Original Paper

Feasibility and Preliminary Effects of a Web-Based Premature Birth Prevention Self-Management Education Program for Women of Childbearing Age: Pilot Randomized Controlled Trial With a Nested Qualitative Evaluation

Sun-Hee Kim[1], PhD; Jin Young Bae[2], MD; Sunwha Park[3], MD; Jennie C De Gagne[4], PhD, DNP; Yu-Jin Lee[5], PhD

[1]College of Nursing, Daegu Catholic University, Daegu, Republic of Korea

[2]Department of Obstetrics and Gynecology, School of Medicine, Daegu Catholic University, Daegu, Republic of Korea

[3]Department of Obstetrics and Gynecology, College of Medicine, Ewha Womans University, Seoul, Republic of Korea

[4]School of Nursing, Duke University, Durham, NC, United States

[5]College of Nursing, Suseong University, Daegu, Republic of Korea

Corresponding Author:
Sun-Hee Kim, PhD
College of Nursing
Daegu Catholic University
33, Duryugongwon-ro 17-gil, Nam-gu
Daegu, 42472
Republic of Korea
Phone: 82 53 650 4831
Fax: 82 53 650 4392
Email: sunhee421@cu.ac.kr

Abstract

Background: Premature birth remains a leading cause of neonatal morbidity and mortality, yet few interventions target women of childbearing age before pregnancy. Digital health interventions using interactive webtoon storytelling may enhance engagement and promote preconception health behaviors, but evidence regarding their feasibility and preliminary effectiveness remains limited.

Objective: This pilot study evaluates the feasibility and preliminary effects of an interactive webtoon-based educational website for preventing premature birth among women of childbearing age.

Methods: This explanatory sequential mixed methods pilot study used a stratified randomized controlled design, with a nested qualitative evaluation of the webtoon arm. Forty-seven eligible women of childbearing age, recruited via social media and online communities, were randomized to either an interactive webtoon-based educational website or a text-based educational website with identical content. Both groups accessed a self-guided web-based program. Outcomes were assessed online at baseline, immediately postintervention, and at the 4-week follow-up using a per-protocol approach. Primary quantitative outcomes included the Self-Management Self-Efficacy for Premature Birth Prevention (SMSE-PBP) and Health Belief Model for Premature Birth Prevention (HBM-PBP) scores. Feasibility outcomes included the intervention completion rate, 8-item Client Satisfaction Questionnaire, and Website Quality Evaluation. Sequential qualitative data were gathered through in-depth interviews with participants in the webtoon arm to explore user experience, perceived utility, and areas for improvement.

Results: A total of 34 participants completed the study (uptake rate, 19/24, 79%; completion rate, 14/19, 74%). High satisfaction and usability supported the feasibility of the intervention. Generalized estimating equations revealed no significant group-by-time interaction effects for SMSE-PBP (time 1: P=.47; time 2: P=.35) or any HBM-PBP subdomains (perceived susceptibility, time 1: P=.53; time 2: P=.64; perceived severity, time 1: P=.76; time 2: P=.96; perceived benefits, time 1: P=.30; time 2: P=.67; and perceived barriers, time 1: P=.23; time 2: P=.44). However, significant main effects of time were observed for SMSE-PBP (time 1: P=.006; time 2: P<.001) and 3 HBM-PBP subdomains—perceived susceptibility (time 1: P<.001; time 2: P<.001), perceived benefits (time 1: P=.02; time 2: P=.001), and perceived barriers (time 2: P=.003)—indicating overall longitudinal improvements across both groups. Qualitative insights, obtained sequentially, highlighted heightened awareness of premature birth prevention,

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an enhanced understanding of the appropriate timing of preventive behaviors, and a broader range of behaviors considered important for premature birth prevention.

Conclusions: The webtoon-based educational website was feasible and acceptable to women of childbearing age. Both programs showed improvements over time in self-management self-efficacy and health beliefs related to premature birth prevention. This pilot study did not detect a clear advantage of the webtoon-based format over the text-based format, possibly because of the short intervention period. Nevertheless, the demonstrated feasibility and acceptability, together with qualitative findings from the webtoon arm, support further refinement of the program and its evaluation in a fully powered randomized controlled trial.

Trial Registration: Clinical Research Information Service KCT0008824; https://tinyurl.com/bdhv9cud

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KEYWORDS

health belief model; health education; internet-based intervention; pilot projects; preconception care; premature birth; randomized controlled trial; self-efficacy; women

Introduction

Background

In 2020, approximately 13.4 million live births globally were preterm (9.9%), a rate that has stagnated for over a decade [1]. Complications of premature birth remain the leading cause of under-5 mortality, accounting for over one-third of neonatal deaths in 2022 (approximately 0.9 million) [2]. Premature infants are at increased risk for low birth weight, developmental delays, and chronic health conditions, requiring continuous medical treatment and rehabilitation throughout their growth and development [3]. Consequently, their families often experience prolonged time, financial, and emotional burdens. In addition, parents experience substantial psychological distress associated with their infant's admission to the neonatal intensive care unit (NICU) [4], including heightened anxiety, stress, and disruptions to daily life [5]. Furthermore, NICU care and long-term rehabilitation substantially increase health care expenditures [6], while chronic conditions and disabilities increase social care costs [7], imposing a heavy financial burden on national health care systems [8].

While hospitalized women experiencing symptoms of premature labor [9] frequently seek educational support for premature birth management and crisis intervention, modifying etiology-driven risk factors at this late stage remains challenging. Consequently, shifting the focus toward primary prevention before conception is essential. Addressing lifestyle and demographic risk factors before conception [10], along with early management of maternal stress [11,12] and comorbid conditions [13], may contribute to reducing the risk of premature birth.

Despite decades of efforts to reduce the incidence of premature birth, rates have shown minimal improvement [14]. Notably, 75.5% of women of childbearing age (WCA) recognize the need for PBP education [15]. Consequently, innovative interventions extending beyond conventional approaches are warranted, including social media strategies [16] and digital platforms such as YouTube- and web-based programs [15]. Although internet-based interventions improve reproductive health knowledge among WCA [17] and enhance psychosocial well-being and glycemic control in pregnant women [18], programs specifically designed to strengthen self-management capacity for PBP among women, as primary preventive agents during preconception and early pregnancy, remain limited [17,18].

In particular, few studies have directly evaluated the incidence of premature birth following preconceptional interventions [17]. Interventions implemented during pregnancy have shown limited effectiveness in substantially reducing the incidence of premature birth [18], with previous research often constrained by low-quality evidence and a high risk of attrition bias [17,18]. Therefore, systematic educational programs that enhance women's preventive self-management beginning in the preconception period are crucial. By reducing the incidence of premature birth, NICU admissions, and related complications, such programs offer substantial clinical and socioeconomic benefits.

Webtoons are a digital storytelling medium that presents sequential visual narratives in a vertical-scrolling format and is accessible without spatiotemporal constraints [19]. Storytelling effectively captures learner engagement by translating abstract information into meaningful narratives, thereby enhancing comprehension, retention, self-efficacy, and behavioral change [20]. In the context of women's pregnancy health, webtoon-based interventions have proven effective across multiple behavioral and cognitive dimensions. Previous studies have reported improvements in actual and perceived knowledge, risk perception, affective responses, self-efficacy, intention to engage in protective behaviors, and subsequent information-seeking behavior [21], as well as environmental health perceptions and pregnancy-related health behaviors [22]. Furthermore, webtoon-based interventions have been shown to enhance self-efficacy and knowledge regarding the prevention of premature labor among WCA [23].

To address the need for engaging and highly accessible preconception interventions, this pilot study developed an interactive webtoon-based educational website and evaluated its feasibility, usability, and preliminary effectiveness compared with an active, text-based control website that delivered identical health content.

Study Objectives

This study aimed to evaluate the feasibility and preliminary effectiveness of the "Pregnancy Story I Didn't Know in Interactive Webtoon Series (PSIDK-iWebtoons)," an interactive

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web-based program for preventing premature birth among WCA. Specifically, we examined differences in Self-Management Self-Efficacy for Premature Birth Prevention (SMSE-PBP) and Health Belief Model for Premature Birth Prevention (HBM-PBP) between participants who received the PSIDK-iWebtoons intervention and those who received a text-based version (Pregnancy Story I Didn't Know in Text-Based Information [PSIDK-Texts]). Feasibility was assessed through participant satisfaction (8-item Client Satisfaction Questionnaire [CSQ-8]), website quality evaluations, and qualitative content analysis of postintervention interviews.

Methods

Study Design

This pilot study used an explanatory sequential mixed methods design [24], featuring a 2-arm, parallel-group randomized controlled trial (RCT) with a 1:1 allocation ratio, to examine the feasibility and preliminary effectiveness of the intervention before a full-scale RCT. The CONSORT (Consolidated Standards of Reporting Trials) checklist is available in Multimedia Appendix 1. The findings of this pilot study informed the development of a subsequently published study protocol [25]. This pilot study was not powered to detect definitive effectiveness but rather to assess feasibility and estimate preliminary effects.

Setting

This pilot study was conducted using a study-specific web platform, Pregnancy Story I Didn't Know. The interactive webtoon intervention delivered through this platform was designated as PSIDK-iWebtoons. Access to the platform was restricted to eligible participants invited from across South Korea, ensuring the secure and controlled delivery of the intervention.

