

A Smartphone-Based Health Behavioral Intervention for Pregnant Women with Iron Deficiency Anemia

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Abstract

Context: Iron deficiency anemia in pregnancy is a major health problem and one of the leading causes responsible for maternal and perinatal morbidity and mortality. **Aim & study design:** A quasi-experimental study design (pre/post-test) was conducted aiming to evaluate the effect of a Smartphone-based health behavioral intervention on pregnant women with iron deficiency anemia. **Sample:** A purposive sample of 50 pregnant women suffering from iron deficiency anemia was included in the study. **Setting:** The study was conducted at Antenatal Outpatient clinic at Ain Shams University Maternity Hospital. **Tools:** Three tools were used for data collection I) A structured interviewing questionnaire, II) Maternal knowledge assessment questionnaire), and III) Women reported self-care practice checklists. **Result:** There was a highly statistically significant improvement in all aspects of pregnant women's knowledge and practice about iron deficiency anemia and their total mean score of hemoglobin level at post intervention compared to pre intervention ($P < 0.001$). Also, there was a positive correlation between pregnant women total knowledge score and total practices score at pre and post intervention ($p < 0.001$). **Conclusion:** Implementation of a smartphone-based health behavioral intervention has a positive effect on the enhancing pregnant women' knowledge and practices regarding iron deficiency anemia as well as improving hemoglobin level among studied women. **Recommendations:** Applying a Smartphone-based health behavioral intervention in different settings of maternity health care. Further research is needed to evaluate the effect of a smartphone-based health behavioral intervention regarding iron deficiency anemia on maternal and fetal outcomes.

Keywords: A Smartphone, health behavioral, pregnant women, iron deficiency anemia

Introduction

Iron Deficiency Anemia (IDA) in pregnancy is a major health problem and one of the leading causes responsible for maternal and perinatal morbidity and mortality. The World Health Organization (WHO) defined anemia as hemoglobin (Hb) level of less than 11 g/dL, or hematocrit less than 33%, at any point during pregnancy. Furthermore, anemia was considered as mild if the Hb level was 9.0-11.0 g/dl, moderate (7.0-9.0 g/dl) and severe (4.0-7.0 g/dl) (Seema., 2017).

Pregnant women are at increased risk for IDA due to increased blood volume during pregnancy resulting from increased support to the fetus and placenta. In general, women in childbearing stage suffer from the loss of large amounts of blood due to childbirth or menstruation, which are factors contributing to the development of iron anemia (AL Abed et al., 2020)

Risk factors associated with IDA during pregnancy include inadequate antenatal care,

short interpregnancy intervals, teenage pregnancy, low socioeconomic status, higher number of previous births, inadequate iron reserves, absence of iron supplementation and iron deficient diets (Egyt EG., 2016).

Pregnancy have accompanied with IDA caused lowered oxygen delivery to the tissues that includes pallor, fatigue, depression, fainting, breathlessness, emotional instability, palpitation, headaches, and hair loss. Besides, chronic IDA lowers quality of life, work tolerance and the productivity. IDA has a major impact on the health of the woman and her fetus, it also affects cognitive and motor development. Moreover, it may be associated with low birth weight of the fetus, premature labor, intrauterine growth retardation, and increased risk of maternal and prenatal mortality (Herbst., et al., 2020).

Pregnancy is the time of rapid medical, social, and behavioral changes for women and their families. Many women have enhanced access to health care during pregnancy and may have increased motivation to improve their health

during this time. Healthy maternal behaviors have been shown to improve the risk of pregnancy-related morbidities. Many health behavior and lifestyle interventions have incorporated Digital health technologies in various areas of chronic disease management.

Digital health technologies such as smartphones have been used for healthcare management and monitoring. Smartphone apps have potential as a flexible, tailored, customizable, wide-reaching, cost-effective, and accepted means of health promotion. Apps could incorporate the most effective components of behavior change, such as goals, self-efficacy, self-monitoring, feedback, tailoring, and planning, into a platform that is user friendly, engaging, and flexible (WHO., 2016)

A smartphone health intervention is the use of electronic information and communication to support and promote long-distance clinical healthcare, patient, and professional health-related education. It has several uses as it helps access care services, and improves the relationship between patients & caregivers (McLean et al., 2019).

Prevention and control of IDA during pregnancy by enhancing knowledge and practice regarding diet and prophylactic treatment by iron-folic acid, and improvement of diet (WHO, 2018), Nurse has a crucial role in promoting and maintaining women's health during pregnancy. The most critical role is depending on teaching and providing pregnant women with accurate information based on social and psychological behavioral changes to maintain health during pregnancy mainly those related to nutritional aspects. They emphasize behavioral changes to assist mothers to change their eating habits and practices that contribute to the nutritional deficit, and provides the appropriate information and advice needed for a healthy pregnancy. (McLean et al., 2019).

Justification of the problems

Iron deficiency anemia is a major cause of morbidity and mortality of pregnant women and increases the risks of abortion, stillbirth, preterm labor, intrauterine growth restriction, low birth weight, postpartum bleeding, infection, and fetal, neonatal, and infant mortality, especially in developing countries. The World Health

Organization (WHO) estimates that about 38% of pregnant women are anemic worldwide, with 18% in high-income countries and 35–75% in low- and middle-income countries. IDA during pregnancy contributes to 22% of all maternal deaths (Ruth et al., 2019).

Lack of knowledge and inadequate practice regarding management and prevention of anemia among pregnant women increases the risk for more than five times. One of the most important responsibilities of a nurse is to provide detailed, concise, and appropriate information to women before, during, and after pregnancy regarding prevention and management of anemia (WHO., 2018).

