Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2022 Apr 30; 10(E):708-713.
https://doi.org/10.3889/oamjms.2022.9192
eISSN: 1857-9655
Category: *E - Public Health*
Section: *Public Health Education and Training*

OPEN ACCESS

The Effect of Family Approach Model Education and Zinc Supplementation on Pregnant Women with Chronic Energy Lack from Poor Family

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Edited by: Sasho Stoleski
Citation: Halisah H, Nur A, Taslim NA, Chalid SM, Juliaty A, Mappaware NA, Ahmad M, Hamid F, Alasiry E, Aminuddin A, Thalib KU, Hermanses SS, Fasiha F, Achmad IH, Mustardianto M. The Effect of Family Approach Model Education and Zinc Supplementation on Pregnant Women with Chronic Energy Lack from Poor Family. Open Access Maced J Med Sci. 2022 Apr 30; 10(E):708-713. https://doi.org/10.3889/oamjms.2022.9192
Keywords: Education; Chronic energy deficiency; Zinc; Teenage pregnancy
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Received: 03-Mar-2022
Revised: 25-Mar-2022
Accepted: 20-Apr-2022

Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Pregnant women's health and nutritional status must be maintained because they are indicators of perinatal growth and neonatal welfare; efforts to prevent fetal growth disorders must begin with pregnant women, one of which is through increased knowledge and nutritional supplementation.

AIM: This study aimed to examine the effect of family-based education and zinc supplementation on knowledge, weight, upper arm circumference, nutritional intake, serum zinc levels, insulin-like growth factor-1 (IGF-1), hemoglobin, infant anthropometry, and placenta in stunted pregnant women.

MATERIALS AND METHODS: Quasi-experiment with a pre-post-test control design was carried out from September 2020 to June 1, 2021, in four areas of the Mamuju Regency City Health Center. The subject population is pregnant women aged 20–26 weeks gestation, experiencing chronic energy deficiency.

RESULTS: The mean knowledge increased in the intervention group with a rate of change of 133.57%, while the control group did not experience a significant increase. Unpaired *t*-test showed a significant difference in the mean serum zinc, IGF-1, and hemoglobin levels with $p < 0.001$.

CONCLUSION: Zinc supplementation is very beneficial for pregnant women, especially teenage pregnant women who have chronic energy deficiency, but the results of zinc supplementation are better accompanied by providing education based on a family approach, as a form of community support system for mothers, because family diet has a strong impact on pregnant women diet.

Introduction

Pregnant women's health and nutritional status is an indicator of perinatal growth and neonatal well-being [1]. If the nutritional status of the mother is lacking, pregnant women will experience nutritional problems such as chronic energy deficiency and nutritional anemia.

Chronic energy deficiency in pregnant women is at risk of causing intrauterine growth restriction (IUGR) and low birth weight (LBW) babies; this occurs because in the early stages of pregnancy, pregnant women experience malnutrition so that it affects the development and embryo capacity and causes LBW infants, which is a predictor of growth failure as a risk factor for stunting [2].

Adolescents are classified as vulnerable to nutritional problems for various reasons, including increased physical, cognitive, and psychosocial growth [3]. Changes in the lifestyle and eating habits of adolescents will affect both their intake and nutritional needs [4], and adolescents have special nutritional needs, especially adolescents who are pregnant.

Teenagers' eating patterns tend to be less diverse because in choosing food, they are influenced by excessive tastes and preferences for certain foods, which can lead to unfulfilled nutritional needs, including the need for micronutrients such as zinc.

Zinc is a micronutrient that is very important for the growth and development of the fetus in the womb [5]. Lack of intake of zinc in pregnant women stimulates the baby's susceptibility to zinc deficiency.

Recently, Indonesia is a country with the seventh-highest prevalence of child marriage in the world and the second highest in Southeast Asia, which is 0.56% of marriages aged <15 years and 11.21% aged <18 years [6]. At the national level, West Sulawesi Province is the area with the highest prevalence of child marriage, which is 19.43%. The poverty factor is the main cause of child marriage in the village. This case is more common in women, especially in children who have dropped out of school.

