

Fertility education: recommendations for developing and implementing tools to improve fertility literacy[†]

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ABSTRACT

Many recent societal trends have led to the need for fertility education, including the age at which individuals become parents, the development of new reproductive technologies, and family diversity. Fertility awareness has emerged as a concept very recently and is increasingly gaining recognition. However, fertility education is often neglected as there is no consensus on the appropriate content, target populations, or on who should provide it. This article attempts to provide an overview of the use of interventions to improve fertility education. We emphasize the importance of delivering evidence-based information on fertility and reproductive health through various methods while providing guidelines for their standardization and systematization. Recommendations are provided to aid the development and implementation of fertility education tools, including: the establishment of a comprehensive understanding of the target populations; the incorporation of theories of behavioural change; the inclusion of the users' perspectives and the use of participatory research; and the use of specific guidelines for increasing engagement. By following these recommendations, it is expected that fertility education resources can contribute to improving fertility literacy, empowering individuals and couples to make informed reproductive decisions, and ultimately reducing the incidence of infertility and need for fertility treatment.

Keywords: reproductive health education / fertility education / fertility awareness / guidelines / good practice / ESHRE

Introduction

Profound sociodemographic changes occurred within the last few decades: gender roles are more fluid, families are more diverse and smaller, and parents are older than previously. Developments in ART have accompanied these changes with increasing possibilities of parenting a child (Inhorn and Birenbaum-Carmeli, 2008), and legislation across different countries is adjusting to these changes. The number of fertility treatment cycles undertaken increases every year around the world (Wyns et al., 2022). While medically assisted reproduction (MAR) accommodates new ways of forming families, the leading cause behind the rise in infertility is the increasing age of parenthood in high income countries (Kuhnt and Passet-Wittig, 2022). The chance of conception is largely (female) age dependent (Raymer et al., 2020), but many individuals and couples feel shocked by a diagnosis of age-related infertility and regret not having been educated about this earlier on (Lee, 2019).

The World Health Organization (WHO) recently recognized the need for fertility education. The term 'fertility awareness' was included in the latest revision of the International Glossary on Infertility and Fertility Care and defined as 'the understanding of reproduction, fecundity, fecundability, and related individual risk factors (e.g. advanced age, sexual health factors such as sexually transmitted infections (STIs), and lifestyle factors such as smoking, obesity) and non-individual risk factors (e.g. environmental and workplace factors); including the awareness of societal and cultural factors affecting options to meet reproductive family planning, as well as family building needs' (Zegers-Hochschild et al., 2017). The need to improve fertility awareness was demonstrated in a systematic review, which revealed that fertility knowledge is in general low to moderate and that neither age nor child wish predict higher levels of fertility awareness (Pedro et al., 2018). There is also strong evidence that individuals overestimate the probability of pregnancy (Ekelin et al., 2012), the

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age at which fertility declines (Delbaere et al., 2020), and the success rates of treatments (Conceição et al., 2017).

Although fertility awareness is essential for making informed reproductive decisions, fertility education is still omitted in reproductive health guidelines (Bakkensen and Goldman, 2021; Practice Committee of the American Society for Reproductive Medicine and Practice Committee of the Society for Reproductive Endocrinology and Infertility, 2022). Furthermore, school sex education programmes focus on how to reduce the risk of STIs and unintended pregnancy (Haberland and Rogow, 2015), but fertility education remains ignored (Harper et al., 2021). Similarly, family planning is mainly directed at contraception and reducing fertility (Cleland et al., 2006; Frayne, 2017), but few preconception health programmes exist (Berglund and Lindmark, 2016). While the need for fertility education and infertility prevention has been emphasized (Bakkensen and Goldman, 2021; Harper et al., 2021), we have yet to implement it.

The International Reproductive Health Education Collaboration (IRHEC), formerly known as the International Fertility Education Initiative (IFEI), adopted as one of its missions to improve reproductive health literacy. Educational resources that effectively increase fertility health literacy or awareness are pivotal to enable informed reproductive decisions, and prevent and manage subfertility and infertility. Still, there is no consensus on the contents of such resources, who they should target or who should provide them (Berglund and Lindmark, 2016; Ojukwu et al., 2016).