Inclusion and Exclusion Criteria

Eligible participants were WCA (19-49 years) who intended to conceive or were planning a pregnancy and had at least one established risk factor for premature birth. Factors associated with an increased risk of premature birth were advanced maternal age (≥35 years), infertility, genitourinary infections, hypertension, diabetes mellitus, thyroid disorders, asthma, coagulation disorders, a history of delivering a low-birth-weight infant, previous cervical surgery, recurrent miscarriage, underweight, overweight, obesity, physically demanding work (eg, shift work or occupations requiring standing for >8 hours per day), smoking, heavy alcohol consumption, and unplanned pregnancy. Additional criteria were the ability to read and write in Korean; access to an internet-capable device; possession of a valid phone number and email address; and active use of mobile messaging or social media. Participants provided written informed consent and agreed to participate in the 3-week web-based program. Participants were excluded if they had a history of premature birth or professional experience in a childbirth-related health care setting.

Sample Size

Although this pilot study was not designed to provide definitive evidence of effectiveness, a sample size calculation was performed to guide recruitment and obtain preliminary estimates for planning a future definitive RCT. Using G*Power version 3.1.9.7 for a repeated-measures ANOVA (effect size f=0.25, α=.05, power=0.90, 2 groups, 3 measurements, correlation=0.50, and ε=1), the minimum required sample size was estimated to be 36 participants. Considering an anticipated attrition rate of 30%, the target sample size was increased to 52 participants.

A total of 52 individuals were assessed for eligibility, of whom 47 were enrolled and underwent age-stratified randomization to either the intervention group (n=24) or the comparison group (n=23). Of these, 19 participants in the intervention group and 15 in the comparison group received the allocated intervention and were included in the final analysis. One participant in the intervention group did not complete the first postintervention assessment (T1) because of an inadvertent failure to respond to the survey but completed the 4-week follow-up assessment (T2) and was therefore included in the final analysis (Figure 1).

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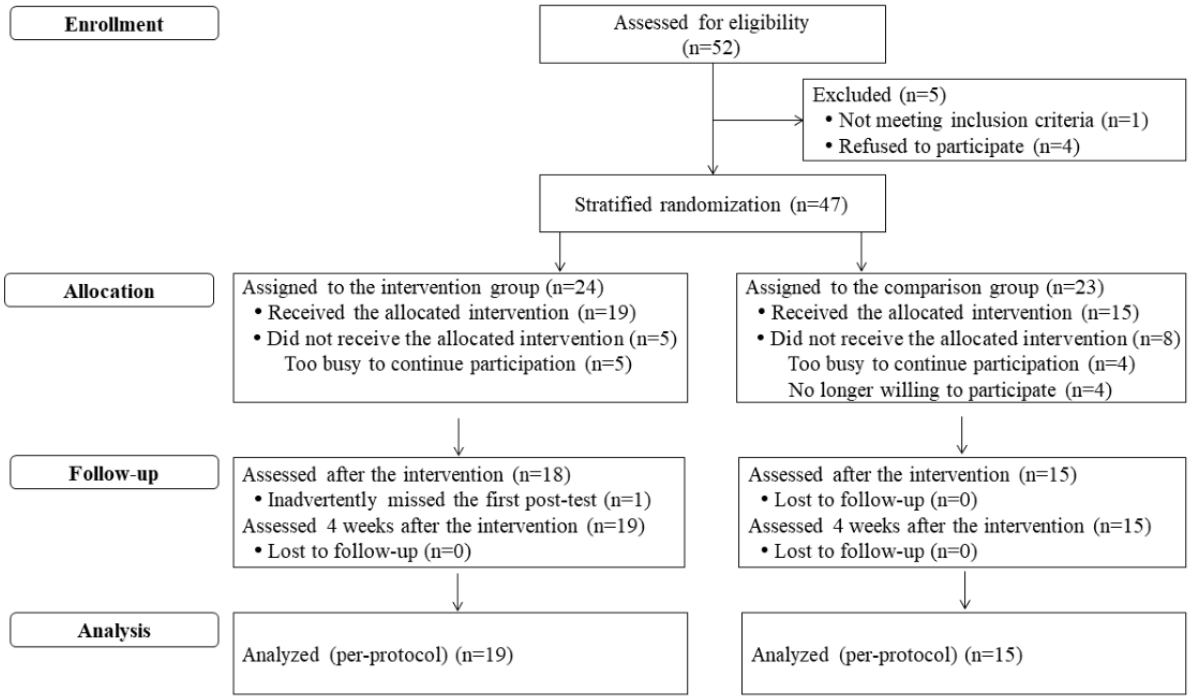
Figure 1. CONSORT (Consolidated Standards of Reporting Trials) diagram showing the flow of participants through the trial. One participant unintentionally missed the first posttest (T1) but completed the second posttest (T2) and was retained in the final analysis.



Intervention Program

The PSIDK-iWebtoons platform was developed through a multistep process involving scenario development, webtoon production, and website construction. The intervention content was informed by qualitative interviews with women who had experienced premature birth and was refined through user and expert reviews to ensure content validity, usability, and clinical relevance. Further details of the development process have been reported in the published study protocol [25].

The text-only website, PSIDK-Texts, was selected as the comparator to control for exposure to the same educational health information while isolating the effects of the interactive webtoon features. The intervention comprised 7 text-based fictional case narratives that delivered educational content equivalent to that of the experimental intervention but without interactive webtoon features, multiple pathways, or alternative endings. Participants also received the same evidence-based professional health information and completed reflective learning activities.

Intervention Implementation

Common Implementation Procedures

To facilitate onboarding, promote intervention adherence, and minimize attrition, a trained research assistant sent structured SMS text messages to participants according to predetermined protocol milestones rather than in response to user inactivity. Before the study, participants in both groups received preparatory SMS text messages 1 week before, 3 days before, and on the day of intervention initiation. These SMS text messages detailed the participation procedures, start dates, and study duration. During the educational intervention period, additional prompts were delivered on days 1, 10, 17, and 19 to remind participants to access and complete the online modules and to provide advance notice of the scheduled completion date. On the day the intervention commenced, participants were provided with comprehensive information necessary for program participation. This information included access details for the study website, the intervention schedule, account registration procedures, guidance on how to use the program, instructions for reflective writing activities, and policies regarding individual account use. Participants accessed their assigned website via the provided link and created a personal account on the intervention start date. They then independently engaged with the posted content for 3 weeks. Participants were free to access the website at their convenience and were allowed to use the program without restrictions on the frequency or duration of learning. The intervention was self-directed, without direct researcher guidance, clinical consultation, or human-delivered co-interventions throughout the study period.

Experimental Group

The PSIDK-iWebtoons intervention was delivered to participants in the experimental group through an online platform. The platform was developed as a responsive web-based application to ensure compatibility across various devices and operating systems, thereby enhancing accessibility. After accessing the website, participants could review the “Program Introduction” page, which provided an overview of the educational program and detailed instructions for participation. The intervention delivered educational content through 7 interactive webtoon series supplemented by professional health information. Participants were encouraged to reflect on the stories and communicate their perspectives by posting written comments on the platform.

The intervention incorporated 7 webtoon series portraying the experiences of 7 women, 6 of whom were affected by risk

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factors associated with premature birth, such as premature labor, cervical insufficiency, and advanced maternal age. The narratives followed the women across the reproductive continuum, including the preconception period, pregnancy, childbirth, NICU hospitalization, and infant discharge. Each series provided 3-4 possible endings, allowing users to experience different outcomes based on the health management decisions they made throughout the storyline (Multimedia Appendix 2).

The platform supported personalized and repeated webtoon series learning. Based on responses to a screening questionnaire on premature birth risk factors, personalized webtoon series recommendations were automatically generated. Participants could revisit each series to explore alternative storylines and endings. The platform also provided a “Learn More” section containing evidence-based professional health information in both topic-specific (Learn Selectively) and comprehensive (Learn All) formats. In addition, the platform included reflective and social learning features that enabled participants to write and share reflections and interact with peers through comments and reaction icons. A Learning Support Center provided announcements and frequently asked questions to support participants throughout the intervention. The platform also included a My Learning Management page that enabled participants to monitor their learning progress, review activities, and access personalized learning records. Further details of the intervention platform and its components are available in the published study protocol [25].

Comparison Group

Participants in the comparison group received the PSIDK-Texts intervention through a separate text-based web platform to maintain group masking. After completing the final assessment, they were granted access to the webtoon-based program. Further details of the comparison intervention are available in the published study protocol [25].

Participant Recruitment

Participant recruitment was conducted in two 2-week cycles: July 17-30, 2023, and August 7-20, 2023. Participants enrolled in each recruitment cycle subsequently proceeded through group allocation, intervention, and data collection according to the study protocol. To recruit participants, study advertisements were disseminated through social networking services, online communities related to marriage and pregnancy preparation, and local public health centers. Although advertisements were posted at local public health centers, all participants were recruited online. Interested individuals accessed the study link, reviewed the study information, and provided informed consent and personal information, including their mobile phone numbers. Mobile phone numbers were used to prevent duplicate participation. The institutional affiliation (Daegu Catholic University) was presented on the study advertisements, informed consent documents, and initial web landing page solely to ensure ethical transparency. The trial ended as planned after the scheduled follow-up was completed.

Participant Allocation

A research assistant who was independent of the intervention and data analysis procedures conducted participant allocation. Participants were randomly assigned to the experimental or comparison group using age-stratified block randomization with a block size of 4 in SPSS Statistics version 25 (IBM Corp). Following advance notification about intervention participation, participants commenced the intervention by accessing the website link corresponding to their assigned group on the intervention start date. The intervention began 2 weeks after the baseline assessment and continued for 3 weeks.

