Effect of a Nurse-Led Smartphone-Based Self-Tracking Program on Women's Fertility Awareness for the Appropriate Use of Infertility Treatment

Fatma Saber Nady Mohammed[1] , Fayza Ahmed Ali Abdelbaky [2], Momen Zakaria Mohammed [3] & Hagar Kamal Masoud Mohammed [4]

(1,4).Lecturer of maternity and newborn health Nursing, Faculty of Nursing-Beni-Suef University,Egypt.
(2).Lecturer of Maternal and Neonatal Health Nursing, Faculty of Nursing,Fayoum University,Egypt.
(3).Lecturer of obestetrics & gynecology medicine,Faculty of medicine -Beni-Suef University, Egypt.

Abstract

Background: Self-tracking tools and practices can be thought as forms of "technology for the self" that allow people to monitor, control, act upon, and optimize their bodies in accordance with standards of appearance and health. **Aim:** to evaluate effect of a nurse-led smartphone-based self-tracking program on women's fertility awareness for the appropriate use of infertility treatment. **Methods:** a case and control group quasi-experimental design was used in the Infertility Diagnosis and Treatment Center in the Specialized Medical Center of the university campus affiliated to Beni-Suef University hospital on a purposive sample of 120 infertile women using a structured interviewing questionnaire& fertility awareness questionnaire which grouped into three parts :(fertility knowledge, attitudes towards fertility-awareness and practices of self-tracking). **Results:** the current study revealed that the percentage of women with satisfactory level of fertility knowledge increased from (15%) before the intervention to (75%) after the intervention, the percentage of those with positive attitudes towards fertility awareness increased from (18.3%) before the intervention to (71.7%)after the intervention, moreover, the level of fertile time' understanding, fertility symptoms awareness and the use of the fertile window were highly significantly improved after the nurse-led self-tracking smartphone applications. **Conclusion:** this study concluded that the nurse-led self-tracking smartphone application was an effective tool in improving levels of women's fertility awareness for appropriate use of infertility treatment. **Recommendation:** integrate the app with existing electronic health records (EHR) to facilitate data sharing and improve continuity of care.

Keywords: fertility awareness, infertility, nurse – led, self-tracking, smart phone.

Introduction

Women infertility ranks as the fifth most serious kind of disability worldwide **(Borumandnia et al., 2022)**. Infertility is an illness, condition, or status characterized by inability to conceive a child successfully depending on the patient's age, physical characteristics, diagnostic procedures, medical, sexual, and reproductive histories, or any combination of those factors **(Gracia et al., 2023).** It is estimated that roughly 1 in 6 women globally suffer from infertility **(World health organization (WHO), 2023).**

Fertility awareness (FA) defined as "the comprehension of sexual reproduction, fertility, and related individual risk factors (like advanced age, issues related to sexual health, and sexually transmitted diseases (STDs)), as well as lifestyle factors (like obesity and smoking) and non-personal risk factors (such as environmental and occupational conditions)". Part of it involves comprehending the factors influencing the requirement of starting a family as well as the social and cultural influences on decisions about family planning **(Zegers et al., 2017).**

The language which the cycle speaks to the body is called fertility biomarkers. Numerous biomarkers, including as variations in the following factors can be assessed at home: (the basal body temperature (BBT), discharge from the vagina, cervical position, and luteinizing hormone, also known as LH, levels) They're used to help in conception by

detecting ovulation and the window of fertility **(Ali et al., 2021).**

In vitro fertilization (IVF), artificially insemination from husband (AIH), timed ovulation induction with sexual activity, and intracytoplasmic sperm injections are among the available treatments for infertility problems **(Carson & Kallen, 2021).**

There are a variety of non-electronic and electronic training techniques available for individuals who are experiencing difficulties becoming pregnant **(Polillo et al., 2023).** Patients can now readily obtain high-quality care with comfort from their homes because of the development combining digitized medical data, telemedicine, internet-based platforms, and mobile apps **(Da Fonseca et al., 2023).**

Since tracking data is regarded as "self-knowledge through numbers, new and developing technology provide the person fresh perspectives on his identity, managing daily routines, and serve as foundation for behavioral changes **(Heyen, 2020).** The three main types of tracking technology are at-home urine hormone tests, temperature monitoring devices, and smartphone applications (apps) **(Worsfold et al., 2021).**

It might be said that individuals receiving therapy for infertility utilize self-tracking to plan and create new information. This draws attention to physiological cues, such blood, swelling, or slight pain. In theory, this produces helpful information about the patient's body and infertility treatment **(Hamper, 2020).**

Menstrual tracking gives people the opportunity to map their fertility and contraception, plan and prepare for their upcoming cycles, gain insight into mood management, gain a better understanding of their bodies, and utilize it as a learning tool for sexual health and wellness **(Tuli et al., 2022).** They advertised that they would empower women by giving them more knowledge, autonomy, and control over their sexual and reproductive health **(Hendl and Jansky, 2022).**

Justification of the problem

There are more than 25 million women in Egypt between the ages of 15 and 49; at least 3 million of them are infertile **(El- Sherif et al., 2021).** In the context of treating infertility, women's self-tracking is a sophisticated, emotionally charged practice that is vital to understanding one's own body. Tracking the menstrual cycle, the fertility window, recording symptoms (such as mood, pain, and sexual activity), and noting how one feels at each stage can all help one gain control over hormones. By monitoring the changes that take place throughout the month, these applications assist women in monitoring their cycles and can provide them with information about when they may reach their peak reproductive window. This information assist in understanding the treatment in general, and the body's responses to hormone therapy, encourages lifestyle modifications and facilitate the referral of women for fertility care **(Lykkebo et al., 2022).**

It would be more convenient to use these programs for self-timing therapy rather than going to the clinic, as having a precise awareness of reproductive facts is crucial for making informed decisions regarding fertility. There is very limited research handling this topic in Egypt that urges the researchers to conduct the current study.

Aim of the study

The study aimed to:

Evaluate effect of a nurse-led smartphone-based self-tracking program on women's fertility awareness for the appropriate use of infertility treatment.

1.3. Hypothesis

The researcher hypothesized that compared with women in the control group; women in the newly developed nurse-led self-tracking smartphone applications group (NSTA) would have higher levels of fertility awareness for the appropriate use of infertility treatment.