Since health education can have many definitions (Liu et al., 2020), it is essential to start by defining fertility education. Adopting the widely accepted WHO definition of health education (World Health Organization, 2020), fertility education is hereby defined as the use of communication strategies and materials to inform and influence decisions and actions to improve fertility literacy or awareness. Fertility education should lead to greater fertility awareness and enable competences to be gradually built into everyday activities, social interactions and across generations (Nutbeam and Muscat, 2021) to inform and facilitate reproductive decision-making. This includes fertility education tools or resources to deliver evidence-based information on fertility and reproductive health effectively. Methods to convey such information may involve traditional forms of communication (e.g. doctor-patient communication in a family planning consultation; lectures in school; brochures at a primary health care centre) and/or digital forms of communication (e.g. website, fertility patient app, video, social media account). The more accessible, understandable, and of practical value for the intended target population, the more effective these tools will be (World Health Organization, 2020).

Digital fertility literacy solutions are of particular interest because they can enable a more active role from the user or patient (Conard, 2019). Digital health literacy is the most significant social determinant of health (Sieck et al., 2021), but most digital health tools are not evidence-based (Jandoo, 2020). More than ever, patients bring their own information to consultations with their doctor, primarily from the Internet (Tan and Goonawardene, 2017). Guiding people to reliable sources of information may reduce the potential damage of inaccurate information, decrease shame in requesting information (Parikh et al., 1996), and lead to better decision-making skills (Conard, 2019).

This article attempts to describe the process of developing fertility education tools, thereby contributing to the effort in standardising and systematizing best-practice guidelines in this field. Recently many noteworthy resources have been developed (for a

detailed list, see www.eshre.eu/IRHEC) based on the fact that infertility may be preventable if potentially modifiable factors, such as lifestyle, are considered. However, estimates show that research results can take up to 17 years until effective implementation by health professionals (Morris et al., 2011). Practice guidelines can bridge this gap (Car et al., 2019) and, for that reason, their publication and implementation are increasing (Rod and Høybye, 2015). It is important to notice that fertility education resources, like any other health education tools, are developed to provide information that enables individuals to make positive behaviour changes that improve reproductive outcomes (Kumar and Preetha, 2012). Conversely, strategies to improve fertility knowledge at a population level usually involve cross-sectoral or cross-government approaches and aim to change policies and patterns of consumption (Kumar and Preetha, 2012) and are out of the scope of this article. We believe that the following recommendations can increase the feasibility and efficacy of implementation of resources designed to increase fertility awareness and/or prevent infertility.

Recommendations for developing and implementing tools to improve fertility literacy

Establish a comprehensive understanding of the target population

Fertility education aims include increasing knowledge about fertility for children and adolescents; promoting informed reproductive decisions for adults (including if and when to have children and whether to undergo fertility preservation); and facilitating decision-making about fertility treatments if facing infertility or if in a same-sex relationship or considering single parenthood. Thus, the goal of fertility education varies depending on stage of reproductive life, and a framework can be adapted accordingly (Fig. 1).

While it was first considered that fertility education interventions should target women intending to have children, we now know that such interventions can induce anxiety (Maeda et al., 2018) as they intensify the societal pressure on women to have children. Based on research that shows that men want children as much as women do and that their understanding of fertility is low (Hammarberg, 2017), contemporary approaches to fertility education also target men. Additionally, fertility education needs to consider those who do not wish to have children to ensure they can avoid unplanned pregnancy. Regardless of the target population, the focus of fertility care interventions should always be on empowering people to make informed decisions, assisting 'individuals and couples to realize their desires associated with reproduction and/or to build a family' (Zegers-Hochschild et al., 2017).

Health and education professionals are also important targets for fertility education. These are indirect recipients and are not depicted in Fig. 1 because interventions must first consider who the patients or users are. They include primary health providers, family planning nurses, gynaecologists and urologists, counselors, and teachers. Interventions for professionals should focus on developing training-specific skills or increasing knowledge regarding communication in a particular age-range or problem.

Understanding the population goes beyond knowing what education people need at the different reproductive life stages and involves a deep understanding of the context in which the intervention will occur. Context is a core element to consider when developing any complex intervention (Skivington et al., 2021).

