Internet-Based Interventions for Preventing Premature Birth in Preconceptional Women of Childbearing Age: A Systematic Review

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Abstract

Background: Preconception health is essential for preventing premature birth, yet engagement in preconception care remains low. Despite the development of several internet-based interventions post-COVID-19, a thorough evaluation of their effectiveness in enhancing preconception care and preventing premature births is necessary.

Objective: This systematic review aims to assess the study designs and evaluate the effectiveness of internet-based interventions in preventing premature birth among preconceptional women of childbearing age.

Methods: We conducted a comprehensive search of MEDLINE, Embase, CINAHL, and Cochrane Library databases to identify randomized trials and quasi-experimental studies on internet-based interventions for preventing premature birth. The search was global and included studies published up to December 2023, without language or geographic restrictions. Two authors independently assessed the risk of bias using the revised Cochrane RoB tool (RoB 2), adhering to PRISMA guidelines. A meta-analysis was not conducted due to heterogeneity in populations, measurements, and interventions.

Results: Eleven articles were included, with varying study approaches. The overall risk of bias was high in most studies. Interventions improved knowledge of reproductive health but had no significant effect on self-efficacy related to preconception health promotion. While some behavioral changes to reduce preconception care risks were effectively promoted, impacts on folic acid use, contraception initiation, and dual method use were inconsistent. Furthermore, there were no significant reductions in sexually transmitted infections or unplanned pregnancies.

Conclusions: Internet-based interventions showed mixed effectiveness across different reproductive health outcomes, with general ineffectiveness in improving reproductive health status. The results, derived from a limited number of studies with a high risk of bias, suggest a need for caution in their application. Future research, including robust clinical trials, is vital to develop, evaluate, and disseminate effective and safe internet-based interventions for preconception care. Clinical Trial: PROSPERO CRD42021277024; https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021277024

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Original Manuscript

Review

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Trial Registration: PROSPERO CRD42021277024; https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021277024

Keywords

contraception; health promotion; high-risk behavior; internet-based interventions; preconception; preconception care; premature birth; reproductive health; self-efficacy; systematic review

Introduction

Background

Premature birth, defined as birth before 37 weeks of gestation, is a significant public health concern globally [1]. It poses significant health risks for both mothers and infants, including long-term health complications and increased healthcare costs [2]. Despite advancements in prenatal care, premature birth rates remain high, and socioeconomic disparities exacerbate these risks [3]. Preconceptional health is pivotal in determining pregnancy outcomes, underscoring the importance of targeted interventions before conception [4].

Historically, efforts to reduce premature birth rates have primarily focused on enhancing prenatal care and addressing modifiable risk factors [5]. Preconception care, however, not only promotes reproductive planning but also interventions aimed at minimizing risks, enabling women to start their pregnancies in optimal health and improving the chances of delivering a healthy newborn [6]. Extensive research indicates that addressing preconception risks can significantly improve maternal health and help prevent premature births [7,8]. However, traditional approaches often struggle to engage preconceptional women of childbearing age (PWCA), limiting their effectiveness [9].

Internet-based interventions have emerged as a promising approach, offering accessible, tailored information and support that meets the individual needs of PWCA [10]. Prior studies highlight the preconception period as an optimal time for mitigating unhealthy lifestyle behaviors, thereby enhancing health knowledge [11-13], promoting behavioral changes such as reducing risk factors like alcohol and smoking, increasing folate intake, and encouraging physical activity [11,12]. These interventions also focus on enhancing contraceptive use [13], updating vaccinations [12], and ultimately improving pregnancy outcomes [6,11,12]. However, the evidence from these reviews is generally weak due to the low quality of the literature, necessitating caution in interpretation [11-13]. Moreover, systematic reviews specifically examining internet-based interventions for PWCA, especially for preventing preterm births, are limited. Post-COVID-19, there has been an uptick in the development of such interventions in various countries including the United States [14,15], France [16], Australia [17], and the Republic of Korea [18]. Therefore, this systematic review seeks to bridge this knowledge gap by synthesizing available evidence and assessing the impact of internet-based interventions on preventing preterm birth in PWCA.

Objectives

We conducted a systematic review of randomized controlled trials (RCTs) and quasi-experimental studies focusing on internet-based interventions aimed at preventing premature births among PWCA. The objectives of this review were to: (1) describe the general characteristics of the studies included; (2) identify the study designs used in internet-based interventions pertinent to premature birth prevention; and (3) evaluate the effectiveness of internet-based interventions in achieving outcomes related to premature birth prevention among the target population.

Methods

Design

This systematic review was reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [19] and was registered in PROSPERO (CRD42021277024). Our review focused on 2 specific research questions formulated using the Population, Intervention, Comparison, and Outcome (PICO) framework: (1) What is the efficacy of internet-based interventions in reducing the risk of premature birth among PWCA compared to standard care?; and (2) How do internet-based interventions affect women's health promotion and health outcomes to decrease the risk of premature birth among the target population? These questions were designed to assess the effectiveness of internet-based interventions in improving critical maternal health outcomes associated with prevention of premature births. Our comprehensive search strategy targeted key electronic databases, including MEDLINE, Embase, CINAHL, and the Cochrane Library, covering studies published up to December 2023. Additionally, we manually reviewed the reference lists of all included publications to ensure a thorough investigation of relevant literature.

Eligibility Criteria

Our inclusion criteria encompassed published RCTs, quasi-experimental studies, and experimental studies with comparators focused on the prevention of premature birth. We imposed no restrictions regarding the country or language of publication. The target population included all women before pregnancy. Only internet-based interventions that utilized various digital platforms, including computers and mobile phones, were included. There were no exclusion criteria for this review.

Search Strategy

The search terms adapted for each database included a combination of terms related to population (eg, "women"), preconception (eg, "premature birth" and "prepregnancy"), information

and communication technology (eg, “computer”), treatment (eg, “internet” and “online”), and study design (eg, “randomized controlled trial”). These terms were used to search titles, abstracts, keywords, or text words. The exact search terms are detailed in Multimedia Appendix 1.

Selection and Data Collection Processes

The initial step involved importing all identified studies into a reference manager to eliminate duplicates. Subsequently, two reviewers independently screened the titles and abstracts. Following this preliminary screening, relevant studies underwent a comprehensive full-text review. Any disagreements during this phase were resolved through discussion or consultation with a third reviewer to ensure consensus on study inclusion. Studies deemed irrelevant after the full-text review were excluded from further consideration. Concurrently, the reviewers collaboratively developed and pretested a data extraction form to systematically gather review characteristics and outcome data from the selected studies. The data extraction process was also independently conducted by two reviewers. In instances of discrepancies in the extracted data, the reviewers engaged in discussions to reach a consensus or consulted the third reviewer for an objective resolution.

Data Extraction

The extracted data comprised study characteristics (eg, authors, year, country of origin, research design, and sample size), study results (eg. primary and secondary findings for outcome measures, including effect sizes), and intervention details (eg, name, method, duration, and group type). Due to the variation in methodologies across studies, conducting a meta-analysis was deemed inappropriate. Instead, information was synthesized narratively, categorizing outcomes into reproductive health perception, reproductive health behaviors, and reproductive health status. Effect sizes were calculated using means and standard deviations (SDs) or frequencies and percentages depending on the study design.

