Empowerment of Technical Secondary School Girls Regarding Preconception Care Through Web-based Health Literacy Program: Intervention Study

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Abstract

Background: Preconception care (PCC) for adolescents in low and middle-income countries has become a necessity. Early marital age in these countries requires early intervention to reduce unplanned pregnancies, mortality, and morbidity rates of both mothers and neonates. Nurses play a crucial role in ensuring coverage of health-empowering services for adolescents. With limited resources, there is an urge for nurses and midwives to provide a tailored, accessible, reliable, empowering method that enables adolescents to make informed decisions and actively participate in managing their PCC. **Purpose:** This study aims to assess the effect of a web-based health literacy program about PCC on technical secondary school girls' e-health literacy, decision-making self-efficacy, and fetal health locus of control. **Methods:** A quasi-experimental design (pretest and posttest) was carried out on 250 school girls from six technical secondary schools. A multistage stratified cluster sampling technique was used. A structured self-administered questionnaire; e-health literacy scale, decision self-efficacy, and fetal health locus of control were utilized for data collection before and after three months of the intervention. **Results:** After 3 months of intervention, there was a significant increase in the mean scores of total e-health literacy, total fetal health locus of control, and decision self-efficacy ($P<0.001$). There was a positive statistically significant correlation between the secondary school girls' decision self-efficacy and both their total e-health literacy score and total fetal health locus of control score at both the pre-intervention and three-month post-intervention assessments ($P<0.001$). Age, family income, and medical condition of the secondary school girls' had a significant relationship with the total e-health literacy and decision self-efficacy scores pre-intervention ($p\leq0.001$). **Conclusions:** Web-based health literacy program about PCC is a promising strategy to improve technical secondary school girls' e-health literacy, decision self-efficacy, and fetal health locus of control. Their e-health literacy, fetal health locus of control, and decision self-efficacy are positively inter-correlated. Their age, family income, and medical condition significantly affected their e-health literacy and decision self-efficacy skills. **Recommendation:** Health care policymakers and planners, and nurses should adopt web-based health literacy programs to raise the secondary school girls' awareness regarding their preconception health and provide access to online, credible, and reliable, empowering resources.

Keywords: Preconception care, Web-based program, E-health literacy, Decision self-efficacy, Fetal health locus of control

Introduction

The well-being of women and children is a crucial factor in determining a nation's overall health. Ensuring proper planning for pregnancy and maintaining good health before conception is essential for increasing the likelihood of a healthy pregnancy and baby. Preconception care (PCC) is a key aspect of health services for women of reproductive age, bridging the gap in maternal care to enhance pregnancy outcomes, childbirth, and children's health (Ololade et al., 2021). Within the healthcare system, nurses play a significant role in

delivering PCC services that empower women and couples (Shirazi et al., 2024).

According to the WHO, PCC is a vital part of reproductive health, concentrating on the conditions and risk factors that may impact a woman if she becomes pregnant (Ayalew et al., 2017). WHO defines PCC as the delivery of biomedical, behavioral, and social health interventions to women and couples before conception (Bekele et al., 2020; Kassa, Human, & Gemeda, 2018; Sori et al., 2021). In general, PCC has gained significant attention since the launch of the Millennium Development Goals and remains a priority within the Sustainable Development Goals, which seek to enhance maternal health before conception. Numerous developed and developing nations have adopted PCC as a key health strategy. This focus on PCC aligns with the broader objective of lowering maternal and infant mortality rates—an issue that continues to be a major concern in the healthcare field (Kurniawati et al., 2023).

From a public health standpoint, the preconception period can be a critical stage in life, such as adolescence, when lifelong health behaviors are formed before a first pregnancy. This phase is especially significant in the continuum of reproductive, maternal, newborn, and child health for promoting preconception well-being (Zaçe et al., 2022). Research suggests that PCC should begin during adolescence and continue as inter-conception care, allowing opportunities for positive behavioral changes to take place before pregnancy occurs (Fadare et al., 2023).

Numerous studies have indicated that pregnancies occurring before the age of 20 are associated with a higher risk of adverse outcomes, including low birth weight, preterm birth, and fetal growth restriction. Additionally, many adolescent girls and young women begin pregnancy in poor health, often with untreated preexisting conditions or a lack of awareness about essential health practices, such as taking daily folic acid supplements, avoiding tobacco and other harmful substances, and staying up to date on vaccinations. These factors increase the risk of adverse maternal and neonatal outcomes (Eldessouki et al., 2020). Each year, an estimated 21 million girls aged 15 to 19 in developing regions become pregnant, with around 12 million giving birth. In Egypt, the prevalence of teenage pregnancy is 9.6% (Alyamani, Elewa, & Newira, 2021). Nearly one in four (22%) Egyptians is an adolescent, and around one-fifth of Egypt's population are girls under the age of 20 (Abdelsattar, 2016; Abdel-Tawab, Gadallah, & Oraby, 2017).

A fundamental aspect of promoting preconception health is ensuring that adolescent girls and young women are well-informed on the topic. Limited knowledge and awareness can serve as obstacles to utilizing preconception care. However, current levels of awareness among young women remain inadequate, with minimal discussion in schools and healthcare settings. According to USAID, literacy rates among Egyptian women are still lower than those of men, with 65% of women being literate compared to 82% of men (USAID, 2017). Currently, young Egyptian adolescents receive little accurate information about reproductive health issues, leaving them vulnerable to negative health outcomes (Nashat, Kabbash, & Attalla, 2020).

Limited knowledge and education often lead adolescent girls and young women to continue engaging in unhealthy behaviors over time (Ekstrand Ragnar et al., 2018). Therefore, there is a clear need for tailored strategies to enhance preconception health within this demographic. Health empowerment is the process by which individuals gain the knowledge and confidence to protect, improve, and make decisions related to their health (Jiang et al., 2022). Evidence has reported that nurses and midwives are at the front of the healthcare system for providing health education, and community-based interventions, leading public health campaigns, performing counseling, and advocating for policy adaptations to improve reproductive health (Shirazi et al., 2024).

Technology-based education offers a modern and effective approach to delivering health information. Adolescents widely use technology, including computers and smartphones, and growing evidence suggests that technology-based interventions can be particularly effective for them, especially in addressing sexual and reproductive health and other sensitive topics. They may perceive guidance from an automated system as less judgmental compared to advice from a health educator or clinician (Bickmore et al., 2020).

Navigating healthcare and promoting well-being in the digital age requires a distinct or expanded set of competencies, known as electronic health literacy (e-health literacy) (Wong et al., 2021). E-health literacy, also referred to as digital health literacy, is defined as the ability to search for, locate, comprehend, and evaluate health information from

electronic sources, and apply this knowledge to make informed health decisions (Kayser et al., 2018; Mitsuhashi, 2018).

