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Full Length Research Paper

Dietary intake of omega-6 and omega-3 fatty acids among pregnant and breastfeeding women in Morogoro, Tanzania

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A new-born's health and wellbeing is determined by the diet and lifestyle of the mother prior, during and after conception. Polyunsaturated fatty acids play an important role for proper development of brain and other organs in the body. This study sought to assess dietary intake of omega 6 and omega 3 fatty acids among pregnant and breastfeeding women in Morogoro municipality, Tanzania. About 318 women completed a repeated 24 h dietary recall questionnaire. For calculation of fatty acid intake, the foods consumed by each participant were entered independently in Nutri Survey software where the amount of nutrients consumed by each individual was calculated and then exported to SPSS for further analysis. The results showed high intake of non-alcoholic and carbonated beverages (213.4 g/day) and low intake of omega 6 and omega 3 rich foods (54.6 g/day). More than half could not attain the recommended minimum dietary diversity score. The average intake of important omega 6 and omega 3 fatty acids ranged from 0.06 to 1.19 g/day and 0.17 to 0.25 g/day, respectively. When compared with the recommended intake of energy as well as important omega 6 and omega 3 fatty acids for both pregnant and breastfeeding women, there were gaps in all of these aspects. Intake of omega 6 and omega 3 rich foods among pregnant and breastfeeding women was lower than recommended. Nutrition education on consumption of appropriate polyunsaturated fatty acid rich foods prior, during and after pregnancy should be given to all women of reproductive age.

Key words: Omega 3 fatty acid, omega 6 fatty acids, diet, essential fatty acids, pregnant women, breastfeeding women.

INTRODUCTION

A new-born's health and wellbeing is determined by the diet and lifestyle of the mother prior, during and after conception and therefore proper diet is important during this period (Marangoni et al., 2016; de Seymour et al., 2022). The period from when the child is conceived until his/her second birthday is considered as the window of opportunity for prevention of many nutrition-related problems (Kattula et al., 2014; Poon et al., 2018). This period is commonly known as 'the first 1000 days' of the child's life (Mameli et al., 2016; Pietrobelli et al., 2017).

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Failure to attain adequate growth of various vital organs and immune system during the first 1000 days of life may be irreversible later in life (Kinshella et al., 2021).

The human brain is one of the most important organs that undergo rapid development during pregnancy and the first two years of life (Velasco et al., 2020). Polyunsaturated fatty acids play a crucial role in the proper development of not only the brain but also other organs in the body (Shahidi and Ambigaipalan, 2018). Fatty acids such as linoleic (LA) (18:2n-6) and alpha-linolenic acid (ALA) (18:3n-3) are termed as essential fatty acid because they cannot be synthesized by humans (Saini and Keum, 2018). Other polyunsaturated fatty acids, such as arachidonic acid (AA) (C20:4n-6), eicosapentaenoic acid (EPA) (C20:5n-3), and docosahexaenoic acid (DHA) (C22:6n-3), can be synthesized from the essential fatty acids linoleic and alpha-linolenic acid. These fatty acids are categorized as omega-6 and omega-3 fatty acids based on the position of the double bond (Urszula Radzikowska et al., 2019). In addition to their role in brain development, these fatty acids are concentrated in the spinal cord, retina, and testes in humans, and they also provide energy (Hakkarainen et al., 2004). They serve other functions such as being components of cell membranes, tissues, and organs, acting as anticoagulants and antihypertensive agents, regulating lipid metabolism, reducing inflammation, and playing a role in the prevention of various types of cancer (Sokoła-Wysoczańska et al., 2018).

Omega-6 fatty acids can be obtained from plant sources such as flaxseed (linseed), canola (rapeseed), soybean, hemp oil, nuts, and chia seeds (Tsoucalas and Sgantzos, 2017). They can also be obtained from animal sources such as dairy products, eggs, and algae. Omega-3 fatty acids are primarily found in fish and seafood, especially in fatty fish oils, sardines, and seaweeds (Kraic et al., 2018). Although these foods are widely available in many parts of the world, their dietary consumption remains quite low, often necessitating the use of expensive supplements during pregnancy.

This study aims to assess the dietary intake of omega-6 and omega-3 fatty acids during pregnancy and the breastfeeding period, as well as to explore the determinants of this intake.