Operational definitions

A nurse-led service or nurse-led care;

Refers to healthcare services or interventions that are primarily managed, coordinated, and delivered by nurses rather than physicians **(Khair& Chaplin, 2017).** These

services capitalize on the specialized knowledge, skills, and experience of nurses to provide high-quality care, often in specific areas of healthcare **(IOM,2001).**

Smartphone;

Is a mobile device that integrates mobile computing and cellular capabilities into a single item. It is designed to offer advanced capabilities and connectivity beyond traditional mobile phones, typically including internet access, a touchscreen interface, and a wide range of applications and services **(World Economic Forum,2018).**

Self-tracking;

Also known as self-monitoring or quantified self, refers to the practice of systematically recording and analyzing various personal data points related to one's daily life, behaviors, and health. This practice is often facilitated by digital tools and devices such as smartphones, wearable technology, and specialized apps**(Norris, 2012).**

Fertility awareness:

Is a method of understanding, tracking and monitoring the distinctive symptoms and signs of a female's menstrual cycle's infertile and fertile phases. It involves observing and recording various physiological indicators as (cervical position, cervical mucus, and basal body temperature; BBT) to identify the days on which a woman is most likely to become pregnant**(Healthwise Staff, 2022).**

2. Material and methods:

2.1. Research Design:

A case and control group quasi-experimental design was used.

2.2. Setting:

The study was carried out in the infertility diagnosis and treatment center in the specialized medical center of the university campus affiliated to Beni-Suef University hospital. This medical units serve the North Upper Egypt region in general and Beni-Suef

Governorate in particular. At the second floor – below the center of human resources development. The center has nine rooms: The unit is equipped with the latest modern medical equipment to provide the best medical services in the field of treating infertility, delayed pregnancy, ICSI and assisted fertilization. It includes preparation rooms and transplant rooms, as well as rooms designated for patients and doctors'. The unit is opened at 8 A.M. to 2 P.M every day.

Subjects

Sampling:

Sample Type and size

The total flow rate of infertile women in the previously mentioned setting through the course of the study were 173 women. So, a purposive sampling of 120 women was recruited (60 control group and 60 study group). The sample size was calculated by using the following equation:

$$n = N / \{1 + N (e)^2\} \text{ (Chandrasekharan et al., 2019)}$$

Where n = sample size, N = population size =173

e= 0.05 is the level of error

n= 173/ {1+173(0.0025)} = 120

2.3.3. The Inclusion criteria:

Women who diagnosed medically with infertility, who have a smartphone with internet connectivity, use what's app application. Also have access to free fertility tracking application for at least three months and input the following entries (cervical mucus consistency, basal body temperature, menstruation, sexual activity, physical symptoms, or a personal note) daily for 15 days.

Exclusion criteria: Women who have family disputes, stressful events like death or disease of relatives, and major life changes in the past three months that have led to physical or psychological problems.

Data collection tools:

A pair of tools was used to collect data:

Tool I: The researchers created an Arabic version of a structured interview questionnaire after reviewing the latest literatures. It was made up of:

Part 1: Personal characteristics of women as age, occupation, level of education, and annual income.

Part 2: included the women's obstetrical history; prior pregnancy, conception methods, action for pregnancy and infertility treatment and fertility consultation for the husband.

Part 3: Menstrual history; menarche age, menstrual cycle duration, premenstrual syndrome, and presence of menstrual pain.

Tool II: Fertility awareness

The questionnaire grouped into three parts:

Part 1: Fertility Knowledge

A self- developed questionnaire with 29 questions about reproductive health drawn from previously published research(**Maeda, E. et al.,2015**), and extra questions about fertility treatments created based on the Japanese translation of the widely used the CFKS-J, or Cardiff Fertility Knowledge Scale; a validated fertility literacy assessment tool(**Maeda, E. et al.,2015**). The following subjects were covered by the questions: the mechanics of conception, the fertile window of menstrual cycles, risk factors for infertility, infertility treatment, and the financial issues associated with infertility treatment. Women were asked to select one of three choices or "I do not know". A single point is provided for a "correct answer," while 0 points are given for an "incorrect" or "don't know" response. The overall fertility score, ranging from 0% to 100%, is categorized into satisfactory and unsatisfactory based on statistical analysis.

- **Satisfactory <65%**

- **Unsatisfactory >65%**

Part 2: Attitudes towards fertility-awareness (Hampton et al.,2012).

Woman's attempts for improving their knowledge is assessed by thirteen Statements on a 5-point Likert scale, ranging from strongly agree to strongly disagree, include: 1. A woman should be educated about reproductive issues when she first consults her doctor about having problems conceiving. 2. Timing sexual activity during the menstrual cycle's fertile window can aid in the natural conception of some infertile couples. Total attitude score was obtained by adding the item scores together to get the overall score. The overall attitude score of women was categorized as follows: negative when it was less than 65% and positive when it was more than 65%.

Part 3: Practices of self-tracking

A questionnaire of 23 multi-choice questions were created for testing:

3:Fertile time' understanding adopted from Uganda Bureau of Statistics (UBOS) and ICF Micro, (2016).

In order to measure a woman's awareness of the time in her menstrual cycle when she has the highest chance of getting pregnant after having sex. The following questions were utilized: "Are there specific days during each menstrual cycle when women are more susceptible to become pregnant if they engage in unprotected sexual activity?" There were five options for their responses. Women who correctly understood the question were those who said that they would be more likely to become pregnant if they engaged in unprotected sexual activity halfway of their two menstrual cycles. On the other hand, incorrectly understanding of the question appeared in women who mentioned other options or said they were unsure of when their menstrual cycle would be fertile.

2: Knowledge Level of fertility awareness symptoms

Determined knowledge of the four natural fertility-awareness methods (questions that address perceived fertile days awareness "5 questions ", awareness of fertile time's mucus type "6 questions ", awareness of ovulation related temperature change "5 questions ", and "6 questions " address Perceived ovulation pain.

Single point is assigned for a "correct answer," while 0 points are given for a "incorrect" .The right answers' percentage can range from 0% to 100%, is the total fertility score, which is divided into two groups based on statistical analysis:

- Satisfactory <65%

- Unsatisfactory >65%

3: Use of the fertile window "fertility awareness symptoms "(Frank-Herrmann et al., 2005).

Four further questions asked women to schedule the sexual activity during their estimated fertile window each month through self-tracking of; changes in cervical mucus consistency, basal body temperature daily, the length of menstrual cycles, and ovulation pain perception over several months to determine the average cycle length through the application or

in a daily data entry diary if they discontinued and/or couldn't use the applications.

Procedures

The following procedures were used when conducting the study:

Five experts from the Maternity and child Health Nursing department and the Obstetrics and gynecological Medicine Specialty performed content validity to ensure that the research tools were thorough and relevant.

Reliability of the tool was done to ensure that the research tools was reliable. Also the internal consistency was calculated to determine the degree to which the tool's items measured the things they were designed to measure. The internal consistency of the instrument was assessed using the Cronbach's alpha coefficient.