Mobile health (mHealth), or the use of mobile technology for health, is becoming an important mechanism to improve maternal and neonatal health globally. Through targeted client communication, mobile phones enable pregnant women to access and/or receive information – whether via hotlines, direct messaging, or smartphone applications – that can potentially lead to improved uptake of maternal and neonatal health services and, subsequently, health outcomes (Sondaal et al., 2016). Therefore, the current study aims to evaluate the effect of a smartphone-based behavioral intervention for pregnant women with iron deficiency anemia.

Aim of the study:

The present study aimed to evaluate the effect of a smartphone-based health behavioral intervention on pregnant women with iron deficiency anemia.

This aim was achieved through the following:

- 1- Assessing women's knowledge and practices regarding iron deficiency anemia during pregnancy.
- 2- Applying a smartphone-based health behavioral intervention through online sessions and mobile messages regarding iron deficiency anemia among pregnant women.
- 3- Evaluate the effect of a smartphone-based health behavioral intervention on pregnant women's knowledge and practices regarding iron deficiency anemia, in addition to Hemoglobin (Hb) level.

Research hypothesis

- Implementation of a smartphone-based health behavioral intervention has a positive effect on enhancing level of knowledge and practices of pregnant women regarding iron deficiency anemia.
- Blood hemoglobin level is expected to be improved among pregnant women after exposure to study intervention.

Subjects and Methods:**Research design:**

A quasi-experimental study design (one group pretest/posttest) was utilized to achieve the aim of this study.

Setting:

The study was conducted at the Antenatal outpatient clinic at Ain Shams University Maternity Hospital.

Subjects:

Sample type: A purposive sample with the following;

Inclusion criteria:

- Pregnant Women suffering from only anemia during pregnancy "HB less than 11gm".
- Pregnant women with gestational age of 12 to 28 weeks.
- Pregnant women who had a smart phone and they are able to operate cellphones.
- Pregnant women who can read and write.

Exclusion criteria:

- Pregnant women suffered from any medical disorder.
- Women have experienced pregnancy complications (bleeding, pregnancy-induced hypertension, and preterm birth, etc.).
- Pregnant women who had learning problem

Sample size: 50 pregnant women were included in this study.

Sample size Equation: The researchers depended on the following equation to calculate the sample size: Steven Thompson Equation (Khuanbai., 2019).

$$n = \frac{Z_{1-\alpha/2}^2 P (1-P)}{d^2}$$

d2

Tools of data collection:**I) A Structured Interviewing Questionnaire:**

It was developed by the researcher based on reviewing recent and related literature (Saim et al., 2020). It was anonymous, written in the English language, and translated to the Arabic language to fit the sample characteristics. It consisted of 13 questions; covering three parts as the following.

Part (I); included general characteristics of the studied sample concerning age, residence, marital status, level of education, and occupation (5 questions).

Part (II); concerned with past and current obstetric history as gravid, para, gestational age, and previous pregnancy complications (7 questions).

Part (III); focused on the assessment of hemoglobin level of the pregnant women through review of the studied women records (one question).

II) Maternal Knowledge Assessment Questionnaire (pre/post test):

It was designed in the Arabic language by the researchers after reviewing related literature (Ghazwan A., et al., 2020) & (WHO, 2018). It consisted of 20 multiple choice questions to assess pregnant women's knowledge regarding iron deficiency anemia including meaning, causes, risk factors, symptoms, maternal and fetal complications, prevention, management, and sources of iron-rich foods.

Scoring system: The scores of items ranged as the following: the correct answer scored two grades, the incorrect answer or did not know scored as one. The total score ranged from 1-40. Total knowledge scores were categorized as the following:

Poor knowledge: >50% (1-19)

Average knowledge: 50>75% (20-30)

Good knowledge: ≤ 75% (30-40)

III) Women Reported Self-Care Practice Checklists (pre-post tool);

It was developed by the researcher based on literature review (Davis, D.L et al., 2020) to assess pregnant women's practices regarding iron deficiency anemia. It composed of 14 items covering three parts. First part: concerned with

antenatal follow up including two items, second part, consisted of 10 items regarding eating habits, and third part; focused on pattern of iron supplementation containing two items.

Scoring system:

It was scored as two scores for done, and one score for not done. Total score ranged from (1-28). The total practice scores were classified as the following: unsatisfactory Practice (>60% 0-17), and satisfactory practice (\leq 60% 17-24).

Validity & reliability:

Tools were evaluated for feasibility and content validity by five experts from the Faculty of Nursing & Medicine, in the Maternity-Gynecological Nursing Department, Public Health Department, and Nutrition Department. Their comments were considered. Reliability was measured using Cronbach's' Alpha coefficient that found to be 0.87 for first tool, 0.85 for second tool and 0.87 for third tool.

Pilot Study:

It was carried out in three weeks on 10 % of the sample (5 pregnant women). The purposes of the pilot study were to test the applicability, clarity of the study tools, and feasibility of the research process, and it served to estimate the time needed to complete the tools. It also helped find any obstacles and problems that might interfere with the data collection process. Based on the pilot study findings, certain modifications to the tools were done such as (omission of some questions from the tool) to strengthen their contents or for more simplicity and clarity. These groups were excluded from the study sample.

Administrative design:

An Official written approval was obtained from the Dean of Faculty of Nursing, Ain Shams University, and the director of Ain Shams University Maternity Hospital as approval for data collection through a written letter clarifying the title, aim, and the study setting.