Education and knowledge are indirect factors that influence a person's behavior. Knowledge of nutrition can determine individual behavior in consuming nutrition.

Knowledge is not behavior but can be a determinant of dietary behavior [7]. Through the family approach model education, pregnant women and their families are empowered to understand the importance of nutrition for pregnant women as well as family members so that adequate nutritional intake is not only for pregnant women but also for family members [8].

Materials and Methods

Quasi experiment with a pre-post-test control design was carried out from September 2020 to June 1, 2021 in four areas of the Mamuju Regency City Health Center. The subject population is normal pregnant women, 20–26 weeks of gestation, height <150 cm, age 19 years, upper arm circumference ≤23.5 cm, and family income below the Regional Minimum Wage of West Sulawesi Province. This study was approved by the Research Ethics Commission of the Hasanuddin University Medical Faculty Makassar, and written consent was obtained from all respondents who were willing to participate in the study. This study has also been registered with Clinical Trials No. NCT05100550. Pregnant women who met the inclusion criteria were given informed consent. The Exclusion criteria were pregnant women whose identified with zinc medication before the the investigation, suffering from pre-eclampsia, and multiple pregnancies.

Method of collecting data

A consecutive sampling method was used to select the sample; the determination of the intervention and control groups was separated based on the area of the public health center. Knowledge data retrieval using a questionnaire, nutrition consumption patterns using a food recall form, and food frequency are then entered into the Nutrisurvey application to calculate the intake of macro- and micronutrients. Mother's weight was measured using a standard digital scale, while height was measured using a Microtoise with an accuracy of 0.1 cm. The Upper arm circumference was measured with a special tape measure. Hemoglobin levels were assessed using the Hemocue device, and serum zinc (Zn) levels were determined using the Colory metric method. Meanwhile, the levels of insulin-like growth factor (IGF-1) were determined using an enzyme-linked immunosorbent assay test (ELISA). A statement of consent was given to subjects who met the criteria and agreed to participate after being notified of the benefits of the study. Subjects were given treatment with zinc supplement tablets as much as 20 mg/day for 12 weeks along with providing education about the benefits and impacts of zinc deficiency for pregnant women using the family approach method as many as four meetings through home visits as well as observing adherence to taking zinc supplements during education implementation. All blood samples were centrifuged in the laboratory to separate the serum and then stored at a temperature of 2°C–8°C; the collected samples were examined for serum zinc and IGF-1 levels at the Laboratory of RSPTN Hasanuddin University Makassar. When the baby is born, anthropometric measurements of the baby are carried out in the form of the baby's weight using the SECA 703 weighing scale big black stainless.

Data analysis

IBM SPSS Statistics for Windows, Version 23.0 (IBM Co., Armonk, NY, USA), was used to analyze the data. Subjects were divided into two groups: Those who were given education with zinc supplementation and those who were only given zinc supplementation without education. We used univariate analysis to describe the frequency, mean, standard deviation, and range, for both groups. The correlation test between education and zinc supplementation on increased knowledge, nutritional intake, weight gain, upper arm circumference, serum zinc levels, IGF-1, hemoglobin, and anthropometry of infants was studied using bivariate analysis.

Results

A total of 61 stunted adolescent pregnant women with an age range of 12–19 years, parity 1–3, unemployed, and with a primary education participated in this study, with 25 (39.72 %) in the

Table 1: Distribution of respondent characteristics in the intervention group and control group

