

RESEARCH ARTICLE

Preconception of folic acid supplementation knowledge among Ethiopian women reproductive age group in areas with high burden of neural tube defects: a community based cross-sectional study

Beyene Begashaw^{1,2}, Zerihun Tariku² and Anteneh Berhane^{2*} 

¹Ethiopia Food and Drug authority, Ethiopia

²Department of Public Health, College of Medicine and Health Sciences, Dire Dawa University, Dire Dawa, Ethiopia

(Received 11 January 2022 – Final revision received 3 April 2022 – Accepted 5 April 2022)

Journal of Nutritional Science (2022), vol. 11, e48, page 1 of 7

doi:10.1017/jns.2022.32

Abstract

Periconceptional folic acid supplementation is effective in the prevention of neural tube defects (NTDs). The aim of the present study was to determine the level of knowledge about the benefits of preconceptional folic acid supplementation in a sample of women of childbearing age and its associated factors. A cross-sectional community-based study design was carried out on a total of 441 women of childbearing age. Questionnaires included knowledge of preconception of folic acid supplements and socio-demographic characteristics. The χ^2 was used to compare categorical data. Multivariate logistic regression was used to isolate the predictive variables and examined individually by calculating the adjusted odds ratio. Statistical significance is declared as $P < 0.05$. We found that 35.1 % (n 155) knew preconceptional folic acid supplementation could prevent NTDs, and 3.8 % (n 17) knew the right time to take preconceptional folic acid supplementation and only 1.7 % (n 7) who had a history of NTDs. Attended secondary education (OR 2.7; 95 % CI 1.1, 6.0, $P = 0.017$), governmental employee (OR 3.5; 95 % CI 2.3, 17.8, $P < 0.001$), current pregnancy status (OR 3.0; 95 % CI 2.1, 4.2, $P = 0.043$), history of visiting the antenatal care service during pregnancy (OR 2.9; 95 % CI 1.07, 7.8, $P = 0.03$), history of taking folic acid supplement (OR 4.5; 95 % CI 2.9, 7.1, $P < 0.001$) were associated. More than half of the participant women did not know about preconception of folic acid supplements that reduce the risk of NTDs. Identification of the level of knowledge on preconception of folic acid may allow for targeted educational or other interventions to further encourage folic acid use.

Key words: Folic acid; Knowledge; NTD; Preconception

Introduction

Neural tube defects (NTDs) are among the most common and serious birth defects of the brain and spinal cord that occur when the neural tube fails to close completely within 28 days of conception, resulting in stillbirths, child deaths or life-long disability^(1–4). The global prevalence of NTD is 0.3 to 1.99 per 1000 births. However, the prevalence of NTD varies from region to region, ranging from 9 cases per 10 000 births in Europe to 21.9 cases in the Eastern Mediterranean region⁽⁵⁾.

In Ethiopia, NTDs are a serious, preventable public health issue, and the burden of NTDs in the eastern part of Ethiopia was 105.7 per 10 000 which is the second highest rate in the country and the proportion of NTDs increased linearly year to year⁽⁶⁾, as women lack knowledge about preconception of folic acid. The countries such as United States, Canada, Costa Rica, South Africa, and Chile have effectively implemented food fortification with folic acid to reduce the risk of NTDs. This resulted in a significant reduction in

Abbreviations: AOR: adjusted odds ratio; CI: confidence interval; FAS: folic acid supplement; IFAS: iron folic acid supplementation; OR: odds ratio; NTD: neural tube defect

