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DETERMINANTS OF PRECONCEPTIONAL AND PERICONCEPTIONAL FOLIC ACID SUPPLEMENTATION AMONG PRENATAL WOMEN IN THE UPPER EAST REGION OF GHANA

ABUBAKAR RASHID KAWAWA

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DETERMINANTS OF PRECONCEPTIONAL AND PERICONCEPTIONAL FOLIC ACID SUPPLEMENTATION AMONG PRENATAL WOMEN IN THE UPPER EAST REGION OF GHANA

BY

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(BACHELOR OF ARTS IN INTEGRATED DEVELOPMENT STUDIES)

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A THESIS SUBMITTED TO THE DEPARTMENT OF PUBLIC HEALTH, SCHOOL OF ALLIED HEALTH SCIENCES OF THE UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN COMMUNITY HEALTH AND DEVELOPMENT

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DECLARATION

Student

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

Name: Abubakar Rashid Kawawa

Candidate's Signature..... Date ……

Supervisor

I hereby declare that, the preparation and presentation of the thesis was supervised in accordance with the guidelines laid down by the University for Development Studies.

Name: Dr. Baba Sulemana Mohammed

Principal Supervisor's Signature…… Date……...

Name: Dr. Paul Armah Aryee

Co- Supervisor's Signature…….……. Date……...

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ABSTRACT

Although preconceptional and periconceptional folic acid (FA) supplementation has been shown to reduce the incidence of neural tube defects (NTDs) by more than 70%, adherence to supplement use remains low. In this retrospective and cross sectional study, the determinants of preconceptional and periconceptional FA use by pregnant women were assessed. Relationships between variable were determined using Chi square. A total of 376 women were interviewed at ANCs in the Upper East Region for the starting time of use of FA supplement. There was inadequate level (45.5%) of knowledge about FA supplementation among the population. A staggering 91% of the study participants did not practice preconceptional FA supplementation. In spite of 80.6% periconceptional FA supplementation, a large percentage (>54%) missed the recommended starting time. Mother's educational attainment, employment status, and income level were associated with preconceptional FA use ($P = 0.004$, $P < 0.001$ and $P < 0.001$ respectively). And in periconceptional stage, there was association with educational attainment ($P = 0.003$). Pregnancy counseling was associated with both preconceptional and periconceptional FA supplement use ($P = 0.001$ and $P = 0.008$, respectively). But more than 75% of the participants did not go for pregnancy counseling. Early booking at ANC was associated with FA supplementation ($P < 0.001$). There was inadequate level of knowledge about FA supplementation among pregnant women in the UER. Vigorous educational and poverty alleviation strategies should be used to encourage pregnancy counseling, and raise women's incomes and then, FA use.

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I wish to thank my wife, Mrs. Mohammed Masalura, (affectionately called Mama) and my friend, Abdul-Jalil a.k.a. HAJ, for having endured my irregular presence at the times they could have needed me most and for the encouragement and support given me. To my wife in particular, I say, I am deeply indebted for the special support.

Finally, this thesis could not have been successful without the valuable information voluntarily given by the study participants. To them therefore, I say I am most grateful.

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DEDICATION

This thesis is dedicated to my family and friends.

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LIST OF ACRONYMS

ANC	Antenatal Clinic
AOR	Adjusted Odds Ratio
ASDs	Autism Spectrum Disorders
CDC	Centre for Disease Control
DNA	Deoxyribonucleic acid
EFSA	European Food Safety Authority
FA	Folic acid
FFI	Flour Fortification Initiative
Ghc	Ghana cedi(s)
GHS	Ghana Health Service
GSS	Ghana Statistical Service
IFA	Iron/Folic Acid
JHS	Junior High School
LACOSREP	Upper East Land Conservation and Smallholder Rehabilitation Project
MCH	Maternal and Child Health
MoFA	Ministry of Food and Agriculture
MTHF	Methyl- tetrahydrofolate
RDA	Recommended Dietary Allowance
RI	Recommended Intake
SD	Standard Deviation
SDG	Sustainable Development Goals
SEM	Standard Error of the Mean
SHS	Senior High School
UER	Upper East Region
UK	United Kingdom

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US	United States
USPSTF	U.S. Preventive Services Task Force
THF	Tetrahydrofolate
WHO	World Health Organization
WIFA	Women In Fertility Age

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CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Background to the Study

Folic acid or folate is needed for the proper development of the human body. Folic acid is necessary for normal foetal spine, brain and skull development **(**Morse, 2012). It is involved in producing the genetic material called DNA and in numerous other bodily functions. Adequate folate intake during the peri-conception period (which is the time right before and just after a woman becomes pregnant) helps protect against a number of congenital malformations, including Neural Tube Defects (Shaw, Schaffer, Velie, Morland and Harris, 1995). Neural tube defects are severe abnormalities of the central nervous system that develop in embryos during the first few weeks of pregnancy resulting in malformations of the spine, skull, and brain.

According to the Flour Fortification Initiative [FFI] (2011), folic acid is needed to produce and maintain new cells and decrease the risk of folate deficiency anemia, known as megaloblastic anemia (FFI, 2011). Women especially need to take the daily recommended dose of folic acid for at least 1 to 3 months before conception and in the early days of pregnancy because the neural tube, which ultimately develops into the child's brain and spinal cord, and depends on maternal folate, forms within 28 days of conception, even before most women know they are pregnant (FFI, 2011).

There is overwhelming evidence that links an increased periconceptional intake of synthetic folic acid (the more bio-available form of folate) to a reduced risk of neural tube defects (Christianson *et al.,* 2006). In 1991, the

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(Medical Research Council [MRC], 1991) conducted a double blind randomized controlled trial at 33 centres in seven countries to determine whether supplementation with folic acid or a mixture of seven other vitamins (A, D, B_1, B_2, B_6, C, and nicotinamide) around the time of conception can prevent neural tube defects. A total of 1817 women at high risk of having a pregnancy with a neural tube defect, because of a previously affected pregnancy, were allocated at random to one of four groups— namely, folic acid, other vitamins, both, or neither. One thousand one hundred and ninety-five had a completed pregnancy in which the fetus or infant was known to have or not have a neural tube defect; 27 of these had a known neural tube defect, 6 in the folic acid group and 21 in the two other groups, a 72% protective effect (relative risk 0·28, 95% confidence interval 0·12-0·71). The other vitamins showed no significant protective effect (relative risk 0·80, 95% Cl 0·32-1·72). This finding led the Medical Research Council to conclude that folic acid supplementation starting before pregnancy can now be firmly recommended for all women who have had an affected pregnancy, and public health measures should be taken to ensure that the diet of all women who may bear children contains an adequate amount of folic acid.

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With global yearly incidence of about 300,000, Christianson *et al.* (2006) neural tube defects have been studied deeply and the cause has been found to be maternal deficiency in folate during the critical period of neural tube closure which is normally completed by day 28 post conception (Peake *et al.,* 2013). There are findings that point to folic acid as having a protective effect against the risk of oral cleft. However, some other findings including that of Hayes *et*

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al. (1996) do not support a protective association between the periconceptional use of folic acid supplements and the risk of oral clefts.

Ideally, the evidence supporting the protective effect of periconceptional intake of folic acid supplement to reduce the risk of neural tube defects should have resulted in the appropriate intake of folic acid supplements among women who are planning a pregnancy. This is because, ideally, most women will plan ahead and begin to adopt healthy behaviours compatible with a healthy pregnancy long before such a pregnancy is necessary. In reality however, the majority of pregnancies are not planned. For this reason, health care providers need to take every opportunity to encourage women to adopt healthy practices that would support a healthy pregnancy (Brown, 2014). With obstetric guidelines recommending that all women of child bearing age use folic acid supplements in the periconceptional period to prevent neural tube defects, (Lunet *et al.,* 2008) it is expected that women all over the world would follow these guidelines in an attempt to have positive pregnancy outcomes.