Risk of Bias (RoB) Assessment

Two reviewers independently evaluated the methodological quality using the revised Cochrane RoB tool for randomized trials [20]. This tool assesses 5 domains: randomization process, deviation from intended interventions, missing outcome data, outcome measurement, and reported result selection grouped into 3 levels of RoB (low risk, some concern, and high risk). Studies were classified into 2 groups: intention-to-treat (ITT) and per-protocol (PP), with any disagreements resolved through discussion or consultation among the reviewers or with a third party.

Statistical Analysis

Owing to the heterogeneity in interventions and participant characteristics, we chose to

conduct a narrative synthesis rather than a meta-analysis. When available, effect sizes were calculated using data from the studies, employing various metrics such as Cohen *f*, Cohen *h*, odds ratio (*P* value and 95% CI), rate ratio (*P* value and 95% CI), and relative risk (*P* value and 95% CI) [21]. Of the 11 papers reviewed, one (9%) did not provide statistical data sufficient to calculate the effect size of the intervention for only some variables, not all. We attempted to contact the author of this paper to obtain additional information, particularly about one of the study's results. Despite multiple inquiries, we received no response, which prevented us from calculating effect sizes for this study. Consequently, effect sizes were calculated for 11 articles. In cases where additional data from the original authors were not acquired, our evaluations relied solely on the information provided within the study itself.

Results

Overview

Initially, a total of 3172 articles were retrieved from the four databases in February 2023. After removing 303 duplicates and 541 ineligible articles, 2328 remained. During the initial screening stage, 2312 papers were excluded after reviewing the study title and abstract. The full texts of the remaining 16 studies were then reviewed, and five of these were excluded; four were not controlled comparative experimental studies but consisted of 1-group pre- and postintervention comparison study, one 1-group cohort study, one agreement test between two methods of data collection, and one study on associative factors of intervention; and one study was excluded because it was not a web-based intervention but a teleconference intervention. In a subsequent search conducted in March 2024, 265 studies were retrieved from four databases in 2023. After excluding 24 duplicates and 74 ineligible articles, 167 remained. During the initial screening stage, 166 papers were excluded after reviewing the titles and abstracts. The full texts of the remaining two studies were reviewed and subsequently excluded: one was not a web-based intervention but rather a live TV channel, and the other was an ineligible intervention, specifically an app predicting pregnancy likelihood. Finally, 11 studies were selected for the systematic review. Figure 1 illustrates the study selection process.

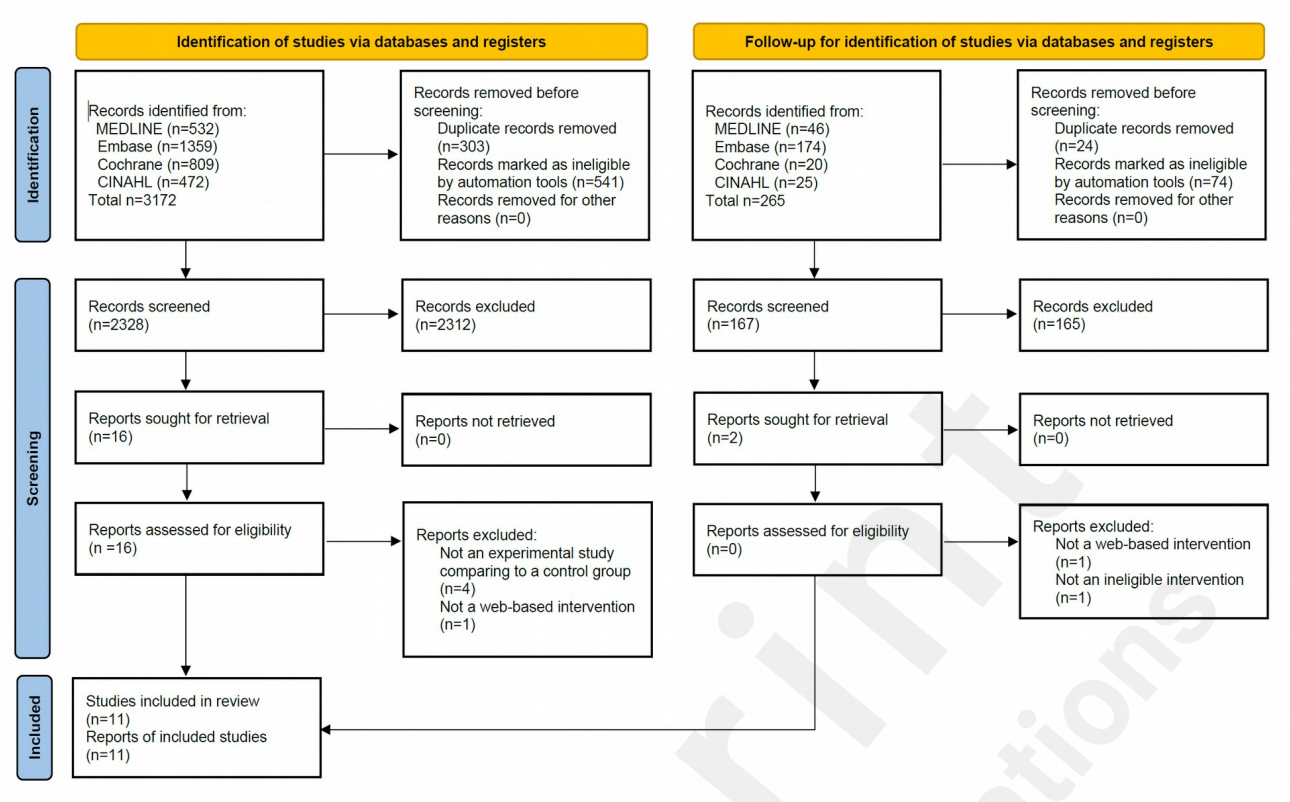

Figure 1. PRISMA diagram showing the selection of included studies.

Quality of the Studies and RoB Assessment

In the subset of studies that used ITT analysis, the overall RoB was classified as low in 40% (2/5) of the studies. There were some concerns regarding bias in 20% (1/5) of the studies, and a high RoB was found in 40% (2/5) of the studies. Among the studies that used PP analysis, none (0/6) were assessed as having a low RoB; only 17% (1/6) of the studies had some concerns, while a high RoB was identified in 83% (5/6) of the studies. The detailed outcomes of the RoB assessment for the 5 ITT and 6 PP studies are illustrated in Figure 2.

