Jurnal Aisyah: Jurnal Ilmu Kesehatan

Volume 10, Issue 1, 03 2025, p. 297-312
ISSN 2502-4825 (print), ISSN 2502-9495 (online)

Diet Quality During Pregnancy Is Associated With Stunting Babies

Authors:

***Antun Rahmadi*[1], *Arie Nugroho* [2], *Bertalina* [3], *Abdullah* [4]**
[1,2,3]*Poltekkes Kemenkes Tanjungkarang; Bandar Lampung*
[4]*Universitas Aisyah Pringsewu; Pringsewu*
*Corresponding Email: *antunrahmadi@poltekkes-tjk.ac.id*

About the Author

1. 1st Author : Antun Rahmadi, SKM.MPH
   Affiliation : Poltekkes Kemenkes Tanjungkarang
   Mailing address : Jl. Raya Natar No.100 Hajimena, Kecamatan Natar Kabupaten Lampung Selatan – Indonesia 35142
   Email of author : antunrahmadi@poltekkes-tjk.ac.id
   Orcid ID : https://orcid.org/0000-0002-9491-8167
   Google Scholar URL : cKFdy9gAAAAJ
   Phone number : +6209655120555

2. 2nd Author : Arie Nugroho, S.Gz, M.Gizi
   Affiliation : Poltekkes Kemenkes Tanjungkarang
   Mailing address : Jl. Raya Natar No.100 Hajimena, Kecamatan Natar Kabupaten Lampung Selatan – Indonesia 35142
   Email of author : arienugroho@poltekkes-tjk.ac.id
   Orcid ID : https://orcid.org/0000-0001-9178-7985
   Google Scholar URL : ahNVYCcAAAAJ
   Phone number : +6282377822282

3. 3rd Author : Bertalina, SKM,M.Kes
   Affiliation : Poltekkes Kemenkes Tanjungkarang
   Mailing address : Jl. Raya Natar No.100 Hajimena, Kecamatan Natar Kabupaten Lampung Selatan – Indonesia 35142
   Email of author : bertalina@poltekkes-tjk.ac.id
   Orcid ID : https://orcid.org/0000-0001-6854-4918
   Google Scholar URL : zC3XLr0AAAAJ
   Phone number : +6285664646206

4. 4th Author : Dr.Abdullah, SKM.MPH
   Affiliation : Universitas Aisyah Pringsewu
   Mailing address : Jl. A. Yani 1A Tambahrejo, Kecamatan Gadingrejo Kabupaten Pringsewu, Lampung – Indonesia 35372
   Email of author : abdullah@aisyahuniversity.ac.id
   Orcid ID : https://orcid.org/0000-0002-9491-8167
   Google Scholar URL : cKFdy9gAAAAJ
   Phone number : +6281278981555

ABSTRACT

This study aims to determine the differences in diet quality during pregnancy between mothers who gave birth to stunted babies and mothers who gave birth to normal babies, using The Alternate Healthy Eating Index for Pregnancy (AHEI-P) to evaluate diet quality. A total of 33 mothers who gave birth to stunted babies (case group) and 38 mothers who gave birth to normal babies (control group) were involved in this study. The results showed that the diet quality of mothers in the control group (score 78.4 ± 7.4) was good, while in the case group (score 74.2 ± 4.3), it still needed improvement. Statistical analysis showed a significant difference in diet quality between the case and control groups (p-value = 0.021). These results indicate that lower diet quality in the case group is associated with risk factors that can affect the incidence of stunting. Low diet quality in the case group is indicated by high consumption of trans fats and sweet drinks and low consumption of vegetables, fruits, and iron. On the other hand, the consumption of nuts in both groups still needs to be improved. These findings emphasize the importance of improving maternal diet quality during pregnancy to prevent infant stunting.

Keywords: diet quality, pregnancy, stunting, maternal nutrition, AHEI-P

ABSTRAK

Penelitian ini bertujuan untuk mengetahui perbedaan kualitas diet selama kehamilan antara ibu yang melahirkan bayi stunting dan ibu yang melahirkan bayi normal, dengan menggunakan The Alternate Healthy Eating Index for Pregnancy (AHEI-P) sebagai alat evaluasi kualitas diet. Sebanyak 33 ibu yang melahirkan bayi stunting (kelompok kasus) dan 38 ibu yang melahirkan bayi normal (kelompok kontrol) dilibatkan dalam penelitian ini. Hasil penelitian menunjukkan bahwa kualitas diet ibu di kelompok kontrol (skor 78,4 ± 7,4) termasuk baik, sementara di kelompok kasus (skor 74,2 ± 4,3) masih memerlukan perbaikan. Analisis statistik menunjukkan adanya perbedaan signifikan dalam kualitas diet antara kelompok kasus dan kelompok kontrol (p-value = 0,021). Hasil ini menunjukkan bahwa kualitas diet yang lebih rendah pada kelompok kasus berhubungan dengan faktor risiko yang dapat mempengaruhi kejadian stunting. Kualitas diet yang rendah pada kelompok kasus diindikasikan oleh konsumsi transfat dan minuman manis yang tinggi, serta rendahnya konsumsi sayur, buah, dan zat besi. Di sisi lain, konsumsi kacang-kacangan pada kedua kelompok masih perlu ditingkatkan. Temuan ini menegaskan pentingnya memperbaiki kualitas diet ibu selama kehamilan untuk mencegah kejadian stunting pada bayi.

Kata kunci: kualitas diet, kehamilan, stunting, gizi ibu, AHEI-P

INTRODUCTION

Stunting is a public health problem often found in developing countries, including Indonesia. Stunting can have long-term impacts on children's physical growth and cognitive development, which can affect their quality of life in the future. Based on data from the 2023 Indonesian Health Survey (SKI), the prevalence of stunting in Indonesia is still high, reaching around 21.5% (Kemenkes, 2023). Babies with stunting have a low body length compared to babies of the same age, which is generally caused by malnutrition that lasts for a long time, both during pregnancy and in the early period of life. One of the factors that contribute to the incidence of stunting is maternal nutritional intake during pregnancy and breastfeeding. The quality of the mother's diet significantly affects the health and growth of the fetus, as well as the baby's development after birth (McLaren, 2022).