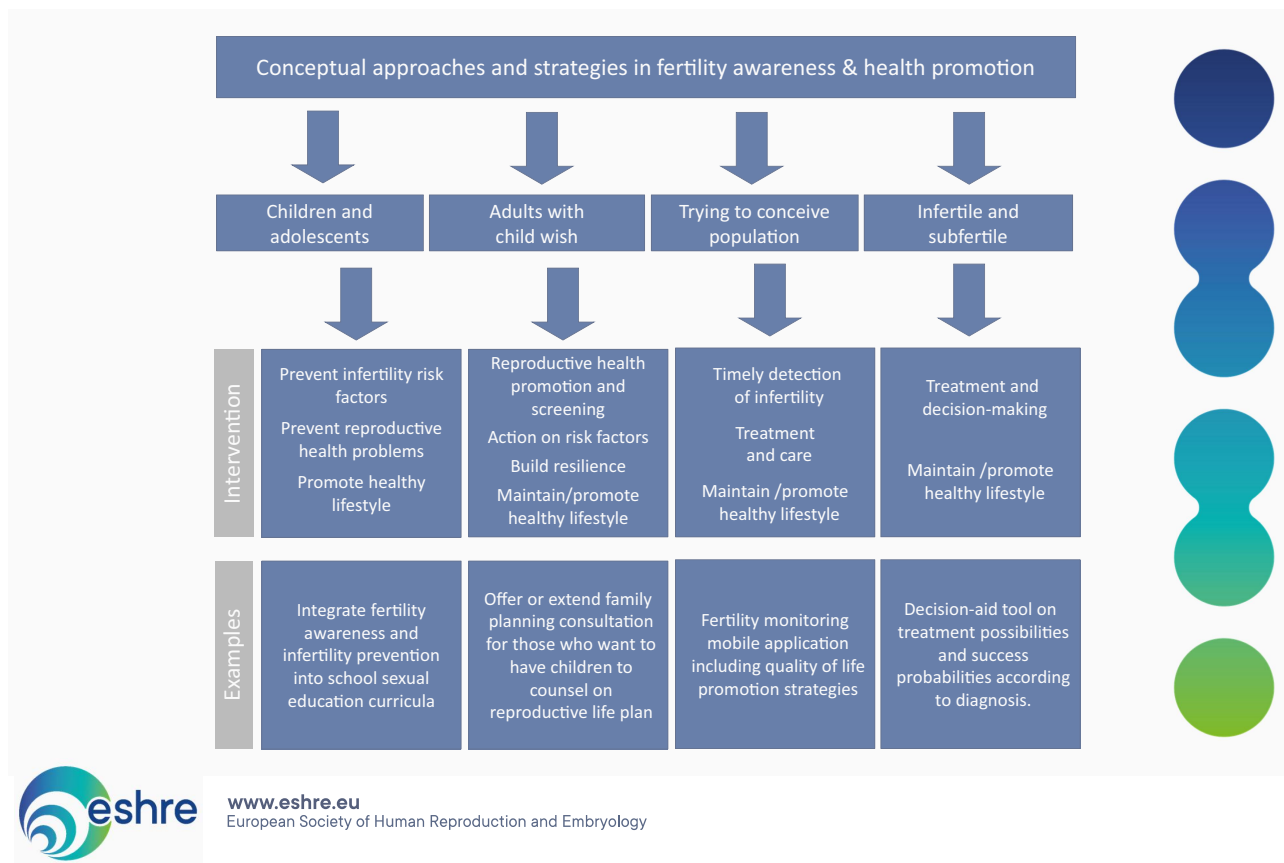


Figure 1. Conceptual framework for fertility education: patient populations and interventions. Adapted from Kumar and Preetha (2012).

Within fertility education, approaches need to be adapted to the context of the target population. For example, a fertility education intervention to increase literacy in reproductive rights needs to consider the legislation in the country or region where it takes place. Likewise, interventions to support medical help-seeking for people with fertility difficulties must consider the options that realistically are available to them.

The type of the educational tool will, of course, depend on population and context. While online training may be suitable for educating specialised nurses on how to talk about fertility education with young adults, a social media resource may be effective in improving adolescents' fertility knowledge directly.

The importance of theories: knowing why the intervention worked (or not)

Theories provide a valuable framework for understanding the complex factors that might influence and/or change individuals' knowledge, attitudes, or behaviours regarding fertility. Only by testing the directional relationships between concepts, i.e. establishing a hypothesis, will a researcher or practitioner know if an intervention is effective in changing what it was intended to change (Moullin et al., 2020). Moreover, theory-driven interventions are known to be more effective than interventions lacking a theoretical basis (Davis et al., 2015), and there is evidence that suboptimal use of frameworks in both research and practice leads to wasted resources, errors in implementation methods and data analyses, and erroneous conclusions (Moullin et al., 2020).

