Benghazi University Medical journal
Faculty of Medicine, University of Benghazi
BUMJ VOLMUE:2 ISSUE:1 June: 2025

The Preconception Diet and Folic Acid Intake in a Post-Conflict Setting: Insights from Private Clinics in Benghazi, Libya.

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Original Research Article

Abstract

Background: Maternal nutrition during the preconception period is crucial for fetal development and pregnancy outcomes.

Aim: This study aims to assess the dietary intake and folic acid (FA) consumption among pregnant women in Benghazi, Libya, following eight years of political instability.

Method: A cross-sectional study was conducted with 74 first-trimester pregnant women attending private antenatal clinics between February and June 2019. Dietary intake was evaluated using the European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire (EPIC-FFQ), adapted for the Libyan population, and analyzed using the food frequency questionnaire European prospective investigation into cancer and nutrition tool for analysis (FETA).

Results: The analysis revealed diets high in energy but deficient in essential nutrients. Only 26% of women-initiated FA supplementation before pregnancy, while 16% did not consume FA at all. The mean fiber intake 15.05 g/day was significantly lower than recommended $p < 0.001$. Micronutrient deficiencies were observed in iron and folate, while vitamin A intake was excessive. Additionally, 43% of participants were overweight or obese before pregnancy. Socioeconomic factors, including low employment rates 30% and limited household income 54% ≤1000 Libyan Dinar/month, likely contributed to these nutritional challenges.

Conclusion: Pregnant women in Benghazi exhibit dietary inadequacies, particularly low fiber, iron, and folate intake, and insufficient pre-conceptional folic acid use, highlighting nutritional vulnerabilities in this conflict-affected area.

Keywords: Periconceptional, Dietary intake, Folic acid supplement, Conflict, Libya Benghazi.

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ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

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Introduction

The periconceptional period represents a pivotal timeframe for human development, wherein both maternal and paternal physiological factors can significantly influence the health outcomes of offspring. The nutritional status of pregnant women during this critical window is paramount, as a diet rich in essential nutrients not only supports maternal health but also fosters optimal fetal development, with implications extending into the long term (1,2). Research consistently indicates that inadequate maternal nutrition correlates with a range of adverse pregnancy outcomes, including intrauterine growth restriction, low birth weight, preterm birth, stunting, and increased maternal and fetal mortality (3). Notably, studies have demonstrated that women adhering to healthier dietary patterns experience improved pregnancy outcomes, even when accounting for pre-existing health issues and weight considerations (4,5). In addition to immediate effects, the lifestyle choices of parents during the preconception period can have lasting repercussions on the health of their children, potentially elevating the risk of various chronic diseases through complex biological mechanisms, including epigenetic modifications and metabolic alterations (6–8). The role of micronutrient supplementation, particularly with folic acid (FA), vitamin D, and iron, has been linked to reduced risks of neural tube defects and adverse birth outcomes (9–11). Furthermore, maternal body mass index (BMI) is a crucial determinant of both immediate and long-term health outcomes for offspring, with studies revealing detrimental effects associated with both underweight and overweight maternal statuses (12–15).

ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

The ongoing conflict in Benghazi, Libya, since 2011, has profoundly disrupted the lives of its residents, particularly affecting pregnant women and their pregnancy outcomes (16). The conflict has led to the destabilization of food supply chains, economic hardship, and population displacement, which likely compromised the availability and affordability of nutritious foods and supplements essential for maternal health. During armed conflicts, women are particularly vulnerable to severe malnutrition, which can exacerbate risks of complications such as difficult labor, premature birth, low birth weight, and maternal mortality from severe anemia (17,18). Despite the critical importance of maternal nutrition and the adverse conditions faced by Libya in recent years, there remains a significant gap in understanding the dietary intake and supplement consumption among pregnant women in the region (19). Current data suggest that Libya has made limited progress in addressing diet-related health issues, including anemia and childhood stunting (20).

The aim of this study is to elucidate the dietary intake and folic acid supplementation practices during the first trimester of pregnancy among women in private clinics in Benghazi. The findings are anticipated to enhance comprehension of the nutritional needs of pregnant women in conflict-affected areas. By analyzing dietary habits and supplementation practices in Benghazi, Libya, the findings will inform evidence-based recommendations for policymakers and healthcare providers both local and worldwide in similar contexts. These insights will guide the development of effective interventions to

ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

address their unique needs and promote healthier pregnancies.

