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Burden and Socio-Demographic Determinants of Folic Acid Deficiency Among Reproductive-Age Women in Rural Nuh, Haryana

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Abstract

Background: Folic acid deficiency is an important nutritional and public health concern among women of reproductive age, particularly in rural and socioeconomically disadvantaged populations. Deficiency during the reproductive period is associated with adverse maternal outcomes and increased risk of neural tube defects in offspring. ***Aim:*** To study the prevalence of folic acid deficiency among women of reproductive age group in a rural field practice area of District Nuh, Haryana, and to identify socio-demographic and related factors associated with folic acid deficiency. ***Methodology:*** A community-based cross-sectional study was conducted among 150 women aged 18–49 years residing in the rural area of Rural Health Training Centre (RHTC), Nagina, District Nuh, Haryana. Participants were selected using multistage random sampling. Data regarding socio-demographic characteristics and associated factors were collected using a pretested semi-structured questionnaire. Serum folate estimation was performed using Enzyme Linked Immunosorbent Assay (ELISA). Serum folate levels less than 3 ng/mL were considered deficient according to World Health Organization criteria. Statistical analysis was performed using SPSS version 26.0, and a p-value <0.05 was considered statistically significant. ***Results:*** The prevalence of folic acid deficiency among study participants was 25.33%. Deficiency was more common among women with lower educational status, higher parity, poor dietary behaviour, and adverse socio-demographic conditions. A significantly higher prevalence of deficiency was observed among illiterate women and women with multiple pregnancies. Logistic regression analysis identified literacy status, dietary behaviour, occupation, and parity as important determinants associated with folic acid deficiency. ***Conclusion:*** Folic acid deficiency remains a significant nutritional and public health problem among women of reproductive age in rural Nuh, Haryana. Strengthening nutritional education, improving dietary awareness, and enhancing implementation of iron and folic acid supplementation programs are essential to improve maternal nutritional status and reduce the risk of adverse reproductive outcomes.

Keywords: Folic acid deficiency; Folate; Women of reproductive age; Rural Haryana; Maternal nutrition; Neural tube defects.

INTRODUCTION

Folic acid, the synthetic form of folate (Vitamin B9), is an essential water-soluble vitamin involved in DNA synthesis, erythropoiesis, amino acid metabolism, and cellular division. Natural folates are present in green leafy vegetables, legumes, citrus fruits, and whole grains, while folic acid is mainly obtained through fortified foods and supplements. Due to limited body stores and variable dietary bioavailability, deficiency can develop rapidly in individuals with inadequate intake or increased physiological requirements.[1] Folate plays a crucial role in one-carbon metabolism, purine and pyrimidine synthesis, methylation reactions, and homocysteine metabolism. Deficiency may therefore result in megaloblastic anemia, impaired cell division, and adverse maternal and fetal outcomes.[2]

Women of reproductive age are particularly vulnerable to folic acid deficiency because of increased nutritional demands during menstruation, preconception, and pregnancy. Adequate folate levels during early gestation are essential for neural tube development, and periconceptional folic acid supplementation significantly reduces the risk of neural tube defects such as spina bifida and anencephaly.[3] Folate deficiency has also been associated with recurrent pregnancy loss, infertility, low birth weight, preterm delivery, placental complications, and maternal anemia.[4]

Despite increased awareness regarding maternal nutrition, folate deficiency remains a major public health concern, especially in low- and middle-income countries. The prevalence among women of reproductive age varies according to dietary practices, socioeconomic conditions, food fortification policies, and healthcare accessibility.[5] Poor dietary diversity, poverty, repeated pregnancies, chronic infections, and limited health literacy contribute significantly to micronutrient deficiencies among women in developing countries.[6] In India, nutritional deficiencies remain highly prevalent among rural and socioeconomically disadvantaged women despite implementation of Iron and Folic Acid (IFA) supplementation and Reproductive and Child Health (RCH) programs.[7] Recent Indian studies have also reported considerable prevalence of folate deficiency among women of reproductive age, emphasizing the need for improved nutritional interventions and public health strategies.[8,9]