* **Corresponding author:** Anteneh Berhane, email antishaction@gmail.com



NTDs, as low as 5 to 6 per 10 000 pregnancies^(7,8). Alternative of fortification of cereal with folic acid, preconception of folic acid supplement (FAS) can reduce the risk of NTDs by 50–70 %^(9–11). In Ethiopia, folate deficiency in reproductive-aged women is widespread, prevalent and a public health problem^(12,13) and the highest prevalence of folate deficiency was found in Harari (81 %), Tigray region (54 %), Dire Dawa (53 %) and the entire country are 46 %⁽¹³⁾. This prevalence supports that there is a high prevalence of NTDs and others related to adverse pregnancy and birth outcomes. Educational interventions implemented in parts of China and the United States showed significant improvements on knowledge of folate^(14,15). However, such interventions have not been implemented throughout worldwide. In many developing countries including Ethiopia the level of knowledge on folic acid, and NTDs, is low⁽¹⁶⁾. A study found in Ethiopia reported that more than 90 % of mothers, including mothers of newborns affected by NTDs, had no knowledge of folic acid use. In addition to this, 100 % of the mothers surveyed were unaware of the association between NTD and folic acid⁽¹⁷⁾.

As Ethiopia makes progress towards achieving the Sustainable Development Goals (SDGs), the government is implementing various strategies to reduce maternal and neonatal mortality and morbidity. The prevalence of NTDs is a high and low level of knowledge of preconception of folic acid, it is crucial to assess the current level of knowledge and identify related factors affecting preconception of folic acid among women reproductive age (WRA). Therefore, the aim of the present study was to add and provide insight to better understand the level of knowledge about FAS as well as to evaluate factors associated with the likelihood of FAS among WRA in eastern Ethiopia with a high prevalence of NTDs. The present study could help to improve certain strategies aimed at increasing knowledge of FAS to reduce NTDs and provides the whole picture of the situation in the study area. The present study is also helpful for policymakers for interventional work using the existing healthcare system and approach to the community on preconception care to improve maternal and infant health in the country.

Methods and materials

Study design and population

This was a community-based cross-sectional study conducted in Dire Dawa city administration, the eastern part of Ethiopia. Randomly selected reproductive age group women (15–49 years) who lived in Dire Dawa city administration for 6 months and above and gives consent to participate were eligible for enrolment into the study in the study. However, women who are non-Ethiopian, who are mentally/physically challenged to provide consent were excluded from the study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki⁽¹⁸⁾.

Sample size determination

The required sample size was determined using a single population proportion formula and calculated by Open Epi Info

version 3.5.3 statistical software package with the following assumptions: The prevalence of women's awareness of folic acid supplementation from the previous study, 15.9 and 20 %^(19,20), respectively, a significant level at 95 % confidence interval (CI) and 4 % marginal errors with an additional 5 % added to account for non-response and the final sample size becomes 441.

Sampling procedure

Then, the calculated sample size was assigned for each randomly selected kebele based on proportional allocation. To reach the study unit, a systematic random sampling method was used in all randomly selected kebeles. When there was no eligible participant in the selected house, the nearby house was asked. In the case of more than one eligible woman encountered in the selected household, a lottery method was used to determine which woman would be interviewed. After taking informed consent, the participants were interviewed.

Data collection tools

An interviewer-administered semi-structured questionnaire was used to collect the necessary data. The questionnaire included socio-demographic characteristics (age, marital status, educational status, occupation, husband's educational status, reproductive and maternal health-related history). An English version of the questionnaire was developed and translated into the local language, then translated back to English to evaluate the consistency of the thought of the questions.

To maintain the quality of the research, the questionnaire was adapted from different literature pretested with a convenient sample of the study population (n 41), and some questions were modified based on the feedback from the pilot testing. Data collectors, and supervisors, were trained for 3 d. The data collection procedure was overseen by the supervisor and the principal investigator. The data collection team holds daily meetings and provides daily feedback.

The knowledge level of the study participants was determined using a dichotomous scale. Participants were asked a list of nine knowledge questions. One point is scored if a participant answers one or more of the correct answers to some of the questions with more than one correct answer. Then, for those who answered, a correct answer was marked as 'yes' and for those who answered, an incorrect answer was marked as 'no'. Knowledge was then measured by calculating the mean of the nine items and whether participants scored ≥ 4 on the correct questions, which were categorised as good knowledge, and whether participants scored ≤ 3 on the correct questions, which were categorised as poor knowledge^(19,20).