While, to the authors' knowledge, a specific theoretical model postulated for fertility awareness does not exist, there are health behaviour models that can help. Developing a tool to improve fertility awareness can rely on theories or models of health

behaviour, which seek to explain why individuals engage in (or fail to engage in) health-related behaviours (Noar, 2004). In general, the premise of these theories is that an individual's intentions and behaviours will determine their actions (Tarkang and Zotor, 2015). Hence, one can identify the causal factors that determine change in intentions and behaviours. The most common variables assessed are knowledge, attitude, and efficacy (Record et al., 2021).

The choice of health behaviour theory is not always evident and, in most conditions, the literature does not provide clear empirical support for researchers and health educators on the most appropriate model (Noar, 2004). However, several studies have successfully applied health behaviour models to fertility education interventions. Here, we describe three of the most used theories and provide examples from existing fertility education efforts.

• Theory of Planned Behaviour

The Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1977) and its extension, known as the Theory of Planned Behaviour (TPB) (Ajzen, 1991), are widely used in health education (Sharma et al., 2021), and numerous interventions have been developed using these theories (Tyson et al., 2014; Lareyre et al., 2021). In TPB, behaviour is determined by behavioural intention, which is dependent on attitude, subjective norm, and perceived behavioural control. Attitude is defined as favourable or unfavourable feelings towards the behaviour, determined by behavioural belief and outcome evaluations. Subjective norm is determined by normative beliefs (i.e. perceived social pressure from important people) and motivation to comply (i.e. the degree to which a person would like to adopt the behaviour of the important people). Perceived behavioural control is determined by control belief (i.e. beliefs about factors that may affect the performance of the behaviour) and perceived

power (i.e. perception about the difficulties involved in performing the behaviour). TPB is a well-established theory to predict various healthy behaviours (Armitage and Conner, 2001; McEachan et al., 2011).

The TPB has been employed to understand fertility decisions such as childbearing (Ajzen and Klobas, 2013; Li et al., 2019), contraceptive use (Der et al., 2021) and elective egg freezing (Caughey et al., 2021). Using 'freezing eggs' as an example of a behaviour, the *intention* to freeze one's eggs would depend on *attitude* (how favourable or unfavourable the person feels about freezing their eggs), *subjective norms* (e.g. important others will support the person freezing their eggs), and *perceived behavioural control* (e.g. 'Whether or not I freeze my eggs is entirely up to me'). Since these constructs of the TPB were proven to be predictors of intentions to freeze eggs, interventions designed to develop a positive attitude towards egg freezing, gain approval from important others, and increase the perception of personal control would likely increase the uptake of egg freezing (Caughey et al., 2021).

Whereas several TPB-based educational programmes have been developed to improve pregnancy health (Lee et al., 2016; Khani Jeihooni et al., 2021), the use of TPB in fertility education is still limited. Kariman et al. (2020) developed a TPB-based fertility education intervention, which included information about the effects of the decline in population growth on the family and the society, as well as medical facts. They showed positive effects of the intervention on knowledge, attitude, perceived behavioural control, and behavioural intention regarding fertility.

• Social cognitive theory

Social cognitive theory (SCT), developed by Bandura (1986), is one of the most frequently applied theories of health behaviour (Baranowski et al., 2002). SCT has often been called a bridge between behavioural and cognitive learning theories since it focuses on the interaction between internal factors, such as thinking and symbolic processing (e.g. attention, memory, motivation), and external determinants (e.g. rewards and punishments) in determining behaviour. Individuals are viewed as active agents that both influence and are influenced by their environment. SCT may contribute to understanding how individuals develop their life goals, including childbearing and parenthood intentions, and how their behaviour is directed to that goal attainment. It also considers how environmental factors (e.g. social, familial, work, and others) influence their behaviour.