Ethical considerations:

Ethical approval was obtained from the Scientific Research Ethical committee of Faculty of Nursing at Ain Shams University before starting the study. Informed consent obtained from participants after explaining the purposes of the study. No harmful methodology used with participants. Each participant had the right to withdraw from the study at any time. Human

rights were granted. Data was confidential, and a coding system for data was used.

Fieldwork:

The data collection procedure was done through four phases: preparatory, assessment, implementation, and evaluation phase. It expended four months, from January 2020 to the end of April 2020. The researchers were available in the study setting three days/week from 9.00 am to 12.00 pm.

Preparatory Phase:

The preparatory phase included reviewing related literature and theoretical background of various aspects of the study using the books, articles, internet, periodicals to develop the data collection tools and prepare the teaching material (Arabic educational booklet). The researchers developed an Arabic educational booklet after reviewing the relevant literature on all aspects of iron deficiency anemia and distributed it to all pregnant women to improve their knowledge and practices regarding management of iron deficiency anemia. It was designed using simple Arabic language and different illustrative pictures to facilitate the women understanding of its contents. It composed of two parts; *The first part*, was consisted primarily of education about iron deficiency anemia, which including meaning, causes, risk factors, the signs, symptoms, consequences, diagnostic test, preventive measures, and management. *The second part*; included healthy behavior information related to iron deficiency anemia including regular antenatal follow up, proper diet (iron-rich food, nutritional substances that increase iron absorption), the importance of iron supplementation during pregnancy, side effects of iron supplementation, and measures to control iron supplementation side effects. Additionally, researchers prepared mobile messages after reviewing evidence-based studies and comprehensive literature on iron deficiency anemia

Assessment phase:

- The researchers first greeted the woman, introduced their selves to each woman, explained the purpose of the study. Then verbal & written consent of women was obtained.
- The researchers met each woman individually in the private area at pre-mentioned setting to ensure confidentiality and privacy during the waiting time of them during their antenatal visits. The researchers assessed women's

general characteristics, their knowledge, and healthy behavior practices regarding iron deficiency anemia. In addition to the hemoglobin level by using tool (I), (II) and (III). The number of interviewed women per day ranged from four to five pregnant women. Time of data collection required 25-30 minutes to fill by the researchers. The data obtained during this phase constituted the baseline for further comparisons to assess the effect of the intervention.

- All telephone numbers of pregnant women were collected by the researchers and were participated in the WhatsApp group on mobile for each one.

Implementation phase:

The researchers classified the pregnant women into five subgroups; each subgroup consisted of ten members. Each subgroup was added to a WhatsApp group on mobile after gathering their phone numbers. All pregnant women received mobile-based instruction

The pregnant women received three online sessions as well as suitable health education mobile messaging. The sessions were given through Zoom Meetings application, one session per week. Each session lasted approximately 20 to 25 minutes.

First session:

The researcher started the first session with general information regarding iron deficiency anemia during pregnancy as "definition, causes, risk factors, and complications.

Second session:

- It was started by a summary about what has been discussed in the previous session and the objectives of the new topics. This session contained risk factors, and diagnostic test for iron deficiency anemia, and preventive measures of iron deficiency anemia.

Third session:

- In this session, the researcher focused on healthy behavior to manage iron deficiency anemia including health nutritional requirements, adequate eating practice, and cooking habits, and importance of iron supplementations enhancers and inhibitors of iron absorption, and iron medication adherence.

- The researcher started all sessions with summarized to the last session and objectives of the new session, also, the sessions ended by a summary of its contents and feedback from the women was obtained to ensure that the women got the maximum benefits.
- The researcher also used telephone call with pregnant for more clarification and reinforcement. The researchers used Teaching materials consisting of images, PowerPoint presentation photographs, handwritten notes, and videos that were shared during online sessions.
- Appropriate health-education mobile messages were divided into seven major categories: general messages on iron deficiency anemia definition, causes, risk factors, maternal & fetal complications, diagnostic test, treatment, and healthy behavior to manage iron deficiency anemia. Every health message was sent at a time of day that was convenient for women, and it was also available in Arabic.

Evaluation phase:

The effect of a smartphone-based health behavioral intervention was evaluated by comparing women's knowledge and practices regarding iron deficiency anemia, in addition to hemoglobin level before and after three months of intervention at outpatient clinic or by phone by using tools (I, II, III).

Statistical Design: The collected data was revised, coded, tabulated, and introduced to a personal computer using Statistical Package for Social Sciences (IBM SPSS 20.0). Descriptive statistics were used to calculate percentages and frequencies for qualitative variables, mean and standard deviations for quantitative variables. The statistical tests such as chi-square test (X^2) were used to estimate the statistically significant differences. For normally distributed data, a comparison between two independent populations was made using independent (t) test. A significant level value was considered when $p < 0.05$, a highly significant level value was considered when $p < 0.01$, and no statistically significant difference when $p > 0.5$.

Results:

Table (1) reveals 62% of studied sample their age ranged between 20-30 years with the mean age of (30.6± 2.34), 68% of them were from an urban area, 96% of them were married.

Regarding the level of education, 60% of the studied sample had secondary education, and 88% were housewives.

Table (2) represents that 46% of the studied sample were primigravida, while 55.5% of them were primipara. Moreover, 48% of studied sample gestational age per week was between 16-24weeks. In addition to 30% of them had a previous history of anemia.

Table (3) indicates that, there was a highly statistically significant difference in all aspects of studied sample knowledge regarding iron deficiency anemia between pre & post intervention ($p < 0.001$), as (92%, 90%,90%, 88%,) of study group had correct knowledge about of preventive measures of anemia,, meaning, effect of it on pregnant women, and causes, respectively as compared to (40%, 42%,40%, 32%,) at pre intervention.

