

Preconception health 3



Intervention strategies to improve nutrition and health behaviours before conception

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The nutritional status of both women and men before conception has profound implications for the growth, development, and long-term health of their offspring. Evidence of the effectiveness of preconception interventions for improving outcomes for mothers and babies is scarce. However, given the large potential health return, and relatively low costs and risk of harm, research into potential interventions is warranted. We identified three promising strategies for intervention that are likely to be scalable and have positive effects on a range of health outcomes: supplementation and fortification; cash transfers and incentives; and behaviour change interventions. On the basis of these strategies, we suggest a model specifying pathways to effect. Pathways are incorporated into a life-course framework using individual motivation and receptiveness at different preconception action phases, to guide design and targeting of preconception interventions. Interventions for individuals not planning immediate pregnancy take advantage of settings and implementation platforms outside the maternal and child health arena, since this group is unlikely to be engaged with maternal health services. Interventions to improve women's nutritional status and health behaviours at all preconception action phases should consider social and environmental determinants, to avoid exacerbating health and gender inequalities, and be underpinned by a social movement that touches the whole population. We propose a dual strategy that targets specific groups actively planning a pregnancy, while improving the health of the population more broadly. Modern marketing techniques could be used to promote a social movement based on an emotional and symbolic connection between improved preconception maternal health and nutrition, and offspring health. We suggest that speedy and scalable benefits to public health might be achieved through strategic engagement with the private sector. Political theory supports the development of an advocacy coalition of groups interested in preconception health, to harness the political will and leadership necessary to turn high-level policy into effective coordinated action.

Introduction

In 2016, the UN committed to “end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons” in target 2.2 of Sustainable Development Goal 2.¹ Growth and development targets for children, and the consequent reduction in their risk of non-communicable disease in adulthood, could be achieved through improving women's nutritional status and health behaviour before conception.² Two previous *Lancet* Series have called for innovation in the design and delivery of affordable, scalable nutrition interventions to improve maternal and child health.^{3,4} In this Series paper, we review what is known about the effectiveness of preconception nutritional and behavioural interventions, and propose a strategy for aligning interventions with individual motivation and receptiveness at different preconception action phases during the life course. We propose a dual strategy targeting health improvement in men and women planning a pregnancy, and in the general population, on the basis that improvements in preconception health require a supportive environment (underpinned by a social movement and policy initiatives), and on the engagement of the private sector.

Intervention strategies

We conducted a quasi-systematic review of trials of preconception nutrition and health behaviour interventions, to identify effective interventions and specify pathways to effect (appendix). We included interventions assessing nutritional status and body composition outcomes, excluding other clinical outcomes such as improved glycaemic control. Pathways to effect were

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Key messages

- Epidemiological data, and findings from developmental biology, suggest that intervening to improve men's and women's nutritional status before pregnancy improves long-term outcomes for mothers and babies
- Trials of interventions to improve nutritional status before conception and birth outcomes are scarce, but new trials are underway
- Effective preconception nutritional interventions include supplementation or food fortification to provide micronutrients, particularly folic acid and iodine
- To maximise benefit and achieve health growth trajectories in the next generation, preconception strategies should be broader than supplementation or fortification, and address wider determinants of health
- Motivations to engage with preconception nutrition differ according to age and life phase; understanding and harnessing these motivations is key to successful intervention
- Interventions should be context-specific and make use of existing platforms for delivery
- Preconception interventions need to be supported by a social movement and political will, both of which require skilful engagement with powerful commercial interests

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See Online for appendix

then incorporated into a life-course framework to aid the targeting of interventions. Preconception interventions were reviewed using the reach, effectiveness, adoption, implementation, and maintenance (REAIM) framework.⁵ Finally, we applied a consumer-marketing approach to the challenge of creating a social movement to strengthen political resolve for wide-scale intervention.

We identified 14 controlled primary studies evaluating three strategies: supplementation and fortification, cash transfers or incentives, and behaviour change intervention. We did not identify enough good quality studies conducted in the preconception period to enable us to perform a meta-analysis or draw firm conclusions about effectiveness; however, epidemiological and biological evidence points to the value of intervening prior to conception. Intervention strategies were selected for review on the basis of being scalable, low risk, and of likely benefit to nutritional outcomes in the preconception period. We developed a model describing the key pathways to be quantified once more high quality data from randomised trials become available (figure 1).

Supplementation and food fortification

Most evidence for the benefits of improving preconception nutrition and health comes from trials examining the effects of micronutrient and energy supplementation. The Bacon Chow study,⁶ done in Taiwan, found that supplementing the diets of women who were undernourished with 800 kcal and 40 g protein per day after the birth of their first baby increased birthweight of the second baby when compared with a control group given just 80 kcal extra per day. A similar study in the USA⁷ also found increased birthweight of subsequent babies among women given supplements for 5–7 months following the birth of their first baby, compared with

those given supplements for up to 2 months. The Mumbai Maternal Nutrition Project^{8,9} showed that a locally sourced, micronutrient-rich snack, given daily before conception and during pregnancy, reduced the likelihood of gestational diabetes and increased birthweight in a high-risk Indian population (but only among mothers who were not underweight). These studies represent the best available evidence for the benefits of preconception nutritional supplementation. Effective strategies to improve access to additional calories before conception still need to be identified in contexts where maternal undernutrition is common.

