Impact of Nutritional Health Education on Knowledge and Practices of Mothers of Anemic Children in El Othmanyia Village – Egypt

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Abstract

BACKGROUND: In Egypt, more than one in four children suffers from some degree of anemia.

AIM: This study was carried out to assess and improve the nutritional knowledge and risky nutritional habits of the mothers of anemic children aged 2–12 years old in El Othmanyia village.

MATERIALS AND METHODS: An interventional study was conducted among anemic children aged 2–12 years old and their mothers in El Othmanyia village, Egypt. The study passed through three stages over 1 and ½ years; pre-interventional assessment of awareness (n = 350), educational interventions targeting anemic children and their mothers, and post-interventional evaluation of change in awareness and practice.

RESULTS: The mean knowledge % score of mothers increased significantly after the intervention (82.2 ± 14.2 vs. 6.3 ± 5.8, respectively). Furthermore, the mean hemoglobin of the studied children increased significantly after the intervention (11.1 ± 0.7 vs. 10.5 ± 0.7). The percent of children with anemia decreased significantly from 100% to 40.3% after the intervention (p < 0.001).

CONCLUSION: The knowledge and practices of mothers are moving in a desirable direction after the health education intervention. Hence, nutrition education is an appropriate, effective, and sustainable approach to combat iron deficiency anemia. Recommendations: A multiple interventional strategies between different ministries to set policies and guidelines that support the healthy nutritional behavior among children are recommended.

Introduction

Anemia is a global public health problem affecting both developing and developed countries. The most common causes of anemia are nutritional causes as deficiency of one or more of the essential nutrients (usually iron, less frequently folate or Vitamin B12) [1].

It is now recognized that at least half of anemic cases worldwide is due to nutritional iron deficiency with an estimated 120 million suffering from iron deficiency anemia (IDA) [2]. In the Middle East and North Africa region, IDA is considered the most prevalent nutritional disorder among women and children [3]. According to the 2014 Egypt Demographic and Health Survey, more than one in four children in Egypt suffer from some degree of anemia [4]. A study conducted in El Menoufia Governorate showed that 25.6% of children aged 6–11 years old have IDA [5]. Another study conducted in El Fayoum Governorate in Upper Egypt showed that 64% of the children had IDA [6]. IDA continues to be a significant public health problem in Egypt despite the governmental efforts to reduce its prevalence [7]. The current study provides a group of community-based interventions aiming to improve the awareness and practices of anemic children and their mothers regarding proper nutrition to reduce the prevalence of IDA in Egypt.

Materials and Methods

Study setting

The study was conducted in El Othmanyia village – Gharbyia governorate, Egypt.

Study design and participants' characteristics

A community-based nutrition education interventional study was delivered to mothers of anemic children aged 2–12 years old along a period of 1 and ½ years starting from February 2017 until August 2018. All children aged 2–12 years old (n = 987) in El Othmanyia village were screened for anemia. Confirmatory test was done for the anemic children (n = 350 children). Mothers of confirmed mild to moderate anemic children

aged 2–12 years old (n = 104 mothers) were exposed to the study intervention.

Children with chronic debilitating diseases, other types of anemia as hemolytic anemia, and those with severe anemia (Hemoglobin (Hb) level lower than 7 g/dl for children aged 24–59 months and lower than 8 g/dl for children aged 5–12 years) were excluded from the study.

Study phases

The study was done over three phases:

The first phase included: Assessing the awareness, attitude, and behaviors of anemic children and their mothers toward proper diet which was conducted along 3 months starting from February 2017 until April 2017.

The second phase of the study included community-based interventions which were conducted along 1 year from May 2017 until May 2018. Community-based interventions proved in Egypt to have a profound impact on raising awareness and behavior change for many health settings [8], [9], [10], [11].

The third phase included evaluation of the impact of the interventions on change of the level of beneficiaries' awareness, attitude, and behavior. The evaluation was conducted along a period of 3 months starting from June 2018 until August 2018.

Data collection types and tools during the first and the third phase

The data-collection tools included laboratory investigations and structured questionnaires.