METHODOLOGY

Description of the study area

The present study was conducted in Morogoro municipality, located in the Morogoro region of Tanzania. The area was chosen due to a limited number of studies on the dietary intake of omega-6 and omega-3 fatty acids among pregnant and breastfeeding women. Morogoro municipality was established in 1988 under the provisions of Section 8 & 9 of the Local Government (Urban Authorities) Act, No. 8 of 1982. It is situated at the coordinates 37.0° East longitude and 4.49° South latitude. According to the National Bureau of Statistics (2022), the Morogoro region has a population of 3,197,104. Major economic activities in Morogoro municipality include trade (wholesale, retail, food vending, and petty trade), industrial activities, as well as transport and communication. Food crops grown in the area include maize, beans, paddy, cassava, sorghum, potatoes, and various types of fruits and vegetables. Additionally, a variety of fish and seafood are sourced from Mindu Dam in Morogoro and imported from different areas of Tanzania, such as Mwanza, Kigoma, and Dar es Salaam.

Study design and sample size

In this cross-sectional study, pregnant and breastfeeding mothers who attended Mafiga and Mazimbu Reproductive and Child Health (RCH) units were included as study subjects. They were randomly selected from Mazimbu, Mafiga, and Kihonda wards, while those not from these study wards were excluded. The sample size was calculated based on the number of women aged between 15 and 49 years in Morogoro municipal (63,807), considering a 5% precision at a 95% confidence level and a 10% non-response rate, resulting in a sample size of 318 respondents.

Data collection

Dietary intake assessment

Omega 6 and omega 3 intakes were obtained from repeated 24 h dietary recall interviews. Three enumerators were trained on how to establish rapport, conduct paper-based interviews as well as how to take measurements or estimate food intake using local utensils and picture books. During the interviews, the enumerators introduced themselves, explained the purpose of the visit and then asked the respondents to read (or assisted to read) the consent forms in order to obtain verbal or written consent.

Socio demographic information of the respondents was obtained and then the respondent was asked to recall all the foods and drinks eaten for the past 24 h including snacks. The enumerator recorded all the foods (pass 1) and then information about ingredients and preparation methods for each food was obtained (pass 2). In the third pass the respondent was asked to estimate the amount of each food consumed using household utensils or picture books provided by the enumerator and then they were recorded. In the fourth pass, the respondents were asked to recall any food or drink that was previously forgotten. If nothing was forgotten, the enumerator scheduled the next interview, which was to be conducted two days after the first interview. During this second visit, only information on the 24 h dietary recall was obtained.

Calculation of fatty acid content

The foods consumed by each participant were entered independently in computerized nutrient intake assessment software Nutri Survey 2007 by Dr. Juergen Erhardt of SEAMEO-TROPMED RCCN University of Indonesia where the amount of nutrients consumed by each individual was calculated. Each food item in 24 h recall was matched with a food item found automatically in Nutri Survey software. Egypt, India and Kenya Food Composition Tables were added to Nutri Survey to accommodate the food items whose match could not be found automatically in Nutri Survey software. The foods consumed were automatically grouped in the Nutri Survey and their mean intake was calculated. The average intake of energy, cholesterol, total fatty acid, saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids (omega 6 (Linolenic and Arachidonic acids) and omega 3 (Alpha

Linoleic, Eicosapentaenoic, Docosapentaenoic and Docosahexaenoic acids) fatty acids) per day was calculated by summing up the day one and day two intakes from all food items consumed by an individual and then they were divided by two. The results were then exported to SPSS further analysis.

Assessment of minimum dietary diversity for women (MDDS-W)

Information of minimum dietary diversity score for women (MDDS-W) was collected through 24 h dietary recall. After collecting information regarding all the foods and drinks eaten for the past 24 h including snacks, the food items were categorized 10 food groups namely grains, white roots and tubers, and plantains; pulses (beans, peas, and lentils); nuts and seeds; dairy, meat, poultry, and fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits. A score of one was placed if the respondent consumed at least one food item in either of the groups and zero if no food item was consumed. The scores for the food groups consumed by each respondent were then summed up and the average was obtained.

Statistical analysis

Statistical analysis was conducted using MS excel 2010, Nutri Survey and Statistical Products and Service Solutions (IBM SPSS version 20.0). For socio-demographic information, descriptive statistics (mean, frequencies and percentages) were calculated. Mean, standard deviation and One-Way Analysis of Variance (ANOVA) were conducted for total omega 6/3, LA, ARA, ALA, EPA, DPA and DHA. Turkeys Honest Significant Difference (HSD) test was used to determine if there was a significant difference between variables. The level of statistical significance was set at $p \leq 0.05$.