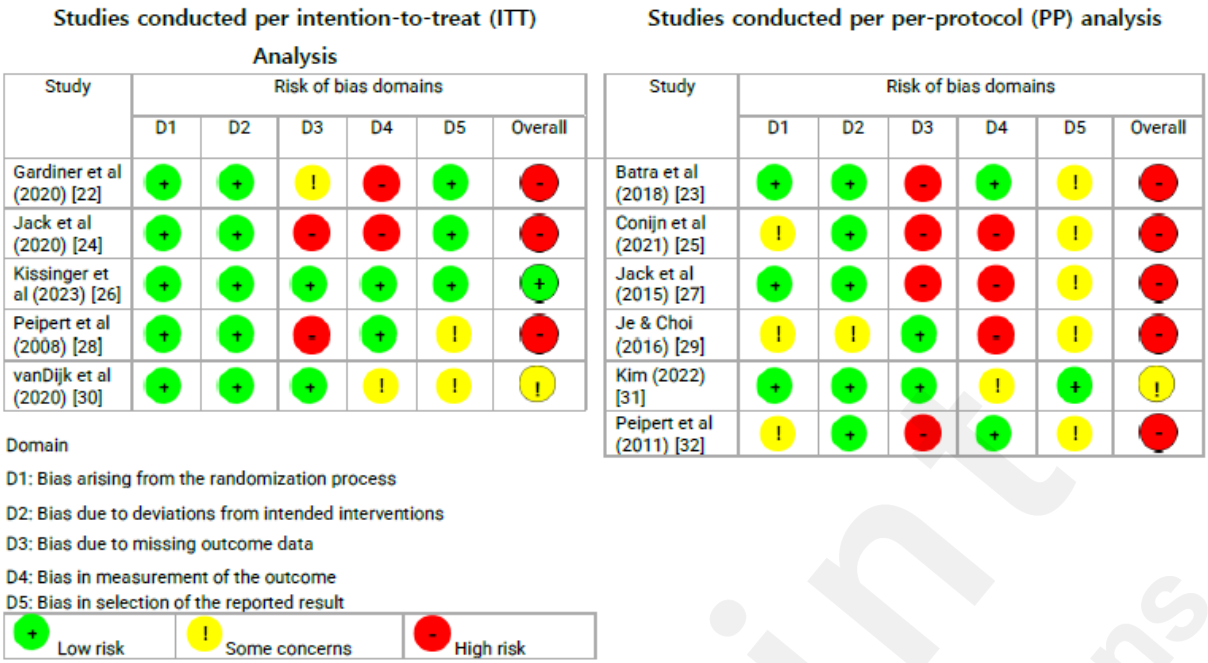

Figure 2. Risk-of-bias (RoB) assessment using the revised Cochrane RoB tool for randomized trials.

Study Characteristics

The 11 studies included in this review were conducted across three countries. The majority were from the United States (7/11, 64% studies [22-24,26-28,32]), followed by the Netherlands (2/11, 18% studies [25,30]), South Korea (2/11, 18% studies [29,31]). The publication years spanned from 2008 to 2022. Most of the studies (6/11, 55%) [22,24-26,30,31] were published from 2020 to the time of the review, 36% (4/11) [23,27,29,32] were published between 2010 and 2020, and 9% (1/11) [28] was published before 2010. Among these, one study was published in Korean [29] and the remaining studies were all written in English.

Regarding research design, 82% (9/11) of the studies employed a randomized controlled experimental design [22-24,26-28,30-32], while 18% (2/11) used a quasi-experimental design [25,29]. Of 11 studies, two [22,32] were secondary analysis studies, and the rest were primary studies. The theoretical frameworks varied: 46% (5/11) utilized the Transtheoretical Model of Health Behavior Change [22,24,27,28,32], 18% (2/11) applied the Health Belief Model [25,29], and 9% (1/11) each employed the Theory of Reasoned Action [23], the Behavior Change Model [30], and Social Cognitive Theory combined with Gender and Power Theory [26]. Additionally, 9% (1/11) of the studies did not specify a theoretical framework [31].

The focus of these studies varied: 36% (4/11) targeted nonpregnant women [23-25,27], 27% (3/11) focused on couples where the female partner was prepregnant and <13 weeks pregnant or pre-married [25,29,30], 9% (1/11) targeted women of childbearing age [31], 18% (2/11) focused on

sexually active women with a male partner [28,32], and 9% (1/11) specifically addressed Black teenaged women [26]. Detailed information on these studies is provided in Tables 1 and 2.

Table 1. Overview of the general characteristics of the studies (N=11).

Characteristics and category	Values, n (%)
Country	
The Netherlands [25,30]	2 (18)
South Korea [29,31]	2 (18)
United States [22-24,26-28,32]	7 (64)
Publication year	
<2010 [28]	1 (9)
2010 -<2020 [23,27,29,32]	4 (36)
≥2020 [22,24-26,30,31]	6 (55)
Publication language	
English [22-28,30-32]	10 (91)
Korean [29]	1 (9)
Research design	
RCT[a] [22-24,26-28,30-32]	9 (82)
Quasi-experimental trial [25,29]	2 (18)
Primary and secondary analysis	
Primary analysis study [23-31]	9 (82)
Secondary analysis study [22,32]	2 (18)
Theoretical framework	
Theory of Reasoned Action [23]	1 (9)
Transtheoretical Model of Health Behavior Change [22,24,27,28,32]	5 (46)
Behavior Change Model [30]	1 (9)
Social Cognitive Theory combined with Gender and Power Theory [26]	1 (9)
Health Belief Model [25,29]	2 (18)
Not reported [31]	1 (9)
Participants' characteristics	
Nonpregnant women [22-24,27]	4 (36)
Pre-pregnant couples [25,29,30]	3 (27)
Women of childbearing age [31]	1 (9)
Sexually active women with a male partner [28,32]	2 (18)
Black teenaged women [26]	1 (9)
Intervention type	
Website [23,26,29,31]	4 (36)
Computerized authoring system [22,24,27,28,32]	5 (46)
Mobile app [30]	1 (9)
Video sharing platform [25]	1 (9)
Intervention delivery method	
Individual [22-24,26-28,31,32]	8 (73)
Couple [25,29,30]	3 (27)
Intervention duration[d]	
≤1 week [31]	1 (9)
1 week ~ ≤1 month [23,26]	3 (27)
1 month < ~ ≤3 months [28,32]	2 (18)
3 months < ~ ≤6 months [27,30]	2 (18)

	6 months < ~ ≤12 months [22,24]	2 (18)
	Not reported [25]	1 (9)
Comparator intervention		
	Suggestion a meeting with a health care provider [22,24,27]	3 (27)
	Standard health information [23,25,28,30,32]	5 (46)
	Attention control intervention [26]	1 (9)
	None [29,31]	2 (18)

[a]RCT: randomized controlled trial.

Table 2. Summary of the study designs for internet-based interventions on women of childbearing age (N=11).

Study, year	Country	Study design (analysis sets)	Participants and female's age (intervention n/control n)	Experimental intervention	Intervention method and group type (I[a] or C[b])	Intervention duration	Comparative intervention
Batra et al [23], 2018	United States	2-armed RCT[c] (ITT[d])	Nonpregnant women, 18-45 years old (146/146)	MyFamilyPlan	Website (I)	Two weeks	Standard health information
Conijn et al [25], 2021	The Netherlands	2-armed quasi-experimental trial (PP[e])	Prepregnant couples, 18-45 years old (789/781)	Educational online video about an autosomal recessive disorder	YouTube (C)	NR[f]	Standard health information
Gardiner et al [22], 2020	United States	2-armed RCT (ITT) Second analysis of Jack et al [24], 2020	Nonpregnant women, 18-34 years old from the previous study (240/240)	Gabby	Telephone and an embodied conversational agent system (I)	Twelve months	Suggestion a meeting with a health care provider
Jack et al [27], 2015	United States	2-armed RCT (PP)	Nonpregnant women, 18-34 years old (36/41)	Gabby	Telephone and an embodied conversational agent system (I)	Six months	Suggestion a meeting with a health care provider
Jack et al [24], 2020	United States	2-armed quasi-experimental trial	Nonpregnant women, 18-34 years old (262/266)	Gabby	Telephone and an embodied conversation	Twelve months	Suggestion a meeting with a health care

