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Correlation between Dha (Docosahexaenoic Acid) Supplementations and Sod (Superoxide Dismutase) On Underweight Pregnant

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ABSTRACT

Background: In 2018, Basic Health Research (RISKESDAS) reported that East Java was one of the provinces in Indonesia with a prevalence of chronic energy deficiency (CED) in women of childbearing age above the national prevalence (19.6%). Chronic Energy Deficiency (CED) is a nutritional problem that can occur in pregnant women due to inadequate energy and protein intake and needs. Chronic Energy Deficiency (CED) is characterized by a pregnant woman's Mid Upper Arm Circumference (MUAC), which is less than 23.5 cm. Nutritional problems and weight loss in pregnant women can cause a decrease in body resistance, and pregnant women become increasingly susceptible to oxidative stress. This research focuses on examining the correlation between the antioxidant SOD and the administration of DHA to underweight pregnant women.

Methods: The research was conducted using an experimental pre and post-test with 21 samples of underweight pregnant women at Made Community Health Center, Surabaya.

Results: Body weight (P < 0,001); Height (P = 0, 88); BMI (P = 0,003); MUAC (P = 0,003); Systolic BP (P = 0,111); Diastolic BP (P = 0,887); Fundal Height (P = 0,001); SOD (P = 0,013).

Conclusions: In this study, a correlation was found between the supplementation of DHA and the weight, BMI, MUAC, fundal height, and SOD levels in underweight pregnant women.

Key Words: *Correlation, DHA, Underweight, SOD*

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INTRODUCTION

Pregnancy is a period calculated from the initiation of the conception/fertilization/fertilization process until the fetus is born. The average duration of pregnancy is calculated from the first day of the last menstrual period (LMP) to 280 days after that, equivalent to 40 weeks, or nine months and seven days. Pregnancy is divided into three trimesters, each consisting of 13 weeks or three months. During pregnancy, physiological changes and adaptations aid the fetus's development and growth in the mother's womb. With the development of the placenta, hormones such as somatomammotropin, estrogen, and progesterone are produced, leading to changes in the uterus, ovaries, cervix, vagina, breasts, respiratory system, digestive tract, integumentary system, urinary system, endocrine glands, cardiovascular system, and musculoskeletal system.

According to the Basic Health Research (Riskesdas) data in 2018, the prevalence of Chronic Energy Deficiency (CED) risk in pregnant women aged 15-49 in Indonesia is 17.3% [1]. Based on data from the East Java Health Office, in 2020, there were 618,207 pregnant women in East Java, and 53,455 of them experienced Chronic Energy Deficiency (CED). Chronic Energy Deficiency (CED) is a nutritional problem in pregnant women due to an imbalance between energy and protein intake and requirements. Chronic Energy Deficiency (CED) is indicated by the Mid Upper Arm Circumference (MUAC) of pregnant women being less than 23.5 cm. Nutritional problems and a decrease in weight during pregnancy can lead to a decrease in immune function, making pregnant women more susceptible to oxidative stress.

Oxidative stress is a condition where there is an imbalance between the generation of reactive oxygen species (ROS) or reactive nitrogen species (RNS) and the cellular antioxidant capacity. Free radicals play a crucial role in oxidative stress. Antioxidants comprise compounds that inhibit substrate oxidation and prevent damage caused by free radicals. Examples of antioxidant enzymes include Superoxide Dismutase (SOD), Catalase, and Glutathione Peroxidase (Gpx), while examples of non-enzymatic antioxidants include antioxidant proteins and Metallothionein.

Superoxide Dismutase (SOD) is a group of enzymes that efficiently catalyze the elimination of superoxide anions. The Superoxide Dismutase enzyme is an endogenous antioxidant that regulates Reactive Oxygen Species (ROS) levels. Based on their biochemical and molecular aspects, Superoxide Dismutase is divided into three types: SOD1, SOD2, and SOD3. Various stressors can trigger the production of ROS and enzymatic antioxidants like Superoxide Dismutase. Antioxidants act as preventers of oxidative stress by inhibiting and neutralizing molecular oxidation.