1. Laboratory investigations: Passes through two levels:
   a. Screening all children of El Othmanyia village aged 2–12 years old (987 children) to detect their hemoglobin level using hemoglobin color scale device (HemoCue™ Hb 201 DM) with accuracy 95% [12]. Anemic children after being screened for anemia were referred to the primary health care unit for confirmation by complete blood count using the new Medonic M32 analyzer which comes equipped with a high-precision shear-valve [13]. Cutoff levels for hemoglobin were set according to age. Children aged 24–59 months old were considered anemic with Hb level <11 g/dl, while children aged 5–12 years old were considered anemic with Hb level <11.4 g/dl. Anemia was further classified to mild, moderate, and severe with Hb cutoff values for children aged 24–59 months were: Mild 10–10.9 g/dl, moderate 7–9.9 g/dl, and severe lower than 7 g/dl. While Hb cutoff for children aged 5–12 years is mild 11–11.4 g/dl, moderate 8–10.9 g/dl, and severe lower than 8 g/dl. All confirmed mild and moderate anemic children aged 2–12 years old were checked for serum iron and ferritin levels at the National Research Centre (NRC) laboratory. Serum Iron was measured on Olympus AU400 automated chemistry analyzer, using fortress diagnostics kit and serum ferritin was measured using an ELISA kit supplied from BLOCHECK, INC (323 vintage park Dr. Foster City. CA 94404)
   b. Blood hemoglobin was measured again after the intervention to assess the hemoglobin level of the studied group.

Questionnaires

Assessment questionnaire

A well-structured questionnaire was developed after reviewing the literature. Content validity was established by a review committee consisting of three dieticians, three pediatricians, and seven public health specialists from the NRC with extensive experience in this field. The medical history and assessment of knowledge sections were then translated in Arabic by consortium from the NRC team to ensure validity and keeping the original meanings of the end point of the questions. It consisted of three sections of close ended questions filled by the researcher. The information collected identified the following: sociodemographic data, medical history of the affected child, and assessment of knowledge regarding anemia.

Food frequency questionnaire (FFQ)

The EPIC-Norfolk FFQ that is adapted to the Egyptian culture was used. In addition, it was modified by consortium from the NRC team according to the availability of the food items in the local village market [14].

24-h dietary recall questionnaire

Mothers were asked to mention all foods and beverages consumed by their children in the past 24 h using the 24-h dietary recall entry sheet by Nelson *et al*. in 1994 [15].

A pilot study was carried out on ten mothers of children with normal hemoglobin (10% of the study sample) to test the clarity of all questionnaires, estimate the time needed to fulfill each one, as well as to identify any obstacles or problems in data collection. These mothers were not included in the study sample. Results of the pilot study were satisfactory for the knowledge assessment questionnaire and FFQ; however, the 24-h dietary recall was modified and adapted to the Egyptian food habits and the results from the market assessment using NutriSurvey program [16] which contains an extensive collection of food databases from all over the world including Egypt.

Food items were quantified using the standardization of cups to have the specificity of the amount.

Description of the community-based intervention

Educational and promotional materials were developed keeping in view the users and the respondents in the community. All the developed and produced materials were distributed to the participants. The developed materials included posters, handouts, food models, and colored food cards. A colorful sheet was created to explain in simple words why it is important for young children to get enough iron in their diet, discussed symptoms of iron deficiency, and provided examples of foods that are good sources of iron, and ways to improve absorption of iron from foods. In addition, the sheet provided a sample menu with high iron meal and snack ideas.

These materials were delivered to the participants in an educational sessions aiming at providing basic knowledge regards IDA. The content of the sessions was based on the review of literature, results of assessment of the pre-interventional phase, as well as the social characteristics of the participants (Table 1).

The participants were divided into small groups (seven groups) based on their geographical location in the village. Each group consisted of fifteen mothers. Each group received seven sessions. Each session lasted approximately 1 h. First, discussion of the session objectives and content was dedicated. The sessions were followed by mothers' participation and interaction for 3 h using the different activities and teaching aids mentioned before to increase their attention, change their attitude and to enforce them to adopt a healthy nutritional behavior.