	Cronbach's alpha
Fertility Knowledge	.734
Attitudes towards fertility-awareness	.799
Practices of self-tracking	
Fertile time' understanding	.656
Knowledge Level of fertility awareness symptoms	
Knowledge of cervical mucus method	.792
Knowledge of basal body temperature method	.687
Knowledge of rhythm-based method	.723
Knowledge of perceived ovulation pain	.691
Use of the fertile window "fertility awareness symptoms"	
Monitoring changes in cervical mucus consistency	.621
Measuring basal body temperature	.738
Tracking the length of menstrual cycles	.630
Tracking the ovulation pain	.771

The scientific research ethics committee of the Faculty of Medicine - Beni-Suef University's provided ethical permission prior to the initiation of the study. Oral consent was given by each woman to take part in the study with the right to withdraw at any time; ethical issues were considered into account; there was no risk to the women's physical, psychological or social well-being; the data was collected and handled in confidence; and each woman was informed of the purpose of the study before any tools were used in order to earn their trust and confidence.

Ten percent (12 women) participated in a pilot research to evaluate the pretest's content, clarity, and fill-time requirements.

Field work:

A formal letter was received by the director of Beni-Suef University Hospital from the dean of nursing faculty at Beni-Suef University requesting permission to perform the study. The major elements of data to be addressed, along with the study's title and objective, were all illustrated to obtain their consent. Data were collected through six

months from the start of April 2023 to the end of September 2023.

This study was carried out in five consecutive stages.

Preparatory Phase

Initially, the researcher reviewed local and international literature to understand the research subject and prepare data gathering instruments.

Step of assessment and interviews: the researchers visited the pre mentioned setting three days per week from 9.00 am to 2.00 pm until the entire pre-specified sample size was reached, introduced themselves, and described the purpose, planned intervention and it's duration in order to get approval, and emphasized the significance of maintaining contact with the researchers. After gathering the baseline data, which included their personal characteristics as well as their menstrual and obstetrics history (Tool I),and used (Tool II) in order to assess fertility awareness through assessment of women's fertility knowledge, attitudes towards fertility-awareness and practice of self-tracking. usually1-3 women were interviewed per week on average. The duration required for each woman to complete the questionnaire varied between 20 and 30 minutes. Then, the researchers created a WhatsApp group for the studied women.

2.6.2. Planning Phase: based on literature reviews and baseline data from the preliminary test evaluations, the researchers prepared an educational intervention in the form of PowerPoint presentation, videos and animation and a printed Arabic booklet.

2.6. 3. Implementation Phase

Five sessions were held for the purpose of raising women's understanding of fertility, approximately one hour-long for each session using a PowerPoint presentation, e-learning videos, and animation.

First session: included comprehensive information on fertility and infertility. Explanation of the menstrual cycle, ovulation, and fertile windows, and sperm's and ovum's age.

Second session: The researchers illustrated and enumerated causes of male and female infertility in detail, factors affecting sperm quality, and how to improve sperm heath.

Third session:

The researchers illustrated details on various infertility treatments, their processes, success rates, and potential side effects. Lifestyle assessments to provide personalized advice on diet, exercise, and stress management.

Fourth session (practical session): to guide women's understandings of their bodies. Researchers demonstrated how to track fertility using **ovulation prediction methods** to improve women's knowledge of their menstruation;

1.Basal Body Temperature (BBT) and cervical mucus monitoring tracking: Women were instructed to take basal body temperature (BBT) first thing in the morning, before eating, drinking, or doing anything else, use a specialized or digital thermometer, document the results on a chart or graph, and keep an eye on it for more than a week from the first fertile day until the BBT rises as the BBT typically rises by 0.2°C (0.4°F) during ovulation and remains elevated for more than a week. Furthermore, to check the consistency of cervical mucus women were asked to use clean fingers or toilet paper, test the mucus's "stretchiness" by placing a drop between the thumb and finger, try to separate them to check if the mucus extends. Then record the amount, color, and thickness of the mucus. Three types of mucus patterns can be distinguished: ovulatory or fertile mucus is watery, clear, and elastic; postmenstrual sterile mucus is dense, dry, and sticky. When in the post-ovulatory infertile pattern: the vaginal opening feels dry once more and the mucus thickens, turns cloudy, and becomes sticky. In order to get pregnant women were instructed to have sexual contact daily or on an alternate day beginning from the first fertile day until three days after your BBT rises.

2.Calendar method: how to calculate the average cycle length over several months to predict the fertile window. Women were instructed to keep track of their menstrual

periods, and find out how many days a cycle is regular and whether it is regular enough to predict when they will ovulate. women should ovulate 14–15 days following the onset of menstrual flow if their cycle lasts 28 days. Take 18 off the number of days in their shortest cycle and 11 off the number of days in their longest cycle to find the first fertile day. Moreover, women were instructed that three to five days following sex, sperm can remain in the vagina.

3.Ovulation pain: describing and encouraging women to keep a diary of the characteristics, duration, intensity and symptoms that may accompany it. Explaining how to differentiate ovulation pain from other types of pain, ovulation pain is sudden, dull pain, lasting a few minutes to a day, affecting one side of the abdomen occurs around 14 days before the period, and potentially causing vaginal bleeding or discharge. and discussing the importance of tracking patterns over several cycles to identify consistent ovulation pain.

Fifth session (practical session):

During this session, each women were:

− Asked to download free fertility tracking apps as Wocute or Glow, login and create their profile to predict their menstrual cycle and ovulation.

− Taught how to input data (BBT, cervical mucus, cycle length, and ovulation pain) into the app for at least three cycles while using hormonal medication for infertility treatment and to schedule their sexual relation around potential fertile days.

- Asked to utilize app features like charts, reminders, and predictions: cycle's red days appeared on the application of fertility tracking (chance of getting pregnancy), which occur from day 6 to day 16 in a 28 day regular cycle, and green one indicating safe days away from the ovulation day).

- The researchers provided each women with a template or app to start tracking their ovulation pain and other fertility signs. Women were instructed that they can use a daily data entry diary to track their ovulation.

Infertile women were given booklets about sessions and were asked to share it with their husbands. Feedback from previous sessions was incorporated into the new session.

Follow up Phase: Researchers followed the infertile women over a period of three months through phone calls, direct messaging or outpatient appointments for providing personalized education and support.

The women in the control group received the existing standard care included medical diagnosis and treatment, along with brief instructions   regarding adherence to treatment.

2.6.5. Evaluation stage: Three months after the intervention during the last follow-up visit, the post-test was took place in the same pre-selected settings. The study and control group's fertility awareness was assessed by the researchers using the same pre-test tools to compare the effects of the pre- and post-tests and assess the study's impact.

2.6.5. Limitation of the Study

−   There is limited studies about use of such applications.

−   Some women considered these is a sensitive topics and didn't want to speak about it

2.6.6. Strengths of the Study

This is the first study that address the effect of self-tracking applications in Egypt. The intervention's level of efficacy exceeded expectations. A two-way educational approach was developed to avoid forgetting . The material was adjusted daily, provided in booklets and WhatsApp groups, allowing women to accurately determine ovulation times for each cycle.

