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Submission date: 22-Dec-2021 03:20PM (UTC+0900)
Submission ID: 1734915490
File name: Pakistan_Jurnal.pdf (615.55K)
Word count: 4013
Character count: 21679

PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

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OPEN ACCESS

Pakistan Journal of Nutrition

ISSN 1680-5194
DOI: 10.3923/pjn.2019.159.164

Research Article

Effect of Supplemental Feeding on the Nutritional Status of Pregnant Women Treated at the Mandala Community Health Centre (*Puskesmas*) of Medan

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Abstract

Background and Objective: Malnourished pregnant women often have low energy and anemia and are at increased risk for spontaneous abortion or stillbirth. Moreover, offspring of malnourished women are more likely to have low birth weight and stunting due to nutritional insufficiency. Supplemental feeding can reduce the risk of maternal malnutrition. The aim of this study was to determine the effectiveness of a supplemental feeding regimen for pregnant women in Indonesia. **Materials and Methods:** A total of 43 pregnant women between 20 and 35 years-old treated at the Mandala Community Health Centre of Medan, North Sumatra, Indonesia, were enrolled in this cohort study. Patient characteristics were assessed, including gestational age and parity. Study subjects were given a supplemental feeding regimen that included cookies made with high protein tempe flour and juice made from papaya and passion fruit. Differences in anthropomorphic measurements, including body weight and upper arm circumference, as well as hemoglobin and albumin blood levels, were measured pre and post-treatment and the differences were analyzed for statistical significance. **Results:** A statistically significant increase in body weight and upper arm circumference was seen at the end of the supplemental feeding period. Hemoglobin levels were also significantly increased after supplemental feeding, whereas pre and post-treatment albumin levels were similar. **Conclusion:** Supplemental feeding with high protein cookies and vitamin C-rich juice can enhance the nutritional status of pregnant women, as evidenced by increased weight gain and hemoglobin levels. This improved nutritional status can help increase the rate of favorable pregnancy outcomes.

Key words: Supplemental feeding, nutritional status, pregnant woman, malnutrition, anemia, cookies, juices

Received: January 23, 2018 **Accepted:** September 15, 2018 **Published:** January 15, 2019

Citation: Ginta Siahaan, Dini Lestrina and Efendi Nainggolan, 2019. Effect of supplemental feeding on the nutritional status of pregnant women treated at the mandala community health centre (*Puskesmas*) of medan. Pak. J. Nutr., 18: 159-164.

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pregnant women who have inadequate nutritional intake can experience low energy levels, anemia and inadequate weight gain relative to gestational age. Nutritional deficiency during pregnancy can also increase the risk of spontaneous abortion and fetal death in utero, as well as the risk that offspring will have low birth weight, congenital defects and stunting[1,2]. Basic Health Research Results in 2013[3] showed that the national prevalence of stunting in Indonesia was 37.2%, which was an increase over the 35.6 and 36.8% seen in 2010 and 2007, respectively. In North Sumatra, the stunting rate was ≥40% and in the North Sumatra city of Medan the stunting rate was 34.9%[3]. Stunting can be caused by maternal malnutrition occurring before and during pregnancy, in addition to low maternal weight gain (<9 kg) and low hemoglobin (Hb; <11 g dL^{-1}) and albumin levels (<3.2 g dL^{-1})[4]. The nutritional status of pregnant women can be assessed by several anthropometric measurements, including body weight and upper arm circumference[5]. Other physical parameters associated with nutritional status of pregnant women are hemoglobin (Hb) and blood albumin levels[6].

Anemic pregnant women are at risk for impaired fetal growth and fetal brain development[4,7]. Globally, the rate of anemia is around 42%, whereas in Indonesia up to 63% of pregnant women are anemic[8]. In 2013, 11.3% of pregnant women had Hb <11% g dL^{-1} and in North Sumatra and in the city of Medan in particular, the rates were 15.6 and 35%, respectively[3].

The amount of protein that must be maintained through the end of pregnancy is about 925 g, most of which is present in maternal tissue, the placenta and the fetus itself. When the Protein Energy Ratio (PER) is 70%, the required mean protein addition is 8.5 g day^{-1} [9]. Decreased levels of albumin, which is important for controlling bleeding during childbirth and is a measure of nutritional status, are representative of decreased overall protein synthesis and can be associated with low energy[10]. Albumin is synthesized in the liver and can also be obtained from high protein foods[11].