A monthly monitoring sheet containing pictures and photos for the types of food was used for follow-up of dietary habits. It was filled daily by the mothers starting from the 1st day after the session for 1 month. Follow-up was done for 4 months.

Ethical disclosures

The study complied with the revised International Ethical Guidelines for Biomedical Research Involving Human Subjects [17]. The Research and Ethical Committee of NRC approved the study protocol with registration number 16,250. An informed consent was obtained directly from enrolled mothers of children before data collection and after explanation of the study objectives. Confidentiality was provided through the whole phases of the study. In addition, children who were found to be ill during the study were given the appropriate care.

Statistical analysis

All completed questionnaires were statistically analyzed using SPSS, version 23 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.).

Data were presented using range, mean, standard deviation, median and interquartile range for quantitative variables, and frequency and percentage for qualitative ones.

Knowledge % score was calculated as follows: Correct answers were coded by one while the incorrect answers were coded by zero; then, we summated the total achieved score obtained by each subject and divide it by the maximum required score. Knowledge % score = (total achieved score)/(maximum required score) × 100.

Comparison of each question before and after intervention was performed using McNemar and Wilcoxon tests for binary and ordinal variables, respectively, while other qualitative variables were subjected for Chi-square test. Comparison between quantitative variables before and after intervention was performed using t-test (if data are normally distributed) or Wilcoxon test (if data are not normally distributed). $p < 0.05$ were considered statistically significant.

Figures were used to illustrate some information and then exported to access. That information in access was used by NutriSurvey program which is the English translation of commercial German software (EBISpro). Calculation of energy and other macronutrients and

Table 1: Content of educational sessions and various teaching aids used

Key messages		Teaching aids
1. Education about definition of IDA and its symptoms	Fatigue, shortness of breath, hair loss, frequent headaches, brittle nails	Posters and PowerPoint illustrating definition of anemia and its symptoms, for example, posters and films showing daily eating plan for meals and snacks which: Emphasize on diet with balanced macronutrients and micronutrients diets of food rich in iron
2. Food rich in iron	Red meat, poultry, seafood, eggs beans, dark green leafy vegetables, such as spinach, dried fruit, such as raisins and apricots	
Dietary habits that influence iron absorption (enhancers and inhibitors of iron absorption)	Enhancers of iron absorption include:	Give examples of daily meals and snacks as well as number of serving from each food group/day
	Hem-iron (animal sources of iron) present in meat, poultry, fish, and seafood	
	Ascorbic acid or Vitamin C present in citrus fruit, their juices, yellow sweet potatoes, vegetables such as green leaves, cauliflower, and cabbage	Handouts and flyers showing types of foods rich in iron and the factors that affect iron absorption
	Some fermented or germinated food and condiments, such as soy sauce (note that cooking, fermentation, or germination of food reduces the amount of phytates)	Colored picture showing example of my healthy plate
	Inhibitors of iron absorption include:	Different Food groups cards rich in iron
	Phytates present in cereal bran, cereal grains, highly-extracted flour, legumes, nuts, and seeds	Puppet show on what causes the child to be anemic and on how to avoid this
	Phytic acid impairs the absorption of iron	Plastic models of fruits and vegetables to children to play with and to keep
	Iron-binding phenolic compounds (tannins) present in tea, coffee, cocoa, herbal infusions in general, and some vegetables; calcium, particularly from milk and milk products	Interactive play time with food cards to identify different food groups in food pyramid
3. Long-term consequences of IDA	language development, cognitive affection, school achievement	

IDA: Iron deficiency anemia.

micronutrients such as vitamin-C and iron was done and compared with recommended daily allowance (RDA) reference and difference to mark the deficiency percentage.

Results

Analysis of the products sold at the shops and markets of the village showed that some iron rich items were not available as red kidney beans, broccoli, whole wheat pasta, quinoa, and oats. Other iron rich items were available but expensive as iron fortified cereals, raisins, prunes, dried apricots, and nuts. However, the market sold other sources rich of iron as eggplant, parsley, beans, spinach, fig, watermelon, in addition to animal protein as beef, chicken, liver, and fish.