3. Statistical design:

 Appropriate statistical techniques and tests of significance were used to gather, organize, code, computerize, and analyze the data. The results were then presented in appropriate tables and figures. To ascertain sample homogeneity at baseline, chi-square and

sample t test were employed. The interaction impact of each measurable outcome was tested using ANOVA. To find the difference in the results between the groups at each time point, a nonparametric test was used "chi-square test of Fisher's exact test". Every significant level was established at p <.05.

Results

Table (1) indicates the personal characteristics of the women under study; the mean age was 31.22±6.25and 31.73±6.14years for control and study groups respectively. (51.7% and 43.3%) of both groups respectively had middle education. (75.0%&38.3 respectively) of control group were rural resident and had temporary job, while ;(60%&35% respectively) of study group were rural resident and not employed. In addition, the income of (58.3 %, 65.0%) of control and study group were below the expenditures. Also, (45% and 60%) of control and study group respectively had no medical /health care background. Finally, there was no statistically significant variation between control and study groups regarding their personal characteristics.

Table (2) illustrates that the mean age of menarche of infertile women was (11.36&12.28) with standard deviation (±2.55&±2.13) years of control and study group, respectively. Furthermore (56.7%, 45.0% &63.3%, 75.0%, respectively) of control and study group had previous and natural pregnancy. (55%) of control group reported having infertility for more than 5 years. While, (50%) of study group reported having infertility for less than 5 years. Also (66.6%, 56.7%) of control and study group husband's respectively had no fertility consultation. (41.7%, 53.3%, respectively) of the control and study group received information from the internet to improve their fertility-awareness.

Table (3); reveals significant improvement in the of fertility knowledge level after the nurse-led self-tracking smartphone applications. As the satisfactory level increased from (15%) pretest to (75%) posttest in study group (P<0.001). While; in the control group the satisfactory level increased from (18.3%) pretest to (21.7%) pretest (p>0.05).

Figure (1); shows an improvement of the studied women's attitude toward fertility-awareness after the nurse-led self-tracking smartphone applications; as the positive attitude's percentage increased from (18.3%) pretest to(71.7%) posttest in study group. While; in control group, the positive attitude's percentage increased from (21.7 %) pretest to (38.3 %) posttest.

Table (4); reveals that the level of fertile time' understanding was highly significantly improved after the nurse-led self-tracking smartphone applications. As the satisfactory level's percentage increased from (11.7%) pretest to (71.7%) posttest in the study group (P<0.001). While; in control group, the satisfactory level's percentage increased from (13.3%) pretest to (26.7%) posttest (p>0.05).

Table (5); shows a statistical improvement of the studied women's level of mucus method, temperature method, rhythm method and ovulation pain knowledge after the nurse-led self-tracking smartphone applications than before it among study group(P<0.001). While; there were minimal variation in fertility symptoms awareness knowledge between the pre and posttest among control group(p>0.05).

Table (6); Shows that the use of the fertile window "fertility awareness symptoms" was highly significantly improved after the nurse-led self-tracking smartphone applications. As the use of mucus method, temperature method, rhythm method and ovulation pain were improved greatly during posttest than pretest among study group (P<0.001). While ; there were minimal variation in the use of the fertile window posttest when compared to pretest among control group(p>0.05).

Table (1): Distribution of the studied women regarding their personal characteristics (n=120)

Items	Control group (n=60)		Study group (n=60)		X^2	p value
	No.	%	No.	%		
Age						
20-<30 years	17	28.3	15	25.0		
30-<40 years	27	45.0	11	18.3	9.164	0.057
40-<50 years	16	26.7	34	56.7		
Mean ±SD	31.22±6.25		31.73±6.14			
Education						
Can't read and write	15	25.0	22	36.7		
Middle Education	31	51.7	26	43.3	8.915	0.063
University Education	14	23.3	12	20.0		
Residence						
Rural	45	75.0	36	60.0	.370	0.543
Urban	15	25.0	24	40.0		
Occupation						
Fulltime job	21	35.0	11	18.3		
Temporary job	23	38.3	14	23.3	19.741	0.232
Self-employee	5	8.3	7	11.7		
Not employee	10	16.7	21	35.0		
Student	1	1.7	7	11.7		
Income						
Below the expenditures	35	58.3	39	65.0	6.322	0.176
Equal the expenditures	15	25.0	13	21.7		
Higher than the expenditures	10	16.7	8	13.3		
Medical /health care background						
None	27	45.0	36	60.0	16.183	0.063
Medical professional	5	8.3	13	21.7		
Worked at health care setting	24	40.0	9	15.0		
Studied medicine/health care	4	6.7	2	3.3		

* Statistically significant at p≤0.05   ** highly statistically significant at p≤0.01

Table (2): Distribution of the studied women regarding their obstetrical history (n=120).

Items	Control group (n=60)		Study group (n=60)		X^2	p value
	No.	%	No.	%		
Age of menarche					1.970	0.054
Mean ±SD	11.36±2.55		12.28±2.13			
Prior pregnancy					3.649	0.056
Yes	34	56.7	38	63.3		
No	26	43.3	22	36.7		
Conception method					6.920	0.140
Natural	27	45.0	45	75.0		
Timed intercourse	16	26.7	6	10.0		
Artificial insemination	17	28.3	9	15.0		
Infertility duration					6.511	0.089
Less than 5 years	21	35.0	30	50.0		
More than 5 years	33	55.0	20	33.3		
More than 10 years	6	10.0	10	16.7		
Action for pregnancy and infertility treatment					14.059	0.594
Consultation	13	21.7	8	13.3		
Diagnostic tests for infertility	12	20.0	13	21.7		
Scheduled sexual intercourse	15	25.0	12	20.0		
Artificial insemination	10	16.7	12	20.0		
In vitro fertilization	10	16.7	15	25.0		
Medical institution type for infertility treatment					13.591	0.138
Private clinics for infertility treatment	23	38.3	21	35.0		
General gynecology clinics	17	28.3	19	31.7		
General hospital	9	15.0	11	18.3		
University hospital	11	18.3	9	15.0		
Infertility consultation for the husband					1.663	0.197
Yes	20	33.3	26	43.3		
No	40	66.6	34	56.7		
Sources of the information to improve their fertility-awareness					5.250	0.263
Internet	25	41.7	32	53.3		
General	21	35.0	20	33.3		
Friend	14	23.3	8	13.3		

* Statistically significant at p≤0.05   ** Highly statistical significant at p≤0.01

Table (3): Distribution of the studied women regarding their Fertility Knowledge (n=120).