		(ITT)			al agent system (I)		provider
Je and Choi [29], 2016	South Korea	2-armed quasi-experimental trial (PP)	Pre-marital couples, 20-39 years old (26/25)	Preconception Health Promotion	Website (C)	Four weeks	None
Kim [31], 2022	South Korea	2-armed RCT (PP)	women of childbearing age, 19-49 years old (49/49)	Webtoon education program on preventive self-management related to premature labor	Website (I)	Two days	None
Kissinger et al [26], 2023	United States	2-armed RCT (ITT and PP)	Black teenaged women, 18-19 years old (315/322)	Be yoU, Talented, Informed, Fearless, Uncompromised, and Loved	Website (I)	Four weeks	Attention control intervention
Peipert et al [28], 2008	United States	2-armed RCT (ITT)	Sexually active women with a male partner, 13-35 years old (272/270)	Dual method contraceptive use	Computer delivered information (I)	Eighty days	Standard health information
Peipert et al [32], 2011	United States	2-armed RCT (PP) Second analysis of Peipert et al [28], 2008	Sexually active women with a male partner from the previous study, 13-35 years old (19/24)	Dual method contraceptive use	Computer delivered information (I)	Eighty days	Standard health information
Van Dijk et al [30], 2020	The Netherlands	2-armed RCT (ITT)	Women contemplating pregnancy or <13 weeks pregnant and	Smarter Pregnancy	Mobile application (C)	Twenty four weeks	Standard health information

			their male Partners, 18-45 (109/109)				

[a]I: individual.

[b]C: couple.

[c]RCT: randomized controlled trial.

[d]ITT: intention-to-treat.

[e]PP: per-protocol.

[f]NR: not reported.

Intervention Characteristics

Intervention Method and Group Type

Overall, 46% (5/11) of the studies utilized a computerized intervention authoring system for delivering intervention [22,24,27,28,32], while 36% (4/11) used websites [23,26,29,31]. Additionally, 9% (1/11) of the studies employed a mobile app [30], and another 9% (1/11) used a video-sharing platform, specifically YouTube [25]. Among these, 27% (3/11) studies targeted couples [25,29,30], and the remaining 73% (8/11) focused on interventions for individuals.

Intervention Duration, and Comparative Approaches

The duration of the interventions varied: 9% (1/11) lasted ≤1 week [31], 27% (3/11) lasted up to 1 month [23,26,29], 18% (2/11) lasted up to 3 months [28,32], another 18% (2/11) lasted up to 6 months [27,30], and 18% (2/11) lasted up to 12 months [22,24]. Nine percent (1/11) of the studies did not specify the duration [25]. Regarding comparative interventions, 46% (5/11) of the studies provided standard health information to the control groups, including standard preconception health information [23], nutritional information without coaching [30], educational text [25], and general contraceptive information along with non-tailored advice [28,32]. Among the other studies, 27%(3/11) suggested a meeting with a healthcare provider [22,24,27] and 9%(1/11) provided an attention control intervention developed for the comparator by researchers [26].Two studies (18%) did not provide any intervention to the control group [29,31] (Table 2).

Outcomes and Effects of Interventions

The outcomes of the interventions, as detailed in Multimedia Appendix 2 [22-32], were categorized into three main areas: reproductive health perception, behaviors, and status. Each category encompasses two to four subcategories (Table 3).

Reproductive Health Perception

Within this domain, a total of 11 distinct outcomes were identified, encompassing a range of factors, such as self-efficacy in reproductive health, perception of reproductive health promotion, knowledge of reproductive health, and perception of hereditary disorders.

Self-Efficacy in Reproductive Health

Three studies assessed self-efficacy related to reproductive health outcome. Two of the 11 studies (18%) focused on self-efficacy related to preconception health attitude and behavior [23] or self-efficacy of preconception health promotion–[29]. Only 1/11 (9%) concentrated on preventive health management self-efficacy related to premature labor [31]. Significant improvements in self-efficacy regarding preconception health attitudes and behaviors were not observed in the intervention groups of the studies that used the website as an intervention method for 2 or 4 weeks [23,29]. Meanwhile, significant improvements in preventive health management self-efficacy related to premature labor was noted immediately after the intervention and 2 weeks later in a study using web cartoons containing a fictional story about premature labor for just 2 days [31]. Additionally, only one study (9%) specifically examined the perception of reproductive health promotion, assessing awareness, benefits, barriers, and content awareness of preconception health promotion, with significant improvements observed [29]. Regarding knowledge of reproductive health, two studies (18%) addressed this area; one (9%) study focused on preventive self-management knowledge related to premature labor [31], and the other on genetic knowledge [25], both showing significant impacts on knowledge. Finally, the perception of hereditary disorders was explored in just one study (9%) [25], which assessed perceived severity of mucopolysaccharidosis III and risk of hereditary disorders. This study found significant improvements in perceived severity and risk, except for the perception of being a carrier of a severe hereditary disease as (very) high risk', which did not show significant change.

Reproductive Health Behaviors

In the area of reproductive health behaviors, the research encompassed 4 categories: self-management for reproductive health, dietary and nutritional intake, behavioral promotion on preconception care risks, and contraception use. Self-management was evaluated in two studies (18%), with one showing significant effects on discussions with healthcare providers about reproductive health, though it did not influence the scheduling of additional appointments to address these concerns [23]. Another study demonstrated significant improvements in reproductive health promotion behaviors [29].

Nutritional aspects were assessed in two studies (18%) [23,30], where interventions

significantly enhanced dietary risk scores and vegetable intake. However, there was no notable change in the use of folic acid supplements or fruit intake [30], highlighting the mixed results of dietary interventions on different nutritional behaviors. Behavioral promotion on preconception care risks was covered in three studies (27%) [22,24,27]. One study documented significant early improvements in health behavior changes related to nutrition, which were not sustained over a year [22]. Significant effects were observed in reducing both the proportion of preconception care risks and the number of such risks per person [27]. Additionally, improvements were noted in the stage and progression of health behavior change related to preconception care risks at 6 and 12 months, although no further progression in health behavior change was observed at 12 months [24].

Contraception use was assessed in in three studies (27%) [23,26,32]. Significant improvements were found in one study for initiating or changing birth control methods [23], while another study revealed a significant intention to use reliable contraception methods within the next year, despite the absence of immediate effects [26]. The effect of interventions on the initiation of dual contraception methods was not significant [32], yet significant improvements were noted in two other studies (18%) [26,28]. Additionally, one study (9%) reported no significant effects on sustenance of dual methods of contraception [32]. Consistent condom use showed no significant effect in one study (9%) [28]; however, another study (9%) reported a significantly higher intention to use condoms at 6 and 12 months [26].

Reproductive Health Status

Two categories were measured in the outcomes related to reproductive health status, specifically focusing on sexually transmitted infections (STIs) and unplanned pregnancies. STIs were assessed in two of the 11 studies (18%) [26,28]. No significant intervention effects were found on the reduction of the presence of any STI, including chlamydia, gonorrhea, trichomonas, pelvic inflammatory disease, or unintended pregnancy [26], nor on any STI in another study [28]. Additionally, two outcomes under the category of unplanned pregnancy were examined; no significant effects were observed on pregnancy rates in one study (9%) [26] and on the incidence of unplanned pregnancies in another study (9%) [28].

Table 3. Categories of outcome measures of internet-based intervention on women of childbearing age.

