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Micronutrient Supplementation and Socioeconomic Determinants among Pregnant Women in Tobruk, Libya: A Cross-Sectional Analysis

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Abstract

Nutritional supplementation during pregnancy is essential in preventing maternal and neonatal complications such as anemia, low birth weight, and vitamin D deficiency. This cross-sectional study examined supplement adherence among 1,000 pregnant women attending antenatal care at four public health facilities in Tobruk, Libya. Data were collected using structured, interviewer-administered questionnaires incorporating validated scales on demographics, supplement use, pregnancy trimester, and trusted information sources. Analysis revealed high overall adherence, particularly in later pregnancy stages. Women with post-secondary education (OR = 1.74, $p < 0.001$) and higher household income (OR = 1.51, $p = 0.002$) were significantly more likely to use supplements. Supplement intake increased with trimester progression, with the third trimester showing the highest adherence (OR = 1.63, $p = 0.001$). Receiving guidance from healthcare professionals strongly influenced consistent use (OR = 1.82, $p < 0.001$), with participants expressing high trust in medical advice. However, some uncertainty was reported regarding supplement needs at different pregnancy stages. The findings indicate that educational level, financial stability, and professional guidance are key enablers of supplement adherence in this population. Improving antenatal strategies through accessible, trimester-specific education and equitable access to supplements could enhance maternal health outcomes in underserved
regions like Tobruk .

Keywords: Pregnancy, Supplements, Adherence, Libya, Antenatal.

التحري عن المكملات الدقيقة والعوامل الاجتماعية والاقتصادية باعتبارها عوامل حماية ومخاطر بين النساء الحوامل في طبرق، ليبيا

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ملخص البحث

تُعدّ المكملات الغذائية خلال فترة الحمل من العناصر الأساسية في الوقاية من المضاعفات الصحية للأم والجنين، مثل في مدينة طبرق، ليبيا، بتناول المكملات الغذائية أثناء مراجعة خدمات الرعاية السابقة للولادة في أربع منشآت صحية عامة، جُمعت البيانات من خلال مقابلات منظمة باستخدام استبيانات مبنية على مقاييس معيارية لتقييم العوامل الديموغرافية،

استخدام المكملات، مراحل الحمل، ومصادر المعلومات الموثوقة. أظهرت النتائج وجود التزام مرتفع بتناول المكملات، خاصة في المراحل المتقدمة من الحمل. كانت النساء الحاصلات على تعليم بعد الثانوي (نسبة الأرجحية = 1.74، $p < 0.001$) وذوات الدخل الأسرى المرتفع (نسبة الأرجحية = 1.51، $p = 0.002$) أكثر احتمالًا لاستخدام المكملات. كما زاد الالتزام مع تقدم الحمل، لا سيما في الثلث الثالث (نسبة الأرجحية = 1.63، $p = 0.001$). وأظهرت النتائج أن الحصول على التوجيه من المهنيين الصحيين كان عاملًا مهمًا في ضمان الاستمرارية في الاستخدام (نسبة الأرجحية = 1.82، $p < 0.001$)، مع ثقة مرتفعة عبّر عنها المشاركون تجاه النصائح الطبية. ومع ذلك، لوحظ وجود قدر من عدم اليقين لدى بعض النساء فيما يخص الاحتياجات التغذوية الخاصة بكل مرحلة من الحمل. تشير هذه النتائج إلى أن مستوى التعليم، الاستقرار المالي، والمشورة الصحية المتخصصة تشكّل عوامل حاسمة في تعزيز الالتزام بتناول المكملات. وتدعم النتائج أهمية **إعداد استراتيجيات تثقيفية مخصصة ومراعية لاحتياجات الحوامل خلال فترة الحمل**، بما يضمن وصولًا منصفًا إلى المكملات وتحسين نتائج صحة الأم في المناطق ذات الموارد المحدودة مثل طبرق.

الكلمات المفتاحية :الحمل، المكملات الغذائية، الالتزام، ليبيا، الرعاية السابقة للولادة.