Subjects and Methods:

Sample selection and study design

This is a cross-sectional study and the data was collected from five private antenatal clinics; (Alom Alhanon, Al Nukhba, Al Madina, Eben Seena and Al Tarek clinic) in Benghazi city. The clinics were chosen based on their size and popularity as private women's health clinics within Benghazi to ensure we could reach a significant portion of the target population. This design allows for the collection of data from a diverse group of participants at a single point in time, facilitating a comprehensive analysis of nutritional practices in this specific population during the periconceptional time. Data were collected through structured interviews and questionnaires administered to participants recruited using a convenience sampling method. Trained female researchers conducted the interviews to ensure cultural sensitivity and respect local traditions. The inclusion criteria were females in their first trimester with no medical complications and agreed to enroll in the study were included.

Data collection and study tool

1.A questionnaire was developed by the research team to achieve the aims of this study. It was divided into three sections as follows:

2.Socio-demographic section: Contains questions on age, nationality, educational level, occupational status and family income. Included questions about pre pregnancy and current use of FA and multivitamins and anthropometric measurements (weight and height) pre pregnancy.

3.Dietary intake: A translated and adapted version of the EPIC -FFQ (21) was used to assess the dietary

ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

intake of the participants. This questionnaire is a validated tool designed to measure an individual's usual food consumption over the previous 12 months.

The questionnaire includes a list of 130 foods and asks participants to rate how often they consume each item. The frequency options range from never to multiple times per day. The serving sizes are specified in units, portions, or household measures. A standard portion size is used for all participants, regardless of their age or gender. EPIC-FFQ was adapted for the Libyan population. Foods frequently consumed in Libya and not available in the list was added (such as cuscus, dates, olives) while foods and beverages that are not consumed by the Libyan population were deleted, such as food contains pork and alcoholic beverages. Two bilingual experts in nutrition reviewed the final Arabic version of EPIC-FFQ. The questionnaire was transformed into digital format. To ensure data accuracy and reliability, field researchers underwent rigorous training in FFQ administration, portion size estimation, data entry, and ethical guidelines for data collection.

Data analysis:

Body mass index (BMI) was calculated using the standard formula: BMI = Weight (kg) / Height $(m)^2$. Participants were categorized into weight status groups: underweight (<18.5), normal weight (18.5-25), overweight (25-30), and obese (≥30). Dietary intake data, collected using the EPIC-FFQ, was analyzed using the FETA software (Mulligan et al. 2014). FETA is a specialized tool designed for analyzing dietary data from EPIC-FFQs. It was used to calculate the average daily intake of energy, macronutrients (car-

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bohydrates, proteins, and fats), and micronutrients (vitamins and minerals). Descriptive statistics: frequency (percentage), mean (± SD) and median (IQR), were used to summarize demographic, socioeconomic, and dietary intake data. Chi-square tests were employed to assess associations between FA supplementation and socio-demographic factors. Independent sample t-tests were used to compare fiber intake with the recommended amount of 14 g per 1000 kcal. One-sample t-tests were used to compare the mean intake of key vitamins and minerals with the recommended dietary intakes for pregnant women (22). Statistical significance was set at a p-value of <0.05. Data were analyzed using IBM SPSS Statistics version 26.

Ethical Considerations:

The University of Benghazi Review Board approved the study design. Before initiating recruitment, official letters were sent to the administrators of the selected private clinics in Benghazi, outlining the study's objectives and seeking their cooperation to facilitate participant enrollment. All potential participants who met the inclusion criteria were provided with a detailed information about the purpose of the study and the confidentiality measures followed by the research team. A written consent form in the Arabic language was signed by each participant. To ensure confidentiality, no personal identifiers were used on the survey forms and all collected data was anonymized and stored securely.

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Results:

From the 93 approached females, 74 pregnant females fulfilled the inclusion criteria and agreed to be enroll in the study (80% response rate). Half of the participants were recruited from the Alom Alhanon clinic, 24% were recruited from Al Nukhba clinic and 25% were recruited from the other clinics. All participants (n = 74) provided complete data for all variables of interest. The age ranged from 17 to 40 years with a mean of 28 years (SD 5.3). All participants were married for a period ranging from 3 months to 16 years, 58% held university degrees or higher. Thirty percent of them had jobs, while the rest were housewives. Fifty seven percent of the husbands were employed, while the rest being self-employed. The family income of 54% of the participants was 1000 LD (approximately $220) or less. The majority of respondents (82%) reported that husbands were the primary earners in the household, while 16% indicated shared financial responsibility between spouses. Table (1) shows the basic characteristics of the participants.