Conversely, mothers who provide good nutritional intake during pregnancy tend to give birth to babies with optimal growth. Nutrition during pregnancy is essential in supporting fetal development and maternal health (Jouanne et al., 2021). A healthy diet can help prevent various pregnancy complications, such as hypertension and premature birth, and ensure that the fetus develops optimally. Therefore, the quality of the mother's diet, which includes the consumption of various types of nutritious foods, is important to study to determine the difference between mothers who give birth to stunted babies and mothers who give birth to babies with normal nutritional status.

Dietary patterns can be evaluated using The Alternate Healthy Eating Index for Pregnancy (AHEI-P) (Chiuve et al., 2012). AHEI-P is a dietary quality index based on a 120-point scale for optimal intake of seven food groups (vegetables, fruits, whole grains, sweetened beverages, nuts/legumes, red/processed meat, fish) and five nutrient-based categories (trans fats, PUFAs, calcium, folate, iron). This index was developed to evaluate healthier diets during pregnancy. By considering various important nutritional components, AHEI-P can provide more complete insights into how diet affects maternal and fetal health and birth outcomes. Although many studies (Al Rahmad, 2023; Keats et al., 2021; Sari et al., 2024) have focused on the influence of specific nutrients during pregnancy (such as folate, iron, or calcium), a more holistic approach to overall diet during pregnancy on birth outcomes is still limited. More in-depth research on overall diet patterns will provide a more complete picture of how the interaction of various nutrients in the diet can affect maternal and fetal health and birth outcomes (Abdollahi et al., 2021; Gete et al., 2020). This study aims to determine the differences in diet quality during pregnancy between mothers who give birth to stunted babies and mothers who give birth to normal babies. By knowing the factors that influence the quality of the mother's diet, it is hoped that more appropriate interventions can be found to reduce the prevalence of stunting in Indonesia and improve the nutritional status of mothers and children. In addition, this study also aims to provide a clearer picture of maternal food consumption patterns that can contribute to the incidence of stunting in babies.

METHOD

Participant characteristics and research design

The study design was case-control. The research occurred in Puskesmas Trimulyo, District Pesawaran, Provinsi Lampung, from July to October 2024. Ethical approval was obtained from the Ethics Committee of Poltekkes Tanjungkarang, number 413 / KEPK-TJK / V / 2024, valid until May 16, 2025. The subjects were mothers who had children aged 0-2 years. The case group (33 subjects) were mothers who gave birth to stunted babies, while the control group (38 subjects) were mothers with normal births. Other criteria for the subjects were having a KIA book and being willing to participate in the research process voluntarily.

Sampling procedures

The sampling procedure includes selecting cases, namely mothers who gave birth to stunted babies, and selecting controls, namely mothers who gave birth to normal babies. The case group was selected from public health centers where babies with stunting had been identified and recorded. The control group was selected from the same public health center but mothers who gave birth to babies with normal conditions (not stunted). To minimize bias, matching subjects in the control group with mothers in the case group was conducted based on several relevant factors, such as age, education, occupation, and socioeconomic status. The sample ratio between cases and controls was 33 to 38 subjects or 1:1.2.

Sample size, power, and precision

The number of mothers involved in this study was 33 in the case group and 38 in the control group, per the initial planning. This sample size was determined based on considerations of subject availability at the Trimulyo Health Center. Since this study is a retrospective case-control study, we used a total sampling approach, namely including all mothers who gave birth to stunted babies recorded at the Trimulyo Health Center in 2023-2024 and selecting mothers who gave birth to normal babies as controls with a ratio of 1:1.2. The sample size was not calculated using formal power analysis because this study focused more on observing local conditions with the available samples. The number of samples (33 cases and 38 controls) in this study had sufficient possibility to detect differences between groups, if any. However, this study's statistical power was lower than that of

studies using larger samples. The precision of parameter estimates was ensured by minimizing systematic errors through careful control selection procedures and matching based on relevant characteristics such as age, education, and socio-economic status.

Measures and covariates

Data were obtained through interviews between researchers and subjects using structured questionnaires. Subject characteristic data, namely age, education level, occupation, and income, were obtained through interviews using structured questionnaires. In contrast, height was obtained using a digital height measuring instrument brand "GEA" with an accuracy of 0.1 cm. Eating history data were obtained from the Dietary History questionnaire. Nutritional intake was obtained from the 24-hour Food Recall and Food Record questionnaires. Food consumption data from the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). To improve measurement quality and reduce bias, all data collectors received orientation on data collection procedures and proper instrument use. Training included interview techniques, measuring height accurately, and data collection from medical records. A supervisor checked data collected through structured interviews to ensure accuracy and completeness. If discrepancies or errors were found in the data, re-interviews were conducted to correct them.

Data analysis

Parameter estimates, such as differences in risk factor prevalence between case and control groups, are expected to be accurate for the population involved despite limited sample sizes. Significant differences between groups are assessed using appropriate statistical tests, such as the chi-square or t-test, depending on the data collection type. Subject characteristic data (age and height) were analyzed using a Paired samples t-test. In contrast, education, occupation, and economic data were analyzed using a Chi-squared test to determine whether there were proportion differences between the case and control groups. The dietary history component was analyzed using a Chi-squared test to decide which variables differed significantly. The mean Adequacy Ratio (MAR) was calculated from the average energy and other nutrient adequacy levels. Four nutrients are included in the MAR analysis: energy, protein, fat, and carbohydrates. Food consumption data were processed to determine the quality of the subject's diet based on The Alternate Healthy Eating Index for Pregnancy (AHEI-P), whose components and portions were adjusted to the 2014 Indonesian Dietary Guidelines issued by the Indonesian Ministry of Health. The adjustments are the maximum, minimum, and portion criteria for vegetables, fruits, nuts, omega-3 and sodium components, and whole grain components converted into grains.

RESULTS AND DISCUSSION

Characteristics of subjects

The average age of the study subjects was 30.4 years, with the youngest being 19 and the oldest being 55. The average height of the subjects was 153.4 cm. Most of the subjects' education level was junior high school/high school (71.8%), most were unemployed (85.9%), and most had low income (90.1%). Based on the statistical analysis, no statistically significant differences were found between the case and control groups for age, height, education, occupation, and income. Therefore, the differences between the two groups regarding these demographic characteristics do not affect the study results. Further research can focus on other variables more relevant to the study's primary objective. (table 1).

