Heliyon 7 (2021) e06348

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

The impact of nutrition education on knowledge, attitude, and practice regarding iron deficiency anemia among female adolescent students in Jordan

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ARTICLE INFO

Keywords:
Iron deficiency anemia
Adolescent
Knowledge
Attitude
Practice
Intervention
Education
Jordan

ABSTRACT

Iron deficiency anemia (IDA) is a crucial health issue and the most common nutritional deficiency-related problem that affects many adolescents worldwide. Considering its link with the lack of appropriate knowledge, attitude, and practice (KAP), it could be preventable. The aims of this study were (1) assessing hemoglobin levels of female adolescent students, (2) examining their knowledge, attitude, and practice regarding IDA, and (3) evaluating the effect of a nutrition education program on the same. A quasi-experimental design (pretest-posttest control group) involving 363 students from four public secondary schools in Jordan was used. Two schools formed the intervention group (n = 194) and two formed the control group (n = 169). Blood tests for hemoglobin levels and self-report questionnaires were the measures employed. A month-long nutrition education program was conducted with the intervention group. The results revealed that 44.5% of the sample had mild anemia, and 10% had moderate anemia. In terms of knowledge, attitude, and practice, 52.4% exhibited adequate knowledge, 45% engaged in healthy practices, and 42.7% had a positive attitude toward IDA. The intervention group's total KAP scores were significantly higher than the control group ($p \leq .05$) post-program. Additionally, the total KAP scores within the intervention group showed significant increase from pre- to post-test ($p \leq .05$). It can be concluded that structured educational intervention effectively improves knowledge, attitude, and practice regarding IDA among adolescent females. Health care professionals must not only be oriented about this health problem among this age group, but also be supported to enable their intervention within a school setting.

1. Introduction

Anemia is a medical condition wherein the number of red blood cells or their oxygen-carrying capacity is insufficient to meet physiological needs (World Health Organization [WHO], 2020). Several factors may cause anemia, such as vitamin A, vitamin B_{12}, folate, and iron deficiencies; chronic inflammation, parasitic infection, and inherited conditions. However, iron deficiency is considered the primary cause worldwide and occurs due to insufficient levels of iron needed to produce red blood cells (American Society of Hematology [ASH], 2018; WHO, 2020). Since our diet is the main source of iron, iron deficiency anemia (IDA) usually develops as a result of low dietary intake, blood loss resulting in loss of iron, problems in iron absorption, and other medical conditions, such as final-stage kidney failure and inflammation. IDA cases range from mild to severe. Mild and moderate IDA may be devoid of any signs or symptoms. However, a severe case of IDA, if left untreated, may entail life-threatening consequences (National Heart, Lung, and Blood Institute, 2019).

Approximately one-third of the world's population is affected by anemia (Chaparro and Suchdev, 2019). Globally, one out of six people are adolescents, and IDA was considered the second cause of years lost by adolescents in 2016 (WHO, 2018). Anemia negatively impacts physical capability, development, performance, and immunity in adolescents, and it may lead to potentially long-term effects in advanced age groups, especially among women during their childbearing age. It may result in increased rates of pregnancy complications, such as low birthweight, premature births, and neonatal mortality (Shaka and Wondimagegne, 2018).

Worldwide estimates of 2016 indicated that 33% of women in their reproductive ages suffered anemia, with the highest prevalence in Asia

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https://doi.org/10.1016/j.heliyon.2021.e06348
Received 10 November 2020; Received in revised form 15 December 2020; Accepted 19 February 2021

and Africa (WHO, 2017). In the Middle Eastern countries, the prevalence of IDA equals its prevalence in other developing countries (25%–35%), much higher than that of industrialized countries (5%–8%). However, in the Middle East, data on IDA prevalence are limited. Most surveys assessed anemia in general, and few specifically assessed IDA (Mirmiran et al., 2012). For example, in Jordan, a national study involving 2797 females aged over 18 years revealed the prevalence of anemia in 19.3% non-pregnant females and 27.4% pregnant women (Abdo et al., 2019). The high prevalence of anemia among adolescents could also be explained by the lack of appropriate knowledge, attitudes, and practice regarding healthy nutrition. Although it could be a preventable problem, most adolescents indulge in unhealthy dietary habits, and they are unaware of IDA and how to prevent it (Jalambo et al., 2017). Many studies acknowledged the lack of appropriate knowledge, attitude, and practice regarding healthy nutrition among adolescents. For example, a cross-sectional study in Iran involving 300 female secondary school students aged 13–16 years revealed that 23.3% students engaged in poor dietary practices and 25.7% had poor knowledge related to anemia, its manifestations, and preventive methods (Tiyuri et al., 2017). In Ethiopia, a community-based cross-sectional study was conducted on 1323 girls aged 10–19 years. Self-reports showed that less than half the sample knew about anemia, and approximately one-third knew about the link between iron-rich food intake and anemia (Gebreyesus et al., 2019).