Strategies to prevent maternal malnutrition often involve implementation of nutritional programs that include supplemental feeding regimens for pregnant women. Successful supplemental feeding programs often take local eating habits into account. Tempe is a fermented soy bean product that is commonly consumed in Indonesia. Supplements that contain tempe can increase nutritional value by increasing the amount of dietary protein, iron and vitamins such as vitamin B_{12}. Tempe can be processed into flours used for the production of baked goods such as cookies[12]. A previous study showed that daily consumption of 50 g of tempe flour biscuits for 4 weeks could increase the weight of children under five by 0.4 kg and their height by 1.6 cm[13]. Cookies made with tempe flour are also a suitable snack food for pregnant women who experience morning sickness early in pregnancy. The protein contained in tempe flour cookies can accelerate fetal growth in utero and also promote the formation of Hb.

In addition to protein, pregnant women should also take daily supplements containing at least 10 mg vitamin C, which is decreased during pregnancy due to increased blood volume[14].

Vitamin C can be obtained from direct consumption of fruits or from fruit juices. Juices combining papaya and passion fruit juice provide adequate amounts of vitamin C and are readily available and affordable. Papaya is high in fiber, which can reduce constipation that is frequent in pregnant women[15].

Furthermore, papaya fruit contains papain that can accelerate protein digestion and facilitate function of iron transport proteins. The addition of passion fruit juice to papaya juice can stimulate appetite while offsetting the odor of papaya that can induce nausea and vomiting in some pregnant women[16].

This study was conducted to examine whether supplemental feeding regimens that include tempe flour cookies and juices made from passion fruit and papaya can improve the nutritional status of pregnant women being treated at the Mandala Medan Community Health Center.

MATERIALS AND METHODS

Study subjects: This study used a pre-test and post-test design to examine differences in nutritional status and physiological factors (body weight, Hb and blood albumin levels) before and after treatment of pregnant women at the Mandala Medan community Health Center administered by the Social Insurance Administrator (BPJS) class III. Subjects having a maternal age between 20 and 35 years and gestational age of 1-7 months were enrolled following screening for exclusion criteria: (1) unwillingness to be included in the study, (2) unwillingness to provide informed written consent, (3) illness as diagnosed by a physician or midwife, (4) pregnancy-related complications, (5) inability to communicate or (5) regular use of iron supplements. Based on these criteria, 43 pregnant women were enrolled. The Medical Research Ethics Commission approved this study (FK USU No.433/ TGL/KEPK FK USU-RSUP HAM/2016).

Supplemental feeding: Supplemental feeding regimens included tempe flour biscuits and a combination of juice including juice from papaya and passion fruit. Tempe flour biscuits weighing 10 g each were made using tempe powder and other flour. The juice was made by boiling 100 g each of passion fruit and papaya with 250 mL water.

For 21 consecutive days the study subjects consumed 3 tempe flour biscuits in the morning and afternoon for a total of 6 biscuits daily. They also consumed 250 mL juice.

The nutritional value contributed in total by the biscuits was 394.2 calories, 8.3 g protein, 25.4 g fat, 49.1 g carbohydrate. The nutritional value added by the juice was 176.3 calories, 2.8 g protein, 2 g fat, 38.2 g carbohydrate, 140 mg vitamin C.

Data collection: Primary and secondary data were collected either directly or from data records maintained at the treating health center. Researchers were assisted by 10 enumerators who were students majoring in Nutrition of Medan Health Polytechnic University.

Data processing: Data for nutrient intake consisted of food recall for 3 days both before and after treatment in addition to interviews used to determine the average nutrient intake (Energy, Protein, Fat, Carbohydrate and Fe). Data were processed using the Nutrisurvey program. Anthropometry measurements including weight, height and upper arm circumference were taken before and after treatment. Biochemical data from collected blood samples included hemoglobin and albumin levels expressed as g dL^{-1}, which were measured using spectrophotometry methods.

Data analysis: Univariate analyses of independent variables and dependent variables were used to describe each variable including maternal age, pregnancy parity, gestational age, nutrient intake, weight, upper arm circumference and albumin levels. The results are presented in a frequency distribution table and analyzed as percentages. Bivariate analyses using paired t tests were performed to compare body weight, LILA, albumin levels and hemoglobin levels in pregnant women before and after treatment.

RESULTS

Study population characteristics and pre-treatment nutritional intake: The majority of the study population was between 26 and 35 years-old (n = 23, 53.4%, Table 1). Around 1/3 of the study subjects were in the second trimester (n = 17, 39.5%) of their second pregnancy (n = 14, 32.6%). On average, the women consumed 2,100 kcal (Table 2).

Supplemental feeding program: Pregnant women enrolled in the supplemental feeding program consumed six 10 g tempe flour cookies and 250 mL papaya/passion fruit juice daily for 21 days. On average, the supplemental nutrition regimen provided about 23% of daily caloric intake (Table 3).

