering interventions to adolescents. Our review reinforces the evidence base that shows the need for school-based interventions to link with other components targeting individual adolescents. Findings from this review were published in the International Journal of Behavioral Nutrition and Physical Activity (49).

2.4 Review of policies implementing the life course approach

A life-course approach recognizes that both past and present experiences are shaped by the wider social, economic and cultural context. The approach has increasingly become important in policy frameworks, and countries have committed to implementing the approach to improve health after the Minsk declaration in 2015. However, further evidence is required to support the development of a framework to measure the implementation of the life-course approach in public health policy.

We aimed to identify the quantitative and qualitative methods developed to measure the implementation of a life-course approach at the national level. The report identifies definitions, indicators and other examples that can be used by policymakers.

Using the recommended methodology for a rapid review described in *A resource for developing an evidence synthesis report for policy-making* (50) a rapid review of published and unpublished literature was conducted. This included published and grey literature on academic databases, along with general website searches and specific searches for strategy

documents by government health agencies in Feb 2018.

The review identified 22 articles globally that provided options for measuring programmes based on a life-course approach. Overall, the practical application of life-course theory was underdeveloped with implementation mainly focused on conditions such as NCDs or life-stages (e.g., pregnancy, childhood and ageing). Only two studies directly addressed the research question by reporting on ways to measure the implementation of the life-course approach. While developing measurement strategies, using a broad set of indicators and domains that are feasible to measure, aligned with existing monitoring frameworks (e.g. sustainable development goals) and reflecting multisectoral and interdisciplinary linkages are recommended.

This policy review suggests that a monitoring and evaluation framework collecting data longitudinally across different life stages over time should be created for Member States (WHO European Region), and this can be done using existing survey platforms and routinely collected quantitative data. This work was commissioned by the World Health Organisation, Regional Office for Europe (Health Evidence Network) and published as a Health Evidence Network Report (51).

2.5 Acceptability of the FIGO nutrition checklist in clinical care

This study focused on the acceptability of the FIGO nutrition checklist (53) (designed for use before conception and during early pregnancy by OBGYNs globally) among healthcare practitioners and women in the reproductive age group (UK). In addition, the study also explored the acceptability of screening for universal pregnancy intention to provide preconception care to a wider population.

The nutritional risk assessment checklist (53) was developed by the Pregnancy and NCDs Committee in FIGO in 2015 (54, 55). The checklist was designed to be a user-friendly tool for HCPs assessing nutrition in women planning pregnancy and in early pregnancy, so that dietary and gestational weight gain recommendations could be discussed at each visit. Moreover, nutritional supplements could then be offered to women who needed them, along with a referral to diet and weight management services if appropriate. Thus, the checklist aims to support the early identification of nutritional issues in pregnancy (or before) and support the prevention of conditions such as gestational diabetes. Two online cross-sectional surveys were conducted, one for women in the reproductive age group living in the UK (Feb-June 2021) and HCPs working in the UK (Sept-Dec 2021) (56).

Findings suggest that, in general, the concept of the checklist was acceptable to women, but HCPs expressed more reservations related to its implementation. Suggestions to improve the content and mode of delivery were provided by both groups. While the content analysis of responses from HCPs revealed some of the potential factors that could affect compliance with using the checklist in practice, particularly those related to time and the health system, it would require further research to investigate the effectiveness of the checklist and follow-up conversations on behaviour change and routine preconception screening on pregnancy planning behaviours.

Both women in the reproductive age group and HCPs agreed that the checklist was easy to use, with women recommending it for preconception and pregnant women. Additionally, HCPs added that the tool would be helpful for initiating nutrition discussions and they recommended it for routine health promotion. This was an important finding in light of the qualitative analysis, which suggested some hesitancy among HCPs to discuss nutrition routinely.

Multiple factors emerged from the findings, stated by both stakeholder groups, which could either deter or encourage discussions on nutrition or diet and how it would impact the patient. Interestingly, few women recalled discussing diet/nutrition and gestational weight gain during their visits to HCPs, and some reported that HCPs were not able to provide adequate information, especially for exercise-related guidelines. This could possibly be influenced by the problems raised by HCPs about initiating discussions on weight management and diet, concerns about inducing anxiety in patients, and the call for more resources and training.

Though the importance of discussing preconception health and pregnancy planning was widely acknowledged, women and HCPs had mixed opinions overall on routinely screening for pregnancy intention. This was despite the sample including a highly motivated group with a majority of respondents who were pregnant/ post-partum or planning a pregnancy in the preconception group. A subset of the preconception and post-partum groups had also visited HCPs to discuss fertility planning further. A large proportion of post-partum women mentioned that they were trying to make changes in their diet and weight after they had their baby, highlighting the opportunity of interconception care.

Reflecting on their personal experience, women also felt that routine discussion could induce stress, triggering negative emotions, especially if they had been trying to conceive or had a previous history of miscarriages. As HCPs who meet the women may differ at different stages, those in primary care may not necessarily be aware how often these issues have been discussed with each woman previously, when posing the sample questions. However, the sample questions presented were considered acceptable and appropriate by both HCPs and women, with some expressing preferences for certain questions, especially those related to the discussion about medication.

Recommendations

Figure 2 presents a model of integrating the checklist and discussion into routine care. Overall, as the checklist was considered acceptable and important as a tool to initiate discussions, and studies have evaluated its validity and feasibility and show promising results, it is recommended that the modified UK-specific checklist can be completed by women either online or as a paper version in a clinic/ hospital. The responses could then be discussed during consultation. The WP10 team is currently working with FIGO to develop a web-based version of the checklist. However, to make the consultations effective and

suitable, **Figure 2** summarises key points for HCPs and promotes patient (person) - centred care. Training of HCPs in Healthy Conversation Skills and CPD for diet and nutrition guidelines would complement the delivery of information through the checklist, along with conversations post-consultation. Incorporating PCC training in the educational curriculum for medical and allied health professions is also imperative. Finally, future research should also consider evaluating the cost-effectiveness and effectiveness of the checklist on lifestyle modification. Including male partners in research related to pregnancy planning could also have significant implications for parental health (57) and needs to be explored further.