Table 1
Characteristics of subjects

Variables	Cases (n = 33)	Controls (n = 38)	*p*-value***
Age (year)*	32,7 ± 9,9	29,8 ± 6,8	0,145
Hihgt (cm)*	153,2 ± 5.7	153,7 ± 5,0	0,741
Education (%)**			0,234
SD	27,3	21,1	
SMP	42,4	28,9	
SMA	24,2	47,4	
PT	6,1	2,6	
Employment status (%)**			0,497
Employe	18,2	10,5	
Unemploye	81,8	89,5	
Income (%)**			1,000
≥ UMK	9,1	10,5	
< UMK	90,9	89,5	

** Paired samples t-test.*
*** Chi-squared test*
**** p-value < 0.05 was considered significant.*

Diet Quality

Table 2 shows the components, AHEI-P scores, and total AHEI-P scores of subjects in the two groups. The AHEI-P scores in the case group ranged from 3.1 to 9.2, with an average total score of 74.2. In the control group, the AHEI-P scores ranged from 3.7 to 9.4, with an average total score of 78.4. The total AHEI-P scores were categorized into two, namely <76.2 as needing improvement, and the total score was good if ≥76.2 (Chiuve et al., 2012). Based on these categories, the total AHEI-P score of the control group was good, while the case group still needed improvement.

Table 2
Subjects AHEI-P scores

Components	Cases (n = 33) Mean ± SD (median)	Controls (n = 38) Mean ± SD (median)	*p*-value*
Vegetables (portion)	4,6 ± 1,7 (4,2)	5,7 ± 1,4 (5,6)	0,005
Fruits (portion)	5,3 ± 1,6 (5,5)	5,1 ± 1,6 (5,3)	0,538
Grains (g)	9,2 ± 0,2 (9,2)	9,4 ± 0,4 (9,3)	0,005
Sweetened beverages (portion)	5,2 ± 5,1 (10,0)	3,7 ± 4,9 (0.0)	0,219
Nuts and legumes (portion)	4,4 ± 2,9 (4,3)	4,6 ± 3,1 (5.3)	0,782
RPM (portion)	8,7 ± 0,9 (8,8)	8,7 ± 0,8 (8.7)	0,996
Trans-fat (% energy)	3,1 ± 0,8 (3,1)	3,9 ± 1,7 (3,3)	0,014
Fish (g)	7,9 ± 1,1 (7,7)	8,6 ± 0,9 (8,7)	0,009
PUFA (% energy)	7,1 ± 1,5 (7,1)	6,1 ± 1,6 (6,3)	0,015
Dietary calcium (mg)	7,7 ± 1,7 (7,8)	8,0 ± 2,0 (8,2)	0,464
Dietary iron (mg)	4,6 ± 1,1 (4,5)	5,9 ± 1,8 (5,6)	0,001
Dietary folate intake (mcg)	6,7 ± 1,3 (6,7)	7,7 ± 2,1 (7,4)	0,028
Total AHEI-P score	74,2 ± 4,3 (74,7)	78,4 ± 7,4 (77,9)	0,021

** Paired samples t-test.*

The significant difference in AHEI-P scores between the case and control groups indicates the importance of a healthy and balanced diet during pregnancy. Lower AHEI-P scores in mothers with stunted infants indicate that poor and less nutritious diets may contribute to fetal and infant growth problems. Therefore, improving the quality of pregnant mothers' diets by providing access to healthy foods and proper nutrition education is an important step to prevent stunting and improve maternal and infant health. A high-quality maternal diet during pregnancy may protect against adverse outcomes at birth (Madzorera et al., 2020).

Vegetables and fruit consumption

The average consumption of vegetables and fruits in the study subjects was 2.3 and 2.1 servings per day in the case group and 2.9 and 2.0 servings per day in the control group. This figure still needs to be below the recommended consumption (Kemenkes, 2014) of 5 servings of vegetables and four servings of vegetables per day. Low consumption of vegetables and fruits in subjects can be caused by various factors related to social, economic, and physical or health aspects of the subjects themselves. Most subjects with low economic status prefer cheaper and more filling foods rather than buying expensive fruit. Some subjects need to gain adequate knowledge about the importance of consuming vegetables and fruits for maternal and fetal health. They may not realize that vegetables and fruits are rich in vitamins, minerals, and fiber, which are essential to support a healthy pregnancy (Molina-Recio, 2022). Some subjects experience digestive problems such as bloating or stomach aches after consuming vegetables and fruits, especially those rich in fiber. This can reduce their desire to eat vegetables and fruits.

Figure 1. Average consumption of vegetables, fruits, nuts/legumes, RPM and SSB by subjects (servings/day)

Nuts and legume consumption

The average consumption of nuts and legumes by subjects was also still below the 2014 Ministry of Health recommendation of 3 servings per day. In the case group, consumption only reached 1.2 servings, while in the control group, it was 1.7 servings per day. Nuts and legumes were mostly consumed by subjects in processed form, such as tofu and tempeh, which are the primary sources of vegetable protein. Nuts have the potential to be the primary source of high-quality protein in the human diet because they are cheap and available almost everywhere. On average, nuts have a Protein Digestibility-Corrected Amino-Acid Score (PDCAAS) rating of 0.5-0.7. In comparison, the PDCAAS scores for beef and egg protein are 0.92 and 1.0, respectively (Schaafsma, 2000). Nuts are also a good source of complex carbohydrates, dietary fiber, iron, zinc, and vitamin B. Nuts can be cultivated in a wide range of temperatures and altitudes, indicating that nuts may be very resilient to future climate change. Legumes are limited in some essential sulfur amino acids, although the consumption of cereals can supplement these. Limitations of legume consumption include high alkaloid content, potential aflatoxin contamination, and long cooking times. However, these limitations can be reduced by soaking, boiling, and fermentation (Semba et al., 2021).