A central tenet of SCT is the concept of self-efficacy, which is an individuals' belief in their capability to perform a behaviour (Bandura, 1977). Self-efficacy is essential for action and regulates motivation and the definition of life goals and will determine how people persist in a specific type of behaviour. The concept of self-efficacy has been widely used in studies focusing on the experience of infertility, mainly as a moderator between internal factors and the impact of fertility treatments (e.g. Khalid and Dawood, 2020, Mirzaasgari et al., 2022). Indeed, when an individual perceives themselves as capable of dealing with a stressful situation, such as infertility, a better emotional adjustment is expected (Cousineau et al., 2006). Less attention has been paid to the role of self-efficacy in fertility awareness and fertility-related behaviour. Packer et al. (2020) have recently studied the role of self-efficacy in childbearing plans, highlighting the importance of developing and implementing SCT-based interventions in fertility awareness and behaviour.

Furthermore, SCTs emphasizes that individuals learn from one another via observation, imitation, and modelling. Even when fertility intentions have not yet been formulated,

automatic and deliberative brain processes that form emotionally laden images of self, family, childbearing, and childrearing can be evoked by a relevant cue in the environment. Intentions, by contrast, are formed through deliberative processes that consciously weigh these emotion-laden images and calculate a desired course of action. Because these calculations are costly for the brain, cognitive theory suggests that they will be formed only when circumstances demand or motivate it, for example when people confront new situations, like marriage. The effects of short-term exposure to fertility-related concepts, such as career aspirations (mainly for women), may vary with more durable, but still environmentally conditioned, aspects of social identity such as religiosity (Marshall and Shepherd, 2018).

To our knowledge, to date no SCT-based fertility education interventions have been implemented or evaluated. Paradoxically, SCT is the theory most frequently used in interventions to promote contraceptive use, often in conjunction with another model of behaviour change (Lopez et al., 2009).

• Health Belief Model

The Health Belief Model (HBM) (Rosenstock, 1974) is a psychological theory of health behaviour change that posits that individuals are more likely to change their health behaviour if they feel they are personally susceptible to a health risk, that the health risk is severe and if they believe there are more benefits than barriers to engage in the behaviour or preventative behaviour (Michie et al., 2017). According to this model, cues to action trigger behaviour change.

In fertility awareness, the HBM helps us understand that individuals need to feel susceptible to fertility problems/infertility to change their behaviour/engage in preventative action (e.g. starting to try to become pregnant, freezing their eggs, etc.). There must be a benefit to taking action and changing their behaviour (e.g. being able to have children in the future). As such, through an HBM lens, to be most effective, fertility awareness interventions should target individuals' sense of susceptibility to the risk of fertility problems along with the benefits and barriers of postponing childbearing (Glanz et al., 2015). Such interventions can include risk assessment and personalized advice.

One example is The Fertility Assessment and Counselling Clinic in Denmark (FAC; Hvidman et al., 2015), that includes an individualised assessment of one's risk of fertility problems. Researchers from the FAC clinic have used the HBM to explain the mechanisms of attending FAC clinic in that it serves as a 'cue to action' wherein women and men make choices such as pursuing fertility treatment or ending a relationship with a partner who is not ready to have children after attending the FAC clinic (Sylvest et al., 2018; Koert et al., 2020). Another example is described below with partnered women who want children.

Choosing and applying a theory for effective behavioural change in fertility education

These three theoretical models, as with many other health behaviour theories, are based on the premise that an individual weighs the potential risks and benefits of changing a behaviour, considers how others will respond, and calculates the likelihood of success of that change (Ryan et al., 2014). The choice of which model to apply depends on the target population (see point 1). For example, adolescents hardly perceive themselves as susceptible to infertility, as has been largely demonstrated before with STIs (Samkange-Zeeb et al., 2011). However, the fear of being unable to conceive is an essential motivator for adults with a child wish. Hence, interventions with adolescents could be based on

SCT, and interventions for people with a child wish can formulate hypotheses informed by the TPB.