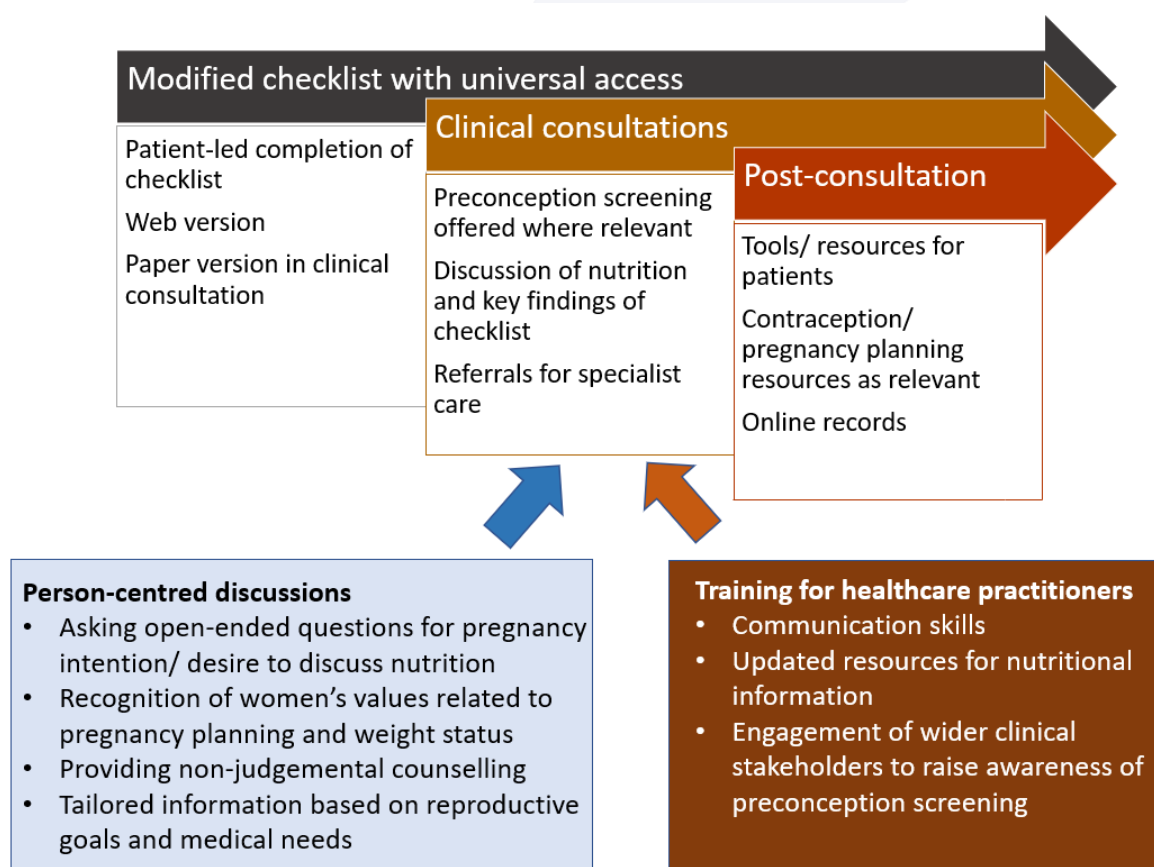


Figure 2. Recommendations for implementing the modified checklist and preconception screening during clinical visits

2.6 Review of interventions and policies in the inter-conception period

The interconception period is considered to be a time when parents are more easily engaged with health messages and the healthcare professionals involved are more easily defined. Through this literature review and policy analysis, articles and guidelines on interconception care to provide recommendations to improve health outcomes of parents, infants and future generations were collated.

Four databases were searched systematically, using MeSH and free-text terms, for review articles on nutrition in the interconception and postpartum period in English between January 2010-21. 30% of titles, abstracts and full-text papers were double-screened. A scoping search on interconception pilot studies and a review of guidelines published by UK public health organisations and government agencies was also conducted.

We found 47 documents with guidelines, 29 reviews and six pilot studies on interconception and postpartum care. Interconception care opportunities include the postpartum period, family planning, routine practice, and risk assessments. Health and non-healthcare professionals have a role to play in ensuring care in the interconception period including GPs, health visitors, dieticians, nutritionists, health psychologists, community groups, local authorities and charities.

The interconception or postpartum period offers a crucial opportunity to intervene to reduce possible long-term effects. Though the policy analysis for this review focussed on the UK setting, the recommendations can have wider benefits/ implications for other countries too. Findings from this project were published in *Reproductive, Female and Child Health* and have been used to develop a policy brief disseminated to key policymakers (58).

2.7 Stakeholder mapping for influencing policies related to preconception health

Throughout the course of the project, multistakeholder and interdisciplinary meetings were led and attended by WP 10 members to map out key players for influencing policy in DOHaD. These included collaborations with the World Health Organisation (Geneva and Regional office in Copenhagen), the Preconception Partnership (UK), the Venice Forum, FIGO among others.

Stakeholders who attended these meetings, or were discussed in the interviews conducted for the project, were then mapped based on their power and influence (using the scoring system described by WHO and ODI) to define the actions that can be taken for stakeholder engagement, and to provide recommendations for engagement. Each quadrant of the map has a separate associated communication strategy that can be used as shown in **Figure 3** below.

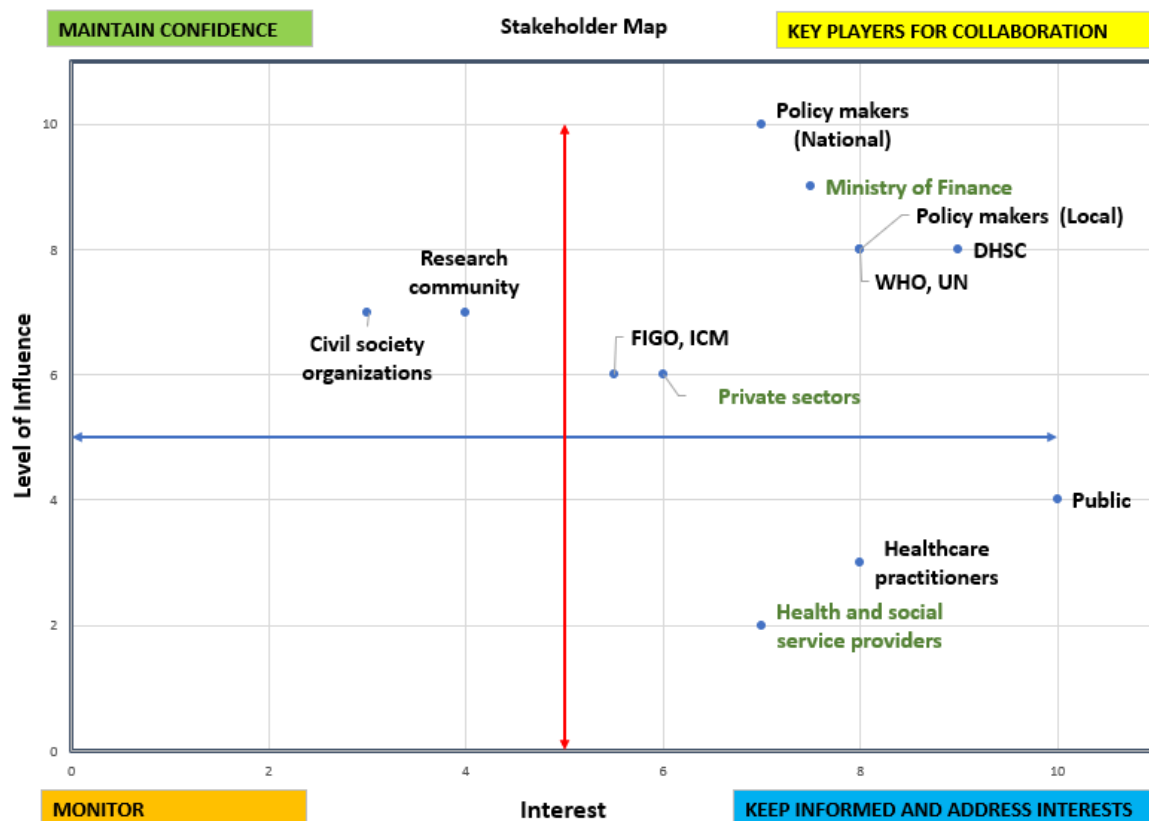


Figure 3. Stakeholder map with four quadrants for management. The Y-axis determines the level of influence from the highest on the top, to the lowest below, and the X-axis measures the level of interest. Stakeholder categories were then plotted on the map based on how they scored for these two elements. Missing actors are depicted in green, and examples of how certain actors within stakeholder groups can vary are also shown. The coloured boxes indicate the recommended actions for the stakeholders within that quadrant. (DHSC – Department of Health and Social Care)

Stakeholders with both a high level of influence and interest need to be managed closely and are the key target groups for collaboration (59, 60) These include departments of health, ministries of finance and local policy-makers. Examples of how certain actors within stakeholder groups can vary are also illustrated. For instance, ministries of finance in different countries have more influence on the issue of investment that can also influence the wider determinants of health, and also the funding received by organisations operating in public health activities. Hence, they have a higher influence than the Department of Health and Social Care.

Stakeholders with high influence, but less interest, need to be kept involved, ideally incentivised with new information, and monitored. This would include providing support for training researchers and supporting civil society organisations in developing programmes for implementation. None of the stakeholders fell into the category of low interest and low influence. Finally, the group with high interest but less influence includes the general public and HCPs, who also tend to be most impacted by policies. Regular updates and feedback from these groups can be beneficial, especially through patient and participant involvement

activities, in all stages of research and evaluation. Actions to address their interests need to be taken into perspective. While HCPs fall into this group, overarching organisations for HCPs such as FIGO, and the Royal Colleges have more influence. It must be mentioned here that a map of HCPs, would also appear different when based on professional roles. It is clear that GPs have a higher impact on PCC compared with midwives (in the UK context) while specialist OBGYNs and midwives have access to high-risk women with GDM and pre-eclampsia for disseminating messages related to interconception care.

