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Review Article

Effectiveness of digital health in improving pregnancy quality among preconception women: A systematic review

Nurleli Nurleli[1,2*], Veni Hadju[3], Rahayu Indriasari[3], Intan S. Areni[4], Masni Masni[5], and Shanti Riskyani[6]

[1]Doctoral Program in Public Health Sciences, Faculty of Public Health, Universitas Hasanuddin, Makassar, Indonesia; [2]Public Health Study Program, Faculty of Public Health, Sekolah Tinggi Ilmu Kesehatan Makassar, Makassar, Indonesia; [3]Department of Nutrition, Faculty of Public Health, Universitas Hasanuddin, Makassar, Indonesia; [4]Department of Electrical Engineering, Faculty of Engineering, Universitas Hasanuddin, Makassar, Indonesia; [5]Department of Biostatistics, Faculty of Public Health, Universitas Hasanuddin, Makassar, Indonesia; [6]Department of Health Promotion and Behavioral Sciences, Faculty of Public Health, Universitas Hasanuddin, Makassar, Indonesia

*Corresponding author: nurleli.stikma98@gmail.com

Abstract

Improving nutrition in women prior to conception represents an alternative approach to enhancing the quality of pregnancy. Increased knowledge and self-efficacy among preconception women positively impact changes in health behavior. The rapid development of technology provides an opportunity to implement innovative interventions, including digital health. The aim of this study was to systematically review the efficacy of digital health interventions in modifying the behavior of preconception women. The data were obtained by searching relevant articles published from 2015 to 2023 in electronic databases, including Google Scholar, Science Direct, Web of Science (WoS), Biomed Central, and PubMed. The following keywords were used: "digital health" OR "mobile health" OR "e-health" AND "preconception women" OR "pre-marriage women." Of the 266 studies identified in the search phase, only those that met the inclusion criteria were included in the review. These criteria included 10 articles that assessed the effectiveness of digital health interventions on the behavior change of preconception women. The articles included in this study originated from diverse countries and addressed various digital health interventions. The findings of the review indicated that ten articles reported an increase in pregnant women's knowledge, nine articles demonstrated an enhancement in self-efficacy, and nine articles documented behavioral changes. The behavioral changes observed included the initiation of folic acid consumption before pregnancy, an increase in vegetable and fruit consumption, and a reduction in unhealthy dietary behaviors, such as maintaining a normal weight, smoking cessation, and reduced alcohol consumption. In conclusion, digital health literacy interventions, delivered via web-based platforms or mobile applications, demonstrate effectiveness in promoting positive preconception health behaviors among women, ultimately contributing to improved pregnancy outcomes.

Keywords: Digital health, preconception women, pregnancy health, women's health, pregnant women

Introduction

Women's health and nutritional status before and during pregnancy are increasingly identified as important determinants of the next generation's health. There is growing evidence emphasizing the need for effective interventions to improve nutrition and reduce other

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modifiable risk factors in women planning pregnancy, particularly during the preconception period [1-3]. This period is critical as it significantly impacts fetal organ development [4]. Research has highlighted that the health of a baby at birth is heavily influenced by the nutritional status of women of childbearing age or pre-pregnancy women three to six months before conception [5]. Achieving optimal nutrition during the preconception period is therefore essential for ensuring normal and healthy fetal development [6,7].

One major consequence of inadequate nutrition during the preconception period is stunting. Studies have shown that chronic energy deficiency (CED) in women before pregnancy and limited nutrition knowledge significantly contribute to the risk of stunting [8-10]. Addressing these issues through targeted interventions could improve maternal and child health outcomes. Strategies to improve the nutritional status of preconception women aim to prepare prospective mothers for healthy pregnancies and contribute to the achievement of healthier families and higher-quality offspring. Research evidence underscored the positive impact of nutritional improvements on pregnancy outcomes. For instance, Dhaded *et al.* reported significant benefits of starting nutritional supplementation more than three months before conception [5]. Similarly, Nguyen et al. found a relationship between maternal preconception nutritional status and child growth patterns at 6–7 years of age [3].