Supplementation interventions are generally acceptable to women, but uptake is often hampered by poor adherence. Several solutions have been proposed, including a contraceptive pill containing folic acid available in the USA;^{10,11} however, the impact of this solution depends on contraceptive pill use, which varies widely between countries. Fortifying foods such as flour or rice has wide potential reach, and is currently mandated in 87 countries.¹² The WHO has also issued a guideline for the fortification of salt with iodine, which can prevent irreversible mental impairment of the fetus.¹³ In addition, reductions in the prevalence of neural tube defects have been observed following mandatory folic acid fortification in Canada, Chile, Costa Rica, South Africa, and the USA.^{14,15} However, folic acid fortification is not mandatory in Europe; in the UK, there are concerns about increasing cancer risk in older populations, potential masking of anaemia caused by vitamin B12 deficiency, and removal of individual choice.¹⁴ Despite these concerns, there is little evidence of negative effects from folic acid fortification.¹⁶ The UK's Scientific Advisory Committee on Nutrition continues to recommend mandatory folic

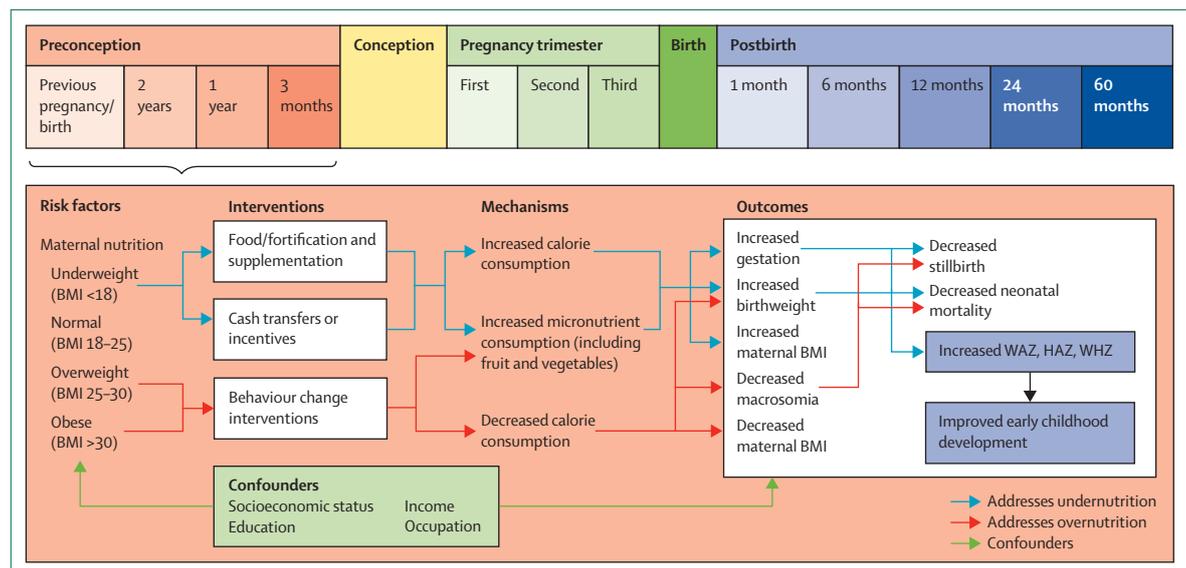


Figure 1: Conceptual model of pathways between interventions to improve maternal nutritional status and maternal and infant outcomes BMI=body-mass index. WAZ=weight-for-age Z score. HAZ=height-for-age Z score. WHZ=weight-for-height Z score.

acid fortification to improve the folate status of women most at risk of neural tube defect-affected pregnancies.¹⁶

Cash transfers and incentives

None of the studies identified investigated the effects of preconception cash transfers on birth or nutritional outcomes. However, this strategy was included in the model because cash transfers are effective in improving school enrolment and attendance among girls, access to preventive health care, and household food consumption in low-income settings.^{17–19} These factors are risks for poor birth and nutritional outcomes, suggesting that preconception cash transfers could be useful.^{20,21} In high-income settings, further work is needed to demonstrate the effectiveness and acceptability of combating overweight and obesity through incentivising the purchase of healthy foods.

Behaviour change interventions

Two systematic reviews^{22,23} examining 12 preconception trials identified possible improvements in health behaviours (including alcohol consumption and smoking), and psychological mediators of intervention effects (such as maternal self-efficacy and perceived control). Neither review reported maternal nutritional status as an outcome. Two studies tested the effect of preconception nutritional or behavioural interventions on birth outcomes: no effect on pregnancy outcomes was found in a Dutch study²⁴ when general practitioners counselled couples on health behaviours; and a negative effect on birthweight of counselling on risk factors including diet, timing of next pregnancy, and specialist referrals was noted in an Australian study.²⁵ The authors of the latter study speculated that improved preconception health meant that previously unsustainable pregnancies were sustained for longer, resulting in increased preterm births and decreased birthweights. If true, this would be an unexpected and adverse effect of preconception intervention.