Folic acid deficiency may result from inadequate dietary intake, impaired absorption, chronic illnesses, alcoholism, increased physiological demand, or medications such as methotrexate and phenytoin that interfere with folate metabolism.[10] Disturbances in one-carbon metabolism and genetic polymorphisms related to folate pathways have also been associated with neural tube defects and adverse pregnancy outcomes.[11] Socio-demographic determinants including literacy, socioeconomic status, occupation, parity, dietary behaviour, and healthcare access strongly influence folate status among women. Women with lower educational attainment often have reduced awareness regarding nutritional supplementation and maternal healthcare practices.[12] Dietary practices and prolonged cooking methods may further reduce folate availability in food.[13]

District Nuh in Haryana represents a vulnerable setting with poor maternal health indicators, lower female literacy, poverty, and inadequate healthcare utilization. Previous studies from Haryana have highlighted a high burden of micronutrient deficiencies and poor maternal healthcare utilization in this region.[9,14] However, limited data are available specifically regarding folic acid deficiency among women of reproductive age in rural Nuh. Assessment of folate status and associated socio-demographic factors is therefore important for planning targeted nutritional interventions and strengthening maternal and child health programs in underserved populations.[15]

MATERIALS AND METHODS

This community-based cross-sectional study was conducted in the rural field practice area catered by the Rural Health Training Centre (RHTC), Nagina, District Nuh, Haryana, over a period of one year. The study population comprised women of reproductive age group (18–49 years) who had been residing in the study area for at least six months.

The sample size was calculated using the standard formula for prevalence studies based on an estimated prevalence of folic acid deficiency of 7.6%, with 95% confidence interval and an absolute margin of error of 4.3%. The minimum calculated sample size was 146; however, a total of 150 women were enrolled after rounding off.

A multistage sampling technique was used for participant selection. Out of the total 12 Anganwadi Centres (AWCs) under the RHTC Nagina field practice area, six AWCs were selected randomly by draw of lots. From each selected AWC, 25 eligible women were selected, giving a final sample size of 150 participants. For household selection, a central landmark such as a mosque, street intersection, or any common public place within the respective AWC area was identified, and households were selected systematically. One eligible participant from each household was included in the study.

Women aged 18–49 years who were willing to participate and provided written informed consent were included in the study. Postmenopausal women, pregnant females, lactating mothers with a child below six months of age, and females receiving antifolate drugs were excluded from the study.

Data were collected by the investigator using a pretested semi-structured questionnaire. Information regarding socio-demographic characteristics and other associated factors was recorded. Venous blood samples were collected from all study participants for estimation of serum folate and other selected biochemical parameters.

Approximately 5 mL of venous blood was collected aseptically from each participant in a red vacutainer. Serum was separated by centrifugation at 3500 rpm for 15 minutes. Routine biochemical investigations were performed on the same day, while serum samples meant for special investigations were stored at −20°C until analysis.

Routine biochemical investigations were carried out using a fully automated analyzer by standard laboratory methods. Serum folate estimation was performed using Enzyme Linked Immunosorbent Assay (ELISA) based on the principle of competitive binding. Streptavidin-coated wells were incubated with extracted folate standards, controls, samples, folate-binding protein-biotin conjugate, and folate-enzyme conjugate. Following incubation and washing, tetramethylbenzidine substrate was added and absorbance was measured spectrophotometrically at 450 nm. The intensity of colour developed was inversely proportional to the concentration of folate in the sample. Results were expressed in ng/mL.

According to World Health Organization criteria, serum folate levels less than 3 ng/mL were considered deficient.