Fertility Knowledge										
Items	Pretest				Posttest				X^2	p value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No.	%	No.	%	No.	%	No.	%		
Control group (n=60)	11	18.3	49	81.7	13	21.7	47	78.3	1.089	0.297
Study group (n=60)	9	15.0	51	85.0	45	75.0	15	25.0	13.979	0.000**

* Statistically significant at p≤0.05
** Highly statistical significant at p≤0.01

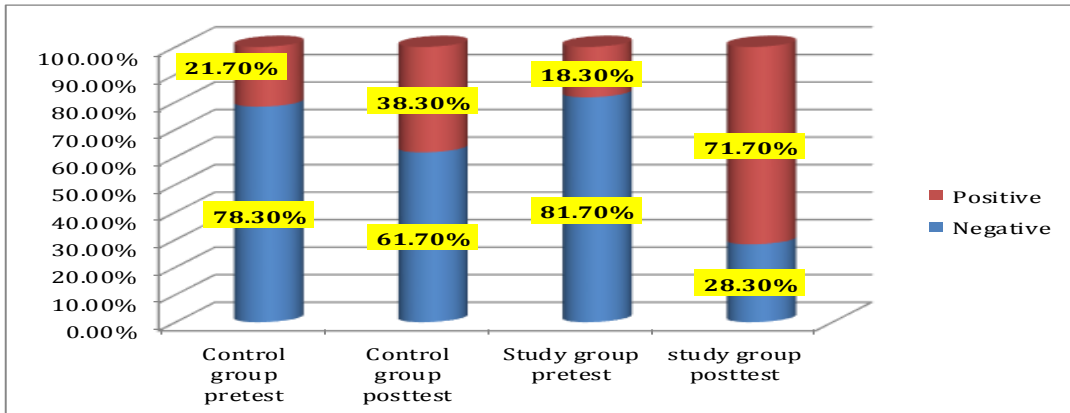**Figure (1): Distribution of the studied women regarding their attitudes towards fertility-awareness (n=120).**

Table (4): Distribution of the studied women regarding fertile time' understanding (n=120).

Fertile time' understanding										
Items	**Pretest**				**Posttest**				X^2	**p value**
	Satisfactory		**Unsatisfactory**		**Satisfactory**		**Unsatisfactory**			
	No.	%	No.	%	No.	%	No.	%		
Control group (n=60)	8	13.3	52	86.7	16	26.7	44	73.3	.998	0.348
Study group (n=60)	7	11.7	53	88.3	43	71.7	17	28.3	17.468	0.000**

*Statistically significant at p≤0.05   ******Highly statistical significant at p≤0.01

Table (5): Distribution of the studied women regarding level of fertility awareness symptoms knowledge (n=120).

Items	Control group (n=60)								X^2	p value	Study group (n=60)								X^2	p value
	Pretest				Post test						Pretest				Posttest					
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory				Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	No.	%	No.	%	No.	%	No.	%			No.	%	No.	%	No.	%	No.	%		
Knowledge of mucus method	5	8.3	55	91.7	12	20.0	48	80.0	.963	0.327	5	8.3	55	91.7	51	85.0	9	15.0	21.818	0.000**
Knowledge of temperature method	3	5.	57	95.0	6	10.0	54	90.0	.305	0.581	6	10.0	54	90.0	41	68.3	19	31.7	28.421	0.000**
Knowledge of rhythm method	6	10.0	54	90.0	13	21.7	47	78.3	1.176	0.278	9	15.0	51	85.0	44	73.3	16	26.7	24.103	0.000**
Knowledge of ovulation pain	4	6.7	56	93.3	8	13.3	52	86.7	.621	0.431	7	11.7	53	88.3	42	70.0	18	30.0	27.857	0.000**

* Statistically significant at p≤0.05   ** highly statistical significant at p≤0.01

Table (6): Distribution of the studied women regarding their use of the fertile window "fertility awareness symptoms" (n=120).

Items	Control group (n=60)										Study group (n=60)									
	Pretest				Post test				X^2	p value	Pretest				Posttest				X^2	p value
	Not done		Done		Not done		Done				Not done		Done		Not done		Done			
	No.	%	No.	%	No.	%	No.	%			No.	%	No.	%	No.	%	No.	%		
Mucus method																				
First month	43	71.7	17	28.3	41	68.3	19	31.7	1.154	0.283	44	73.3	16	26.7	15	25.0	45	75.0	3.726	0.04*
Second month	48	80.0	12	20.0	45	75.0	15	25.0	1.875	0.171	49	81.7	11	18.3	13	21.7	47	78.3	7.273	0.007**
Third month	52	86.7	8	13.3	44	73.3	16	26.7	1.148	0.284	52	86.7	8	13.3	10	16.7	50	83.3	10.421	0.001**
Temperature method																				
First month	45	75.0	15	25.0	39	65.0	21	35.0	1.026	0.311	47	78.3	13	21.7	16	26.7	44	73.3	6.035	0.001**
Second month	46	76.7	14	23.3	40	66.7	20	33.3	2.141	0.143	47	78.3	13	21.7	16	26.7	44	73.3	6.035	0.001**
Third month	38	63.3	22	36.7	37	61.7	23	38.3	1.466	0.226	40	66.7	20	33.3	18	30.0	42	70.0	4.420	0.03*
Rhythm method																				
First month	41	68.3	19	31.7	39	65.0	21	35.0	1.655	0.198	43	71.7	17	28.3	16	26.7	44	73.3	3.933	0.047*
Second month	39	65.0	21	35.0	36	60.0	24	40.0	1.108	0.293	37	61.7	23	38.3	12	20.0	48	80.0	6.035	0.001**
Third month	43	71.7	17	28.3	36	60.0	24	40.0	1.481	0.224	45	75.0	15	25.0	11	18.3	49	81.7	7.095	0.008**
Ovulation method																				
First month	36	60.0	24	40.0	36	60.0	24	40.0	3.297	0.069	47	78.3	13	21.7	16	26.7	44	73.3	4.490	0.034*
Second month	42	70.0	18	30.0	38	63.3	22	36.7	1.118	0.290	44	73.3	16	26.7	13	21.7	47	78.3	8.626	0.003**
Third month	40	66.7	20	33.3	36	60.0	24	40.0	2.208	0.137	40	66.7	20	33.3	12	20.0	48	80.0	9.324	0.002**

* Statistically significant at p≤0.05   ** Highly statistical significant at p≤0.01

Discussion

Infertility affects one in six married women globally**(Margan et al.,2022).** The number of Assisted Reproductive Technology (ART) cases have increased, but only 1.7% of US babies are born due to successful ART conception**(Centers for Disease Control and Prevention,2021).** Only one IVF cycle can cost between $15,000 and $30,000. Medication costs can make up 35% of expenses**(Conrad& Grifo, 2023).**Period-tracking is the most popular category of women's mobile health apps**(Statista,2023),** allowing users to monitor, control, and optimize their bodies according to appearance and health standards. This technology is part of bio-pedagogy, a self-education framework **(Polzer et al.,2022).** Digital menstruation tracking programs also predict ovulation and offer advice on menstruation, conception, pregnancy, and general health **(Healy,2021,Hohmann &Marriott,2021).** However, self-monitoring in medical care has not received enough attention. The purpose of this study was to assess effect of a nurse - led self-tracking smartphone applications on improving infertile women awareness of fertility for the appropriate use of infertility treatment. The study findings illustrated acceptance of research hypothesis, which indicate after applying the nurse-led self-tracking smartphone applications (NSTA), fertility awareness would predicted to be improved significantly in participants of (NSTA) group than in participants of the control group.