In a study by Popa *et al.* (2013) nutritional knowledge was shown to be independently associated with the use of folic acid supplements. This underscores the need to imbibe nutritional knowledge in women of child bearing age so as to ensure positive pregnancy outcomes. However such maternal knowledge of the importance of the use of folic acid supplement during the most critical window of opportunity to prevent neural tube defects, and the actual use of the folic acid supplement are rather low (Robert *et al.,* 1997; Rofail *et al.,* 2012; Wolff *et al.,* 2009).

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There are a number of studies that have confirmed the low levels of prenatal intake of folic acid supplements in different settings. An earlier study on awareness and use of folic acid and iron supplements among pregnant women in Northern Tanzania found that prenatal intake of folic acid and iron supplements among pregnant women was reported to be 17.2% only and 22.3% respectively (Ogundipe *et al.*, 2012). A similar study among pregnant women in Oslo reported that most of the study participants do not use folic acid supplements during the recommended period, with only 17% using it (Braekke and Staff, 2003). The low intake levels have also been confirmed by (Barbour *et al.*, 2012; Rofail *et al.*, 2012).

Other studies in different settings have tried to establish the factors responsible for folic acid supplement intake during preconception and in early pregnancy as per World Health Organisation (WHO) and country-specific guidelines. Some of the factors outlined in previous studies include whether target groups are currently reached by existing campaigns culturally and whether such campaigns (if any), are modified to make them relevant to those target groups, and inclusion of folic acid supplement benefits within high school and university educational programs (Rofail *et al.* 2012). In another study, Peake *et al*. (2013) identified a number of factors determining the periconceptional folic acid supplement intake in the United Kingdom (UK), and found unintended pregnancy, age, socioeconomic status, and ethnicity as very important factors associated with low folic acid supplementation. With many of the studies elsewhere showing that low socioeconomic status is associated with low intake of folic acid supplement, (Peake *et al.*, 2013) this study becomes even more relevant in Northern Ghana and in the Upper East Region of Ghana in

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particular given that this region is one of the poorest regions of the country (LACOSREP, 2005).

There are a couple of studies that suggest that there is little awareness of neural tube defects in Africa, and that, most African countries lag behind in the global efforts at preventing them (Rabiu & Adeleye, 2013). In a related finding, Christianson *et al.* (2006) also report that there is a paucity of data on the prevalence of birth defects in middle and low-income countries. Worse of all, Almeida and Cardoso (2010) in their study on "Recommendations for folate intake in women: implications for public health strategies", concluded and bemoaned that there is limited adherence to supplementation. These findings, among other things, make this study a necessary prerequisite to provide a baseline data on the situation for further study into preconceptional and periconceptional folic acid supplementation and to establish and assess the determinants of folic acid supplementation during the recommended periods of preconception and periconception in the UER of Ghana.

The aim of this study was to assess the determinants of folic acid supplement intake during the preconceptional stage and in early pregnancy among pregnant women seeking ANC services in health facilities in the UER of Ghana. This will help inform policy makers plan interventions that aim at improving pregnancy outcomes specific to the prevention of neural tube defects, and more over there are no published scientific studies from the UER on this topic.

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1.2 Problem Statement

According to a study by Christianson *et al.* (2006), an estimated 300,000 children are born with neural tube defects globally each year resulting in the death of approximately 88,000 WHO (2015) and about 8.6 million disability adjusted life years (DALYs) (WHO, 2015). Individuals and families who are affected by neural tube defects suffer from social and financial impacts that eventually affect the larger society in terms of productivity. The implication could be even worse for developing countries where there is little awareness of neural tube defects (Lo *et al.,* 2014; Rabiu & Adeleye, 2013). With about 70% of all neural tube defects cases known to be preventable through preconceptional and periconceptional folic acid supplementation (Nawapun & Phupong, 2006), it is a national policy in Ghana that women of child bearing age are given folate supplementation. Studying the determinants of folic acid supplementation may be just a step away from reducing the incidence of the disease. In Ghana and in the Upper East Region in particular, there is no published scientific literature on determinants of supplementation of folic acid by women of child bearing age. Although understanding the determinants of preconceptional and periconceptional folic acid supplementation can help make recommendations to improve outcomes, there is no data on the determinants of preconceptional and periconceptional use of the folic acid supplement in the study area. One study (Owusu *et al.,* 2010) gave a clue about the folate status of Ghanaians living in urban Accra, but not down to the study area. In their cross-sectional study to compare the folate status of Ghanaians living in the UK and an urban population in Accra, the authors suggested that there was a marked improvement in the folate status in the UK resident

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Ghanaians. This was attributed to the consumption of folic acid fortified food and the use of folic acid supplements by the UK –based Ghanaians. Based on the findings of their study, they recommended that there was the need to step up action on the folate status of the Ghana residents. And this will be effective with scientifically generated data unravelling the determinants of folate supplementation.

With the absence of data on the extent of preconceptional and periconceptional folic acid supplementation by pregnant women in the Upper East Region, and with the complete lack of data on the determinants folic acid use by pregnant women during the preconceptional and periconceptional period, there is need for a study such as this, to fill the gap and provide recommendations, to try and achieve optimal pregnancy outcomes.

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1.3 Significance of the Study

The findings of this study will benefit society in many ways. If used by government, it can help reduce its spending on maternal and child health, especially neural tube defects related expenditures. The socioeconomic burden on families who would have been affected by neural tube defects would be curtailed.

For researchers, the study is an attempt at solving the problem of paucity of data on the preconceptional and periconceptional folic acid supplementation in the Upper East Region. Furthermore, health professionals and other policy makers can use the findings of this study to formulate policies on preconceptional and periconceptional folic acid supplementation in the Upper

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East Region in particular and in the whole country as a whole. In conclusion, this study can serve as a guide for public health practitioners interested in maternal and child health (MCH) specific to nutrition, to proffer an intervention regime on preconceptional and periconceptional folic acid supplementation in the Upper East Region.

1.4 Conceptual framework

The conceptual frame work for this study (Figure 1.1) was developed by the researcher, after taking into consideration how the variables may interplay to determine compliance with folic acid supplementation among pregnant women.