The choice of theoretical model also depends on formulating the 'why' and 'how' questions and answers (Noar, 2004). For example, the 'why' question could be 'Why do partnered women who want to have children delay motherhood when the risk of not achieving a live birth increases with age?'. If we take the HBM as rationale, the answer would include the following: they perceive themselves as not susceptible to infertility; they consider that the consequences of not achieving a live birth through spontaneous conception can be easily overcome (e.g. willingness to undergoing fertility treatment, adopting a child/children, or choosing to stay childless); they believe that trying to conceive earlier does not increase the probability of pregnancy; they believe that the benefits of conceiving earlier do not outweigh the advantages of delaying motherhood; they do not have triggers around them to motivate action (e.g. partner or peer pressure); and they do not believe they have enough self-efficacy to take action. Pedro et al. (2021) tested these hypotheses in a sample of partnered women. They observed that those who perceived themselves as at risk of being infertile were more willing to anticipate childbearing than those who did not perceive themselves at risk. Still, this willingness depended on perceiving infertility as a significant threat and the willingness to undergo MAR treatments. This study suggests that interventions with this population should target these mediators and include information about infertility and fertility treatments. The 'how' question for this problem could be 'How can a fertility education programme prevent infertility in partnered women who want to have children?'. Formulating this question will allow us to identify the relationships between targeted constructs and the behavioural outcome, and identify the analyses needed to test if the interventions lead to change (Teixeira et al., 2020).

It is worth mentioning that adaptations or complementary models can be used to develop a fertility education tool, and even merging two theories that suit the population and the 'why' and 'how' questions can be appropriate for prevention (Noar, 2004). As mentioned above, health behaviour theories focus on personal attitudes and beliefs as inherent to individual behaviour change. One of the main critiques directed at these theories is that they do not consider cultural appropriateness (Tan and Cho, 2019) or environmental conditions (Noar, 2004).

Incorporating users' perspective: the importance of participatory research

Besides individual factors, the social, economic, cultural, historical, and political variables of a particular setting affect how individuals of a given generation perceive their fertility or reproductive health. Hence, a needs assessment must be conducted before developing any intervention or programme. Having the input from the target population is vital to better understand self-efficacy, triggers, and motivation (Noar, 2004). The benefits of involving the target population as co-creators of knowledge have been acknowledged for some years (Wittink and Oosterhaven, 2018).

In the case of fertility education, this means trying to involve people with different lived experiences including those who are not currently planning pregnancy but who might want children in the future, those who have previously faced or currently face fertility problems, and people who know that they will need fertility treatment to conceive, such as same-sex couples. It may also be useful to involve caregivers or primary attachment figures. For example, it has been demonstrated that sexual health interventions in schools that include the training of parents and

peer facilitators are more effective than those who target students only (Poobalan et al., 2009). This might be useful for interventions trying to include fertility education and infertility prevention in sexual education curricula. Or, when considering an intervention to decrease decision uncertainty in potential donors, it might be advantageous to consult not only previous donors but also their spouses and children. Previous calls have been made for giving preference to eliciting qualitative or participatory research rather than sitting representatives of all groups in panel meetings in the case of children and adolescents (Larsson et al., 2018). This advice obviously applies to children of donors, but researchers should also consider separating groups by treatment outcome.

When recruiting co-creators, considering diversity is important to ensure the views of people of different ethnicities and socioeconomic backgrounds are represented. Some populations are recognised as understudied including men (Martins et al., 2016), single mothers by choice (Volgsten and Schmidt, 2021), and the and lesbian, gay, bisexual, transgender, intersex, queer/questioning (LGBTQ+) population (Kirubarajan et al., 2021). The gap in sexual health education for LGBTQ+ people is particularly evident and is increasingly documented (Keuroghlian et al., 2017), and a recent call has been made for inclusiveness in fertility education to reach greater equity of care (Mertes et al., 2023).

Involving end users (a small sample of people that meet all eligibility criteria of the target population) in the development of educational resources not only adds valuable insights to the content, design, and understandability but also helps to set priorities on the main questions and interactions with the public (Movsisyan et al., 2020). Hence, incorporating the users' perspectives means that several rounds of 'pretesting' may be needed before a resource is ready to be launched. With the tool designed and at an alpha version, researchers can incorporate additions and recommendations for improvement from end users and ask for feedback on comprehension, attractiveness, acceptance, believability, motivation, and preliminary indications of effectiveness (Movsisyan et al., 2020). Experimental research designs can be used to execute these tasks, such as in-depth or semi-structured interviews, focus groups, and intercept surveys.

Besides representatives from the target population, it is essential that other stakeholders and implementers are consulted (Moore et al., 2019; O' Cathain et al., 2019) including health and education professionals who will be using the educational resource in their interactions with the target populations (Vaisson et al., 2021). Iterative consultation cycles are warranted to ensure that multiple perspectives are sought, and publications or reports should describe how feedback from stakeholders was incorporated (Skivington et al., 2021).