Nutrition education in schools proved effective in improving adolescent knowledge, attitude, and practice to prevent anemia (Angadi and Ranjitha, 2016). Furthermore, nutrition education is a long-lasting strategy because it builds a good nutritional status (Sharma and Singh, 2017). For example, a community-based intervention study was conducted in India involving 300 adolescent girls aged 13–17 years, who were divided equally into intervention and control groups. The nutrition education program for anemia was conducted only with the intervention group for four months. The results revealed a significant positive impact on the status of hemoglobin levels and KAP scores of the intervention group (Kamalaja et al., 2018). In the same manner, a randomized control trial (RCT) was conducted in Gaza strip, Palestine, involving 89 girls aged 15–19 years, who were divided into control and intervention groups. The intervention group attended nutrition education lectures for three months. The pre- and posttest results indicated good knowledge and positive attitude scores, and adoption of desired practice significantly improved in the intervention group (Jalambo et al., 2017b).

This study used a nutrition education program as intervention to enhance the nutritional knowledge, attitude, and practice regarding IDA among female adolescents. The results might potentially prompt action on the part of stakeholders and policymakers in Jordan to initiate policies and guidelines to reduce IDA among adolescents. Nurses play a critical role in conducting health education programs, especially at the primary level of prevention. In Jordan, previous studies acknowledged the prevalence of anemia among adolescents. However, there is a lack of studies examining the effectiveness of educational intervention on improving knowledge, attitude, and practice among adolescents. The objectives of the study were to assess the hemoglobin levels of female adolescent students from grades 8 to 10 in Irbid, Jordan; examine their knowledge, attitude, and practice regarding IDA; and evaluate the effect of a nutrition education program on improving the same. We hypothesized that the implementation of a nutrition education program effectively improves the knowledge, attitude, and practice regarding iron deficiency anemia among female adolescent students in Jordan.

2. Methods

2.1. Design and setting

A quasi-experimental (pretest-posttest control group) design was employed in four governmental schools in Irbid, northern Jordan, which are affiliated to the Ministry of Education. These schools are considered large, with a capacity to accommodate 700–900 students.

2.2. Population and sample

The population of this study included female adolescent students from grades 8 to10 in northern Jordan. The study sample was selected using a cluster random sampling method. First, two out of eight educational directorates in the Irbid governorate were randomly selected. Second, the list of all girls middle and secondary schools was obtained from these directorates. Subsequently, four schools were randomly selected from both directorates (two schools from each directorate). Two schools were randomly assigned as the intervention group and two as the control group. Third, three classes (8, 9, and 10) were randomly selected from each school. Female adolescent students from grades 8 to 10, aged 13–15 years, who were not involved in any health education program, and had no chronic disease were included. Finally, all eligible students in the class were voluntarily recruited for the study.

Based on G power (2014) for the calculation of the sample size (F test, four groups) and using a power level of .05 (alpha = .05, 1- β = .80) with medium effect size, the minimum required total sample size was 360 participants. A total of 463 female students were approached from four public schools in Irbid. Among them, 417 met the inclusion criteria, of which 400 agreed to participate (response rate was 95.9%). The 400 participants were divided into two groups: 200 in the control group and 200 in the intervention group. The final total sample consisted of 363 participants. Thus, the completion rate was 90.8%. Finally, 169 patients were in the control group and 194 in the intervention group (Appendix A).