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https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

Table .(1) : Demographic characteristics of 74 participants included in the study

Characteristic (Total= 74)	No. (%)
Clinic	
Alom Alhanon	37(50)
Al Nukhba	19(25.6)
Other clinics	18(24.4)
Family income	
Less than 1000 Libyan dinars	40(54)
1000-1500 Libyan Dinar	27(36.5)
More than 1500 Libyan dinars	7(9.5)
Education level	
Primary school	10(13.5)
Secondary school	21(28.4)
University degree or higher	43(58.1)
Occupation	
Housewife	52 (70)
Employee	22(30)
Age	
<30 Year	47 (63.5)
≥30 Year	27 (36.5)
Pre pregnancy BMI	
Under weight	3 (4.1)
Normal	39 (52.7)
Over weight	20 (27)
Obese	12 (16.2)
First pregnancy	
Yes	28(37.8)
No	46(62.2)
Supplement intake*	
FA before pregnancy	19 (26)
FA after pregnancy	62 (83.7)
Multivitamins after pregnancy	15 (20.3)
*Some of the participants took the FA and/or supplements before and after pregnancy.	

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Anthropometric Measurements and Folic Acid (FA) Intake

The mean Body Mass Index (BMI) among participants was 24.9 (SD 4.5), indicating a normal weight status; however, 4% were classified as underweight, and 43% were categorized as overweight or obese (Table 1). Regarding FA intake, 26% of participants began consuming FA before pregnancy, while 58% initiated intake only after becoming pregnant, and 16% did not take FA at all. Additionally, only 20% reported taking multivitamins during their current pregnancy. A Chi-square test indicated no significant association between FA consumption prior to pregnancy and variables such as duration of marriage ($p = 0.64$), first-time pregnancy ($p = 0.79$), family monthly income ($p = 0.88$), or educational attainment ($p > 0.20$).

Daily average intake of food groups

As shown in Table 2, the daily average intake of various food groups revealed key insights. The median (IQR) daily intake was as follows: vegetables 228 g (133 g), milk and dairy products 395 g (298 g), fruits 220 g (309 g), fish and fish products 19 g (48 g), meat and meat products 141 g (93 g), and eggs and egg dishes 41 g (28 g).

Daily average intake of energy, macro and micronutrients and comparison with recommendations

As table (2) shows, the median daily energy intake was 10 MJ (5 MJ), with fat at 93 g (56 g), protein at 109 g (54 g), carbohydrates at 284 g (139 g), and fiber at 14 g (29.3 g). Analysis indicated that the distribution of energy from macronutrients fell within acceptable recommendations, with carbohydrates comprising 47.8%, protein 18.3%, and

ISSN: Online 3005-7450, ISSN:Link 3005-7442
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fat 36.3% of total energy intake. However, there was considerable variability in macronutrient intake, with carbohydrates ranging from 28.5% to 64.4%, protein from 10.3% to 30.7%, and fat from 26.3% to 45.2%.

The recommended dietary intake for fiber is 14 g per 1000 kcal (Institute of Medicine 2006). A new variable was created to calculate the fiber recommendations for each participant according to their reported energy intake using the formula:

The recommended dietary intake for fiber is 14 g per 1000 kcal (Institute of Medicine, 2006). An independent sample t-test comparing current fiber intake (mean 15.05 g, SD 6.39) with the recommended intake (mean 35.4 g, SD 12.77) revealed a significant deficiency (p < .001), with a difference of 20.36 g (95% CI: -23.65, -17.07).

ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

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Table .(2): Mean and median food groups, macronutrients and energy intake (g/day) and the percentage of energy distribution from macronutrients among the 74 participants.

Food Group/Nutrient	Mean ± SD	Median (IQR)
Eggs and Egg Dishes (g/day)	44.4 ± 39.39	41 (29)
Meat and Meat Products (g/day)	158.8 ± 103.45	140.9 (92.91)
Fish and Fish Products (g/day)	40.7 ± 72.30	19.29 (47.54)
Milk and Milk Products (g/day)	461.3± 245.93	395.03 (222.69)
Fruit (g/day)	271.7 ± 214.96	220.40 (187.33)
Vegetables (g/day)	239.5 ± 129.5	228.32 (132.66)
Englyst Fiber Non-Starch Polysaccharides (NSP)	15.05 ± 6.39	14.14 (8.8)
Total energy intake (MJ)	10.6 (3.8)	10 (5)
Carbohydrate (g/day)	299.98 ± 111.09	284.33 (138)
Percentage of energy from Carbohydrate	47.8	
Protein (g/day)	116.10 ± 46.50	108.95 (53.7)
Percentage of energy from Protein	18.5	
Total Fat (g/day)	104.41 ± 44.37	92.96 (55.8)
Percentage of energy from Fat	36.7	