The rapid advancement of communication and information technology offers new opportunities to address health challenges, including promoting health messages to the public. Among these advancements, smartphone technology has transformed how people access information and interact with digital platforms, including digital health tools [11-13]. Studies conducted by the Pew Research Center (2018–2021) revealed that mobile devices are the most accessed media by women, highlighting their potential as an effective medium for health promotion [14]. Digital health interventions, such as smartphone-based applications, can serve as innovative tools to enhance knowledge, improve self-efficacy, and encourage behavior change [15, 16]. For instance, research exploring self-efficacy in preconception care found that women's self-efficacy was positively linked to their perceived benefits and expectations of preconception care [17-20]. This makes self-efficacy a crucial determinant for promoting healthy behaviors and improving the success of preconception care [17,21-23].

Despite their potential, digital health applications face several implementation challenges, such as network coverage, internet access, electricity availability, smartphone ownership, and cultural considerations [14,17]. Furthermore, while many digital health applications have emerged to support preconception care, there remains a gap in understanding their effectiveness in influencing behavior change among preconception women. Therefore, the aim of this study was to evaluate the effectiveness of digital health interventions in promoting behavior change among preconception women and to identify areas that need further development to maximize their impact.

Methods

Information sources and search strategy

A systematic selection process was conducted following PRISMA guidelines. A comprehensive literature search was performed across Google Scholar, ScienceDirect, Web of Science (WoS), BioMed Central, and PubMed to identify relevant studies on digital health in preconception care. The search strategy focused on articles published in open access. The keywords used in the literature search were selected based on relevant terminology in the field of digital health and preconception care. The search strategy included free-text keywords such as “digital health" OR "mobile health" OR "e-health" AND "preconception women" OR "pre-marriage women” to ensure broad coverage of the available literature.

Eligibility criteria

The inclusion criteria focused on studies examining digital health interventions targeted at preconception women and employing an experimental study design while excluding protocols. A total of 10 articles were selected based on these criteria. To ensure the information remains current, the search was limited to literature published within the last five years from the search date (2020-2024).

Study risk of bias assessments

The quality assessment of all included studies was evaluated using the Mixed Methods Appraisal Tool (MMAT) [24]. This appraisal tool consists of two screening questions for all types of studies and five quality assessment questions [24]. The review process begins with the use of screening questions to review the suitable studies potentially assessed using the MMAT. Then, all the reviewed studies were assessed using the five quality assessment questions based on the appropriate category for each study.

Data extraction and collection process

The screening process was conducted in three stages. First, duplicate records were removed. Second, two independent reviewers screened the titles and abstracts of the remaining articles to exclude those that did not meet the eligibility criteria, such as non-research items (e.g., books, conference papers, annual reports) or articles lacking relevant keywords. Third, full-text articles of potentially eligible studies were assessed based on predefined inclusion and exclusion criteria. Articles were excluded if they were review studies or did not specifically focus on preconception care for women. The screening and selection process was conducted by two authors (NN and VH). Any discrepancies in study selection were resolved through discussion, and if consensus could not be reached, the third author (RI) was consulted to make the final decision.

Synthesis method

The data were synthesized and narratively due to variations in study designs, interventions, and outcomes. Key themes were categorized into types of mHealth (apps, text-based programs, and web platforms), study characteristics (design, subject, intervention), main results (knowledge, behavior, self-efficacy, and nutrition), and targeted outcomes (adherence, health literacy, and behavioral changes), and features and contents provided. Quantitative results, such as changes in health behaviors or self-efficacy, were summarized descriptively, while qualitative findings on user experiences were integrated to complement these results. Comparative analysis highlighted differences in intervention effectiveness by geography, type, and study design, with data cross-checked by two reviewers (NN and VH) to ensure accuracy.