Table 2 showed the sociodemographic background of the studied participants, it was found that the mean mothers' age was 32.5 ± 9 years. Nearly half of them had secondary education and almost all of them were housewives. Medical history of the studied children was presented in Table 3. About half of the children had suffered previously from anemia. More than half of them were asymptomatic (61.3%) while only a few complained of pallor (16%), tiredness (13%), and lack of concentration (10%). Only half of the mothers of the anemic children knew they had anemia. Although 71%

of children who previously had anemia started treatment, 82% of them did not follow-up after treatment mostly due to financial issues (50%). In addition, most of the children did not take any food supplements (93%) (Table 3).

Regarding the risky dietary habits, an improvement in awareness of the surveyed mothers was noticed after health education as most of the mothers identified drinking tea and having sweets and soda as risky dietary habits. In addition, before the intervention none of mothers knew any of the following risky dietary habits: Drinking milk directly after a meal, mixing molasses with tahini, a diet that is of more plants than animal protein, which improved dramatically after the intervention. Furthermore, after the intervention a significantly higher percent of mothers identified liver and meat, eggplant, leafy vegetables, and molasses as iron rich food (98%, 95.1%, 95.2%, and 95.1%, respectively) compared to mothers' knowledge in the pre-intervention assessment (28.8%, 16.3%, 13.4%, and 1.9%, respectively). Before the intervention, only few mothers identified defective academic achievement, defective cognition, and language disorders as side effects of anemia (9.6%, 2.8%, and 1.9%, respectively) compared to 88.4%, 37.5%, and 61.5%, respectively, after the intervention. These differences were statistically

Table 2: Sociodemographic characteristics of the studied families

Sociodemographic data	Description (n=104)
Mother's age (years)	
Range	18–60
Mean±SD	32.5 ± 9.3
Median (IQR)	30 (25–38)
Mother education n (%)	
Illiterate	11 (10.6)
Read and write	14 (13.4)
Primary	6 (5.8)
Preparatory	8 (7.7)
Secondary	53 (51)
University	12 (11.5)
Mother occupation n (%)	
Housewife	100 (96.1)
Farmer	2 (1.9)
Worker	1 (1)
Professional	1 (1)
Marital status n (%)	
Married	100 (96.1)
Widow	3 (2.9)
Divorced	1 (1)
Father's education (n=101) n (%)	
Illiterate	0 (0)
Read and write	9 (9)
Primary	11 (10.9)
Preparatory	12 (11.9)
Secondary	57 (56.4)
University	12 (11.8)
Father's occupation (n=101) n (%)	
Not working	27 (26.7)
Farmer	24 (23.7)
Worker	42 (41.6)
Employee	8 (8)
Number of house tenants	
Range	2–10
Mean±SD	5.9 ± 1.7
Median (IQR)	6 (5–7)
Number of children in the house	
Range	1–5
Mean±SD	2.7 ± 1
Median (IQR)	3 (2–3)

Table 3: Medical history of anemic children enrolled in the study in El Othmanyia village

Medical history of the child	(n=119)
Does the child suffer from chronic diseases n (%)	
Yes	9 (7.6)
No	109 (91.6)
Do not know	1 (0.8)
Which chronic disease n (%)	
Bronchial asthma	3 (2.5)
Constipation	5 (4.2)
Depression	1 (0.8)
No chronic disease	110 (92.4)
Did he have anemia before n (%)	
Yes	58 (48.7)
No	24 (20.2)
Do not know	37 (31.1)
Did you know he had anemia (n=58) n (%)	
Yes	31 (53.4)
No	27 (46.6)
Was he treated (n=31) n (%)	
Yes	22 (71.0)
No	9 (29.0)
For how long (n=22) n (%)	
<6 months	21 (95.5)
6–12 months	1 (4.5)
Did you do follow-up (n=22) n (%)	
Yes	4 (18.2)
No	18 (81.8)
Why not (n=18) n (%)	
Financial	6 (50.0)
TTT incompliance	10 (29.4)
Ineffective TTT	2 (8.8)
Did he suffer from Anal pruritus in the past 2 weeks n (%)	
Yes	23 (19.3)
No	88 (73.9)
Do not know	8 (6.7)
Was he treated (n=23) n (%)	
Yes	22 (95.7)
No	1 (4.3)
Is he complaining of the following symptoms n (%)	
Tiredness	15 (12.6)
Shortness of breath	4 (3.4)
Pallor	19 (16.0)
Tachycardia	1 (0.8)
Tachypnea	0 (0)
Hypotension	3 (2.5)
Limbs tingling	2 (1.7)
Growth retardation	5 (4.2)
Abnormal eating	0 (0)
Low food intake	7 (5.9)
Lack of concentration	12 (10.1)
Asymptomatic	73 (61.3)