The stakeholders can also be managed appropriately to “shift” their positions on the map. For example, effective communication through advocacy campaigns has the potential to create a social movement and bottom-up demand for women's and children's health. Similarly, policy-makers' interest in the issue of life course and preconception may fall during events such as the pandemic, when the focus is on infectious disease management, economic uncertainties due to lockdown and on short-term goals for mitigation. Selection of stakeholders from the map, based on the issue under consideration (e.g., developing preconception services for obesity management), followed by targeted communication methods are recommended. While the scope for private sector engagement in policy-making has increased with the rise of neoliberal democracies, this has also led to an increase in lobbying and pressure strategies by the food and beverage industry (61) Studies have shown that voluntary public-private partnerships, such as the Public Health Responsibility Deal in the UK, did not have a positive impact on improving health outcomes such as cardiovascular disease due to the lack of robust evaluation, monitoring and independent target-setting (62) Thus, future involvement of actors from the private sectors (in research, policy-making or advocacy campaigning) must be done cautiously, with a plan to develop accountability and evaluate the impact of actions taken by the private sector for preventing NCDs.

2.8 The economic case for investing in Maternal Neonatal and childhealth (63)

The periods of conception, pregnancy and the first 1000 days of life are crucial for a person's lifelong health. The recent rise in obesity before conception, through pregnancy and during childhood is increasing the risk of a non-communicable disease epidemic in the future. Preventive measures targeted at the community level and implemented by local authorities may be the most effective way of creating healthy environments that improve lifelong health.

Working paper 1:

Projected health and economic effects of the increase in childhood obesity during the COVID-19 pandemic in England: the projected cost of inaction

The prevalence of overweight and obesity in young children has risen sharply during the COVID-19 pandemic. We estimate the future health and economic effects of this increase in England.

We used annual Body Mass Index (BMI) data from the National Child Measurement Programme in England for children aged 4-5y and 10-11y from 2006/07 until 2020/21. We determined the impact of the pandemic by estimating a pre-pandemic overweight and obesity prevalence trend using years 2006 to 2019 to predict the post-pandemic prevalence and compared it to the actual prevalence in 2020/21. We then projected the future added lifelong medical and social costs.

The average impact of the pandemic on children aged 4-5y and 10-11y during 2020/21 was an overweight and obesity prevalence of 5.5 points over expected values. This means over 308,000 additional children became overweight or obese during the pandemic, of whom over 104,000 with severe obesity. The impact was magnified by deprivation, with childhood obesity 7.0 prevalence points (pp) greater than expected in the highest decile of deprivation compared to 2.8 pp in the least deprived decile. Children aged 4-5y of Asian and Black ethnicity showed the highest difference in overweight and obesity (8.95 pp and 7.66 pp respectively) above expected prevalence compared to those of White (3.7 pp) or Chinese (3.8 pp) ethnicity. The lifelong healthcare cost of failing to take action to remedy the increase associated with the COVID-19 pandemic on 4- to 11-year-olds will amount to £1.9 billion with the cost to society amounting to £29 billion.

Coupled with the greater impact of the pandemic on children from certain ethnic backgrounds, and from more deprived areas of England, these data raise social justice and equity as well as financial considerations. Thus, implementing policies among children and adolescents to address the recent acceleration in obesity and overweight prevalence is an urgent priority.

Working paper 2:

Economic orthodoxy underestimates the value of maternal, newborn, child and adolescent health to future societal wellbeing.

In this commentary article, we discuss how conventional economic thinking, dominated by the flawed measure, Gross Domestic Product (GDP), is damaging societal wellbeing. GDP does not capture the unremunerated work upon which societal wellbeing depends, such as parenting, caring, and domestic tasks. Continued reliance on this economic orthodoxy, despite longstanding recognition of its shortcomings, detracts from investments in a key area essential for societal wellbeing, namely maternal, newborn, child and adolescent health (MNCAH). There is a compelling need to redefine economic progress through equitable models and metrics that incorporate the short- and long-term societal value of activities that improve MNCAH

3. Multistakeholder meetings for dissemination in policy

The following meetings were conducted to inform the policy recommendations and the stakeholder mapping.

(details were provided during Milestone for WP10)

3.1 Workshop 1: Evidence to policy workshop Copenhagen 2019

27th May 2019 14:00-17:30

University of Copenhagen, Faculty of Medicine, Nielsine Nielsen auditoriet

All members of the lifecycle consortium and external cohorts were invited. In addition, speakers (listed in the programme below) also attended the workshop to provide input on policymaking.

The LifeCycle collaboration between cohorts in Europe (and more widely) enables analysis of data from over 250,000 children and their parents. Work packages 10 and 11 in the Lifecycle project seek to engage with key stakeholders across Europe (and beyond) including decision-makers (legislators, policymakers, policy networks and agencies, health service commissioners, NGOs). With this objective, a workshop was held in conjunction with the Lifecycle general assembly meeting in May 2019 as a plenary session of the LifeCycle General Assembly in May 27-29 2019 in Copenhagen.

The plenary speakers discussed the underlying principles and presented examples of translating research evidence into policy. The goal was to ensure that researchers in the LifeCycle consortium understand the issues and the skills needed to assist such translation. Pre-reading for the workshop and background documents were circulated beforehand (policy brief on preconception health draft document – included in **Appendix A**)

PROGRAMME

Chair: Prof Mark Hanson (Southampton)

Translating evidence to policy: principles and practice	Prof. Sir Peter Gluckman FRS (Auckland; Chair of INGSA)
Strengthening health systems to improve health and wellbeing across the life-course: The Danish example	Dr Søren Brostrøm (Director General of the Danish Health authority)
Implementing and monitoring the life-course approach through national-level policies – opportunities and challenges	Dr Nils Fietje (Research Officer, Division of Information, Evidence, Research & Innovation, WHO Regional Office for Europe, Copenhagen)
Humanomics, Implementation science and need for Interdisciplinary co-creation	Prof David Budtz Pedersson (Aalborg University, Copenhagen)

Structured discussion on the position paper for policy consideration (pre-circulated)	Q&A with panel of speakers (and Dr Karin Kjær Madsen Head of Secretariat for the Danish Council for Research Policy)
Synthesis and alignment with WPs 9 & 11	Profs. John Wright (Bradford) and Veit Grote (Munich)

3.2 Workshop 2: Venice Forum



March 22-24, 2021

Online

The Venice Forum on *Why investing in Maternal, Newborn and Child Health (MNCH) is critical for a sustainable future after COVID-19* was held as a series of five panel discussions online over 22-24 March 2021.

Lifecycle was a key organising member of the Forum, chaired by Prof Mark Hanson (UOS). Leading biomedical and social science experts, economists, and public health leaders convened in the event over 22-24 March 2021 to consider the case for a radical rethink of current investment priorities to for a sustainable future. The workshop was a starting point of an ambitious 2021-2022 roadmap to refocus national stimulus strategies and investments on a health and wellbeing-centred agenda for resilience and recovery. The Venice Forum focussed on the WP10 target group of future parents, mothers and young children. Free registration for a wider audience was also open for the Forum, with global representation in speakers and attendees.

A concept brief was circulated to invited speakers for comment, which after the forum has been refined and published on the WHO- Partnership for Maternal Newborn and Child Health (PMNCH) [website](https://pmnch.who.int/resources/publications/m/item/venice-forum-declaration) (<https://pmnch.who.int/resources/publications/m/item/venice-forum-declaration>).

Consensus emerging from the Venice Forum will chart a course for investment in the health of women and young children. This can support national leaders in explaining and implementing reprioritisation and alignment of investments with a view to building productive, resilient populations for a sustainable future.

The Venice Forum will further contribute to the work of The Partnership for Maternal, Newborn and Child Health. Together they will form a collaborating platform for the development and political advocacy of the investment case, working closely with leading global financing platforms such as the Global Financing Facility for Women's, Children's and Adolescents' Health, the World Bank, Gavi, and the WHO.

The meeting explored practical steps for investment in MNCH, built on the three pillars of science, justice and economics. In addition to adopting an economic model of growth that incorporates contributions that improve MNCH, other interventions might include better parental leave provision to promote child cognitive and emotional development,

incentivising the pharmaceutical industry to develop women's health programmes, and tackling obstacles to securing women's reproductive rights.