Results

Study selection

The PRISMA flowchart in **Figure 1** outlines the systematic selection process for a study on digital health in preconception care. The screening process began with 266 articles from databases such as Google Scholar, ScienceDirect, Web of Science (WoS), BioMed Central, and PubMed. After removing 69 duplicates, 197 remained. Further screening excluded 33 articles lacking relevant keywords or being non-research publications. Among the 164 remaining, 141 were excluded due to missing keywords, irrelevant focus, or population mismatch, leaving 23 articles on digital health in preconception care. Finally, 13 more articles were excluded (2 reviews, 11 not specific to preconception women), resulting in 10 articles meeting the critical appraisal criteria.

Risk of bias assessment

A quality assessment of the included studies based on key methodological criteria is presented in **Table 1**. The evaluation consists of two screening criteria and five quality indicators, assessing aspects such as research clarity, data relevance, sampling strategy, measurement appropriateness, bias risk, and statistical analysis. While all studies demonstrated clarity in their research questions and relevance in their data collection, variations were observed in other criteria. Notably, several studies did not meet the criterion for sample representation or had a higher risk of non-responsive bias, potentially affecting the reliability of their findings. Despite these variations, most studies achieved high total scores, with the lowest at 71.4% and the highest at 85.7%, leading to their overall classification as high-quality studies. This assessment highlights the strengths of the included research while also identifying areas where methodological rigor could be improved in future studies.