Variable	Control (n = 30)				Intervention (*n* = 31)			
	n (%)	Minimum	Maximum	Mean ± SD	n (%)	Minimum	Maximum	Mean ± SD
Age		12	9	17.5 ± 1.73		13	9	17.46 ± 1.54
Parity		1	3	1.47 ± 0.48		1	3	1.43 ± 0.66
Occupation								
Housewife	30 (100)				31 (100)			
Education								
No school	4 (6.34)				4 (6.34)			
Basic education	25 (39.72)				26 (41.20)			
Further education	2 (3.24)				2 (3.24)			
Income/month								
< 1 million	18 (29.5)				19 (31.1)			
1–<2 million	12 (19.7)				12 (19.7)			
Pre-test results								
Knowledge		13.33	53.33	35.10 ± 12.37		13.33	53.33	32.68 ± 12.22
Weight		40.00	56.00	48.51 ± 5.10		40.00	64.00	50.55 ± 5.01
Upper arm circumference		20.0	23.51	22.64 ± 0.981		19.0	23.5	22.15 ± 1.30
Macronutrient intake								
Carbohydrate		51.50	521.90	189.97 ± 119.89		60.30	337.80	179.34 ± 72.13
Protein		22.80	116.80	43.73 ± 23.53		22.80	89.00	45.81 ± 20.47
Fat		2.60	93.90	36.01 ± 20.74		4.40	91.30	38.49 ± 21.45
Micro nutrition intake								
Zn		22.80	116.80	43.73 ± 23.53		22.80	89.00	45.81 ± 20.47
Vitamin C		0.00	71.60	10.99 ± 19.87		0.00	26.10	6.77 ± 6.48
Folic acid		10.80	197.40	58.14 ± 41.89		6.00	148.50	55.44 ± 37.69
Energy intake		683	761	133.0 ± 332.2		522	1755	1074.4 ± 347.6
Zn Level		23.82	40.38	31.60 ± 3.33		29.12	39.20	33.43 ± 2.37
IGF-1 levels		2.01	4.93	3.30 ± 0.65		2.30	4.65	3.31 ± 0.58
Hemoglobin		8.10	12.30	10.28 ± 1.09		7.90	12.00	10.22 ± 0.84

Source: Primary data. IGF-1: Insulin-like growth factor-1, Zn: Zinc, SD: Standard deviation.

control group and 26 (41.20 %) in the intervention group. The participants in the study are all from low-income families. Based on the results of the initial knowledge examination, body weight, upper arm circumference, macro- and micronutrient intake, serum zinc levels, IGF-1, and hemoglobin levels were all lower in the intervention group than in the control group (Table 1).

The intervention group's mean knowledge increased, but the rate of change in the control group did not increase significantly. Statistical analysis revealed a significant difference in knowledge between the mother and fetus in the second group with p < 0.001. Both groups' upper arm circumference (MUAC) increased before and after the intervention. Statistical analysis revealed a significant difference in upper arm circumference between mothers who received family-based education and zinc supplementation and mothers who received only zinc without family-based education, with p = 0.005 (Table 2).

Table 2: Analysis of differences in knowledge, weight, and size of upper arm circumference in the intervention group and the control group

Variable	Mean ± SD		p*	p**
	Pre-test	Post-test		
Knowledge				
Control (30)	35.10 ± 12.37	33.97 ± 11.91	0.089	< 0.001
Intervention (31)	2.68 ± 12.22	74.40 ± 9.90	< 0.001	
Mother's weight				
Control (30)	48.51 ± 5.10	53.40 ± 5.48	< 0.001	< 0.001
Intervention (31)	50.55 ± 5.01	58.90 ± 4.74	< 0.001	
Upper arm circumference				
Control (30)	22.65 ± 0.98	24.95 ± 0.80	< 0.001	0.005
Intervention (31)	22.15 ± 1.30	25.98 ± 1.78	< 0.001	

*p: Paired t test, **p: Unpaired *t*-test. SD: Standard deviation.

After zinc supplementation, the mean intake of macronutrients and micronutrients, as well as energy intake, increased in both groups, but the increase was higher in mothers who received family-based education. Statistical analysis showed a significant difference in macronutrient and micronutrient intake in the second group with p < 0.001. The mean value of serum zinc, IGF-1, and hemoglobin levels in both groups also increased before and after the intervention. Statistical test results: Unpaired *t*-test showed a significant difference in the mean levels of serum zinc, IGF-1 and hemoglobin with p < 0.001 (Table 3).