Categories	Subcategories	Outcomes measurements
Reproductive health perception		
	Self-efficacy of reproductive health	Self-efficacy on preconception health attitude and behavior [23]
		Preventive health management self-efficacy related to

		premature labor [31]
		Perceived self-efficacy of preconception health promotion [29]
	Perception of reproductive health promotion	Self-perception of awareness of preconception health promotion [29]
		Content awareness of preconception health promotion [29]
		Perceived benefits of preconception health promotion [29]
		Perceived barriers of preconception health promotion [29]
	Knowledge of reproductive health	Preventive self-management knowledge related to premature labor [31]
		Genetic knowledge [25]
	Perception of hereditary disorders	Perceived severity of Mucopolysaccharidosis III [25]
		- Mucopolysaccharidosis III is a severe disease
		- Mucopolysaccharidosis III has a very bad life expectancy
		Perceived risk of hereditary disorder [25]
		- Being a carrier of a severe hereditary disease as (very) high risk
		- Both partners are carrier of the same disease as (very) high risk
		- Having a child with a severe hereditary disorder as (very) high risk
Reproductive health behaviors		
	Self-management for reproductive health	Self-reported discussion of reproductive health with provider [23]
		Scheduling an additional appointment to address her reproductive health after her well-woman visit [23]
		Reproductive health promotion behavior [29]
	Dietary and nutritional intake	Initiating folate supplementation [23]
		Folic acid supplement use [30]
		Dietary risk score [30]
		Vegetable intake [30]
		Fruit intake [30]
	Behavioral promotion on preconception care risks	Preconception care risks from the nutrition domain [22]
		- At 6 months, Risks that progressed
		- At 6 months, Risks at action or maintenance
		- At 12 months, Risks that progressed
		- At 12 months, Risks at action or maintenance
		Reductions in proportion of preconception care risks [27]
		Reductions in number of preconception care risks per person [27]
		Preconception care risks [24]
		- At 6 months, Risks at action or maintenance
		- At 12 months, Risks at action or maintenance

		- At 6 months, Risks that progressed forward
		- At 6 months, Risks that regressed backward
		- At 12 months, Risks that progressed forward
		- At 12 months, Risks that regressed backward
	Contraception use	Initiating or changing the birth control method [23]
		Initiating reliable contraception use [26]
		Intention to use reliable contraception in the next year [26]
		Initiation of dual methods of contraception [26,28,32]
		Sustenance of dual methods of contraception [32]
		Intention to use condoms [26]
		Consistent condom use [28]
Reproductive health status		
	Sexually transmitted infection	Presence of an STI[a] [26]
		Any STI or unintended pregnancy [28]
		Any STI [28]
		Chlamydia [28]
		Gonorrhea [28]
		Trichomonas [28]
		Pelvic inflammatory disease [28]
	Unplanned pregnancy	Pregnancy rate [26]
		Unplanned pregnancy [28]

[a]STI: sexually transmitted infection.

Discussion

Principal Findings

This systematic review provides a comprehensive evaluation of internet-based interventions aimed at preventing premature birth in PWCA. While reviewing 11 studies, it becomes evident that such research is relatively sparse, with only 9 primary studies directly addressing this topic, highlighting a significant gap in preconception health interventions online. This scarcity is consistent with broader trends noted in previous reviews, which found limited digital strategies being employed within preconception healthcare [33,34]. Meanwhile, the potential of mobile applications to enhance health behaviors crucial for preconception care—such as weight management [35], physical activity, and nutrition [35,36]—has been reported. Despite their proven efficacy in other health domains and their capabilities for providing cost-effective, accessible care [37], mobile apps specifically designed for preconception health are not being developed at the same pace as other health technologies. The post-COVID-19 era has seen an increased reliance on digital solutions for health services, reflecting

a shift in user behavior and acceptance of online health services [38,39]. However, the surge in general health app development has not paralleled innovations in preconception health, marking a critical area for future research and development [40]. Given these insights, it is imperative to prioritize the exploration and creation of mobile applications that cater specifically to preconception health needs. These efforts should aim to harness the broad accessibility and engagement capabilities of smartphones to reduce risks associated with premature birth and promote overall reproductive health among PWCA.

The majority of the studies we reviewed were conducted in high-income countries such as the United States, the Netherlands, and South Korea [41], where the widespread availability of the internet and digital devices facilitates the implementation of web-based interventions. An analysis of the publication years within this study reveals a growing trend in these interventions, with more than half of the studies conducted after 2020. The COVID-19 pandemic acted as a catalyst for rapid advancements in mobile technology, significantly enhancing the capability of individuals to connect with healthcare systems and access essential health-related guidance [42]. This period also witnessed a notable surge in the development of health and fitness apps, with the iOS app market seeing an unexpected growth of 29.9% in the availability of these apps post-pandemic [40]. However, the development of apps specifically for preconception health has not kept pace with these technological advancements, indicating a significant opportunity for innovation and enhancement in this specific area of health technology.

In terms of intervention duration, our review found that the length of internet-based interventions was strategically aligned with their cognitive and behavioral targets. Short-term interventions, lasting less than one month, typically focused on assessing the effects on health-related beliefs [25,29], knowledge [25,31], intention [26], and self-efficacy [23,31]. In contrast, longer interventions, those exceeding 80 days, aimed to initiate or modify behaviors [22,24,27,28,30,32]. The efficacy of these long-term interventions in fostering healthful behaviors, curbing unhealthy ones, maintaining behavioral changes in physical activity, and promoting sustained abstinence from substance abuse highlights their critical role [43]. As a result, trials designed to enhance health awareness or beliefs often opted for shorter durations, while those seeking substantive behavioral change generally favored longer-term interventions to achieve more profound and lasting impacts.

The reliability of the studies reviewed was predominantly questionable, with only one out of the eleven studies (9%) exhibiting a low RoB [22]. The majority displayed moderate to high risk, attributed to significant issues like extensive missing outcome data, the reliance on self-reported outcome measures, and the absence of blinding regarding intervention status. These issues highlight

the critical need for more rigorously designed high-quality studies within this domain. Internet-based interventions pose inherent challenges such as the difficulty of blinding and participant attrition, which can influence the accuracy of self-reported data. Therefore, RCTs must be meticulously planned to mitigate these biases, taking into consideration the specific characteristics of participants during data analysis and interpretation.

In terms of intervention effectiveness, internet-based approaches targeting enhancements in reproductive health perception—specifically focusing on reproductive health promotion, knowledge, and the perception of hereditary disorders—were predominantly short-term and utilized platforms such as websites or YouTube. While statistically significant effects were observed in these areas [23,25,29,31], except for the perceived risk of hereditary disorders [25], caution is warranted. The robustness of these findings is questionable as the results for the perception of reproductive health promotion and hereditary disorders are each derived from a single study, and the insights on knowledge of reproductive health from just two studies.

Furthermore, there were no consistent statistically significant effects noted in self-efficacy related to preconception health attitudes and behaviors [23], nor in the perceived self-efficacy of preconception health promotion [29]. This is in contrast to a non-internet-based systematic literature review [44], which reported significant improvements in participants' knowledge and self-efficacy concerning reproductive life planning, albeit these findings were considered of low quality. Such disparities underscore the urgent need for additional high-quality research to develop and refine internet-based interventions that effectively enhance reproductive health perception. Future studies should focus on improving intervention strategies, extending durations, and refining methods to support evidence-based enhancements in preconception health behaviors.