To obtain the number and percentage of women who achieved by consuming at least five food groups (MDDS-W), SPSS (version 20.0) was used.

Ethical considerations

The study was approved by the National Institute for Medical Research (reference number, NIMRI/HQ/R.8a/Vol.IX/3959). On the other hand, Sokoine University of Agriculture, Morogoro Regional Secretary Office, Morogoro Municipal Council and Ward Executive Officers provided permission for conducting the research. Also written and signed informed consent was obtained from all the participants before the interviews.

RESULTS

Social and demographic characteristics of the study subjects

The mean age of all the participants was 28.8 years (28.8 ± 6.3). The majority of the respondents were breastfeeding women (68.2%, n=217). Half of them (50%, n=159) had primary school education as their highest level of education. Most women in both categories were homemakers (42.8%, n=136), and approximately 42% (n=134) were married. There was no significant difference in terms of socio-demographic characteristics between pregnant and breastfeeding women (Table 1).

Intake of different food groups

Non-alcoholic beverages such as carbonated drinks, coffee and coffee substitutes, processed and unprocessed fruit juices as well as tea had the highest mean intake of 213.4 g per day. Cereal and cereal products had the second higher score of 176.1 g per day. The food groups with lower mean intake were meat products such as sausages (0.2 g/day), sugar and confectionaries (0.34 g/day), oils, fats and butter (0.83 g/day) as well as pulses, nuts and seeds (0.93 g/day) (Table 2).

Minimum dietary diversity for women (MDDs-W)

MDD-W is a dichotomous indicator of whether women aged 15 to 49 years have consumed at least five out of ten defined food groups the previous day or night (FAO and FANTA, 2016). If a woman consumes at least five food groups per day, there is a high chance of meeting micronutrient needs. Based on the findings from this study, more than 77% of the respondents consumed less than five food groups (Figure 1).

Calories intake and percentage share of fat and fatty acids in the diet

Total energy intake per day for pregnant and breastfeeding women ranged from 1116 to 1098 Kcal (Table 3). The contribution of fat to the total calories was approximately 14%. Saturated fatty acids had the contribution of 4.6 to 5.5% whereas monounsaturated and polyunsaturated fatty acids had the percentage shares of 4.3 to 4.6 and 3.0 to 3.0, respectively.

Estimation of energy, omega 6 and omega 3 fatty acid mean intake in the diet

Intake of energy and energy-giving foods, saturated, monounsaturated, and polyunsaturated (omega-3 and omega-6) fatty acids is summarized in Table 4. The mean energy content of the foods was lower than recommended for both pregnant and breastfeeding women (1116.79 and 1098 Kcal, respectively). There was no significant difference in the mean intake of short, middle, and long chain fatty acids for both pregnant and breastfeeding women ($p \geq 0.05$). However, there was a significant difference in the mean intake of polyunsaturated fatty acids ($p \leq 0.05$). In terms of eicosapentaenoic acid (EPA (C20:5n-3)) and docosahexaenoic acid (DHA (C22:6n-3)) intake, there was a significant difference among pregnant and breastfeeding women ($p \leq 0.05$). There was no significant difference in the mean intake of omega-6 fatty acids alpha-linolenic acid (ALA (C18:3n-3)) and arachidonic acid (ARA (C20:4n-6)) for both pregnant and

Table 1. Socio-demographic characteristics of the study participants.

Variable	Pregnant women [101(31.8%)]	Breastfeeding women [217 (68.2%)]	Total [318 (100%)]	P value
	n (%)	n (%)		
Mean age (years)		28.8 ± 6.3		
Age (years)				
18-24	39 (12.3)	68 (21.4)	107 (33.7)	
25-34	51 (16.0)	97 (30.5)	148 (46.5)	0.053
>35	11 (3.5)	52 (16.4)	63 (19.7)	
Education level				
Never been to school	6 (1.9)	17 (5.3)	23 (7.2)	
Primary school	49 (15.4)	110 (34.6)	159(50.0)	0.868
Secondary school	31 (9.7)	59 (18.6)	90 (28.3)	
Post-secondary education	15 (4.7)	31 (9.8)	46 (14.5)	
Occupation				
Home maker	42 (13.2)	94 (26.6)	136 (42.8)	
Formal/informal employment	28 (8.8)	66 (20.8)	94 (29.6)	0.703
Self-employed	31 (9.7)	57 (17.9)	88 (27.6)	
Marital status				
Never been married	31 (9.7)	66 (20.8)	97 (30.5)	
Married	44 (13.8)	90 (20.3)	134 (42.1)	0.554
Separated/Divorced	5 (1.6)	23 (7.2)	28 (8.8)	
Living together	21 (6.6)	38 (12.0)	59 (18.6)	