Statistical analysis

Categorical variables are presented as frequency and percentage and continuous variables are expressed as mean \pm standard deviation (SD). χ^2 test was used for significant difference between knowledge of participants and other predictors. Generalized linear models with multiple logistic regressions

**Table 1.** Socio-demographic characteristics of study population (*n* 441)

Variable	Categories	<i>n</i> (%)
Age (years)	15–24	53 (12)
	25–34	245 (55.6)
	35–44	110 (24.9)
	>44	33 (7.5)
Educational status	No formal education	178 (40.4)
	Primary education	101 (22.9)
	Secondary education	105 (23.8)
	College and above	57 (12.9)
Occupation status	Housewives	249 (56.5)
	Daily labourer	81 (18.4)
	Private employee	71 (16.1)
	Government employee	29 (6.6)

were conducted to see the effect of predictors on knowledge of participants. The Akaike Information Criterion (AIC) was used for model selection, and the smallest AIC value represented a better fitting model. Important assumptions were checked using the standard procedures. The goodness of fit of the final model was examined by the Hosmer–Lemeshow test ($P > 0.05$). Multicollinearity was assessed using standard error (SE) and the accepted maximum value was 2. Outcomes presented as odds ratios (ORs) with 95 % CIs. A two-sided P -value of < 0.05 was considered statistically significant. SPSS version 25 statistical software was used for analysis.

Results

A total of 441 women were participated in the study. The mean age of women was 30.7 years old with standard deviation (30.7 ± 5.9 years). A total 56.5 % (*n* 249) of participants were housewives. Approximately, 23.8 % of the sample had completed at least secondary education (Table 1).

Of all studied women, only 35.1 % (*n* 155) had a good knowledge and majority (>50 %) still had a poor knowledge on preconception of folic acid supplement. The majority 53.6 % (*n* 236) of participants heard about the preconception of FAS, of these, the majority of 47 % (*n* 111) commonly cited healthcare providers were the source of information. Only, fewer women 8.4 % (*n* 37) understood that it was required for preventing birth defects; 3.8 % of the subjects were aware that the right time of initiation of FAS is 3 months before pregnancy. These findings are summarised in Table 2.

Few of 8.2 % (*n* 36) and majority 83 % (*n* 366) of participants were pregnant and had <5 gravidity, respectively. Majority 390 (88.4 %) of the participants were followed antenatal care (ANC) services. History of NTDs was presented for 1.7 % of the participant's women. The result portrays that 10.1 %, and 20.8 % of women had history of preterm, and spontaneous abortion, respectively (Table 3).

There was a statistically significant difference between educational status, occupational status and monthly average income of the study participants with awareness of preconception of folic acid for the prevention of NTDs ($P < 0.001$; $P < 0.001$; $P < 0.001$, respectively). In addition, there was a statistically significant difference between having history of NTDs and spontaneous abortion with taking of FAS ($P = 0.04$; $P = 0.032$, respectively) (Table 4).

Table 2. Frequency distribution of participants according to knowledge of folic acid (FA) and neural tube defects (NTDs) (*n* 441)

Knowledge	<i>n</i> (%)
Overall knowledge status	
Poor knowledge	286 (64.9)
Good knowledge	155 (35.1)
Heard about the preconception of FAS	
No	205 (46.5)
Yes	236 (53.5)
Ever heard of NTDs	
No	102 (23.1)
Yes	339 (76.9)
Source of information	
Healthcare providers	111 (47)
Families/Friends	67 (28.4)
TV/radio	58 (24.6)
Awareness of preventive role of FAS	
No	63 (14.3)
Yes	378 (85.7)
Right time of initiation to take FAS	
No	424 (96.1)
Yes	17 (3.9)
Frequency of to take FAS (how often per day)	
No	99 (22.4)
Yes	342 (77.6)
Total month of FA intake	
No	57 (13)
Yes	384 (87)
Foods that are rich in folate	
No	147 (33.3)
Yes	294 (66.7)
Folic acid user for NTD prevention	
No	344 (78)
Yes	97 (22)

FAS, Folic acid supplement.