Effect of supplemental feeding on nutrition status: Changes in anthropomorphic measurements and blood chemistry values before and after the supplemental nutrition program were assessed (Table 4).

The mean body weight increased by ~1 kg at the end of the supplemental feeding period and the differences between the pre and post-treatment weights were significant (Table 4). The post-treatment measurement showed a significant increase in upper arm circumference compared to the pre-treatment measurement (Table 4). For blood chemistry, post-treatment hemoglobin levels were significantly increased relative to pre-treatment levels, whereas pre and post-treatment albumin levels were similar

Table 1: Study population characteristics

		Frequency	
Characteristics	Category	No.	Percentage
Age (years-old)	17-25	15	35.0
	26-35	23	53.4
	>35	5	11.6
Parity	1	10	23.3
	2	14	32.6
	3	8	18.6
	4	7	16.3
	5	2	4.7
	6	2	4.7
Gestational age	First trimester	11	25.6
	Second trimester	17	39.5
	Third trimester	15	34.9

Table 2: Average pre-treatment nutritional intake of study subjects

Intake	No.	Minimum	Maximum	Mean	Standard deviation
Energy (kcal)	43	1520.1	2535.4	2099.1	300.3
Protein (gr)	43	45.4	86.9	61.7	10.0
Fat (gr)	43	45.4	112.0	71.1	12.0
Carbohydrate (gr)	43	243.3	552.6	306.7	52.0
Fe (mg)	43	14.1	34.9	25.1	6.4
Vitamin C	43	66.6	88.9	78.8	6.4

Table 3: Average contribution of supplemental feeding to daily intake

Intake	Contribution (%)	Total
Energy	22.80	570.50 kcal
Carbohydrate	24.20	87.30 g
Protein	14.61	11.10 g
Fat	35.10	274.00 g
Fe	18.20	7.84 mg
Vitamin C	56.40	87.80 mg

(Table 4). Taken together, these results indicate that supplemental feeding can improve the nutritional status of pregnant women.

DISCUSSION

Pregnancy places significant physiological and metabolic demands on a woman's body. Thus, additional nutrients are required to support fetal and placental growth and maturation and also to respond to changes in hormonal balance and enzymatic functions. Insufficient nutrition during pregnancy can result in adverse physiological responses, including anorexia, anemia, emesis and other health complications[17].

In this study, the majority of study subjects were between 25 and 36 years-old. This maternal age range is associated with better outcomes than those seen for older or younger women for whom the reproductive organs may not have fully matured[18].

A subset of women in this study had been pregnant three or more times. Parity can affect pregnancy outcomes and women who have given birth multiple times are at higher risk for postpartum hemorrhage. Moreover, a study performed at Bukit Tinggi Regional Hospital indicated that the risk of low birth weight increases by as much as 4-fold as parity increases[19].

Most women in this study were in their second and third trimester (39.5 and 34.9%, respectively). At these later stages of pregnancy, energy demands increase to support expansion of uterine tissue and increases in blood volume as well as breast and fatty tissue growth. Additional energy is also needed during the third trimester to promote fetal and placental growth[18].

Average nutritional intake: Based on the 2013 Basic Health Research Results in Indonesia, the average nutritional requirement for pregnant women is 2,500 kcal, 76 g protein, 78 g fat, 356 g carbohydrate and 35 mg iron.

According to a study by Adrian and Ezy[19], additional food during pregnancy, especially during the third trimester, is critical for increasing the likelihood of favorable pregnancy outcomes[19]. In this study, the supplemental feeding regimen for pregnant women provided additional energy (570.5 kcal), protein (11.1 g), fat (274 g), carbohydrate (87.3 g) and iron (7.8).

The majority of study subjects had good levels of nutritional intake in terms of energy, protein, fat, carbohydrate and iron, wherein 65.1, 54.4, 67.4, 74.4 and 41.9%, respectively, were in the "good" category.

Mileiva *et al.*[20] previously found that supplementary feeding with garut cookies that included tapioca flour can supplement nutrient intake by pregnant women. This result was reinforced by results reported by Nugrahini *et al.*[21] showing increased energy and protein intake after completion of a supplemental feeding program for pregnant women who were treated for chronically low energy at a community health care clinic in Surabaya[21]. Similarly, Pratiwi[22]. found similar effects for a supplemental feeding program that provided an additional 600-700 kcal and 15-20 g protein daily for pregnant women experiencing chronically low energy[22].