Statistical analysis showed differences in pregnancy outcomes (infant and placental anthropometry) between mothers who received family-based zinc supplementation and mothers who received

Table 3: Analysis of differences in nutritional intake, serum zinc levels, insulin-like growth factor-1, and hemoglobin in the intervention group and the control group

Variable	Mean ± SD		p*	p**
	Pre	Post		
Macronutrient intake				
Carbohydrates (g)				
Control (30)	189.97 ± 119.89	193.94 ± 117.48	0.006	< 0.001
Intervention (31)	179.34 ± 72.13	281.61 ± 54.27	< 0.001	
Protein (g)				
Control (30)	43.73 ± 23.53	47.50 ± 24.34	< 0.001	< 0.001
Intervention (31)	45.81 ± 20.47	78.49 ± 16.48	< 0.001	
Fat (g)				
Control (30)	36.01 ± 20.74	38.10 ± 20.74	0.329	< 0.001
Intervention (31)	38.49 ± 21.45	60.63 ± 12.83	< 0.001	
Micronutrient intake				
Zn (mg)				
Control (30)	43.73 ± 23.53	45.23 ± 25.53	0.024	< 0.001
Intervention (31)	45.81 ± 20.47	78.49 ± 16.48	< 0.001	
Vitamin C (mg)				
Control (30)	10.99 ± 19.87	11.46 ± 19.82	0.052	< 0.001
Intervention (31)	6.77 ± 6.48	29.25 ± 15.72	< 0.001	
Folic acid (mcg)				
Control (30)	58.14 ± 41.89	70.38 ± 41.89	< 0.001	< 0.001
Intervention (31)	55.44 ± 37.69	173.15 ± 73.25	< 0.001	
Energy intake (kcal)				
Control (30)	1133.01 ± 332.20	1304.30 ± 330.61	< 0.001	0.004
Intervention (31)	1074.42 ± 347.59	1549.96 ± 317.95	< 0.001	
Zn level (g/dl)				
Control (30) s	31.60 ± 3.34	35.13 ± 3.46	< 0.001	< 0.001
Intervention (31)	33.43 ± 2.36	45.16 ± 5.76	< 0.001	
IGF-1 level (ng/ml)				
Control (30)	3.29 ± 0.65	4.19 ± 1.10	< 0.001	< 0.001
Intervention (31)	3.30 ± 0.58	5.59 ± 1.62	< 0.001	
Hb level (g/dl)				
Control (30)	10.28 ± 1.08	11.00 ± 0.81	0.001	0.001
Intervention (31)	10.22 ± 0.84	11.73 ± 0.77	< 0.001	

*p: Paired t-test, **p: Unpaired t-test. IGF-1: Insulin-like growth factor-1, Hb: Hemoglobin, Zn: Zinc, SD: Standard deviation.

only zinc supplementation (Table 4). The size of the sole of the foot does not have a significant relationship with the given intervention.

Table 4: Analysis of anthropometric differences between placenta and infants in the intervention group and the control group

Variable	Mean ± SD		p
	Control (n = 30)	Intervention (n = 31)	
Baby anthropometry			
Birth weight (g)	2938.7 ± 309.08	3226.1 ± 273.05	< 0.001
PB born (cm)	48.10 ± 1.18	49.32 ± 1.27	< 0.001
Head circumference (cm)	31.45 ± 1.09	32.60 ± 1.18	< 0.001
Bust (cm)	31.37 ± 2.25	32.39 ± 1.28	0.033
Abdomen circumference (cm)	30.18 ± 2.18	31.45 ± 1.91	0.019
Length T.feet (cm)	7.29 ± 0.73	7.60 ± 0.68	0.089
Anthropometry of the placenta			
Weight (g)	525.23 ± 87.81	587.9 ± 76.85	0.004
Diameter (cm)	17.77 ± 2.55	18.95 ± 1.67	0.036
Thickness (cm)	1.48 ± 0.48	1.15 ± 0.4	0.003

p: Unpaired t-test, SD: Standard deviation.

Discussion

This study discovered a statistically significant effect of family approach education and zinc supplementation on increasing knowledge. Individual nutrition knowledge provides new information that can stimulate attitude change and subsequently result in better dietary practices. The increase in nutrient supply is not only due to an increase in knowledge, which has an impact on nutritional consumption behavior, it is also due to the effect of zinc, which stimulates smell and taste via central nervous system stimulation, which affects appetite, resulting in an increase in food utilization, nutritional intake becoming adequate, and having a positive impact [9].