Table 3. Reproductive and maternal health-related history of participants (*n* 441)

Variable	<i>n</i> (%)
Current status of pregnancy	
No	405 (91.8)
Yes	36 (8.2)
Total number of pregnancies (Gravidity)	
<5	366 (83)
>5	75 (17)
Follow ANC during pregnancy	
No	51 (11.6)
Yes	390 (88.4)
Took IFAS or multivitamins	
No	198 (44.9)
Yes	243 (55.1)
History of NTDs	
No	398 (98.3)
Yes	7 (1.7)
History of preterm	
No	364 (89.9)
Yes	40 (10.1)
History of spontaneous abortion	
No	320 (79.2)
Yes	84 (20.8)

ANC, antenatal care; IFAS, iron folic acid; NTDs, neural tube defects.

Factors association of knowledge with preconception of folic acid

On multivariable logistic regression analysis, independent determinants of knowledge were: women who were attended

**Table 4.** Relation between socio-demographic characteristics and knowledge about folic acid (*n* 441)

Variables	Level of knowledge		<i>P</i>
	Poor knowledge <i>n</i> (%)	Good knowledge <i>n</i> (%)	
Age (years)			
15–24	36 (67.9)	17 (32.1)	0.373
25–34	151 (61.6)	94 (38.4)	
35–44	78 (70.9)	32 (29.1)	
>44	21 (63.6)	12 (36.4)	
Marital status			
Married	229 (63.8)	130 (36.2)	0.633
Divorced	32 (72.7)	12 (27.3)	
Widowed	17 (63.0)	10 (37.0)	
Single	8 (72.7)	3 (27.3)	
Educational status			
No formal education	62 (76.5)	19 (23.5)	<0.0001*
Able to read and write	68 (70.1)	29 (29.9)	
Primary education	70 (69.3)	31 (30.7)	
Secondary education	65 (61.9)	40 (38.1)	
College Diploma and above	21 (36.8)	38 (63.2)	
Occupational status			
Housewife	180 (72.3)	69 (27.7)	<0.0001*
Daily labourer	53 (65.4)	28 (34.6)	
Private employee	42 (59.2)	29 (40.8)	
Government employee	11 (27.6)	21 (72.4)	

* Pearson correlation significant at $P < 0.05$.

secondary education (OR 2.7; 95 % CI 1.1, 6.0, $P = 0.017$), governmental employee (OR 3.5; 95 % CI 2.3, 17.8, $P < 0.001$), current pregnancy status (OR 3.0; 95 % CI 2.1, 4.2, $P = 0.043$), history of visit ANC during pregnancy (OR 2.9;

95 % CI 1.07, 7.8, $P = 0.03$) and history of taking FAS (OR 4.5; 95 % CI 2.9, 7.1, $P < 0.001$) (Table 5).

Discussion

Ethiopia is one of the developing countries where the incidence of NTDs is highly prevalent⁽⁶⁾ and where one-third of women were affected by folate deficiency⁽¹³⁾. It is important and crucial that WRA is having a knowledge of taking folic acid before pregnancy and during postpartum period for at least 4 weeks which helps protect against the occurrence of NTDs and other congenital abnormalities. This understanding is also important while planning folic acid intervention programmes and essential for understanding the effect of folic acid intervention on NTD.

Knowledge of preconception of folic acid in the present study was (35.15 %) and comparatively much lower than those of many studies conducted in developed countries like Canada (81 %)⁽²¹⁾, the Netherlands (57.3 %)^(22,23), Taipei (90 %)⁽²⁴⁾ and Western Australia (89 %)⁽²⁵⁾. It is important to note, however, that these countries have targeted women of childbearing age through national health awareness programmes that have been implemented since the mid-1990s. In other countries with minimal or no national awareness campaigns conducted thus far, like Ethiopia is lower than developed countries.