Red/Processed Meat (RPM) consumption

Red/Processed Meat (RPM) includes red meat such as beef and lamb and processed meat such as meatballs, corned beef, and sausages, which are animal protein sources for the body. The average consumption of RPM in the subjects of this study was 0.5 servings per day in both the case and control groups. The average consumption of RPM subjects was in the minimum-maximum score interval, namely <1.5 servings per day. RPM can be a good source of protein, essential for fetal growth and the health of pregnant women. Protein also plays a role in repairing body cells and forming muscles and tissues. RPM is the primary source of heme iron, a type of iron that is more easily absorbed by the body than iron from plant sources. Iron is essential for preventing anemia in pregnant women and ensuring that oxygen can be sufficiently distributed to the fetus. In addition to protein and iron, red meat also contains vitamin B12, zinc, and selenium, which support the immune system, the metabolism of pregnant women, and fetal development (WHO, 2023). Although RPM can provide benefits for pregnant women, its consumption must be limited. Pregnant women should prioritize consuming healthy foods that are more natural and nutritionally balanced, such as fresh meat, fish, and vegetable protein sources. Processed RPM tends to contain high levels of saturated fat. Excessive consumption can increase the risk of obesity, gestational diabetes, and hypertension in pregnant women (Thornburg et al., 2022). This condition can be risky for the health of the mother and fetus. Processed RPM as a carcinogen can increase the risk of cancer, especially colon cancer. Consuming large amounts of processed red meat during pregnancy can increase this risk. Processed RPM often contains much salt (sodium), which can increase blood pressure and risk causing preeclampsia, a dangerous condition of high blood pressure during pregnancy. Excess sodium consumption can also cause swelling (edema) and kidney problems in pregnant women. In addition, processed RPM often contains preservatives such as nitrates and nitrites, which can be harmful to health (Petit et al., 2019). Several studies have shown that consuming high amounts of nitrates and nitrites can increase the risk of disorders in fetal development or even congenital disabilities (Vranić et al., 2023). Animal protein generally has advantages over vegetable protein because its amino acids are more complete, and its nutritional quality is better because the body more readily absorbs it. On the other hand, RPM has a higher cholesterol and saturated fat content, so its consumption needs to be limited in adults. Consumption of animal protein included in the RPM group can be replaced with animal protein found in the low-fat group, such as fish or poultry.

Sugar-Sweetened Beverages (SSB) consumption

The average consumption of sweetened beverages among subjects was 0.7 servings in the case group and 0.9 servings in the control group. Sweetened beverages such as tea or coffee with added sugar and other instant drinks are part of the consumption pattern of the study subjects. Consumption of Sugar-Sweetened Beverages (SSB) or sweetened beverages containing added sugar, such as soda, packaged juice, or other sweetened beverages, can have various effects on pregnant women's and their fetuses' health. Although occasional consumption may not have much impact, consuming them in excessive amounts or routinely during pregnancy can pose several risks. Consumption of sweetened beverages high in added sugar can cause a significant spike in blood sugar levels, increasing the risk of pregnant women developing gestational diabetes (Saavedra & Dattilo, 2022). This condition can affect the health of the mother and baby, potentially causing premature birth, high birth weight, and complications during delivery. SSBs contain empty calories, meaning they provide many calories but little nutrition. Excessive consumption can lead to unhealthy weight gain in pregnant women, which can be at risk of obesity or metabolic disorders, as well as contributing to the development of other health problems such as hypertension or preeclampsia. Preeclampsia is a dangerous condition characterized by high blood pressure and organ damage, especially the kidneys. Research shows that excessive consumption of SSBs can increase the risk of preeclampsia in pregnant women, which can be harmful to the mother and fetus. Several studies have shown that excessive sugar consumption, especially in the form of SSBs, can affect fetal development. High blood sugar

levels due to SSB consumption can affect the development of the fetal nervous system, potentially increasing the risk of cognitive development disorders in children (Rios-Leyvraz et al., 2022). Some types of SSBs, especially those containing caffeine (such as cola), can cause dehydration (Bamia & Cornelis, 2019). Dehydration during pregnancy can affect the health of the mother and baby, causing symptoms such as fatigue, headaches, and an increased risk of premature contractions. Consumption of Sugar-Sweetened Beverages during pregnancy should be limited because it can cause various health risks, both for the mother and the fetus. To replace SSBs, pregnant women can consume water, coconut water, or natural fruit juices without added sugar, which are more beneficial for the health of the body and fetus.

Grains and fish consumption

Foods included in the grain group in this study are whole grains and refined grains. Whole grains are grains in which all parts (kernel, bran layer, and germ) remain intact, so they contain more fiber, vitamins, and minerals than refined grains. The body needs grains because of their high carbohydrates, which are a source of energy. Figure 2 shows that the average grain consumption of subjects in the case and control groups was 142.8 and 144.5 grams per day. This amount of consumption shows that it has exceeded the maximum score criteria (target 90 g/hr), even though most of them are refined grains. White rice is a grain consumed by all subjects, while other grains, such as corn, are rarely consumed. Some subjects consume processed wheat products such as noodles and cakes. Consuming whole grains provides various significant health benefits, both for the body and supporting a healthy diet.

Consuming whole grains during pregnancy provides various health benefits for pregnant women and their fetuses. Whole grains contain high dietary fiber, which helps smooth digestion and prevent constipation. Fiber also supports the growth of good bacteria in the gut, which is essential for the health of the pregnant mother's digestive system. Whole grains have a lower glycemic index than refined grains, so they can help keep blood sugar levels more stable. Whole grains contain iron and folate, which prevent anemia (lack of red blood cells) in pregnant women. Folate is essential in early pregnancy because it helps prevent neural tube defects in the fetus (Landberg & Scheers, 2021). Whole grains contain vital vitamins and minerals, such as B vitamins (especially vitamins B1, B3, and folate), which support energy metabolism and the development of the fetal nervous system. In addition, whole grains contain magnesium, which is vital for the development of fetal bones and muscles and helps reduce the risk of leg cramps that often occur during pregnancy. Several studies have shown that consuming fiber from whole grains during pregnancy can help reduce the risk of premature birth (Alexander et al., 2024). Switching from refined grains to whole grains offers many health benefits, including improving digestion, controlling blood sugar levels, supporting heart health, and helping to maintain a healthy weight. This transition becomes even more critical during pregnancy to support maternal health and fetal development. Replacing refined grains with whole grains is a simple but highly effective step to improve your diet and overall health.