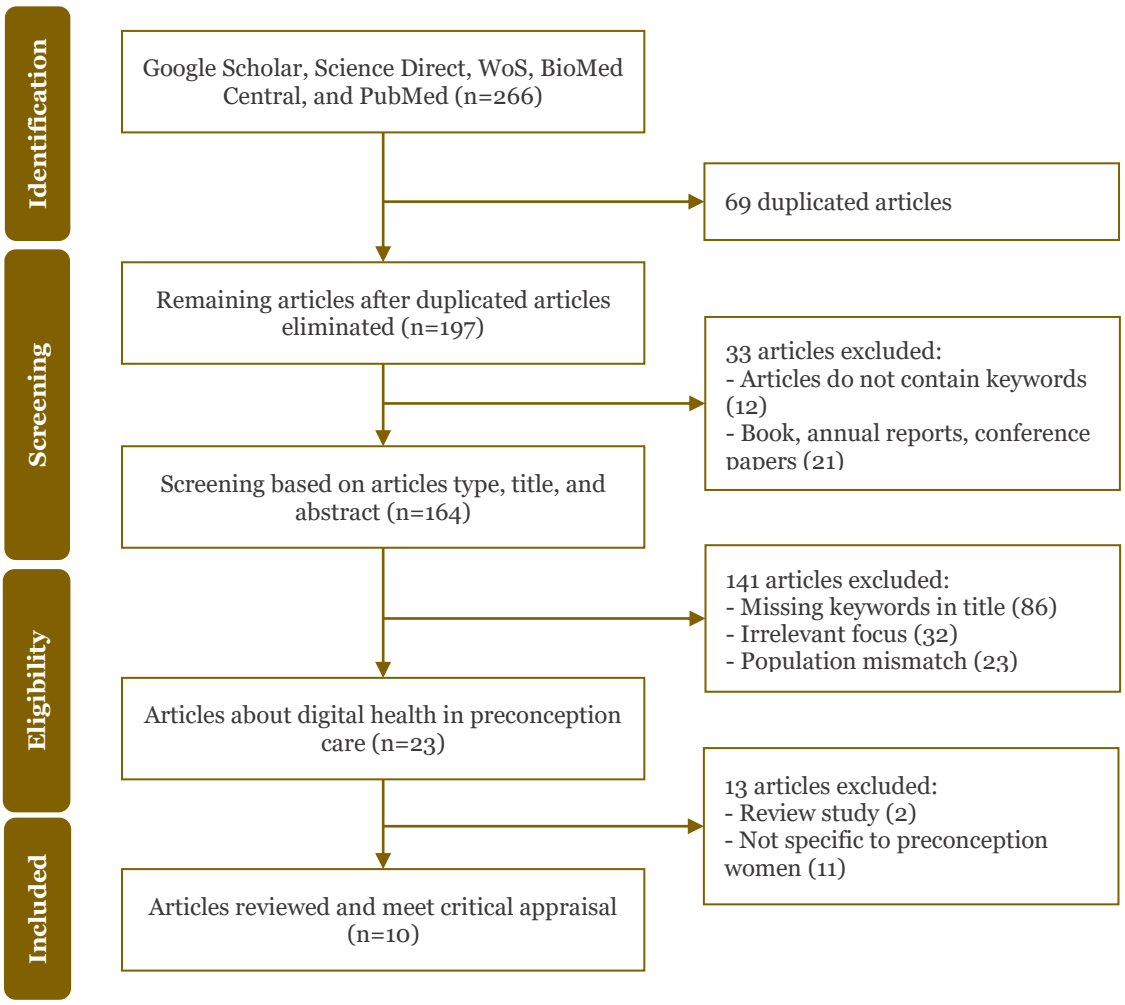

Figure 1. PRISMA flowchart for the article screening process.

General characteristics of the included study

This study reviewed a total of ten studies (nine randomized controlled trials [RCTs] and one pretest-post-test) that explored how digital health interventions impacted the health of pre-conception women, as detailed in **Table 2**. These interventions included programs for pregnancy management (Smarter Pregnancy), delivering information (Gabby System chatbots), combining online and in-person support (eFUSE), promoting lifestyle changes (HeLTI), mobile health websites (RLPC), maternal health support (Jom Mama), and general chatbots. Delivery methods used SMS, educational website animations, and chatbot conversations; the detailed features and content of the digital health platform are shown in **Table 3**.

Features and targeted outcomes

This review found that the content and features offered by the Smarter Pregnancy application meets the needs of preconception women and contribute to increased knowledge, self-efficacy, and behavior changes that promote a healthy pregnancy. The application offered a screening questionnaire for the couple's nutrition and lifestyle (containing date of birth, consumption of folic acid, vitamin D, and pregnancy status), an educational video about nutritional needs and a healthy lifestyle in preparation for pregnancy, a guide lifestyle (maternal physical activity), pregnancy guide, information about the Smarter Pregnancy application itself, information for professionals regarding user's nutritional behavior and lifestyle, and questions and answers [31, 34]. For a conversation with Gabby (animated conversation agent), the available content and features are menstrual cycle monitoring, ovulation prediction, fertility tips, reproductive health information, custom questions and answers (acting as artificial intelligence-AI), education about pregnancy care, and emotional support [27-30,35].

Table 1. Quality assessment of included articles

Articles	Screening 1	Screening 2	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Total score (%)	Category
	Clarity of research questions	Data address research questions	Relevance of sampling strategy to addressing the research question	Representation of the sample to the population	Appropriateness of measurement	Low risk of non-responsive bias	Appropriateness of statistical analysis		
van Dijk (2020) [25]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Oostingh (2020) [26]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
van Der Windt (2020) [27]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Jack (2020) [28]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Gardiner (2021) [29]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Soepnel (2022) [10]	Yes	Yes	Yes	Yes	No	No	Yes	71.4	High
Bickmore (2020) [30]	Yes	Yes	Yes	No	Yes	No	Yes	71.4	High
Hojeij (2023) [31]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Skogsdal (2019) [32]	Yes	Yes	Yes	Yes	Yes	No	Yes	85.7	High
Hanafiah (2022) [33]	Yes	Yes	Yes	No	Yes	No	Yes	71.4	High

Table 2. Description of the included articles related to the effectiveness of digital health on behavior change