Table 4: Pre- and post-intervention comparison between mothers' knowledge regarding anemia

Parameters studied	Pre (n=104)	Post (n=104)	p-value
Definition of anemia n (%)			
Yes	19 (18.3)	97 (93.3)	<0.001#
No	85 (81.7)	7 (6.7)	
Risky dietary habits n (%)			
Diet mainly of plant origin	0 (0)	65 (62.5)	<0.001#
Drinking tea directly after a meal	21 (20.2)	94 (90.4)	<0.001#
Lack of Vitamin C	9 (8.6)	89 (85.5)	<0.001#
Drinking milk directly after a meal	0 (0)	88 (84.6)	<0.001#
Molasses with tahini	0 (0)	89 (85.5)	<0.001#
Sweets and soda drinks	17 (16.3)	87 (83.6)	<0.001#
Strict diet	0 (0)	60 (57.7)	<0.001#
Iron rich food n (%)			
Leafy vegetables	14 (13.4)	99 (95.2)	<0.001#
Fruits	4 (3.8)	89 (85.5)	<0.001#
Liver and red meat	30 (28.8)	102 (98.0)	<0.001#
Molasses	2 (1.9)	99 (95.1)	<0.001#
Eggplant	17 (16.3)	99 (95.1)	<0.001#
Egg yolk	5 (4.8)	93 (89.4)	<0.001#
Dried Fruits	0 (0)	95 (91.3)	<0.001#
Symptoms and signs of anemia n (%)			
Tiredness	17 (16.3)	99 (95.1)	<0.001#
Shortness of breath	1 (0.9)	89 (85.5)	<0.001#
Pallor	10 (9.6)	101 (97.1)	<0.001#
Tachycardia	0 (0)	83 (79.8)	<0.001#
Tachypnea	0 (0)	78 (75.0)	<0.001#
Hypotension	0 (0)	92 (88.4)	<0.001#
Low food intake	6 (5.7)	87 (83.6)	<0.001#
Lack of concentration	5 (4.8)	91 (87.5)	<0.001#
Limbs tingling	2 (1.9)	70 (67.3)	<0.001#
Growth retardation	4 (3.8)	92 (88.4)	<0.001#
Abnormal eating	0 (0)	69 (66.3)	<0.001#
Side effects of anemia n (%)			
Defective cognition	3 (2.8)	39 (37.5)	<0.001#
Defective academic achievement	10 (9.6)	92 (88.4)	<0.001#
Behavioral changes	0 (0)	72 (69.2)	<0.001#
Language disorders	2 (1.9)	64 (61.5)	<0.001#
Mother knowledge % score			
Range	0–30	43.3–100	<0.001**
Mean±SD	6.3 ± 5.8	82.2 ± 14.2	
Median (IQR)	3.3 (3.3–10)	83.3 (73.3–93.3)	

#McNemar test, **Wilcoxon test.

significant with p < 0.001. Pre- and post-intervention comparison between mothers' knowledge regarding anemia showed that the mean knowledge % score of mothers increased significantly after the intervention (82.2 ± 14.2 vs. 6.3 ± 5.8) with p < 0.001 (Table 4).

The prevalence of anemia among the studied children was 35.5%. Moreover, pre-intervention, the hemoglobin screening for all children aged 2–12 years old in El Othmanyia village ranged from 6.8 g/dl to 12 g/dl while confirmatory hemoglobin ranged from 7.8 g/dl to 11.4g/dl. Pre- and post-intervention comparison between laboratory results of anemic children showed that the mean hemoglobin of the studied children increased significantly after the intervention (11.1 ± 0.7 vs. 10.5 ± 0.7, p < 0.001) and the percent of children with anemia decreased significantly from 100% to 40.3% after the intervention (p < 0.001) (Table 5).