Addressing preconception undernutrition in low-income settings could require broader behavioural strategies than tackling overnutrition in high-income settings. Low-resource households cannot simply change their behaviour if food is unavailable, and so strategies must combine behaviour change with food access, as was done in the CARING Trial^{26,27} in eastern India. A health-care approach was used that successfully engaged women and reduced maternal and neonatal mortality in rural, low-resource settings, known as participatory learning and action through women's groups.²⁸ Facilitated by a trained health-care professional, this group-based, problem-solving approach involves women of all ages, and tackles a variety of maternal and newborn problems including nutrition. Although the original trials testing this approach did not report on nutritional outcomes, the CARING trial found that the approach improved key secondary outcomes, including dietary diversity and handwashing (although no

significant increase in child length was measured). Interventions in high-resource contexts can focus on individual choice, but multilevel interventions might be more effective.²⁹ Intervention trials developed as part of the Canadian Government's Healthy Life Trajectories Initiative are good examples of multilevel interventions that aim to address preconception nutrition and health behaviour, but also wider health and social determinants. These trials will provide gold standard evidence of the effectiveness, and cost-effectiveness, of multicomponent preconception interventions in improving outcomes for children.

Preconception interventions often require engagement from individuals who are not thinking about becoming pregnant in the near future, and are unlikely to be using maternal health services. Interventions to improve health behaviours in adolescents and young adults might, therefore, have to be placed outside maternal and child health services and appeal to motivations unrelated to health, such as self-image.^{30–32}

Motivation and engagement

The complexities involved in changing individual and population health behaviours are well recognised. It is usually not enough to simply educate or give advice, as knowing something is good for you is rarely sufficient to change behaviour. Successful behaviour change requires the target population to engage with the need to change, sustain the motivation to maintain the change, and be supported by contexts that facilitate change (service providers, society, social networks, and environments).³³

Figure 2 shows a model of preconception action phases, adapted from the Rubicon model of action phases and the Action phase model of developmental regulation, and applied to preconception motivations and interventions.^{34,35} The model is based on five assumptions: first, most young adults intend to become parents at some point, and this goal begins to form in childhood; second, young adults have the adaptive capacity to pursue this goal among their other developmental life-course goals, and to translate it into action; third, the goal to become a parent is nested within other facilitating and conflicting developmental life-course goals, which are pursued as opportunities evolve over time; fourth, motivation to become a parent is the driver that translates that goal into relevant preconception behaviours; and fifth, translating the goal to become a parent into conception and pregnancy outcomes is imperfect.

The model distinguishes four phases, characterised by overarching biological or psychological agendas and motives, in relation to the goal to become a parent. As an individual moves through the phases, interventions become less general and more targeted towards specific populations (in keeping with the dual strategy for promoting preconception health proposed here). In the early phases of the model, intervention reach will be increased, although effect sizes are likely to be small due to low intensity. The benefits of interventions in these

For the **Healthy Life Trajectories Initiative** see <http://www.cihr-irsc.gc.ca/e/49511.html>

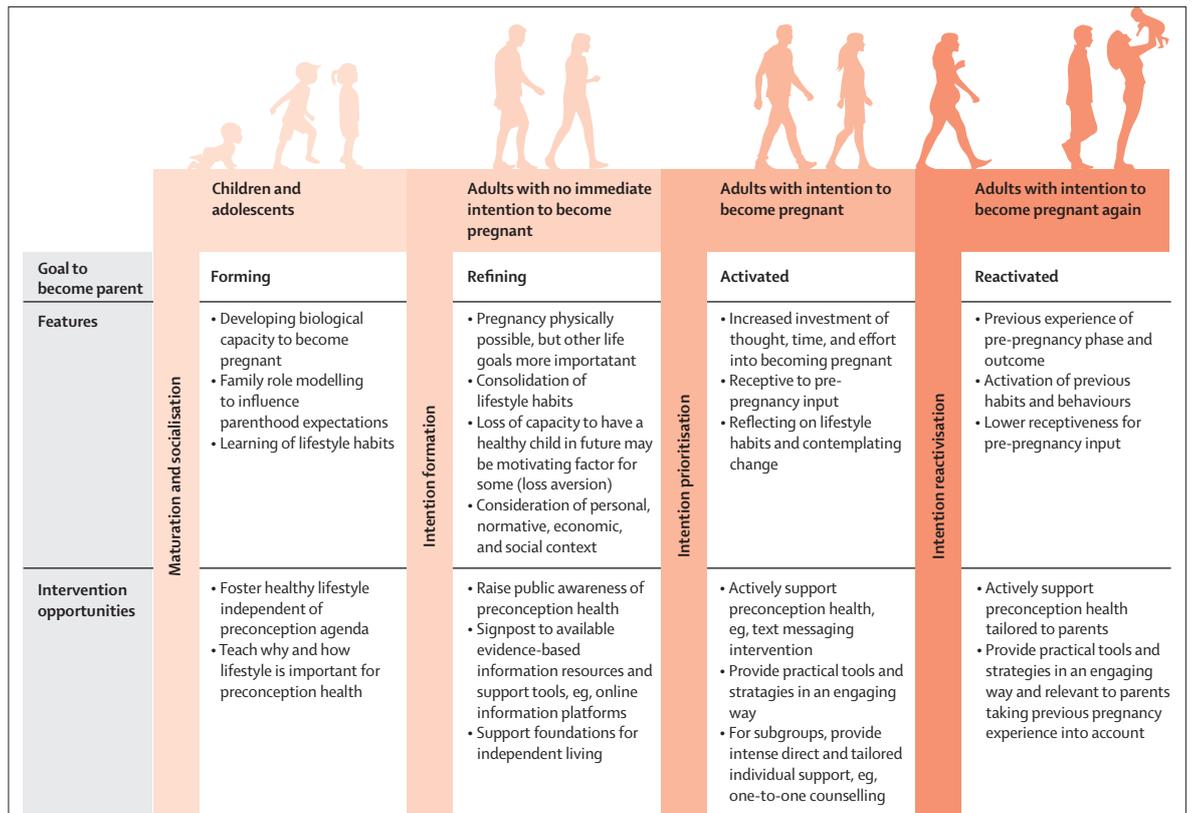


Figure 2: Model of preconception action phases

The model outlines four phases individuals move through in relation to the goal to become a parent, highlighting features and intervention opportunities for each phase (adapted from the Rubicon model of action phases and the Action phase model of developmental regulation).^{34,35}