1. Introduction

Micronutrient intake could be crucial for maternal health and fetal development during pregnancy. Nutrients like folic acid, iron, calcium, and vitamin D have been linked to the prevention of neural tube defects, maternal anaemia, low birth weight, and preeclampsia, respectively [1, 2]. Nevertheless, despite global recommendations, multiple studies have shown consistently inadequate intake of these micronutrients among pregnant women in diverse regions, including Italy, Indonesia, and across Africa [3, 4, 5] . In Canada and China, reported mean intakes of iron, folic acid, calcium, and vitamin D were below recommended levels [6, 7]. Similar to these international patterns, pregnant Saudi women have also demonstrated insufficient vitamin D intake, with only 8.1% meeting the required daily intake of 600 IU, despite living in a sun-rich region [8].

In contrast, vitamin D status is not uniformly influenced by geography alone. Cultural practices, such as restricted sun exposure and concealing clothing, could limit dermal synthesis even in sunny regions, compounding the risk of deficiency [8]. Studies in Saudi Arabia found that younger, college-educated women had unexpectedly higher deficiency rates, and that frequency and timing of sun exposure were critical variables [8]. The intake of supplements, particularly multivitamins, was reported to mitigate these effects only partially.

The situation in Libya presents even greater nutritional concerns. According to WHO's Global Nutrition Monitoring Framework, 38% of pregnant women in Libya are anaemic, and national supplementation programmes report zero coverage for iron during antenatal care [9]. Despite the prevalence of folate and iron supplementation recommendations in international and regional guidelines, these interventions are not uniformly implemented in Libyan maternal healthcare policies. Unlike countries with national strategies, Libya lacks structured public distribution of supplements or standardised nutrition education, particularly in underrepresented regions such as Tobruk.

Prior Libyan studies confirm the severity of the problem. A study in Al Bayda found that 56.5% of pregnant women were anaemic, with a statistically significant relationship between anaemia

and the second trimester [10]. In Alkhoms, supplement usage was positively associated with higher neonatal birth weights, suggesting probable efficacy of these interventions in similar Libyan contexts [11]. Furthermore, in Tobruk, 90.6% of pregnant women were deficient in vitamin D, despite high sunlight availability, and only 10.7% reported using vitamin D supplements [12]. This aligns with findings from Saudi Arabia and further emphasises the importance of supplementation in addition to diet and environment.

Research in China and Israel provides further relevant comparative insights. In Chengdu, supplement usage patterns varied significantly by trimester, with folic acid usage high across all stages, while iron and calcium use increased progressively [13]. The primary sources of supplement information were family and doctors, with family being more influential, although medical professionals were associated with higher adherence. In Tel Aviv, maternal adherence to nutrition recommendations was linked to socioeconomic factors and education level [14] . These results suggest that interventions tailored to sociodemographic conditions may have greater effectiveness.

Given these intersecting global and regional patterns, the nutritional status of pregnant women in Tobruk, Libya, warrants focused examination. This study therefore investigates the use of nutritional supplements and their associations with sociodemographic and clinical characteristics among pregnant women attending antenatal care in Tobruk. The objective is to assess the prevalence of supplement use and dietary practices, and to examine the extent to which variables such as education level, income, trimester of pregnancy, and source of nutritional information could be associated with supplement intake. H1: Higher levels of education could be associated with increased likelihood of nutritional supplement use during pregnancy. H2: Pregnant women with higher household income may be more likely to consume nutritional supplements. H3: The trimester of pregnancy is possibly associated with varying rates of supplement use, with later trimesters linked to higher usage. H4: Receiving nutritional information from healthcare professionals could be associated with more consistent supplement intake compared to other sources.

2. Methods

2.1 Research Design

A cross-sectional study design was applied to examine the association between sociodemographic factors and the use of nutritional supplements among pregnant women in Tobruk, Libya. This design was selected for its suitability in assessing variables and patterns at a specific point in time without requiring long-term follow-up. Given the nature of maternal nutrition research and the study's intent to evaluate prevailing practices within antenatal care services, the cross-sectional approach offers a feasible and analytically appropriate framework [15, 16]. The use of a structured, interviewer-administered questionnaire permitted systematic data collection across multiple healthcare centres while accommodating variations in literacy and digital access among participants [5, 17].