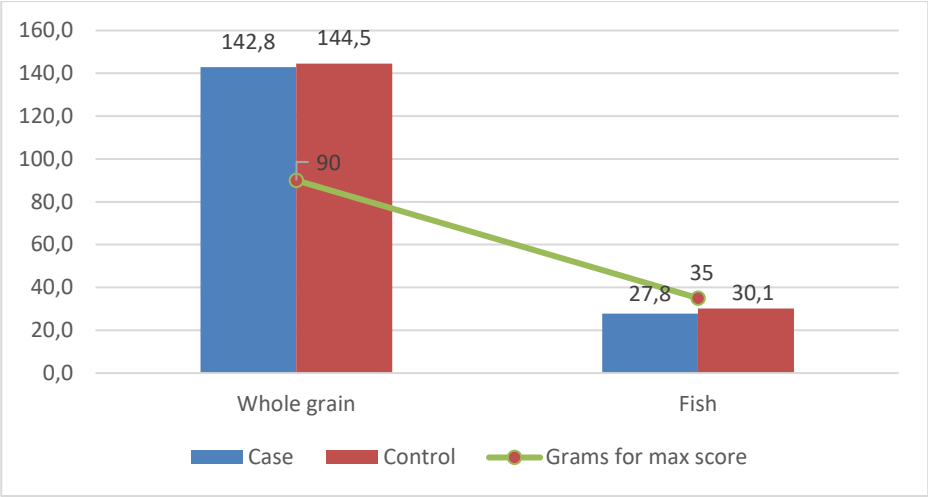

Figure 2. Average consumption of whole grains and fish by subjects (g/day)

Trans-fat and PUFA intake

In this study, fish is considered the primary source of EPA and DHA fatty acids, so its assessment is comparable to the direct evaluation of EPA and DHA intake. The average fish consumption in subjects was 27.8 g per day in the case group and 30.1 g per day in the control group. Fish consumption in both groups of subjects was still below the highest score criteria of 35 g per day. Fish consumption during pregnancy is significant to support fetal development and maternal health. Fish, especially fatty fish such as salmon, sardines, and mackerel, are rich in omega-3 fatty acids (DHA and EPA). These fatty acids are essential for fetal brain and eye development and can reduce the risk of premature birth and support nerve development. Fish is a good source of protein, which is needed for the growth and repair of maternal and fetal body cells. Fish contain various important vitamins and minerals, such as Vitamin D, which play a role in the absorption of calcium and the development of fetal bones and teeth. Vitamin B12 is essential for forming red blood cells and nervous system function. Iodine, which supports the development of the fetal thyroid gland, plays a role in brain growth and metabolism regulation (Salanta, 2020). However, care must be taken when choosing fish. Fish that contain high levels of mercury, such as swordfish, shark, or king mackerel, should be avoided as they can harm fetal brain development (Ladis & Anita, 2021). In addition, it is necessary to avoid eating raw fish (such as sashimi or sushi) during pregnancy to reduce the risk of infection.

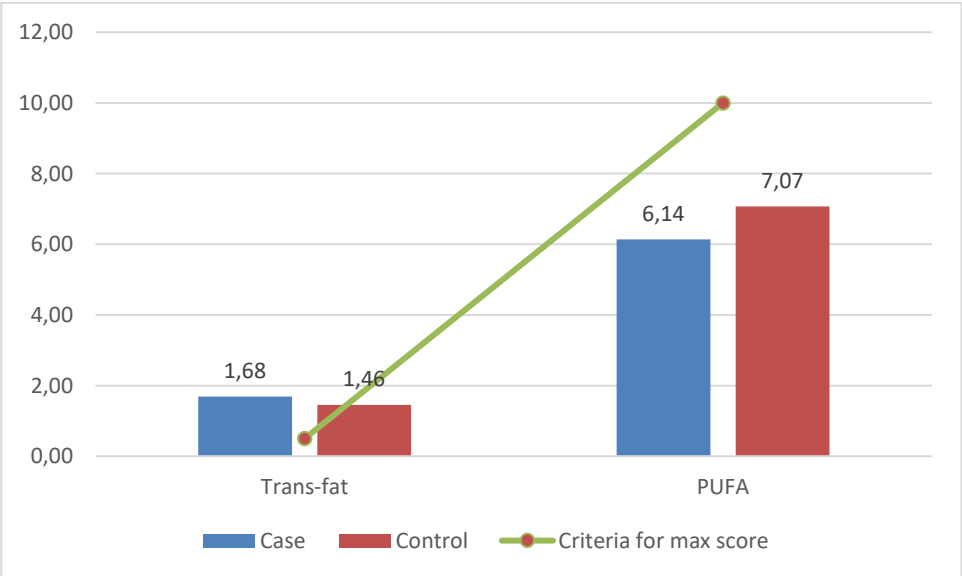

Figure 3. Average intake of trans-fat and PUFA by subjects (% energy/day)

Consumption of Polyunsaturated Fatty Acids (PUFA) during pregnancy is significant because this type of fat has various benefits for maternal health and fetal development. PUFA consists of two main groups, namely Omega-3 (especially DHA and EPA) and Omega-6, which are crucial in supporting health during pregnancy. To achieve the maximum AHEI-P score, the proportion of PUFA consumption is >10% of energy. PUFA consumption in subjects averaged 6.14 and 7.07% of energy per day, most of which is omega-3 obtained from fish consumption. A small portion of omega-6 is obtained from nuts and seeds. PUFA consumption must be balanced because excessive omega-6 intake without a balance of omega-3 can potentially trigger inflammation. Therefore, it is essential to maintain a healthy ratio between omega-6 and omega-3 in the diet during pregnancy. Omega-3 and omega-6 are two types of essential fatty acids that are important for body health, but they function in different ways. Omega-6s tend to have pro-inflammatory (increase inflammation) effects in the body, while omega-3s tend to have anti-inflammatory (reduce inflammation) effects. Therefore, the right balance between the two is essential for maintaining health, especially in avoiding chronic inflammatory conditions contributing to heart disease, diabetes, and other disorders. The optimal ratio of omega-3s to omega-6s in the diet is usually suggested to be around 1:4 to 1:1. However, in many modern societies, diets often contain much higher levels of omega-6s than omega-3s, with ratios as high as 1:15 or more (Steven M. Teagarden DC, 2023).

Trans-fat is unsaturated fat in processed foods and fried in partially hydrogenated oils (Kodali & List, 2019). Consumption of trans-fat during pregnancy should be avoided or limited as much as possible because it can be risky for the health of the mother and fetus. Excessive consumption of trans-fat can affect fetal brain development. The fetal brain develops rapidly during pregnancy, and healthy fatty acids such as omega-3 are essential for optimal brain development. Trans-fat can disrupt the balance of these essential fats and potentially affect the cognitive and behavioral development of the child after birth (Patel, 2018). Trans-fat increases bad cholesterol (LDL) levels and decreases good cholesterol (HDL). This contributes to an increased risk of heart disease and other cardiovascular disorders. Since pregnancy already increases the risk of heart disease in the mother, trans-fat consumption will only worsen this condition (Spiller, 2020). Several studies have shown that high trans-fat consumption during pregnancy may be associated with an increased risk of preterm birth and low birth weight babies (Ren et al., 2021). Consuming trans-fat during pregnancy can increase the risk of various health problems for both the mother and the fetus. Therefore, maintaining a trans-fat-free diet and prioritizing a balanced diet rich in healthy nutrients is essential to support maternal health and infant development.