Table 5: Pre- and post-intervention comparison between laboratory results of anemic children aged 2–12 years old in El Othmanyia village

Parameters studied	Pre (n=119)	Post (n=119)	p-value
Hb (g/dl)			
Range	7.8–11.4	8.8–12.7	
Mean±SD	10.5 ± 0.7	11.1 ± 0.7	<0.001*
Median (IQR)	10.6 (10.3–10.9)	11.1 (10.8–11.6)	
Anemia			
Yes	119 (100.0)	48 (40.3)	<0.001#
No	0 (0)	71 (59.7)	
Anemia grade			
Mild	74 (62.2)	29 (24.4)	<0.001**
Moderate	45 (37.8)	19 (16)	

Table 6: Percent of children according to their rate of consumption of different food items mentioned by their mothers in El Othmanyia village

Items, percent	Pre-intervention (n=119)				Post-intervention (n=119)				p-value*
	Frequency								
	Did not eat	Once/ week	Two/ week	Three/ week	Did not eat	Once/ week	Two/ week	Three/ week	
Chicken, fish	31.1	60.5	8.4	0.0	7.6	50.4	42.0	0.0	<0.001
Meat, liver	53.4	44.1	2.5	0.0	15.1	72.3	11.8	0.8	<0.001
Eggs	13.5	67.2	17.6	1.7	1.7	18.5	58.0	21.8	<0.001
Beans	12.6	64.7	21.8	0.9	0.8	27.8	66.4	5.0	<0.001
Fresh vegetables	43.8	44.5	10.9	0.8	10	42.9	43.7	3.4	<0.001
Cooked vegetables	16.8	56.3	26.1	0.8	2.6	24.6	66.9	5.9	<0.001
Fresh fruits	53.4	37.3	9.3	0.0	15.2	36.1	44.5	4.2	<0.001
Dried fruits	92.4	7.6	0.0	00	31.1	50.4	18.5	0.0	<0.001
Molasses	61.3	37.0	1.7	0.0	12.6	23.5	59.7	4.2	<0.001
Seed	84.9	10.9	3.4	0.8	29.4	31.1	37.8	1.7	<0.001
Pasta/rice	0.0	40.9	35.3	23.8	3.4	58.0	37.8	0.8	0.084
Baladi bread	15.1	47.1	35.3	2.5	0.9	27.7	66.4	5.0	<0.001
Cheese	43.8	48.7	6.7	0.8	15.1	28.6	52.9	3.4	<0.001
Yoghurt	73.1	25.2	1.7	0.0	13.5	24.4	57.1	5.0	<0.001
Milk	24.4	64.7	9.2	1.7	4.2	23.5	52.1	20.2	<0.001
Carbonated drink	16.8	47.9	31.9	3.4	61.4	29.4	9.2	0.0	<0.001
Tea	14.3	37.0	42.0	6.7	53.9	31.9	13.4	0.8	<0.001
Fruit juices	15.2	71.4	13.4	0.0	3.4	16.8	69.7	10.1	<0.001
Sweet/day	0.0	37.0	46.2	16.8	43.7	42.9	12.6	0.8	<0.001

*Chi-square test.

Table 6 represented the analysis of the rate of consumption of different food items by the surveyed children as mentioned by their mothers, it revealed that the percent of children who consumed chicken, meat, egg, beans, fresh vegetables, cooked vegetables, fresh fruits, and fruit juice (twice/week) increased post-intervention than pre-intervention (42% vs. 8.4%, 11.8% vs. 2.5%, 58% vs. 17.6%, 66.4% vs. 21.8%, 43.7% vs. 10.9%, 66.9% vs. 26.1%, 44.5% vs. 9.3%, and 69.7% vs. 13.4%), respectively, and the difference was statistically significant.