Authors (year), country	Program/Type of mHealth	Study characteristics	Results	Targeted outcomes
van Dijk *et al*. (2020) [25], The Netherlands	Smarter Pregnancy (Web-based application) (https://www.slimmerzwanger.nl)	Design: RCT Subject: Women aged 18–45 years who are planning a pregnancy or already pregnant (<13 weeks gestation) intervention (n=128), control (n=126) Duration of intervention: 24 weeks for intervention and 36 weeks for follow-up questionnaire	The smarter pregnancy app trial showed a reduction in women's dietary risk score (DRS) in the intervention group compared to the control group and demonstrated lifestyle change effects, especially high adherence and greater improvement in nutritional behaviors such as vegetable intake	Increasing knowledge, self-efficacy, and as a reminder
Oostingh *et al*. (2020) [26], The Netherlands	Smarter Pregnancy in English (Web-based application) (https://www.slimmerzwanger.nl)	Design: RCT Subject: Women aged between 18–45 who are undergoing IVF/ICSI program and some husbands, with the Intervention group (n=414) and Control group (n=434) Duration of intervention: 24 weeks	The Smarter Pregnancy program significantly improved nutrition and lifestyle behaviors in couples undergoing IVF/ICSI treatment	Increasing knowledge and as a reminder
van der Windt *et al*. (2020) [27], The Netherlands	Combination of counseling services "Healthy Pregnancy" and Smarter Pregnancy platform (https://www.smarterpregnancy.co.uk)	Design: one group pretest- posttest design Subject: Married couples who are planning a pregnancy or are already pregnant with a gestational age <12 months, with women (n=450) and men (n=61). Duration of intervention: 6 months	Following the six-month intervention, participants performed a series of positive lifestyle changes, including increased consumption of vegetables, fruit, and folic acid, and a reduction in tobacco and alcohol intake	Increasing knowledge and as a reminder
Jack *et al*. (2020) [28], USA	Gabby (animated conversation agent via two-way counselor)	Design: RCT Subject: Black and African-American women aged 18–34 years who were not pregnant. Intervention group (n=262) and control group (n=266)	The results of the interaction with Gabby may facilitate the advancement of preconception care to the action or maintenance stage of the transtheoretical model, as compared to the control group.	Increasing knowledge and self-efficacy

Authors (year), country	Program/Type of mHealth	Study characteristics	Results	Targeted outcomes
		Duration of intervention: 12 months, each interaction for 2 hours	This change was maintained at the 12-month follow-up	
Gardiner *et al.* (2021) [29], USA	Gabby (animated conversation agent via two-way counselor)	Design: RCT Subject: 480 black women aged 18–34 Intervention group (n=240), control (n=240) Duration of intervention: 6 months	After six months, women who used Gabby demonstrated improvement on the nutrition and supplement risk change scale compared to those in the control group. Additionally, they reached the action and maintenance stages of nutrition and supplement risk change compared to those in the control group	Increasing knowledge, self-efficacy, and as a reminder
Soepnel, *et al.* (2022) [10], South Africa	Healthy Life Trajectories Initiative (HeLTI; HeLTI)	Design: RCT Subject: Preconception women (n=240) Intervention group (n=120), control (n=120) Duration of Intervention: 6 months	The text message intervention was found to be acceptable and had perceived benefits, including supplement intake reminders, gaining knowledge, and feeling supported	Increasing knowledge and self-efficacy
Bickmore *et al.* (2020) [30], USA	Gabby (animated conversation agent via two-way counselor)	Design: RCT Subject: Adolescent and young adult women aged 18–34 years (n=528) Intervention group (n=262), control (n=266) Duration of intervention: 12 months	Interactions with agent conversations on PCC-related topics were acceptable, with many who used the system frequently during the 12 months of the intervention found to report high levels of trust in the agents and satisfaction with the intervention and reported that they followed (or would follow) Gabby's recommendations	Increasing knowledge and self-efficacy
Hojeij *et al.* (2023) [31], The Netherlands	Smarter Pregnancy (https://www.slimmerzwanger.nl)	Design: RCT Subject: Women of childbearing age aged at least 18 years and planning to become pregnant (n=1691). All participants were classified into 3 groups based on Smarter Pregnancy coaching and mode of conception: (1) the ART intervention group; (2) the ART control group, and (3) the natural conception intervention group. Intervention group (n=749), control (n=311) Natural Intervention group (631) Duration of Intervention: 24 Weeks	The intervention group demonstrated higher levels of attitudes and practices related to vegetable intake and exhibited lower levels of negative attitudes toward vegetable intake than the control group and the natural conception group. However, there was no statistical difference between the intervention and control groups on changes in attitudes and actions related to fruit consumption	Increasing knowledge and self-efficacy
Skogsdal *et al.* (2019) [32], Sweden	Friendly website mobile (https://www.reproduktivlivsplan.se)	Design: RCT Subject: Women of childbearing age aged 20-40 years, Intervention group (n=592) and control group (n=606). Duration of intervention: ±14 months	The intervention group demonstrated an increase in knowledge and awareness (self-efficacy) regarding the factors influencing preconception health	Increasing knowledge and self-efficacy
Hanafiah *et al.* 20220 [33], Malaysia	Jom Mama	Design: RCT	There was no significant difference in the change in waist circumference between	Increasing knowledge and self-efficacy