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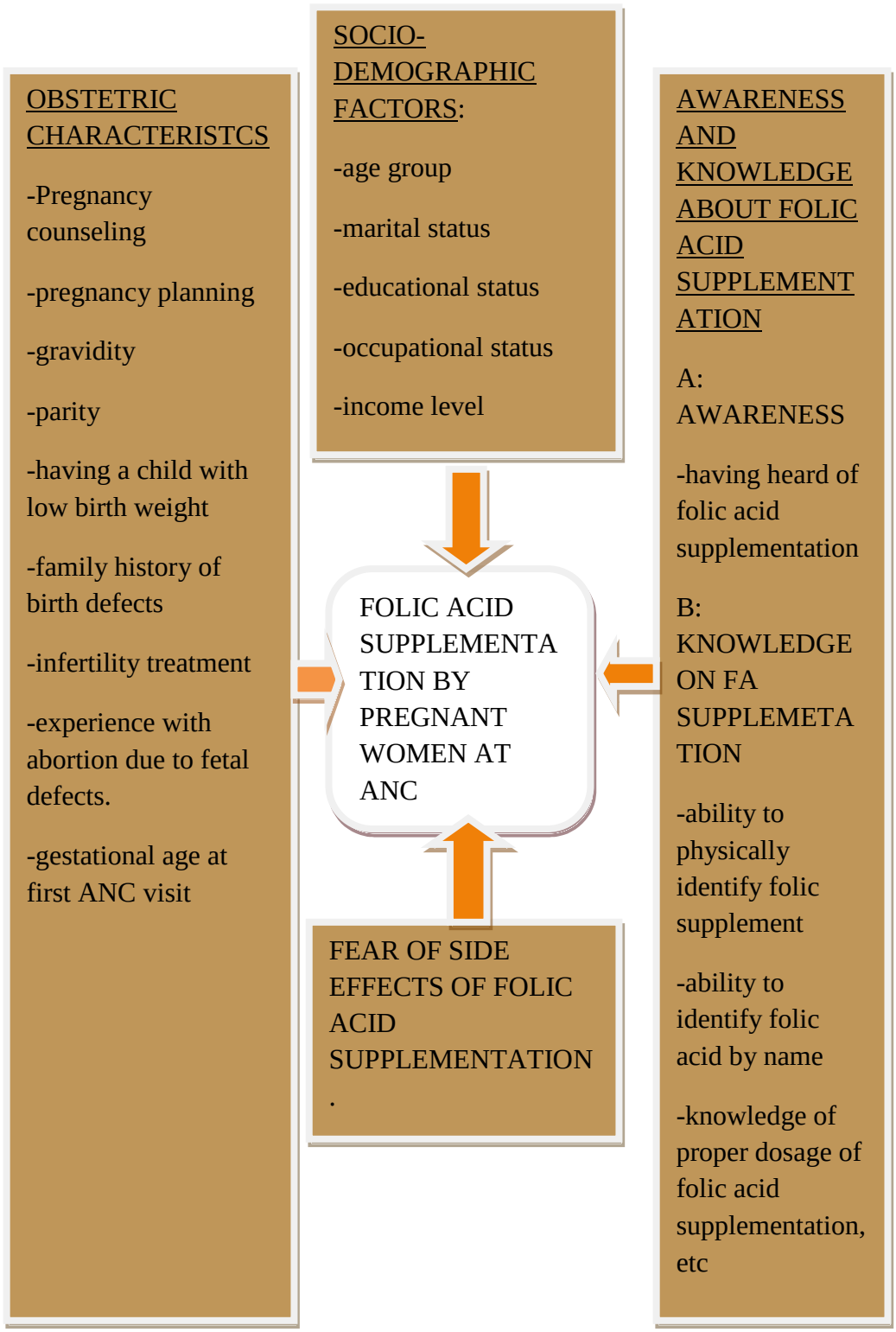

Figure 1. 1 Conceptual framework

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Two main variable groups were identified; the dependent variable and the independent variables. Folic acid supplementation which is the dependent variable may be influenced by a number of factors (the independent variables). The socio-demographic characteristics that were observed included age, marital status, educational status, occupational status and level of income. These may interact to affect the uptake of folic acid supplementation by women in their reproductive age. For example, it is expected that, mothers who are likely to be young, may have less exposure to pregnancy and child birth related experience. This then can lead to decreased compliance with folic acid supplementation especially during preconceptional stage. Also, mothers of advanced age who would likely have several children might equally exhibit less than optimal compliance because they may have a perception of guarantee since they already have some children. Marital status of a woman may also influence her compliance with folic acid supplementation in the sense that women who are married are likely to have the support of their husband in terms of reminders and insistence. With regards to educational status, higher education by the mother is likely to increase her awareness and subsequently her compliance with folic acid supplementation. Regarding occupational status, mothers who have an occupation or whose occupations pay higher wages/incomes may have the financial ability to access folic acid for supplementation which can enhance their compliance with its uptake during preconceptional stage.

Obstetric characteristics of a woman that may be related with her compliance with folic acid supplementation include pregnancy counseling, pregnancy planning, gravidity, gestational age at first visit to ANC, parity, having a child

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with low birth weight, family history of birth defects and experience with abortion due to fetal defects. Usually, women who go for pregnancy counseling are also likely to plan their pregnancy. They are hence more likely to be aware of folic acid supplementation and to comply with it.

Being aware of and having knowledge about folic acid supplementation would likely lead to compliance. This is because women who are aware of the importance of the supplement would ordinarily take steps to follow guidelines, and that involves folic acid supplementation.

One of the strongest factors that may be linked to compliance may the perception of side effects of folic acid supplement. The underlying assumption is that mothers who have a perception that folic acid supplement may have negative consequences on their health and/or the outcome of their pregnancy may exhibit suboptimal supplementation compared to those who do not have perceptions of side effects of the supplement.

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1.5 Research Questions

1. What is the prevalence of preconceptional and periconceptional folic acid supplementation among pregnant women in the UER of Ghana?
2. What is the relationship between socio-demographic characteristics of mothers and folic acid supplementation?
3. What is the relationship between awareness/knowledge of the benefits of folic acid and its supplementation?
4. What is the relationship between patient's obstetric characteristics and folic acid supplementation?
5. What are the side effects that are associated with supplemental folic acid?

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1.6 Objectives

1.6.1 General Objective

The main objective of the study was to assess the determinants of compliance with folic acid supplementation among pregnant women in the Upper East Region of Ghana.

1.6.2 Specific Objectives

1. To determine the prevalence of preconceptional and periconceptional folic acid supplementation.
2. To determine the relationship between socio-demographic characteristics and folic acid supplementation
3. To determine the relationship between awareness/knowledge of folic acid and its supplementation
4. To determine the relationship between patient's obstetric history and folic acid supplementation.
5. To determine the side effects associated with folate supplementation

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1.7 Thesis Organisation

Chapter 1 outlines the introduction to the study, statement of the problem, objectives of the study, research questions and justification of the study. Chapter 2 presents a review of relevant literature that relate to the research theme. Chapter 3 describes the details of the methodology used in the study. As such, detailed descriptions have been given on the study design, sample size, sampling technique, and instrument of data collection, ethical considerations, study variables and limitations of the study. Chapter 4 talks about the results and

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analysis of the research findings. The findings of this study are therefore found in chapter 4. Chapter 5 discusses the empirical findings from the study. In this chapter, issues under the broad topics of preconceptional and periconceptional supplementation with folic acid, gestational age at first ANC visit and its relationship with folic acid use, maternal age and folic acid use, awareness and knowledge on folic acid and folic acid use, clinical presentation of side effects of folic acid use and its consequence on folic acid use, among others, are discussed.

Chapter 6 outlines the conclusions and recommendations. The conclusion summarises the entire work, while the recommendations target policy makers and all other stakeholders for the adoption of appropriate healthy behavioural approaches.

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CHAPTER TWO

LITERATURE REVIEW

In this section, literature on the preconceptional and periconceptional supplementation of folic acid has been reviewed. The review starts with a broad question to elicit what folic acid is and what it is used for, and was based mostly on the variables used for this study.

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2.1 What is Folic acid?

Folic acid is the synthetic form of the naturally occurring B-Vitamin, folate, which is used in the synthesis of nucleotides and is particularly important during early pregnancy because of its essential role in the synthesis of DNA in cells (Brown, 2014). Other names for folic acid include folate, folacin, vitamin B-9, L-methylfolate, B-complex vitamin (US Natural Library of medicine; Brown, 2014). Folic acid is mostly found in nature as folylpolyglutamates, containing most of the active forms, which is often hydrolysed into monoglutamate during digestion (Institute Of Medicine, [IOM], 1998).

The umbrella term "folic acid" has been used generally to denote all forms of vitamin B9, including those found in plasma and erythrocytes. There are however key differences between folate (occurring naturally in foods) and oxidized folic acid (synthetic form used in food supplements and fortified foods). Folate is in the form of polyglutamates (pteroylpolyglutamate) whereas folic acid is in monoglutamate (pteroylmonoglutamate) form. Polyglutamates have higher metabolic activity and are better retained by cells, while monoglutamates pass through cell walls more rapidly. In

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humans, the metabolism of polyglutamates requires their deconjugation to monoglutamates within enterocytes, explaining their low bioavailability (~50%) compared to monoglutamates (~85%). Moreover, anti-folate components present in vegetables as well as exposure to heat and light during cooking and storage, all contribute to lowering folate availability (Almeida & Cardoso, 2010).