2.3. Instruments

A structured questionnaire consisting of two sections was used. The first section, developed by the researchers, was related to demographic and menstrual factors. The information included age, parents' educational qualification, monthly family income, and whether the student was menstruating or not. The second section was the Knowledge, Attitude, and Practice (KAP) questionnaire developed by the Food and Agriculture Organization of the United Nations (Marías and Glasauer, 2014). The valid and reliable Arabic version of the questionnaire was used in this study, which was translated by Jalambo et al. (2017a,b) to measure the knowledge, attitude, and practice regarding IDA among adolescent girls in the Gaza Strip. It contains 17 multiple-choice questions wherein 8 questions measure knowledge, 3 measure practice, and 6 measure attitude. The section on knowledge included questions about recognition, consequences for women and children, causes and prevention of IDA, iron-rich food, and food that increases/decreases iron absorption. For analysis, participants who reported that they 'know' the answer to any item were classified as having adequate knowledge, while participants who reported that they 'do not know' the answer were classified as having inadequate knowledge. In the section on practice, the first question asked if the participant had an iron-rich food intake yesterday, the second related to whether the participants usually consume vitamin C-rich fruits, and the third one assessed the usual consumption of tea or coffee. If the answer to the final two questions was yes, the participants answered two additional questions about daily consumption of coffee or tea and timing of intake. For analysis, participants were classified as having healthy practices if they reported that they consumed iron-rich food yesterday, usually consume vitamin C-rich fruits, or do not usually consume tea/coffee. However, participants who reported the opposite answers were classified as having unhealthy practices. The section on attitude included questions to measure participants' perceptions about the probability of suffering IDA, the seriousness of the disease, how good, difficult, confident they are about preparing iron-rich meal; and the taste of iron-rich meal. For analysis, participants were classified as having positive attitudes if they think that IDA is a serious disease or it is likely to suffer from this disease, if they feel good or confident about preparing iron-rich meal, if they think that preparing this meal is not difficult, or if they like the taste of this meal. Participants

who reported opposite answers or "maybe/not sure" answers were classified as having negative attitudes.

Furthermore, to measure hemoglobin levels, participants' blood samples were collected and sent to the laboratory for analysis only before the intervention.

2.4. Ethical consideration and data collection

The data collection began after obtaining approval from the Institutional Review Board of Jordan University of Science and Technology and permissions from the Ministry of Education and the selected schools' principles. Data were collected between September and November 2019. In the first interview, the purpose and procedures of the study were explained, and the students were assured of voluntary participation, confidentiality of all provided data, and the ability to withdraw at any time. Informed consents and assents were obtained from the parents and participating students before data collection. One of the researchers, who is a registered nurse, collected the data with the help of two trained healthcare providers. Six classes in two schools were classified as the intervention group and six classes in the other two schools were classified as the control group. In total, data were collected on six occasions for each class in the intervention group and on two occasions for each class in the control group. On the first occasion, the pretest questionnaire was administered and explained to eligible students who agreed to participate in both groups. It took 15–20 min to complete, and the researcher was present to clarify any query. On the same occasion, blood samples were collected from the students. Beginning with the second to fifth occasions, the nutrition education program was conducted with only the intervention group over four weeks (one session per week). On the sixth occasion for the intervention group and second for the control group, the posttest questionnaires were provided after completing one month of intervention. The duration of this intervention was determined based on previous literature in which the durations of intervention ranged from one week to three months (Chaluvaraj and Satyanarayana, 2018; Gopal and Chand, 2017; Ibrahim and El-Lassy, 2013; Jalambo et al., 2017b).

2.5. Nutrition education program

The intervention was divided into four sessions containing lectures, videos, and brochures, and each session lasted for approximately 45 min. The content of lectures was based on the WHO guidelines titled "Nutrition anemia: Tools for effective prevention and control" (WHO, 2017). One of the researchers, who is a registered nurse, conducted interactive lectures in the presence of teachers to ensure order was maintained. PowerPoint presentations and videos were used to present the educational material, and the brochures were distributed at the end of each session. Lectures contained accurate, updated, acceptable, and simple information about the definition of IDA, manifestations, risk factors, consequences, epidemiological description, the association between dietary habits and IDA, the benefits of performing good alternative habits and being free from IDA, and sources of food that are related to IDA. All materials were presented in the Arabic language (the participants' mother tongue), translated and back-translated by professional translators, and checked by a panel of experts for content validity. The control group did not undergo the educational program.

2.6. Data analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 25.0. Descriptive statistics, including means, standard deviations, percentages, and frequencies were used to describe the participants' characteristics. The Independent Samples t-Test was used to compare the main study variables (knowledge, attitude, and practice) between the control and intervention groups. A paired sample t-test was used for a pretest and posttest comparison of the study variables within each group.

3. Results

3.1. Descriptive characteristics of the participants

The final sample included 363 participants (169 in control group vs. 194 in intervention group). Of these, only 290 students took the blood test, and the rest refused because of their fear of needles but met the other requirements of the study. The mean age of participants was 14.15 years (SD = .81), 71.6% of their fathers and 66.7% of their mothers had finished high school or had a lower level of educational qualification. About 54.3% of the participants had an income of less than 500 Jordanian dinars (<$ 700) per month, and 89.3% reported to have already completed their menstrual cycle for the period relevant to filling in the survey (Appendix B).