Authors (year), country	Program/Type of mHealth	Study characteristics	Results	Targeted outcomes
		Subject: Preconception women aged 20–39 years (n=305). Intervention group (n=145), control (n=160) Duration of Intervention: 33 weeks	the intervention and control groups of women. Regarding BMI, the obese intervention subgroup decreased slightly	

Note: IVF/ICSI, in-vitro fertilization/intracytoplasmic sperm injection; RCT, randomized control trial; BMI, body mass index; PCC, preconception care; ART, assisted reproductive technology

Table 3. Features and content of the digital health application

No	Features and Content	van Dijk (2020) [25]	Oostingh (2020) [26]	van Der Windt (2020) [27]	Jack (2020) [28]	Gardiner (2021) [29]	Soepnel (2022) [10]	Bickmore (2020) [30]	Hojeij (2023) [31]	Skogsdal (2019) [32]	Hanafiah (2022) [33]
1	Screening questionnaire	✓	✓	✓	✓	✓	NA	✓	✓	✓	✓
2	Lifestyle guidelines (physical activity, diet, stress management, etc.)	✓	✓	✓	✓	✓	NA	✓	✓	✓	✓
3	Pregnancy guidelines	✓	✓	✓	NA	NA	NA	✓	✓	✓	NA
4	Q&A/consultation	✓	✓	✓	✓	✓	✓	✓	✓	✓	NA
5	Educational video	NA	✓	✓	NA	NA	NA	NA	✓	NA	NA
6	Menstrual cycle/ovulation monitoring	✓	✓	✓	✓	✓	NA	✓	NA	✓	NA
7	Pregnancy planning	✓	✓	✓	✓	✓	NA	✓	NA	✓	NA
8	Pregnancy monitoring/fetal development	NA	NA	NA	✓	✓	NA	✓	NA	NA	NA
9	Information for health workers about the user's condition	✓	✓	✓	NA	NA	NA	NA	✓	NA	NA
10	Health literacy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Professional help hotline	NA	NA	NA	NA	NA	✓	NA	NA	✓	NA

NA: not applied; Q&A: question and answer

The mobile-friendly website (www.reproduktivlivsplan.se) has content and features including a reproductive life plan (desire to have children or not), information about fertilization (explanation of egg cells, sperm cells, ovulation, menstrual cycle), information about fertility and health (age, health and environment, diet and exercise, alcohol, tobacco and drugs, diet and exercise, sexual transmitted infections (STIs), help getting pregnant, and pregnancy protection), fertility knowledge test, professional (medical) help, and seven language selection [32]. The HeLTI application is in the form of text messages containing health literacy, compliance with supplement consumption, and reporting side effects [10]. The Jom Mama application includes improving healthy diet practices, increasing physical activity, reducing sedentary activity, and increasing social support to reduce stress and waist circumference [33].