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were represented as frequency and percentage. Chi-square test was used to assess associations between categorical variables, while Student's t-test was used for comparison of means. Logistic regression analysis was used to identify significant determinants of folic acid deficiency. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 150 women of reproductive age group (18–49 years) were included in the study. Among them, the majority belonged to the 20–29 years age group (48.0%), followed by 30–39 years (31.3%), 40–49 years (12.0%), and 18–19 years (8.7%). Most participants were Muslim (78.7%), and the majority were housekeepers (68.0%). Regarding educational status, 22.7% of participants were illiterate, while only a small proportion had graduate or postgraduate education. Most women enrolled in the study were married (75.3%).

The study demonstrated a considerable burden of folic acid deficiency among women of reproductive age residing in the rural field practice area of District Nuh, Haryana. Serum folate levels less than 3 ng/mL were considered deficient according to World Health Organization criteria.

Age-wise comparison showed that folic acid deficiency was more prevalent among younger women, particularly in the 20–29 years age group. Religion-wise analysis demonstrated a higher proportion of folic acid deficiency among Muslim women as compared to Hindu women. Occupational distribution revealed relatively higher deficiency among housekeepers and labourers.

Educational status was significantly associated with folic acid deficiency. Women with lower educational attainment and illiterate participants had comparatively higher prevalence of deficiency than women with higher literacy levels. Dietary behaviour also influenced folate status, with nutritionally inadequate dietary practices being associated with greater deficiency.

Marital status and parity demonstrated important associations with serum folate levels. Married women and women with higher parity showed increased prevalence of folic acid deficiency, suggesting increased nutritional demand and depletion associated with repeated pregnancies.

Logistic regression analysis identified literacy level, occupation, dietary behaviour, and parity as important determinants associated with folic acid deficiency among women of reproductive age group in the study population.

Table 1. Socio-demographic Characteristics of Study Participants (N=150)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (Years)	18–19	13	8.67
	20–29	72	48.00
	30–39	47	31.33
	40–49	18	12.00
Religion	Hindu	32	21.33
	Muslim	118	78.67
Occupation	Farmer	11	7.33
	Housekeeper	102	68.00
	Labourer	7	4.67
	Private Job	4	2.67
	Shopkeeper	1	0.67
	Student	25	16.67
Literacy Level	Illiterate	34	22.66
	Up to Primary	45	30.00
	Primary to Matric	18	12.00
	Matric to 12th	38	25.33
	Graduate	14	9.33
	Postgraduate	1	0.66
Marital Status	Married	113	75.33
	Unmarried	37	24.67

Table 2. Association of Folic Acid Deficiency with Socio-demographic Factors Among Women of Reproductive Age (N=150)

Variable	Category	Deficient (<3 ng/mL) n (%)	Non-deficient (≥3 ng/mL) n (%)	p-value
Overall Prevalence	Deficient	38 (25.33%)	—	—
	Non-deficient	—	112 (74.67%)	—
Age Group	18–19 years	0 (0.0)	13 (11.61)	
	20–29 years	6 (15.79)	66 (58.93)	
	30–39 years	18 (47.37)	29 (25.89)	
	40–49 years	14 (36.84)	4 (3.57)	<0.001*
Religion	Hindu	2 (5.26)	30 (26.79)	
	Muslim	36 (94.74)	82 (73.22)	0.0102*
Literacy Level	Illiterate	24 (63.16)	10 (8.93)	
	Up to Primary	12 (31.58)	33 (29.46)	
	Primary to Matric	0 (0.00)	18 (16.07)	
	Matric to 12th	2 (5.26)	36 (32.14)	
	Graduate	0 (0.00)	14 (12.50)	
	Postgraduate	0 (0.00)	1 (0.89)	<0.001*
Dietary Behaviour	Non-vegetarian	36 (94.74)	82 (73.20)	
	Vegetarian	2 (5.26)	30 (26.79)	<0.05*
Marital Status	Married	37 (97.37)	76 (67.86)	
	Unmarried	1 (2.63)	36 (32.14)	0.0102*
Parity	Nullipara	1 (2.63)	39 (34.82)	
	1 child	1 (2.63)	20 (17.86)	
	2 children	2 (5.26)	31 (27.68)	
	3 children	7 (18.42)	20 (17.86)	
	4 children	19 (50.00)	2 (1.79)	
	5 children	8 (21.05)	0 (0.00)	<0.001*

*Chi-square test applied.