Calcium, iron, and folate intake

Calcium, iron, and folate are three nutrients that are very important for pregnant women. Each has a vital role in supporting the mother's health and the fetus's development. Calcium is essential for forming the bones and teeth of the fetus. Adequate calcium requirements also help maintain the density of the pregnant woman's bones so that they do not experience a significant decrease. Calcium also affects muscle function, nerves, and blood clotting. In pregnant women, adequate calcium intake can help prevent preeclampsia (high blood pressure) and other complications. Iron is essential for forming hemoglobin, which carries oxygen throughout the body, including the fetus—the need for iron increases during pregnancy to support a larger blood volume and prevent anemia. Pregnant women who are deficient in iron can experience fatigue and decreased immunity and are at higher risk of infection. Folate is essential for preventing neural tube defects in the fetus, such as spina bifida. This is because folate supports the development of a healthy fetal nervous system. Folate also helps produce red blood cells, essential for preventing anemia in pregnant women. The intake of the three nutrients, especially iron intake in the subjects, is still low on average compared to the RDA (Maslova, 2019).

Low iron intake in pregnant women can be caused by various factors, including physiological, social, economic, and dietary habits. Many pregnant women do not consume enough iron-rich foods, especially animal foods that contain heme iron, which is more easily absorbed by the body. A diet that is often plant-based with few sources of iron (such as vegetables or grains) without paying attention to how it is absorbed can also cause iron deficiency. Some pregnant women may not know how important it is to have adequate iron intake during pregnancy, and there are negative impacts that can be caused by iron deficiency, such as anemia and pregnancy complications. Pregnant women with economic limitations may be unable to afford nutritious foods, such as red meat, fish, or iron supplements (Moini et al., 2023). Combining these factors can cause iron deficiency, which hurts the health of pregnant women and their fetuses. Therefore, providing good health education, increasing access to adequate nutrition, and ensuring that pregnant women receive the necessary examinations and supplements is critical.

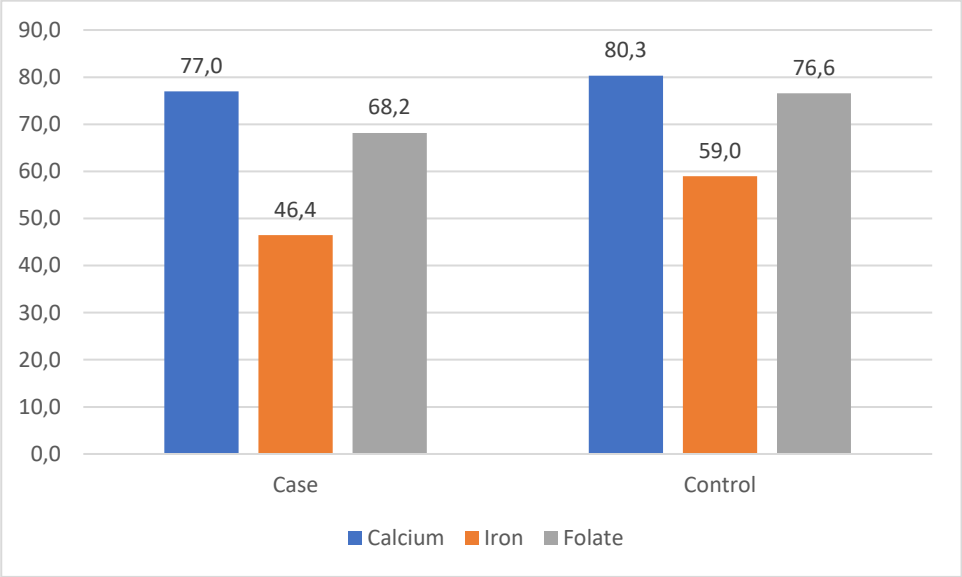

Figure 4. Average intake of calcium, iron and folate (% RDA/day)

Diet History

Dietary history is one of the methods used to evaluate an individual's long-term food intake. This method is a detailed retrospective dietary assessment used to estimate a person's typical food and nutrient intake over a certain period. Variations of dietary history methods applied in this study were comprehensive interviews about the individual's usual consumption patterns using structured questionnaires, investigating the usual quantity and frequency of consumption with Semi-quantitative FFQ, and estimated food records used as cross-checks of the history. Several dietary history variables that differed between the case and control groups are shown in Table 3.

Table 3
Dietary history subject

Variabel	Cases (n = 33)	Controls (n = 38)	*p*-value*	*OR*
Main meal portion size				
≤ standard portion	66,7	39,5	0,022	3,1
> standard portion	33,3	60,5		
Main meal frequency				
1-2 times/day	39,4	13,2	0,011	4,3
> 3 times/day	60,6	86,8		

Breakfast habit				
No	27,3	7,9	0,030	4,4
Yes	72,7	92,1		
Snack eating habit				
≤ 2 times/day	51,5	26,3	0,029	3,0
> 2 times/day	48,5	73,7		

* Chi-squared test

The analysis of the diet history questionnaire showed a significant difference in the proportion of the average main meal portions between the case group and the control group. The proportion of subjects whose main meal portions during pregnancy were more extensive than usual was higher in the control group (60.5%) compared to subjects in the case group 33.3%. Likewise, the proportion of the frequency of the main meal, subjects in the case group whose main meal frequency was more than three times per day was lower (60.6%) than subjects in the control group (86.8%). Another diet history that was significantly different between subjects in the case group and the control group was the habit of eating breakfast and the habit of eating snacks. The results of the odds ratio analysis showed that subjects in the case group who usually ate smaller portions than usual during pregnancy, ate 1-2 times a day, skipped breakfast and snacks, had a 3.0-4.4 times greater risk of giving birth to stunted babies compared to subjects in the control group.

During pregnancy, the mother's body requires more energy and nutrients to support fetal growth and maintain maternal health. A regular diet with more significant portions and frequent meals is essential (Bernstein & McMahon, 2022). In the second and third trimesters, the calorie needs of pregnant women increase, but this increase does not mean that mothers have to eat for two. Eating smaller, more frequent meals (e.g., 5-6 times a day) can help maintain stable blood sugar levels and prevent excessive hunger, often during pregnancy. A healthy breakfast provides the energy needed to start the day well. Skipping breakfast can disrupt the body's metabolism and risk causing nausea or fatigue, which pregnant women often experience. Adding nutritious snacks like fruit, nuts, or yogurt can help maintain higher nutrient needs without overdoing it. These foods also provide important fiber and vitamins for pregnant women (Tahara et al., 2023).