Regarding personal characteristics; the mean age was 31.22±6.25and 31.73±6.14years for control and study groups respectively. Near to two thirds of the control group and the study group had previous pregnancy. Regarding conception method; near to half of the control group and two thirds of the study group got pregnancy naturally. More than half of control group reported having infertility for more than 5 years. While, half of study group reported having infertility for less than 5 years. From the researcher point of view, young couples perceived that with old age; women might face decreased egg quality and quantity. Additionally, infertility treatment can help by selecting the best eggs and sperm for fertilization. Similarly, **Yokomizo et al.,(2o21)** in Japan who carried out the study to find out how well a smartphone application could improve literacy around fertility treatments by offering high-quality information about fertility treatments, and discovered that the participants' mean age (32.6 years), duration of pregnancy desire (15.2 months), as well as percentage of women undergoing fertility treatment (15.6%) seemed comparable to those of the broader Japanese population.

Additionally, the results of this study were in line with **Aimagambetova et al., 2020** in Kazakhstan, who evaluated 304 infertile women in three different cities for psychological distress and found that the median duration of infertility was her 5.9 years.

Contrarily, **Abd-Elhamed et al., (2023)** in Minia ,Egypt who intended to assess how a social media-based intervention affected the rate of pregnancy, anxiety, and adjustment in infertile women using assisted reproductive technology. It was found that slightly half and more of them had employment, came from rural areas, had some education, and that nearly the age of about half were around 18 and 28, with a mean age of 29.2 ±7.9. Additionally, it was discovered that approximately two-thirds of the analyzed sample had an infertility diagnosis made during the last five years, and that over 75% of the samples had primary infertility.

It is crucial that women who are attempting to conceive possess the necessary knowledge to maximize their chances of becoming pregnant naturally, given the scarcity of access to ART and its high emotional and financial cost **(Halleran et al., 2022).**

The present study showed the fertility knowledge level was improved significantly after the nurse-led self-tracking smartphone applications. Since the percentage of satisfactory level increased before the intervention from less than one quarter of the study group to three quarters after the intervention (P<0.001). In this regard, **Yokomizo et al.,(2o21)** in Japan discovered that information about fertility and therapy offered through a smartphone application improved the understanding of fertility for those who undergone infertility treatment. Also, these

results agreed with **Maeda, et al., (2021)** who evaluated the impact of employing an automated conversation software, or chatbot for fertility education on knowledge, intentions to change preconception behavior, and anxiety using a social media research panel online. They discovered that chatbots were a more useful tool than traditional information delivery. Additionally, **Stern et al., (2013)** in Sweden who looked into whether providing reproductive life plan (RLP)-based information in counseling about contraception improves women's understanding of reproduction, especially folic acid intake before becoming pregnant. They discovered that giving individuals individualized written and oral material improved their understanding of reproductive health. The results of this study are in line with the current modern way of living to use a smartphone application for information gathering. Information sent via a smartphone application is allowed. Also, women get the information they need from Internet-based resources, such as smartphone applications. As this impart knowledge in many different ways, including movie-based learning and other methods as opposed to data from booklets or brochures.

In psychology, an attitude is a grouping of thoughts, beliefs, and behaviors directed toward a certain thing, person, thing, or situation. In general, a strong intention to carry out an action is reflected in an extremely positive attitude toward the conduct. Interest among women in monitoring their reproductive or menstrual cycles for family planning and health monitoring has significantly increased over the past few decades **(Smith, 2019).** The current study's findings confirmed that, given that there was a variation in the effect of the nurse-led self-tracking smartphone applications on the studied women attitude toward fertility-awareness. In the study group, the proportion of positive attitudes rose from less than one quarter of the study group prior to the intervention to less than three quarters following it. These outcomes align with **Khadivzadeh et al., (2021)** in Mashhad who evaluated how education affected attitudes about reproductive control and knowledge of fertility counseling and found a significant statistical variation in the average attitudes

about fertility control after the interventions. Additionally, **Duane et al., (2022)** addressed the widely used fertility awareness based methods (FABMs) in North America and discovered that FABMs can be useful for family planning, both to achieve and prevent conception, as well as for medical diagnosis and management. Moreover**, Arévalo et al., (2002)** who assessed the effectiveness of the Standardized Days Method (SDM), as awareness of fertility -based approach, in Peru, Bolivia, and the Philippines, and discusses how education impacts its acceptance and use. They found that once the woman is able to reproduce, a couple modifies their sexual conduct; the SDM offers substantial protection against unintended pregnancy and is socially acceptable in a variety of contexts. According to the current study findings; the rationale behind women's positive attitude towards fertility awareness may be attributed to educational content, which enhances their knowledge about fertility, reproductive health, and fertility tracking methods**.**

Fertility awareness programs can reduce unnecessary patient intervention by increasing conception rates and reducing referrals to artificial reproductive technology (ART) **(Mahey et al.,2018& Capotosto, 2021)**. In fact, research indicates that many women trying to conceive are unaware of the menstrual cycle, ovulation, or the fertile period. The majority of ART referrals are made based only on the patient's self-report of ovulation, despite the fact that fertility awareness and the usage of fertility-awareness methods are inadequate. Instruction on ovulation markers and tracking techniques can help women feel less stressed and more emotionally healthy while waiting for a successful pregnancy **(Capotosto, 2021).** The results of this study confirmed that, as the levels of fertile time' understanding, fertility symptoms awareness, and the use of the fertile window were highly significantly improved after the nurse-led self-tracking smartphone applications. It showed good agreement with the outcome published by **Frank-Herrmann et al., (2007)** in Germany, who investigated the efficiency of fertility awareness methods and highlights the role of education in helping couples correctly identify the fertile window and manage their reproductive health. The

satisfactory level knowledge and practices of self-tracking could be attributed to the fact that the nurse-led self-tracking smartphone applications with various available, easily accessed information resources regarding fertility symptoms awareness educated women and were used as additional incentive to use methods of fertility awareness on a regular basis to monitor ovulation in order to improve the likelihood of pregnancy.

Additionally, these findings is in line with the result of **Freundl et al., (2007**) in Germany who assessed effect of education on the successful practice of natural family planning methods and their impact on managing infertility. They discovered that, particularly in couples experiencing infertility that cannot be explained, self-monitoring using natural contraception techniques could possibly be all that is required. Also, **Hilgers et al. (1992)** in Omaha, Nebraska, who examined if the Billings ovulation method's standardized adaptation was beneficial for fertility-focused sexual relations, and checked whether cervical mucus discharge occurs at the time of ovulation or not. They found that when couples concentrated on the fertile stage, 76% of them were able to conceive in their first cycle, 90% by their third cycle, and 98% by the sixth cycle.