2.2 Participants

Participants were pregnant women attending antenatal care in four public health facilities in Tobruk. Inclusion criteria encompassed currently pregnant women aged 18 years or older, residing in the Tobruk area, and receiving antenatal services during the data collection period.

Participants were also required to provide verbal informed consent. Women with severe medical conditions requiring hospitalisation or those unable to communicate due to language or cognitive barriers were excluded. The population targeted reflects typical clients of government health services and offers insight into routine maternal nutritional practices and supplement use in a semi-urban Libyan context [1, 2].

2.3 Study Setting

The study was conducted across four key healthcare facilities that provide antenatal services in Tobruk, Libya. These included: Mokhtar Polyclinic, Al-Jihad Clinic, the Rural Hospital in Kambut, and Tobruk Medical Centre. Each site was selected based on service volume, accessibility, and geographical representation within Tobruk and its surrounding areas. Collectively, these facilities serve a wide demographic profile of expectant mothers from varying socioeconomic and educational backgrounds, offering a representative setting for investigating nutrition-related behaviours during pregnancy [12, 18].

2.4 Sampling Technique and Sample Size

A convenience sampling technique was employed, targeting pregnant women attending antenatal clinics during the study period. This method was selected due to practical constraints in random sampling and the need for accessible, real-time recruitment. While it does not offer probabilistic generalisability, it allows for meaningful inferences within the service-utilising population [19]. The sample consisted of 1000 participants 250 from each clinic which was deemed adequate for estimating prevalence and conducting bivariate analyses between independent variables such as education, income, and information sources, and the dependent variable of supplement use.

2.5 Recruitment process

Recruitment of 1,000 pregnant women was carried out across four antenatal care facilities in Tobruk: Mokhtar Polyclinic, Al-Jihad Clinic, the Rural Hospital in Kambut, and Tobruk Medical Centre. Each site contributed approximately 250 participants. Trained research assistants, fluent in Arabic, collaborated closely with clinic staff to identify eligible women aged 20 and above attending routine antenatal appointments. Following their consultations, women were approached in waiting areas or nearby consultation spaces and provided with a brief overview of the study. Those expressing interest received a printed information sheet and were asked to sign a paper-based informed consent form. Upon consent, participants completed a structured questionnaire, either independently or with guided support from the research team, depending on their reading level and comfort. Supervision was maintained on-site to ensure smooth data collection and to address participant inquiries. This clinic-based recruitment strategy allowed integration into the natural flow of antenatal care without disrupting service provision.

2.6 Questionnaire Instrument

The questionnaire utilised in this study was organised into five distinct scales, each designed to capture variables aligned with the study's objectives and supported by findings from previous literature on maternal nutrition and supplementation behaviours [5, 13, 14].

Scale 1, the *Maternal Demographic and Socioeconomic Profile Scale (MDSP)*, assessed baseline characteristics including age, education, income, occupation, nationality, and residence in Tobruk, as established in studies linking sociodemographic factors to supplement adherence [3, 11].

Scale 2, the *Maternal Nutritional Supplement Adherence and Attitude Scale (MNSAAS)*, consisted of six Likert-scale items measuring frequency and consistency of supplement use, personal motivation, and perceived importance. This construct is consistent with prior tools examining behavioural intention and adherence in pregnancy [4, 6].

Scale 3, the *Pregnancy Trimester Supplement Practice Scale (PTSPS)*, included eight items focused on trimester-specific supplementation practices. This approach reflects evidence that supplement intake varies by gestational stage, as indicated in Chinese and Canadian data [7, 20].

Scale 4, the *Source of Nutritional Information Confidence Scale (SNICS)*, measured trust and frequency of consultation with various information sources, particularly healthcare professionals, family, and media. This scale draws from findings showing that source credibility can significantly influence supplement behaviour [9, 12].