Effect of supplemental feeding on nutritional status factors and weight gain: The supplemental foods in this study included cookies produced with tempe flour that has a high protein content and fruit juice combining passion fruit and papaya that provides adequate amounts of vitamin C. Both items have favorable taste and nutritional content, thus increasing the rate of consumption and nutritional benefit, respectively. Enhanced nutritional status can in turn translate into a higher likelihood of a healthy birth. Moreover, supplementary feeding of foods that have an appealing taste can stimulate appetite and reduce rates of indigestion.

Most carbohydrates in circulating blood are available as glucose that can serve as an immediate energy source. Excess carbohydrates can be stored in the liver and muscles as glycogen, which can be converted to fat for stored energy in fatty tissue. Thus, excessive carbohydrate intake should be avoided in pregnancy to reduce the risk of excess weight gain. This result is consistent with a previous study by Masrizal[23] who demonstrated that adequate carbohydrate consumption is associated with healthy weight gain during pregnancy[23].

One limitation of this study is the difficulty in predicting changes in nutritional status based on body weight because the pre-pregnancy body weights were not known.

Upper arm circumference: The upper arm circumference showed on average a significant increase after supplemental feeding, with 88.4% (n = 38) of women exhibiting an increase. This result indicates that the supplemental feeding could enhance the nutritional status of the study subjects.

Table 4: Anthropomorphic characteristics and blood chemistry before and after supplemental nutrition program

Indicators	No.	Minimum	Maximum	Mean	Standard deviation	p-value
Initial weight (kg)	43	39.40	83.7	60.50	9.380	0.001
Final weight (kg)	43	39.60	82.6	61.50	9.410	
Initial upper arm circumference (cm)	43	20.50	34.2	26.30	3.220	0.001
Final upper arm circumference (cm)	43	21.00	34.6	26.70	3.160	
Initial Hb level	43	7.40	13.4	10.90	1.500	0.010
Final Hb level	43	7.90	13.6	11.10	1.470	
Initial albumin level	43	3.08	4.7	3.76	0.477	0.342
Final albumin level	43	2.80	4.9	3.79	0.523	

Hemoglobin levels: Hemoglobin levels can be used to determine anemia status, which can be affected by physiological changes that occur during pregnancy, fetal age and nutritional status[24]. Based on hemoglobin levels, 23.3% (10/43) of study subjects were anemic prior to the supplemental feeding (Table 4). After treatment, a significant decrease ($p<0.05$) in the anemia rate was seen, with only 11.6% (5/43) of study subjects exhibiting anemia. This increase could be due to enhanced iron absorption due to the protein provided by the tempe flour cookies that are high in vitamin B_9, which can be converted to vitamin B_{12} to support production of Hb-forming elements during red blood cell maturation[17].

Albumin levels: Levels of albumin, which is synthesized in the liver and represents 60% of total plasma protein, are a marker of blood protein status. Albumin is important for transport of nutrients across the placenta[11]. In this study, we saw no effects of supplemental feeding on albumin levels. This result may be due to the fact that protein intake by the study subjects remained below the recommended daily amount of 77 g, despite the additional protein available provided by the tempe flour cookies[25]. Moreover, the half-life for albumin formation is longer than the 21 day period used for this study. During pregnancy, protein intake should be increased to promote fetal growth and facilitate nutrient transport[1]. However, Ogawa *et al.*[11] suggested that serum albumin of pregnant women should be monitored due to its role in blood clotting needed during childbirth. Albumin levels are also strongly associated with preeclampsia, especially in the third trimester when blood albumin concentrations are often low[26]. As such, pregnant women should be monitored to ensure the maintenance of optimal albumin levels that will be needed to avoid complications at delivery.

CONCLUSION

The supplemental feeding regimen described here could be implemented for pregnant women living in the region served by Mandala Community Health Care.

The supplemental feeding regimen can also be used for children under five who are malnourished and fertile women who are planning to become pregnant. Supplemental feeding could include other food items that incorporate high protein tempe flour.

RECOMMENDATION

Training programs for Posyandu clinic staff and young mothers should be developed to provide instruction on how to prepare nutritious, high protein foods.

SIGNIFICANCE STATEMENT

This study shows that supplemental feeding of pregnant women in North Sumatra, Indonesia enhanced nutritional status manifested as increased body weight and upper arm circumference as well as increased hemoglobin levels. Supplemental feeding can promote optimal metabolism needed to sustain fetal and placental growth and in turn reduce the risk of low birth weight. This study provides evidence that supplemental feeding could be a successful strategy to provide nutritional support for pregnant women, particularly for low-income women who may lack access to adequate nutrition.

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