Figure (1): displays that, 78 % of the studied sample had poor level of total knowledge score regarding iron deficiency anemia at pre intervention while 84% of them had good level of knowledge at post intervention.

Table 4 reveals that, there was a highly statistically significant improvement of studied sample' s practices toward iron deficiency anemia at post-intervention as compared to pre intervention ($p < 0.001$), as (92, 88, 88%,84%) of the studied sample were consumed vitamin C

rich-foods during or after meal, Regular checked of HB level, eating iron rich foods, and eat regular frequent meals, respectively compared to (28, 34, 40%,36%) at pre intervention.

Table (5) points out that that 52% of studied sample do not use iron tablets regularly at pre intervention which improved to be used regularly among 88% of them at post intervention. In addition to, 6% only of studied sample drink iron with Juice (V. c) at pre intervention that improved to reach 80% post intervention.

Figure (2): indicates that, 70% of the studied sample had unsatisfactory total level of practice score regarding iron deficiency anemia at pre intervention while the most of them (88%) had a satisfactory level at post-intervention.

Table (6): clarifies that, there was a highly statistically significant difference in total mean scores of hemoglobin level of studied sample between pre-intervention and post intervention, ($p < 0.001$), as (78%&22%) of studied sample had normal and mild hemoglobin level respectively at post-intervention compared to (48%&36%) of them had moderate and mild level of anemia respectively at pre intervention.

Table (7) points out that there was a highly statistical significance correlation between pregnant women's total score of practices and total score of knowledge at pre and post intervention.

Table (1): Distribution of studied sample according to their general characteristics: (n=50)

General characteristics	No.	%
Age		
Less than 20	4	8
20-<30	31	62
30-<	15	30
Mean±SD	30.6± 2.34	
Residence		
Rural	16	32
Urban	34	68
Marital status		
Married	48	96
Divorced	2	4
Educational level:		
Read & write	6	12
Primary education	6	12
Secondary education	30	60
University education	8	16
Occupation		
Working	6	12
Housewife	44	88

Table (2): Frequency and percentage distribution of studied sample according to their obstetric history: (n=50):

Obstetric history	No	%
Gravida		
1	23	46
2	13	26
3+	14	28
Parity (n=27)		
1	15	55.5
2	8	29.7
3+	4	14.8
Current pregnancy Gestational age		
≥12	10	20
16>24	24	48
≥24-28	16	32
Previous history of anemia		
Yes	15	30
No	35	70

Table (3): Frequency and percentage distribution of the studied sample according to their correct knowledge regarding iron deficiency anemia at pre and post intervention: (n=50)

Items	Pre-intervention		Post-intervention		X ²	P value
	No	%	No	%		
Meaning	22	42	45	90	23.93	0.000**
Causes	16	32	44	88	32.67	0.000**
Risk factors	14	28	42	84	31.82	0.000**
Signs and symptoms	22	44	40	80	13.75	0.000**
Effect of anemia on pregnant women	20	40	45	90	27.47	0.000**
Effect of anemia on the neonate	15	30	41	82	27.44	0.000**
Preventive Measures	20	40	46	92	30.13	0.000**
Treatment	18	36	45	90	12	0.001*

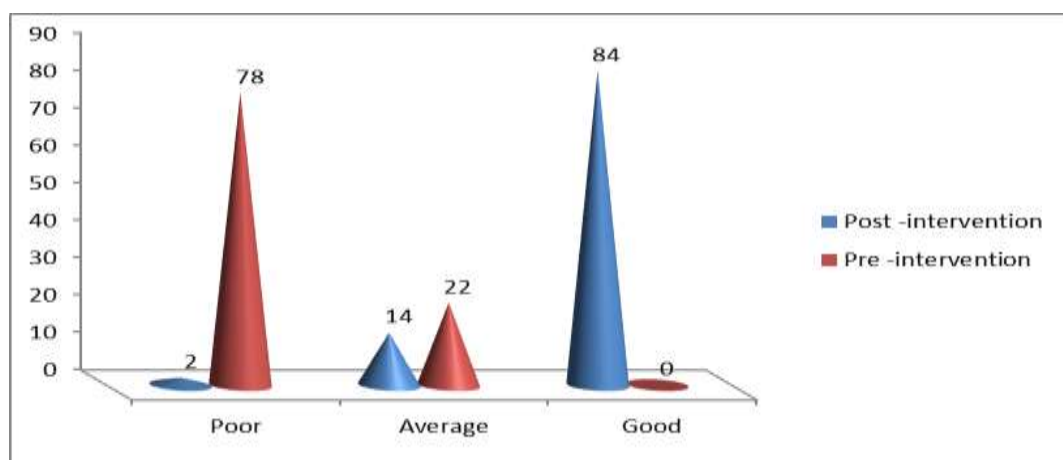
Figure (1): Studied sample' total knowledge score regarding iron deficiency anemia at pre & post-intervention:(n=50)

Table (4): Frequency and percentage distribution of the studied sample according to their practices regarding iron deficiency anemia at pre& post intervention: (n=50)

Items	Pre intervention		Post intervention		X ²	P value
	No	%	No	%		
Regular antenatal follow up	15	30	25	50	39.08	0.000**
Regular check of HB level	17	34	44	88	21.64	0.000**
Eat regular frequent meals	18	36	42	84	12.72	0.000**
Eating iron rich foods	20	40	44	88	25	0.000**
Consume vitamin C rich foods during or after meal	14	28	46	92	38.47	0.000**
Consumption of tea/ coffee after meal	41	82	14	28	29.46	0.000**