Results also showed that the mean daily intake of protein, Vitamin D, calcium, Iron, and zinc increased significantly post-intervention. Despite this increase in the consumption, yet the percent intake in relation to the RDAs and dietary reference intake is still low for Vitamin D (72.3%), calcium (78.6%), iron (79.2%), and zinc (84.1%). Furthermore, the percent of children who consumed one cup per serving of drinks

Table 7: Mean±SD of the main daily nutrients' intake and the % of intake in relation to the RDAs and DRIs of study subjects

Nutrient intake	Pre-intervention (n=119) Mean±SD %RDA and DRIs**	Post-intervention (n=119) Mean±SD %RDA and DRIs	P value#	RDAs/DRIs
Energy (Cal)	1885.93 ± 25.32 104.77	1701.76 ± 28.51 94.54	<0.001*	1800
Protein (g)	27.53 ± 3.03 91.77	32.49 ± 3.12 108.30	<0.001*	30
Fat (g)	81.29 ± 3.98 135.48	61.87 ± 4.94 103.12	<0.001*	60
Carbohydrate (g)	289.57 ± 43.80 222.75	253.74 ± 38.51 195.191	<0.001*	130
Dietary fiber (g)	16.91 ± 4.35 67.64	23.17 ± 9.05 92.68	<0.001*	25
Vitamin A (µg)	437.19 ± 15.34 62.46	709.25 ± 13.28 101.32	<0.001*	700
Vitamin D (µg)	4.48 ± 0.47 44.80%%	7.23 ± 0.52 72.30	<0.001*	10
Calcium (mg)	643.51 ± 37.21 64.35	786.17 ± 49.31 78.62	<0.001*	1000
Iron (mg)	4.19 ± 0.38 41.90	7.92 ± 0.80 79.20	<0.001*	10
Zinc (mg)	6.28 ± 2.15 62.80	8.41 ± 2.70 84.10	<0.001*	10

#t-test *Significant at p<0.05. **RDA: Recommended daily allowance.**DRI: Dietary reference intake.

as carbonated drinks (44% vs. 37%) and tea (44% vs. 27%) decreased post-intervention while the percent of children who consumed three pieces or more of sweets daily decreased post-intervention (11%) compared to pre-intervention (62%) (Table 7).

Discussion

The prevalence of anemia among children aged 2–12 years old in El Othmanyia village, Egypt was 35.5%. This result was higher than the result presented by Abdel-Rasoul *et al.* in Menoufia, Egypt in 2015 (25.6%). Other studies in different countries showed higher prevalence of anemia; in Kenya (92%), Ghaza (59.7%), and Kazakhstan (49.8%) [18], [19], [20].

In the current study, the percent of anemic children significantly decreased from 100% before the intervention to 40% after the intervention. This comes in accordance with a study in the United States which showed that the prevalence of anemia dropped to 28.6% in the group who received nutrition education sessions versus 62.5% in the control group [21]. Moreover, the mean hemoglobin of the studied children increased significantly after the nutritional educational sessions. These results were similar to the results presented by Gitau *et al.* in Kenya (12.8 g/dl–13.4 g/dl) and Grover and Choudhary in India (8.55 g/dl–10.66 g/dl) [22], [23]. Another study conducted in India in 2019 showed that anemia cure rate was higher in children in the intervention group compared with the control group (55.7% vs. 41.4%) [24]. However, a study in Iran showed no significant increase in mean hemoglobin level after the nutritional educational intervention [25].

This study highlights marked gaps in nutrition related knowledge of mothers in El Othmanyia village. Before the intervention the mean knowledge score of mothers was 6.3 and it increased significantly after the intervention (82.2). These results come in agreement with the results presented by Kumari and Dubey in Rajasthan (9.3 vs. 13.83) [26]. Other studies also showed comparable results in Kenya (9.87 vs. 39.29), Selangor and Kuala Lumpur (48.3 vs. 55), and Ghana (8.3 vs. 21.6) [27], [28], [29].