High levels of e-health literacy are associated with reduced healthcare costs, prevention of illness and chronic diseases, improved quality of life, and lower mortality rates. In contrast, individuals with limited e-health literacy are less effective in managing their health conditions, which often leads to poorer health outcomes and greater reliance on healthcare services (Coşkun et al., 2019; Lee, Shin, Lin, Lee & Wang, 2016; Smith et al., 2019; Xu et al., 2021). Additionally, there is a recognized link between health literacy and self-efficacy, suggesting that individuals with higher levels of health literacy are more likely to understand their health conditions and feel more capable of managing their care effectively (Wayment et al., 2020). Self-efficacy refers to a person's belief in their ability to carry out actions needed to achieve a desired outcome. It influences how people apply their knowledge and skills to reach those outcomes (Ong-Artborirak et al., 2023).

Supporting adolescent girls and young women in achieving better maternal and newborn health outcomes can be accomplished by equipping them with the necessary skills to effectively utilize digital health services (Zolbin et al., 2022). These digital platforms allow users to access extensive health-related information online, enhance their understanding of health conditions, and manage those conditions more efficiently (Sarfati et al., 2018).

Empowering adolescents to make rational health-related decisions and providing them with accessible, reliable resources that contribute to their preconception health, parenthood capability, and long-term health have become a nursing challenge (Woods-Townsend et al., 2021; Yadav & Kumar, 2023). While the school-going adolescent population is the most accessible group for delivering knowledge effectively, there have been few online health literacy programs on preconception health specifically designed for adolescent girls in low and middle-income countries (Kurniawati et al., 2023). The primary aim of this study was to assess the effect of a web-based health literacy program about preconception care on technical secondary school girls' e-health literacy, decision self-efficacy, and fetal health locus of control.

Aim of the study

This study aims to assess the effect of a web-based health literacy program about preconception care on technical secondary school girls' e-health literacy, decision self-efficacy, and fetal health locus of control.

Study Hypothesis

1. Technical secondary school girls who receive the web-based health literacy program demonstrate improved e-health literacy mean scores after the intervention compared to their mean scores before the intervention.
2. Technical secondary school girls who receive the web-based health literacy program demonstrate improved decision self-efficacy mean scores after the intervention compared to their mean scores before the intervention.
3. Technical secondary school girls who receive the web-based health literacy program demonstrate improved fetal health locus of control mean scores after the intervention compared to their mean scores before the intervention.

Methods

Study design

A quasi-experimental design (pre-test and post-test) was utilized in this study.

Study setting

The study was conducted at six governmental technical secondary schools in Mansoura city, Dakahlia governorate, Egypt. These schools were Meethadar Commercial School for Girls, Al Raydaniyah Industrial School for Girls, Badawai Technical Secondary School, Mansoura Agricultural Secondary School, Meet-Ali Joint Commercial School, and Aoish Al-Hagar Industrial School.

Study Subjects

The study subjects were adolescent school girls enrolled in technical secondary schools in Mansoura City during the academic year 2022/2023.

Participants were chosen based on the following criteria: being in the third grade, having reached menarche, residing in Mansoura with internet access via a computer or smartphone, having no prior exposure to health information or formal education—whether in-person or online—on preconception health, and providing signed informed

consent to participate in the study. However, the critically ill, married, or previously married girls, were excluded from study.

Sample size calculation

The sample size was determined using the OpenEpi free software program (www.openepi.com), with e-health literacy as the primary outcome of interest. The calculation was based on a previous study conducted in Turkey, where the average e-health literacy score increased from 26.99 ± 5.58 before the intervention to 30.55 ± 6.92 after the intervention (Coşkun et al., 2019). With an alpha level of 0.05 and a power of 0.9 (indicating a 90% likelihood of detecting a significant effect), the minimum required sample size was calculated to be 66 per group, which was rounded up to 70 per group. To account for a 10% attrition rate, the final required sample size was determined to be 231 participants, factoring in a design effect of three due to the multistage cluster sampling method.

Sampling technique and procedure

A multistage stratified cluster sampling method was employed to select the secondary school girls for the study. The first stage; the educational sector of Mansoura city was classified into two sectors namely the Eastern and Western. A list of the governmental technical secondary schools for girls only or mixed schools with three years of education in each sector was obtained from the Dakahlia Directorate of the Egyptian Ministry of Education. In the second stage, technical secondary schools in each sector were stratified according to their types into three strata commercial, agricultural, and industrial. The total number of eligible secondary schools was 18 (6 in the eastern sector and 12 in the western sector). Then, three schools were chosen from each stratum randomly. In the third stage, one third-grade classroom was selected from each school through a non-replacement lottery method. A total of 6 classes out of 40 were selected. We used TREND guidelines to report our data. Study flow diagram: technical student girls' recruitment was carried out as illustrated in figure 1.