Mean Adequacy Ratio (MAR)

Cross-checking of dietary history, especially to assess nutritional adequacy, was conducted using the estimated food record method. The results of recording consumption for three days by the subject were analyzed using the Mean Adequacy Ratio (MAR). MAR is an indicator used to assess overall nutritional adequacy by measuring how well the intake of various nutrients consumed by an individual or group compares to the recommended dietary requirements for each nutrient. The mean adequacy ratio (MAR) is calculated as the sum of the Nutrient Adequacy Ratio (NAR) for all nutrients evaluated divided by the number of nutrients evaluated, expressed as a percentage. MAR ≥ 75% is considered adequate nutrient intake. MAR is the average of the NAR for some or all nutrients considered. Nutrient intake is assessed as inadequate, reasonably acceptable, and sufficient if NAR <66%, NAR = 66% to <100%, and NAR ≥ 100% (Molani-Gol et al., 2023). The results showed that the four nutrients evaluated (energy, protein, fat, and carbohydrates) were in the reasonably adequate category (66 to <100%). MAR analysis shows that the case group is in the inadequate category (73.4%) while the control group is in the adequate category (80.8%).

In this study, we analyzed the adequacy of energy, protein, fat, and carbohydrates in two groups, namely the case group and the control group. NAR was calculated by comparing the nutrient intake consumed by individuals in each group with the recommended needs based on the Recommended Dietary Allowance (RDA). Based on the results of the paired samples t-test statistical analysis, it was obtained that there was a statistically significant difference between the case group and the control group in terms of NAR energy, protein, and carbohydrates ($p < 0.05$) but no difference in fat intake. MAR analysis showed a significant difference between the case and control groups (table 2).

Table 3.
Differences between NAR and MAR of case and control group subjects

Nutrient	Groups	N	Mean	SD	sig. (2-tailed)*
NAR Energy	Case	33	70.2	12.6	0.024
	Control	38	77.8	15.1	
NAR Protein	Case	33	72.4	16.0	0.021
	Control	38	82.5	19.9	
NAR Fat	Case	33	70.2	25.9	0,083
	Control	38	81.8	29.7	
NAR Carbohydrate	Case	33	85.5	13.2	0.008
	Control	38	94.1	13.8	
MAR	Case	33	73.4	12.9	0.040
	Control	38	80.8	17.5	

**Paired samples t-test*

The significant difference in MAR between the group of mothers who gave birth to stunted babies and normal babies shows a close relationship between maternal nutritional adequacy during pregnancy and the babies' health (Monfared, 2024). Mothers are a vital factor in preventing stunting. Mothers are the only source of nutrition for developing children during pregnancy. Nutritional adequacy during pregnancy prevents stunting (Saleh et al., 2021). During pregnancy, the body requires increased macronutrients, including carbohydrates, proteins, and fats. Carbohydrates provide energy, proteins help the fetus grow and develop, while fats support organ formation and the absorption of fat-soluble vitamins. Micronutrients such as vitamins and minerals are essential for many biological processes. Folate, iron, calcium, iodine, and vitamin D are vital during pregnancy for neural tube development, blood production, bone health, thyroid function, and immune system support (Fleischhacker, 2023). Pregnant women must meet their macronutrient and micronutrient needs because this is directly related to optimal fetal growth and average birth outcomes. Adequate carbohydrates, proteins, and fats support fetal development, provide the energy needed by the mother's body, and ensure the formation of essential organs in the fetus. A balanced diet during pregnancy also reduces the risk of complications and ensures the birth of a healthy and well-developed baby.

CONCLUSION AND SUGGESTIONS

Diet quality was measured by the AHEI-P score. The diet quality of the control group was good, but the case group still needed improvement. Low diet quality was caused by high consumption of trans fats and Sugar-Sweetened Beverages. Low consumption of vegetables, fruits, and iron also affected the quality of the subjects' diet, while consumption of nuts still needed to be improved. There was a difference in diet quality between the case and control groups. To improve diet quality during pregnancy, it is best to focus on increasing the consumption of nutritious foods such as protein from chicken, fish, and nuts, as well as complex carbohydrates such as brown rice and potatoes. Consumption of green vegetables, such as spinach and broccoli, and fruits rich in vitamin C, such as oranges and apples, need to be increased. Also, ensure iron intake through animal foods as sources of iron, such as chicken liver, and calcium from milk or tempeh. During pregnancy, it is advisable to avoid foods containing trans fat and prefer healthy fats, such as those found in avocados, nuts, and fatty fish, and limit sweetened drinks (such as soda, packaged juices, and other sweet drinks).

ETHICAL CONSIDERATIONS

Funding Statement.

This research was funded by Poltekkes Kemenkes Tanjungkarang, through a Collaborative Research Grant between Universities (PKPT) number HK.02.03/F.XLIII/48/2024 given in 2024. The author expresses gratitude for the financial support that made this research possible.

Conflict of Interest Statement

The author declares no conflict of interest related to this research. All data and research results presented in this article are objective research results and are not influenced by personal or commercial interests.

REFERENCES

Abdollahi, S., Soltani, S., De Souza, R. J., Forbes, S. C., Toupchian, O., & Salehi-Abargouei, A. (2021). Associations between maternal dietary patterns and perinatal outcomes: a systematic review and meta-analysis of cohort studies. Advances in Nutrition, 12(4), 1332–1352.

Al Rahmad, A. H. (2023). Scoping Review: The Role of Micronutrients (Fe, Zn, Iodine, Retinol, Folate) During Pregnancy. Jurnal Kesehatan Manarang, 9(1), 1–13.

Alexander, L. L., LaRosa, J. H., Bader, H., & Garfield, S. (2024). *New Dimensions in Women's Health with Navigate Advantage Access*. Jones & Bartlett Learning.

Bamia, C., & Cornelis, M. (2019). *The Impact of Caffeine and Coffee on Human Health*. MDPI AG.

Bernstein, M., & McMahon, K. (2022). *Nutrition Across Life Stages*. Jones & Bartlett Learning.