Although lower in this study than in developing countries like Egypt (71.6 %)⁽²⁶⁾, Saudi Arabia (88.4 %)⁽²⁷⁾, Nigeria (64.6 %)⁽²⁸⁾, Qatar (53.7 %) and the United Arab Emirates (46.6 %). This difference may be due to the difference in study population where previous studies were conducted in pregnant women, while the present study was conducted in women childbearing age (15–49 years). Additionally, the lowest level of awareness in the present study may be due to low media coverage in Ethiopia. Furthermore, the fundamental facts for the poor knowledge of FAS among WRA could be

Table 5. Multivariate analysis of study participants (*n* 441)

Variables	Level of knowledge		AOR (95 % CI)	<i>P</i>
	Poor <i>n</i> (%)	Good <i>n</i> (%)		
Educational status				
No formal education	46 (79.3)	12 (20.7)	1.00	
Able to read and write	66 (73.9)	23 (26.1)	1.3 (0.5, 3.15)	0.520
Primary education	62 (78.5)	17 (21.5)	0.86 (0.3, 2.1)	0.759
Secondary education	67 (54.9)	55 (45.1)	2.7 (1.1, 6.0)	0.017*
College and above	45 (49.5)	46 (50.5)	2.1 (0.8, 5.1)	0.100
Occupational status				
Housewife	180 (72.3)	69 (27.7)	1.00	
Daily labourer	53 (65.4)	28 (34.6)	2.1 (1.1, 3.9)	0.016*
Private employee	42 (59.2)	29 (40.8)	1.9 (1.08, 3.6)	0.027*
Government employee	8 (27.6)	21 (72.4)	3.5 (2.3, 17.8)	<0.0001*
Currently pregnant				
No	32 (88.9)	4 (11.1)	1.00	0.043
Yes	254 (62.7)	151 (37.3)	3.0 (2.1, 4.2)	
History of visiting ANC during pregnancy				
No	45 (88.2)	6 (11.8)	1.00	0.035
Yes	241 (61.8)	149 (38.2)	2.9 (1.07, 7.8)	
History of taking FAS				
No	163 (82.3)	35 (17.7)	1.00	<0.0001**
Yes	122 (50.4)	120 (49.6)	4.5 (2.9, 7.1)	

AOR, adjusted odds ratio; ANC, antenatal care; CI, confidence interval; FAS, folic acid supplement. Maximum standard error = 1.569, Hosmer–Lemeshow test $P = 0.829$, Max standard error = 0.89.

* Significant at P -value < 0.05 .



a result of the absence of policy on preconception care service in the healthcare system and this care gives a large room for improvement in the preconception of folate knowledge. The other one might be the failures of healthcare providers to prescribe FAS at protective time.

However, the finding of the present study is much larger than the study conducted in Adet town of Amhara region (15.9 %) ⁽¹⁹⁾ in Manna District, Oromia region, Southwest Ethiopia (6.7 %) ⁽²⁹⁾ in Tanzania (6.9 %) ⁽³⁰⁾ and in Pakistan (6.7 %) ⁽³¹⁾. This difference might be due to the fact that women's knowledge with regard to preconception of folic acid supplementation is the study time difference and geographical area between our study and previous studies.

Our finding reveals that in which women's education was a strong predictor of knowledge of preconception of FAS. This association lends support to the findings of previous studies among Ethiopian women ⁽¹⁹⁾, and Norwegian and Italian women ^(32,33) and in different studies around the world ⁽³⁴⁻³⁸⁾. The possible association can be explained by the fact that when people are educated they are exposed to various sources of information and can easily understand the information. This finding gives highlights the contribution of women's education to access simple information about their health issues including prevention approaches of NTDs through preconception of folic acid supplementation and/or fortified foods or, at the very least, better diet and lifestyles. Given the association between women's education and having a knowledge on preventatives, this strategy may work if delivered in the appropriate way for different parts of society to enhance risk reduction and ensure all WRA received some level of protection.

In addition, our study found that women who had an occupation were more likely to have a good awareness of preconception of FAS compared to women who are housewives. The finding of the study agrees with a study conducted in Korean women of childbearing age ⁽³⁹⁾ and in Saudi Arabia ⁽⁴⁰⁾. This might be due to exposure to different people and the environment might give a chance to know about the benefits of FAS.