early phases will be general; healthy diets will benefit both the individual and society, and enhance motivation in those not planning imminent pregnancy. Creating a social movement could raise awareness of the importance of preconception nutrition, and generate a supportive social environment for preconception health. It could also help build engagement at each phase, and facilitate preparation for pregnancy as a normal part of having a baby within standard health-care practice.³⁶

Intervening with children and adolescents

In the first phase of preconception action, motivation to become a parent forms without any physical capability for childbearing, which changes as children develop into adolescents. Laying foundations for a healthy life is essential for reasons independent of any preconception health agenda, and there is a need to raise awareness of healthy preparation for pregnancy as a concept from an early age.

Recent recognition of the triple benefit from investment in adolescent health—their health now, their health in the future, and the health of the next generation—has focused attention on this life-course phase.^{37–39} 90% of the world's 1.8 billion adolescents live in low-income and middle-income countries (LMICs); up to half experience

stunted growth and pregnancy is common.⁴⁰ For this group, a key intervention in improving outcomes for mothers and babies is to delay first pregnancy beyond 18 years, when nutrients are no longer needed to support maternal growth.⁴⁰ In high-income countries, adolescents have the poorest diets of any age group.⁴¹ Physiological responses and health behaviours established during adolescence continue into adulthood, and neurological and epigenetic changes in adolescence suggest that it is a crucial period for establishing long-term health risk.^{42,43} Adolescents typically disengage with traditional health messages, prioritising the immediate over the long-term, and having a strong desire for autonomy causes them to reject instructive health education.^{44,45} Effective interventions with adolescents need to empower and encourage by giving, rather than taking away, responsibility.

The LifeLab programme is an example of a school-based intervention, aimed at developing adolescents' motivations for improving their diets and physical activity levels through engagement with science, with an emphasis on their health but with reference to benefits for their future children (appendix).^{46,47} The students report that being good parents in the future is important to them; learning about preconception health motivates

them to improve their diets and physical activity. LifeLab has potential to help children and adolescents develop a concept of preconception and parenthood, but this concept alone might not motivate change because it is not an immediate imperative. Motivation is a necessary but not sufficient condition for behaviour change.⁴⁸ The addition of an in-person intervention to LifeLab would support students' capabilities (ie, "you can do this! I believe in you!"), and opportunities for behaviour change (ie, "how are you going to exercise more and what is your plan for eating healthily?"). Where female participation in formal schooling is low, alternative approaches are needed to ensure engagement of adolescent boys and girls.

In rural South Africa, where there are high rates of adolescent overweight and obesity, the Ntshembo (Hope) intervention⁴⁹ aims to achieve a healthy body-mass index in 14–19 year-olds through a 2-year programme of behaviour change support. Working with adolescents, their carers, and village leaders, Ntshembo is explicitly designed to address individual and community motivations and capabilities, and to provide opportunities for adolescents to eat well and exercise more. It harnesses the power of social influence on adolescent behaviour through peer support, and employs community health workers trained to support problem-solving and capitalise on adolescents' need for autonomy; the development of an adolescent-friendly health service to deliver gender and context-specific interventions is widely supported.⁵⁰ As in LifeLab, the preconception agenda in Ntshembo is largely that of the intervention developers, who will need to engage with adolescents' own imperatives for the intervention to succeed.

Interventions with adults not immediately intending to become pregnant

In this second phase, the goal to become a parent is refined and shaped by the individual's psychological, social, economic, and biological status.^{51–53} As young adults mature, developmental goals such as completing education, obtaining employment, and forming intimate relationships generally take priority over becoming a parent. Consequently, preconception health will have little motivational currency during this phase. Effective methods of engagement at this stage will be highly context-specific.

In some cultures, marriage offers an opportunity to engage couples in thinking about their nutrition and health before conception, particularly in countries where premarital testing aimed at reducing transmission of inherited disorders is mandatory. The Jom Mama project,⁵⁴ supported by the Malaysian Government, uses an existing premarital HIV screening and wellness programme to provide preconception nutrition support to couples, using a combination of an online platform and in-person behaviour change support (appendix). Newly married Malaysian women said that having a

healthy baby in the future was a major motivation for improving their diets and physical activity (panel). However, other life-course goals, such as work, were a barrier to eating well and being active. The effectiveness of this intervention might be constrained by its focus on individual responsibility, and the fact that it does not directly address the challenge of social influences or an obesogenic environment.

The absence of dedicated preconception health care in many countries means interventions to improve preconception nutritional status need to take advantage of routine contact between young adults and health-care professionals.⁵⁵ For example, offering support in reproductive health clinics has the potential to improve the preconception nutritional status of women who might or might not be actively planning pregnancies. This requires health-care professionals to be aware of the importance of preconception nutrition, have the skills to intervene, and see offering nutritional support as part of their job. To help raise awareness, the USA's Centers for Disease Control and Prevention promotes a Reproductive Life Plan⁵⁶ intended to encourage people of child-bearing age to prepare for pregnancy, and maximise the preconception benefit of interactions with health-care professionals.