In this study, specific subcategories of reproductive health behaviors were examined, with only two studies assessing each of self-management for reproductive health [23,29] and dietary and nutritional intake [23,30]. The limited number of studies, coupled with inconsistencies in measurement approaches, has resulted in insufficient evidence to conclusively determine their effectiveness. Additionally, subcategories focusing on behavioral promotion to mitigate preconception care risks were evaluated through long-term interventions. While the results demonstrated effectiveness at the 6-month mark across all relevant studies [22,24,27], the assessments at the 12-month mark indicated only partial effectiveness [22,24]. This variability highlights the crucial need for more research to validate and refine these interventions. Furthermore, the analysis of contraception uses across two studies [23,26] revealed inconsistencies in the effectiveness of initiating birth control methods, underscoring the challenges in achieving consistent

outcomes across diverse demographic and temporal contexts. For instance, the “MyFamilyPlan” program targeted non-pregnant women over a brief two-week period with immediate post-intervention evaluation [23], whereas the “Be yoU, Talented, Informed, Fearless, Uncompromised, and Loved (BUtiful)” program engaged Black teenage women over four weeks, with assessments extending to 6 and 12 months [26]. These differences exemplify the complex dynamics in implementing and evaluating web-based interventions, which can significantly affect outcomes. Peipert et al.'s study [32] further complicates the landscape, showing no effect on initiating dual methods of contraception despite an 80-day intervention with sexually active women, evaluated 18 months post-intervention. In contrast, another study reported positive effects [26], suggesting that variations in intervention design, population demographics, and contextual factors such as educational level, substance use, and accessibility of family planning services [32,45] can profoundly impact intervention success. These disparities necessitate a cautious approach to interpreting results and call for a more nuanced understanding of how different factors influence the effectiveness of contraception interventions. Additionally, broader reviews in reproductive health interventions [12] have also pointed to a scarcity of robust data, with only a few studies examining outcomes like folic acid supplementation, vaccination uptake, increased physical activity, and smoking and alcohol consumption reduction. These studies were generally rated as having weak to moderate quality, further emphasizing the ongoing need for high-quality research that can establish effective, reliable interventions in these critical areas of reproductive health.

The evaluation of STIs and unplanned pregnancies within this systematic review involved just two of the eleven studies [26,28], revealing a significant research gap. Despite the targeted interventions, which included providing participants with quarterly newsletters for a year [26] and a more condensed 80-day intervention period [28], no significant improvements were observed at the 6- and 12-month post-intervention assessments. This inconsistency contrasts with findings from a non-internet-based systematic review, which demonstrated efficacy in reducing STI re-infection rates [46], while another highlighted the ineffectiveness of educational interventions in significantly reducing unintended pregnancies [13]. These discrepancies underscore the need for more robust, internet-based experimental studies that can effectively address and impact reproductive health status.

This study concentrated on internet-based interventions designed to optimize health prior to pregnancy. The scope of preconceptional care is broad, covering 14 domains as defined by clinical practice guidelines, which include health promotion, immunization, infectious diseases, medical conditions, psychiatric conditions, parental exposures, family and genetic history, nutrition,

environmental exposures, psychosocial risks, medications, reproductive history, special populations, and emerging concerns such as Zika [47]. Despite these extensive areas, the research predominantly focused on the health promotion domain, with only a single study delving into genetic history. The lack of evaluations in the other domains underscores significant gaps that need to be addressed in future research. Moreover, the studies reviewed reflect a continuing shortage of internet-based interventions specifically aimed at preventing premature birth. This challenge is not unique to internet-based strategies but is also evident in broader reproductive health interventions, as demonstrated in a systematic review focused on reproductive life planning [44]. These findings point to a crucial need for further exploration and development of digital interventions that comprehensively cover the diverse aspects of preconceptional care, ensuring that potential technological solutions are fully harnessed to improve pre-pregnancy health outcomes.

Strengths and Limitations

This systematic review significantly contributes to the existing body of literature by methodically examining web-based interventions aimed at preventing premature birth among PWCA. One of its major strengths lies in its extensive exploration of a diverse range of reproductive health outcomes. The review's inclusive selection criteria, devoid of geographical or language restrictions, enhance its global relevance and allow for a comprehensive assessment of the potential and challenges associated with internet-based interventions in preconception care.

Despite its comprehensive scope, this review encounters several inherent limitations characteristic of systematic research. The analysis was confined to four databases, which may have limited the breadth of studies included and potentially omitted relevant research published elsewhere. This focus predominantly on experimental studies may have excluded valuable qualitative and mixed-methods research that could provide deeper insights into the contexts and nuances of internet-based interventions. Additionally, while a rigorous search strategy was employed to mitigate publication bias, the exclusion of grey literature such as dissertations, conference abstracts, and other non-peer-reviewed sources could mean that some significant findings were overlooked. This limitation is particularly relevant in the rapidly evolving field of digital health interventions, where much innovative work may not yet be published in traditional academic journals. Moreover, the review’s reliance on studies conducted predominantly in regions with high internet usage may also skew the applicability of the findings globally. This geographic concentration raises concerns about the generalizability of the results, as the effectiveness of web-based interventions might differ substantially in areas with limited internet access or technological infrastructure. Finally, the high prevalence of studies with significant risks of bias reflects a common challenge in systematic reviews

—relying on the quality of existing research. Studies with a high risk of bias can affect the overall conclusions of the review, necessitating cautious interpretation of the findings and highlighting the need for more robust, high-quality primary research in this area.

Conclusions

This systematic review critically evaluates the efficacy of internet-based interventions in improving preconception health and preventing premature birth among women of childbearing age. The findings reveal that while some interventions successfully enhanced knowledge of reproductive health, they were less effective in altering health behaviors such as contraception use and dietary supplement intake. Notably, the interventions did not significantly impact reproductive health status indicators. The inconsistent results across different domains suggest a complex interaction between intervention design and participant engagement, underscoring the challenges of implementing digital health strategies effectively. This variability, coupled with the high risk of bias in many studies, highlights critical areas for improvement in research methodology and intervention design. Moving forward, there is a clear need for more rigorous, well-designed studies that not only refine these interventions but also expand their scope to more comprehensively address the multifaceted needs of preconception care. Such research should aim to harness the full potential of digital technology in public health to create more nuanced and impactful interventions that can significantly enhance outcomes for women globally.

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Authors' Contributions

SHK, SYJ, and JHP developed the research questions. SHK was responsible for the methodology design and leading the review process. The review process, including resolving discrepancies, screening and selecting studies, and extracting and coding data, was jointly conducted by SHK, SYJ, JHP, and JCDG. Descriptive analyses and the preparation of tables and figures for the manuscript were conducted by SHK, SYJ, and JCDG. All authors were involved in the interpretation of the findings and initial drafting of the manuscript. The manuscript was revised, and the final version approved by all authors.

Conflicts of Interest

None declared.

Abbreviations

ITT: intention-to-treat

PP: per-protocol

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PWCA: preconceptional women of childbearing age

RCT: randomized controlled trial

RoB: risk of bias

STI: sexually transmitted infection.

Multimedia Appendix

Multimedia Appendix 1. Search strategy for the specific database.

Multimedia Appendix 2. Outcome measures and effects of internet-based intervention on preconceptional women of childbearing age.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram showing the selection of included studies.

Figure 2. Risk-of-bias (RoB) assessment using the revised Cochrane RoB tool for randomized trials.

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INTERNET-BASED INTERVENTIONS FOR PREVENTING PREMATURE BIRTH IN PRECONCEPTION

Multimedia Appendix 2. Outcome measures and effects of internet-based intervention on preconceptional women of childbearing age (N=11).