Blinding

At enrollment, participants were informed that they would receive 1 of 2 online educational programs and that assignment to either program would be determined randomly. As both interventions were delivered through web-based platforms with comparable structures, participants were not informed of the specific group to which they had been assigned. Participant masking was maintained throughout the intervention period, follow-up assessments, and qualitative interviews.

A researcher enrolled participants, while a research assistant generated the random allocation sequence and assigned participants to the interventions. The researcher responsible for participant communication, study administration, data collection, and statistical analysis was not blinded to group allocation.

Data Collection

Quantitative Data Collection

Quantitative data were collected between July 17 and October 29, 2023, at 3 time points: baseline (T0), posttest 1 (T1), and posttest 2 (T2). For both groups, data were collected using SurveyMonkey (SurveyMonkey Inc), with SMS text messages containing a URL link to the online survey sent at the same scheduled time points. Baseline data were collected 2 weeks before the intervention and included general demographic characteristics, pregnancy-related characteristics, the SMSE-PBP, and the HBM-PBP. Posttest 1 data were collected during the week immediately following completion of the 3-week intervention period. Posttest 2 data were collected over a 1-week period beginning 4 weeks after completion of the intervention. At both posttest assessments, participants completed the SMSE-PBP and HBM-PBP scales. In addition, participants in the experimental group completed the CSQ-8 and a Website Quality Evaluation at posttest 1 to assess the acceptability, feasibility, and overall quality of the educational program. Intervention completion and adherence rates were objectively tracked using web server logs provided by the website administrator.

Primary Outcome: SMSE-PBP

SMSE-PBP was measured using the SMSE-PBP, developed by Kim and Lee [26]. The SMSE-PBP consists of 60 items across 3 domains: pre-pregnancy SMSE-PBP (13 items), pregnancy SMSE-PBP (32 items), and hospital SMSE-PBP (15 items). Each item is rated on a 5-point Likert scale, ranging from 1 (I can hardly do it) to 5 (I can do it very well). Although each domain can be used independently, the instrument was also

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designed to be used as a single, comprehensive scale by combining all 3 domains [26]. In this study, the mean item score was calculated by summing the scores of all 60 items and dividing the total by 60. Higher scores indicate greater SMSE-PBP. In the original study, Cronbach α coefficients were 0.88 for the pre-pregnancy SMSE-PBP, 0.96 for the pregnancy SMSE-PBP, and 0.96 for the hospital SMSE-PBP [26]. In this study, the baseline Cronbach α coefficient was 0.98 for the overall SMSE-PBP, while the baseline Cronbach α coefficients for the 3 domains ranged from 0.87 to 0.96.

Secondary Outcome: Health Belief Model Scale for Premature Birth Prevention

Health beliefs regarding premature birth prevention were measured using the HBM-PBP, developed by Kim et al [27]. The HBM-PBP consists of 96 items across 4 domains related to PBP: perceived susceptibility (21 items), perceived severity (26 items), perceived benefits (27 items), and perceived barriers (22 items). Each item is rated on a 5-point Likert scale, ranging from 1 (not likely at all) to 5 (very likely). For each domain, the mean item score was calculated by summing the item scores and dividing by the number of items in that domain. Higher scores indicate stronger health beliefs regarding PBP in the corresponding domain. In the original study, Cronbach α coefficients were 0.87 for perceived susceptibility, 0.94 for perceived severity, 0.94 for perceived benefits, and 0.92 for perceived barriers [27]. In this study, the baseline Cronbach α coefficient was 0.94 for the overall HBM-PBP, while the baseline Cronbach α coefficients for the 4 domains ranged from 0.86 to 0.94.

Feasibility Outcomes

The 8-Item Client Satisfaction Questionnaire

Satisfaction with the web-based educational program was measured using the CSQ-8, developed by Attkisson and Zwick [28]. The CSQ-8 consists of 8 items, each rated on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The mean item score was calculated by summing the scores of all 8 items and dividing by 8. Higher scores indicate greater satisfaction with the web-based educational program. In this study, the Cronbach α coefficient was 0.94.

Website Quality Evaluation

Website quality was evaluated using a modified version of the website quality evaluation instrument originally developed by Kang et al [29] and subsequently revised by Choi [30]. The instrument consists of 20 items, each rated on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The mean item score was calculated by summing the scores of all 20 items and dividing by 20. Higher scores indicate better perceived website quality. In this study, the Cronbach α coefficient was 0.92.

Demographic and Pregnancy-Related Characteristics

Participants' demographic characteristics, including age, education, occupation, marital status, household income, and area of residence, as well as pregnancy-related characteristics, including previous childbirth experience, pregnancy-related health conditions, number of children, experience of prenatal education, and previous education on premature birth, were assessed.

Qualitative Data Collection

Qualitative data were collected from October 30 to November 5, 2023, following completion of the second posttest assessment, to examine the educational impact of the web-based intervention and evaluate participants' experiences with and perceptions of the program. To recruit interview participants, invitation SMS text messages were sent to individuals in the experimental group. A total of 10 participants volunteered to participate in the interviews. All volunteers were included in the qualitative study and participated in individual in-depth interviews. The demographic characteristics of the interview participants are summarized in Multimedia Appendix 3.

Participants who expressed interest in the interviews were contacted by telephone to arrange a convenient interview time and determine their preferred interview format (telephone or videoconference). One-on-one semistructured interviews were conducted with these participants to explore their experiences with the educational program and assess its perceived effectiveness, usability, and feasibility.

Interview questions focused on perceived changes in self-efficacy for PBP, health beliefs regarding PBP, and intentions to engage in preventive health behaviors compared with participants' preintervention status. Additional questions explored participants' overall experiences with the educational program, perceptions of the educational content, and experiences using the website. Follow-up and probing questions were used as needed to obtain more detailed information and clarification. Qualitative data were collected to evaluate the web-based intervention and the website.

Data Analysis

Statistical Analysis

The primary analyses were conducted using a per-protocol approach. Participants who received the allocated intervention were included in the analyses, whereas those who did not receive the allocated intervention were excluded from the per-protocol population. The data were analyzed using SPSS Statistics 25 (IBM Corp). Frequencies, percentages, means, and SDs were calculated to describe the participants' demographic and pregnancy-related characteristics. The normality of the data distributions for the variables was assessed using the Shapiro-Wilk test.

The homogeneity of demographic and pregnancy-related characteristics between the 2 groups was assessed using the Mann-Whitney *U* test for nonnormally distributed continuous variables and the chi-square test or Fisher exact test for categorical variables, as appropriate. The major measurement variables (SMSE-PBP, HBM-PBP, CSQ-8, and website quality evaluation) were summarized as means and SDs. Baseline homogeneity of the outcome variables was assessed using the independent-samples *t* test for normally distributed variables and the Mann-Whitney *U* test for nonnormally distributed variables. No imputation was performed. Repeated measurements were analyzed using generalized estimating

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equations with a gamma distribution, a log link function, and an unstructured working correlation structure. Model effects were evaluated using Wald χ^2 statistics. As baseline perceived severity on the HBM-PBP differed significantly between the 2 groups (P=.04), a post hoc sensitivity analysis was performed using a generalized estimating equation model adjusted for baseline perceived severity (time 0) as a covariate (Multimedia Appendix 4). The reliability of all measurement tools was assessed using Cronbach α. All statistical tests were 2-sided, with a significance level of α=.05.

Qualitative Data Analysis and Trustworthiness/Rigor

The interview data were analyzed using the qualitative content analysis approach described by Hsieh and Shannon [31], with NVivo 14 (Lumivero) used to facilitate data organization and analysis. The researcher repeatedly reviewed the audio recordings, transcripts, and field notes to become immersed in the data and enhance understanding of the study phenomenon. Data were analyzed through open coding, with codes revised and refined throughout the analytic process. Related codes were organized into categories, and overarching themes were identified by integrating recurring meanings across the data.

To enhance the rigor of the study, the criteria proposed by Lincoln and Guba [32]—credibility, transferability, dependability, and confirmability—were applied throughout the research process. Credibility was established through in-depth individual interviews and member checking, whereby participants reviewed and confirmed the accuracy of the interpretations derived from their interview data. To enhance transferability, participants with diverse characteristics were recruited, including variations in age, educational attainment, occupation, marital status, monthly income, parity, and number of children. These characteristics and the study context were described in detail to facilitate assessment of the applicability of the findings to other settings. Dependability was strengthened through a systematic analytic process in which one researcher (YJL) conducted the primary data analysis and another researcher (SHK) independently reviewed the analytic procedures and findings. Confirmability was enhanced by continuously comparing the emerging findings with the original interview data throughout the analysis. In addition, 2 researchers (SHK and YJL) experienced in qualitative research reviewed the analysis and interpretations to minimize researcher bias and ensure that the findings were grounded in the data.

Ethical Considerations

Ethical approval for this study was granted by the Institutional Review Board of Daegu Catholic University (institutional review board approval number CUIRB-2021-0081-02) before any study procedures were initiated. Before enrollment, participants reviewed an online study information sheet outlining the study purpose, procedures, confidentiality protections, voluntary nature of participation, and participants' rights. Electronic informed consent was obtained from all participants before data collection. For the qualitative interviews, participants received additional information regarding audio recording and transcription procedures, and written informed consent was obtained before the interviews. Participants received compensation in the form of gift vouchers valued at approximately KRW 4000 (KRW 1=US $0.00075) for each completed survey and KRW 30,000 for participation in a qualitative interview.