Training for health-care professionals in skills to support behaviour change is available in the form of Healthy Conversation Skills;⁵⁷ this set of easily acquired, theory-based skills for practitioners is designed to engage and motivate patients and clients during brief consultations. Unlike giving information and advice, the Healthy Conversation Skills training promotes the use of open discovery questions, listening, reflecting, and goal-setting to enable a woman or couple to prepare for pregnancy, and support them in finding their own solutions to challenges. The skills have been used in maternal and child health contexts around the world, and their use is both acceptable and feasible.^{58,59}

Armed with these skills, practice and community nurses, sexual and reproductive health clinic staff, those working in early pregnancy units (who treat women who have miscarried), and staff providing weight management services are all potential agents for delivering appropriate, timely, and culturally sensitive support to improve preconception nutritional status at scale. Extending this skills training to community health workers, with support from local and national policies, has the potential for widespread impact on preconception health; in other contexts this approach can improve health outcomes in a range of public health and primary care settings.^{60,61} An approach such as Healthy Conversation Skills enables health-care professionals to provide care that is responsive to women's personal, social, and cultural environments.⁵⁵

In contexts outside health care, supermarkets represent an unexploited opportunity for promoting preconception nutrition. Supermarkets have an unparalleled reach into communities and expertise in customer engagement. Women do most of the family food shopping, and in

For USA's Centers for Disease Control and Prevention preconception health guidance see <https://www.cdc.gov/preconception/index.html>

Panel: Motivations for engagement in interventions to improve preconception health

In the development of the Jom Mama intervention, 18 couples were interviewed about their motivations to engage with the intervention programme, and to improve their health before conception. Having a healthy pregnancy and a healthy child were clear motives for improving diet and lifestyle:

- “Because I want to conceive as I’ve never conceived before. So getting pregnant will motivate us.” (Respondent 12)
- “I wanted to be healthy for myself and for my child...I think my commitment as a wife and mother is important.” (Respondent 10)

Interviewees suggested that a range of incentives, including financial and personalised support from health-care staff, would sustain their engagement in a programme of diet and lifestyle improvement, as would stories from others at the same stage of life. They also proposed that programme content should be simple, attractive, and specifically targeted to them, and that it should not interfere with their working hours, suggesting that delivery should be on a digital platform, accessible at their convenience.

Participants described features of their lives as young, working people that acted as barriers to improving their diets and physical activity levels in preparation for pregnancy.

- Working patterns: “I usually don’t take breakfast...and then I start work, rest at 12.30 pm, but if I’m too busy I don’t rest until the evenings, sometimes at 6 pm, sometimes until 8, 9 pm only then I go home.” (Respondent 8)
- Eating habits: “Sometimes I have lunch at 12 noon... sometimes at 3 pm...it’s uncertain.” (Respondent 13)
- Exercise: “Not after marriage...can’t make it in the evening. No time.” (Respondent 1)

In the UK, women who had recently had a child attending routine appointments with health visitors were approached and asked whether they would be planning another pregnancy in the following 12 months. Those who indicated they would be interested were invited to participate in a pilot study of the effectiveness of the Smarter Pregnancy intervention and subsequently provide an in-depth interview. 15 women were interviewed and their views of preconception care were sought.

Women felt that just because they had already had a baby did not mean they were aware of what was required for a healthy conception and pregnancy. Because of their involvement in the

interconception study, they accepted that preconception care was important, something they might not have considered before:

- “We’ve not had something like this before and I felt like, at that time when I wanted to get pregnant...you don’t know, even though you’ve had three kids already before. You just forget everything.” (Woman 31, married with three children aged 14 years, 8 years, and 4 years)
- “I know [now] that our body has to be ready before we get pregnant. You need to be prepared. Everything has to be enough. Since then, I know, I start to understand you have to eat enough vitamins to get pregnant.” (Woman 31, married with two children—a baby and a 10-year-old)

When they discussed the implications of their new understanding, women highlighted the importance of improving their health prior to conceiving, with specific focus on improving their diet and being a healthy weight:

- “In terms of...sometimes, you lose track of what is healthy. So that is when I had to relook at my diet in terms of having more vegetables and then taking my folic acid and looking at all of these healthy things.” (Woman 40, previous stillbirth, currently pregnant)

Key sources of information for preconception care were the internet and friends and family. There was a desire for reliable and accredited sources of information to put couples’ minds at ease. What the women said suggests there is a gap in current provision of preconception health information:

- “I think the problem is if people don’t know, they go to Google. And you go to Google, and you get some chat on Mumsnet. And it’s a load of women feeding other women garbage... there’s so much false information out there. But if you don’t know that, you go ‘This is what it means.’ Stuff like this [the intervention material] just keeping people on the straight and narrow is quite helpful.” (Woman 32, one child aged 1 year, recent miscarriage)

There was agreement among women that healthier lifestyles can contribute to healthier pregnancies, a reflection that they had not considered this for their previous pregnancy, and an intention to improve their nutritional status in preparation for the next pregnancy. Therefore, the inter-partum period might be a fruitful time to engage women in preconception health care.