Our study revealed that there is associated with currently pregnant and had a history of ANC attendance. The findings of the study are in line with a study conducted in Korea ⁽⁴⁰⁾, in Sudan ⁽³⁴⁾, in Ethiopia, Hawassa ⁽²⁰⁾ and in Manna District, Oromia region, Southwest Ethiopia ⁽²⁹⁾. The similarity might be due to the fact that contact with healthcare providers and attending to ANC increases the exposure to health-related information including awareness of folic acid. As the number of contacts with healthcare providers increases, so does access to information, which in turn increases health-seeking behaviour and service utilisation.

Our findings give insight that the need of educational interventions to increase the knowledge of preconception of FAS and NTDs as well uptake among WRA in the country. Different previous studies have shown that educational interventions are an effective approach to increase not only in knowledge and awareness of the use of folic acid, but also on uptake. The United States based studies have shown that educational interventions play a great role to increase folic acid awareness from 78 to 98 % and knowledge of the role of folic acid in the prevention of birth defects from 82 to 92 % ⁽⁴¹⁾. Additionally, awareness campaigns have been

shown to increase usage from 6 to 41 % in the UK ⁽⁴²⁾ and from 8 to 35 % in the US (1992–2007) which suggests that educational interventions may be well received.

However, women with unplanned pregnancies may not benefit from this approach. Therefore, the government must use folic acid-fortified foods in addition to educational programmes. This approach itself presents an important opportunity to reduce the risk of NTD in high-risk populations including in eastern Ethiopia ⁽⁶⁾. Therefore, combining both approaches will help reduce risk and ensure that all pregnancies are protected to some level of protection.

The current study has some strengths: it was conducted in a community-based study, so the findings represent and reflect the general population or the true population. On the other hand, the present study used the maximum sample size considered. But it has not been ended without limitation; our study is purely quantitative and incapable of investigating the myriad contextual and social factors that may limit women's knowledge of folic acid supplement prejudices. Therefore, it is very worthwhile to suggest the future qualitative research to follow up on these findings. Also, the present study was that it is conducted in one region, relatively a big city. So the finding of the present study may not be generalised to other regions of the country, especially rural areas and small towns. Recall bias can occur in response to some questions, such as those related to obstetrical and gynaecological factors, that are asked for history taking prior to conception. Despite those limitations, the present study provides some insight into the knowledge of women for usage of folic acid for prevention of NTDs.

Conclusion

The findings of this study concluded that women's knowledge on preconception of folic acid supplementation was very low and only one-third of women had good knowledge. Educational, occupational status, current pregnancy status, visit ANC during pregnancy and history of taking FAS were the identified predictive factors. The poor level of knowledge evident in our study, demands that the medical community should broadcast the benefit of folic acid supplementation for prevention of NTDs. The study revealed that there is a real unmet need to provide women of childbearing age with appropriate counselling and education regarding the benefits and timely use of folic acid supplementation. So, the government and stakeholders should advocate the benefit of preconception of folic acid through different media including health extension workers and the existing health care system in order to prevent the incidence of NTDs. Furthermore, we recommended other studies in the study area and look forward to staple food fortification.

Acknowledgements

The authors would like to thank all of the study participants, data collectors and supervisors who participated in the study.

B. B. and A. B. wrote the manuscript; Z. T. prepared the figures. All authors reviewed the manuscript.

There is no fund granted for this work.

The authors declare no conflicts of interest in this work.



All necessary data for this work are available within the manuscript. Additional data can be obtained from the corresponding author on a reasonable request.

All methods of this study were carried out in accordance with the Declaration of Helsinki-Ethical principle for medical research involving human subjects. Before beginning data collection, the ethics review committee of the Department of Public Health, Dire Dawa University granted ethical clearance with the reference number IRB/PGY/738/21. Written informed consent to participate was obtained from participants and legally authorised representatives 'of minors below 16 years of age and illiterates' after the purpose of the study was explained and their privacy and confidentiality were maintained. All personal identifiers were excluded, and data were kept confidential and used for the proposed study only.