Table (5): Frequency and percentage distribution of the studied sample according to their use of iron supplement at pre& post intervention: (n=50)

Items	Pre intervention		Post intervention		X ²	P value
	No	%	No	%		
Patten of Iron supplementation use						
Regular	15	30	44	88	36.54	0.000**
Irregular	26	52	5	10		
Do not take it	9	18	1	2		
Drinks are taken with Iron tablet						
Milk	10	20	0	0	57.35	0.000**
Juice (V. c)	3	6	40	80		
Water	37	74	10	20		

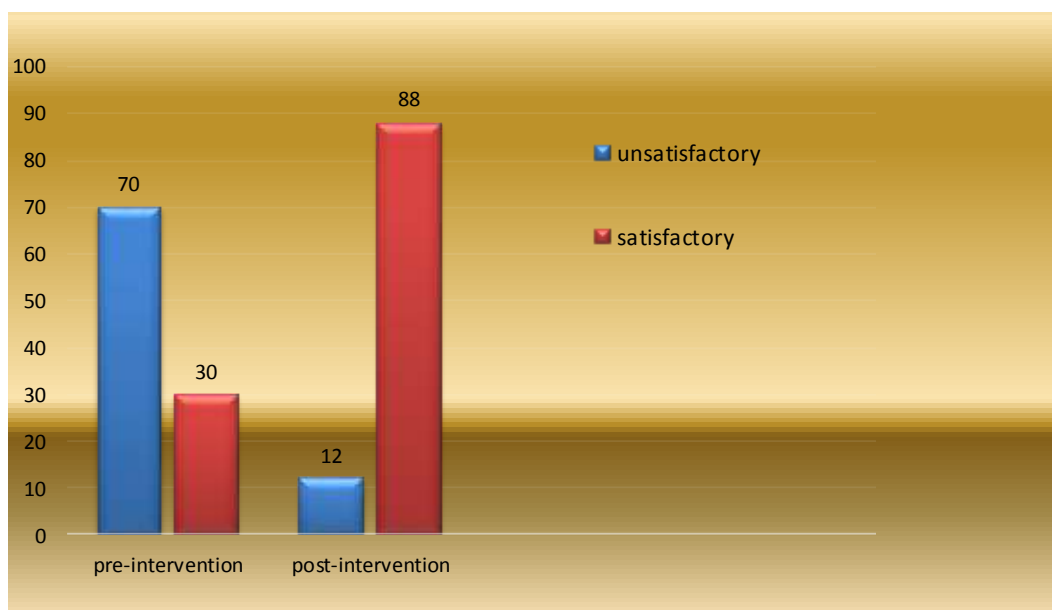
Figure (2): Studied sample' total practice score regarding iron deficiency anemia at pre& post intervention: (n=50)

Table (6): Frequency and percentage distribution of the studied sample according to their Hemoglobin level at pre& post intervention: (n=50)

Hb Level	Pre-intervention		Post intervention	
	No	%	No	%
Normal	8	16	39	78
Mild	18	36	11	22
Moderate	24	48	0	0
Mean \pm SD	8.88 \pm 0.86		11.14 \pm 0.82	
t-test & P value	T = 12.42		P = 0.000**	

Table (7): Correlation between studied samples total knowledge score and total practice score regarding iron deficiency anemia at pre &post intervention: n =(50)

Total practice score	Total Knowledge score	
Pre intervention	r= 76.9	P=0.001**
Post-intervention	r= 94.6	P=0.001**

Discussion

In the changing scenarios of health care system of today's world, the trends in midwifery and obstetrical nursing are also changing. There are new advancements in care being provided, parenthood planning, national maternal health policies in items of health education and improving awareness which has a positive effect on enhancing health and wellbeing, so the present study was conducted to evaluate the effect of a smartphone-based health behavioral intervention on pregnant women with iron deficiency anemia **Atnafu et al. (2017)**.

General characteristics can play a major role in determining anemia among pregnant women. according to this study and concerning general characteristics of the studied sample, more than half of the pregnant women their age ranged between twenty and thirty years with the mean age of (30.6 \pm 2.34) and more half of them completed secondary education, more than two thirds were housewife, the current study has also demonstrated that more than half of them were primipara. As well as one third of them had a previous history of anemia during pregnancy. This finding assured that the studied women needed to receive full guidance, support, and education by health care team regarding common health issues.

Concerning pregnant women's knowledge about iron deficiency anemia the current study findings indicates that slightly more than three quadrants of the pregnant women had poor level of total knowledge score at pre intervention while most of them had good level at post intervention with a highly statistically significant improvement

regarding all aspects of knowledge including preventive measures of anemia, meaning, effect of it on pregnant women, and causes. This result confirmed the positive effect of health education using new technology as smartphone application on enhancing pregnant women knowledge and awareness regarding iron deficiency anemia.

These findings were supported by **Rukmaini, Lipoeto, Effendi (2019)** who studied the effect of health education and mobile control application program on anemia among pregnant women and found that a significant improvement of pregnant women's knowledge regarding anemia after intervention. In the same line **Abd Elhaleem et al. (2019)** who showed a highly significant improvement in the pregnant women' knowledge regarding definition, causes, signs, and symptoms of IDA as well as effect of IDA on pregnant women and fetus, preventive measures of IDA, plant and animal foods rich in iron, and importance of iron supplementation after applying of nursing intervention using mobile application. This may be attributable to the mobile applications that are an increasingly popular mode of accessing, storing, and sharing health information among the pregnant women **Zhu et al. (2019)**.