Results

Baseline Assessment

Baseline data for both groups are presented in Table 1. Comparisons between the 2 groups showed no statistically significant differences in age (P=.75), education (P=.84), occupation (P>.99), marital status (P=.97), household income (P=.71), area of residence (P=.67), previous childbirth experience (P=.61), pregnancy-related health conditions (P=.57), number of children (P=.59), experience of prenatal education (P=.46), or previous education of premature birth (P=.41).

Baseline SMSE-PBP scores and HBM-PBP scores for perceived susceptibility, severity, benefits, and barriers are presented in Table 2. No statistically significant differences were observed between the 2 groups in SMSE-PBP (P=.34) or in perceived susceptibility (P=.18), perceived benefits (P=.38), or perceived barriers (P=.20) on the HBM-PBP. However, a statistically significant difference was observed in perceived severity on the HBM-PBP (P=.04).

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Table 1. Baseline demographic and pregnancy-related characteristics of the experimental and comparison groups (N=34).

Variables/categories	Total (n=34)	Experimental group (n=19)	Comparison group (n=15)	Chi-square (*df*) or Mann-Whitney *U* test	*P* value
Age[a], mean (SD)	33.68 (7.34)	33.32 (7.30)	34.13 (7.61)	–0.32	.75
Education[b], n (%)				0.85	.84
High school or below	3 (9)	1 (5)	2 (13)		
Bachelor	26 (77)	15 (79)	11 (73)		
Master or more	5 (15)	3 (16)	2 (13)		
Occupation[b], n (%)				0.38	>.99
None	13 (38)	7 (37)	6 (40)		
Permanent position	19 (56)	11 (58)	8 (53)		
Temporary position	2 (6)	1 (5)	1 (7)		
Marital status[c], n (%)				0.00 (1)	.97
Single	16 (47)	9 (47)	7 (47)		
Married	18 (53)	10 (53)	8 (53)		
Household income (KRW[d])[b], n (%)				N/A[e]	.71
<5,000,000	11 (32)	7 (37)	4 (27)		
≥5,000,000	23 (68)	12 (63)	11 (73)		
Area of residence[b], n (%)				N/A	.67
Metropolitan	27 (79)	16 (84)	11 (73)		
Province	7 (21)	3 (16)	4 (27)		
Previous childbirth experience[c], n (%)				0.26 (1)	.61
Yes	12 (35)	6 (32)	6 (40)		
No	22 (65)	13 (68)	9 (60)		
Pregnancy-related health conditions[b], n (%)				N/A	.57
Yes	3 (9)	1 (5)	2 (13)		
No	31 (91)	18 (95)	13 (87)		
Number of children[a], mean (SD)	0.62 (0.89)	0.53 (0.84)	0.73 (0.96)	129.00	.59
Experience of prenatal education[b], n (%)				N/A	.46
Yes	9 (26)	4 (21)	5 (33)		
No	25 (74)	15 (79)	10 (67)		
Previous education on premature birth[c], n (%)				0.68 (1)	.41
Yes	14 (41)	9 (47)	5 (33)		
No	20 (59)	10 (53)	10 (67)		

[a]Mann-Whitney *U* test.

[b]Fisher exact test

[c]Chi-square test.

[d]KRW 1=US $0.00075.

[e]N/A: not applicable (ie, no test statistic is reported for the Fisher exact test).

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Table 2. Mean and SD values of outcome variables between both groups across study time points and the baseline comparisons (N=34).

Variables and time	Experimental group (n=19), mean (SD)	Comparison group (n=15), mean (SD)	Comparison of groups at T0, *t* test (*df*) or Mann-Whitney *U* test; *P* value
SMSE-PBP[a,b]			114.00; .34[c]
Time 0	3.80 (0.60)	4.07 (0.41)	
Time 1	4.18 (0.42)	4.35 (0.40)	
Time 2	4.34 (0.44)	4.47 (0.34)	
Perceived susceptibility of HBM-PBP[d,e]			–1.37 (32); .18[f]
Time 0	3.79 (0.39)	3.98 (0.44)	
Time 1	4.23 (0.46)	4.35 (0.36)	
Time 2	4.26 (0.50)	4.39 (0.45)	
Perceived severity of HBM-PBP			2.14 (32); .04[f]
Time 0	3.37 (0.57)	2.93 (0.62)	
Time 1	3.49 (0.66)	3.05 (0.57)	
Time 2	3.38 (0.87)	2.93 (0.62)	
Perceived benefits of HBM-PBP			–0.89 (32); .38[f]
Time 0	3.71 (0.49)	3.85 (0.41)	
Time 1	4.06 (0.59)	4.04 (0.45)	
Time 2	4.12 (0.56)	4.18 (0.45)	
Perceived barriers of HBM-PBP			1.30 (30.4); .20[f]
Time 0	4.15 (0.53)	3.96 (0.32)	
Time 1	4.34 (0.47)	3.99 (0.37)	
Time 2	4.38 (0.50)	4.31 (0.34)	

[a]SMSE-PBP: Self-Management Self-Efficacy for Premature Birth Prevention.

[b]SMSE-PBP scale: time 0=baseline test; time 1= after intervention; and time 2=4 weeks after intervention.

[c]Mann-Whitney *U* test.

[d]HBM-PBP: Health Belief Model for Premature Birth Prevention.

[e]HBM-PBP scale: time 0=baseline test; time 1= after intervention; and time 2=4 weeks after intervention.

[f]Independent *t* test. One participant in the intervention group was missing at time 1 (n=18).

Outcome Measures

Primary Outcome

No statistically significant group-by-time interactions were observed for SMSE-PBP (group × time 1: Wald χ^2=0.53, *P*=.47; group × time 2: Wald χ^2=0.86, *P*=.36). However, statistically significant changes over time were observed for SMSE-PBP (time 1: Wald χ^2=7.48, *P*=.006; time 2: Wald χ^2=12.59, *P*<.001; Table 3).

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Table 3. Generalized estimating equation[a] analysis regarding the effects of webtoon education on preventive self-management related to premature labor (N=34).[b]

Variables and categories	B	SE	95% Wald CI	Wald chi-square test	*P* value
SMSE-PBP[c]					
Group	–0.27	0.17	–0.60 to 0.05	2.67	.10
Time 1	0.28	0.10	0.08 to 0.48	7.48	.006
Time 2	0.40	0.11	0.18 to 0.61	12.59	<.001
Group × time 1	0.12	0.16	–0.20 to 0.43	0.53	.47
Group × time 2	0.15	0.16	–0.17 to 0.47	0.86	.36
Perceived susceptibility of HBM-PBP[d]					
Group	–0.19	0.14	–0.47 to 0.08	1.94	.16
Time 1	0.37	0.08	0.21 to 0.53	20.79	<.001
Time 2	0.41	0.10	0.21 to 0.61	15.98	<.001
Group × time 1	0.09	0.14	–0.19 to 0.36	0.40	.53
Group × time 2	0.07	0.14	–0.22 to 0.35	0.21	.64
Perceived severity of HBM-PBP					
Group	0.44	0.20	0.04 to 0.83	4.75	.03
Time 1	0.12	0.10	–0.07 to 0.31	1.52	.22
Time 2	0.00	0.14	–0.27 to 0.27	0.00	.99
Group × time 1	0.05	0.16	–0.27 to 0.36	0.09	.77
Group × time 2	0.01	0.21	–0.40 to 0.42	0.00	.96
Perceived benefits of HBM-PBP					
Group	–0.14	0.15	–0.43 to 0.15	0.87	.35
Time 1	0.19	0.08	0.03 to 0.35	5.36	.02
Time 2	0.33	0.10	0.13 to 0.54	10.39	.001
Group × time 1	0.15	0.14	–0.13 to 0.42	1.07	.30
Group × time 2	0.07	0.17	–0.26 to 0.41	0.18	.67
Perceived barriers of HBM-PBP					
Group	0.19	0.14	–0.09 to 0.47	1.80	.18
Time 1	0.03	0.08	–0.13 to 0.20	0.16	.69
Time 2	0.35	0.12	0.12 to 0.58	9.06	.003
Group × time 1	0.13	0.11	–0.08 to 0.34	1.42	.23
Group × time 2	-0.12	0.15	–0.41 to 0.18	0.60	.44

[a]Generalized estimating equation models were fitted using an unstructured working correlation structure, a gamma distribution, and a log link function.

[b]Reference categories were the comparison group and time 0 (baseline).

[c]SMSE-PBP: Self-Management Self-Efficacy for Premature Birth Prevention.

[d]HBM-PBP: Health Belief Model for Premature Birth Prevention.

Secondary Outcome

No statistically significant group-by-time interactions were observed for any of the HBM-PBP subdomains: perceived susceptibility (group × time 1: Wald χ^2=0.40, *P*=.53; group × time 2: Wald χ^2=0.21, *P*=.64), perceived severity (group × time 1: Wald χ^2=0.09, *P*=.77; group × time 2: Wald χ^2=0.00, *P*=.96), perceived benefits (group × time 1: Wald χ^2=1.07, *P*=.30; group × time 2: Wald χ^2=0.18, *P*=.67), and perceived barriers (group × time 1: Wald χ^2=1.42, *P*=.23; group × time 2: Wald χ^2=0.60, *P*=.44; Table 3).