Chiuve, S. E., Fung, T. T., Rimm, E. B., Hu, F. B., McCullough, M. L., Wang, M., Stampfer, M. J., & Willett, W. C. (2012). Alternative dietary indices both strongly predict risk of chronic disease. *The Journal of Nutrition*, *142*(6), 1009–1018.

Fleischhacker, W. (2023). The importance of diet during pregnancy: Impacts on the developing baby and maternal healt. *Clinical Nutrition and Hospital Dietetics*, *43*(3), 1–2.

Gete, D. G., Waller, M., & Mishra, G. D. (2020). Effects of maternal diets on preterm birth and low birth weight: a systematic review. British Journal of Nutrition, 123(4), 446–461.Jouanne, M., Oddoux, S., Noël, A., & Voisin-Chiret, A. S. (2021). Nutrient requirements during pregnancy and lactation. Nutrients, 13(2), 692.

Keats, E. C., Oh, C., Chau, T., Khalifa, D. S., Imdad, A., & Bhutta, Z. A. (2021). Effects of vitamin and mineral supplementation during pregnancy on maternal, birth, child health and development outcomes in low-and middle-income countries: A systematic review. Campbell Systematic Reviews, 17(2), e1127.

Kemenkes. (2014). *Permenkes Pedoman Gizi Seimbang* (p. 96). https://peraturan.bpk.go.id/Details/119080/permenkes-no-41-tahun-2014

Kemenkes. (2023). Survei Kesehatan Indonesia dalam angka 2023 (I). BKPK. https://www.badankebijakan.kemkes.go.id/ski-2023-dalam-angka/

Kodali, D. R., & List, G. R. (2019). *Trans Fat Alternative*. CRC Press.

Ladis, P., & Anita. (2021). *The Wise Woman's Guide to Your Healthiest Pregnancy and Birth: From Preconception to Postpartum*. Health Communications Incorporated.

Landberg, R., & Scheers, N. (2021). *Whole Grains and Health*. Wiley.

Madzorera, I., Isanaka, S., Wang, M., Msamanga, G. I., Urassa, W., Hertzmark, E., Duggan, C., & Fawzi, W. W. (2020). Maternal dietary diversity and dietary quality scores in relation to adverse birth outcomes in Tanzanian women. *The American Journal of Clinical Nutrition*, *112*(3), 695–706.

Maslova, E. (2019). *The Role of Pregnancy Nutrition in Maternal and Offspring Health*. MDPI AG.

McLaren, S. W. (2022). Nutrition and Global Health. Wiley. https://books.google.co.id/books?id=AeeLEAAAQBAJ

Moini, J., Akinso, O., & Ahangari, R. (2023). *Global Malnutrition: Pathology and Complications*. CRC Press.

Molani-Gol, R., Kheirouri, S., & Alizadeh, M. (2023). Does the high dietary diversity score predict dietary micronutrients adequacy in children under 5 years old? A systematic review. *Journal of Health, Population and Nutrition*, *42*(1), 2.

Molina-Recio, G. (2022). Nutrition for a healthy pregnancy and environment. In *Fertility, Pregnancy, and Wellness* (pp. 295–317). Elsevier.

Monfared, Z. (2024). The Importance of Nutrition for Fetal Health. *Japanese Journal of Medical Science*, *2*(1), 1–8.

Organization, W. H. (2023). *Red and processed meat in the context of health and the environment: many shades of red and green. Information brief*. World Health Organization.

Patel, V. (2018). *The Molecular Nutrition of Fats*. Academic Press.

Petit, G., Jury, V., de Lamballerie, M., Duranton, F., Pottier, L., & Martin, J. (2019). Salt intake from processed meat products: Benefits, risks and evolving practices. *Comprehensive Reviews in Food Science and Food Safety*, *18*(5), 1453–1473.

Ren, X., Vilhjálmsdóttir, B. L., Rohde, J. F., Walker, K. C., Runstedt, S. E., Lauritzen, L., Heitmann, B. L., & Specht, I. O. (2021). Systematic literature review and meta-analysis of the relationship between polyunsaturated and trans fatty acids during pregnancy and offspring weight development. *Frontiers in Nutrition*, *8*, 625596.

Rios-Leyvraz, M., Montez, J., & W. H. O. (2022). *Health effects of the use of non-sugar sweeteners: a systematic review and meta-analysis*. World Health Organization.

Saavedra, J. M., & Dattilo, A. M. (2022). *Early Nutrition and Long-Term Health: Mechanisms, Consequences, and Opportunities*. Woodhead Publishing.

Salanta, L. C. (2020). *The Health Benefits of Foods: Current Knowledge and Further Development*. IntechOpen.

Saleh, A., Syahrul, S., Hadju, V., Andriani, I., & Restika, I. (2021). Role of maternal in preventing stunting: a systematic review. *Gaceta Sanitaria*, *35*, S576–S582.

Sari, D. K., Amelia, R., Masyithah, D., & Tantrakarnapa, K. (2024). Low serum lipase levels in mothers of children with stunted growth indicate the possibility of low calcium absorption during

pregnancy: A cross-sectional study in North Sumatra, Indonesia. Plos One, 19(6), e0298253.

Schaafsma, G. (2000). The protein digestibility–corrected amino acid score. *The Journal of Nutrition*, *130*(7), 1865S-1867S.

Semba, R. D., Ramsing, R., Rahman, N., Kraemer, K., & Bloem, M. W. (2021). Legumes as a sustainable source of protein in human diets. *Global Food Security*, *28*, 100520.

Spiller, G. A. (2020). *Handbook of Lipids in Human Nutrition*. CRC Press.

Steven M. Teagarden DC. (2023). *Healthy Past 100: The Cutting-Edge Science-Based Guidebook to Extraordinary Health and Disease Prevention Beyond 100*. BookLocker.com, Inc.

Tahara, Y., Escobar, C., Oike, H., & Qian, J. (2023). *The present and future of chrono-nutrition studies*. Frontiers Media SA.

Thornburg, K. L., Purnell, J., & Marshall, N. (2022). Concerns regarding red meat consumption during pregnancy: a reply. *American Journal of Obstetrics & Gynecology*, *227*(2), 360–362.

Vranić, D., Milešević, J., Trbović, D., Gurinović, M., Korićanac, V., Zeković, M., Petrović, Z., Ranković, S., & Milićević, D. (2023). Exposure to phosphates and nitrites through meat products: Estimation of the potential risk to pregnant women. *Nutrients*, *15*(12), 2777.