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2.2 Overview of the folate metabolic pathway

The folate metabolic pathway (Figure 2.1) shows that folates require several transport systems to enter the cells; the best characterized being the reduced folate carrier (RFC1). Methylenetetrahydrofolate reductase (MTHFR) reduces 5,10-methylenetetrahydrofolate (5,10-MTHF) to 5-methyltetrahydrofolate (5-MTHF). Subsequently, methionine synthase (MTR) transfers a methyl group from 5-MTHF to homocysteine (Hcy) forming methionine (Met) and tetrahydrofolate (THF). Methionine is then converted to S-adenosylmethionine (SAM) in a reaction catalyzed by methionine adenosyltransferase (MAT). Most of the SAM generated is used in transmethylation reactions, whereby SAM is converted to S-adenosylhomocysteine (SAH) by DNA methyltransferases (DNMTs) that transfer the methyl group to the DNA. Vitamin B12 (or cobalamin) is a cofactor of MTR, and methionine synthase reductase (MTRR) is required for the maintenance of MTR in its active state. If not converted into methionine, Hcy can be condensed with serine to form cystathionine in a reaction catalyzed by cystathionine β-synthase (CBS), which requires vitamin B6 as a cofactor. Cystathionine can be then utilized to form the

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antioxidant compound glutathione (GSH). Another important function of tetrahydrofolate derivatives is in the de novo synthesis of DNA and RNA precursors, where they are used by thymidylate synthase (TYMS) and methylenetetrahydrofolate dehydrogenase (MTHFD) for the synthesis of nucleic acid precursors. MTHFD is a trifunctional enzyme that interconverts tetrahydrofolate derivatives for purine, methionine and thymidylate synthesis. TYMS requires 5,10-MTHF and deoxyuridine monophosphate (dUMP) for the production of deoxythyminemonophospate (dTMP) and dihydrofolate (DHF) production for the synthesis of pyrimidines. Other enzymes participate in folate metabolism, among them is phosphoribosylglycinamidetransformylase (GART) which is a protein required for purine synthesis (Coppedè *et al.*, 2010).

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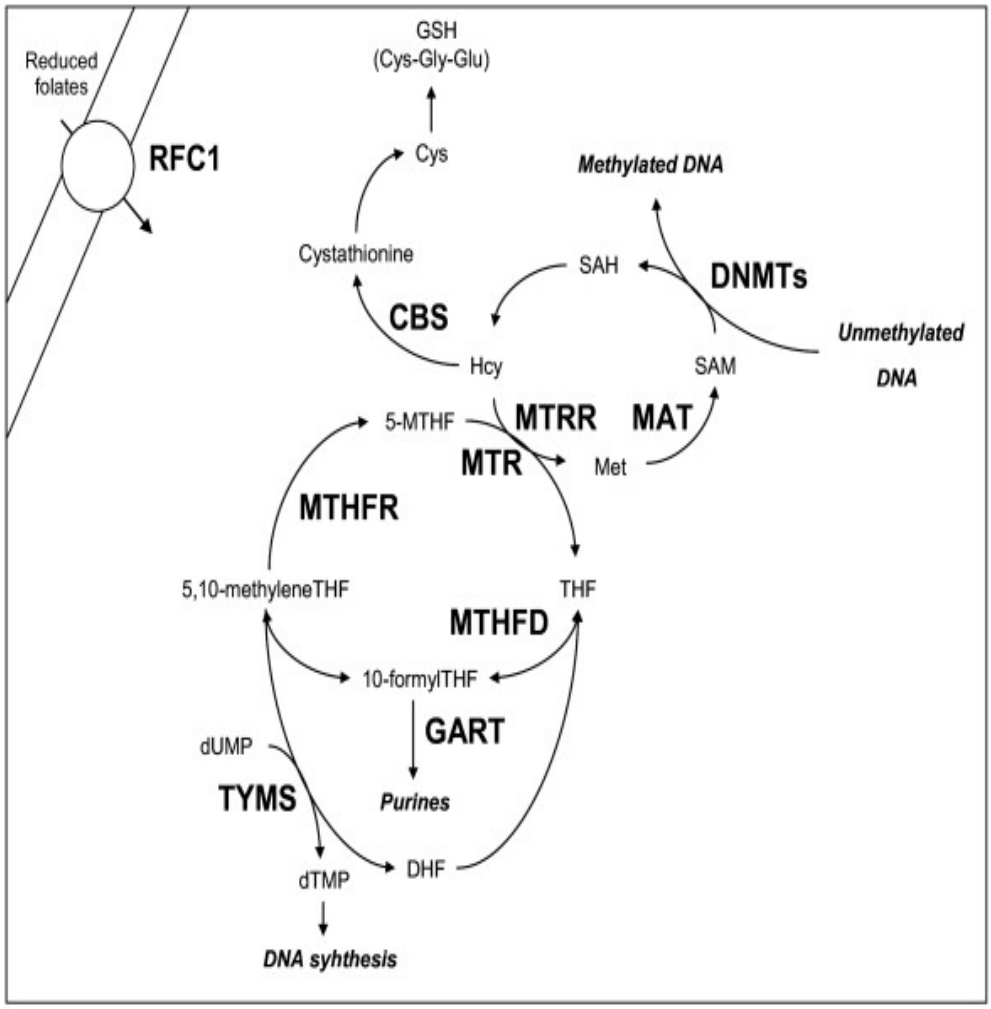

(Copped *et al.*, 2010).

Figure 2. 1 Overview of the folate metabolic pathway

2.3 Digestion, Absorption and Storage of folate

After consuming folate rich foods, food folates are hydrolyzed to the monoglutamate form in the gut prior to absorption by active transport across the intestinal mucosa. Before entering the bloodstream, the monoglutamate form is further reduced to tetrahydrofolate (THF) which is also further converted to either methyl or 10-formyl-tetrahydrofolate (10-FTHF) forms (Bailey and Gregory, 2006 as cited in Akwetea, 2015). This form is then reduced to 5-methyl- tetrahydrofolate (5-MTHF) for absorption by the intestinal cell prior to folate release into the portal circulation (Rosenberg *et*

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al., 1971). It is indeed, this form of folate (5-methyl-THF) that is found in plasma Bailey & Gregory (2006) as cited in Akwetea, (2015). Folic acid can also be found in the blood unaltered (known as unmetabolized folic acid), but whether this form has any biological activity or can be used as a biomarker of status is not known.

Regarding the quantity and specific storage point of folate, the (National Institutes of Health [NIH], 2011) indicates that the total body content of folate is estimated to range from 10 to 30 mg. And about half of this amount is stored in the liver and the remainder in blood and body tissues.

There are several ways of determining the body's folate content/status. One of the most common ways is the use of serum folate concentration. According to the NIH (2011), when using this approach, a value of serum folate concentration above 3ng/mL indicates adequacy, although an earlier study by Coll *et al.* (2004) has suggested that a serum folate concentration less than 7ng/mL indicates inadequacy. One of the setbacks of this approach is that, serum folate concentration is sensitive to recent dietary intake. For this reason, this indicator might not be able to reflect long-term status. Because of the inherent setbacks of using the serum folate concentration, other indicators have been developed. One such alternative indicator is the erythrocyte folate concentration which provides a long-term measure of folate intakes, so when day-to-day folate intake are variable—such as in people who are ill and whose folate intake has recently declined—it might be a better indicator of tissue folate stores than serum folate concentration. An erythrocyte folate concentration above 140 ng/mL indicates adequate

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folate status, although some researchers have suggested higher values to be optimal for preventing neural tube defects (NIH, 2011).

A combination of serum or erythrocyte concentration and indicators of metabolic function can also be used to assess folate status. Plasma homocysteine concentration is a commonly used functional indicator of folate status because homocysteine levels rise when the body cannot convert homocysteine to methionine due to a 5-methyl-THF deficiency. Homocysteine levels, however, are not a highly specific indicator of folate status because they can be influenced by other factors, including kidney dysfunction and deficiencies of vitamin B12 and other micronutrients. The most commonly used cutoff value for elevated homocysteine is 16µM/L, although slightly lower values of 12 to 14µM/L have also been used.