Statistically significant changes over time were observed for the HBM-PBP subdomains of perceived susceptibility (time 1: Wald χ^2=20.79, *P*<.001; time 2: Wald χ^2=15.98, *P*<.001), perceived benefits (time 1: Wald χ^2=5.36, *P*=.02; time 2: Wald

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χ^2=10.39, *P*=.001), and perceived barriers (time 2: Wald χ^2=9.06, *P*=.003). A statistically significant difference between the groups was observed for perceived severity on the HBM-PBP (Wald χ^2=4.75, *P*=.03; Table 3).

In the sensitivity analysis adjusted for baseline perceived severity (Multimedia Appendix 4), the between-group difference in perceived severity on the HBM-PBP was no longer statistically significant (Wald χ^2=0.95, *P*=.33), whereas the between-group differences in perceived susceptibility (Wald χ^2=5.79, *P*=.02) and perceived barriers (Wald χ^2=4.23, *P*=.04) became statistically significant.

Nested Qualitative Evaluation of the Web-Based Intervention

Shift Toward Proactive and Comprehensive PBP Behaviors

Overview

The qualitative evaluation results are presented in Multimedia Appendix 5. Following the intervention, participants demonstrated a shift in their perceptions of PBP behaviors. Three dimensions were identified: awareness of the necessity of PBP behaviors, expansion of the timing of PBP behaviors, and diversification of the categories of practice for PBP behaviors. Notably, the program completion rate emerged as a factor influencing the timing of preventive behaviors.

Awareness of the Necessity of PBP Behaviors: A Shift From the Unknown to an Essential Task

Participants reported that they first recognized the importance of PBP behaviors after joining the program, and their perception of PBP as an essential prerequisite for a healthy delivery was strengthened.

Expansion of the Timing of PBP Behaviors: A Shift From Reactive Response to Proactive Management

Participants showed clear differences in their perceptions of the timing of preventive behaviors according to their level of program completion. Those who completed the program shifted from a reactive stance—responding only after risk symptoms emerged—to a proactive view that prevention should begin during pregnancy planning or early pregnancy. By contrast, participants with lower completion rates showed no change in their perceptions and continued to view prevention as something to be undertaken only during pregnancy or after symptoms appeared.

Diversification of the Categories of Practice for PBP Behaviors: Expansion From a Fragmented Level of Risk Factor Elimination to a Comprehensive Health Management System

Participants broadened their understanding of preventive behaviors from a fragmented approach focused solely on eliminating diseases and risk factors to a more comprehensive approach that actively promotes health and involves using the health care system to manage health beginning before pregnancy.

Continuum of Proactive SMSE-PBP

Overview

Participants reported that, following the intervention program, their SMSE-PBP had progressed from a basic cognitive stage to an active control stage, with specific changes observed at each time point.

Prepregnancy Stage: Proactive Management Intention and Implementation Efficacy

Participants shifted the perceived starting point of PBP to the prepregnancy period, demonstrating a strong willingness to take action to create a healthy environment for conception. Their confidence in performing both daily health management and issue-specific management (such as folic acid supplementation and management of underlying conditions) was enhanced. Furthermore, they developed confidence in collaborative preventive care, moving beyond passively listening to expert advice to proactively seeking consultations.

During Pregnancy Stage: High-Risk Symptom Surveillance and Immediate Response Capacity

Before the intervention, daily-life management for PBP was focused mainly on early pregnancy. After the intervention, however, participants showed a shift in perception and increased confidence in managing their health throughout pregnancy. They also became better able to identify high-risk symptoms that had previously been unfamiliar or unclear to them (such as preeclampsia and premature labor) and gained confidence in their ability to monitor these symptoms themselves.

They internalized specific, step-by-step coping strategies for managing risk symptoms during pregnancy, going beyond “simple hospital visits” to include immediate rest, seeking help, and other concrete actions in response to symptoms.

Their ability to actively seek in-depth counseling from health care professionals and request support from family members and relatives was strengthened, expanding their approach to care from isolated self-management to management supported by a broader network.

Stage of Hospitalization and Postdischarge: Securing Continuity of Proactive Self-Management

Beyond merely following health care providers’ instructions, participants demonstrated self-efficacy as active co-managers by closely monitoring their own symptoms and sharing this information with medical staff. They also demonstrated a high level of acceptance and willingness to adhere to recommendations, even when medical decisions were difficult to accept.

They developed the ability to sustain self-management after discharge by actively asking health care providers questions, following their instructions, and mobilizing family resources to support ongoing self-care.

Critical Point of the Intervention

A small number of participants (2 individuals) reported experiencing psychological burden due to the increased self-management tasks and expressed uncertainty about their ability to recognize symptoms accurately.

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HBM-Based Changes in Perceptions of PBP

Overview

The intervention program altered participants' Health Belief Model constructs related to PBP in multiple ways, as detailed below.

Perceived Susceptibility to Premature Birth: Rediscovering Relevance

Participants became aware of their own vulnerability by recognizing that various factors they had previously overlooked were directly associated with premature birth.

Participants recognized that lack of antenatal care, specific medical conditions (underlying diseases), age, and weight management could contribute to premature birth. Accordingly, they acknowledged the importance of preventive management and expressed confidence in their ability to implement it.

They came to understand that inappropriate health behaviors and psychological stress could contribute to premature birth, thereby expanding the scope of everyday health management to include PBP.

Perceived Severity of Premature Birth: Heightened Awareness of Multidimensional Loss

Participants developed a clearer understanding of the physical, psychological, and social consequences they could face if premature birth occurred.

Participants expressed heightened concern not only about the infant's hospitalization and potential developmental delays but also about the persistence of maternal complications and delays in their own physical recovery.

They perceived the emotional trauma of feeling guilty about the baby's premature birth, depressive feelings, regret about the pregnancy, and fear of recurrence in a subsequent pregnancy as serious threats. They also expressed concern about disruptions to childcare and work life and a decline in overall family quality of life. However, a few participants also demonstrated excessive trust in medical technology, reflecting a treatment optimism bias.

Perceived Benefits of PBP: Firm Conviction in the Usefulness of Anticipatory Management

After the intervention, participants expressed strong confidence in the positive outcomes of PBP behaviors.

Participants became convinced that planned pregnancy (including birth spacing), elimination of risk factors before conception, and maintenance of healthy lifestyle practices during pregnancy could substantially reduce the risk of premature birth.

They recognized that early detection of risk symptoms and prompt medical intervention were decisive factors in preventing premature birth. They also emphasized that medical management contributes to psychological stability and disease control.

Perceived Barriers to PBP: Overcoming Barriers While Remaining Practical Constraints and Psychological Obstacles

Through increased awareness of PBP, participants demonstrated efforts to overcome perceived barriers. However, some continued to report difficulties in sustaining preventive behaviors because of ongoing environmental and structural constraints, lack of knowledge, and psychological barriers.

Limited time due to employment, financial costs, the psychological burden associated with shifting workloads to others, and restricted access to health care hindered the actual implementation of preventive behaviors. In particular, perceived inconvenience associated with preconception medical care and the psychological burden of work responsibilities remained obstacles to sustaining preventive practices.

Insufficient knowledge of the warning signs of premature birth and lack of awareness of high-risk factors, together with complacency and an underestimation of the importance of PBP and antenatal care, emerged as key psychological barriers to engaging in preventive behaviors.

Feasibility, Safety, User Satisfaction, and Website Quality

Intervention Uptake, Completion, and Safety

The intervention demonstrated good feasibility, with an uptake rate of 79% (19/24) in the experimental group and 65% (15/23) in the comparison group. Within the experimental group, 14 out of 19 (74%) participants who initiated the program completed it, whereas the remaining 5 participants showed partial or unknown engagement (1/19, 90% engagement; 1/19, 60% engagement; 1/19, 30% engagement; 1/19, 10% engagement; and 1/19, no response). No adverse events, unintended negative effects, or harms related to the web-based intervention were reported in either group during the study period.

The mean total CSQ-8 score was 3.56 (SD 0.45). Among the individual items, fulfillment of personal requirements, effectiveness in problem-solving, overall satisfaction, and future engagement had the highest mean score of 3.61 (SD 0.50), whereas satisfaction with the amount of help received had the lowest mean score of 3.44 (SD 0.62).

The mean total website quality evaluation score was 3.43 (SD 0.41). Among the individual items, site name and author attribution had the highest mean score of 3.67 (SD 0.49), whereas location display had the lowest mean score of 3.11 (SD 0.90; Table 4).

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Table 4. Client satisfaction and website quality evaluation (N=18).

Items	Mean (SD)
8-Item Client Satisfaction Questionnaire (total)	3.56 (0.45)
Quality of the education program	3.56 (0.51)
Fulfillment of personal requirements	3.61 (0.50)
Recommendation to others	3.50 (0.51)
Satisfaction with help received	3.56 (0.51)
Satisfaction with the amount of help	3.44 (0.62)
Effectiveness in problem solving	3.61 (0.50)
Overall satisfaction	3.61 (0.50)
Future engagement	3.61 (0.50)
Website quality evaluation (total)	3.43 (0.41)
Purpose statement	3.56 (0.51)
Target audience specification	3.61 (0.50)
Site name	3.67 (0.49)
URL/domain	3.56 (0.51)
Author attribution	3.67 (0.49)
Content expertise	3.61 (0.50)
Specification of information limitations	3.44 (0.62)
Feedback collection mechanisms	3.39 (0.61)
Handling of user opinions	3.39 (0.61)
Initial creation date indication	3.39 (0.50)
Linked sites	3.39 (0.70)
Site map	3.39 (0.70)
Usage guidelines/help	3.33 (0.69)
Location display	3.11 (0.90)
Accessibility of materials	3.33 (0.59)
Cost of accessing information[a]	3.17 (0.99)
Expressiveness	3.39 (0.61)
Layout	3.44 (0.62)
Graphics	3.56 (0.51)
Privacy protection measures	3.22 (0.65)

[a]Reversed score.