Table 3. Logistic Regression Analysis of Determinants Associated with Folic Acid Deficiency

Determinant	Association with Folic Acid Deficiency
Lower literacy status	Significant positive association
Higher parity	Significant positive association
Non-vegetarian dietary behaviour	Significant association
Occupation (housekeepers/labourers)	Significant association
Increasing age	Significant association

DISCUSSION

The present community-based cross-sectional study was conducted among women of reproductive age group residing in the rural field practice area of District Nuh, Haryana, to assess the prevalence of folic acid deficiency and identify associated socio-demographic determinants. The study demonstrated a substantial burden of folic acid deficiency among women in this rural population, emphasizing that folate deficiency continues to remain an important nutritional and public health challenge in underserved areas of India.

In the present study, folic acid deficiency was observed in 25.33% of the participants. This prevalence is comparable to the findings reported by Bhide and Kar among urban Indian women in the periconception period, where folate deficiency was identified in 24% of participants.[8] The similarity of findings indicates that folate deficiency remains prevalent across both rural and urban populations despite implementation of national supplementation programs. However, the prevalence observed in the current study was higher than that reported by Das et al. among women of reproductive age in rural Haryana, where serum folate deficiency was reported in approximately 11% of participants.[4,9] The comparatively higher prevalence in the present study may be explained by the poorer socioeconomic conditions, lower literacy levels, inadequate dietary diversity, and limited healthcare accessibility in District Nuh, which is recognized as one of the aspirational districts of India.[14]

Recent evidence from India has continued to highlight the burden of folate deficiency among women of reproductive age. Shenoy and Subramanian reviewed the burden of folic acid deficiency in India and reported that prevalence varied widely across different population groups, ranging from 2% to nearly 80%, depending on geographic region, nutritional status, and study population.[6] The authors emphasized that women in the reproductive age group remain particularly vulnerable because of increased physiological demands and inadequate dietary intake. Similarly, studies from Punjab and Haryana have demonstrated high prevalence of folate insufficiency even among non-pregnant women, indicating a persistent risk for neural tube defects and adverse reproductive outcomes.[4,16]

Age-wise analysis in the present study showed greater prevalence of folic acid deficiency among women in the active reproductive age groups, especially 20–39 years. Increased nutritional demand associated with menstruation, repeated pregnancies, and poor nutritional replenishment may contribute to this observation. Similar findings have been documented in studies conducted in low- and middle-income countries, where women in reproductive years were found to be nutritionally vulnerable due to repeated physiological stress and inadequate micronutrient intake.[5,19]

Religion-wise analysis in the current study demonstrated a higher prevalence of folic acid deficiency among Muslim women. This finding may reflect the demographic composition of the study area as well as differences in literacy, socioeconomic conditions, dietary patterns, and healthcare utilization. The association is likely influenced more by underlying social determinants than religion itself. Previous studies from rural Haryana and other underserved regions have similarly highlighted the influence of socioeconomic and cultural factors on maternal nutritional status and utilization of reproductive healthcare services.[14]

Educational status emerged as one of the strongest determinants associated with folic acid deficiency in the present study. Illiterate women and those with lower educational attainment had significantly higher prevalence of deficiency compared to women with higher levels of education. Similar observations were made by Bhide and Kar, who identified low educational status as an important predictor of folate deficiency among Indian women.[8] Education improves awareness regarding balanced nutrition, maternal healthcare, dietary diversification, and adherence to folic acid supplementation programs. Women with better literacy are more likely to utilize antenatal services and adopt preventive nutritional practices. Similar observations regarding awareness and utilization of folic acid supplementation among women have been reported in studies from Ghana and Ethiopia.[12,15]