The following recommendations were developed after the meeting:

TEN ESSENTIAL ENDEAVOURS FOR INVESTING IN MNCH

- Present clearly the overwhelming **EVIDENCE** for investing in MNCH.
- Develop new **ECONOMIC** models to attribute value to the unremunerated work largely carried out by women, and embed this in economic policies aimed at promoting health, wellbeing, resilience and prosperity.
- Advance gender **EQUITY** through strong commitment to the prevention of violence against women and children, and call for a Global Treaty against such violence.
- **EDUCATE** and support prospective parents in preparing for pregnancy in the preconception period of their life-course through novel initiatives in schools and communities to promote physical and mental wellbeing.
- **EMPOWER** parents to provide support for nurturing child care in the pre-school years, through paid parental leave.
- **EVALUATE** and report access to services for sexual and reproductive health and assisted reproductive technologies, safe abortion, and postpartum care as part of a needs-based continuum of care pathway, especially for the poor and vulnerable.
- Connect MNCH to **ENVIRONMENT** issues including climate change, indoor and outdoor air pollution, environmental toxicants, sanitation and clean water and food security.
- **EXPAND** Research, development and innovation in MNCH in public, private and third sectors and require the representation of women and children in R&D.
- **ENGAGE** with advocacy groups and organisations working in each of the above areas to grow a coalition of committed partners.
- **ENSURE** accountability is attributed at all levels of government, professional and other support organisations for the delivery of a life-course and needs-based approach to promoting MNCH. Break down silos and prevent parallel, competing agendas.

With the Venice forum and LifeCycle a paper is being prepared to gain support from actors, advocates and policy-influencers globally, in collaboration with the PMNCH – WHO group to develop the case for investment in MNCAH.

3.3 Workshop 3

Due to COVID19 a planned workshop on interconception care and Nutrition in collaboration with the RANK foundation had to be cancelled. However, a policy brief was developed and sent to key policy stakeholders for comment.

Publications related to the Workshops:

- Meeting summary Venice Forum:
<https://pmnch.who.int/resources/publications/m/item/venice-forum-declaration>
- Background paper: Jacob CM, Briana D, Di Renzo GC, Modi N, Bustreo F, Conti G, Malamitsi-Puchner A, Hanson M. Building resilient societies after COVID-19 requires multifaceted investment targeting maternal, neonatal and child health. *Lancet Public Health*. 2020 (64).
- After Workshop in Copenhagen: Paper on the importance of translation of DOHAD concepts in policy (65).

4. Public health recommendations for the prevention of NCDs

The recommendations were developed based on the projects and meetings discussed above and a document analysis of interdisciplinary workshops held between 2017 – 2022. The five groups/ meetings were – The Venice Forum, the UK Preconception Partnership, Meeting on policy for Lifecycle consortium (discussed in this report), Working group on metrics and measurement for healthy ageing, National Institute for Health Research – Biomedical Research Centre Southampton (workshop on transgenerational Nutrition).

Overall, our analysis shows that the existing opportunities such as pre and inter-conception care should be harnessed and, in parallel, a research agenda to address the limitations in evidence need to be addressed. These are summarised in **Table 3** below, divided into the three stakeholder groups most targeted by the networks (policy-makers, HCPs and the general public – with a focus on young people and adolescents).

Table 3. Evidence-based priority areas and gaps for three key stakeholder groups for developing the research agenda and implementing DOHAD policy to prevent NCDs and improve preconception health

	Policies and national-level programmes	Healthcare practice	General population/
Priority areas for action with increasing evidence	<ul style="list-style-type: none"> • Planning obesity and NCD prevention interventions together with structural interventions e.g., targeted food taxes, subsidies, food labelling (66) and linked with SDGs and climate change agenda • Maternal mental health (before, during and after pregnancy) (67) • Investing in disadvantaged children (68) 	<ul style="list-style-type: none"> • Considering the whole family and early childhood development (73) • Focus on missed opportunities in the healthcare system for a continuum of care. These include women seeking fertility, approaching endocrinologists, GPs, cardiologists etc. (5) nurses, pharmacists, community midwives and post-natal health visiting teams (70) • Better detection and management of NCDs through clinical pathways: this can be facilitated by adherence to guidelines by the International Federation of 	<ul style="list-style-type: none"> • In developing interventions, consider social determinants of Health (78) • Embedding prevention in policies beyond maternal and child health e.g., environment, education, economic stress climate change, pollution, environmental toxicants • Consider wider outcomes to measure

	<ul style="list-style-type: none"> • Better workplace policies • Breastfeeding friendly environments • Good quality evidence for: Early childhood development and school readiness (69, 70), stress in pregnancy affecting executive function in the next generation(67) • Implementation of nurturing care framework(72) 	<p>Obstetricians and Gynaecologists (FIGO) (e.g., Hyperglycaemia in pregnancy, Adolescent, Preconception and Maternal Nutrition guidelines)(75, 76), RCOG ‘Better for Women’ report, to adopt a life course approach (77).</p> <ul style="list-style-type: none"> • Particular attention to maternal mental health and stress • Developing tools to enable the discussion of nutrition by HCPs • Focus of consultation on fitness and nutrition and not weight loss • Workforce development, training to engage women effectively 	<p>effectiveness of interventions - educational achievement, earnings, employment, human capital (79)</p> <ul style="list-style-type: none"> • Engaging wider public in population-level programmes and generating demand for action on NCDs (74) through campaigns using carefully framed messages • In LMICs effective measures before conception will have added benefits due to lower rates of attendance for antenatal care
Gaps in evidence and areas requiring more engagement	<ul style="list-style-type: none"> • Increase leadership and commitment from political agencies • Develop monitoring and reporting mechanisms for these initiatives to increase accountability (80) • Develop mechanisms to collect good quality data from routine systems (as used to develop the Lancet report card on preconception health (81)) • Develop novel measures for ‘value’ e.g., health capital and capacity across the life-course, measures of community resilience 	<ul style="list-style-type: none"> • Increase the focus on collective (e.g., family, communities) and not only individual-level advice for balanced diets in pregnancy, avoidance of alcohol, smoking, unsafe foods, violence and drugs in pregnancy, managing GDM, supporting breastfeeding and care of the newborn (73, 82) • Involvement of missing actors – midwives, community health workers in LMICs 	<ul style="list-style-type: none"> • For research, improve follow-up for sustained effects (83) • Household surveys using systems such as the Demographic Health Survey to explore trends related to socioeconomic status and nutrition • Making women’s health more visible: Data disaggregated by age and sex to monitor the after-effects of the pandemic and identify different impacts among men and women, and by life-stages. • Clarify language to be used in the

			preconception period to engage with prospective parents
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Recommendations for implementation

The recommendations adopt a two-pronged approach– 1. Building a robust case for maternal and child health through measurement, monitoring and better-quality data; 2. Implementing through a multi-system approach.

Figure 4 below, summarises the recommendations for the approach for implementation, highlighting the key points emerging from the document analysis and discussions in the meeting. Measurement and data were a strong theme with several recommendations on how this could be harnessed to increase accountability.