Docosahexaenoic Acid Omega-3 (DHA; 22:6N-3) is essential to cell membranes. Low concentrations of DHA in pregnant women have been assumed to increase the risk of postpartum depression and premature birth. DHA levels in pregnant women increase during embryogenesis to reduce the decline in neurotrophic factors induced by oxidative stress. Pregnant women consuming seafood may risk mercury exposure; therefore, oral supplementation of DHA at doses of 200-300 mg can be an alternative and is recommended for pregnant women.

Oxidative stress leads to endothelial dysfunction, eventually leading to preeclampsia. Some studies suggest that low levels of antioxidant vitamins in pregnant women contribute to preeclampsia [2].

In this study, we will examine the correlation between the antioxidant SOD and the administration of DHA to underweight pregnant women. We hope that this study will reveal the role of DHA in improving underweight pregnancies in terms of oxidative stress.

METHODS

Our research is an experimental cohort study using a quantitative method, examining a specific sample using specific instruments. It aims to determine the administered treatment's effects and validate or test formulated hypotheses. We employed a one-group pretest-posttest approach in this study, examining participants before and after the intervention. The research aims to explore the correlation between behavioral interventions like DHA supplementation in underweight pregnant women and SOD levels as antioxidants within predetermined time frames and designated districts.

We conducted an experimental cohort study using a quantitative method, focusing on examining the impact of a treatment on a specific sample using specific instruments. The primary objective is to test hypotheses and observe the effects of the treatment administered. We conducted assessments before and after the intervention using a one-group pretest-posttest approach. Our research aims to explore the relationship between DHA supplementation in underweight pregnant women and SOD levels as antioxidants within specified time frames and district locations.

RESULTS

Based on the research conducted between June 1st and August 31st, 2023, we gathered a sample of 21 underweight pregnant mothers (N) to conduct pre-and post-tests. The fundamental characteristics of our research sample were analyzed according to the following table. The characteristics of the sample obtained in the study involved 21 underweight pregnant women with an age range from 21 to 36 years (27.62 ± 3.76), gestational age ranging from 6 to 38 weeks (18.81 ± 9.62), weight ranging from 38 to 47 kg (42.57 ± 3.15), height ranging from 144 to 161 cm (152.42 ± 5.40), BMI ranging from 17.3 to 18.8 kg/m^2 (18.29 ± 0.29), systolic blood pressure ranging from 90 to 128 mmHg (104.19 ± 10.33), and diastolic blood pressure ranging from 59 to 80 mmHg (66.71 ± 7.27) (Table 1).

There were significant differences between the initial and final body weight values. The increase in final body weight values indicates that the administration of DHA can significantly increase body weight. However, there was no significant effect on height due to DHA administration. The BMI showed significant differences between initial and final values, indicating an effect of DHA administration on BMI. MUAC also showed significant differences, indicating the impact of DHA administration on MUAC. Although there were no statistical differences in systolic and diastolic blood pressure at the beginning and end, there was a significant increase in the final TFU value, indicating that DHA administration affected this parameter. Additionally, the SOD value also showed significant differences between the initial and final values, suggesting that DHA administration brings about significant changes in the SOD levels of pregnant women (Table 2).

DISCUSSION

Docosahexaenoic Acid Omega-3 (DHA; 22:6N-3) is vital in cell membranes. The presence of low concentrations of DHA in pregnant women is believed to increase the risk of postpartum depression and premature birth. During embryogenesis, DHA levels in pregnant women increase to reduce the decline of neurotrophic factors triggered by oxidative stress. Pregnant women consuming seafood may be at risk of mercury exposure; thus, oral DHA supplementation in 200-300 mg doses could be an alternative and recommended for pregnant women.

Arini and Firdaus [3] researched the effects of DHA and protein intake on fetal weight and length in pregnant women. They argued that maternal nutritional health, both before and during pregnancy, significantly impacts the growth of the fetus in utero [3].

To assess whether pregnant women have good, insufficient, or excessive nutrition, nutritional status assessment is needed by measuring the Body Mass Index (BMI), anthropometric measurements including height and weight, and Mid Upper Arm Circumference (MUAC) as the primary sign of whether pregnant women have good, insufficient, or excessive nutrition [4].