These findings agreed with **Hegde et al., (2016)** who assess the Impact of Mobile-based Intervention on Health Literacy among Pregnant Women in Urban India. This quasi-experimental study involved a single group, pre-post evaluation design of the 400 pregnant women. The intervention through a free mobile voice call service that sends timed and targeted preventive care information messages directly to the mobile

phones of enrolled women throughout pregnancy and infancy, the voice messages included information regarding anemia and nutrition during pregnancy, breastfeeding, and immunization. This study demonstrates the feasibility and value of delivering mobile health messages to pregnant women to improve health literacy regarding preventive care during pregnancy and early childhood in urban India. This assured the positive effect of smart phone application and mobile based intervention on improving pregnant women knowledge and awareness.

In the other hand and contrary to our study findings **Murthy et al. (2020)** studied the Effects of an m-Health voice message service (mMitra) on maternal health knowledge and practices of low-income women in India: revealed that women did not show many significant changes in increased knowledge on maternal care topics in the intervention group. This difference between two studies findings may be due to that Murthy study aimed to gain a general understanding of knowledge on a broad set of topics related to maternal, newborn and childcare among poor urban women.

By investigating practices of pregnant women regarding iron deficiency anemia, the present study demonstrated that, more than two third of the studied women had unsatisfactory level of total practice score at pre intervention whereas after intervention most of them had satisfactory level with a highly statistically significant improvement related to all aspects of practices in the form of consumed vitamin C rich-foods during or after meal, Regular checked of HB level, eating iron rich foods, and eat regular frequent meals. This is reflected the significant role of a smartphone-based health behavioral intervention on enhancing pregnant women's health behavioral practice regarding management of iron deficiency anemia.

This result was consisted with **Oumer & Hussein, (2019)** who conducted an Institutional Based Cross Sectional Study on assessing Knowledge, Attitude and Practice of Pregnant Mothers towards Preventions of Iron Deficiency Anemia in Ethiopia: Revealed that majority of pregnant women had poor adherence to prevention practice of IDA. Even if the results are comparable with other studies, the level of

knowledge, attitude and good practices on IDA are not satisfactory. Improving the health care plan of women and stressed on tremendous factors that aggravate and made pregnant at risks of anemia in addition to the physiological vulnerability was required. These behavioral and other factors need to be addressed in the country specific targets for making the Sustainable Development goals soon and decreasing anemia by half in the coming 2025

On accordance with our study findings a quasi-experimental research design study conducted by **Abd Elhaleem et al. (2019)**. To examine the effect of Mobile application-assisted nursing intervention on Pregnant Women Regarding Iron Deficiency Anemia at antenatal outpatient clinics at Mansoura and Tanta University Hospitals involved of 210 pregnant women revealed that the majority of pregnant women had inadequate level of practice before intervention; meanwhile, the majority of them had an adequate level after intervention.

Our study findings agree with **Nagraj S., et al., (2020)** who studied "SMART health pregnancy: feasibility and acceptability of complex intervention for High-Risk Pregnant Women in Rural India: Protocol for a Pilot Cluster Randomized Controlled Trial" Illustrated that The SMART health Pregnancy intervention seeks to introduce concepts of integrated life-long women's health into standard antenatal and postnatal care, whilst strengthening existing practices. This posted the evidence to suggest that involving smart health in women's health is feasible and can improve antenatal care practices.

The previous findings were confirmed by a study done by **Amirreza et al., (2019)** who mentioned that educational intervention based on the social networks in the context of mobile phones has an effective role in changing the behavior of women during pregnancy and can motivate them and change their behavior for promoting their health during the pregnancy.

This result was supported by **Abujilban et al. (2018)** who conducted study on using a randomized controlled trial to evaluate the effectiveness of a health information package in Jordanian anemic pregnant women's knowledge and regarding anemia on hundred pregnant women, revealed that women in the intervention group had higher scores than control group in

posttest regarding educating them with appropriate dietary information to be more familiar with food classifications, improved their ability to select food rich in iron, protein, and vitamin C, which would further help in increasing their hemoglobin levels.

The present study findings point out that that more than half of studied sample do not use iron tablets regularly at pre intervention which improved to be used regularly among majority of them at post intervention. In addition to, minority of studied sample drink iron with Juice (V. c) at pre intervention that improved to reach majority post intervention. This demonstrates the significance and benefit of the introduction of smartphone-based health behavioral interventions for pregnant women.

The present study results were matched with **Adewumi A., et al. (2019)** who conducted a quasi-experimental single group study with a pre-test-post-test design on pregnant women in their third trimester to determine The Impact of an Android Application on Compliance with Iron Supplementations among Pregnant Women in Jambi City, Indonesia. It documented that monitoring through the Android application increased pregnant women's compliance with taking iron supplements and presented a linear impact on increasing their Hb level.

This finding supported by another study carried out by **Rosmaria et al., (2020)** who examine the effectiveness of the application model (Sumiferos) for preventing anemia with pregnant women compliance in consuming Fe tablets at PutriAyu Health Center in Jambi city and reported that the mobile application (Sumiferos) can improve the compliance of pregnant women in consuming Fe tablets regularly. due to direct contact or communication between officers and pregnant women continuously so that the condition of pregnant women can be monitored.