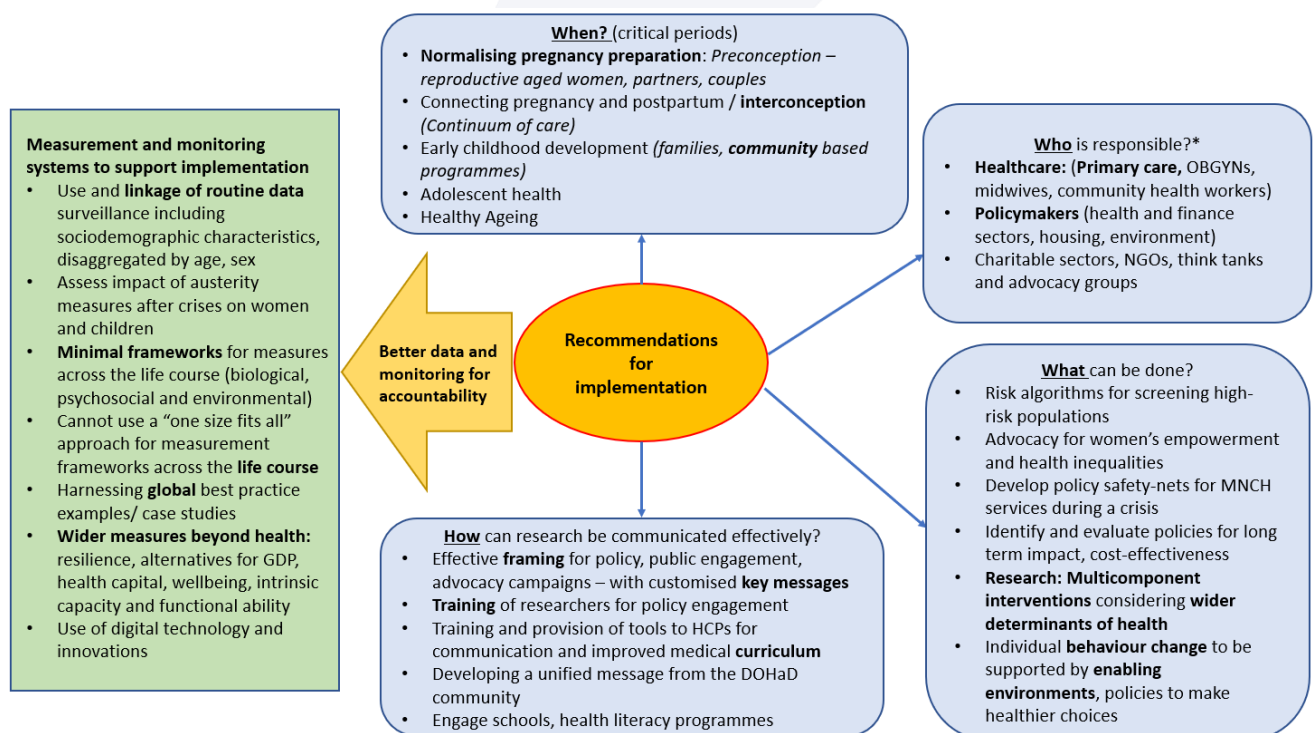


Figure 4. Key recommendations for implementation

5. Incorporating the preconception health agenda in the life course framework for preventing NCDs

The recognition that women enter maternity care pathways too late to prevent or manage obesity and NCD risks was seen from our reviews, and this has pushed the current movement on normalising pregnancy preparation. This approach, which could target women and couples to enter pregnancy in the best possible health, considering wider factors and adopting biopsychosocial-ecological models, was a common theme found in this

WP 10. While the call for such integration has been discussed before (39) based on our findings, an approach integrating the socioecological model of health for the life course approach to PCC is presented in Figure 4. The pathway provides examples of how all levels of the socio-ecological model will need to be engaged, and communicate with each other, for increasing the impact of interventions. Selected opportunities for action are presented in **Figure 5**, at all levels of the socio-ecological model for stakeholders. Stakeholders communicate through different channels across the levels to link the top-down and bottom-up approaches. At the international/ national and institutional level, policies to reduce inequalities that complement interventions to build resilience across the life course are recommended. Each socio-ecological level independently influences health, and also bidirectionally influences others including the reciprocal interactions between biology, psychology, and socio-economic factors.

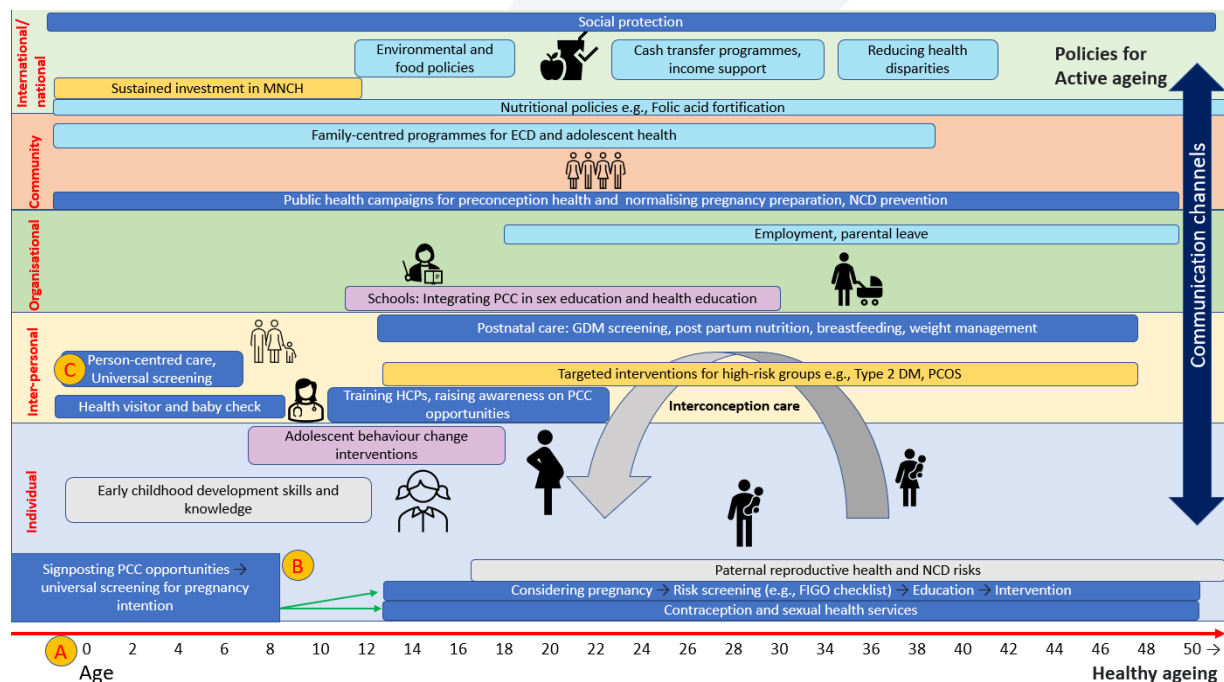


Figure 5. A life course approach to implementing an integrated NCD prevention and PCC agenda. A – preconception health of the parent; B- opportunities in routine service; C – Applicable across all life stages; UHC – universal health care

6. Contribution of partners

Activities for this Deliverable were conducted in collaboration with WPs 9 and 11. The reviews conducted in WP9 informed some of the policy recommendations. Additionally, the evidence for preconception period being a critical period for intervention and risk prevention was strengthened by work conducted by the Lifecycle group (6). The concept development and content writing for an e-Learning module on an online platform, Early Nutrition Elearning Academy (ENEA) (WP 11), was based on the reviews conducted for this deliverable. The course targets clinicians and aims to provide a summary of risk factors and interventions in the preconception period to prevent NCDs in the next

generation. It also includes a section on how the FIGO nutrition checklist can be used in routine practice in the preconception and early pregnancy period.

7. Deviations from original plan

WP10 integrates findings from LifeCycle WPs and related research through systematic reviews and workshops and translates the results to economic, public health and personalized prevention recommendations and strategies. Several tasks including 10.3 were delayed due to COVID over 2020-21, and workshops have been held online, limiting discussion. This had delayed our summarizing all findings for policy, clinical and general public stakeholders. However the pandemic in some ways strengthened the reason for our economic analysis as it also enabled us to consider the period post pandemic to include the impact of COVID 19 on outcomes such as childhood obesity. This was crucial to developing actionable recommendations for future parents, clinicians and policy-makers.

8. Dissemination of results

8.1 Academic Publications

The following publications were developed based on the activities conducted for WP10 discussed above. These have been mentioned above in reference to each task.