References

- Butterworth C & Bendich A (1996) Folic acid and the prevention of birth defects. *Annu Rev Nutr* **16**, 73–97.
- Persad VL, Van den Hof MC, Dubé JM, *et al.* (2002) Incidence of open neural tube defects in Nova Scotia after folic acid fortification. *CMAJ* **167**, 241–245.
- Greene ND & Copp AJ (2014) Neural tube defects. *Annu Rev Neurosci* **37**, 221–242.
- Greene NDE & Copp AJ (1981) Neural tube defects. *The Lancet* **318**, 1290–1291.
- Ibrahim Z, Ahlia S, Tsang Becky L, *et al.* (2016) Describing the prevalence of neural tube defects worldwide: a systematic literature review. *PLoS ONE* **11**, e0151586.
- Berhane A & Belachew T (2022) Trend and burden of neural tube defects among cohort of pregnant women in Ethiopia: where are we in the prevention and what is the way forward? *PLoS ONE* **17**, e0264005.
- Crider KS, Bailey LB & Berry RJ (2011) Folic acid food fortification—its history, effect, concerns, and future directions. *Nutrients* **3**, 370–384.
- Rahman A, Hamdani SU, Awan NR, *et al.* (2016) Effect of a multi-component behavioral intervention in adults impaired by psychological distress in a conflict-affected area of Pakistan: a randomized clinical trial. *JAMA* **316**, 2609–2617.
- Reynolds E (2002) Fortification of flour with folic acid: fortification has several potential risks. *Brit Med J* **324**, 918.
- Cavalli P (2008) Prevention of neural tube defects and proper folate periconceptional supplementation. *J Prenat Med* **2**, 40.
- Berry RJ, Li Z, Erickson JD, *et al.* (1999) Prevention of neural-tube defects with folic acid in China. *N Engl J Med* **341**, 1485–1490.
- Ethiopian Public Health Institute (2017) *Ethiopian National Micronutrient Survey Report* EPHI.
- Haidar J, Melaku U & Pobocik RS (2010) Folate deficiency in women of reproductive age in nine administrative regions of Ethiopia: an emerging public health problem. *South Afr J Clin Nutr* **23**, 132–137.
- Lin Q, Yang L, Li F, *et al.* (2017) A village-based intervention: promoting folic acid use among rural Chinese women. *Nutrients* **9**, 174.
- Flores AL, Isenburg J, Hillard CL, *et al.* (2017) Folic acid education for Hispanic women: the Promotora de Salud model. *J Women's Health* **26**, 186–194.
- Samar V, Arif S & Samar R (2018) The awareness and the use of folic acid during pregnancy at Civil Hospital, Hyderabad. *i-Manager's J Nurs* **8**, 23.
- Welderufael AL, Berihu BA, Berhe Y, *et al.* (2019) Nutritional status among women whose pregnancy outcome was afflicted with neural tube defects in Tigray region of Ethiopia. *Brain Dev* **41**, 406–412.
- World Medical Association (2001) World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. *Bull World Health Organ* **79**, 373.
- Goshu YA, Liyeh TM, Ayele AS, *et al.* (2018) Women's awareness and associated factors on preconception folic acid supplementation in Adet, northwestern Ethiopia, 2016: implication of reproductive health. *J Nutr Metab* **2018**, 4936080.
- Kassa A & Yohannes Z (2018) Women's knowledge and associated factors on preconception care at Public Health Institution in Hawassa City, South Ethiopia. *BMC Res Notes* **11**, 1–6.
- Best Start Resource (2009) *Preconception Health Care Awareness and Behaviors in Ontario City*. Center for Preconception Health.
- Temel S, Erdem Ö, Voorham TA, *et al.* (2015) Knowledge on pre-conceptual folic acid supplementation and intention to seek for preconception care among men and women in an urban city: a population-based cross-sectional study. *BMC Pregnancy Childbirth* **15**, 1–11.
- Bitzer J, von Stenglin A & Bannemerschult R (2013) Women's awareness and periconceptional use of folic acid: data from a large European survey. *Int J Women's Health* **5**, 201.