In addition to **Irma N., et al. (2020)** who revealed that present changes in the intervention group's capital actions who received education through an anemia management module are relatively higher Improvement found on habitual ways Fe with good tablet consumption (consuming the juice, avoiding the consumption of iron tablets along with tea, coffee, or milk). This result illustrated that Provision of

educational interventions appropriately can help to improve health behavior practices regarding anemia.

The present study revealed a remarkable increase Hb level among pregnant women after intervention. The present study clarified there was highly statistically significant improvement in total mean score of hemoglobin level at post-intervention compared to pre intervention. This outcome highlighted the possibility of preventing and reducing anemia during pregnancy by appropriate health education and ongoing monitoring by using new technology as smartphone.

This result agreed with **Singh et al. (2020)** who showed that serum hemoglobin, of expectant mothers are likely to improve when they are continually supervised and monitored by trained female community health volunteer and mobile text messages related to dietary intake during pregnancy and postpartum.

Also, these findings were in line with a study by **Rukmaini., (2019)** that presented the mean of Hb level in the experiment group was higher than control group which indicate health education and mobile control application program has a positive effect on clinical outcome such hemoglobin among pregnant women. In accordance with **Abd Elhaleem et al. (2019)** who demonstrated that this a high significance difference and improvement between the first and second time of measuring hemoglobin level before and after intervention which explained the effect of the health education by using mobile assisted nursing intervention on the improvement of hemoglobin level in the study group.

The result of this study disagreed with **Garcia PJ et al. (2018)** who conducted Randomized Controlled Trial (RCT) of SMS Messages to Pregnant Women in Peru and reported that in relation to iron intake, did not find any effect in the prevention or reduction of anemia in the pregnant women. The discrepancy among different study results could be explained by the differences in the sampled population, and also the differences in the data collection tools.

The present study pointed out that there was a positive correlation between pregnant women's total score of practices and total score of

knowledge regarding iron deficiency anemia at pre and post intervention.

This result is agreed with a study done by **Imunticha F., et al. (2015)** who study titled with Knowledge and self-reported practices on prevention of iron deficiency anemia among women of reproductive age in rural area and revealed that Knowledge on IDA had significant relationship with practice on prevention of anemia.

In conclusion, the present study emphasized and concluded important evidence concerning the remarkable effect of the application of a smartphone-based health behavioral intervention on enhancing knowledge and practices of pregnant women regarding iron deficiency anemia. The aim of successful health education is to acquire the patient with necessary information needed to improve health in a short period of time to prevent recurrent problems. Nursing intervention based on education using new technologies can help the women have a correct and rapid knowledge, led to an improvement in physical health, also reducing complications. these findings proved and supported our study hypothesis.

Conclusion:

The study concluded that; The current study findings supported the research hypothesis as Implementation of a smartphone-based health behavioral intervention has a positive effect on the enhancing pregnant women' knowledge and practices regarding iron deficiency anemia as well as improving hemoglobin level among studied women.

Recommendations:

Considering the findings of the current study, the following recommendations were suggested:

- Applying a Smartphone-based health behavioral intervention in different settings of Maternity health care.
- Counselling and health educational programs should be developed for pregnant women about iron deficiency anemia to enhance their knowledge, awareness, and practices concerning how to maintain a healthy behavior during pregnancy.
- Further researches is needed to evaluate the effect of a smartphone-based health behavioral

intervention regarding iron deficiency anemia on maternal and fetal outcomes.

References

- Abd Elhakeem S. H., Abd Elwahab. HE., Abdel-Fatah H.I. (2019):** Knowledge, Attitude and Practice Regarding Prevention of Iron Deficiency Anemia among Pregnant Women in Tabuk Region, International Journal of Pharmaceutical Research & Allied Sciences, 8(2);87-97.
- Abd-Elhaleem M., Elkheshen S., Emad M. (2019):** Effect of Mobile Application Assisted Nursing Intervention on Pregnant Women Regarding Iron Deficiency Anemia. Egyptian Journal of Health Care, 10(4); 318-332.
- Abujilban S., Hatamleh R., Al-Shuqerat S. (2019):** The impact of a planned health educational program on the compliance and knowledge of Jordanian pregnant women with anemia, Women Health, 59(7);748-759.
- Adewumi A., Adesola O., Daniel O., (2019):** Knowledge and practices regarding prevention of anemia amongst pregnant women in rural communities of South-West Nigeria, Caspian J Reprod Med, 7 (2); 7-14.
- AL Abed G. A., Arar A. A., Salim M. A. (2020):** Assessment of Pregnant Women Knowledge and Practices Concerning Iron Deficiency Anemia at Al-Amara City/Iraq , 20 (3); 151-158.
- Amirreza N., Ehsan N., Malihe T., Mahnaz T. (2019):** The effects of the COVID-19 pandemic on quality of life; a survey of mildly disabled multiple sclerosis patients, Eastern Mediterranean Health Journal, Mahnaz Talebi: Talebi 511@ yahoo.com.
- Atnafu A., Otto K., Herbst CH. (2017):** The role of mHealth intervention on maternal and child health service delivery: findings from a randomized controlled field trial in rural Ethiopia. mHealth, 3: 39; 1-13. <https://doi.org/10.21037/MHEALTH.08.04>.