3.2. Percentage of iron deficiency anemia among female adolescent students

Among the 290 participants who agreed to take the blood test, the mean hemoglobin level was 11.68 (SD = 1.24). The laboratory results revealed that 45.5% (n = 132) of the participants had a normal level. In contrast, 44.5% (n = 129) had mild anemia, 10% (n = 29) had moderate anemia, and none of them had severe anemia (Table 1).

3.3. Level of knowledge, attitude, and practice regarding iron deficiency anemia

Regarding knowledge, 52.4% of all participants reported adequate overall knowledge about IDA. For example, most knew about easily absorbed iron-rich foods and the prevention of anemia (92.3% and 76%, respectively). However, 54.3% of them had never heard of IDA, 50.4% were unaware of the food that increases iron absorption, and around 73% were unaware of the consequences of IDA in pregnant women and children (Table 2).

Regarding practice, 45% of all participants reported overall healthy practices related to IDA. For example, 68.3% reported consumption of at least one iron-rich food the day before, and 88.7% reported that they usually "consumed vitamin C-rich fruit or juice." Despite this, only 9.1% reported consuming it correctly during the meal. In the same manner, 70% reported the consumption of caffeine either in the form of coffee or tea; only 25.3% consumed this correctly two hours after the meal (Table 3).

Regarding perception, 42.7% of all participants reported an overall positive perception toward IDA. Only 36.1% believed that IDA was a serious problem. Furthermore, 60.6% believed that it was good to prepare meals with iron-rich food, while 34.5% believed it was difficult, and only 28.7% felt confident in preparing iron-rich food (Table 4).

3.4. Effect of educational intervention on improving students' knowledge, attitude, and practice regarding iron deficiency anemia

Before the education program, there was no significant difference between the control group and the intervention group in terms of the total knowledge score, t (361) = .89, p = .37; and in terms of the total dietary practice score, t (361) = .17, p = .86. However, there was a significant difference between the two groups in terms of the total attitude score, t (361) = -3.23, p = .001, but this difference increased post-intervention. After the education program, the intervention group had significantly higher total scores of knowledge t (361) = -27.67, p = .000; attitude t (361) = − -7.68, p = .000; and practice t (361) = -3.37, p = .001 compared to the control group (Table 5).

On the other hand, the intervention group showed a significant increase in the total scores of knowledge, t (193) = -33.77, p = 0.000; attitude t (193) = -6.16, p = 0.000; and practice t (193) = -5.09, p = 0.000 from pretest to posttest. While the control group showed no significant increase in the total scores of knowledge, t (168) = 1.69, p =

Table 1. Hemoglobin levels among study participants (n = 290).

Level of Anemia	Frequency (%)	Hemoglobin Parameters
Normal	132 (45.5%)	≥12 g/dl
Mild anemia	129 (44.5%)	10–11.9 g/dl
Moderate anemia	29 (10%)	8–9.9 g/dl
Severe anemia	0 (0%)	<8 g/dl
Total	**290 (100%)**	

Table 2. Students' responses on knowledge part in the KAP questionnaire (n = 363).

Item	Answer	n	(%)
1.Previous hearing about iron-deficiency anemia	**Yes**	**166**	**(45.7)**
	No	197	(54.3)
If yes, Recognize that someone has anemia	**Know**	**119**	**(32.8)**
	Don't Know	244	(67.2)
2. Consequences of iron-deficiency anemia for infants and young children	**Know**	**98**	**(27)**
	Don't Know	265	(73)
3.Consequences of iron-deficiency anemia for pregnant women	**Know**	**100**	**(27.5)**
	Don't Know	263	(72.5)
4. Causes of iron-deficiency anemia	**Know**	**192**	**(52.9)**
	Don't Know	171	(47.1)
5. Prevention of anemia	**Know**	**276**	**(76)**
	Don't Know	87	(24)
6. Iron-rich food-easily absorbed	**Know**	**335**	**(92.3)**
	Don't Know	28	(7.7)
7. Food that increases iron absorption	**Know**	**180**	**(49.6)**
	Don't Know	183	(50.4)
8. Food that decreases iron absorption	**Know**	**245**	**(67.5)**
	Don't Know	118	(32.5)

*Adequate knowledge marked bold.