Table (3) illustrates micronutrient intake and comparisons with the Recommended Dietary Intake (RDI) for pregnant women aged 19 to 50 years. In summary, while the mean daily intake of Vitamin A, Vitamin C, Calcium, and Selenium exceeded the RDI, intakes of Iron and Folate were significantly below recommendations ($p < 0.001$), as detailed in Table (3). Intakes of Vitamin B12, Zinc, and Vitamin D met the RDI.

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Table .(3): A comparison between average daily intake of key vitamins and minerals and the dietary reference intake (DRI) for pregnant women aged 19-50 using one sample t test

	Mean ± SD	DRI	p value	95% Confidence Interval of the Difference	
Vitamin A retinol (µg/ day)	1708± 1784	770	<0.001	525.0	1351.6
Vitamin C (mg/day)	123 ± 57.7	85	<0.001	25.1	51.8
Iron (mg/day)	12.6 ± 5.4	27	<0.001	-15.6	-13.1
Calcium (mg/day)	1294 ± 447	1000	<0.001	190.8	397.9
B12 (µg/day)	11.4 ±10.2	2.6	0.25	-0.3	0.1
Zinc (mg/day)	12.8 ± 5.5	12	0.20	-0.5	2.1
Selenium (µg/day)	90.2± 46	60	<0.001	19.6	40.9
Folate (µg/day)	280 ± 104	600	<0.001	-505.9	-485.3
Vitamin D (µg/day)	5.5 ± 6.1	5	0.50	-1.0	1.9

ISSN: Online 3005-7450, ISSN:Link 3005-7442
https://www.journals.uob.edu.ly/BUMEJ DOI: https://doi.org/10.37376/benuivmedj.v1i2

Discussion:

This study aimed to evaluate the dietary intake and FA use among pregnant women in Benghazi, Libya, following eight years of political instability and armed conflict. The findings revealed an imbalanced dietary intake among participants, despite seemingly adequate total energy intake and macronutrient distribution.

Although the participants consumed sufficient energy and macronutrients, significant deficiencies were observed in key nutrients such as fiber, iron, and folate. Notably, fruit and vegetable consumption exceeded the recommended five servings daily, but this did not compensate for the lack of essential micronutrients. The diet also exhibited elevated levels of vitamin A, which, while essential for fetal development, can have teratogenic effects if consumed excessively from animal sources like liver (23) . The mean daily intake of Vitamin A among the pregnant women in this study was significantly higher than the DRI of 770 µg/day ($p<0.001$). The 95% confidence interval for the difference between the mean intake and the DRI (525.0 to 1351.6) further supports this observation, indicating that the average intake substantially exceeds the recommendation. A balanced approach emphasizing plant-based sources of vitamin A and avoiding excessive intake from animal-based sources or supplements is crucial. The study's findings were compared with other studies one from Libya (Misurata city) in Libyan females that was published in 2018 (24), and one from the United States in pregnant females that was published in 2023 (25). For instance, there was similarity in intake of energy (10.6 vs 11 MJ/day) and vitamin D (5.5 vs 5.1 µg/

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day), to those reported by Faid et al. in 2018 in Misurata city in Libya, but differences were noted in carbohydrate, protein, and fat consumption. Where our participants had higher carbohydrate (300 vs 232 g/day) and protein (116 vs 96.6 g/day) intake and lower fat intake (104 vs 129 g/day) compared to Faid et al. study. These discrepancies can be attributed to differences in study populations such as age and BMI. The participants in this study were younger (28 ± 5.3 years) and had a lower BMI (24.9 ± 4.5) compared to Faid et al. study (33.0 ± 9.3 years and 33 ± 9.3 BMI) and regional dietary variations and preferences, since Misurata city is located >800 km to the west of Benghazi (24).

When compared to a US study by Olendzki et al. that was conducted in 2023 (25), our participants consumed more energy (10.6 ± 3.8 vs 8.7 ± 2.2 MJ), but the percentage of energy from macronutrients was comparable. However, significant disparities in micronutrient content were observed, with lower consumption of iron (12.6 ± 5.4 vs 16 ± 5.6 mg), selenium (90.2 ± 46 vs 117.4 ± 40.8 µg), and folate (280 ± 104 vs 460.4 ± 143 µg) in current study. Calcium and zinc intakes were similar between the two studies (25). However, factors related to dietary assessment and analysis tools could limited these comparisons.