- Jou H-J, Hsu I-P, Liu C-Y, *et al.* (2010) Awareness and use of folic acid among pregnant women in Taipei. *Taiwanese J Obstet Gynecol* **49**, 306–310.
- Oddy W, Miller M, Payne J, *et al.* (2007) Awareness and consumption of folate-fortified foods by women of childbearing age in Western Australia. *Public Health Nutr* **10**, 989–995.
- Hassan H, Youness E, Zahran K, *et al.* (2015) Pregnant women's awareness, intention and compliance regarding folic acid usage for prevention of neural tube defects according to health belief model in Beni-Suef City. *Pyrex J Nurs Midwifery* **1**, 13–26.
- Al-Akhfash AA, Abdulla AM, Osman AM, *et al.* (2013) Maternal knowledge and use of folic acid among Saudi females. *Saudi Med J* **34**, 1173–1178.
- Anzaku AS (2013) Assessing folic acid awareness and its usage for the prevention of neural tube defects among pregnant women in Jos, Nigeria. *J Basic Clin Reprad Sci* **2**, 13–17.
- Teshome F, Kebede Y, Girma K, *et al.* (2022) A survey on women's awareness of iron and folic acid intake during preconception period and its associated factors in Manna District, Oromia region, Southwest Ethiopia. *Nurs Open* **9**, 950–958.
- Mwandelile IF, Mpembeni R, Abade A, *et al.* (2019) Awareness and factors associated with reported intake of folic acid-fortified flour among women of reproductive age in Ifakara, Morogoro region, Tanzania: a cross-sectional study. *BMC Nutr* **5**, 1–7.
- Rehan M, Mahmood N & Mazhar S (2015) Knowledge, attitude and practices regarding periconceptional folic acid supplementation in a tertiary care hospital. *Ann Int Med Dent Res* **11**, 172–175.
- De Santis M, Quattrocchi T, Mappa I, *et al.* (2013) Folic acid use in planned pregnancy: an Italian survey. *Matern Child Health J* **17**, 661–666.
- Nilsen RM, Vollset SE, Gjessing HK, *et al.* (2006) Patterns and predictors of folic acid supplement use among pregnant women: the Norwegian Mother and Child Cohort Study. *Am J Clin Nutr* **84**, 1134–1141.
- Alsammani MA, Kunna A & Adam EM (2017) Factors associated with folic acid knowledge and intake among pregnant women in Sudan. *East Mediterr Health J* **23**, 662–669.
- Al Hossani H, Abouzeid H, Salah M, *et al.* (2010) Knowledge and practices of pregnant women about folic acid in pregnancy in Abu Dhabi, United Arab Emirates. *EMHJ-East Mediterr Health J* **16**, 402–407.
- Köken GN, Derbent AU, Erol O, *et al.* (2013) Awareness and use of folic acid among reproductive age and pregnant women. *J Turk German Gynecol Assoc* **14**, 87.
- Yasmin S, Siddiq A, Rockliffe L, *et al.* (2022) Knowledge of neural tube defects and prevention through folic acid use among women in Faisalabad, Punjab, Pakistan: a cross-sectional survey. *Int J Women's Health* **14**, 425–434.
- Hisam A, Rahman MU & Mashhadi SF (2014) Knowledge, attitude and practice regarding folic acid deficiency; a hidden hunger. *Pak J Med Sci* **30**, 583.



39. Kim J, Yon M, Kim C-I, *et al.* (2017) Preconceptional use of folic acid and knowledge about folic acid among low-income pregnant women in Korea. *Nutr Res Pract* **11**, 240–246.
40. Kim MJ, Kim J, Hwang EJ, *et al.* (2018) Awareness, knowledge, and use of folic acid among non-pregnant Korean women of childbearing age. *Nutr Res Pract* **12**, 78–84.
41. deRosset L, Mullenix A, Flores A, *et al.* (2014) Promotora de salud: promoting folic acid use among Hispanic women. *J Women's Health* **23**, 525–531.
42. Rofail D, Colligs A, Abetz L, *et al.* (2012) Factors contributing to the success of folic acid public health campaigns. *J Public Health* **34**, 90–99.