A study found that after a nutrition education intervention, pregnant women's awareness of healthy nutrition increased significantly from 3% to 31%. Increased knowledge on nutritional intake leads to increased nutritional intake, which increases body weight and upper arm circumference [10]. Another study found an increase in daily food intake as well as an increase in body weight after nutrition education [11]. Education is an important factor in the success of health and care services. Education and knowledge are not factors that directly influence a person's behavior [12]. In addition to knowledge, the environment has a significant impact on the development of eating behavior [13]. The environment includes family environment, school, as well as advertisement through electronic and print media [7]. Eating habits in the family have a big influence on a person's eating pattern; a person's preference for food is formed from the eating habits in the family [14].

This study also found an increase in serum zinc, IGF-1, and hemoglobin levels. An increase in serum zinc levels is associated with the consumption of nutrients that aid in zinc absorption [15]. The increase in zinc absorption is mediated by a number of endogenous substances that can act as zinc ligands [16]. Citric acid, picolinic acid, and prostaglandins are examples of these ligands. The amino acid ligands are histidine, cysteine, lysine, and glycine. Pancreatic secretions contain constituents known to increase zinc absorption [16]. Zinc stimulates growth by increasing the concentration of IGF-1 which is produced by the liver in response to growth hormone. The results of this study are in line with the results of previous studies, which found that there was a relationship between zinc supplementation and increased levels of IGF-1 in adolescents [17], [18]. The same result was also stated by Sumarmi *et al*. [19], and Yee [20]. IGF-1 and IGF-2 (IGFs) are found in the group of peptide growth factors that are bound to one of the six IGF binding proteins. IGFs act as autocrine and paracrine growth factors in tissues that control the processes of mitosis, differentiation, chemotaxis, and apoptosis [19]. Although IGF-1 levels were found to be low in fetal circulation, there was a positive correlation between serum IGF-1 levels and fetal weight. Zinc stimulates growth by increasing the concentration of insulin growth-like factor hormone-1 (IGF-1) which is produced by the liver in response to growth hormone [21]. Zinc supplementation is effective in helping pregnant women with low nutritional status [22]. The relationship between zinc, GH, and animal growth proves that zinc can be directly involved in the synthesis and action of GH. Zinc is a micronutrient that affects iron metabolism [23]. Zinc can interact with iron directly or indirectly [24]. The role of zinc and its synthesis as proteins, including iron transport proteins, namely transferrin, is an indirect interaction [23]. The role of zinc, which works in almost all body metabolism, is in the formation of red blood cells by helping the essential carbonic anhydrase enzyme to maintain acid–base balance. Furthermore, zinc enables the enzyme carbonic anhydrase in stimulating the production of gastric hydrochloric acid, which can increase hemoglobin levels. The results of a similar study found that pregnant women who were given zinc and iron tablets had a higher average difference in hemoglobin levels (1.07 g/dl) compared to pregnant women who received iron tablets alone (0.81 g/dl) [26]. Similarly, another study found a significant relationship between zinc consumption and hemoglobin levels [27]. Taslim *et al*. [28] get an increase in hemoglobin (Hb) levels of mothers who are chronically deficient in energy after being given additional food and iron. However, the holistic impact of iron and zinc over various life stages (pregnancy, lactation, and early childhood) is needed to understand the potential role of interventions administered throughout the first 1000 days of life. Another study discovered that mothers with high serum zinc levels also had high IGF-1 levels, and it was concluded that IGF-1 levels were related to birth weight and weight of the babies [29]. Placental anthropometry, on the other hand, is related to birth weight and baby weight because it describes the mother's ability to supply nutrients and oxygen to the fetus [30]. IGF-1 Maternal factors can affect fetal growth through the action of stimulating the activity of nutrient transporters in the placenta [31]. The placenta plays a very important role in the growth and development of the fetus so that disturbances in placental function can cause overgrowth or IUGR [19]. Maternal hormones such as insulin, IGF-1, and mTOR signaling in the trophoblast are the main regulators of amino acid transport in the placenta, where amino acids are needed by the fetus for the process of forming tissues and organs [17].

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