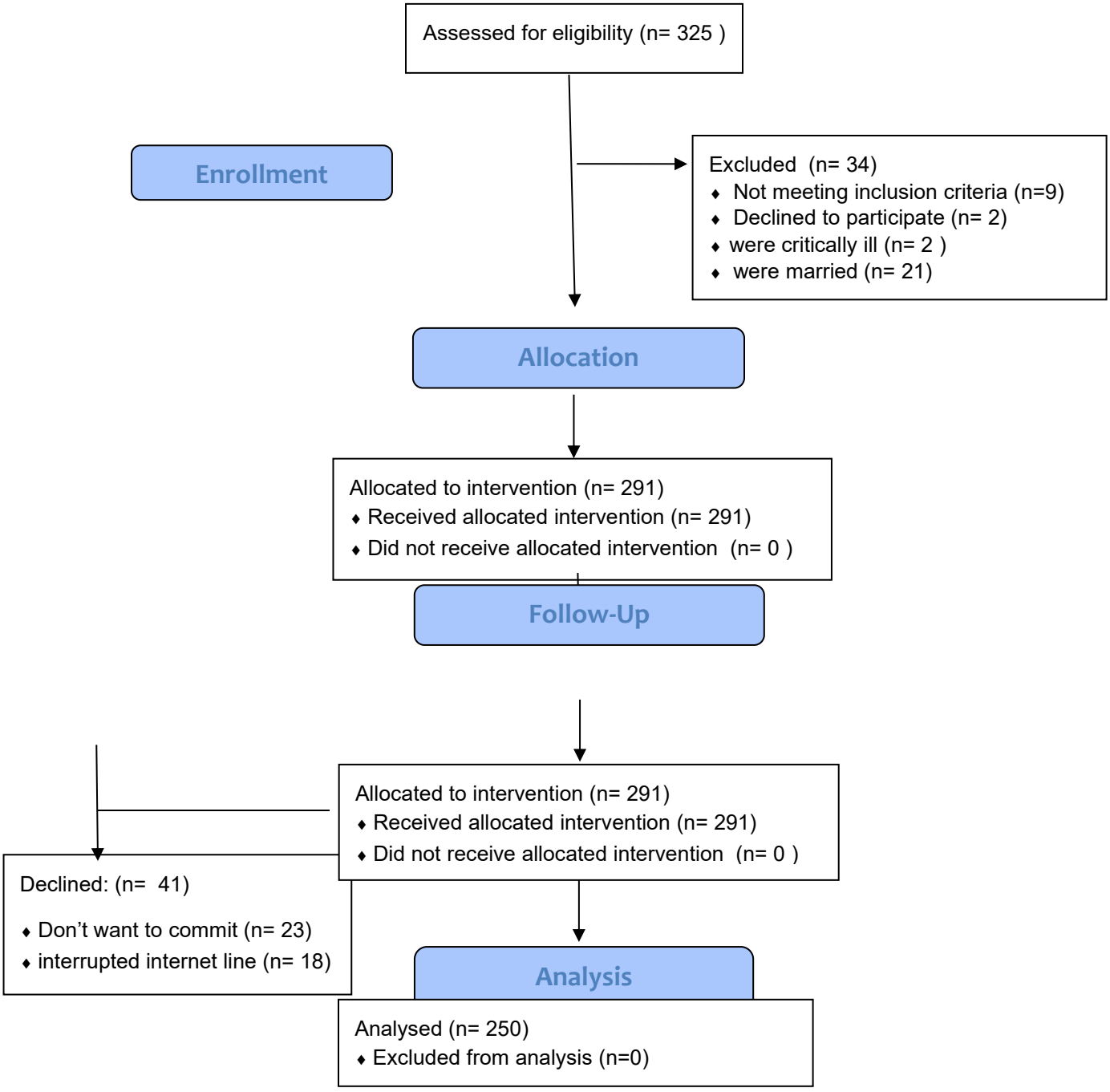

***Figure* 1.** Study TREND flow chart of enrollment details

Study tools

Following a comprehensive review of the relevant literature, the researchers constructed a structured, self-administered questionnaire, incorporating one adopted scale and two adapted scales. They were translated into the Arabic language by a translator specializing in medical texts and the researchers. Subsequently, the Arabic version was back-translated into English to ensure accuracy. The original and back-translated versions were then compared by the same team, and any minor discrepancies were resolved through group consensus. Additionally, adjustments were made to the translated study tools to simplify the language and eliminate culturally sensitive terms.

Tool I. Structured self-administered questionnaire. It has three main parts, and only closed questions with specific possible answers were used.

Part I. Demographic data. It included questions about residence, age, marital status, occupation, family income, and Internet access.

Part II. Medical history. This part included questions about the current health problems, including cardiovascular, metabolic, musculoskeletal, depression, anxiety, bronchial asthma, obesity, and cancer.

Part III. It included questions about sources of health information such as family, friends, healthcare providers, media, internet.

Tool II. E-health literacy. The e-Health Literacy Scale, adapted from Norman and Skinner (2006), consists of eight items designed to assess knowledge, skills, confidence, and perceived ability to locate, evaluate, and apply online health information related to PCC. The scale comprised two distinct dimensions. The first dimension measured competence in identifying and searching for online health information related to preconception care, consisting of four items with a score range of 4 to 20. The second dimension assessed competence in evaluating and applying online health information on preconception care, also including four items with a score range of 4 to 20. All items were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The total possible scores ranged from a minimum of 8 to a maximum of 40. Higher scores on the scale indicated a greater level of e-health literacy.

Tool III. Decision self-efficacy scale. This scale, adopted from O'Connor (1995), was designed to assess self-confidence and belief in one's decision-making abilities. It evaluates students' perceptions of their capability to gather information on preconception care, express their concerns and opinions, and make informed choices. his 11-item instrument utilized a five-point response scale, ranging from 0 (not at all confident) to 4 (very confident). To calculate the final score, responses were summed, divided by 11, and then multiplied by 25. The total scores ranged from 0 to 100, where 0 indicated extremely low self-efficacy and 100 represented extremely high self-efficacy.

Tool IV. Fetal health locus of control scale. This scale, adapted from Soliday, Strahm, & Mammenga (2016) and Wurtele (1986), consists of 18 items designed to evaluate a woman's beliefs about her influence on fetal health. It comprises three dimensions, with the first being Internal Health Locus of Control, which reflects the extent to which an individual believes that her health is determined by her own actions and behaviors. The second dimension, Chance Health Locus of Control, refers to the belief that health is influenced by chance, fate, or luck. The third dimension, Powerful Others Health Locus of Control, reflects the belief that one's health depends on the actions of influential individuals, such as doctors, family members, or friends. Each item was rated on a scale from 1 (strongly disagree) to 9 (strongly agree). In this study, the first and third dimension was composed of 12 items (6 items/domain with a scoring range of 6 to 54 marks/domain). The second dimension was modified from a 6-item domain to a 4-item domain due to cultural issues (four items with a score range from 4 to 36 marks).

Validity and reliability. A panel of five academic experts in nursing and medicine assessed the face and content validity of the study tool. The panel consisted of three professors specializing in community health nursing, pediatric nursing, and obstetric and gynecological nursing, along with two experts in public health and preventive medicine, each with over ten years of experience. They evaluated the tool for clarity, accuracy, format, consistency, and relevance. All suggested modifications were implemented.

The reliability of the study scales was assessed using Cronbach's Alpha coefficient test. The e-Health Literacy Scale demonstrated an overall reliability of 0.929 before the intervention and 0.874 after. The Decision Self-Efficacy Scale had a Cronbach's alpha of 0.876 pre-intervention and

0.777 post-intervention. Meanwhile, the Fetal Health Locus of Control Scale showed a reliability score of 0.800 before the intervention and 0.769 afterward.

Pilot study

A pilot study was conducted with 23 secondary school girls, representing 10% of the total sample, to evaluate the clarity, reliability, and applicability of the study tool, as well as to estimate the time required for completion. Based on the pilot results, necessary modifications were made to the data collection tools, including rewording certain questions and statements. Following these adjustments, the final fieldwork plan was developed. Since changes were implemented, data from the pilot study participants were excluded from the final analysis. To maintain result stability, these girls were not included in the main study sample.

Ethical consideration. The Research Ethics Committee of the Faculty of Nursing, Mansoura University, reviewed and approved the study proposal (Reference No. P.0455). Official letters from the Faculty of Nursing at Mansoura University were sent to the Dakahlia Directorate of the Egyptian Ministry of Education in Mansoura to inform them of the study's objectives and request permission to conduct the research in the designated settings. Approval letters were then issued by the Mansoura Educational Directorate and delivered to the directors of selected secondary schools through the researchers. Meetings were conducted with the directors of the selected schools to explain the study's objectives, schedule data collection, ensure that the collected data would be used solely for research purposes, and obtain their approval and cooperation. Verbal consent was obtained from participating students, while written consent was secured from their parents or legal guardians through the school administration after explaining the study's purpose and benefits. Confidentiality was guaranteed, participation was entirely voluntary, and the study did not interfere with regular school lessons throughout its duration.