Table 2. Mean intake of different food groups.

Food group	Mean Intake (g)
Non-alcoholic beverages	213.44±32.08
Cereal products and grains	176.1±24.09
Dairy products	130.21±24.24
Fish and fish products	54.56±13.91
Bread and rolls	37.67±10.66
Alcoholic beverages	32.04±21.76
Fruits	25.79±13.12
Meat (beef/pork)	19.08±12.99
Egg and egg products	13.1±6.671
Vegetables	12.51±8.53
Cakes, pastries and biscuits	4.5±3.106
Roots and tubers	4.42±2.002
Poultry	1.34±2.89
Pulses, Nuts and other seeds	0.93±1.52
Oils, fats and butter	0.83±4.62
Seasonings, raisings, additives and spices	0.81±4.42
Sugar and confectionaries	0.34±3.96
Meat products such as sausages	0.2±0.34

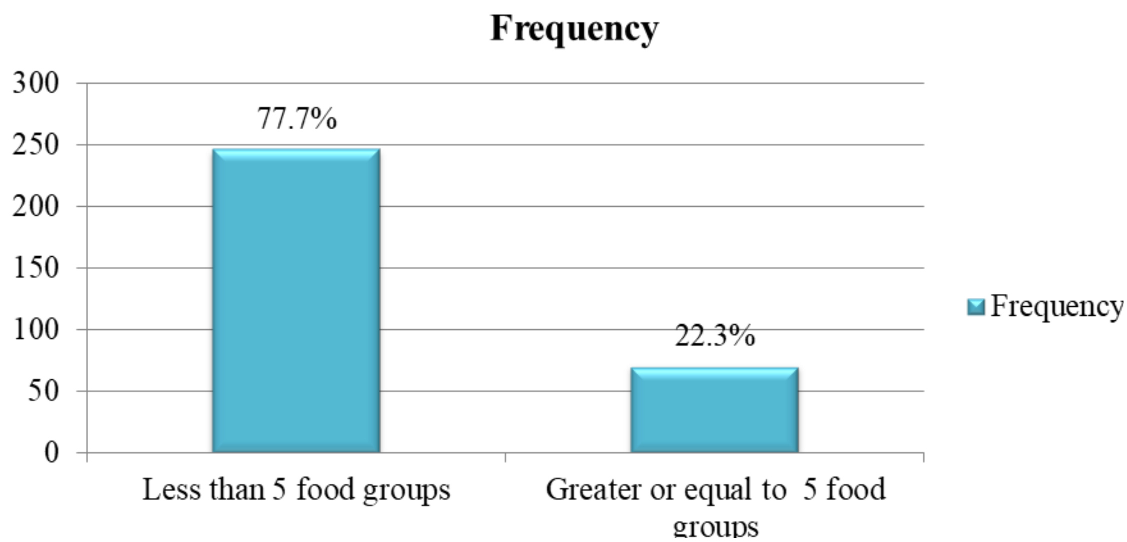

Figure 1. Minimum dietary diversity scores for women (MDDS-W).

Table 3. Calories intake and percentage share of fats in the diet.

Physiological state	Total calories	% calories intake as fat	% intake as saturated fat	% intake as unsaturated fatty acids	
				MUFA	PUFA
Pregnancy	1116.79	14	4.64	4.31	3.02
Breastfeeding	1098.85	13.5	5.47	4.63	2.95
Recommended	2400-2500	15-30	≤1	8-19	6-10

MUFA=Monounsaturated fatty acids, PUFA=Polyunsaturated fatty acids.

Table 4. Energy, omega 6 and omega 3 fatty acid intake.