Dietary behaviour was also significantly associated with folic acid deficiency in the present study. Women with inadequate dietary practices showed higher prevalence of deficiency, likely because of insufficient intake of folate-rich foods such as green leafy vegetables, legumes, fruits, and fortified cereals. Similar findings have been reported in recent Indian studies evaluating micronutrient deficiencies among women. Goh et al. observed high prevalence of folate insufficiency among women in Punjab, India, and emphasized inadequate dietary intake as a major contributor to micronutrient deficiency.[16] In another recent study, Pattisapu et al. demonstrated that consumption of folic acid-fortified iodized salt significantly improved serum folate levels among rural Indian women, highlighting the importance of food fortification strategies in resource-limited settings.[17] These findings collectively indicate that dietary inadequacy remains one of the most important contributors to folate deficiency in Indian women.

Parity demonstrated a strong positive association with folic acid deficiency in the present study. Women with higher parity showed greater prevalence of deficiency, indicating depletion of maternal folate stores with repeated pregnancies and inadequate nutritional recovery. Similar findings have been reported in several previous studies where multigravidity and higher parity emerged as important determinants of folate deficiency.[8,19] Repeated reproductive cycles without adequate nutritional supplementation can substantially increase micronutrient deficiencies among women residing in low-resource communities.

The findings of the present study also have important implications for maternal and child health. Folate deficiency during the preconception period and early pregnancy is strongly associated with neural tube defects, low birth weight, intrauterine growth restriction, and adverse pregnancy outcomes.[3] Recent Indian studies have emphasized that folate insufficiency among reproductive-age women remains a major concern for prevention of neural tube defects.[4,9] Yajnik and Deshmukh also highlighted the importance of one-carbon metabolism and maternal micronutrient status in fetal growth and long-term metabolic programming among Indian populations.[20]

District Nuh continues to experience poor maternal health indicators, lower female literacy, early marriages, high fertility rates, and inadequate healthcare utilization.[14] These factors likely contribute to the higher burden of folic acid deficiency observed in the present study. Strengthening implementation of Iron and Folic Acid supplementation programs, improving nutritional education, promoting dietary diversification, and enhancing awareness regarding preconception folic acid supplementation may significantly improve maternal nutritional status in this vulnerable population.[7,13,18]

The strengths of the present study include its community-based design and focus on a socioeconomically disadvantaged rural population where limited data regarding folic acid deficiency are available. However, certain limitations should also be acknowledged. The cross-sectional design limits causal interpretation. Dietary practices were assessed based on participant responses and may be affected by recall bias. Additionally, the study was confined to a single rural field practice area, which may limit generalizability of the findings to broader populations.

Overall, the present study demonstrates that folic acid deficiency remains a significant nutritional and public health problem among women of reproductive age in rural Nuh, Haryana. Lower literacy status, inadequate dietary behaviour, and higher parity emerged as important determinants associated with folic acid deficiency. These findings highlight the urgent need for targeted nutritional interventions, improved awareness regarding folic acid supplementation, and strengthening of maternal healthcare services in underserved rural communities.

CONCLUSION

The present community-based cross-sectional study demonstrated that folic acid deficiency is a significant nutritional and public health problem among women of reproductive age residing in the rural field practice area of District Nuh, Haryana. A considerable proportion of women were found to have deficient serum folate levels, reflecting inadequate nutritional status in this vulnerable population. Lower educational status, inadequate dietary practices, higher parity, and poor socio-demographic conditions emerged as important determinants associated with folic acid deficiency. The findings highlight the persistent burden of micronutrient deficiencies among rural women despite ongoing maternal and child health initiatives. Since folate deficiency during the reproductive period is closely associated with adverse maternal outcomes and increased risk of neural tube defects in offspring, early identification and timely nutritional intervention are essential. Overall, the study emphasizes the need for targeted community-based nutritional strategies and strengthened implementation of Maternal and Child Health (MCH) and Reproductive and Child Health (RCH) programs to improve the nutritional and reproductive health status of women in underserved rural populations.

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