The achievement of optimal folate status to prevent neural-tube defects, and possibly other diseases, is hindered by the well-recognised incomplete bioavailability of the natural folates found in foods compared with the synthetic vitamin, folic acid. The difference in folate bioavailability from different foods is considered to be dependent on a number of factors, including the food matrix, the intestinal deconjugation of polyglutamyl folates, and the instability of certain labile folates during digestion and the presence of certain dietary constituents that may enhance folate stability during digestion (Pentieva & McNulty, 2004). Establishing recommendations for folic acid/folate has been hampered by the differences in bioavailability. To deal with the differences in bioavailability, dietary folate equivalents (DFE) are used. The use of DFE presumes that the bioavailability of folic acid added to foods is 1.7-fold greater than that of

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natural folate (mathematically, DFE = folate + 1.7 x folic acid). With this in mind, the folate status of an individual therefore depends on the source of the vitamin in the diet as well as the absolute amount consumed (Almeida & Cardoso, 2010).

Folate bioavailability is defined as the proportion of an ingested amount of folate that is absorbed in the gut and that becomes available for metabolic processes. In human intervention studies, relative bioavailability is usually assessed by comparison with a reference dose of folic acid. The bioavailability of food folate is generally lower than that of folic acid (Winkels *et al.*, 2007).

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2.4 What are some uses of folic acid?

During pregnancy, the rate of cell division and erythrocyte formation increase dramatically (IOM, 1998). As a consequence, the uterus enlarges, the placenta develops, maternal blood volume increases and the embryo develops into a foetus, leading to the transfer of folate from the mother to the growing foetus, increasing the demand for folate beyond the sole requirement of the mother (IOM, 1998).

There are a number of studies that also suggest that supplementing with folic acid during the periconceptional stage has the tendency to reduce the risk of giving birth to children with autism spectrum disorders, (ASD), including autistic disorder, Asperger syndrome and Pervasive Developmental Disorder–Not Otherwise Specified (PDD-NOS). For example, a study by Surén and colleagues on association between maternal use of folic acid supplements and risk of Autism Spectrum Disorders in

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Children showed that, out of a total of 85,176 children studied for ASDs there was an inverse association between folic acid use and subsequent risk of autistic disorder. Autistic disorder was present in 0.10% (64/61,042) of children whose mothers took folic acid, compared with 0.21% (50/24,134) in children whose mothers did not take folic acid. The conclusion was that maternal use of folic acid supplements around the time of conception was associated with a lower risk of autistic disorder (Surén *et al.,* 2013).

Folic acid has also been used to prevent colon cancer or cervical cancer. It is also used to prevent heart disease and stroke, as well as to reduce blood levels of homocysteine, high level of which has been linked to heart diseases. Folic acid is used for memory loss, Alzheimer's disease, age-related hearing loss, preventing the eye disease known as age-related macular degeneration (AMD), reducing signs of aging, weak bones (osteoporosis), jumpy legs (restless leg syndrome), sleep problems, depression, nerve pain, muscle pain, AIDS, a skin disease called vitiligo, and an inherited disease called Fragile-X syndrome. It is also used for reducing harmful side effects of treatment with the medications lometrexol and methotrexate (Surén *et al.,* 2013). According to the King Edward Memorial Hospital Clinical Guidelines (2013), the primordial central nervous system begins as a plate of cells in embryonic life which folds on itself to form the neural tube that will subsequently close between 21 and 28 days post conception. This happens even before women realize they are pregnant (Christianson *et al.,* 2006). This emphasizes the importance of taking folic acid supplement during the preconceptional period.

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Maternal lack of folic acid is implicated in incomplete closure of the neural tube, leading to neural tube defects including anencephaly, encephalocoely and spina bifida (King Edward Memorial Hospital Clinical Guidelines, 2013).

According to Cheschier (2013), after congenital cardiac malformations, including septal defects, patent ductus arteriosus and narrowing of the valves, neural tube defects are the second most common type of birth defect, the global yearly incidence of which, according to the UN (2012), is about 300,000 children. In a study by Lo and colleagues, they report that hundreds of thousands of mortalities are recorded from the yearly 300,000 incidence with a similar number of survivors suffering permanent disability of varying degrees (Lo *et al.*, 2011).

In Europe, more than 4,500 pregnancies are affected each year by neural tube defects such as spina bifida and anencephaly, with 70% of these cases believed to be preventable through preconceptional and periconceptional folic acid supplementation (Nawapun & Phupong, 2006). In China alone, according to Yunni and colleagues, 100,000 infants are born each year with neural tube defects (Blencowe et al., 2010 as cited in Yunni *et al.*, 2011). In a recent publication Chitayat *et al.* (2016) presented statistics which are not too different from the foregoing figures. They indicate that whereas the incidence of neural tube defects is around 1/1000 in the United States, it is 3- to 5-fold higher in Northern China and 3-fold higher in India.

The call for folic acid fortification policies of some food staples or supplementation with folic acid is justified by a cursory look at the high cost

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of handling children affected by neural tube defects. For example, in a finding titled Updated Estimates of Neural Tube Defects Prevented by Mandatory Folic Acid Fortification — United States, 1995–2011, the life-time direct costs for a child with spina bifida are estimated at $560,000, and for anencephaly (a uniformly fatal condition), the estimate is $5,415. If these costs are multiplied by the then current NTDs case estimates, it translates into an annual saving in total direct costs of approximately $508 million for the NTD-affected births that were prevented (CDC, 2015).

In the advanced countries, because of availability of advanced medical technology and enlightenment, and higher household incomes, many of the affected families may afford to pay for the cost of treatment and their governments may be able to provide social services to affected people that would improve the quality of life of such affected populations. But even then, recommendations on appropriate supplementation with folic acid are barely adhered to (Almeida & Cardoso, 2010; Christianson *et al.*, 2006).

The situation may be even worse for low and middle income countries. In these countries (and this includes most African countries), there is limited amount of data on neural tube defects, Lo *et al.* (2014) and, besides, the burden of neural tube defects as well as the effectiveness of folic acid fortification/supplementation are unclear (Blencowe *et al.,* 2010). In Africa precisely, there is little awareness of neural tube defects (Rabiu & Adeleye, 2013). The previously cited study by Lo et al. (2014) has however identified some burden of neural tube defects in 18 lower and middle income countries and puts the total burden of neural tube defects in those 18 countries based on live birth at 1.76/1000. The burden of spina bifida is 1.13/1000 whilst

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those of anencephaly and encephalocoele are 0.25 and 0.15 respectively (Rabiu & Adeleye, 2013). The very low prevalence of neural tube defects reported in the study by Rabiu and Adeleye (2013) might have been the result of the paucity of statistics as noted by Christianson *et al.* (2006). The effort to provide data on the incidence of neural tube defects has seen an online medical site (http://www.rightdiagnosis.com) extrapolating estimates of the disease based on the population of the respective countries or regions of the world as presented in Table 2.1 below (Health Grades Inc., 2015). The data provided are very detailed and give an overview of the incidence of the disease in a very broad way.

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Table 2. 1 Extrapolated incidence of neural tube defects by regions of the world

REGION	EXTRAPOLATED INCIDENCE	POPULATION ESTIMATE USED
Caribbean	66	3,897,960
Central Africa	1,357	79,836,729
Central America	337	19,913,300
Central Asia	825	48,565,676
Central Europe	2,641	164,423,616
Eastern Africa	2,977	175,084,338
Eastern Asia	25,981	1,527,162,188
Eastern Europe	3,558	210,172,527
Middle East	3,068	180,720,662
North America	7,334	431,122,873
Northern Africa	2,056	120,897,168
Northern Asia	46	2,751,314
Northern Europe	337	19,908,270
Oceania	497	29,327,241
South America	5,118	300,988,859
Southeastern Asia	8,627	507,186,716
Southeastern Europe	876	51,188,794
Southern Africa	1,051	81,933,044
Southern Asia	24,093	1,416,211,830
Southern Europe	1,168	68,705,006
Southwestern Asia	1,172	68,893,918
Southwestern Europe	1,076	63,367,202
Western Africa	1,189	180,992,637
Western Europe	3,654	152,388,422

Source: Health Grades Inc. (2015)

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In Table 2.1, an attempt has been made to provide a global picture on the incidence of neural tube defects. It is observed that Eastern Asia which has the largest estimated population used (1,527,162,188), also presented the largest extrapolated incidence (25,981). Also, Northern Asia has the least population estimated used (2,751,314) in the analysis and it also presented the smallest extrapolated incidence (46).