Fieldwork

The fieldwork was conducted over seven months, from early October 2022 to late April 2023. The researcher visited the designated study locations three days a week (Sunday, Monday, and Thursday) between 8:00 AM and 12:00 PM, rotating among the settings based on students' lesson schedules and break times.

The study was conducted in sequential phases, including preparation, assessment, planning, implementation, and evaluation.

Preparatory phase: The process included reviewing recent national and international literature related to the study area through journals, periodicals, textbooks, and online sources. This was done to establish a knowledge base and develop the study tools.

Assessment phase: Once all official permissions were secured, the researchers met with the secondary school girls in their classrooms to introduce themselves, provide a brief explanation of the study's purpose, and obtain their consent to participate. To ensure independent responses, the students were seated at a reasonable distance from each other to prevent copying or discussion. The researchers then distributed the data collection forms and provided instructions on how to complete them.

The students then completed the forms under supervision. To prevent missing data, the completed questionnaires were collected immediately and reviewed for completeness. The time required to fill out the forms ranged from 25 to 30 minutes. On average, the entire interview process for each classroom took approximately 90 to 120 minutes. One classroom was assessed per day, with around three classrooms evaluated per week.

Planning phase: The educational content for the website was developed based on findings from the assessment phase of the study group. It was designed using relevant literature on PCC and the conceptual framework of health literacy and decision-making. Key topics included comprehensive information on PCC, social support for health, skills to evaluate health information, effective communication with healthcare providers, navigation of the healthcare system, locating reliable health information, and understanding health information for informed decision-making. To enhance clarity and readability, the content was supplemented with examples to increase the secondary school girls' awareness of these issues.

An IT specialist developed a website (Figure 2) with a management panel on the World Wide Web, modeled after the Health Concern Website, accessible at https://healthconcern.online. Memberships were approved, and researchers uploaded educational content, including pages, videos, images, and documents. The platform also allowed for sending and receiving messages. The secondary school girls could access the website from

home or school using personal computers, smartphones, tablets, or iPads.

The modules section (Figure 3) included four specific topics (Table 1) with weekly updated learning units. The main focus was on enhancing PCC health literacy and decision-making skills. Overall, the content addressed key aspects of PCC, health literacy, and decision self-efficacy. An interactive design with clickable graphics was used, incorporating various multimedia formats such as text, images, and videos. To improve comprehension, the content was tailored to the target audience by using simple, direct language, avoiding academic jargon, and adjusting the extent and complexity accordingly.