Desired and missing features

In terms of desired digital health features for preconception women's health, several studies showed that users like applications that offer advanced features such as data monitoring and tracking or the ability to synchronize data across various devices, as well as suggestions regarding behavior changes, and emotional support [25,26,28]. Users in several studies also suggested improvements to the content or application features that will improve their overall experience. Users prefer applications that are easy to use, have an attractive appearance, and take up less memory space.

Various digital health tools targeting preconception women's health were identified. However, several important content areas and features that could optimize preconception care and support healthy pregnancy preparation are missing from the reviewed applications. These missing features include information on age, number of children, pregnancy spacing, nutritional status, ideal health conditions (such as hemoglobin-Hb levels and leukocyte activity), and the absence of diseases that may impact pregnancy outcomes. Additional content should cover unplanned pregnancies, health conditions that need to be watched out for (anemia, STIs, malnutrition, hypertension, diabetes mellitus, obesity, human immunodeficiency virus-HIV/acquired immunodeficiency syndrome-AIDS, reproductive tract infections, infertility, and other diseases that can interfere with fertility and birth outcomes like malaria, Hepatitis B, Toxoplasmosis, Other infections such as syphilis, varicella-zoster, and parvovirus B19, Rubella, Cytomegalovirus, and Herpes simplex virus-TORCH, Thalassemia, Hemophilia), recording of Hb levels, leucocyte integral activity, waist circumference, and supplement consumption routines. Information related to stunting and recording the types of food consumed daily would also be beneficial [9,36-41].

Discussion

Adequate nutrition in the preconception period has significant implications for the health of the mother and newborn [3,4,42]. Maternal nutrition and health status at the time of conception are important determinants of embryo and fetal growth, and emerging evidence suggested that a mother's diet and lifestyle influence the long-term health of her baby [3,4]. Nutritional status is influenced by many variables, including access to healthy food options and dietary supplements (e.g., folic acid), income, community environment, lifestyle habits such as smoking and participating in physical activity, and the presence of physiological stress [3,4,42]. A healthy lifestyle helps optimizing an individual's well-being and health outcomes throughout their life course. Previous studies have shown that following a healthy lifestyle is associated with improved quality of life and life expectancy [10,25,27-33,43].

The importance of effective interventions in improving nutrition and reducing other risk factors can be modified in women who are planning pregnancy, especially in the preconception period [1,3]. Most adverse reproductive and pregnancy outcomes originate during this period. However, the underutilization of preconception services means that the prevalence of these modifiable risk factors remains very high in the reproductive-age population [18]. Knowledge of women of childbearing age combined with self-efficacy supports more significant behavioral changes compared to those without self-efficacy [18,19,23]. The findings of this review article showed that digital-based interventions have a positive impact on increasing knowledge, self-efficacy, and behavior change in preconception women. However, the distrust or lack of

awareness and culture that has developed over time has contributed to gaps in the utilization of health services and public communication between service providers [10,26-33].

This systematic review included eleven studies that met the eligibility criteria, offering valuable insights into the role of digital health interventions in preconception care. Digital health interventions in preconception care focus on promoting health and education by enhancing knowledge, attitudes, and self-efficacy among women planning for pregnancy. These interventions assess various factors, including user compliance, adherence to application recommendations, acceptance, feasibility, and overall effectiveness. [10,25,27-30]. In addition, the application also evaluates reproductive outcomes, maternal pregnancy, and birth in sub-fertile couples and obese women undergoing IVF programs [26].

The digital health interventions not only included health education and health promotion, but also provided behavior change communication delivered through counseling, notifications, and reminders for consultations, medication adherence, or follow-up services [27-30,35]. Participants' test results and clinical notes can be monitored via the application, this is also a motivation for participants because they can see changes and provide decision support for participants. Interventions given between 6 months and 1 year have been proven to increase participants' knowledge [10,25,27-30]. Several studies state that digital health-based nutrition education interventions provide positive results in increasing knowledge, attitudes, and intentions to optimize preconception behavior [31,33,43].