Nested Qualitative Findings on User Experience and Educational Benefits

System Usability and Interface Evaluation

Participants generally reported high satisfaction with the intuitive screen layout and design, although some features varied in terms of accessibility, visibility, and usability. Participants often accessed the webtoon without reviewing the program guide and were unaware of advanced My Page functions, such as checking endings and resuming where they had left off. This made reviewing different endings inconvenient and reduced their motivation for repeated learning. The text-centered Learn More content and the additional clicks required to access Learn Selectively and Learn All also limited their use, with some participants unaware that these features existed. Reflections were viewed positively for encouraging deeper thinking and sharing; however, the writing burden and discomfort with public exposure discouraged some participants from using this feature.

Appropriateness of Educational Content and Learning Immersion

The narrative, story-based learning approach delivered in a webtoon format, together with diverse cases, instilled in participants a strong willingness to take preventive action.

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Implementation Strength of the Program and Needs for Improvement

Participants evaluated the program as providing practical guidance on managing premature birth risk factors beginning at the pregnancy planning stage and expressed willingness to recommend it to others.

Although these topics were already covered in the program content, participants requested more detailed information on alcohol and smoking cessation and individualized dietary interventions tailored to their personal health status.

Discussion

Principal Findings

This pilot RCT demonstrated that the PSIDK-iWebtoons intervention was feasible to implement, with feasibility benchmarks achieved for recruitment, retention, participant satisfaction, and website quality. Both groups showed improvements over time in SMSE-PBP and several HBM-PBP subdomains. However, no statistically significant group-by-time interactions were detected, indicating that this pilot study did not demonstrate a superior effect of PSIDK-iWebtoons compared with PSIDK-Texts.

Comparison With Previous Studies

In this study, participants reported high satisfaction with the web-based educational program, and qualitative findings indicated that webtoon-based storytelling enhanced learning immersion and willingness to engage in premature birth prevention behaviors. This is consistent with previous research showing that scenario-based and emotionally engaging education is more effective than information-focused education in improving health behavior knowledge [23,33], health behaviors [33], and self-efficacy [23,34]. Quantitative findings from the webtoon arm also showed high ratings for fulfillment of personal needs, problem-solving effectiveness, and willingness to recommend the program. Qualitative findings further indicated that the personalized "recommended series" helped participants identify their premature birth risk factors starting at the pregnancy-planning stage and understand feasible preventive behaviors in daily life. These findings suggest that the program enhanced not only knowledge but also the perceived applicability of preventive behaviors. Therefore, PBP education for WCA should incorporate personalized, story-based, interactive content that promotes learner immersion and self-reflection rather than relying solely on factual information.

By contrast, participants requested more advanced information on alcohol and smoking management and individualized dietary therapy tailored to their health status. Although the program addressed alcohol and smoking in 2 separate series, related health management strategies were presented relatively briefly, leading participants to seek more specific and in-depth information. This may reflect both the limited content on these topics and participants' increased motivation to apply health information to their own circumstances. These findings are consistent with previous studies showing that users of digital health interventions expect not only basic information but also tailored, in-depth content relevant to their individual needs [35,36]. In Korea, smoking prevalence among WCA has been reported as 4.0% in their 20s, 4.1% in their 30s, and 6.0% in their 40s, while annual and monthly drinking rates range from 84.8% to 88.7% and from 63.0% to 67.2%, respectively [37]. These findings highlight smoking and alcohol use as important modifiable risk factors that should be addressed before pregnancy. Pregnancy also represents a potentially important motivational period for smoking cessation and alcohol reduction [38]. Therefore, future versions should strengthen alcohol- and smoking-related content and provide tailored, advanced health management information based on users' risk factors and health status through the "Learn More" section, which follows the basic webtoon-based learning.

Health information system features, including functionality, aesthetics, and ease of use, are critical to human-computer interaction and system utilization [39]. Participants in the webtoon arm reported high satisfaction with website quality in both the quantitative and qualitative findings, particularly regarding information accessibility, graphics, simple menu structure, risk-based recommended series, and intuitive screen layout. These findings may reflect the person-based approach used during website development, in which users' needs and experiences were incorporated and usability was repeatedly assessed and refined among WCA [40]. The webtoon-centered visual content and simple interface enabled participants to navigate the program without additional training, likely contributing to their high satisfaction. Consistent with evidence that users tend to explore topics of greatest interest first [40], the website prioritized series recommended based on individual premature birth risk assessments, allowing users to access personally relevant content intuitively. This user-centered information architecture and interface design likely enhanced perceived usability and convenience. As usability is a key factor in user satisfaction [41], it may also promote engagement and continued system use [42].

In digital health interventions, merely providing functions is insufficient; interface design that enables users to easily discover and use these functions is a key factor in enhancing user experience and program utilization [39]. The platform's information architecture, which prominently displayed personalized recommended webtoon series at the top of the main screen, appeared to facilitate access to learning materials by directing participants' attention to the recommended content first. By contrast, although the "Learn More" menu, which provided text-based health information, was positioned at the top of the main screen to maximize visibility and discoverability, a small number of participants did not recognize its existence. This finding suggests that visibility alone may not ensure feature utilization. Although the menu was prominently positioned, participants may have perceived the webtoon series as providing sufficient information or the text-based content as less engaging or more difficult to understand. As a result, they may not have accessed the menu or recalled its existence during interviews.

In addition, the "Checking Endings" and "Resuming From Where They Left Off" functions were located within My Page and required an additional step to access, which may have limited their use. This suggests that the issue was related more to information architecture and user interface design than to the

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usefulness of these functions [39]. Similarly, the "Collected Endings" function, an important educational feature for comparing choice outcomes and reflecting on decision-making, may not have been sufficiently visible or discoverable. Limited digital literacy may have further contributed to navigation difficulties [43]. To enhance user satisfaction, future versions should incorporate user experience improvements, such as more intuitive menu labels and feature placement, first-use tutorials or guidance pop-ups, and greater visual emphasis on key features, along with adequate user training [39].

In this study, SMSE-PBP improved significantly over time, but no significant group-by-time interaction was observed, indicating improvement in both groups. The absence of a significant interaction may reflect the small sample size and limited statistical power [44], as well as the relatively short, low-intensity, web-based intervention, which may have been insufficient to produce substantial between-group differences in self-efficacy [45]. Moreover, both groups received the same evidence-based educational content (Learn More) and participated in identical reflection activities, differing only in delivery mode (webtoon vs text). Thus, both interventions may have contributed to the observed improvement, resulting in a small between-group difference. Qualitative findings from the webtoon arm provided complementary insights into the quantitative findings, with participants reporting enhanced self-efficacy and a greater capacity for proactive self-management across the trajectory from preconception through pregnancy, hospitalization, and postdischarge. These findings suggest that PSIDK-iWebtoons contributed to participants' experiences of improved self-efficacy; however, because the between-group difference was not statistically significant, a greater effect of PSIDK-iWebtoons than PSIDK-Texts cannot be concluded.

In this study, no significant group-by-time interaction effects were found for any HBM-PBP subdomain, indicating that PSIDK-iWebtoons did not improve health beliefs more than PSIDK-Texts. However, perceived susceptibility, benefits, and barriers changed significantly over time in both groups, suggesting that both interventions contributed to these improvements. Qualitative findings from the webtoon arm were consistent with the quantitative findings, with participants reporting increased perceptions of susceptibility and the benefits of preventive behaviors. They also identified the physical, psychological, and social impacts of premature birth, as well as barriers to preventive behaviors, including lack of information, time and financial constraints, and work-related and psychological burdens. These findings suggest that the webtoon-based intervention may have supported a deeper understanding of PBP. Similarly, a significant improvement in perceived susceptibility was reported following a 12-week nutrition education intervention for pregnant women at risk of gestational diabetes [46]. Although daily SMS text messages were provided, the core education consisted of only 2 face-to-face sessions, which may have limited opportunities for repeated and in-depth learning. This suggests that repeated learning opportunities and sufficient interaction may be more important than intervention duration alone in modifying health beliefs. Finally, the absence of significant group-by-time interactions, consistent with the SMSE-PBP findings, may reflect limited statistical power due to the small sample size and the relatively short, low-intensity intervention period [45]. In the sensitivity analysis adjusting for baseline perceived severity, the significant between-group difference in perceived severity observed in the unadjusted analysis was no longer statistically significant. By contrast, perceived susceptibility and perceived barriers, which were not significantly different between groups in the unadjusted analysis, showed significant between-group differences after adjustment. These findings indicate that adjustment for baseline perceived severity influenced the estimated between-group differences across HBM-PBP subdomains, warranting cautious interpretation of the observed between-group effects.