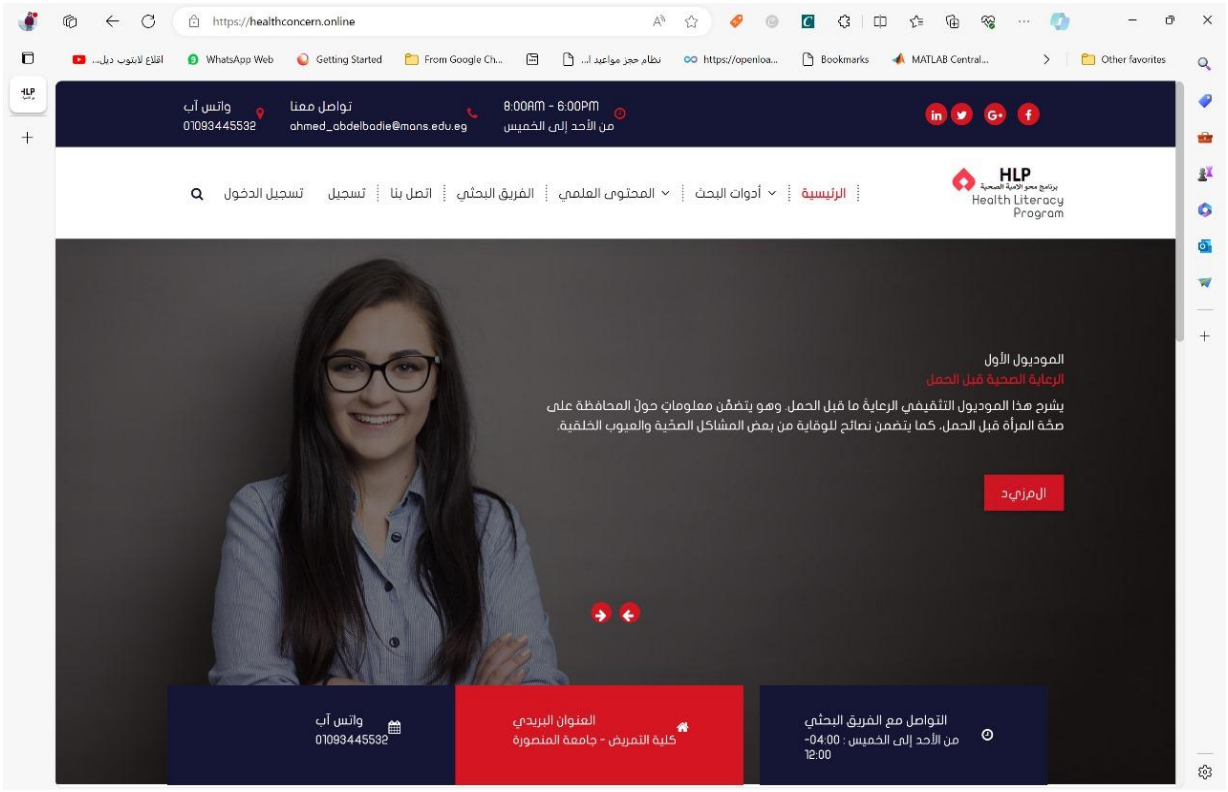

***Figure* 2.** Health Empowerment Web-based Program Website

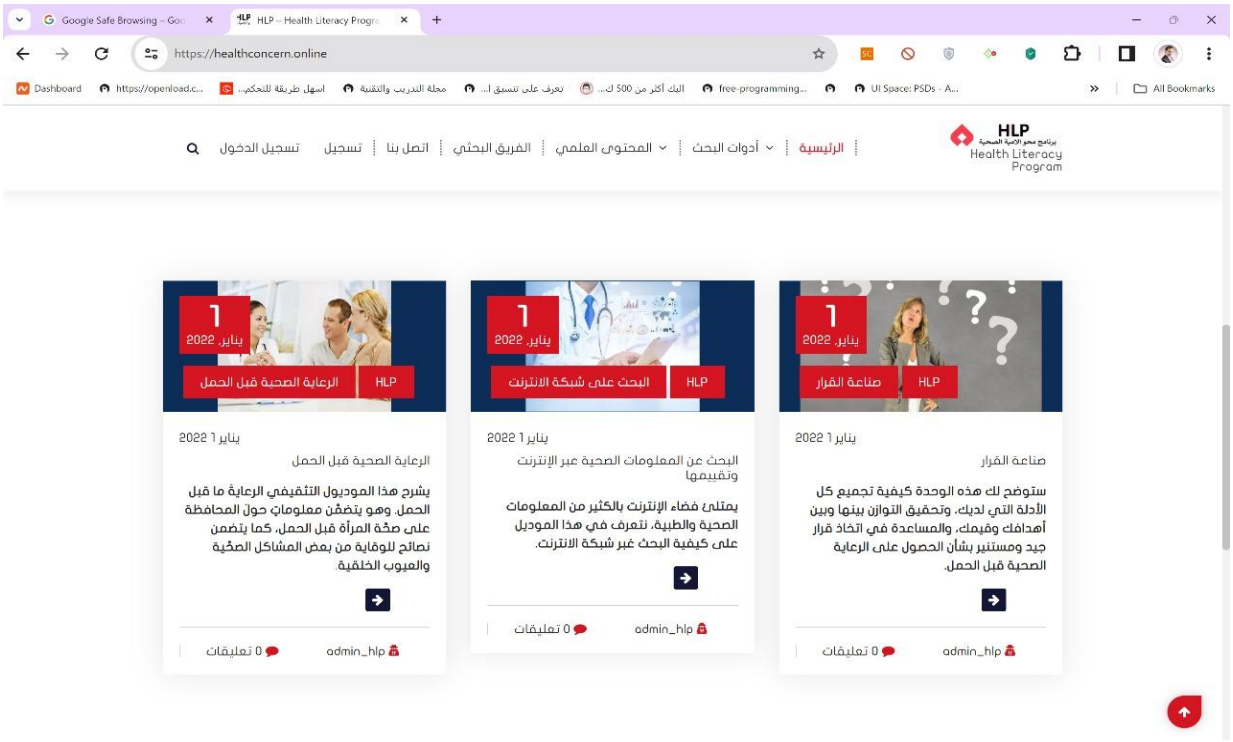

***Figure* 3.** Health Empowerment Web-based Program modules

Implementation phase: The researchers visited each school and gathered the secondary school girls in the classroom. A one-hour informational session was then conducted to provide guidance on website registration, navigation, using the member panel, contacting the site manager, and understanding the purpose and content of the educational program. Participants were given the website URL and invited to access it. They then engaged in a four-week multimedia, interactive, and self-administered online intervention program consisting of four modules. One module was released each week, making the intervention last four weeks in total. Each module required approximately 20 minutes to complete.

During this process, the secondary school girls received consultations on their questions and needs through the website, with responses based on relevant literature. Educational inquiries were addressed via the message menu. Additionally, participants received reminder messages at least twice a week for four weeks to encourage engagement with the educational program. The website remained accessible for three months before being closed. By the end of the intervention, each student had logged in at least seven times, and the website recorded a total of 3,192 visits. Three months after the website's closure, researchers re-administered the same forms that had been given to students before the intervention.

Evaluation phase: The effectiveness of the program was evaluated three months after the website's closure by using the same forms that were administered to the secondary school girls before the intervention.

Table 1: Modules and updated learning units accessible on the online platform during the 4-week intervention period

Module No	Topic	Content description
Module 1	Preconception Care: The Evidence.	This module provides scientific evidence related to the definition, aim, and positive effects of PCC. In addition, risk factors threaten maternal and fetal outcomes, and evidence-based recommendations regarding preconception care interventions for planning a healthy pregnancy.
Module 2	Finding and Evaluating Online resources About preconception care.	This module presents a formal introduction to scientific online resources and the evaluation of the credibility of online health information. It outlines key databases that offer reliable information on PCC, details the process of conducting effective searches, and explains how to utilize the gathered evidence to support informed decision-making regarding PCC.
Module 3	Decision Making – preconception care.	This module offers structured guidance on synthesizing the information acquired from preceding modules, aligning it with individual goals and values, and engaging in meaningful dialogue with relevant stakeholders to facilitate informed decision-making regarding the utilization of preconception healthcare services. To support this process, the universally recognized SCOPED framework—comprising Situation, Choices, Objectives, People, Evaluation, and Decisions—has been integrated as a decision-making tool for participants.
Module 4	Working with PCC Practitioners.	This module provides a comprehensive overview of healthcare services in Egypt, with a particular focus on the primary healthcare framework. It outlines the available services, types of healthcare centers, and the roles and responsibilities of primary healthcare providers and PCC practitioners. Additionally, it addresses strategies for effectively communicating the use of PCC services within the context of conventional healthcare systems.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) software for Windows (Standard Version 26). To assess normality, a one-sample Kolmogorov-Smirnov test was conducted first. Categorical variables were summarized using frequencies and percentages (%), while numeric variables were presented as mean ± standard deviation (SD) for normally distributed data. Independent t-tests were used to compare two groups, while paired t-tests were applied for paired data. Comparisons involving more than two groups were conducted using ANOVA. Pearson correlation analysis was performed to examine relationships between continuous variables. A significance threshold of 5% (p-value) was set for all statistical tests. Outcome differences were reported as mean differences (MD) with 95% confidence intervals (CI).

Results

This study included 250 secondary school girls. The participants had a mean age of 17.94 ± 0.53 years, with ages ranging from 17 to 19 years. The majority (76.8%) resided in rural areas, and approximately 71.2% came from families with sufficient monthly income. In terms of methods of access to the internet, 96% of them use their phones, followed by 58.4%, 20.8%, and 15.6% who access it with a tablet, laptop, and personal computer, respectively. Depression, bronchial asthma, and musculoskeletal disorders were the most reported medical conditions affecting them by 16%, 8%, and 6.4%, respectively (Table 2).

Figure 4 illustrates that 61.60% of the secondary school girls mentioned their family and relatives as the main source of health information. Media, the Internet, and healthcare providers were also mentioned as sources of health information by 59.20% and 58.80% respectively.

Table 3 presents the comparison of e-health literacy levels, fetal health locus of control, and decision self-efficacy before and three months after the intervention. A significant difference was observed in the mean scores of total e-health literacy, fetal health locus of control, and decision self-efficacy between the pre- and post-intervention assessments ($P<0.001$). Notably, the mean e-health literacy score showed a significant increase from 22.97±7.11 before the intervention to 33.22±3.99 three months later ($P<0.001$). The participants' e-

health literacy subscale scores reflected that their confidence in recognizing and seeking online health information related to PCC increased from 11.21±4.47 pre-intervention to 16.66±2.23 at 3-months post-intervention. Also, the results reveal an increase in their confidence in evaluating and using online health information related to PCC from 11.76±3.20 pre-intervention to 16.56±2.07 at 3-months post-intervention. Furthermore, the mean total fetal health locus of control score increased significantly in the 3-month post-intervention compared with the baseline from 101.46±18.79 to 132.62±9.92 (P<0.001). Moreover, the mean total decision self-efficacy score increased significantly in the 3-month post-intervention compared with the baseline from 64.67±18.95 to 90.81±8.80 (P<0.001).