Review articles for evidence synthesis

- Jacob CM, Newell M-L, Hanson M. Narrative review of reviews of preconceptional interventions to prevent increased risk of obesity and non-communicable diseases in children. *Obes Rev.* 2019;20(S1): 5-17.
- Jacob CM, Killeen SL, McAuliffe FM, Stephenson J, Hod M, Diaz Yamal I, et al. Prevention on non-communicable diseases by interventions in the preconception period: A FIGO position paper for action by the healthcare practitioners. *Int J Gynecol Obstet.* 2020;151(S1): 6-15.
- Jacob CM, Hardy-Johnson P, Inskip H, Morris T, Parsons C, Barrett M, et al. A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10 to 19 years. *Int J Behav Nutr Phys Activity.* 2021;18:1.
- Jacob CM, Cooper C, Baird J, Hanson M. What quantitative and qualitative methods have been developed to measure the implementation of a life-course approach in public health policies at the national level? (Health Evidence Network synthesis report; No. 63). World Health Organisation. 2019.
- Watson D, Jacob C, Giles G, McAuliffe F, Godfrey K, Hanson M. A review of nutritional and lifestyle interventions and guidelines for promoting maternal and child health in the interconception period.

Policy and public health Recommendations

- Jacob CM, Briana D, Di Renzo GC, Modi N, Bustreo F, Conti G, et al. Building resilient societies after COVID-19 requires multifaceted investment targeting maternal, neonatal and child health. *Lancet Public Health*. 2020;5(11):E624-7.
- Jacob CM, Hanson M. Implications of the Developmental Origins of Health and Disease (DOHaD) concept for policy-making. *Curr Op Endocr Metab Res*. 2020;13:20-27.
- Penkler M, Jacob CM, Müller R, Kenney M, Norris SA, da Costa CP, et al. Developmental origins of health and disease, resilience and social justice in the COVID era. *J Dev Orig Health Dis*. 2021;13:413-6.

Publications based on research activities (both led by WP and with collaborators):

- Choedon T, Sethi V, Chowdhury R, Bhatia N, Dinachandra K, Murira Z, et al. Population estimates and determinants of severe maternal thinness in India. *Int J Gynecol Obstet*. 2021;155(3):380-97.
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- Killeen SL, Callaghan SL, Jacob CM, Hanson M, McAuliffe FM. "It only takes two minutes to ask" - a qualitative study with women on using the FIGO Nutrition Checklist in pregnancy. *Int J Gynecol Obstet*. 2020;151(S1):45-50.
- Killeen SL, Callaghan SL, Jacob CM, Hanson M, McAuliffe, FM. Examining the use of the FIGO Nutrition Checklist in routine antenatal practice: multistakeholder feedback to implementation. *Int J Gynecol Obstet*. 2020;151(S1):51-6.
- Jacob CM, Lawrence W, Inskip H, McAuliffe FM, Killeen SL, Hanson M. Do the concepts of 'life course approach' and 'developmental origins of health and disease' underpin current maternity care? Study protocol. *Int J Gynecol Obstet* 2019;147(2):140-6.
- McAuliffe FM, Killeen SL, Jacob CM, Hanson M, Hadar E, McIntyre HD, et al. Management of prepregnancy, pregnancy and postpartum obesity from the FIGO Pregnancy and Non-Communicable Diseases committee: A FIGO (International Federation of Gynecology and Obstetrics) guideline. *Int J Gynecol Obstet* 2020;151(S1):16-36.
- Chopra M, Kaur N, Singh KD, Jacob CM, Divakar H, Babu GR, et al. Population estimates, consequences, and risk factors of obesity among pregnant and postpartum women in India: Results from a national survey and policy recommendations. *Int J Gynecol Obstet* 2020;151(S1):57-67.
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8.2 Contribution to online website development for the nutrition checklist in partnership with FIGO for the general population and HCPs

Based on our findings, we have been collaborating with the FIGO-Pregnancy Obesity and Nutrition Initiative to develop a web version of the checklist which can be completed by women remotely before consultations. The acceptability and validity of a translated version of the checklist are also being evaluated in India, and we have been supporting the development of that study to test the use in an LMIC setting. The Indian checklist is designed to consider regional dietary variations in India and will include an element of training HCPs e.g., nurses to discuss the checklist with the women.

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Appendix 1.

Implementation and Reporting on the Life-Course Approach to Health, Wellbeing and Resilience: the importance of the preconception period

Prof Mark Hanson (University of Southampton), Prof Sir Peter Gluckman (International Network for Government Science advice), Dr Chandni Maria Jacob (University of Southampton)
Policy brief developed for Lifecycle workshop Copenhagen 2019

Key Points

- ❖ The Minsk Declaration of the Member States in the WHO European Region (2015) states that ‘the life-course approach is an essential step towards the implementation of Health 2020 and the goals and targets in the United Nations 2030 Agenda for Sustainable Development.’ Through the declaration, Member States committed to making greater use of the life-course approach in needs assessments, selection of priorities, monitoring, evaluation and reporting at the regional level.
- ❖ A recent report by the WHO Health Evidence Network 1 reviewed how European Region Member States are measuring and reporting on strategies to implement the life-course approach. It made the case for developing unambiguous definitions of the core concepts and the constructs that need to be measured and using existing frameworks for measurement through increased intersectoral collaborations and linkages.
- ❖ This Position Paper, compiled in collaboration with the EU Horizon 2020 LifeCycle programme, accordingly provides expert input to Member States on a pathway forward.
- ❖ Despite extensive evidence on the importance of using a life-course approach, the diversity of approaches to implementation has impeded development of a unified approach to measuring effective implementation. The focus must be on measuring those key indicators in each life stage that reflect potential risks and protective factors across the life-course.
- ❖ This Paper highlights the importance of the preconception period in the development of strategies to promote health across generations. Public health interventions in this phase of the life-course can be particularly effective and affordable, are supported by citizens, and can have measurable impact over a 5 year timescale.

- ❖ The paper provides options to help align reporting on the preconception component of the life-course approach with existing frameworks such as Health 2020 and the SDGs.

The challenge to health and wellbeing in the European region

Health 2020, the European health policy framework, aims to “improve the health and well-being of populations, reduce health inequities and ensure people-centred health systems”.² Importantly, Health 2020 recommends the adoption of a common, outcome-focused, region-wide policy framework. Both Health 2020 and the Minsk declaration (2015)³ identify well-being, resilience and the life-course as a key concepts for incorporation into health policies across the WHO European Region.

NCDs are the leading cause of mortality in the EU, costing EU economies €115 billion, or 0.8% of GDP annually.⁴ There has been some reduction in NCD-related premature mortality across the region: in 2014, the age-standardized overall premature mortality rate for the four major NCDs region was 379 per 100 000 (vs. 421 per 100 000 in 2010). However data for only 40 countries (of 53) were available.⁵ Life expectancy at 65 increased throughout the region from 2010-2015 and healthy life years at age 65 increased from 8.8 to 9.4 years for females and from 8.7 to 9.4 years for males (Eurostat data). However this varied by region (e.g. the increase for Swedish females was 16.8 years, for males 15.7 years; for Slovakian females is was 3.8 years, for males 4.1 years).

Although Member States in the WHO European Region are on track to achieve the NCD target by 2020, indicators for obesity, smoking and alcohol do not show the same trends. This could indicate an impending rise in NCDs with both short- and long-term consequences. The prevalence of overweight and obesity among adults in the European Region is high and increased from 55.9% in 2010 to 58.7% in 2016 for overweight, and from 20.8% in 2010 to 23.3% in 2016 for obesity. In most countries, prevalence of overweight was higher in men and obesity was higher among women. Obesity during key periods in the life-course such as pregnancy is not systematically recorded routinely, however studies have estimated that the highest prevalence of maternal obesity in Europe was in the UK and Ireland (7-25% prevalence in EU overall).⁶

The prevalence of overweight and obesity among young people (11, 13 and 15 years old) varied between countries, sex and age groups. In these age groups the highest prevalence of overweight in the Region was reported for Greenland, Greece, Italy and Malta, while it was lowest for Denmark.⁵

The LifeCycle programme⁷ (European Commission Horizon 2020 funded) is a network of birth cohorts from 10 countries in the European Region and Australia. The programme explores life-course risk factors and evaluates a range of early life interventions to promote health. With

cooperation of the LifeCycle group, this position paper aims to provide an overview of the life-course approach, with recommendations on implementation and monitoring with a focus on early life.