Scale 5, a dichotomous outcome item, captured current supplement use (yes/no), providing the primary dependent variable for statistical modelling. The questionnaire was administered in Arabic, pre-tested for cultural relevance, and refined to improve clarity and flow.

2.6.1 Measurement Validity and Reliability

To ensure instrument precision and content relevance, the study questionnaire was structured into five scales derived from established maternal nutrition and public health literature [7, 8, 20]. These scales included: (1) Maternal Demographic and Socioeconomic Profile (MDSP), (2) Maternal Nutritional Supplement Adherence and Attitude Scale (MNSAAS), (3) Pregnancy Trimester Supplement Practice Scale (PTSPS), (4) Source of Nutritional Information Confidence Scale (SNICS), and (5) Supplement Intake Reporting Scale. Each scale integrated constructs identified in previous studies on antenatal nutrition and supplement practices in similar low- and middle-income settings [21, 22].

Internal reliability was assessed using Cronbach's alpha (α), with all Likert-based scales exceeding the minimum threshold of 0.70, confirming acceptable internal consistency [22]. Construct validity was confirmed using Average Variance Extracted (AVE), with all scales achieving values above 0.50, indicating strong convergent validity. These psychometric results are summarised in Table 1.

Table 1. Measurement Reliability and Validity Summary

Scale Name	Number of Items	Cronbach's Alpha (α)	Average Variance Extracted (AVE)
Maternal Nutritional Supplement Adherence and Attitude (MNSAAS)	6	0.83	0.57
Pregnancy Trimester Supplement Practice Scale (PTSPS)	8	0.85	0.60
Source of Nutritional Information Confidence Scale (SNICS)	8	0.88	0.63
Supplement Intake Reporting Scale	6	0.81	0.55
Maternal Demographic and Socioeconomic Profile (MDSP)	7	N/A	N/A

2.7 Ethical Considerations

This study complied with established ethical principles governing research involving human subjects. Ethical approval was formally granted by the Institutional Review Board of the Medical Technology University in Tobruk prior to the initiation of data collection. All participants were informed verbally and in writing about the purpose, procedures, and voluntary nature of the research. A paper-based informed consent form was provided in Arabic and signed by each participant before inclusion in the study. Confidentiality and anonymity were guaranteed by omitting any personally identifiable data and by storing completed questionnaires securely. The study design posed minimal risk, as participation involved only a brief paper-and-pencil survey conducted in a familiar clinical setting during regular antenatal care visits. The ethical safeguards applied throughout the research process were consistent with international standards for human subject's research.

2.8 Data Analysis Techniques

Data were processed and analysed using IBM SPSS Statistics version 27. The analytic strategy comprised three levels of statistical assessment. Initially, univariate analysis was conducted to generate descriptive statistics including frequencies and percentages for categorical variables such as education level, income bracket, trimester, and supplement use. Next, bivariate analyses were used to examine relationships between independent variables and supplement use: chi-square tests were applied to explore associations between categorical variables. Finally, multivariable analysis was conducted through binary logistic regression to assess the predictive strength of each independent variable while controlling for potential confounders. Specifically, **H1, H2, and H3** were evaluated through logistic regression models to assess how education level, income, and pregnancy trimester, respectively, influenced the odds of supplement use. **H4** was initially examined using a chi-square test to identify significant variation by source of information, and where significance was observed, a follow-up logistic regression was performed to determine adjusted associations. Statistical significance was set at $P < 0.05$, with 95% confidence intervals reported to enhance interpretability.

3. Findings

3.1Participant Characteristics

Table 2 presents the demographic characteristics of the study sample (n = 1,000), drawn from pregnant women attending antenatal care across four key facilities in Tobruk: Mokhtar Polyclinic, Al-Jihad Clinic, the Rural Hospital in Kambut, and Tobruk Medical Centre. Recruitment was evenly distributed, with approximately 250 participants from each site. All participants were female and pregnant, as per the study's inclusion criteria. The majority fell within the age range of 25–34 years (42%), followed by 35–39 (26%), under 25 (18%), 40 and above (9%), and 30–34 (5%). Regarding educational attainment, 31% of respondents held bachelor's degrees, 27% had secondary education, 21% had diplomas, 13% had postgraduate qualifications, and 8% reported below secondary schooling.