Table 4 indicates a statistically significant positive correlation between the secondary school girls' decision self-efficacy and both their total e-health literacy score and total fetal health locus of control score (P<0.001) at both the pre-intervention and three-month post-intervention assessments.

Table 5 highlights a statistically significant relationship between the secondary school girls' total e-health literacy scores and their age, family income, and medical condition at the pre-intervention stage only (p≤0.001). Additionally, total decision self-efficacy scores were significantly associated with age (P=0.025) and family income (P=0.032) before the intervention. However, no statistically significant relationships were observed three months' post-intervention (P≥0.05).

Discussion

Adolescent girls in low- to middle-income countries have less access to preconception care (PCC) information compared to their peers in high-income countries, where technological advancements like online platforms and social media facilitate information-seeking. This underscores the need to deliver comprehensive PCC information to broader community groups, such as high school and university students, using diverse educational approaches and media. Therefore, this study aimed to examine the effectiveness of a web-based health literacy program about preconception care on technical secondary school girls' e-health literacy, decision self-efficacy, and fetal health locus of control.

In terms of socio-demographic characteristics, the secondary school girls had a mean age of 17.94 years, ranging from 17 to 19 years. According to Kurniawati et al. (2023), this age group is crucial for promoting healthy lifestyles, empowering individuals, and ultimately contributing to better maternal and newborn health outcomes in the future. The majority of them resided in rural areas, which may be attributed to the lack of emphasis on preconception education in these regions. These findings align with the study by Khalaf, Ail, Hassan, and Mohamed (2022), which examined the impact of an educational program on preconception care for adolescent students and found that most participants were female, with nearly three-quarters coming from rural backgrounds.

In this study, a small percentage of participants reported health conditions such as depression, bronchial asthma, and musculoskeletal disorders. This finding aligns with the study by Bala, Maharaj, Boppana, and Teelucksingh (2023), which examined the preconception health status of non-gravid women aged 18 to 45 years. Their study found that 23.7% of participants were overweight or obese with elevated HbA1c levels, while 7.4% had both elevated HbA1c levels and stage 1 or 2 hypertension. These conditions are linked to various health issues that serve as risk factors for adverse pregnancy outcomes.

The Internet is particularly appealing to young people due to its accessibility, anonymity, and non-judgmental nature, making it a valuable resource for seeking sensitive information, such as sexual and reproductive health. The findings of this study indicate that the secondary school girls primarily use personal phones to access health information online, followed by personal tablets, laptops, and desktop computers. Similarly, a study by Ibegbulam et al. (2018) on Internet use for reproductive health information among secondary school girls found that 45% accessed the Internet via mobile phones, 22.5% used home computers, 17% relied on personal iPads, and 8% used electronic devices belonging to relatives.

The results supported the study's hypothesis, indicating that the mean scores for e-health literacy, decision self-efficacy, and fetal health locus of control significantly increased after the intervention, compared to their scores before the intervention. The intervention in this study resulted in a significant increase in the mean e-health literacy scores among the secondary school girls. After three months of the intervention, the total e-health literacy scores rose by

approximately 11 points. This suggests that their knowledge of internet-related health information improved, making it easier and more appealing for them to search for and assess health information online. This result indicates that designing web-based educational modules based on PowerPoint presentations, and the use of multimedia such as videos in addition to including illustrations, photos, text, and narration that can be delivered via the Internet, motivated the secondary school girls to increase their knowledge from healthy sources.

This result aligns with the findings of König and Suhr (2023), who assessed the effectiveness of a widely used free online intervention and reported that participants showed improved digital health literacy. They specifically demonstrated greater skills in information appraisal, searching, evaluating reliability, and determining relevance. Similarly, a study by Chang et al. (2022) examined the impact of an intervention on older adults' information, motivation, behavioral skills, and behaviors related to e-health information. The results showed significant increases in e-health literacy efficacy, searching performance, and understanding scores.

The findings are also consistent with those of Roh and Won (2023), who assessed the effect of an online e-health literacy intervention on female college students. Their results showed a significant improvement in e-health literacy in the experimental group compared to the control group following the intervention. Additionally, Carrasco-Dajer et al. (2024) investigated the effects of a culturally tailored digital literacy intervention on older adults and its connection to health literacy, quality of life, and overall well-being. Their results demonstrated a significant direct impact of the intervention on improving digital literacy levels. Furthermore, a study by Mitsuhashi (2018) explored the effects of a two-week e-learning program on the e-health literacy of Japanese internet users, revealing an increase of 2.31 points (SD = 7.27) in e-health scores after the intervention. Additionally, Main et al. (2022) evaluated the effects of e-health tutorials on the e-health literacy of older adults, finding significant improvements in their computer and internet knowledge, e-health literacy efficacy, evaluation skills, and procedural skills from pre-test to post-test.

Decision-making, especially in relation to health, is a fundamental aspect of everyday life. While some health-related decisions can be straightforward, others may be more complex, involve significant uncertainty, and have a profound effect on individuals' lives (Gültzow, 2022). The present study findings indicated that the mean total decision self-efficacy score increased significantly to about 26 points after 3 months of the intervention. This result indicates that the web-based program can be an effective intervention to boost the secondary school girls' confidence in handling such issues and complement their engagement in decision-making. This can be due to providing them with accurate, unbiased, and detailed information in lay terms that are needed to assess their options, informing them about the potential outcomes of a decision, examining their values as they relate to those options, and offering structured guidance for deliberation and communication.

This finding is compatible with a study by Anraad et al. (2023), which evaluated the impact of an online tailored decision aid designed to encourage informed decision-making regarding maternal pertussis vaccination. The study found that the intervention improved participants' decision-making and decisional certainty. Similarly, Pordelan et al. (2020) explored the effects of online counseling and face-to-face counseling within a guidance framework on university students' career decision-making self-efficacy. Their results indicated that online counseling significantly enhanced students' career decision-making self-efficacy. Additionally, Allen, et al. (2020) developed and tested an interactive web-based decision aid for prostate cancer screening preparation. Their results revealed that men experienced less decisional conflict. Most men stated that the interactive web-based intervention helped them make informed decisions in collaboration with their healthcare providers. Additionally, Beulen et al. (2016) assessed the impact of a web-based multimedia decision aid on decision-making related to prenatal testing. They found that using the decision aid enhanced informed decision-making about prenatal testing, attributing this improvement to a boost in decision-relevant knowledge.