Before the intervention mothers had defective knowledge concerning IDA which significantly improved after the intervention. Regarding the definition of anemia, our study showed that the percent of mothers aware of the definition of anemia significantly increased after the intervention. This comes in agreement with Abdel-Rasoul *et al.* in Egypt in 2017 (93% vs. 55%) [30]. Further assessment of the knowledge revealed that before the intervention, few mothers identified drinking tea directly after the meal as a risky dietary habit. However, after the intervention, a significant improvement was detected. A study conducted in India to examine anemia-related

knowledge in adolescent schoolgirls also showed that only 13.3% of participants were able to identify drinking tea post meals as a risk factor for anemia [31].

Regarding other risky dietary habits, few mothers reported lack of Vitamin C in a meal before the intervention. However, after the intervention, our results showed significant improvement. These results were in agreement with a study carried in Malaysia where 100% of participants who received the intervention were aware that tea inhibits iron absorption and Vitamin C enhances iron absorption compared to 78.8% and 78.2%, respectively. However, no improvement was demonstrated by the counterpart group [32]. Another study carried in Egypt showed similar results [30]. It is suggested to start maternal education as early as possible even before conception. Several Egyptian studies showed the influence of early educational programs and early initiation of breast feeding on improving the Egyptian dietary habits to healthy one with subsequent influence on improvement of the cognitive and psychosocial function [33], [34], [35], [36].

In addition, before the intervention, only few mothers identified tiredness, pallor, and delayed child's growth as symptoms of anemia. These results were much lower than those presented by Abdel-Rasoul *et al.*, 2017 in Egypt (38%, 89%, and 42%, respectively) [30]. However, after the intervention comparable results were found where most of the participants identified these as symptoms of anemia.

In addition to defective knowledge in this study, poor eating habits are another reason for the high rates of anemia among children. Their daily iron requirements are not met by the typical diet despite availability of iron rich food in the market. This is because of an inadequate intake of iron-rich foods and foods that enhance iron absorption, and/or excess intake of inhibitors of iron absorption such as tea and whole wheat bread in addition to skipping meals. Many Egyptian studies showed that school meals have profound effect on improving the dietary intake of minerals and vitamins and improving their cognitive functions and academic achievements [37], [38].

Analysis of the FFQ showed that the percent of children who consumed iron rich food (twice/week) as chicken and fish, meat and liver, green leafy vegetables, increased significantly post-intervention. Other studies also reported an increase in consumption of iron rich foods after nutrition intervention [39], [29], [23]. Furthermore, our study showed that the percent of children who consumed carbonated drink, tea, and sweets decreased significantly after the intervention compared to before the intervention. Likewise, Rojhani and Niewiadomska-Bugaj revealed similar results in the United States in 2004 (52% vs. 46%) [21].

Analysis of the 24-h dietary recall of participants in this study revealed a significant increase in the mean daily intake of protein, Vitamin A, calcium, Iron, and zinc post-intervention and this comes in concordance with

a study done in Kenya [27]. Another study conducted in Indonesia among 83 female adolescents aged 16–18 years students of the Hidayatullah Arrohmah Islamic Boarding School Malang showed that before the intervention 66% of respondents had low protein intake. However, the protein intake increased after the intervention (87%). As for iron, about 92% and 2% respondents were in very low and low intake. However, after the intervention this number decreased to 86% and 11%, respectively. However, there was no effect of the nutrition education on the Vitamin C intake [40].

There were some limitations through the study, which could not be handled. Dietary habits of the children were more influenced by the culture, family, peers, media, and environment. Moreover, due to the cultural habit that all family members eat from one big dish, it was difficult to estimate the portion size that the children eat. Furthermore, the geographic place of the village being 3 h away from Cairo with unprepared roads resulted in difficulty in transporting the blood samples from the village to the laboratory of the NRC especially that there was no centrifuge in the village.

Conclusion and Recommendations

The study showed that the knowledge and practice of most mothers of anemic children have changed dramatically as a result of the applied interventions. This reflects the necessity of educational interventions to the poor rural communities to promote the health of the future generations.

Comprehensive nutritional education can have a great impact on the health of anemic children. However, to reduce the prevalence of IDA in Egypt, an intercollaborative approach between different ministries is recommended to set polices and guidelines that support the healthy nutritional behavior among children. Furthermore, the role of school is fundamental in controlling the problem through managing the food choices at the school.

Acknowledgments

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