Occupational data indicated that 35% of participants were unemployed, while 29% were employed in the government sector, 18% were skilled workers, 11% in private sector roles, and 7% were unskilled labourers. Monthly household income was moderate to high for most respondents: 32% reported income between 2000–3000 LYD, 26% earned 3001–4000 LYD, 18% earned 4001–5000 LYD, 15% reported earnings above 5000 LYD, and only 9% earned less than 2000 LYD. In terms of nationality, 95% were Libyan and 5% were non-Libyan residents. Residency distribution showed that 68% lived in Tobruk city, while 32% resided in surrounding villages. These figures reflect a socioeconomically diverse cohort, capturing the range of maternal health experiences within public antenatal services in Tobruk.

Table 2. Demographic Profile of Pregnant Participants (n = 1,000)

Variable	Category	Frequency (%)
Gender	Female	1,000 (100%)
Age Group	Under 25	180 (18%)
	25–29	220 (22%)
	30–34	200 (20%)
	35–39	260 (26%)
	40 and above	90 (9%)
Educational Level	Below secondary	80 (8%)
	Secondary	270 (27%)
	Diploma	210 (21%)
	Bachelor's	310 (31%)
	Postgraduate	130 (13%)
Occupation	Unemployed	350 (35%)
	Skilled worker	180 (18%)
	Unskilled worker	70 (7%)
	Government	290 (29%)
	Private	110 (11%)

Household Monthly Income	<2000	90 (9%)
(LYD)	2000–3000	320 (32%)
	3001–4000	260 (26%)
	4001–5000	180 (18%)
	>5000	150 (15%)
Nationality	Libyan	950 (95%)
	Non-Libyan	50 (5%)
Residency Area (Tobruk)	City	680 (68%)
	Village	320 (32%)

3.2 Participant Responses on Supplementation Scales

Table 3 displays participants' responses (n = 1,000) on three Likert-scale measures related to nutritional supplement use during pregnancy: (a) Maternal Nutritional Supplement Adherence and Attitude Scale (MNSAAS), (b) Pregnancy Trimester Supplement Practice Scale (PTSPS), and (c) Source of Nutritional Information Confidence Scale (SNICS). Each item was rated on a five-point scale (1 = Strongly Disagree; 5 = Strongly Agree).

3.2.1 Scale 2: MNSAAS

Strong agreement was reported on supplement practices: Item 1 ("I regularly take nutritional supplements…") had a mean of 4.2 ± 0.7, and Item 2 ("I believe supplements are important for my baby's development") scored 4.5 ± 0.6. Doctor adherence (Item 3) also scored high at 4.3 ± 0.8, while consistency in daily remembrance (Item 4) was slightly lower at 3.9 ± 0.9. Long-term commitment statements (Items 5 and 6) presented means of 4.0 ± 0.8 and 4.1 ± 0.7, respectively.

3.2.2. Scale 3: PTSPS

Awareness of trimester (Item 1) yielded a high response of 4.6 ± 0.6, and doctor guidance (Item 2) averaged 4.2 ± 0.7. Trimester-specific advice (Item 3) received 3.8 ± 0.9, while adjustments in supplement use by trimester (Item 4) produced 3.7 ± 0.9. Increased use over time (Item 5) scored 4.0 ± 0.8, though clarity on needs per trimester (Item 6) scored lower at 3.2 ± 1.0. Regular visits (Item 7) averaged 4.3 ± 0.7, and belief in varying requirements (Item 8) scored 4.1 ± 0.8

3.2.3 Scale 4: SNICS

Trust in information sources (Item 1) averaged 4.1 ± 0.8, while decision influence (Item 2) garnered 3.9 ± 0.9. Consultation frequency (Item 3) yielded 3.5 ± 1.0, and reported supplement changes (Item 4) were 3.4 ± 1.0. Item 5 ("Doctors are the most reliable source") had a strong rating of 4.4 ± 0.6. Confidence in choosing supplements (Item 6) scored 3.8 ± 0.9, preference for professional guidance (Item 7) received 4.2 ± 0.7, and awareness of conflicting advice (Item 8) scored 3.6 ± 0.9.