Outcomes	Outcome measures [References]	Effect size (between groups comparison)	p-value (confidence interval)	Effect of intervention
Reproductive health perception				
Self-efficacy of reproductive health				
	Self-efficacy on preconception health attitude and behavior [23]	NR[a]	NR	No effect
	Preventive health management self-efficacy related to premature labor [31]	f[b]=0.161	Changes in T0–T1, in T0–T2: .002 (0.02, 0.11), <.001 (0.12, 0.30)	Changes in T0–T1, in T0–T2: Effect, Effect
	Perceived self-efficacy of preconception health promotion [29]	f=0.096	.166	No effect
Perception of reproductive health promotion				
	Self-perception of awareness of preconception health promotion [29]	f=0.413	<.001	Effect
	Content awareness of preconception health promotion [29]	f=0.509	<.001	Effect
	Perceived benefits of preconception health promotion [29]	f=0.216	.004	Effect
	Perceived barriers of preconception health promotion [29]	f=0.231	<.001	Effect
Knowledge of reproductive health				
	Preventive self-management knowledge related to premature labor [31]	f=0.337	Changes in T0–T1, in T0–T2: .006 (0.01, 0.11), <.001 (0.09, 027)	Changes in T0–T1, in T0–T2: Effect, Effect
	Genetic knowledge [25]	NR	< .001	Effect
Perception of hereditary disorders				
	Perceived severity of mucopolysaccharidosis III [25]			
	- Mucopolysaccharidosis III is a severe disease [25]	h=0.277	< .001	Effect
	- Mucopolysaccharidosis III has a very bad life expectancy [25]	h=0.224	< .001	Effect
	Perceived risk of hereditary disorder [25]			
	- Being a carrier of a severe hereditary disease as (very) high risk [25]	h=0.000	≥ .05	No effect
	- Both partners are carrier of the same disease as (very) high risk [25]	h=-0.164	.001	Effect
	- Having a child with a severe hereditary disorder as (very) high risk [25]	h=-0.141	.005	Effect
Reproductive health behaviors				
Self-management for reproductive health				

INTERNET-BASED INTERVENTIONS FOR PREVENTING PREMATURE BIRTH IN PRECONCEPTION

Self-reported discussion of reproductive health with provider [23]	OR[d]=1.97	.01 (1.22-3.19)	Effect
Scheduling an additional appointment to address her reproductive health after her well-woman visit [23]	NR	NR	No effect
Reproductive health promotion behavior [29]	f=0.277	.001	Effect
Dietary and nutritional intake			
Initiating folate supplementation [23]	NR	NR	No effect
Folic acid supplement use [30]	Rate ratio=1.02	(-0.08, 0.26)	No effect
Dietary risk score [30]	Rate ratio=1.31	(0.19, 1.34)	Effect
Vegetable intake [30])	Rate ratio=1.20	(0.25, 0.86)	Effect
Fruit intake [30]	Rate ratio=1.00	(-0.21, 0.39)	No effect
Behavioral promotion on preconception care risks			
Preconception care risks from the nutrition domain [22] - At 6 months, risks that progressed [22]	RR[f]=1.22	.019 (1.03, 1.45)	Effect
- At 6 months, risks at action or maintenance [22]	RR=1.26	.004 (1.08, 1.48)	Effect
- At 12 months, risks that progressed [22]	RR=1.01	.928 (0.85, 1.20)	No effect
- At 12 months, risks at action or maintenance [22]	RR=1.12	.168 (0.95, 1.31)	No effect
Reductions in proportion of preconception care risks [27]	h=0.171	< .01	Effect
Reductions in number of preconception care risks per person [27]	h=0.288	< .05	Effect
Preconception care risks [24]			
- At 6 months, risks at action or maintenance [24]	RR=1.16	<.001 (1.07–1.26)	Effect
- At 12 months, risks at action or maintenance [24]	RR=1.17	<.001 (1.08–1.27)	Effect
- At 6 months, risks that progressed forward [24]	RR=1.17	.001 (1.06–1.30)	Effect
- At 6 months, risks that regressed backward [24]	RR=0.83	.010 (0.72–0.96)	Effect
- At 12 months, risks that progressed forward [24]	RR=1.07	.071 (0.97–1.85)	No effect
- At 12 months, risks that regressed backward [24]	RR=0.84	.030 (0.72–0.98)	Effect
Contraception use			
Initiating or changing the birth control method [23]	OR=0.44	.03	Effect
Initiating reliable contraception use [26]	6 months: RR=1.45	6 months: .056 (0.99, 2.12)	6 months: No effect

		12 months: RR=1.33	12 months: .133 (0.92, 1.91)	12 months: No effect
	Intention to use reliable contraception in the next year [26]	6 months: RR=1.54 12 months: RR=1.27	6 months: .014 (1.03, 2.18) 12 months: .167 (1.09, 1.77)	6 months: Effect 12 months: Effect
	Initiating dual methods of contraception [26]	Relative risk=1.45	.052 (1.00, 2.11)	Effect
	Reported any dual method use [28]	HR[e]=1.70	(1.09, 2.66)	Effect
	Initiation of dual methods of contraception [32]	Relative risk=1.52	(0.96, 2.41)	No effect
	Sustenance of dual methods of contraception [32]	Relative risk=0.89	(0.45, 1.75)	No effect
	Intention to use condoms [26]	6 months: RR=1.46 12 months: RR=1.43	6 months: .027 (1.05, 2.04) 12 months: .035 (1.05, 2.00)	6 months: Effect 12 months: Effect
	Consistent condom use [28]	HR=1.26	(0.88, 1.79)	No effect
Reproductive health status				
Sexually transmitted infection				
	Presence of an STI[g] [26]	6 months: RR=0.06 12 months: RR=1.32	6 months.105 (0.33, 1.11) 12 months: .386 (0.70, 2.48)	6 months: No effect 12 months: No effect
	Any STI or unintended pregnancy [28]	HR=1.19	(0.79, 1.79)	No effect
	Any STI [28]	HR=1.29	(0.70, 2.36)	No effect
	Chlamydia [28]	HR=1.31	(0.61, 2.82)	No effect
	Gonorrhea [28]	HR=1.83	(0.61, 5.50)	No effect
	Trichomonas [28]	HR=0.41	(0.72, 8.02)	No effect
	Pelvic inflammatory disease [28]	HR=1.03	(0.20, 5.19)	No effect
Unplanned pregnancy				
	Pregnancy rate [26]	HR=0.96	.090 (0.44, 2.03)	No effect
	Unplanned pregnancy [28]	HR=1.17	(0.71, 1.95)	No effect