- Davis, D.L., Creedy, D.K., Bradfield, Z. et al., (2020):** Development of the WomanCentred Care Scale- Midwife Self Report(WCCSMR). *BMC Pregnancy Childbirth* 21,523<https://doi.org/10.1186/s12884-021-03987-z>
- Egypt E.G. (2016):** Prevalence of Anemia among Women of Reproductive Age: % of Women Aged 15-49 1990 - 2016 | Yearly | % | World Bank.
- Garcia P.J., Perez-Lu J., Curioso W.H., Carcamo C.P., Beuermann D. (2018):** Randomized Controlled Trial (RCT) of SMS Messages to Pregnant Women in Peru: WAWARED RCT, *Rep Glob Health Res*, 4(1);1-9.
- Ghazwan A., Aqeel A., Mustafa S. (2020):** Assessment of Pregnant Women Knowledge and Practices Concerning Iron Deficiency Anemia at Al-Amara City/Iraq, *Medico-legal Update*, 2(3); 151-156.
- Hegde A., Riddhi P., Doshi . (2016):** Assessing the Impact of Mobile-based Intervention on Health Literacy among Pregnant Women in Urban India University of Connecticut Health Center, Farmington, CT, USA.
- Herbst., Christopher H., Amr E., JakubKakietek., Alia H., Oliver P. (2020):** Scaling Up Nutrition in the Arab Republic of Egypt: Investing in a Healthy Future. *International Development in Focus*. Washington, DC: World Bank. doi:10.1596/978-1-4648-1467-9
- Imunticha F., Reeshma K., Rency Q., (2015):** Knowledge and self-reported practices on prevention of iron deficiency anemia among women of reproductive age in rural area, *International Journal of Advances in Scientific Research*, 1(7); 289-292.
- Irma N., Choiroel A., Sudirman. (2020) :** The Effect of Application Anemia Management Module on Improving Maternal Behaviors and Hemoglobin Level among Pregnant Women with Anemia, *International Journal of Nursing and Health Services (IJNHS)*,3 (5);576-587.
- Khuanbai Y. (2019):** "Re: Calculation of sample size". Retrieved from: https://www.researchgate.net/post/Calculation_of_SampleSize.
- McLean S., M. Francis, N. , Alvarado., (2019):** Point-of-Encounter Assessment: Using Health Belief Instructions Constructs to Change Grading Behaviors, *Journal of medical education and curricular development*,6(1); 1-11.
- Murthy M., Chandrasekharan S., Prakash M., Ganju A. (2020):**Effects of an mHealth voice message service (mMitra) on maternal health knowledge and practices of low-income women in India: findings from a pseudo randomized controlled trial, *BMC Public Health* 20:820 <https://doi.org/10.1186/s12889-020-08965-2>.
- Nagraj S., Kennedy SH., Jha V,Norton R., Hinton L, Billot L, Rajan E, Arora V, Praveen D and Hirst JE. (2020):** SMARThealth Pregnancy: Feasibility and Acceptability of aComplex Intervention for High-Risk Pregnant Women in Rural India: Protocol for a Pilot Cluster Randomised Controlled Trial. *Front. Glob. Womens Health* 2:620759.doi: 10. 3389/ fgwh. 2021.620759
- Oumer A., Arif H. (2019):** Knowledge, Attitude and Practice of Pregnant Mothers towards Preventions of Iron Deficiency Anemia in Ethiopia: Institutional Based Cross Sectional Study, *Health Care Current Reviews*, 7 (1); 238.
- Rosmaria, Utama SY, Hindriati T, et al. (2020) Effectiveness of website application (Sumiferos) for preventing anemia with pregnant women compliance in consuming Fe tablets. *Obstet Gynecol Int J*. 2020;11(3):197–200. DOI: 10.15406/ogij.2020.11.00509
- Rukmaini., NurIndrawaty .,Lipoeto., Masrul., Nursyirwan Effendi., (2019):** The Effect of Health Education and Mobile Control Application Program on Anemia among Pregnant Women, *Journal of Pharmacy and Nutrition Sciences*,9 (6);287-295.

- Ruth A., Jacob S., Moses K., Laura E. Murray K. (2019):** The prevalence of anemia and iron deficiency among pregnant Ghanaian women, a longitudinal study, *Global nutrition targets 2025: anaemia*, 16(3): e0248754.
- Seema. (2017):** Prevalence of Anemia among pregnant women in rural Koppal: a study from teaching hospital, Koppal, India, *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*; 6(9):3792-3795).
- Singh JK et al., (2020):** Effects of Female Community Health Volunteer Capacity Building and Text Messaging Intervention on Gestational Weight Gain and Hemoglobin Change Among Pregnant Women in Southern Nepal: A Cluster Randomized Controlled Trial. *Front. Public Health* 8:312. doi: 10.3389/fpubh.2020.00312.
- Sondaal S.F., Browne J.L., Amoakoh. M, Borgstein A., Miltenburg AS., Verwijs M., Klipstein- K. (2016):** Assessing the Effect of mHealth Interventions in Improving Maternal and Neonatal Care in Low- and Middle-Income Countries: A Systematic Review. *PLoS One*,4;11(5):e0154664.doi:10.1371/journal.pone.0154664. PMID: 27144393; PMCID: PMC 4856298.
- Toteja G.S., Singh P., Dhillon B.S., Saxena B.N., Ahmed F.U., Singh R.P., Sarma U.C. (2016):** Prevalence of anemia among pregnant women and adolescent girls in 16 districts of India, *Food and Nutrition Bulletin*, 27(4): 311-315.
- WHO (2016):** *Guideline: Daily Iron and Folic Acid Supplementation in Pregnant Women.* Geneva.
- World Health Organization., (2018):** Worldwide prevalence of anemia: WHO global database on anemia.
- Zhu N., Zhang D., Wang W., Li X., Yang B., Song J., Zhao X., Huang B., Shi W., Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W., (2019):** China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China., *N Engl J Med*, 382(8):727-733.doi: 10. 1056/ NEJMoa 2001017.