Based on the study results, there were significant changes before and after DHA administration concerning the weight of pregnant women ($p = 0.00$). Similar findings were presented by Santana et al. [5], indicating that the supplementation of 600mg of omega-3 daily in the late second trimester resulted in significant weight gain in pregnant women ($p < 0.001$) [5]. Another study by Chandradewi [6] indicated that providing additional food in the form of biscuits made from soy flour, cornstarch, sugar, skim milk, eggs, and margarine to pregnant women experiencing chronic energy deficiency resulted in a significant weight gain ($p < 0.05$) [6]. Research conducted by Silawati and Nurpadilah [7] involving supplementary food and milk for pregnant women with chronic energy deficiency (CED) at the Curug Public Health Center, Tangerang Regency in 2019 showed a significant weight gain ($p = 0.00$) [7].

The Body Mass Index (BMI) is an index measuring a person's body proportion to their height, calculated by dividing weight (kilograms) by height squared (meters). An increase in weight correlates with an increase in BMI [8]. The study results showed significant changes concerning pregnant women's BMI before and after DHA administration ($p = 0.00$). Research by Damayanti et al. (2022) involving supplementary food in the form of biscuits for pregnant women with chronic energy deficiency (CED) at the Sei Suka Public Health Center in 2021 showed that biscuit supplementation significantly increased the Body Mass Index (BMI) of pregnant women ($p = 0.001$). Siahaan's study (2023), involving nutritional supplementation for pregnant women with chronic energy deficiency, showed a significant weight gain between the pre-test and post-test ($p = 0.001$). Therefore, it can be concluded that this significant weight gain also contributed to a significant increase in the Body Mass Index (BMI). However, the research conducted by Siti [9] showed contrary findings, where weight gain in pregnant women in gold mining areas did not show a significant relationship with energy intake ($p = 0.963$), carbohydrates ($p = 0.518$), protein ($p = 0.655$), and fat ($p = 0.515$) [9].

Based on the study results, there were significant changes before and after DHA administration concerning pregnant women's MUAC ($p = 0.003$). Diana and Bahagia [10] provided supplementary food for 90 days to 58 pregnant women with chronic energy deficiency in the Gunuh Meriah Public Health Center. This intervention effectively increased Mid Upper Arm Circumference (MUAC) in pregnant women with CED with a value of $p = 0.00$ [10]. Another study by Ayu et al. [11] investigated the effectiveness of Supplementary Food Provision (PMT) biscuits in increasing Mid Upper Arm Circumference (MUAC) in pregnant women. The study, conducted in Rengas Dengklok Public Health Center, Karawang Regency, in 2021, revealed a significant increase in MUAC in pregnant women receiving 56 biscuits compared to those receiving 28 biscuits, with a value of $p = 0.00$ [11]. In a study conducted by Asmirati et al. [12] at the Salassae Public Health Center, supplementary biscuits made from fish were provided to pregnant women with chronic energy deficiency. The results showed a significant increase in MUAC, with a value of $p < 0.00$ [12].

Based on the research results, no significant changes were observed before and after the administration of DHA regarding systolic blood pressure ($p = 0.111$) and diastolic blood pressure ($p = 0.887$). The International Society for the Study of Hypertension in Pregnancy (ISSHP), internationally approved, defines preeclampsia as a systolic blood pressure increase to 140mmHg and diastolic blood pressure to 90 mmHg in at least two measurements with a 4-hour interval in previously normotensive pregnant women. This condition must also be accompanied by one of the symptoms, proteinuria or other maternal organ dysfunction, occurring at least at 20 weeks of gestation [13]. Another study conducted by Jones et al., providing DHA supplementation to pregnant rats, showed a significant decrease in placental oxidative stress levels after the administration of DHA. High placental oxidative stress is a significant factor in the pathophysiology of preeclampsia [14]. In a paired case-control study in China in 2021 involving 440 average and preeclamptic pregnant women, it was found that the intake of arachidonic acid (AA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) was inversely related to the risk of developing preeclampsia. These results indicated that low LCPUFA intake during pregnancy could increase the risk of preeclampsia. Based on a meta-analysis conducted by Bakouei et al. [15], analyzing 14 controlled randomized trials (RCTs), it was found that omega-3 supplementation had a protective effect against the occurrence of preeclampsia ($p = 0.024$) [15]. Another meta-analysis study conducted by Abdelrahman et al. [16], involving 21,919 pregnant women who received omega-3 supplementation during pregnancy, showed that the supplementation had a positive impact in preventing preeclampsia, increasing fetal weight, and reducing the risk of premature delivery [16].