Nutrient	Pregnant women	Breastfeeding women	P value
	Mean intake	Mean intake	
Macronutrients			
Energy (Kcal)	1116.79±475.96	1098±486.46	0.60
Fat (g)	25.94±26.1	23.82±22.86	0.03
Protein (g)	54.03±31.89	58.85±41.23	0.46
Carbohydrates (g)	245.18±74.76	242.74±88.83	0.24
Fatty acid based on chain length			
Short chain FA (g)	0.3±0.53	0.3±0.55	0.51
Medium chain FA (g)	0.23±0.37	0.24±0.39	0.43
Long chain FA (g)	13.5±17.96	13.4±17.8	0.58
Fatty acid based on double bonds			
Cholesterol	143.85±241.3	139.73±212.4	0.79
SFA (g)	8.60±9.6	8.40±9.56	0.76
MUFA (g)	7.98±10.5	7.11±8.7	0.06
PUFA (g)	5.59±6.99	4.54±5.33	0.01
Omega 3 fatty acids			
ALA (C18:3n-3) (g)	0.20±0.27	0.22±0.28	0.76

Table 4 Contd.

EPA (C20:5n-3) (g)	0.13±0.28	0.18±0.39	0.03
DHA (C22:6n-3) (g)	0.22±0.37	0.28±0.49	0.05
Omega 6 fatty acids			
LA (C18:2n-6) (g)	1.21±2.45	1.17±2.14	0.41
ARA (C20:4n-6) (g)	0.07±0.11	0.09±0.15	0.241
n-6/n-3	0.54	4.78	

Kcal=Kilocalories, g=grams, FA=fatty Acid, SFA=saturated fatty acids, MUFA=monounsaturated fatty acids, PUFA=polyunsaturated fatty acids, ALA=alpha linolenic acid, EPA=eicosapentaenoic acid, DHA=docosahexaenoic acid, LA=linoleic acid, ARA=arachidonic acid, n-6/n-3= omega 6/omega 3 ratio.

Table 5. Mean intake of Omega 6 and Omega 3 Fatty versus recommended intake for both pregnant and breastfeeding women.

Nutrient	Mean intake (g)	Recommended intake	Gap
Macronutrients			
Energy (Kcal)	1104±482.47	2400	-1296
Fat (%)	13.73	20-35 (Mean=27.5)	-13.77
Protein (%)	15.88	10-15 (Mean=12.5)	+3.38
Carbohydrate (%)	70.26	50-60 (Mean=55)	+15.26
Omega 3 fatty acids			
ALA (C18:3n-3) (g)	0.21±0.28	1.4	-1.19
EPA (C20:5n-3) (g)	0.17±0.36	2.0	-1.83
DHA (C22:6n-3) (g)	0.25±0.46	1.0	-0.75
Omega 6 fatty acids			
LA (C18:2n-6) (g)	1.19±2.24	13	-11.81
ARA (C20:4n-6) (g)	0.06±0.07	0.8	-0.74

Kcal=Kilocalories, g=grams, FA=fatty acid, SFA=saturated fatty acids, MUFA=monounsaturated fatty acids, PUFA=polyunsaturated fatty acids, ALA=alpha linolenic acid, EPA=eicosapentaenoic acid, DHA=docosahexaenoic acid, LA=linoleic acid, ARA=arachidonic acid, n-6/n-3= Omega 6/Omega 3 ratio.

breastfeeding women ($p \geq 0.05$).

Comparison of mean intake of omega 6 and omega 3 fatty acid and recommended intake

The results from this study showed that dietary intake of omega-6 and omega-3 fatty acids were lower than what is recommended. The intake of carbohydrates and protein exceeded the recommended amount by 15 and 3%, respectively.

There were gaps in energy intake (-1296), fat intake (-13.77), and in both omega-3 and omega-6 fatty acids (Table 5).

DISCUSSION

This study sought to assess the dietary intake of omega-6 and omega-3 fatty acids among pregnant and breastfeeding women in Morogoro municipality, Tanzania. The results showed a high intake of non-alcoholic drinks such as carbonated drinks and processed juices. These drinks are known to contain excessive sugar and even caffeine, which may predispose pregnant women to severe risks such as gestational diabetes, pregnancy-induced hypertension, as well as overweight and obesity. These conditions may, in turn, affect the health of the growing baby during and after pregnancy. High consumption of sugary drinks may be attributed to the increased industrial production of cheaper beverages, making them more available and accessible. It could also be influenced by hormonal changes during pregnancy, leading to food aversions, cravings, and nausea, which, in turn, reduce the intake of real foods (Saunders et al., 2019). A similar study conducted in Nigeria among pregnant women also revealed a high consumption of carbonated drinks (Etukudoh and Ocheola, 2022).