Furthermore, the results of the current study were consistent with those of **Stanford et al., (1998)** in USA, who evaluated the natural contraceptive methods interest among women, and concluded that; a large number of women who do not now use fertility awareness-based treatments expressed interest in doing so in the future in order to become pregnant. Finally, the outcomes of the current study confirmed the conclusions of **Gambier-Ross et al. (2018)** in the UK, who examined in detail how apps are used to measure fertility. Using a mixed-methods approach that included follow-up interviews as well as survey , it was discovered that the primary reasons people used fertility tracking apps were: 1) to monitor their cycle (72%), 2) to try to conceive (34%), 3) to get information about infertility treatment (12%), and 4) to prevent getting pregnant (4%).

Conclusion

Considering the results of this study , the study hypotheses was accepted as the nurse-led self-tracking smartphone application was an effective tool in improving levels of women's fertility awareness for the appropriate use of infertility treatment.

Recommendation

The following recommendations are made in light of the study's findings;

1.Ensure comprehensive thorough training for nurses on using the mobile application and interpreting the data collected and provide training on counseling and supporting patients in using the application effectively.

2.Integrate the app with existing health records to facilitate data sharing and improve continuity of care.

3.Conduct research studies to evaluate the application's effectiveness in improving fertility awareness and treatment outcomes.

4.Create fertility awareness initiative to make fertility education more widely available, guarantee that all women and men and are capable of making educated decisions, and enhance public knowledge of the modifiable factors that influence fertility and reproductive outcomes.

References:

Abd-Elhamed, M.,Ahmed , Fathy, E., Sabry, Osman, N., Ezzat Ahmed, ., Taha & Saber, E., Hanafy,(2023): Effect of Social Media-based Intervention on Adjustment, Anxiety and Pregnancy Rate among Infertile Women Undergoing Assisted Reproductive Technology. Vol , (11) No, *(43), January, 2023, pp (120 – 134. Print Issn: 2314-8845 Online Issn: 2682-3799* doi: 10.21608/ASNJ.2023.187708.1490

Aimagambetova, G., Issanov, A., Terzic, S., Bapayeva, G., Ukybassova, T., Baikoshkarova, S., & Terzic, M., (2020): The effect of psychological distress on IVF outcomes: Reality or speculations? PLoS One, 15(12), e0242024. doi: 10.1371/journal.pone.0242024.

Ali, R.; Gürtin, Z.B.; Harper, J.C., (2021): Do Fertility Tracking Applications Offer Women Useful Information about Their Fertile Window? *Reprod. Biomed. 42*, 273–281. https://doi.org/10.1016/j.rbmo.2020.09.005

Arévalo, M., Jennings, V., & Sinai, I., (2002). "Efficacy of a new method of family planning: the Standard Days Method."* Contraception, 65(5),   333-338. **doi:** https://doi.org/10.1016/S0010-7824(02)00288-3

Borumandnia N, Majd HA, Khadembashi N, Alaii H., (2022); Worldwide trend analysis of primary and secondary infertility rates over past decades: a cross-sectional study. Int J Reprod   BioMed   20(1):37,   doi: 10.18502/ijrm.v20i1.10407.

Capotosto ,M., Perez, (2021): An integrative review of fertility knowledge and fertility-awareness practices among women trying to conceive. Nurs Womens Health. 25(3):198-206. doi: 10.1016/j.nwh.2021.04.001.

Carson, S. A. & Kallen, A. N., (2021): Diagnosis and management of infertility: a review. *JAMA* **326**,   65–76   doi: 10.1001/jama.2021.4788.

Centers for Disease Control and Prevention (2021); Infertility FAQs. https://www.cdc.gov/reproductivehealth/infertility/index.htm.

Chandrasekharan, S., Sreedharan, J., & Gopakumar, A., (2019): Statistical issues in small and large sample: Need of optimum upper bound for the sample size. *International Journal of Computational & Theoretical Statistics*, *06*(02),   108-118. doi:10.12785/ijcts/060201.

Conrad,M., & Grifo, J.,(2023): How Much Does IVF Cost? Available at Forbes Media

Da Fonseca MH, Kovaleski F, Picinin CT, Pedroso B, Rubbo P., (2021); E-health practices and technologies: a systematic review from 2014 to 2019. Healthcare. 9(9):1192.   MDPI.   doi: 10.3390/healthcare9091192.

doi: 10.1007/s00404-002-0293-8

Duane, M.,Joseph B. Stanford, Christina A. Porucznik, and Pilar Vigil,(2022); Fertility Awareness-Based Methods for Women's Health and Family PlanningFront Med (Lausanne).   9:   858977.   doi: 10.3389/fmed.2022.858977.

El- Sherif M A, Kamal N N, Ahmed ER and Sayed S I. ,(2021) : Coping Strategies and Quality of Life among Infertile Women, Minia District., MJMR, Vol (32), No(2).doi: 10.21608/MJMR.2021.231542

Frank-Herrmann P., Gnoth C., Baur S., Strowitzki T. & Freundl G., (2005); Determination of the fertile window: reproductive competence of women–European cycle databases. *Gynecological Endocrinology* 20(6), 305–312.   doi: 10.1080/09513590500097507.

Frank-Herrmann, P., Heil, J., Gnoth, C., Toledo, E., Baur, S., Pyper, C., & Freundl, G., (2007); "The effectiveness of a fertility awareness based method to avoid pregnancy in relation to a couple's sexual behaviour during the fertile time: A prospective longitudinal study."* Human Reproduction, 22(5), 1310-1319. https://doi.org/10.1093/humrep/dem003

Freundl, G., Frank-Herrmann, P., & Gnoth, C., (2007); "Natural family planning and the management of infertility."* Archives of Gynecology and Obstetrics, 275(4), 273-281. PMID: 12439549

Gambier-Ross,K., David J McLernon and Heather M Morgan,(2018): A mixed methods exploratory study of women's relationships with and uses of fertility tracking appsDigital Health, Volume 4: 1–15 doi: 10.1177/2055207618785077 journals.sagepub.com/home/dhj

Gracia,C., Jacob Anderson,J., Amato,P., Rebecca Flyckt, R., Hansen,K., et al., (2023); ;definition of infertility: a committee opinion available at american society for reproductive medicine. PMID: 32115183).