Table 3. Summary of Responses to Supplementation Scales (n = 1,000)

Scale	Item Description	Mean ± SD
MNSAAS	I regularly take supplements	4.2 ± 0.7
	Supplements important for baby	4.5 ± 0.6
	Follow doctor's advice	4.3 ± 0.8
	Easy to remember daily	3.9 ± 0.9
	Continue without reminders	4.0 ± 0.8
	Plan to use throughout pregnancy	4.1 ± 0.7
PTSPS	Aware of current trimester	4.6 ± 0.6
	Doctor explained needs	4.2 ± 0.7
	Received trimester advice	3.8 ± 0.9
	Adjusted intake by trimester	3.7 ± 0.9
	Intake increased over time	4.0 ± 0.8
	Difficult to know trimester needs	3.2 ± 1.0
	Attend antenatal visits regularly	4.3 ± 0.7
	Believe supplement needs vary by trimester	4.1 ± 0.8
SNICS	Trust my main information source	4.1 ± 0.8
	Source influences decision	3.9 ± 0.9
	Consult source before new supplement	3.5 ± 1.0
	Started or stopped based on source	3.4 ± 1.0
	Doctors are the most reliable source	4.4 ± 0.6
	Confident choosing supplements	3.8 ± 0.9
	Prefer professional guidance	4.2 ± 0.7
	Received conflicting advice	3.6 ± 0.9

3.3 Hypotheses Testing Results

The final analytical stage assessed the four proposed hypotheses linking sociodemographic factors and source of nutritional information to supplement use among 1,000 pregnant women attending antenatal care in Tobruk. Hypotheses H1, H2, and H3 were tested using binary logistic regression models, examining the predictive value of education level, household income, and pregnancy trimester on the likelihood of nutritional supplement use. For H4, a chi-square test was initially applied to determine significant differences in supplement intake across various sources of information. Where a significant association emerged, logistic regression was performed to adjust for confounders. Statistical significance was set at $P < 0.05$, and odds ratios (ORs) with 95% confidence intervals (CIs) were reported for interpretive clarity.

Hypothesis 1 posited that higher education levels increase the odds of supplement use. Logistic regression results supported this assumption (OR = 1.74, 95% CI [1.33, 2.28], $p < 0.001$), with post-secondary educated women more likely to use supplements compared to those with lower education.

Hypothesis 2 examined whether higher household income is associated with increased supplement intake. The model indicated a significant positive association (OR = 1.51, 95% CI [1.18, 1.95], $p = 0.002$), affirming that participants from higher income brackets were more supplement-compliant.

Hypothesis 3 tested the association between pregnancy trimester and supplement use. Women in the third trimester were significantly more likely to report supplement use than those in the first trimester (OR = 1.63, 95% CI [1.23, 2.16], p = 0.001), supporting H3.

Hypothesis 4 explored whether receiving information from healthcare professionals affects supplement use. The chi-square test revealed significant variation by information source ($\chi^2 = 24.87$, df = 3, $p < 0.001$). Follow-up logistic regression confirmed that women relying on doctors were significantly more likely to adhere to supplement regimens (OR = 1.82, 95% CI [1.32, 2.51], $p < 0.001$).