Many studies have established a number of factors that determine supplementation with folic acid based on the WHO and country specific guidelines. Some of these findings have been reviewed in detail in the subsequent sections of this thesis.

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2.5 Public health strategies to increase folic acid use

Many authors have discussed various means by which the population could achieve the required amount of folic acid in order to optimize its benefit. In 1992 for instance, the CDC outlined three potential approaches through which folic acid could be delivered to the general population in the recommended dosage. One of these approaches has to do with life style change which is improvement of dietary habits. This means people should be health conscious and strive to consume folate-rich foods in an attempt to improve their folate status. Another approach was identified as fortification of food supply with the appropriate amount of folic acid. The third approach described was the use of dietary supplements of folate or related compounds (CDC, 1992).

According to de Benoist (2008), in the finding of a WHO Technical Consultation on folate and vitamin B_{12} deficiencies, the overarching and

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long-term strategy recommended for the control of folate and vitamin B_{12} deficiency is the consumption of a diet that meets the recommended intakes of these vitamins. It however adds that, in populations where it is unlikely that diet will provide the recommended intakes of these nutrients, strategies such as supplementation and fortification should be considered. This confirms the finding by Arnold *et al.* (2006) and FFI (2011) that diet alone cannot provide sufficient levels of folate, for which reason other public health strategies have been followed to help boost the folate levels of the at risk population groups. One such strategy, as mentioned in this section is the fortification of some commonly eaten foods such as wheat flour with folic acid (Arnold *et al.*, 2006; FFI, 2011), in the hope that it can help improve the folate levels in the general population and in particular that of the population at risk. Ghana is one of the countries that has adopted the policy on mandatory wheat flour fortification with folic acid, realizing the role of this B vitamin in the prevention of neural tube defects (FFI, 2011), and improving pregnancy outcomes.

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Fortification has an advantage over other strategies in that it reduces cost of having to provide folic acid to every woman of child bearing age, as in the case of supplementation (Arnold *et al.*, 2006). According to the WHO (2002), fortification is always less costly than supplementation because it does not require a visit to a provider, and the unit cost of supplementation increases sharply with increasing coverage. Due to the finding that fortification is less costly than supplementation, the WHO concludes that regardless of the coverage of fortification, it has always been the preferred option at low levels of resource availability (WHO, 2002). The FFI

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corroborates this in a conclusion that this is why some countries rather choose to institute mandatory fortification of some common industrial foods (FFI, 2011). Like many other interventions, fortification with folic acid also has its shortfalls. For example, it has been estimated that only 1% of industrially milled rice is fortified with folic acid. In countries where rice is the main staple (for example, China), this does not allow effective folate fortification (Chitayat *et al.,* 2016). For this reason, the other strategies of achieving optimal levels of folic acid have been highlighted. One such strategy that has worked is the national folic acid campaign which was launched in Israel in the year 2000. Realizing the need to decrease the risk of neural tube defects, the Israeli Ministry of Health (MOH) issued guidelines in August 2000 recommending daily folic acid supplementation for women in their childbearing age, and concurrently launched a national folic acid campaign. The effects of the campaign were assessed by comparing the results of a survey conducted in 2002 with a baseline survey conducted in June 2000. It emerged that the national periconceptional folic acid campaign resulted in significant increases in awareness and knowledge, and a six-fold increase in its intake (Amitai *et al.*, 2004). The other strategy to increase folic acid intake among the population at risk is through daily supplementation with folic acid during preconceptional and periconceptional periods (FFI, 2011). In a study on choosing interventions to reduce specific risks, the World Health Organization (2002) in its 2002 World Health Report indicated that supplementation yields greater improvements in population health than fortification. In terms of coverage, the WHO (2002) in comparing the benefits obtained from supplementation

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and fortification, concluded that "supplementation has a larger impact on population health than fortification for equivalent levels of coverage".

2.6 Recommendations for supplementing with folic acid

Recommendations for folate intake have been a subject of controversy for many years (IOM, 1998). Over the years, the Recommended Dietary Allowance (RDA) for folate has shifted up and down (IOM, 1998). It observes that low folate intake has been linked with vascular disease and other

chronic conditions as well as risk of neural tube defects and other congenital malformations in the offspring of women of reproductive age.

On the other hand, even though it is generally regarded as not toxic for normal humans, folic acid may be implicated in causing neurological disorders when administered to patients with undiagnosed pernicious anemia (Butterworth and Tamura, 1989) until after irreversible neurological damage has occurred (Institute of Health [IOH], 1998). Other adverse effects include the fact that, when not given with caution, seizure control may be affected in drug-treated epileptic patients (Butterworth and Tamura, 1989).

According to the IOH (1998), a study was commissioned by the Panel on Folate, Other B Vitamins, and Choline; the Subcommittee on Upper Reference Levels of Nutrients; and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. The task was to analyze

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the evidence on the benefits and adverse effects of different folate intakes so as to set DRIs for all the B vitamins and choline.

Some cutoffs have been agreed upon by considering the obstetric history of a woman and other conditions that may hamper a woman's absorption of folate/ folic acid. For example, the RDA of folic acid in nulliparous and multiparous non-pregnant women of childbearing age, for the prevention of first and recurrent neural tube defects is 400 µg/day and increases to 600µg/day during pregnancy (Brown, 2014; Carmichael *et al.*, 2007; WHO, 2012). The recommendations by the WHO for supplemental dose of 400 µg/day (0.4mg/day) of folic acid dates as far back as 1998 following publication of several scientific studies supporting the periconceptional use of folic acid in the prevention of neural tube defects (WHO, 2012).

Much recently, Chitayat *et al.* (2016) have reviewed the optimal dosage of folic acid that should be given to women of reproductive age who are planning or not avoiding conception. The aim of the review was to propose updated guidelines and thus help health care providers and patients. Based on their findings, they proposed that, in addition to fortification of dietary staples with folic acid, women of reproductive age should supplement before conception with 0.4-1.0 mg of folic acid daily as part of their multivitamins.

Natural food sources of folate are vegetables including, but not limited to green leafy vegetables, spinach, fruits, avocado, banana, orange juice, asparagus, peas, dried beans, dry cereals as well as liver and yeast (European Food Safety Authority [EFSA], 2010). The fact that natural diet

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by itself alone is not sufficient to meet the Recommended Intake (RI) for folic acid during pregnancy (Almeida & Cardoso, 2010; Navarrete *et al.*, 2010), makes supplementation with folic acid a cornerstone.

2.7 Factors that Determine Supplementation with Folic acid

2.7.1 Knowledge and Use of Folic acid

Italy is one of the countries which made strong recommendations that in order to reduce the risk of pregnancies affected by neural tube defects, women who are pregnant or are planning to become pregnant need to receive folate supplementation (i.e. 0.4 or 4-5 mg per day). Between January and October 2014, a study by Guaraldi *et al.* (2015) was conducted to investigate the awareness and the real use of folate of 650 pregnant women regarding the benefit of folic acid supplementation. Their results were that although significant proportion of women knew folate benefits in pregnancy, actual folate supplementation during periconceptional period was inadequate.

According to Temel *et al.* (2015) in Rotterdam, The Netherlands' study of knowledge of a large city population on preconception folic acid supplementation and intention to seek for preconception care, it was found that despite campaigns about folic acid supplementation, knowledge on this supplement remains low.