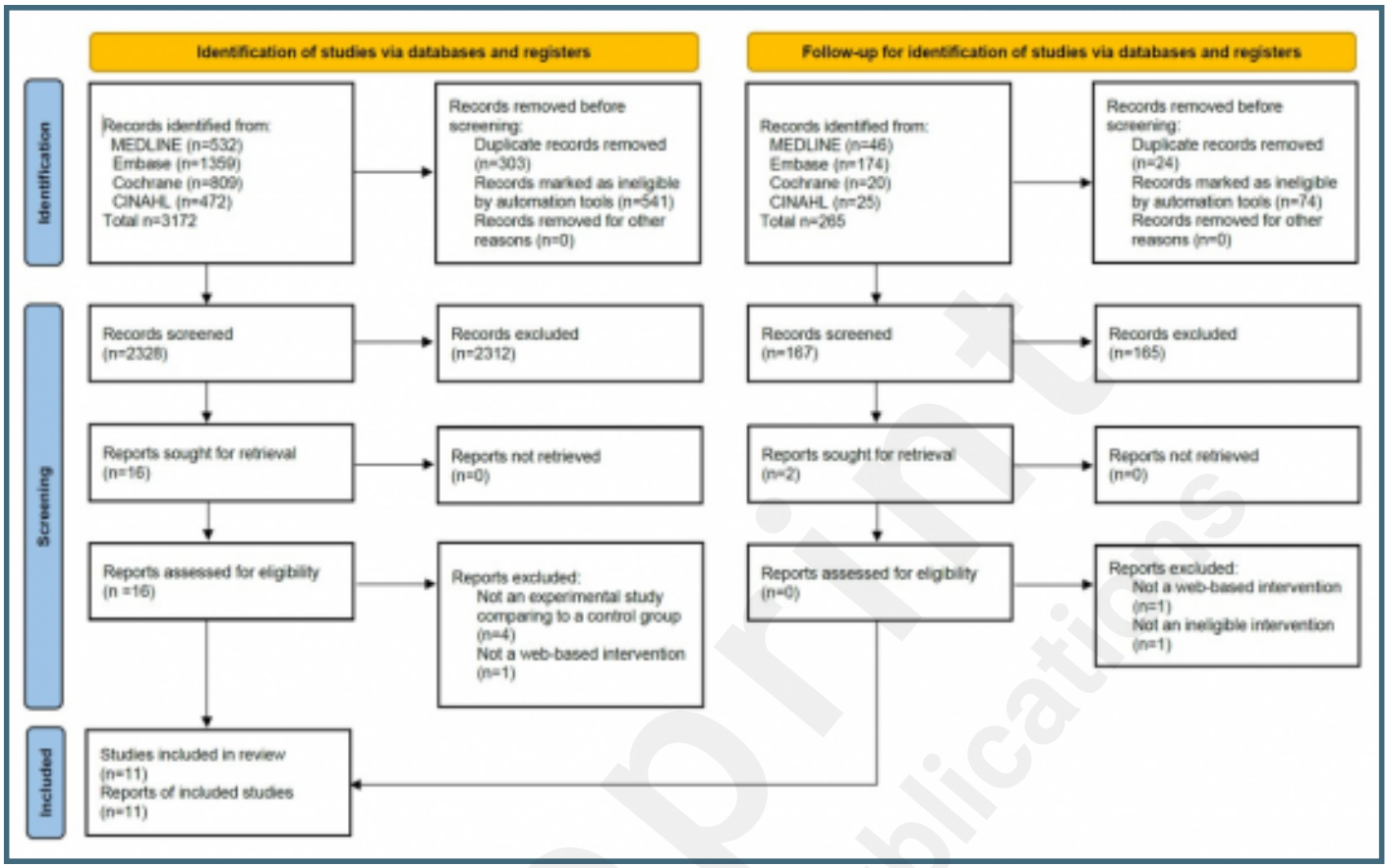
The decimal places of the p-value were basically written up to the 3rd place. However, the p-value with only two decimal places was the value suggested by the original author and could not be calculated in this study.

[a]NR: Not report
[b]f: Cohen's f
[c]h: Cohen's h
[d]OR: odd ratio
[e]HR: hazard ratio
[f]RR: rate ratio
[g]STI: sexually transmitted Infection

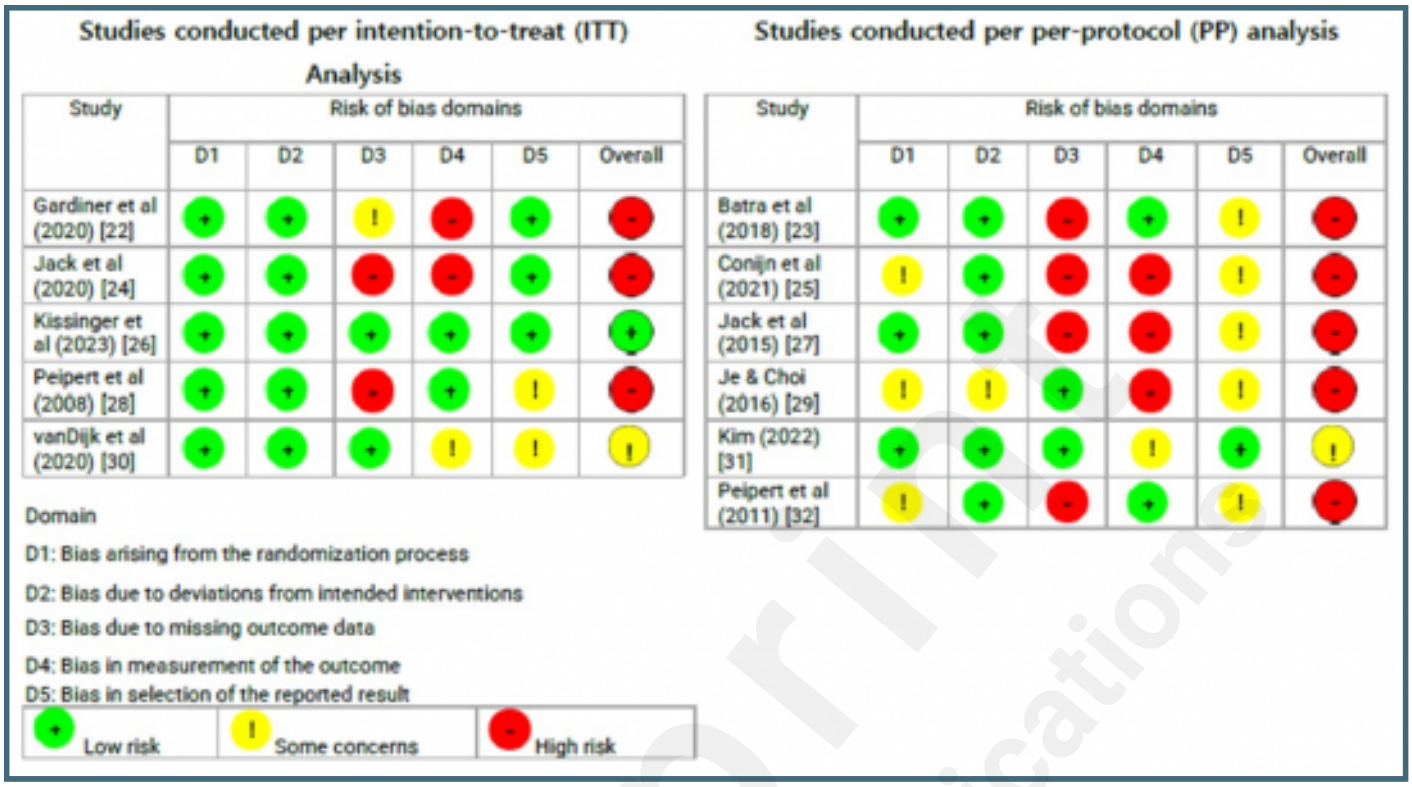
Supplementary Files

Figures

PRISMA diagram showing the selection of included studies.



Risk-of-bias assessment using the revised Cochrane RoB tool for randomized trials.



Multimedia Appendixes

Search Terms on Databases.
URL: http://asset.jmir.pub/assets/628dbd4a6c84be81bc5e2e4821aeb6c2.docx

Outcome Measures and Effects of Internet-based Intervention on Preconceptional Women of Childbearing Age.
URL: http://asset.jmir.pub/assets/1ae4fc34c6c0b94f140e5f696e251c50.docx