Only 26% of the participants-initiated FA supplementation before pregnancy as recommended (9). This rate was higher than that reported by Abdulmalek (2017) in Benghazi, where only 6% of women started FA supplementation before pregnancy. Post-pregnancy supplementation rates were also higher in this study (83.8% vs 74%). These differences may be due to demographic varia-

ISSN: Online 3005-7450, ISSN:Link 3005-7442
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tions, as the current study focused on pregnant women attending private clinics with higher educational attainment (26).

The low iron intake was consistent with the high prevalence of anemia among childbearing women in Libya, estimated at 29.9% in 2019 by the WHO (27) Iron deficiency anemia can lead to significant maternal and fetal complications, highlighting the need for targeted interventions to address this issue.

The study highlights a significant disparity between the high educational attainment and low employment rates among the participants. Despite 58% holding a university degree or higher, only 30% of these educated women were employed. This reflects a common challenge in Arab societies, where cultural and societal norms often prioritize family and domestic roles for women, limiting their workforce participation. This limited economic independence has profound implications for household income and the ability to access nutritious food and quality healthcare. The majority of households in the study had a monthly family income of ≤1500 Libyan Dinar (approximately $330), a relatively low figure. This economic structure restricts women's financial autonomy, even with high educational levels, hindering their ability to make independent decisions regarding their diet, healthcare, and overall well-being.

A significant proportion of participants (43%) were categorized as overweight or obese before pregnancy, which is lower than the national prevalence 66.8% in 2016 (27), but still raises concerns about potential adverse pregnancy outcomes. Pre-pregnancy obesity is associated with adverse health

ISSN: Online 3005-7450, ISSN:Link 3005-7442
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effects for the mother and the baby.

The conflict may not have led to acute malnutrition directly in this group but it could have contributed to a state of “masked malnutrition” characterized by imbalanced diets. However, establishing a definitive connection between these dietary deficiencies and the conflict is challenging due to several limitations such as the lack of data about diet and FA intake before the conflict. However, one can anticipate several factors associate the conflict with the observed situation. The first is the economic instability and reduced household incomes could have limited access to diverse and nutritious food options, forcing families to choose cheaper, often less nutritious alternatives. The second is the disruption of health care and shifting the priorities towards emergency services during the conflict, compromising the provision of essential maternal health services, including nutritional counseling and prenatal care.

This study represents a significant contribution to the limited literature on maternal nutrition in challenging environments. It provides valuable insights into the dietary habits of pregnant Libyan women within a specific sociocultural and economic context. However, limitations include the retrospective nature of the dietary assessment tool, which may be subject to recall bias, and the use of a convenience sample from private healthcare centers, potentially limiting the generalizability of the findings. A limitation of this study is the reliance on self-reported pre-pregnancy weight and height, which may be subject to recall bias. However, this method was chosen to establish a baseline BMI that was less likely to be

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masked by the initial weight fluctuations that can occur during the first trimester of pregnancy. The small sample size further restricts the ability to draw definitive conclusions. Future research should incorporate biomarker validation, utilize larger and more diverse samples, and conduct qualitative studies to explore the sociocultural factors influencing dietary choices and access to healthcare. While the EPIC-FFQ has been validated in other contexts, further investigation may be necessary to confirm its applicability in the Libyan context.

Public Health Implications:

The observed imbalances in nutrient intake among pregnant women in Benghazi may have significant implications for maternal and fetal health. Addressing these nutritional gaps requires a multipronged public health approach. This should include nutrition education emphasizing balanced diets and the importance of essential nutrients like iron and folic acid, food fortification to enhance the micronutrient content of staple foods, supplementation programs for women of childbearing age, and strengthening maternal health services to ensure access to quality prenatal care, including regular check-ups and nutritional counseling. By implementing these strategies, we can effectively improve the nutritional status of pregnant women in Benghazi and contribute to better maternal and fetal health outcomes.

In conclusion, this study elucidating the dietary intake and folic acid supplementation practices during the first trimester of pregnancy in Benghazi revealed significant dietary inadequacies, specifically low intakes of fiber, iron, and folate despite seemingly adequate energy and macronu-

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trient consumption. Additionally, the uptake of pre-conception folic acid supplementation was low. These findings highlight substantial nutritional challenges faced by pregnant women in this conflict-affected region, underscoring the need for targeted interventions to improve their dietary quality and folic acid use to promote healthier pregnancies.

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