Health locus of control is a valuable instrument for evaluating health beliefs based on internal and external loci. The present findings showed that the mean total fetal health locus of control score increased significantly to about 31 points in the 3-month post-intervention. This significant change in internal score suggests that the

web-based intervention was effective in modifying the beliefs of the secondary school girls in a way that dependence on health on themselves and significant others increased. Our results are consistent with several interventional studies. Mirghafourvand et al. (2020) investigated the effect of preconception counseling on health locus of control. They reported a significant increase in internal locus of control scores within the intervention group compared to the control group following the intervention. Similarly, Javaid et al. (2019) assessed the impact of a short-term preconception health education program on young females and found that it significantly influenced both internal and external health locus of control, with marked improvements observed post-intervention. In another study, Ahmed et al. (2021) examined the efficacy of nursing interventions in enhancing health locus of control and self-efficacy among women with gestational diabetes. Their results indicated a statistically significant enhancement in internal locus of control scores in the intervention group relative to the control group. Furthermore, Fardaza et al. (2017) evaluated an educational intervention based on the locus of control model in patients with type II diabetes and observed a notable increase in the mean locus of control scores within the experimental group two to three months after the intervention. In contrast, Armour et al. (2022) evaluated a web-based educational resource aimed at improving menstrual health literacy and self-management among young women and found only a modest, statistically non-significant increase in internal health locus of control, rising from a baseline mean of 29.19 (3.39) to 29.96 (3.25) at one-month follow-up.

The present study revealed a significant positive correlation between the total decision self-efficacy and overall e-health literacy scores among secondary school girls. Inadequate health literacy can contribute to heightened levels of uncertainty, conflict, and anxiety during the decision-making process. Contributing factors include limited ability to read, comprehend, and critically assess health information, restricted access to trustworthy sources, and insufficient knowledge of the subject matter—all of which may lead to regret or dissatisfaction with one's choices. Enhanced e-health literacy, therefore, strengthens an individual's capacity to participate effectively in health-related decision-making. This finding aligns with the results of Shen et al. (2019), who examined the link between health literacy and decision-making among breast cancer patients and reported a significant inverse correlation between health literacy and decisional conflict ($P < 0.001$, $r = -0.81$). Additionally, a study by Seo et al. (2016) investigating decision-making preferences among medically underserved patients found that sufficient health literacy was significantly associated with a preference for patient-involved decision-making (OR = 1.7; $p = 0.009$).

The current study also found a significant positive correlation between the secondary school girls' total decision self-efficacy and their total fetal health locus of control score. Generally, individuals with an internal locus of control tend to take greater responsibility and actively work to address problems. Additionally, they are more inclined to participate in treatment decisions. This finding is consistent with the study by Adenike (2023), who explored the role of health locus of control and health behaviors in women's health. Their research revealed a significant relationship between the dimensions of health locus of control and health behaviors among women in the institution. Additionally, Kordi et al. (2017) conducted a study on predicting fetal health locus of control and self-care behaviors. They found that the internal dimensions ($P < 0.0001$) and powerful others ($P = 0.012$) of fetal health locus of control are significant predictor variables for self-care.

The present study findings illustrated that there was a statistically significant relation between the secondary school girls' total e-health literacy and decision self-efficacy scores with their age, family income, and medical condition in pre-intervention. This finding suggests that younger participants tend to have higher health literacy scores. Online information sources, such as the Internet and social media, are often linked to higher literacy levels. Thus, using the Internet to search for healthcare information can be seen as a way to develop health literacy skills. Older age groups and older adults tend to use the Internet and other online information sources less, likely due to a decline in cognitive abilities associated with aging. Additionally, individuals with higher incomes typically exhibit higher levels of health literacy. Higher income is linked to better access to health information, enabling individuals to make more informed health decisions. On the other hand, people with low incomes face more barriers to accessing healthcare and are less likely to seek medical attention. Furthermore, health is a condition that involves the

body, mind, and spirit, influencing all areas of human life. Illness, however, can negatively impact both the quality of life and health literacy.

Several studies support the findings of this study. A systematic review by Sabaghinejad (2023) investigating factors that predict and are associated with health literacy identified age, gender, education, social status, occupational status, personal income, and health status as the most frequently significant factors linked to health literacy. Another systematic review by Estrela et al. (2023) reported similar findings regarding sociodemographic factors influencing digital health literacy. Additionally, Özbay, Boztepe, & Özcebe (2022) conducted a study on inequality among adolescents in developing countries and found that e-health literacy levels increased with the adolescents' age, family monthly income, and their decision-making scores. Furthermore, Haruna, Duah, & Lee (2024) conducted a study on factors related to health decision-making autonomy and found that age, education level, and household wealth index were independently linked to higher chances of complete decision-making autonomy in healthcare. Similarly, Sun et al. (2019) investigated socio-demographic predictors of the ability to engage in healthcare activities. Their study showed that an individual's age, educational level, and employment status were associated with their capacity to participate in various healthcare activities.

Conclusion

Web-based health literacy program resulted in significant increase in the e-health literacy, fetal health locus of control, and decision self-efficacy of the technical secondary school girls. Their e-health literacy, fetal health locus of control, and decision self-efficacy are positively inter-correlated. Their age, family income, and medical condition significantly affected their e-health literacy and decision self-efficacy skills.

Recommendations

- Policymakers, planners, and nurses should adopt web-based health literacy programs to raise the secondary school girls' awareness about preconception care and improve their ability to find and use accurate online information to enhance their self-management and reduce health disparities.
- Collaborating with schools to integrate the program into their health education curriculum could improve accessibility and ensure that more students benefit from it.

Further researches are needed to:

- Examine the effectiveness of web-based health literacy programs about preconception care using strong study designs, such as randomized controlled trials, to determine if these programs delivered as stand-alone or as part of multifaceted interventions are effective over time for a longer period of follow-up time after the intervention.
- Include a more diverse sample of secondary school girls, including different age groups, socioeconomic statuses, cultural backgrounds, and geographic locations. This would provide a clearer understanding of how the program performs across different demographics and help identify any disparities or additional factors that influence outcomes.