This study provides an early contribution to the field by evaluating an interactive webtoon-based educational website for PBP in a context where educational interventions utilizing webtoons and targeting PBP remain scarce. By incorporating both quantitative and qualitative evaluations, the study examined not only preliminary outcomes but also user experiences and areas for improvement. The findings provide foundational information for refining web-based PBP programs, particularly through enhanced content and personalized features, and for informing future large-scale evaluations. Although progression criteria were not prespecified, the observed feasibility outcomes may also inform progression benchmarks for a future definitive RCT, including an intervention uptake rate of approximately 80%, a completion rate of approximately 70%, a mean CSQ-8 score of ≥3.5, and a mean website quality score of ≥3.4.

Limitations

This study has several limitations. First, restricting participants to digitally literate WCA limits the generalizability of the findings to broader populations or pregnant women. Second, the per-protocol analysis (excluding 13 of 47 randomized participants) may have introduced attrition bias and affected the findings. Third, reliance on self-reported questionnaires and interviews to evaluate website usability and satisfaction may have introduced social desirability, recall, and self-selection biases. Fourth, qualitative interviews were conducted solely with the intervention group by an unblinded interviewer, making the findings susceptible to interviewer bias and precluding comparisons with the comparison group. Fifth, without trial-based reminders and incentives, real-world implementation would require integrating the platform into routine clinical, community, or workplace settings to sustain engagement. Finally, the multicomponent design (webtoons, gamification, personalized recommendations, and reviews) prevented the individual contributions of each feature from being isolated, and the educational content omitted clinical interventions (eg, progesterone, cerclage, and low-dose aspirin).

Future studies should evaluate individual components independently using intention-to-treat analyses, blinded mixed-methods designs involving both groups, and integrated clinical-lifestyle curricula. Ultimately, adequately powered, large-scale RCTs with long-term follow-up are needed to confirm the effects on actual premature birth rates and neonatal outcomes.

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In conclusion, both PSIDK-iWebtoons and PSIDK-Texts demonstrated feasibility, high user acceptability, and significant time-dependent improvements in key psychological outcomes (SMSE-PBP and HBM-PBP subdomains). Although this pilot trial detected no clear advantage of the webtoon format over text, the findings support further refinement of the program and evaluation in a fully powered RCT. The qualitative findings should be interpreted cautiously because the qualitative evaluation was limited to the webtoon arm.

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Data Availability

The datasets generated and analyzed during this study are not publicly available because of ethical and privacy restrictions in accordance with the institutional review board–approved protocol and participant consent.

Generative AI Use

The authors declare that generative AI was used in the creation of this manuscript. Generative AI (ChatGPT, Gemini, Claude, Perplexity) was used for proofreading, editing, or language polishing; translation. The authors verified all outputs of the tool(s) used in the preparation of this manuscript and take full responsibility for the final content of the manuscript.

Authors' Contributions

Conceptualization: SHK, YJL
Data curation: SHK, YJL
Formal analysis: SHK, YJL
Funding acquisition: SHK
Intervention development: SHK, JYB, SP, JCDG, YJL
Investigation: SHK, YJL
Methodology: SHK, JYB, SP, YJL
Project administration: SHK
Supervision: SHK
Webtoon content development: SHK, JYB, SP, JCDG, YJL
Writing – original draft preparation: SHK, JCDG
Writing – review and editing: all authors
All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

CONSORT-EHEALTH checklist (version 1.6.1).
[PDF File (Adobe PDF File), 14513 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Main themes and contents of the Pregnancy Story I Didn’t Know in Interactive Webtoon Series.
[DOCX File , 16 KB-Multimedia Appendix 2]

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Multimedia Appendix 3

Demographic characteristics of interview participants.
[DOCX File , 18 KB-Multimedia Appendix 3]

Multimedia Appendix 4

Sensitivity analysis: generalized estimating equation analysis adjusted for baseline perceived severity of the Health Belief Model for Premature Birth Prevention.
[DOCX File , 23 KB-Multimedia Appendix 4]

Multimedia Appendix 5

Qualitative evaluation of the effects of web-based intervention.
[DOCX File , 18 KB-Multimedia Appendix 5]

References

1. Bradley E, Blencowe H, Moller AB, Okwaraji YB, Sadler F, Gruending A, et al. Born too soon: global epidemiology of preterm birth and drivers for change. Reprod Health. Jun 23, 2025;22(Suppl 2):105. [FREE Full text] [doi: 10.1186/s12978-025-02033-x] [Medline: 40551192]
2. United Nations Inter-Agency Group for Child Mortality Estimation. UNICEF (United Nations Children's Fund). New York, NY. United Nations Inter-agency Group for Child Mortality Estimation (UN IGME); 2025. URL: https://data.unicef.org/resources/levels-and-trends-in-child-mortality-2024/ [accessed 2025-12-03]
3. Ashorn P, Ashorn U, Muthiani Y, Aboubaker S, Askari S, Bahl R, et al. UNICEF–WHO Low Birthweight Estimates Group. Small vulnerable newborns-big potential for impact. Lancet. May 20, 2023;401(10389):1692-1706. [doi: 10.1016/S0140-6736(23)00354-9] [Medline: 37167991]
4. Shrestha T, Pandey Bista A, Sharma C, Silwal Raut K, Panta B, Rana Thapa M, et al. Stress among parents of preterm infants admitted to neonatal care units of public hospitals in Nepal: a cross-sectional study. BMJ Paediatr Open. Nov 05, 2025;9(1):e003606. [FREE Full text] [doi: 10.1136/bmjpo-2025-003606] [Medline: 41198249]
5. Janssen LE, Laarman ARC, van Dijk-Lokkart EM, Bröring-Starre T, Oudijk MA, de Groot CJM, et al. Long-term maternal mental health after spontaneous preterm birth. Am J Perinatol. May 2024;41(S 01):e2893-e2900. [FREE Full text] [doi: 10.1055/a-2182-4131] [Medline: 37758204]
6. Kovács G, Abonyi-Tóth Z, Fadgyas-Freyler P, Kaló Z. Incremental cost of premature birth - a public health care payer perspective from Hungary. BMC Health Serv Res. Jun 24, 2023;23(1):686. [FREE Full text] [doi: 10.1186/s12913-023-09697-w] [Medline: 37353814]
7. Kim SW, Andronis L, Seppänen AV, Aubert AM, Zeitlin J, Barros H, et al. SHIPS Research Group. Economic costs at age five associated with very preterm birth: multinational European cohort study. Pediatr Res. Sep 2022;92(3):700-711. [FREE Full text] [doi: 10.1038/s41390-021-01769-z] [Medline: 34773085]
8. Yu S, Lui K, Fiebig DG, Travadi J, Homer CSE, Sinclair L, et al. Preterm birth and total health care use and costs in the first 5 years of life: a population-based study. J Pediatr. Jul 2023;258:113327. [doi: 10.1016/j.jpeds.2023.01.006] [Medline: 36657660]
9. Kim H, Park H. Health-care needs of high-risk pregnant women hospitalized in maternal-fetal intensive care units: a mixed-methods design. Korean J Women Health Nurs. Jun 2018;24(2):196-208. [FREE Full text] [doi: 10.4069/kjwhn.2018.24.2.196] [Medline: 37684925]
10. Khekade H, Potdukhe A, Taksande AB, Wanjari MB, Yelne S. Preconception care: a strategic intervention for the prevention of neonatal and birth disorders. Cureus. Jun 2023;15(6):e41141. [FREE Full text] [doi: 10.7759/cureus.41141] [Medline: 37519532]
11. Janssen LE, Gieskes AA, Kok M, de Groot CJM, Oudijk MA, de Boer MA. Stress-reducing interventions in pregnancy for the prevention of preterm birth: a systematic review and meta-analysis. J Psychosom Obstet Gynaecol. Dec 2023;44(1):2281238. [FREE Full text] [doi: 10.1080/0167482X.2023.2281238] [Medline: 38064297]
12. Mayne G, Ghidei L, Buckley A, Perng W, Hurt KJ, Tracer DP. Stress-induced developmental plasticity and spontaneous preterm birth: a justice-oriented eco-evo-devo review. Eur J Obstet Gynecol Reprod Biol X. Sep 2025;27:100409. [FREE Full text] [doi: 10.1016/j.eurox.2025.100409] [Medline: 40586095]
13. Vogel JP, Chawanpaiboon S, Moller A, Watananirun K, Bonet M, Lumbiganon P. The global epidemiology of preterm birth. Best Pract Res Clin Obstet Gynaecol. Oct 2018;52:3-12. [doi: 10.1016/j.bpobgyn.2018.04.003] [Medline: 29779863]
14. Ohuma EO, Moller A, Bradley E, Chakwera S, Hussain-Alkhateeb L, Lewin A, et al. National, regional, and global estimates of preterm birth in 2020, with trends from 2010: a systematic analysis. Lancet. Oct 07, 2023;402(10409):1261-1271. [FREE Full text] [doi: 10.1016/S0140-6736(23)00878-4] [Medline: 37805217]