In the UK, women are under the care of the community health visiting services from pregnancy up to 5 years of age of the child.

high-income countries, these choices are made in supermarkets.⁶² The food choices of disadvantaged women are particularly susceptible to the supermarket environment, suggesting that modifications which encourage the purchasing of healthy foods, might have greatest impact on women with poor diets.⁶³ In LMICs, the role of supermarkets as food purveyors is rapidly expanding, although not necessarily in remote and rural areas where increasing the accessibility of nutrient-dense food remains a priority.^{64,65} A model whereby supermarkets

offer preconception nutritional support alongside sales of folic acid and other supplements is one that could be developed in high-income countries and, if successful, translated to LMICs as supermarkets become more widespread.

Interventions with adults intending to become pregnant

In the third phase, the goal to become a parent has been activated through a combination of social (eg, subjective norms), situational (eg, marriage), and biological (eg, age)

factors, and is now actively pursued. This phase is characterised by an increased investment of thought, time, and effort into becoming pregnant. Willingness to engage in interventions increases, and behaviours can range from passive (eg, reduced investment in contraception), to active. With appropriate support, preconception interventions are likely to be translated into behaviour change. Interventions need to allow for swift and discrete implementation, given the sensitive nature of couples' plans for conception, and active promotion through channels such as contraception counselling.

Since this group is likely to be engaged and seeking information, preconception health services in primary care, with a focus on nutrition, could be appropriate. Interventions offered in this setting can improve preconception health behaviours in women who are planning to become pregnant.^{23,66,67} Screening for pregnancy intention, as outlined in the first paper in this Series, would enable practitioners in sexual and reproductive health clinics to offer preconception support, for example, to women attending for removal of implants and intrauterine devices.

Digital interventions (online or smartphone-based) offer privacy and easy access for disadvantaged or disenfranchised groups less likely to engage with more formal services. Smarter Pregnancy is a rare example of a digital intervention designed specifically to support improvements in preconception nutrition and health behaviours, and has had some success with couples who are actively preparing for pregnancy (appendix).^{68,69} Mobile phone interventions to improve maternal and child health in LMICs have delivered tailored information and supported improved infant feeding outcomes.⁷⁰ Combining digital interventions with motivational human interaction increases engagement with, and the effectiveness of, behaviour change interventions.⁷¹ An accessible, population-wide preconception health-care service could be offered to women via a digital intervention, and combined with face-to-face or telephone contact with health-care staff trained in a motivational approach, such as Healthy Conversation Skills.

Interventions with adults intending to become pregnant again

In the fourth phase, the goal to become a parent is reactivated. Preparation for pregnancy is likely to be influenced by couples' previous preconception experiences. Previously uncomplicated pregnancies might decrease receptiveness for preconception input; if their first baby was healthy why would couples change their preparations? However, women and their families have intensive contact with health services and health-care professionals during pregnancy, and are motivated to make dietary changes. Therefore, interventions can support maternal dietary behaviour change and reduce postnatal weight gain.⁷²⁻⁷⁶

In LMICs, interest has focused mainly on maternal underweight and micronutrient deficiencies. Women are willing to take nutritional supplements during pregnancy, with consequent reductions in low birthweight,⁷⁷ however, few studies have focused on supporting change in habitual dietary behaviour, likely because choices tend to be limited in undernourished settings. Exceptions include qualitative studies⁷⁸ that have suggested modifiable dietary behaviours in populations in LMICs. Young, rural Indian women report avoiding specific nutritious foods because of fears they could harm a pregnancy, underat in the belief that this will make delivery easier, consume the least nutritious foods after other family members have eaten because of household hierarchies, and observe women's cultural fasting days (eating predominantly low-nutrient foods).^{79,80} These data provide further evidence for extending initiatives that support wider social and cultural change to include preconception nutritional interventions.

Maternal and child health-care systems offer post-partum or interpartum opportunities for working with women to support dietary behaviour change. Women interviewed following an interpartum intervention at a health visitor clinic in London, UK, had a new awareness that their nutritional status during and between pregnancies had an impact on the baby (panel). In high-income countries, post-partum studies have mainly focused on limiting weight retention among normal or overweight women, and improving glucose tolerance among women with a history of gestational diabetes.^{81,82} Interventions to address both diet and physical activity that include self-monitoring of progress, could be more effective than interventions that focus on only one behaviour or that do not support monitoring of weight.^{83,84} Some studies have successfully used education programmes, or financial incentives, to improve dietary quality by reducing energy intake and increasing fruit, vegetable, and whole grain intake.^{85,86}

Many post-partum randomised studies report low recruitment or retention rates; post-partum mothers report multiple barriers to participation, including little spare time, stress, and sleep deprivation.⁸⁷ Interventions might need to take a supportive approach involving home visits, and provision of foods, child care, and self-monitoring facilities such as weighing scales.⁸⁷ One solution could be to integrate in-person support for interpartum behaviour change with a digital service. Post-partum weight retention is associated with lifetime obesity risk and adverse outcomes in the next pregnancy.⁸⁸ A cluster randomised trial⁸⁹ of an internet-based weight loss programme, coupled with face-to-face support (Fit Moms/Mamás Activas) in low-income women in California, USA, found that women in the intervention group maintained significantly greater weight loss at 12 months than did women who did not receive the intervention (3.2 kg vs 0.9 kg; difference 2.3 kg [95% CI 1.1-3.5]).