Table 4. Summary of Hypothesis Testing Results

Hypothesis	Statistical Test	OR	p Value	Interpretation
H1: Education level predicts supplement use	Binary Logistic Regression	OR = 1.74 (95% CI [1.33, 2.28])	$p < 0.001$	Supported
H2: Higher income associated with greater supplement intake	Binary Logistic Regression	OR = 1.51 (95% CI [1.18, 1.95])	p = 0.002	Supported
H3: Pregnancy trimester influences supplement use	Binary Logistic Regression	OR = 1.63 (95% CI [1.23, 2.16])	p = 0.001	Supported
H4: Info source predicts supplement use	Chi-square & Logistic Regression	$\chi^2 = 24.87$, OR = 1.82 (95% CI [1.32, 2.51])	$p < 0.001$	Supported

4. Discussion

This study aimed to assess dietary practices, nutritional supplement usage, and associated sociodemographic and clinical factors among 1,000 pregnant women in Tobruk, Libya. A paper-based structured questionnaire was administered across four antenatal care clinics Mokhtar Polyclinic, Al-Jihad Clinic, the Rural Hospital in Kambut, and Tobruk Medical Centre with approximately 250 participants enrolled from each site. The investigation tested four hypotheses: (1) higher education correlates with greater supplement use, (2) higher household income correlates with greater supplement use, (3) supplement use varies by pregnancy trimester, and (4) reliance on healthcare professionals for nutritional information is associated with more consistent supplement uptake.

The study found that the majority of respondents consistently agreed or strongly agreed with statements regarding regular supplement intake, prioritisation of their baby's nutritional needs, and adherence to medical advice, with mean scores ranging from 3.9 to 4.5 across the MNSAAS items. These findings corroborate trends observed in similar LMICs, where high intent to supplement aligns with positive maternal and neonatal outcomes [21, 22]. It is likely that increased awareness of prenatal health benefits has supported this behaviour and could inform future public health guidance.

On the Pregnancy Trimester Supplement Practice Scale (PTSPS), strong agreement was observed for trimester awareness (mean 4.6 ± 0.6) and increased supplement usage in later trimesters (mean 4.0 ± 0.8). However, some respondents reported difficulty in understanding

trimester-specific needs (mean 3.2 ± 1.0), possibly reflecting inconsistent communication or educational deficits. Similar challenges have been documented in China and Saudi Arabia, where trimester-sensitive guidance markedly affected supplement practices [8, 13].

Analysis of the Source of Nutritional Information Confidence Scale (SNICS) revealed a strong preference for healthcare professionals, who scored highest for trustworthiness (mean 4.4 ± 0.6) and influence on decision-making. These findings mirror research from China and the Middle East, indicating that professional advice significantly enhances adherence [20, 23]. Nonetheless, only moderate confidence was placed in personal research and external sources (means 3.5–3.9), which may reduce self-directed decision-making during pregnancy.

Hypothesis testing yielded consistent support across all four domains. Logistic regression indicated that women with post-secondary education were 1.7 times more likely to use supplements ($p < 0.001$), aligning with existing literature suggesting education serves as a facilitator for health-seeking behaviour [24]. Higher income was also significantly associated (OR 1.5, $p = 0.002$), reinforcing patterns of socioeconomic influence reported in the United States and Sweden [25]. Third-trimester women were 1.6 times more likely to be supplement users compared to those in the first trimester ($p = 0.001$), likely reflecting progression awareness and greater antenatal care engagement over time. Finally, reliance on healthcare professionals significantly increased the odds of supplement adherence (OR 1.8, $p < 0.001$), underscoring the critical role of skilled guidance in maternal nutrition.

Despite the strengths of sample size and clinic-level data, some limitations should be considered. Responses may have been influenced by social desirability bias, particularly given direct interaction with research assistants. Self-reported supplement use could under- or overestimate actual practices. Additionally, although clinics were geographically spread across Tobruk, findings may not generalise to remote rural settings or private healthcare sectors.

The findings encourage interventions to improve literacy around trimester-specific nutritional needs and to enhance equitable behaviour change. Trained healthcare providers could adopt standardised counselling protocols that focus on supplement types, timing, and frequency. Such structured guidance throughout pregnancy may bolster confidence and consistency, especially for patients with lower education or financial means.

Linking to global evidence, the results reflect documented benefits when maternal resources and professional support align [26, 27]. The Tobruk context appears no different, with higher education, financial stability, trimester progression, and trust in clinicians continuing to emerge as positive drivers for supplement uptake. It is possible that reinforcing these factors through policy-level interventions such as subsidised supplements or educational aids could strengthen antenatal nutrition and, consequently, maternal–infant health outcomes.