Why a life-course approach is needed

The life-course is a sequence of age ranges which people pass through as they progress from conception to death.⁸ An individual's health, wellbeing and resilience at a particular time are only partly dependent on their contemporaneous behaviour and environment: the pathway which their life took to reach that point is even more important.⁹ The life-course approach conceptualises health as connected through the life stages, interacting with environmental, biological, economic, behavioural, social and psychological factors. Events occurring in critical periods can have cumulative effects through the life-course.¹⁰ **After these** transitional periods it is more difficult to regain lost health and, in addition, wellbeing and resilience to later health challenges can be reduced. Maternal and child health¹¹ **offer particular opportunities to gain or lose health across the life-course and across generations (Figure 1).**

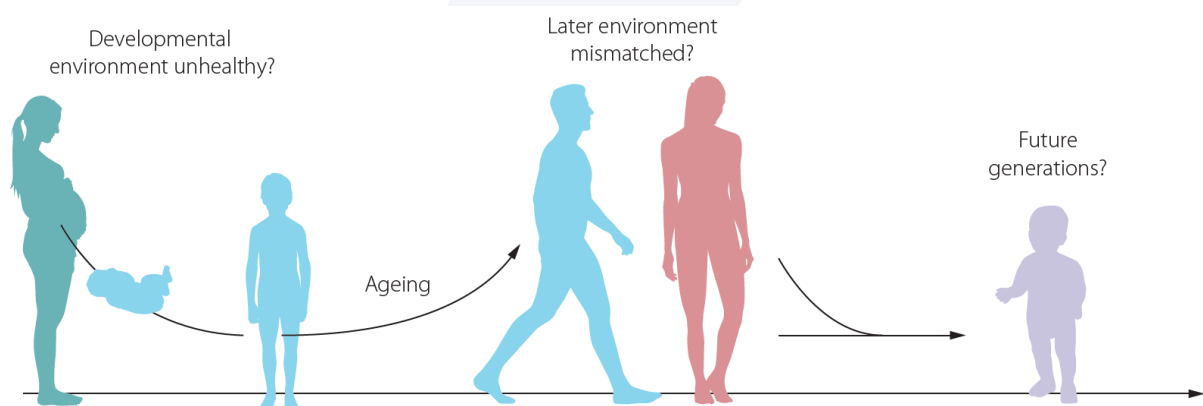


Figure 1: Importance of early developmental environment and match with later environment in influencing health of current and future generations. (Adapted from Hanson 2019¹²).

Resilience to risk factors¹³ not only affects overall health and wellbeing but impacts on other domains such as socio-economic status, healthcare expenditure and productivity. Resilience also influences susceptibility to NCDs and the rate of decline of function with ageing. Early interventions can have multiple benefits as some factors in early development affect multiple health domains. This is particularly true of promoting healthy development in the first 1000 days of life (from conception to age 2 years) which is well demonstrated to affect child's cardiorespiratory and metabolic health, growth and body composition, and neurocognitive and emotional development. Providing a healthy and stimulating environment in early childhood can have longer-term effects on educational achievement, employment prospects and social contributions^{14, 15} as well as promoting resilience to later challenges such as an obesogenic environment, the psychological effects of social media,

environmental or economic shocks etc. **Maternal and probably also paternal obesity, even before pregnancy, is now shown to be a predictor of pregnancy outcomes and childhood obesity with long-term effects.**^{16,17} This focuses attention on parental health, wellbeing and resilience in the pre-conception period.

The life-course approach is at the heart of global and European strategies and action plans of the World Health Organization, such as the Minsk declaration (2015),³ Health 2020² and the World report on ageing and health.¹⁸ A barrier is that life-course frameworks can seem complex, requiring extensive and longitudinal data for different pathways at each critical life stage. Whilst all Member States in the European region may not have data collection systems in place for all indicators (as for H2020 indicators) the recent Health evidence network (HEN) report 63¹ provides an overview on the status of reporting on the life-course approach and presents actionable options for implementation and monitoring.

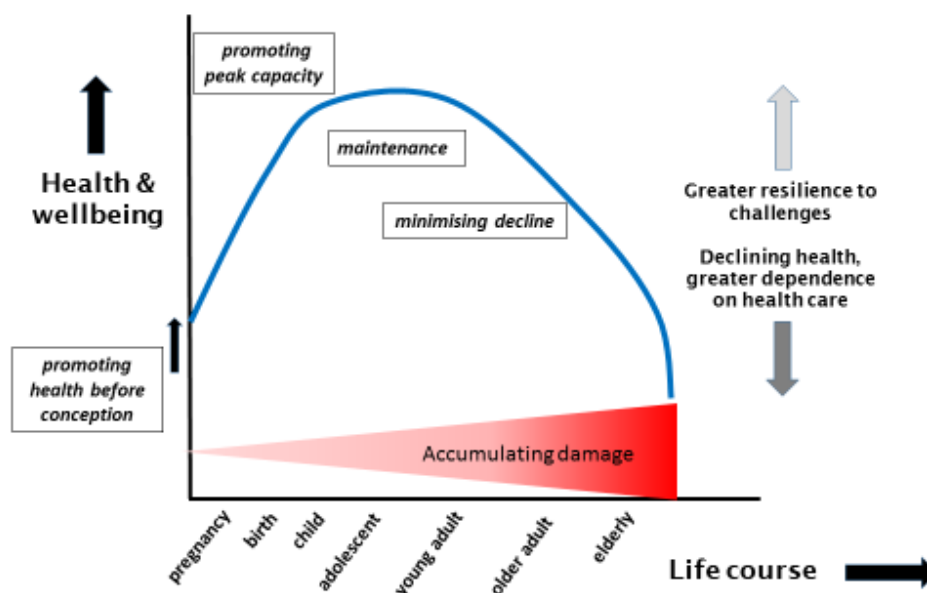


Figure 2: The trajectory of health and well-being across the life-course, depicted in terms of function and resilience to challenges. Factors affecting life-course health operate even in the period before conception and influence the passage of health and well-being across generations. The aim of interventions using a life-course approach is to promote the development of peak function, to maintain it for as long as possible and to minimize its decline. The rate of decline is further influenced by factors such as resilience to challenges and socioeconomic context. (Figure From Health Evidence network synthesis Report 63).

Harnessing the preconception period to implement a life-course approach to health, wellbeing and resilience

To use the life-course approach in practice policy-makers will need to integrate programmes across health, education and related services during critical periods of the life-course. A suite of evidence-informed and cost-effective interventions in a critical period will improve the later resilience of individuals to environmental and socioeconomic challenges. The HEN report suggests that a basic framework for implementation, followed by monitoring and reporting, should be contextualized to the challenges faced by each region.¹ Public engagement and working with communities is essential for developing programmes that meet needs and increase uptake of services. Multiple stakeholders such as health care professionals also need to be included during intervention development. Box 1 gives examples of interventions in the preconception period targeted to improve health through

Box 1. Examples of preconception interventions to improve lifelong health and wellbeing^{17, 19, 20}

- ❖ Women's health in the months and years before they become pregnant can affect fertility, their own health during pregnancy, and the baby's development and life-long health. Studies have shown that BMI before pregnancy is more closely associated with maternal and infant complications than weight gain during pregnancy.
- ❖ In the Netherlands, complications related to maternal smoking, alcohol consumption and inadequate folic acid supplementation were responsible for 83% of the mortality rate. To address these issues, the mhealth 'Smarter Pregnancy' programme was developed and offered to couples contemplating pregnancy (n=1275) or already pregnant (n=603). The personal online coaching programme was created to achieve behaviour change and maintain healthy nutrition and lifestyle. After 6 months of coaching, the programme was seen to be effective to increase intakes of vegetables by 26.3% [95%CI 23.0-29.9] and fruits by 56.3% [95%CI 48.8-63.6%]. Folic acid use increased by 35.1% [95%CI 29.1-41.6]. Tobacco intake and alcohol consumption reduced by 35.1% and 41.9% respectively. The intervention was also associated with a higher chance of becoming pregnant for both infertile and fertile couples. Couples and women are hard to access before they become pregnant and such mhealth platforms can be useful to provide population health services that can have a life-long effect.
- ❖ A pilot study has developed a 'preconception report card' on risk factors to describe and monitor preconception health in England using metrics from multiple routine data sources.²¹ The indicators include variables for obesity, nutritional status and dietary habits, alcohol intake, smoking, mental health, contraception and unplanned pregnancy.

pregnancy and early childhood, and also to prevent the transgenerational passage of risk of NCDs. We note that his approach does not obviate that of ameliorating disadvantage later in life to confer benefits for older members of the population, as many of the interventions operate at the level of the whole community.