In another study Nelson *et al.* (2013) on the relationship between awareness and supplementation with folic acid among Canadian women, they discovered that although most women in their study understood the benefits of folic acid supplementation, a little over a third of them did not take folic

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acid supplements prior to becoming pregnant, and less than half supplemented according to national guidelines. These findings led them to recommend that "identification of those subpopulations whose use of supplements is suboptimal may allow for targeted educational or other interventions to further encourage folic acid use" (Nelson *et al.,* 2013).

This finding is not too different from that of Wu *et al.* (2007) who found in their survey on knowledge and use of folic acid supplement for the prevention of birth defects amongst Honduran women that 45% of patients were familiar with folic acid. Of that number, 30% knew appropriate timing of consumption and 25% reported proper pre-natal supplementation (Wu *et al.,* 2007).

In addition to the above, the findings by Zeng *et al.* (2011) suggest that there is a consistent trend regarding knowledge and actual intake based on recommendations. These authors reported in their study on folic acid awareness and intake among women in areas with high prevalence of neural tube defects in China that among 33,025 participants, 57% had heard of folic acid but only 15% knew all of the core information. The intake rate was as low as 12%; only 8% took the recommended dose and only 4% of non-pregnant women took folic acid. About 24% of women had misconceptions about folic acid and rural residence was a risk to low awareness of folic acid supplementation. A number of socio-economic and obstetric variables of the participants were responsible for the observed of folic acid awareness and intake. Some of the variables that were implicated included ethnicity, educational level, average annual income per person and pregnancy. Furthermore, another finding which is consistent with the above

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is that of Nawapun and Phupong (2006). They reported in their study on awareness of the benefits of folic acid supplementation and prevalence of the use of folic acid supplements to prevent neural tube defects among Thai women, that even though majority of the women (more than 70%) who participated in their study reported that they had heard of folic acid, they reported a low figure of 9.7% as the number of participants who actually took folic acid supplement during their periconceptional period. This finding is supported by the study by Barbour *et al.* (2012) in a focus group discussion involving 211 women about the "uptake of folic acid supplements before and during pregnancy". They reported that only 31 per cent of folic acid supplement users followed recommendation guidelines. In a very recent study, the level of awareness of folic acid supplementation among Korean pregnant women was as high as 97.9% (Kim *et al.*, 2017). The percentage of women who demonstrated knowledge about appropriate timing of folic acid supplementation and the use of folic acid supplement in the prevention of NTDs was over 70%. However, only a little over 26% actually supplemented during the preconceptional period.

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Clearly, based on the findings above, awareness of folic acid supplementation and intake levels is low, although awareness is always disproportionately higher than actual intake rate (Nawapun & Phupong., 2006). Considering the overwhelming importance of periconceptional folic acid supplementation, a number of studies have delved into the topic including that of Morin *et al.* (2001). The authors found in a study of women of British Columbia that 71% of the surveyed women knew that vitamins could help prevent birth defects. Of those, 76.3% identified folic

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acid as the one vitamin specifically associated with reduction of birth defects. It was identified that 49.4% of all women took vitamins prior to pregnancy (Morin *et al.,* 2001).

Moreover, a survey of women living in Vancouver, Canada by French *et al.* (2003) on folate intakes and awareness of folate to prevent neural tube defects concluded that most (95%) of the women had heard of folate with lack of awareness of the importance of folate being the most common reason given for choosing not to use folic acid supplements before pregnancy. In that study however, 78% of the women indicated that with knowledge of the benefits of folate, they would use the recommended supplemental folic acid dosage daily to reduce the risk of birth defects. These finding show that education on the importance of folic acid can lead to the desired behavioural change.

From the foregoing reviews, it can be observed that, although most of the studies reported varying degrees of appreciable levels of knowledge and awareness of preconceptional and early pregnancy intake of folic acid, fewer women actually supplemented according to recommendations.

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2.7.2 Reported side effects of supplemental folic acid

A number of factors militate against compliance with supplement uptake including side effects (Gebremedhin *et al.,* 2014) and the negative relationship between side effects and actual uptake of iron/folic acid (IFA) supplements were recently highlighted in an Ethiopian study that was undertaken to assess the incidence/prevalence of adherence to the supplements. According to Gebreamlak, Dadi and Atnafu (2017), most of the women in their study who did not adhere to supplementation implicated

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side effect as the main reason holding them back. When asked to state the specific side effects, heartburn, vomiting, constipation and diarrhea were cited as the main side effects. Another study with findings regarding side effects of iron/folic acid supplements was conducted in South India. In their study to assess compliance with iron-folic acid therapy among pregnant women in the South of India, Mithra *et al.* (2013) concluded that some of the perceived side effects that accounted for non-compliance included vomiting, constipation and gastritis. In another study to understand the determinants of compliance with supplement uptake among women who had low compliance, one of five main reasons that were advanced by the women for not taking the folic acid tablets as recommended was that they experienced gastrointestinal side-effects. This includes one or a combination of nausea, vomiting, diarrhoea and constipation (Seck & Jackson, 2008). In South Africa, Kalipa and et al. (2017) found that among pregnant teenagers, side effects such as feeling of nausea, vomiting and stomach pain were the main reasons for not complying with the prescribed folic acid supplementation. Similarly, among non-pregnant adolescents (10-16 years) who took a combination of iron and folic acid supplementation tablets, 36.6%, 13.6%, 10.7%, 9.3% and 5% reported stomach ache, nausea, vomiting, black stool and diarrhea, respectively (Sajna & Jacob, 2017). The side effects of nausea and vomiting appear to be the most common reason militating against compliance. In a qualitative study conducted by Nisar *et al.* (2014) in Pakistan, one pregnant woman was quoted as saying “I used these tablets [folic acid supplement] but after few days I had vomiting and diarrhea. With this, my mother-in-law told me to stop this medicine; she

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[mother-in-law] told me not to take any medicine during pregnancy". This means that the determinants of compliance to folic acid supplementation are not solely the decision of the pregnant woman, but include the opinions and advice of her family, social network and other significant individuals within the community. That also implies that interventions such as education at ANC only may not be effective as that is usually limited to the pregnant woman. As Titaley and Dibley (2015) indicated, broad community awareness and participation is significant in ensuring compliance among pregnant women. To achieve such level of awareness among the population requires inter-agency and inter-sectoral cooperation. For example, it may involve collaboration between the Ghana Health Services and bilateral/multilateral organizations such as UNICEF and local non-governmental organisations that operate in the various communities. Other relatively easier ways of reaching the population with such important information include passing it through the religious leaders in churches and mosques. With increasing technology, it is not also out of place to use mobile phones messaging platforms to pass information on folic acid supplementation. For instance the Mobile Technology for Community Health (MOTECH), has been piloted in the Upper East Region already and could offer an opportunity to integrate folic acid supplementation information into the platform (Ghana Health Service - Upper East Region, 2013). Another study by French *et al.* (2003) on folate intakes and awareness in Vancouver, Canada has indicated that supplementation with too high doses of folic acid to reduce the side effects of methotrexate therapy for psoriasis may influence the efficacy of treatment. In another

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study on effects of folic acid on the mental state and fit-frequency of drug-treated epileptic patients the findings were that folic acid partially reverses both the therapeutic (antiepileptic) and retarding effects of phenobarbitone, phenytoin and primidone (Reynolds, 1967). This finding is likely to induce lower levels of supplementation with folic acid among epileptic patient women who are undergoing treatment.

In their study on Nutritional knowledge as a determinant of vitamin and mineral supplementation during pregnancy, Berger and Dillon (2002) concluded that the characteristics and side effects of supplements are, among others, the reasons educators on supplements do not engage the target population.

Again, in a prospective study of 603 women in a teaching hospital in the UK, women who did not take folic acid during the periconceptional stage implicated side effects as their reason, saying they previously experienced some side effects from the supplement (Maher & Keriakos, 2014).

Some other side effects of folic acid supplement use have also been mentioned and they include nausea, gas or bloating, poor appetite, trouble sleeping and feeling depressed (Willey, 2015).

In another study by Nisar and colleagues (2014) among Pakistani women, fear or experience of side effects has been implicated for non-use of folic acid in antenatal.