The review also found that the use of digital health showed an increase in knowledge, attitudes, self-efficacy, nutritional behavior, and lifestyle in women of childbearing age. Increasing the self-efficacy of women of childbearing age as a result of the counseling and education provided during the intervention period had a positive impact on behavior change so that participants became confident and confident that they could lead a healthy lifestyle. In addition, it was reported that the results of interventions in several digital health programs such as Smart Pregnancy and the Gabby application with specific targets for women undergoing IVF found that there was an increase in self-efficacy after following the intervention in the form of training and counseling which gave them the confidence and confidence to make lifestyle changes [10,25-30,32].

In terms of behavior change, digital health such as Smart Pregnancy, RLPC, Gabby, chatbots, and text messaging are considered suitable for lifestyle change interventions selected by fertility experts because these programs provide support for changing lifestyle factors deemed most relevant to preconception care [25,27-31]. Behavioral changes found in this review include healthy lifestyle changes such as starting to consume folic acid before pregnancy and increasing consumption of vegetables and fruit. A decrease in the risk value of an unhealthy diet also occurs, such as normalizing body weight and stopping smoking and alcohol consumption, thereby increasing fertility and the chance of having children [10,25-30,32]. This review also explained the use of the application that showed high satisfaction by the participants because it is easy to use and effective [26]. Validated lifestyle interventions may contribute to the reduction of pregnancy complications, including fetal growth restriction, gestational diabetes, hypertensive complications, and preterm birth. The Smarter Pregnancy app intervention demonstrated published clinical data on fetal growth restriction, where there was a 2.6% reduction in the occurrence of fetal growth restriction per couple. High compliance and greater improvements in nutritional behavior, especially vegetable intake, in women in the intervention group emphasize the effectiveness of empowering women using digital health-based lifestyle change interventions [25-27].

The strengths of this systematic review lie in its rigorous methodology, including a comprehensive literature search, well-defined inclusion criteria, and a structured quality assessment process. The review synthesized evidence from multiple studies evaluating digital health interventions for lifestyle modification during the preconception period, providing a broad perspective on their effectiveness. Furthermore, most of the included studies utilized randomized controlled trial designs, enhancing the reliability of the findings. The risk of bias assessment results also indicated that the included studies met critical appraisal standards, strengthening the validity of the conclusions drawn in this review. The selection process was carefully designed to ensure that only relevant and high-quality studies were included. Given the diverse study designs

and intervention types, a thematic synthesis approach was employed, which allowed for a more comprehensive and flexible analysis of digital health interventions in preconception care.

Despite the strengths, one of the limitations of this systematic review is the reliance on a simple Boolean string search to identify eligible studies, rather than using a more structured approach such as the PICO framework (Population, Intervention, Comparison, Outcome). While the Boolean search allowed for a broader range of studies to be included, this approach may have reduced the precision of the selection process and potentially led to the inclusion of less relevant studies. Future research could benefit from adopting the PICO framework to ensure a more focused and comprehensive selection of studies. Additionally, the review did not conduct a meta-analysis, which could have provided stronger evidence regarding the effectiveness of digital health interventions. Another limitation is the potential exclusion of gray literature and non-English studies, which may have impacted the comprehensiveness of the findings.

Conclusion

Optimizing health in the preconception period is crucial for improving reproductive outcomes and the future health of parents and offspring. This review emphasizes the potential of digital lifestyle interventions to increase knowledge, self-efficacy, and behavior changes in women planning pregnancy. Despite existing research on preconception interventions, most focus on micronutrients, weight management, or specific health conditions, with few studies on comprehensive nutrition interventions to prevent stunting and improve pregnancy outcomes. Additionally, there is a limited exploration of motivational factors influencing behavior change. A major challenge is the lack of self-efficacy and preconception nutrition awareness among women. Culturally appropriate mobile applications with clear, accessible language are essential for reaching diverse populations and addressing different educational levels.

Ethics approval

Not required.

Acknowledgments

None.

Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

This study used artificial intelligence (AI) tools (ChatGPT) in the capacities of language refinement (improving grammar, sentence structure, and readability of the manuscript). We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

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