Implementation

Actions to consider include:

1. Developing an action plan to target interventions at critical periods, especially healthy development in adolescents and young people in the preconception period, in pregnancy and the child up to age 2 years.
2. Developing and evaluating programmes that explicitly incorporate such a life-course perspective within existing programmes and services. Where effectiveness is demonstrated Member States should be encouraged to share experience.
3. Enhance collaboration within and beyond the health sector, linking with other services such as education, social services, transport *etc.* Involving multiple stakeholders and working across government and other agencies to co-create interventions can lead to a transformation in environmental and social sectors which affects health and wellbeing across the life-course.
4. Leverage intervention and wider awareness through media, local and wider bodies (the general public and civil society organisations; WHO; professional organizations; the private sector as appropriate).
5. Link health and other services to establish continuity of care from preconception and continuing throughout life for women, children and families. Working with health care providers to identify and modify current practice and policies in health systems, and provide training and assistance as necessary.
6. Timely and relevant assessment/ screening programmes during the preconception period (for adolescents, young women and their partners), pregnancy and early childhood, based on the risks operating in these critical periods, in order to identify people who are on a high risk trajectory and to provide appropriate intervention and support. Assessments in clinics as well as routine surveys should cover a range of parameters (physical, social, cognitive and psychological) including physical activity patterns, diet *etc.* These assessments should not only look for deficits but also provide information to chart health trajectories for domains across the life-course.
7. Encourage interdisciplinary research alongside these public health programmes.

Monitoring

A weakness of most surveillance systems is the lack of indicators based on longitudinal data. Cross-sectional indicators are often selected to be used immediately on release for specific outcomes. Longitudinal indicators that also examine a combination of risk and resilience factors have been tested in the USA MCH programme.¹⁰ Using a risk-based approach by tracking disease prevalence and mortality is the predominant approach in public health. However, resilience measures could be reflected in some of the current indicators – e.g. proficiency in 4th grade, receipt of immunization.

Cross-sectional indicators cannot be specifically tied back to critical periods of development. Age and sex disaggregated data is crucial to understanding the differences in patterns of conditions such as obesity and to developing targeted interventions. New approaches to analysis and visualization of data that demonstrate individual trajectories and disease progression capture the temporal and multivariate nature of life-course indicators.¹

Although monitoring life-course parameters is complex, it will be well-received by multiple stakeholder groups as innovative, evidence-informed, far-sighted and responsible. Qualitative life-course methodologies have not been harnessed to their full potential and are capable of presenting social and cultural norms and evaluating the implementation of services. Box 2 presents data sources available in the European region, and indicators from the H2020 framework that are aligned with recommended life-course measures. We note however that these place little emphasis on adolescence, preconception, pregnancy and early childhood, not including for example the percentage of women seen by a healthcare professional by 10 weeks of pregnancy, rates of gestational diabetes, pre-eclampsia, preterm birth, low or high birth weight, breast feeding, maternal mental health, childhood BMI in pre-school years. The Table also lists Life-Course Targets and indicators for Health 2020 V.04^{2 24}

Actions to consider based on the HEN report are listed below. The HEN report provides options for measurement and monitoring across the life-course. Use existing platforms, surveys, birth cohorts and longitudinal studies that follow up post-pregnancy, through childhood and adolescence, can be used as sources to identify the most important measures of early life-course parameters to populate a life-course framework with validated and tested measures, which can be built on subsequently.

1. Use of a whole-of-government approach that would include common goals such as well-being as measures of national progress
2. Develop a dashboard of indicators, aligned with H2020 indicators, with a particular emphasis on the preconception period (Refer to Lancet paper England).
3. Integrate life-course indicators as new priority and performance measures to update existing data collection systems. This can be aligned with efforts to improve coordination and linkage of services across the life-course.
4. Obtain data on macro- and community factors such as socioeconomic status and education to understand disparities in maternal and child health outcomes.

² Note: The H2020 indicators were compared with the life-course indicator sets included in the HEN report 63 (e.g. AAI, AMNCP) for inclusion in box 2. Not all studies included in the policy review had indicators (refer full report for discussion on types of studies reporting on life-course outcomes).

Box 2: Examples of resources for measuring and reporting on the life-course approach

Tools and datasets in the European Region:

European Health for All database, Eurostat

Global Adult Tobacco Survey (GATS), Global Youth Tobacco Survey (GYTS), Global School Health Survey (GSHS)

Health Behaviour in School-aged Children (HBSC)

European School Survey Project on Alcohol and Other Drugs

Database of labour statistics of the International Labour Organization (ILO)

European Union Statistics on Income and Living Conditions

Mortality indicator database of the WHO Regional Office for Europe

European Childhood Obesity Surveillance Initiative (COSI)

Others: OECD, World bank, Routinely collected national data for Health2020 indicators and SDGs, WHO Health information Gateway, WHO NCD monitoring framework

In UK – National diet and Nutrition Survey, Clinical Practice Research Datalink, National Child Measurement Programme, MSDS

The European child and adolescent health strategy (CAH)²² (2015–2020) aims to “make children’s lives visible”. Outcomes included the development of country profiles that provide Member States with a view of the status of children and young people in their countries through indicators, including data from the HBSC survey. These tools support the regional commitment embedded in the strategy and the implementation of national programmes to achieve optimal health early in the life-course.

Suggested criteria for life-course indicators: Equity, resource realignment, impact, intergenerational wellness, and life course evidence, considering availability, quality and simplicity: with emphasis on indicators that address critical and transitional periods throughout life. (For more details see full version of HEN report 63)^{1, 10, 23}

Core indicators

Additional indicators

1. Unemployment rate, disaggregated by age and sex
Educational attainment of people aged 25 years and over who have completed at least secondary education
2. Life expectancy at birth, disaggregated by sex
3. Vaccine coverage among children
4. Proportion of children of official primary school age not enrolled, disaggregated by sex
5. Age-standardized prevalence of current (includes both daily and non-daily or occasional) tobacco use among people aged 18 years and over
6. Total (recorded and unrecorded) per capita alcohol consumption among people aged 15 years and over within a calendar year (litres of pure alcohol), reporting recorded and unrecorded consumption separately, if possible
7. Age-standardized prevalence of overweight and obesity in people aged 18 years and over (defined as a body mass index (BMI) ≥ 25 kg/m² for overweight and ≥ 30 kg/m² for obesity), where possible disaggregated by age and sex, reporting measured and self-reported data separately
8. Private household out-of-pocket expenditure as a
9. proportion of total health expenditure
10. National and/or subnational policy addressing the reduction of health inequities established and documented
11. Age-standardized overall premature mortality rate (from 30 to under 70 years) for 4 major noncommunicable diseases (cardiovascular diseases, cancer, diabetes mellitus and chronic respiratory diseases disaggregated by sex;
12. GINI coefficient (income distribution)
13. Life satisfaction, disaggregated by age and sex

1. Life expectancy at ages 1, 15, 45 and 65 years, disaggregated by sex
2. Healthy life years at age 65, disaggregated by sex
3. Availability of social support
4. Percentage of people aged 65 years and over living alone
5. Maternal deaths per 100 000 live births (ICD)
6. Prevalence of weekly tobacco use among adolescents
7. Heavy episodic drinking (60 g of pure alcohol or around 6 standard alcoholic drinks on at least one occasion weekly) among adolescents
8. Prevalence of overweight and obesity among adolescents
9. Standardized mortality rate from all causes, disaggregated by age and sex

³ Note: The WHO H2020 indicators were compared with the life-course indicator sets included in the HEN report 63 (e.g. AAI, AMNCP) for inclusion in the table. Not all studies included in the policy review had indicators (refer full report for discussion on types of studies reporting on life-course outcomes).

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