Creation of a social movement

A social movement to optimise preconception health, nutritional status, and health behaviours needs to involve the whole population and harness political will and leadership. A social movement in Brazil led to significant improvements in preconception nutrition for women, and virtual eradication of undernutrition and wasting among children younger than 5 years, between 1994 and 2006.^{90,91} The movement involved, first, a national campaign against hunger that raised public awareness of the need to tackle malnutrition, and, second, development of an advocacy coalition with political affinities that created a critical mass of activists, and monitored the government's progress in reducing malnutrition. Eradicating malnutrition became a high-profile social responsibility, prompting strong leadership from central government in addressing food security. Underpinning Brazil's approach was an appreciation that how women feed themselves and their children is not solely an individual responsibility, but involves wider determinants.

Social movements are distinct from social marketing campaigns. The latter would traditionally attempt to improve nutrition and health behaviour through providing information and recommending behaviour change, but could fail to reach the neediest groups and inadvertently widen inequalities.^{92,93} The UK's Change4Life intervention adopted this approach, with little evidence of effectiveness.⁹⁴ Social practice theory provides some insight as to why such campaigns are insufficient; individuals and communities require, not only knowledge, but also resources to enact change, and a purpose or meaning to provide motivation.⁹⁵ A social movement providing these factors might best be founded in socially constructed ideas of human action, and allied to the field of consumer marketing and brand creation.

Consumer marketing recognises that individual behaviour and choices are a function of self-image, and brands must develop an emotional and symbolic connection with consumers, making the brand a form of self-expression.⁹⁶ A campaign using brand development practice would target emotions that are central to an individual's identity. This approach is epitomised in such campaigns as the handwashing with soap social movement, which applied brand marketing practices and an advocacy campaign to address infant mortality under the tag-line Help a Child Reach 5. The media campaign followed the principles of being personally relevant, emotionally engaging, and easy to understand.⁹⁷ The evidence-based rationale for handwashing is given only after the other appeals have been made. The campaign was driven by a multinational company (Unilever), supported by an alliance of public health activists and academics. It has received strong endorsement by the inclusion of handwashing with soap as an indicator in the UN's sustainable development goals, and government policy initiatives to improve washing facilities.

The handwashing movement is an example of mutual benefit for public health and for private sector profit that can come from a joint social purpose. Companies are more likely to do the right thing in a sustainable way if public health benefit is accompanied by commercial gain.⁹⁷

In 2013, Black and colleagues³ declared that "the private sector is an important force in shaping nutrition outcomes and has the potential to do more" to improve maternal and child nutrition. Engaging with the food industry is crucial because of their reach and power to shape consumer behaviour. A major difficulty with applying the mutual benefit approach to improving preconception nutrition and lifestyle through a relationship with the food industry is their history of malpractice in respect to infant feeding,⁹⁸ and their role in generating and sustaining an obesogenic environment. Whether commercial and public health interests can be aligned in the way they have been for handwashing remains to be seen. One attempt is Unilever's campaign to market iron-fortified stock cubes to reduce iron-deficiency anaemia in women in Nigeria.⁹⁹ However, lobbying by some members of the food industry against sugar-sweetened beverage taxes suggests that caution is required to ensure the legitimacy of campaigns and health actions from the food industry. Independent monitoring of food industry activities by academia and the public is crucial to building societal support that will catalyse government and industry actions in respect of preconception health.¹⁰⁰

Marketing principles suggest that a preconception social movement should be emotionally engaging and positively framed, appealing to positive emotions, such as love, as opposed to campaigns that call on personal responsibility or fear. The call to action would target the whole population and would ask people to, for example, support young women or couples to achieve an optimal pre-pregnancy weight, or eat a variety of fruits and vegetables. The challenge is to identify simple actions around which the campaign could be built.

Advocacy coalitions

Political science suggests that a strong advocacy coalition within international, national, and local policy subsystems should be developed to place preconception nutrition firmly on government agendas to incite global policy action.¹⁰¹ International organisations are already engaged in advocacy to promote improved preconception health care. In 2012, WHO coordinated a global consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity, and provided a package of evidence-based interventions, including nutritional interventions.¹⁰² Preconception nutrition was then integrated into a number of transnational organisation initiatives. With the notable exception of the Netherlands, only LMICs have shown political support for the adoption of strategies to address social, environmental, and economic determinants of maternal and child malnutrition.^{90,103} Political debate in the Netherlands was sparked by

For Help a Child Reach 5 see <http://www.lifebuoy.com/article/category/1102088/help-a-child-reach-5>