Reconsidering an example of the previous section, a needs assessment with partnered women with a child wish might reveal that participants need to increase their susceptibility to infertility and want to be informed, but that this information should be preferably transmitted through the interactions they have with reproductive health professionals, and that direct information should be given preferably at an earlier age. Trusted sources of information include gynaecologists, general practitioners and nurses in family planning (Khurana and Bleakley, 2015). The consultation with primary health care practitioners could, for example, reveal that in that particular region women in their early thirties regularly attend a family planning consult every year. Consequently, the focus of the intervention would shift from a direct information delivery to a randomised controlled trial where partnered women with a child wish at a primary health

care centre/hospital would be randomized to receive evidence-based information on fertility and infertility from their family planning consultation doctors, personalizing information according to the desire for childbearing and the planned timing. In comparison with the ones who would follow the regular routine (control group), we would expect women in the intervention group to be more informed, use better strategies for trying to conceive with increased chances of spontaneous conception, and know when to seek specialized help with more timely referral to a fertility specialist.

Use of guidelines for increasing engagement

While content is the most important part of any tool, how it is presented is crucial for effective engagement. After gathering a comprehensive understanding of the target population, selecting an appropriate theoretical framework that supports the establishment of hypotheses, and involving co-creators in the development of the resource, the team should have a good understanding of what will constitute effective engagement from the target audience. However, identifying the characteristics that enhance clarity and aid the communication of messages and materials to the public is of utmost importance. Several peer-reviewed guidelines exist that can help make resources as effective as possible. These evidence-based recommendations can be general to all interventions and specific to the chosen tool. An example of helpful guidelines is the Centers for Disease Control and Prevention (CDC) Clear Communication Index (Baur and Prue, 2014), which contains a list of evidence-based criteria for developing health information, including content, language and design. Another valuable checklist if the content is digital is the Health Literacy Online Strategies Checklist (Office of Disease Prevention and Health Promotion, 2016), with similar points, including the importance of using positive communication. Several governmental institutions have also produced recommendations that can be followed, such as the Office of Disease Prevention and Health Promotion (Hou, 2012) on writing and designing websites or the National Institutes of Health (National Institutes of Health, 2015) on how to make communication clear.

Regardless of the chosen way to deliver information, literacy is a factor to consider when developing a fertility education tool and should be evaluated before public release. Highly literate individuals can apply their skills both in situations that require content knowledge and new content (Nutbeam et al., 2018) and are more likely to use social media platforms as a source of health-related information than people with low literacy (Kim and Xie, 2017). This discrepancy might be explained by the fact that the readability level of online health information exceeds the recommended sixth-grade level (Kim and Xie, 2017). Even when we incorporate the users' perspective in the development stage and consider diversity, social desirability and agreement, bias must be considered in participatory design (Arcia et al., 2016). This is because volunteers are often biased by familiarity with the health issue and culture (Ospina-Pinillos et al., 2018), and recruitment is frequently carried out through patient associations. These biases may lead to an overestimation of users' literacy levels. Hence, assessing readability, and understanding and testing the tool on people with limited literacy skills is essential to ensure that the content is accessible and easy to understand and can prevent dropout or attrition rates.

Literacy can be evaluated both for printed and digital materials. The Suitability of Assessment Materials scale (Doak et al., 1996) assesses both readability and comprehension of printed materials, including dimensions such as content (e.g., purpose and scope), literacy demand (e.g. reading level), graphics

(e.g. relevance of illustrations), layout and typography (e.g. sub-headings use), learning, stimulation and motivation (e.g. self-efficacy), and cultural appropriateness (e.g. cultural images). It is the most cited method for assessing the accessibility of patient materials beyond reading level (Ryan et al., 2014). When considering an online tool, the eHealth Literacy Scale (Norman and Skinner, 2006) is the most used screening tool to measure knowledge, comfort, and perceived skills at finding, evaluating, and applying e-health information to health problems (Kim and Xie, 2017), providing important clues on users' comfort and skill in using information technology for health information.

Other factors, besides absence of bias and readability, found to be relevant before launching a health education tool are accessibility, usefulness, comprehensiveness, credibility, and interactivity (Kim and Xie, 2017). These components are essential to all target populations. Interactive tools, for example, were found to be more effective than static contents not only in adolescents but also in older adults, and people with low socio-economic status (Kim and Xie, 2017), and medical health professionals (Car et al., 2019).