Declarations:

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Competing interests:

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Table (2): *Demographic characteristics of the technical secondary school girls (n=250)*

Demographic data	n (%)
Age (Years)	
Mean ± SD	17.94±0.53
Min-Max	17.00-19.00
Residence	
Rural	192(76.8)
Urban	58(23.2)
Family income	
Enough	178(71.2)
Not enough	50(20.0)
Enough and save	22(8.8)
Medical condition	
Depression	40(16.0)
Bronchial asthma	20(8.0)
Skeletal	16(6.4)
Cardiovascular Disease	10(4.0)
Diabetes Mellitus	3(1.2)
Cancer	2(0.8)
Obesity	1(0.4)
Methods of access to the internet	
Phone	240(96.0)
Tablet	146(58.4)
Laptop	52(20.8)
Personal Computer	39(15.6)

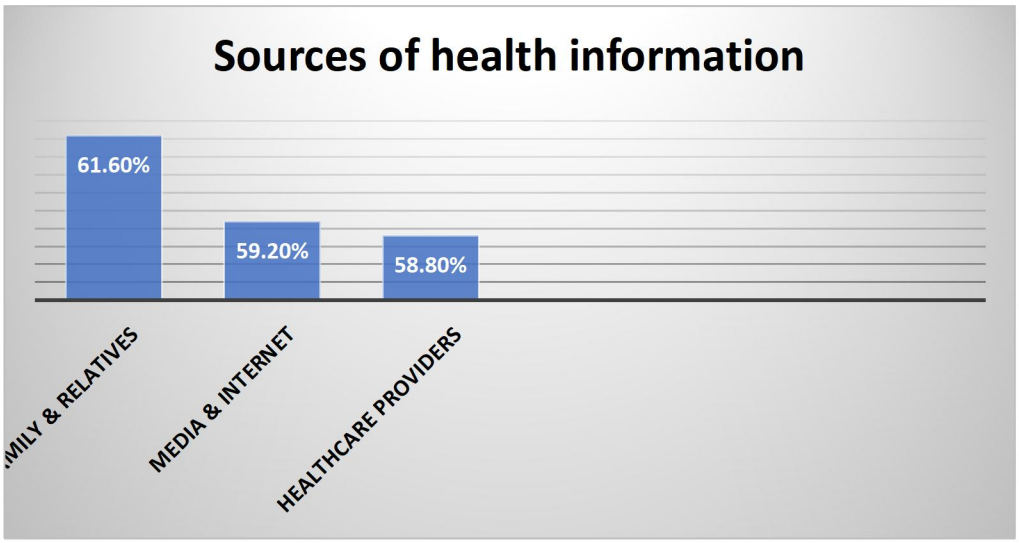

***Figure* 4.** Sources of health information among the technical secondary school girls (n=250)

Table (3): *Comparison of mean scores of e-Health literacy, fetal health locus of control, and decision self-efficacy among participants pre-, and 3 months' post-intervention*

Variables		Pre-intervention (n=250)	3-months Post-intervention (n=250)	Mean difference (95% CI)	Test of sig. P value
		Mean ± SD			
E-Health literacy	Recognizing and seeking online health information related to PCC	11.21±4.47	16.66±2.23	5.45 (4.9- 6.0)	t=19.41 P≤0.001*
	Evaluating and using online health information related to PCC	11.76±3.20	16.56±2.07	4.80 (4.4-5.2)	t=24.59 P≤0.001*
	Total e-health literacy	22.97±7.11	33.22±3.99	10.25 (9.4-11.1)	t=23.42 P≤0.001*
Fetal Health Locus of Control	Internal	39.88±8.49	51.19±3.57	11.3 (10.3-12.3)	t=22.73 P≤0.001*
	Chance	27.69±7.50	34.28±3.74	6.6 (5.8-74.)	t=16.07 P≤0.001*
	Powerful Others	33.88±11.42	47.14±7.25	13.25 (12.1-14.4)	t=22.72 P≤0.001*
	Total Fetal Health Locus of Control	101.46±18.79	132.62±9.92	31.15 (29.1-33.2)	t=29.73 P≤0.001*
Self-Efficacy		28.45±8.33	39.96±3.87	11.50 (10.6-12.4)	t=25.13 P≤0.001*
Decision self-efficacy %		64.67±18.95	90.81±8.80	26.14 (24.1-28.2)	t=25.13 P≤0.001*

Note. Highly statistically significant at ** $p \leq .001$.

Table (4): *Correlation between participants' decision self-efficacy, e-health literacy, and fetal health locus of control scores pre-, and 3 months post-intervention (n=250)*

Variables		Decision Self-efficacy Pre-intervention		Decision Self-efficacy 3-months Post-intervention	
		r	P value	r	P value
E-Health literacy	Recognizing and seeking online health information related to PCC	0.332	≤0.001*	0.344	≤0.001*
	Evaluating and using online health information related to PCC	0.422	≤0.001*	0.368	≤0.001*
	Total E Health literacy	0.399	≤0.001*	0.384	≤0.001*
Fetal Health Locus of Control	Internal	0.391	≤0.001*	0.383	≤0.001*
Fetal Health Locus of Control	Chance	0.126	0.047*	0.009	0.890
	Powerful Others	0.140	0.027*	0.283	≤0.001*
	Total Fetal Health Locus of Control	0.312	≤0.001*	0.348	≤0.001*

Note. r: Pearson correlation coefficient, highly statistically significant at ** p ≤ .001.

Table (5): *Relation between Total e-health Literacy and Decision Self-Efficacy Scores, and Personnel Characteristics of technical secondary school girls pre-, and 3 months' post-intervention n (250)*

Personnel characteristics	Total e-health literacy score				Total decision self-efficacy score			
	Before intervention Mean (SD)	Test of sig. P value	After three months Mean (SD)	Test of sig. P value	Before intervention Mean (SD)	Test of sig. P value	After three months Mean (SD)	Test of sig. P value
Age (Years)								
17 y	19.41±7.58	F=7.299 P=0.001*	32.60±3.76	F=1.012 P=0.365	65.32±18.17	F=3.762 P=0.025*	89.69±9.74	F=0.491 P=0.613
18 y	23.51±6.87		33.45±4.01		63.10±19.47		90.96±8.61	
19 y	24.89±6.28		32.75±4.16		73.35±14.41		91.61±8.65	
Residences								
Rural	22.61±7.18	t=1.427 P=0.155	33.15±4.06	t=0.516 P=0.606	65.45±18.35	t=1.195 P=0.233	91.05±8.84	t=0.761 P=0.448
Urban	24.13±6.78		33.46±3.75		62.06±20.78		90.04±8.68	
Family income								
Not enough	16.82±4.86	F=33.149 P≤0.001*	32.10±4.12	F=2.683 P=0.070	58.50±22.13	F=3.489 P=0.032*	90.59±8.99	F=0.025 P=0.975
Enough	24.07±6.83		33.45±3.93		65.99±17.71		90.89±8.76	
Enough & Save	28.00±4.95		33.95±3.83		67.97±18.84		90.70±9.03	
Medical history								
Yes	20.03± 7.47	t= 3.85 P≤0.001*	32.59± 4.41	t= 1.43 P=0.152	63.96± 22.35	t= 0.338 P=0.736	91.12± 8.67	t= 0.320 P=0.749
No	23.94± 6.73		33.43± 3.83		64.90± 17.75		90.71± 8.86	

Note. Highly statistically significant at ** $p \leq .001$

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