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15. Kim SH, Hong JY, Park MK. Educational status and needs of premature birth prevention and its association with preconception health behavior among women of childbearing age in Korea. J Korean Acad Community Health Nurs. Dec 2022;33(4):372-384. [doi: 10.12799/jkachn.2022.33.4.372]
16. Vitner D, Barrett J, Katherine W, White SW, Newnham JP. Community-based, population-focused preterm birth prevention programs - a review. Arch Gynecol Obstet. Dec 2020;302(6):1317-1328. [doi: 10.1007/s00404-020-05759-0] [Medline: 32875346]
17. Kim SH, Jung SY, Park JH, De Gagne JC. Internet-based interventions for preventing premature birth in preconceptional women of childbearing age: systematic review. J Med Internet Res. Jun 03, 2025;27:e60690. [FREE Full text] [doi: 10.2196/60690] [Medline: 40460430]
18. Kim SH, Park JH, Jung SY, De Gagne JC. Internet-based interventions for preventing premature birth among pregnant women: systematic review. JMIR Pediatr Parent. Apr 02, 2024;7:e54788. [FREE Full text] [doi: 10.2196/54788] [Medline: 38564247]
19. Cho H, Adkins D, Gould H, Bond K, Flood K. Readers' advisory guide development for webtoon. Inf Res. Mar 11, 2025;30(iConf):866-874. [doi: 10.47989/ir30iConf47179]
20. Manolescu D. The power of storytelling. JCSLL. May 26, 2025;6(4):11-18. [doi: 10.46809/jcsll.v6i4.363]
21. Adebayo AL, Davidson Mhonde R, DeNicola N, Maibach E. The effectiveness of narrative versus didactic information formats on pregnant women's knowledge, risk perception, self-efficacy, and information seeking related to climate change health risks. Int J Environ Res Public Health. Sep 23, 2020;17(19):6969. [FREE Full text] [doi: 10.3390/ijerph17196969] [Medline: 32977683]
22. Kim HK, Kim HK, Kim M, Park S. Development and evaluation of prenatal education for environmental health behavior using cartoon comics. J Korean Acad Nurs. Aug 2021;51(4):478-488. [doi: 10.4040/jkan.21083] [Medline: 34497256]
23. Kim SH. Development and effects of a webtoon education program on preventive self-management related to premature labor for women of childbearing age: a randomized controlled trial. Korean J Women Health Nurs. Sep 2022;28(3):250-263. [FREE Full text] [doi: 10.4069/kjwhn.2022.09.22] [Medline: 36403576]
24. Creswell JW, Plano Clark VL. Designing and Conducting Mixed Methods Research. Thousand Oaks, CA. SAGE Publications; 2017.
25. Kim SH, De Gagne JC. Examining the effectiveness of interactive webtoons for premature birth prevention: protocol for a randomized controlled trial. JMIR Res Protoc. May 15, 2024;13:e58326. [FREE Full text] [doi: 10.2196/58326] [Medline: 38748471]
26. Kim SH, Lee YJ. Development and validation of a Self-Management Self-Efficacy Scale for Premature Birth Prevention (SMSE-PBP) for women of childbearing age. BMC Womens Health. Feb 20, 2024;24(1):134. [FREE Full text] [doi: 10.1186/s12905-024-02964-w] [Medline: 38378535]
27. Kim SH, Jung SY, Kim Y, Lee YJ. Development and psychometric properties of the Health Belief Model Scale for Premature Birth Prevention (HBM-PBP) for women of childbearing age. Int J Womens Health. 2024;16:1173-1186. [FREE Full text] [doi: 10.2147/IJWH.S456201] [Medline: 38952793]
28. Attkisson CC, Zwick R. The client satisfaction questionnaire. Psychometric properties and correlations with service utilization and psychotherapy outcome. Eval Program Plann. 1982;5(3):233-237. [doi: 10.1016/0149-7189(82)90074-x] [Medline: 10259963]
29. Kang SW, Yoo JS, Ko IS. Development of a health information web site evaluation categories with items for diabetes mellitus. J Korean Soc Med Inform. Dec 2005;11(4):345-352. [doi: 10.4258/jksmi.2005.11.4.345]
30. Choi YS. The development of web-based Ventilator Management Education Program. Journal of the Korea Academia-Industrial Cooperation Society. Nov 30, 2012;13(11):5284-5291. [doi: 10.5762/KAIS.2012.13.11.5284]
31. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. Nov 2005;15(9):1277-1288. [doi: 10.1177/1049732305276687] [Medline: 16204405]
32. Lincoln YS, Guba EG. Naturalistic Inquiry. Beverly Hills, CA. SAGE Publications; 1985.
33. Mead C, Tindall R, Charlton K. Evaluation of a nutrition education resource for refugees and newly arrived migrants to Australia. Health Promot J Austr. Apr 2023;34(2):536-543. [doi: 10.1002/hpja.625] [Medline: 35642434]
34. Zike DM, Hansen MA, Arvinen-Barrow M. Psychosocial factors associated with athlete adaptation to spinal cord injury: a systematic review. Disabil Rehabil. Jun 2025;47(11):2735-2747. [doi: 10.1080/09638288.2024.2406981] [Medline: 39329402]
35. Lee VV, Vijayakumar S, Ng WY, Lau NY, Leong QY, Ooi DSQ, et al. Personalization and localization as key expectations of digital health intervention in women pre- to post-pregnancy. NPJ Digit Med. Sep 30, 2023;6(1):183. [FREE Full text] [doi: 10.1038/s41746-023-00924-6] [Medline: 37775533]
36. Hovingh JW, Elderson-van Duin C, Kuipers DA, van Rood Y, Ludden GDS, Hanssen DJC, et al. Tailoring for health literacy in the design and development of eHealth interventions: systematic review. JMIR Hum Factors. Sep 02, 2025;12:e76172. [FREE Full text] [doi: 10.2196/76172] [Medline: 40896843]
37. Korea Disease Control and Prevention Agency. 2024 Korea National Health Statistics: Korea National Health and Nutrition Examination Survey (KNHANES), 9th Survey, 3rd Year (2024). Cheongju, South Korea. Korea Disease Control and Prevention Agency; Dec 2024. URL: https://knhanes.kdca.go.kr/knhanes/archive/wsiStatsClct.do [accessed 2026-01-08]

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38. Doherty E, Dilworth S, Wiggers J, Wolfenden L, Wilson A, Leane C, et al. Preventive health risks in pregnancy: cross-sectional prevalence survey in three regions of New South Wales, South Australia and Tasmania. Aust N Z J Public Health. Apr 2025;49(2):100226. [FREE Full text] [doi: 10.1016/j.anzjph.2025.100226] [Medline: 40157825]
39. Hallal R, Abdul Aal S, Wahab M, Sakan MA, Hadla R, Zahed K. Assessing the usability and user experience of health information systems: a rapid review. Telemed J E Health. Dec 2025;31(12):1401-1413. [doi: 10.1177/15305627251381636] [Medline: 40982360]
40. Arnold C, Williams A, Thomas N. Engaging with a web-based psychosocial intervention for psychosis: qualitative study of user experiences. JMIR Ment Health. Jun 19, 2020;7(6):e16730. [FREE Full text] [doi: 10.2196/16730] [Medline: 32558659]
41. Chaudhary K, Shanmugavel A, Shrestha B, Nepal J, Shrestha B, Paudel P, et al. Usability acceptability and satisfaction of a new mobile intervention among Nepalese women with gestational diabetes: a cross-sectional study. JNMA J Nepal Med Assoc. Oct 2025;63(290):714-720. [doi: 10.31729/jnma.v63i290.9201] [Medline: 41783631]
42. Lightfoot CJ, Wilkinson TJ, Billany RE, Sohansoha GK, Vadaszy N, Ford EC, et al. Use, usability, and experience testing of a digital health intervention to support chronic kidney disease self-management: mixed methods study. J Med Internet Res. Jun 19, 2025;27:e75845. [FREE Full text] [doi: 10.2196/75845] [Medline: 40537087]
43. Yslado-Méndez R, Escobar-Agreda S, Villarreal-Zegarra D, Trejo Flores WM, Sánchez-Broncano JD, Vilela-Estrada AL, et al. Effectiveness, usability, and satisfaction of a self-administered digital intervention for reducing depression, anxiety, and stress in a university community in the Andean Region of Peru: randomized controlled trial. JMIR Form Res. Oct 15, 2025;9:e71465. [FREE Full text] [doi: 10.2196/71465] [Medline: 41092084]
44. Serdar CC, Cihan M, Yücel D, Serdar MA. Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies. Biochem Med (Zagreb). Feb 15, 2021;31(1):010502. [FREE Full text] [doi: 10.11613/BM.2021.010502] [Medline: 33380887]
45. Matthay EC, Hagan E, Gottlieb LM, Tan ML, Vlahov D, Adler N, et al. Powering population health research: considerations for plausible and actionable effect sizes. SSM Popul Health. Jun 2021;14:100789. [FREE Full text] [doi: 10.1016/j.ssmph.2021.100789] [Medline: 33898730]
46. Sharifat R, Borazjani F, Araban M, Pakpour AH, Angali KA, Aiiashi S. Nutritional education on health beliefs, metabolic profiles, and quality of life among high-risk pregnant women for gestational diabetes mellitus: a randomized controlled trial. Sci Rep. Nov 12, 2024;14(1):27712. [FREE Full text] [doi: 10.1038/s41598-024-78447-7] [Medline: 39532953]

Abbreviations

CONSORT: Consolidated Standards of Reporting Trials
CSQ-8: 8-item Client Satisfaction Questionnaire
HBM-PBP: Health Belief Model for Premature Birth Prevention
NICU: neonatal intensive care unit
PSIDK-iWebtoons: Pregnancy Story I Didn't Know in Interactive Webtoon Series
PSIDK-Texts: Pregnancy Story I Didn't Know in Text-Based Information
RCT: randomized controlled trial
SMSE-PBP: Self-Management Self-Efficacy for Premature Birth Prevention
WCA: women of childbearing age

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