Design is also a very important aspect of educational resources and often neglected because researchers are unfamiliar with it. There are existing guidelines that consider how learning is facilitated, and engagement can be boosted through illustrations and charts, target audience familiarity with characters when using videos, and the speed of audio. The US Department of Health and Human Services web design and usability guidelines include strength of evidence for each recommendation (U.S. Department of Health and Human Services & U.S. General Services Administration, 2006). If the educational resource consists mainly of videos (for example, when producing a national campaign), it is worth using specific video guidelines (e.g. Brame, 2016). When considering developing a decision aid for people facing fertility treatment and its options, the research team should use the quality criteria from the International Patient Decision Aid Standards (IPDAS, Elwyn et al., 2006; Volk et al., 2013).

The design of a resource will influence engagement with it. In the context of fertility education, engagement refers to a desire and capability to actively participate by interacting with the designed resource or tool to optimise reproductive decision-making. It is the responsibility of the research team to devise educational resources that motivates users to take action (Hou, 2012). Engagement is critical in individual digital change behaviour interventions, where attrition is high, almost half of the material provided is not accessed, and interventions are evaluated by participants as too time-demanding (Car et al., 2019). Testing a beta version or pilot testing of any resource will help reduce these risks. When conducting a pilot study, both quantitative and qualitative research can make significant contributions and have different advantages (Creswell, 2015), and in most cases, the use of mixed methods will maximise the benefits. Having participants test the resource will show that engagement goes far beyond their ability to use technology, which often does not correlate with behaviour change (Michie et al., 2017). Pilot results will help establish the minimum engagement required for the desired change in behaviour for a particular educational resource, as it has been shown that change points vary according to intervention types (Michie et al., 2017).

Conclusion

The need for developing and deploying fertility education has emerged in this century as profound changes in the transition to

parenthood and family configurations have occurred. This paper provides guidance for developing educational tools to increase fertility awareness and literacy, and facilitate decision-making by individuals. Key messages include:

- Ensure that all the fertility information is based on up-to-date and robust evidence.
- Be cognizant of cultural and societal factors that influence reproductive decision-making, including societal pressure and legislation.
- Focus on empowering individuals to make informed decisions rather than solely increasing knowledge.
- Health and education professionals must be trained in effective communication of messages to target populations.
- Educational tools should be tailored to the target population and context (e.g. online training for specialists and social media resources for adolescents).
- Theory-based interventions are more effective in promoting behavioural change than interventions lacking a theoretical underpinning.
- The choice of a theory to guide the development of a resource depends on the target population and the 'why' and 'how' questions the intervention addresses.
- Incorporating the perspectives of the target population will provide valuable insights into self-efficacy, triggers, and motivation. Involving users in multiple rounds of pretesting and feedback can help refine the tool's content, design, and effectiveness.
- Recruitment of end-users as co-creators should consider racial, ethnic, and socioeconomic disparities to ensure inclusiveness and equity. Understudied populations such as men, single mothers by choice, and the LGBTQ+ population should be included in the development of generic or specific interventions to address existing gaps in fertility knowledge and education.
- Consultation with stakeholders and implementers, including health and education professionals, is essential to incorporate multiple perspectives and ensure the acceptability and feasibility of the intervention.
- Consideration of literacy levels can ensure accessibility for all users.
- Accessibility, usefulness, comprehensiveness, credibility, interactivity, and design are relevant to the efficacy of a fertility education tool. Interactive and visually engaging tools are more effective than static tools, regardless of the targeted population.

Data availability

No new data were generated or analysed in support of this article.

Authors' roles

M.V.M., E.K., R.S., and E.M. designed the study. M.V.M. drafted most part of the manuscript, with contributions from E.K., R.S., M.M.-R., E.M., K.H., and J.H. All authors made significant contributions critically revising the manuscript and approved the final version for submission.

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Conflict of interest

J.H. has received consultancy fees from Gedeon Richter, Haleon, and Natural Cycles. J.H. has also received payment for talks and travel support from Bayer, Merck, Gedeon Richter and Cook IVF. J.H. also receives author royalties for the book 'Your Fertile Years'. The other authors have no conflicts of interest to declare.

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