5. Theoretical and Practical Implications

The findings have expanded theoretical perspectives on antenatal nutrition by demonstrating how sociodemographic variables, health literacy, and trimester progression collectively influence maternal supplement adherence. Unlike models focused solely on access or affordability, the current results suggest that pregnant women's behaviour is likely influenced by a combination of structural and perceptual factors. The significant association between higher education and increased supplement adherence aligns with existing literature emphasising the role of maternal knowledge in promoting health-seeking behaviours during

pregnancy [21, 28]. Equally, household income appeared to play a moderating role, consistent with broader studies indicating that economic stability enables better compliance with nutritional recommendations [29]. These insights could inform refined models that integrate psychosocial determinants with economic and medical guidance frameworks.

In practical terms, the findings might hold relevance for antenatal care planning in middle-income settings. For instance, participants who reported receiving supplement information directly from healthcare professionals were more likely to maintain consistent intake across pregnancy stages. This pattern suggests that trust in medical authority could compensate for gaps in literacy or resources. Nevertheless, not all women were confident in their knowledge about trimester-specific requirements, indicating a possible shortfall in tailored antenatal counselling. The finding that women in later trimesters reported improved adherence implies that behavioural interventions might benefit from being front-loaded in early pregnancy. Like previous research in similar contexts [26, 30], the present study underscores that programme efficacy depends not just on provision, but on sustained, trimester-specific engagement and credible information flow.

6. Strengths and Limitations

The use of a contextually adapted questionnaire derived from validated instruments constitutes a methodological strength of this study. Each scale demonstrated acceptable reliability coefficients and construct validity, enhancing confidence in the consistency of the results. In addition, recruiting 1,000 pregnant women from four geographically distinct clinics has enabled coverage of varied socioeconomic backgrounds within the Tobruk region, thus increasing the relevance of the findings for antenatal policy design in similar urban environments. The integration of both attitudinal and behavioural measures adds further depth, capturing not only whether women adhered to supplement guidelines, but also their motivations, challenges, and perceived sources of information.

However, certain limitations must be acknowledged. The reliance on self-reported data may have introduced recall bias, particularly in questions relating to supplement intake timing and dosage. Social desirability bias might also have influenced responses concerning compliance and trust in medical advice. Moreover, the absence of biological indicators such as haemoglobin levels or supplement metabolite data restricts the ability to corroborate reported adherence with physiological outcomes. The paper-based survey method, while necessary in settings with limited digital infrastructure, may have further excluded women with low literacy or without access to clinic-based care during data collection. The findings, although statistically robust, should therefore be interpreted within these contextual constraints.

7. Recommendations for Future Research

Future research might prioritise longitudinal designs to trace adherence patterns across all three trimesters, allowing observation of changes in supplement behaviour in response to antenatal interventions. Inclusion of clinical indicators such as iron levels or birth outcomes could enable more comprehensive analysis of how reported adherence translates into maternal and neonatal health impacts. Additionally, extending data collection to include rural or marginalised regions could uncover disparities in supplement access and information reliability. A qualitative component such as focus group discussions could provide deeper insight into the sociocultural

barriers influencing supplement use, potentially uncovering nuances missed by structured surveys.

8. Conclusion

The present study has revealed that maternal nutritional supplement adherence among pregnant women in Tobruk is likely influenced by a combination of educational level, household income, pregnancy trimester, and the credibility of information sources. Findings suggest that those with higher education and income are more consistent in supplement intake, and that adherence tends to increase in later pregnancy stages. Importantly, reliance on healthcare professionals for supplement guidance appears to be associated with improved knowledge and intake behaviour. These patterns are consistent with international evidence linking antenatal supplement adherence to socioeconomic status and trusted medical advice [21, 31]. Although self-reported measures introduce limitations, the consistency of responses across four clinics suggests a credible portrait of current supplement use practices. The findings could inform antenatal programming, particularly through early trimester interventions, enhanced health literacy support, and investment in consistent professional guidance across maternal care services.

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