Halleran,M., Chernoff,A., and Jennifer. Gordon , (2022): Fertility Knowledge Among Women Struggling to Conceive Without Medical Intervention: A Brief Report. Front Glob Womens Health; 3: 828052. doi: 10.3389/fgwh.2022.828052

Hamper J., (2020): 'Catching ovulation': exploring women's use of fertility tracking apps as a reproductive technology. *Body and Society* 26(3):   3–30. https://doi.org/10.1177/1357034X19898259

Hampton,D., Kerry , Jennifer M. Newton, Cert Sci, (2012): Fertility-awareness knowledge, attitudes, and practices of women seeking fertility assistance First published: 05 July https://doi.org/10.1111/j.1365-2648.2012.06095.x

Healthwise Staff, (2022): Fertility Awareness available at https://www.healthlinkbc.ca/tests-treatments-medications/medical-tests/fertility-awareness

Healy, R.L. Zuckerberg, (2021): get out of my uterus! An examination of fertility apps, data-sharing and remaking the female body as a digitalized reproductive subject. *J. Gend. Stud.* *30*, 406–416. https://doi.org/10.1080/09589236.2020.1845628

Hendl, T., and Jansky, B., (2022): Tales of self-empowerment through digital health technologies: a closer look at "Femtech". *Rev. Soc. Econ.* 80, 29–57. doi: 10.1080/00346764.2021.2018027

Heyen,N., Nils, (2020): From self-tracking to self-expertise: The production of self-related knowledge by doing personal Public Underst Sci. 29(2): 124–138. doi: 10.1177/0963662519888757

Hilgers et al., (1992): "Cumulative Pregnancy Rates in Patients with Apparently Normal Fertility and Fertility-Focused Intercourse," Journal of Reproductive Medicine 37: 864–866.

Hohmann-Marriott, B.,(2021): Periods as powerful data: User understandings of menstrual app data and information. New Media Soc. 14614448211040245. doi:10.1177/14614448211040245

IOM,(2001): Crossing the quality chasm: A new health system for the 21st century. Washington, DC: National Academy Press.

Khadivzadeh, T., Rahmati , R., and Esmaily,H.,(2021): Effect of education on knowledge of fertility counseling and attitudes toward fertility control J Educ Health Promot. 2021; 10: 319. doi: 10.4103/jehp.jehp_76_21.

Khair, K., Chaplin,S.,(2017): What is a nurse-led service? A discussion paper J Haem Pract; 4(1). doi: 10.17225/jhp00100

Maeda, E., Sugimori, H., Nakamura, F., Kobayashi, Y., Green, J., Suka,M., Okamoto, M., Boivin, J., Saito, H., (2015): A cross sectional study on fertility knowledge in Japan, measured with the Japanese version of Cardiff Fertility Knowledge Scale (CFKS-J). Reprod.Health 12, 10. ISSN: 1742-4755

Mahey R, Gupta M, Kandpal S, et al., (2018):Fertility awareness and knowledge among Indian women attending an infertility clinic: a cross-sectional study. *BMC Womens Health*;18(1):177-177. ISSN: 1472-6874

Margan R, Margan M-M, Fira-Mladinescu C et al.,(2022): Impact of stress and financials on romanian infertile women accessing assisted reproductive treatment. Int J Environ Res Public Health 19:3256. https://doi.org/10.3390/ijerph19063256.

Norris, J., (2012): Self-tracking may become key element of personalized medicine. UCSF News http://www.ucsf.edu/news/10/12913/self-tracking-may-become-key-element-personalized-medicine

Petersen, M. L., Mahnke, M. S., & Nielsen, M., (2022). Practices of self-tracking in infertility treatment: How bodily awareness is constituted. Qualitative Health Communication, 1(2). https://doi.org/10.7146/qhc.v1i2.130468

Polillo A, Gran-Ruaz S, Sylvestre J, Kerman N., (2021); The use of Ehealth interventions among persons experiencing homelessness: a systematic review. Digit Health 7:2055207620987066 doi: 10.1177/2055207620987066.

Polzer, J.; Sui, A.; Ge, K.; Cayen, L.,(2022): Empowerment through participatory surveillance? Menstrual and fertility self-tracking apps as postfeminist biopedagogies. In Gender, Sex, and Tech! An Intersectional Feminist Guide; Fellows, J., Smith, L., Eds.; Canadian Scholars and Women's Press: Toronto, ON, Canada; pp. 163–184.

Smith A., (2019):Fertility awareness based methods (FABMs): evaluating and promoting female interest for purposes of health monitoring and family planning [Master's thesis]. University of Alabama, Fayetteville, AL, United States: Available online at: https://scholarworks.uark.edu/etd/3279

Stanford, Lemaire, Thurman,(1998):Women's interest in natural family planning J Fam Pract . Jan;46(1):65-71. PMID: 9451372

Statista, (2023): Contraception & Fertility Apps. https://www.statista.com/ outlook/dmo/digital-health/ehealth/ehealth-apps/contraception-fertilityapps/worldwide.

Stern, J., Larsson, M., Kristiansson, P. & Tydén, T., (2013); Introducing reproductive life plan-based information in contraceptive counselling: an RCT. Hum. Reprod. 28, 2450–2461 doi: 10.1093/humrep/det279.

Tuli,A., Singh,S., Narula,R., Kumar,N., and Singh,P., (2022): Rethinking Menstrual Trackers Towards Period-Positive Ecologies. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (New Orleans, LA, USA) (CHI '22). Association for Computing Machinery, New York, NY, USA,

Article   283,   20   pages. https://doi.org/10.1145/3491102.3517662

Uganda Bureau of Statistics (UBOS) and ICF Micro, (2016): Uganda Demographic and Health Survey, Key Indicators, Calverton, Maryland: UBOS and ICF Macro. used under Creative Commons licence (CC BY-SA 2.0)

World Economic Forum(2018) :IBM Created the World's First Smartphone 25 Years Ago." https: //www.weforum.org/ agenda/2018/03/remembering-first-smartphone-simon-ibm/

World health organization (WHO),(2023): 1 in 6 people globally affected by infertility: WHO report.   Accessed at:https://academic.oup.com/hropen/article//2/h oad007/7066921

Worsfold L., Marriott L., Johnson S., Harper J.C.,(2021): Period tracker applications: What menstrual cycle information are they giving women? *Women's   Health.* ; doi: 10.1177/17455065211049905.

Yokomizo, R., Nakamura,A., Sato,M., Nasu,R., Hine,M., Kevin Y. Urayama, Kishi, H., Sago,H.,   Okamoto,A.,   and Umezawa,A.,(2021): Smartphone application improves fertility treatment-related literacy in a large-scale virtual randomized controlled trial in Japan Published in partnership with Seoul National University Bundang Hospital npj Digital Medicine 163. doi:10.1038/s41746-021-00530-4

Zegers-Hochschild F, Adamson GD, Dyer S, et al.,(2017): The international glossary on infertility and fertility care,. *Hum Reprod.* 2017;**32**(9):1786–1801. doi: 10.1093/humrep/dex234.