The study also revealed a high intake of cereal products and grains, likely because cereals such as maize and rice are the staple foods in the area. Despite the high consumption of these food products, known for their high energy content in the form of carbohydrates, the total energy intake was lower than recommended (WHO, 2008; Meija and Rezeberga, 2017; Most et al., 2019). Inadequate calorie intake during pregnancy and breastfeeding can lead to intrauterine growth retardation, low birth weight, preterm delivery, birth defects, reduced physical, and mental potential of the child, and neonatal death (Tyagi, 2023). Similar studies conducted in Tanzania and elsewhere have also reported low calorie intake among pregnant women (Tayyem et al., 2019; Middleton et al., 2019; Cliffer et al., 2023; Tyagi, 2023).

For a woman of reproductive age to attain the minimum recommended micronutrient intake, she should consume at least five food groups (MDDS-W) (FAO and FANTA, 2016). The results from this study revealed that the majority of pregnant and breastfeeding women consumed less than five food groups, which increases their likelihood of not meeting the recommended minimum micronutrient intake. Low micronutrient intake, accompanied by poor consumption of essential fatty acids such as omega 6 and omega 3 fatty acids, may lead to an increased risk of poor pregnancy outcomes such as low birth weight, stillbirth, and stunting, among others. The findings from the study conducted by Shumayla et al. (2022) were in contrast to the findings from this study, where high nutritional knowledge was a factor that influenced the high consumption of diverse groups of foods. Another study suggested that seasonality may be a factor that influences the consumption of different food groups (Custodio et al., 2016). Therefore, several factors such as education, seasonality, and other socio-demographic and economic factors need to be taken into account in order to improve the intake of both macro and micronutrients.

Foods that are known to contain high polyunsaturated fatty acids, such as pulses, nuts, seeds, fish and fish products, as well as fats and oils, were consumed in low amounts. This may be contributed to by hormonal changes during pregnancy that can intensify the sense of smell and most of these foods have strong odors that may lead to aversions.

The low intake of these foods may result in a low intake of omega 6 and omega 3 fatty acids, which in turn may lead to various negative health outcomes, such as poor brain and visual development during pregnancy, low birth weight, and poor cognitive development in children, among others (Hoge et al., 2019; López-Vicente et al., 2019; Shrestha et al., 2020). Low intake of omega 6 and omega 3 foods has been reported in several other studies (Gaitán et al., 2018; Hoge et al., 2018; Stråvik et al., 2019).

The World Health Organization (2020) recommends that 20 to 35% of total energy intake should be contributed by fat. However, in this study, the percentage contribution of fat was low. Additionally, dietary intake of important omega 3 fatty acids, such as alpha-linolenic acid (ALA) (18:3n-3), eicosapentaenoic acid (EPA) (C20:5n-3), and docosahexaenoic acid (DHA), among pregnant and breastfeeding women was lower than the recommended levels. This may be due to the low intake of foods known to contain high levels of omega 3 and omega 6 fatty acids. Therefore, it is important to encourage pregnant and breastfeeding women to consume foods rich in omega 3 and omega 6 fatty acids. Several studies have shown a positive association between the intake of omega 6 and omega 3 rich foods and neurodevelopment, brain development, strong vision, and other health outcomes (Starling et al., 2015; Marshall et al., 2022).

Conclusion

The intake of omega 6 and omega 3 rich foods among pregnant and breastfeeding women was limited. When compared to the recommended intake of polyunsaturated fatty acids, there were gaps in the intake of different types of both omega 6 and omega 3 fatty acids. Nutrition education on the consumption of appropriate polyunsaturated fatty acid-rich foods before, during, and after pregnancy should be provided to all women of reproductive age.

Limitations of the study

This study was cross-sectional, and therefore the causal relationship between low intake of omega 6 and omega 3 fatty acids could not be established. A longitudinal study could be undertaken to assess exposure and outcomes over time. Additionally, the method used for data collection relied on a person's ability to recall the foods eaten on the previous day, their cooperation, and communication ability. Therefore, other methods such as food records can be used to obtain more precise results.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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