Based on the research results, significant changes were observed before and after the administration of DHA regarding the Fundal Height of pregnant women ($p = 0.001$). Similar findings were recorded in a study by Siahaan and Henderi [17], where a significant difference was found between the Fundal Height (TFU) of average pregnant women and pregnant women with chronic energy deficiency (CED) ($p < 0.00001$). However, after intervention in pregnant women with CED through micronutrient supplementation in Surabaya in 2019, there was no significant difference in TFU between CED pregnant women given DHA and average pregnant women ($p=0.101$) [17]. In a study by Setyowati et al. [18], additional high-calorie and protein food supplements and blood supplement tablets containing calcium and folic acid were given to pregnant women with CED. Before the intervention, the average TFU value in pregnant women with CED was 19.51 cm; after the intervention, it increased to 33.57 cm. This result indicates a significant increase in Fundal Height with an average value of 14.06 cm [18]. Measurement of Fundal Height (TFU) is one of the routine activities in antenatal care to estimate Fetal Weight. In a study conducted by Alifka et al. [19], a significant relationship was found between the nutritional knowledge level of pregnant women and the estimated Fetal Weight ($p = 0.003$) [19].

Based on the research findings, there were significant changes observed before and after the administration of DHA in the SOD levels of pregnant women ($p = 0.013$). The findings from this data are supported by the research conducted by Jones et al., providing DHA supplements to pregnant rats. The results indicated a significant decrease in placental oxidative stress levels after DHA administration ($p < 0.001$) [14]. Omega-3 fatty acid (n-3 FA) supplementation can reduce oxidative stress, as revealed in a study conducted by Sley et al. [20]. This research explored the correlation between n-3 FA supplementation during pregnancy and the concentration of 8-iso-prostaglandin F2α (as an oxidative stress biomarker) in urine. The results showed that using n-3 FA supplements in 165 third-trimester pregnant women in the United States resulted in a 10.2% decrease in 8-iso-prostaglandin F2α levels [20]. Another study conducted by Tatsumi et al. [21] concluded that DHA could reduce cytotoxicity induced by oxidative stress in IFRS 1 cells ($p < 0.01$) [21].

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DECLARATIONS

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Conflict of interest: No conflicts of interest could influence the results or interpretation of this research.

Ethical approval: This research has obtained a permit from the National Unity and Politics Agency (Badan Kesatuan Bangsa dan Politik) with approval number 070/7145/209/2023. All procedures involving research subjects were conducted following the guidelines specified in the ethical clearance from the Health Research Ethics Committee of the Faculty of Medicine Ciputra University (Komisi Etik Penelitian Kesehatan Fakultas Kedokteran Universitas Ciputra), approval number 044/EC/KEPK-FKUC/VII/2023. All participants provided written consent before participating in this study.

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Table 1: Characteristics of research sample

No.	Category	Mean ± SD
1.	Age	27.62 ± 3.76
2.	Gestational Age	18.81 ± 9.62
3.	Weight	42.57 ± 3.15
4.	Height	152.42 ± 5.40
5.	BMI	18.29 ± 0.29
6.	Systolic BP	104.19 ± 10.33
7.	Diastolic BP	66.71 ± 7.27

Table 2: Research results of several factors in underweight pregnant women

No.	Description	Before	After	P Value
1	Weight	42.57 ± 3.15	44.59 ± 3.30	P 0.00
2	Height	152.42 ± 5.40	152.36 ± 5.05	P 0.88
3	BMI	18.29 ± 0.29	19.23 ± 0.88	P 0.003
4	MUAC	24.42 ± 1.60	25.4 ± 2.26	P 0.003
5	Systolic BP	104.19 ± 10.33	107.29 ± 13.642	P 0.111
6	Diastolic BP	66.71 ± 7.27	67.38 ± 11.42	P 0.887
7	Fundal Height	16.14 ± 7.77	18.62 ± 7.57	P 0.001
8	SOD	15.57 ± 2.29	17.51 ± 2.79	P 0.013