.091; attitude, t (168) = -1.30, p = .195; and practice, t (168) = -.54, p = .587 from pretest to posttest (Table 6).

4. Discussion

This study assessed the prevalence of IDA among female adolescents. The results revealed that more than half the participants had mild to moderate anemia. Although most were mild cases, they must be considered because of the potential of advancing into moderate or severe stages, if left untreated. The results were consistent with or revealed higher rates than those reported in studies conducted in developing countries, such as India, Indonesia, and Ethiopia (Kumari et al., 2017; Sumarlan et al., 2018; Teji et al., 2016), as well as developed countries, such as Turkey, Europe, and Canada (Balcı et al., 2012; Ferrari et al., 2011; Tahir et al., 2020). The possible reasons for these differences might be their consideration of different age groups, socio-cultural differences, and the varied economic status. On the other hand, the results of national studies (Abdo et al., 2019; Faris, 2014) involving different age groups indicated that the prevalence of IDA is relatively high and needs serious solutions to avoid future health problems among Jordanian women.

This study also examined the knowledge, attitudes, and practices regarding IDA among female adolescents. Although more than half the participants exhibited adequate overall knowledge about IDA, many possessed inadequate knowledge about related issues, such as prior knowledge of anemia, its consequence, or the food that increases iron absorption. Previous studies in India (Singh et al., 2019) and Ethiopia (Gebreyesus et al., 2019) reported similar results. This study's results highlighted the need to extensively educate adolescents about IDA, which further indicates how inadequate the current educational resources in schools and homes are. This study also revealed that less than half the participants engaged in healthy practices or had a positive attitude related to IDA. For example, many stated that they usually consumed vitamin C-rich fruits, but most of them did not consume fruits during meals to enhance iron absorption. Additionally, most consumed caffeine, which inhibits iron absorption, and they also were not confident about preparing iron-rich food. Consistent with these findings, some previous studies reported poor knowledge, attitudes or practices by adolescents regarding IDA in Jordan, Palestine, and Iran (El-Qudah, 2014; Jalambo et al., 2017a; Tiyuri et al., 2017). A possible interpretation for our results might be attributed to adolescence, which is considered a critical period of life associated with many physical, hormonal, and psychological changes. Such changes often affect dietary practices and attitudes.

We hypothesized that implementing a nutrition education program effectively improves the knowledge, attitude, and practice regarding IDA among female adolescents. This hypothesis was supported as the intervention group, post intervention, significantly improved in these aspects compared to the control group. Prior evidence demonstrated that implementing a structured and comprehensive educational program is an effective strategy for improving knowledge, attitude, and practice among adolescents even if it is a short-duration program. For example, studies in Egypt and Palestine conducted three months of educational interventions and showed significant score improvements from pretests to posttests (Ibrahim and El-Lassy, 2013; Jalambo et al., 2017b). Moreover, studies in India carried out 7 to more than 10 days of educational interventions and showed significant improvement in scores (Gopal and Chand, 2017; Chaluvaraj and Satyanarayana, 2018). Thus, our findings added to prior evidence that supports the implementation of educational programs among adolescent females. It also emphasized that school is an ideal place to reach many students at the same time and implement an

Table 3. Students' responses on practice part in the KAP questionnaire (n = 363).

Item		N	(%)
1. Intake of at least one iron-rich food yesterday	**Yes**	**247**	**(68.3)**
	No	115	(31.7)
2. Usual consumption of vitamin-C-rich fruits	**Yes**	**322**	**(88.7)**
	No	41	(11.3)
If yes,			
Daily intake of vitamin C rich fruits or Juice	**Yes**	**104**	**(32.3)**
	No	218	(67.7)
Timing of intake	Before meal	112	(30.9)
	During meal	**33**	**(9.1)**
	After meal	175	(48.2)
	Other	15	(4.1)
	Don't know	28	(7.7)
3. Usual Consumption of coffee/tea	Yes	254	(70)
	No	**109**	**(30)**
If yes,			
Daily consumption of coffee/tea	Yes	121	(33.3)
	No	**222**	**(61.2)**
	Don't know	20	(5.5)
Timing of intake	2 hours before meal	6	(1.7)
	Direct before meal	9	(2.5)
	During meal	35	(9.6)
	Direct after meal	188	(51.8)
	2 hours after meal	**92**	**(25.3)**
	No time	23	(6.3)
	Don't know	10	(2.8)

*Healthy practices marked bold.

Table 4. Students' responses on attitude part in the KAP questionnaire (n = 363).