	Study design	Participants	Estimated completion	Sites
Nutritional Intervention Preconception and During Pregnancy to Maintain Healthy Glucose Metabolism and Offspring Health (NiPPeR study, NCT02509988)	The aim is to assess whether a nutritional drink taken before conception and continuing through pregnancy, assists in the maintenance of healthy glucose metabolism in the mother and promotes offspring health	1800 women	October, 2018	New Zealand, Singapore, and UK
Inter-pregnancy Coaching for a Healthy future (Inter-ACT, NCT02989142)	The intervention targets women with excessive weight gain in their first pregnancy, and attempts to reduce complications in the second pregnancy through an interpartum programme of coaching, combining face-to-face counselling with the use of a mobile application connected to medical devices (scale and pedometer)	1100 women	September, 2020	Belgium
Women First: Preconception Maternal Nutrition (WF, NCT01883193)	Multicountry three-arm, individually randomised, non-masked, controlled trial to ascertain the benefits of ensuring optimal maternal nutrition before conception, and providing an evidence-base for programmatic priority to minimise the risk of malnutrition in females of reproductive age. Women are required to take a lipid-based micronutrient supplement. Run from University of Colorado, Denver, CO, USA	7374 women	October, 2019	Democratic Republic of the Congo, Guatemala, India, and Pakistan
Development of Pre-pregnancy Intervention to Reduce the Risk of Diabetes and Prediabetes (Jom Mama, NCT02617693)	The aim is to assess the efficacy of a pre-pregnancy intervention to reduce the risk of diabetes and prediabetes. A lifestyle intervention combines behaviour change counselling from community health promoters trained to support behaviour change, and utilisation of an eHealth platform providing preconception information and support	660 women	November, 2017	Malaysia
Erasmus MC Care Innovation for a healthy pregnancy (NTR4150)	To test whether use of the Smarter Pregnant intervention (a mobile application comprising an interactive food and lifestyle coaching programme) leads to an improvement in unhealthy food habits (intake of fruits and vegetables, and folic acid use) after 6 months, measured as a decrease in the Food Risk Score of women and men considering pregnancy	3000 men and women	January, 2017*	The Netherlands
Healthy Lifestyles Trajectory Initiative (HeLTI)	Four interlinked preconception nutrition intervention trials planned by a consortium of the Canadian Institute for Health Research, the WHO, the governments of Canada, China, India, and South Africa, and academic partners in each country. These randomised controlled trials aim to test the effect of a package of nutritional and lifestyle interventions before conception on offspring body composition	Not applicable	October, 2017 (start date)	Canada, China, India, and South Africa
The Low Birth Weight in South Asia Trial (LBWSAT) ^{105†}	This cluster randomised controlled trial aims to identify the most cost-effective means of increasing birthweight by comparing birthweight in current programme areas with birthweight in areas where one of three combinations of interventions is conducted: first, a behaviour change strategy involving working with participatory women's groups and other community members, to change pregnant women's eating behaviour and to increase their intake of nutritious food; second and third combine this strategy with provision of a food supplement or a cash payment, respectively. The primary outcome of the trial is birthweight, accurate to 10 g, measured within 72 h of birth	17 000 pregnant women, 13 000 babies	Unknown	Nepal (80 study areas)

*This study has been extended as recruitment was slower than anticipated. †This trial is not a preconception trial, but will have implications for understanding the value of cash transfers and participatory women's groups in improving the nutritional status of women of childbearing age.

Table: Ongoing trials of preconception nutrition interventions

academics drawing attention to high national perinatal mortality rates, especially among poor immigrant communities. The promotion of preconception health to reach the poorest in the Netherlands has since become a priority, and includes addressing social deprivation and broad determinants of maternal ill-health.

Policy change is more likely if advocacy coalitions are developed to focus on a specific policy subsystem and engage multiple participants (ie, government agencies, research institutions, non-government organisations, the media, commercial interests, and influential individuals) to build critical mass.¹⁰¹ Strong leadership, adequate resources, and a coordinated infrastructure are required to ensure advocacy coalitions sustain engagement over the potentially lengthy period of time necessary to achieve high-level, coordinated policy action, particularly in competitive policy subsystems with opposing advocacy coalitions. Initiatives such as sugar taxes or marketing restrictions to curb sugar intake have gained policy traction in some countries following decades of increasing

evidence, advocacy, and public awareness, in spite of strong opposition from food companies.¹⁰⁴ A major advantage of campaigning for better preconception nutrition is that the focus is building stronger mothers and babies and reducing non-communicable disease burden in the next generation; these are uncontroversial messages, easy for the public to engage with emotionally.

Conclusion

A dual strategy targeting women and couples planning a pregnancy, coupled with promoting the health of all women of child-bearing age, could be the most effective approach to improving preconception health. Sparse evidence from robust and context-relevant trials of preconception nutrition and health behaviour interventions, makes it hard to draw firm conclusions about their effectiveness in improving outcomes for mothers and babies on a large scale. Trials of preconception interventions are far fewer than those conducted during pregnancy, because recruitment is more difficult and

outcomes can be assessed only in women who subsequently become pregnant. Fortunately, several such trials are underway (table). Meanwhile, public health strategies to improve nutritional status in children and in adults of reproductive age should be strengthened without delay.

Interventions could be more effective for longer if they use existing delivery platforms within a systems approach. System-wide changes to accommodate preconception health care will need support from a social movement that establishes its importance for the health of the next generation, stresses societal responsibility, and requires strong local, national, and international leadership. The strength of this social movement, and the capacity to deliver effective nutrition and behavioural interventions, could be enhanced through carefully negotiated engagement with commercial interests.

Contributors

MB conceptualised the paper in consultation with all authors and wrote the first draft with substantial inputs from TC, JS-W, GN, SUD, FFS, CHDF, SAN, CV, NMK, WTL, and JS. TC, JS-W, and GN carried out the review and produced the pathways model of intervention effects. The analysis of preconception action phases was developed by SUD and FFS. SAN, RS-T, DP, and KW-T provided data and wrote descriptions of exemplar intervention studies. CHDF wrote the first draft of the section on interventions with adults intending to become pregnant again. Sections on the creation of a social movement and advocacy coalitions were produced by CV and NMK. JS oversaw and advised on all aspects of producing and editing the paper. All authors saw successive drafts of the paper and provided input. MB finalised the paper and is the overall guarantor.

Declaration of interests

We declare no competing interests.

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