Item		n	(%)
1. How likely do you think you are to be iron-deficient/anemic?	Not likely	166	45.7
	Not sure	94	25.9
	likely	**103**	**28.4**
2. How serious do you think iron-deficiency/anemia is?	Not serious	142	39.1
	Not sure	90	24.8
	Serious	**131**	**36.1**
3. How good do you think it is to prepare meals with iron-rich food?	Not good	101	27.8
	Not sure	42	11.6
	Good	**220**	**60.6**
4. How difficult is it for you to prepare meals with iron-rich food?	Difficult	125	34.5
	Maybe	58	15.9
	Not difficult	**180**	**49.6**
5. How confident do you feel about preparing meals with iron-rich food?	Not confident	202	55.6
	May be	57	15.7
	Confident	**104**	**28.7**
6. How much do you like the taste of an iron-rich food item or meal?	Dislike	103	28.4
	Not sure	68	18.7
	Like	**192**	**52.9**

*Positive perceptions marked bold.

organized program with interactive activities. Finally, our findings support the idea that although students in different countries have different cultural backgrounds and learning experiences, they are still in need for nutrition education as a strategy to enhance their knowledge, attitudes, and practice.

This study provides valuable information about the benefits of educational intervention as a practical solution. It is essential to establish policies and make decisions to take care of Jordanian adolescents by adopting effective educational programs. Besides, it is crucial to add routine hemoglobin and ferrous checkups to health promotion programs in schools and to commit schools to a specific diet or certain healthy food choices. Health care providers can play a critical role in solving these problems at the primary and secondary levels of prevention through educational lectures and regular screening. They must be provided with regular training to enhance their educational capabilities.

Table 5. Independent Samples t-test Between the Intervention and Control Groups Before and After the Educational Program (n = 363).

Education Program	Control group Mean (SD)	Intervention group Mean (SD)	t	df	p	Mean Difference
Before:						
Total knowledge score	4.94 (2.26)	4.74 (1.96)	.89	361	.37	.19
Total practice score	3.28 (1.42)	3.25 (1.41)	.17	361	.86	-.02
Total attitude score	2.25 (1.29)	2.97 (2.67)	-3.23	361	.001	-.72
After:						
Total knowledge score	4.79 (2.08)	9.65 (1.18)	-27.67	361	.000	-4.85
Total practice score	3.39(2.75)	4.37 (2.74)	-.3.37	361	.001	-.97
Total attitude score	2.53 (2.67)	4.15 (1.11)	-7.68	361	.000	-1.61

Table 6. Paired Samples t-Test within the Intervention and Control Groups Before and After the Educational Program (n = 363).

Pretest- posttest	t	df	p	Mean Difference	SD
Intervention					
Total knowledge score	-33.77	193	.000	-4.90	2.02
Total practice score	-5.09	193	.000	-1.11	3.04
Total attitude score	-6.16	193	.000	-1.17	2.65
Control					
Total knowledge score	1.69	168	.091	.14	1.13
Total practice score	-.54	168	.58	-.11	2.68
Total attitude score	-1.30	168	.195	-.27	2.77

Despite important and significant findings, the pretest-posttest design as a major strength, and a control group for comparison purposes, this study has some limitations. First, the study findings have limited generalizability because the participants were chosen from one city in the north. Second, self-reported questionnaires could entail probable response biases. Third limitation pertains to investigating hemoglobin levels without doing so for the ferrous levels and without considering other factors to exclude biases, such as current menstrual period or nutritional status. Finally, not investigating hemoglobin levels post-intervention to ensure its effect due to the short duration of the intervention might affect the completeness of the study results. Thus, we recommend implementing studies that include large and representative samples in addition to comprehensive biometric measurements before and after the educational intervention.

5. Conclusion

Iron deficiency anemia is a major health problem among female adolescent students. Their knowledge, attitude, and practice regarding the same need to be improved, and educational intervention is an effective method to do so. More efforts are required to increase adolescents' awareness regarding this to boost their current and future health status. Health care professionals must be oriented about this health problem among this age group and also be supported to help them assess, intervene, and regularly evaluate this problem, especially within a school setting.

Declarations

Author contribution statement

Nesrin N. Abu-Baker, Anwar M. Eyadat: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Abdullah M. Khamaiseh: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This work was supported by Jordan University of Science and Technology (416/2019).

Data availability statement

The data that has been used is confidential.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

Supplementary content related to this article has been published online at https://doi.org/10.1016/j.heliyon.2021.e06348.

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