Indeed, there is a study (Chitayat *et al.*, 2016) that argues that there are no such documented studies on risks of exposure to folic acid intake. They

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however cited a study from Spain in which results from an observational study indicated that there may be increased neurocognitive risks when the dose of folic acid exceeded 5mg/day. However, they cautioned that this finding was based on very small numbers of patients, and the risk emerged only above 5 mg/day. This caution is meant to buttress the point that there are no risks once patients do not exceed the recommendation.

The general trend from these findings reveals that the fear of side effects forms the basis for some women in certain studies not willing to take folic acid supplements.

2.7.3 Gestational age at first visit to ANC

A number of studies have underscored the importance of early visit to antenatal clinic and how that can translate into better nutritional knowledge and hopefully lead to adoption of the desired behaviour. For instance, in a finding regarding folic acid use and utilization of ANC services, Popa *et al.* (2013) found that those with greater engagement with prenatal care had better nutritional knowledge and used supplements more than those with less engagement with prenatal care. This was summarized by the authors in their own words: 'Importantly, we also found that less well-educated women who engaged with prenatal care were more likely to take folic acid. This suggests that the interventions (prenatal visits) are productive and that the Romanian government should seek ways of encouraging less well-educated women to participate'. This finding by Popa *et al*. (2013) is similar to that of Nisar *et al.* (2014) in a study of non-use of iron and folic acid supplements among Pakistani women. They found that among other things, non-use of antenatal care services resulted in some proportion of non-use of

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iron and folic acid supplement (Nisar *et al.* 2014). Another study with similar result is that of Lunet *et al.* (2008) in their study of adequacy of prenatal care as a major determinant of folic acid, iron and vitamin intake during pregnancy. They concluded based on their findings that the use of all types of supplements studied was positively associated with the adequacy of prenatal care (Lunet *et al.*, 2008). This finding is also supported by the study by Ogundipe and colleagues who argued that women who have more ANC visits have significantly greater odds of using folic supplements (Ogundipe *et al.*, 2012).

Contrary to the finding by Popa *et al.* (2013), and Nisar, Dibley and Mir (2014), one study by Maher and Keriakos (2014) on women's awareness of periconceptional use of folic acid before and after their antenatal visits reported that antenatal clinic visits did not improve women's awareness about folic acid (Maher & Keriakos, 2014).

2.7.4 Mothers' knowledge about the likely consequences on the foetus

The link between periconceptional folic acid use and reduction in neural tube defects has been established since publications first emerged in the early 1990s, establishing the unambiguous relationship between the two variables. The question now is whether mothers have imbibed knowledge about the consequences of the lack of folic acid on their foetus, especially with regards to neural tube defects. A number of studies including that of Nelson *et al.* (2013) made some investigations regarding awareness of the benefit of folic acid. For example, Nelson *et al.* (2013) reported that, overall, 77.6% of the women they surveyed were aware of the benefits of taking folic acid before pregnancy, and that level of educational attainment

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and age were positively correlated with such awareness (Nelson *et al.* 2013). In a study with similar objective conducted among 450 Thai women on 'Awareness of the benefits of folic acid and prevalence of the use of folic acid supplements to prevent neural tube defects among Thai women', the conclusion was that few women (24.4%) understood that folic acid could help prevent neural tube defects (Nawapun & Phupong, 2007). Concerning their source of information on folic acid, the media (television/magazine/leaflet) featured prominently, (48.6%) (Nawapun & Phupong, 2007). This finding was not too different from that of Maher and Keriakos, (2014). Their finding was that "nearly 98% of the women stated that they had heard of folic acid, but only 42–52% knew the medical condition it protects against".

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2.7.5 Maternal age

There are several socio-economic and demographic variables of the woman that may influence her compliance to folic acid supplementation recommendations. Among such variables is the age of the woman. One of the studies that assessed compliance to folic acid supplementation with respect to women's age is that of Taye and colleagues (2015). In their work, Taye *et al.* (2015) found that out of a total of 628 women who gave birth within 12 months prior to their study, a fifth (20.4%) of them were compliant with iron foliate supplementation, and it was found that, among other things, maternal age was a predictor of iron and folate tablet compliance. Older women, as found by Nilsen *et al.* (2006) were more likely to supplement with folic acid during the periconceptional period than younger women. In another study titled "Nutrient intakes during pregnancy:

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the influence of smoking status and age" age has been explicitly shown to have a strong and significant association with most nutrients including antioxidants, and the conclusion was drawn that young maternal age was a risk factor for low micronutrient intake (Mathews *et al.*, 2000). Similarly, in the United Kingdom, series of systematic reviews were carried out by Stockley and Lund (2008) to assess use of folic acid supplements among low-income and young women. They found that, next to unintended pregnancy, age was the next most important factor associated with lower rates of use of folic acid supplements.

Kim *et al.* (2017) studied age and other socio-demographic variable on pregnant Korean women to observe relationship with preconceptional folic acid supplementation. However, their finding was that, being aware of folic acid prior to becoming pregnant was the only variable related to preconceptional folic acid supplementation, but not age. In addition, an Amish study of women resident in the Mid-west, demonstrated that age was inversely related to folic acid supplementation (Abbot, 2000).

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2.7.6 Maternal educational status

In a study by Popa and his colleagues (2013) pertaining to whether maternal educational status was a determinant of folic acid supplementation, they found that the use of folic acid was independently associated with a higher level of formal education. Women with higher education were almost three times more likely to use folic acid supplement. This study is corroborated by a very recent study by Kim *et al.* (2017) involving Korean pregnant women. This study reported that women who had at least a university degree were

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more likely to supplement with folic acid prior to becoming pregnant than women with lower levels of formal education.

Another study with a similar finding is that of Nisar and colleagues (2014). In their study of factors associated with non-use of iron and folic acid supplement among Pakistani women, they concluded that, among other things, socio-demographic factors significantly associated with the non-use of antenatal iron and folic acid supplements including lack of education by the mother. In their study, Gebreamlak, Dadi, and Atnafu (2017) also suggest that the determinants of folic acid supplementation adherence among mothers include a number of socio-economic variables such as health education, being self-employed and having had a secondary level education. Similarly, Roy *et al.* (2013) found that maternal education and ANC attendance were predictors of adherence to folic acid supplementation.

Other indicators of low socio-economic status that determine folic uptake may include the place of residence (either rural or urban), access to information, independence of the woman about issues that affect her health and being financially capable. These were succinctly captured in the findings of Titaley and Dibley (2015). Using nationwide representative data, Titaley and Dibley (2015) found that mothers from rural areas had increased odds for not using antenatal iron/folic acid supplements. They also reported that, women in rural areas of Indonesia were at least 73% more likely to evade using the supplements compared to their counterparts who were resident in the urban areas. According to Titaley and Dibley (2015), the risk of not using folic acid supplement increased with the reduction of household wealth index and parental education. Titaley and Dibley (2015) were also

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emphatic on other barriers to compliance which they reported as low autonomy of mothers on their own health, distance to health facilities, low knowledge of obstetric complications and low exposure to mass media. Titaley and Dibley's (2015) finding that low exposure to the mass media is associated with low compliance to recommended folic acid supplement intake could have a very significant implication for the Upper East Region where barely 1.3% of women in the reproductive age group (15-49 years) are exposed to the mass media (Ghana Statistical Service, 2015). It also suggests limited access to the mass media could partly explain the relatively lower compliance among rural women compared to urban women as found by Gebre *et al.* (2015) in Ethiopia. This means that increasing community awareness and participation in health programs, improving coverage and access to health services together with strengthening counseling sessions during antenatal care could help improve the uptake of iron/folic acid supplements. According to a study conducted in India by Chourasiaa Pandeyb and Awasthic (2017), well educated women were at least four times more likely to adhere to the recommended dose of iron supplements (OR = 4.21; 95% CI = 3.30–5.36, p <0.01) compared to uneducated women. Clearly, education has been proven as a strong determinant in many scenarios, and the use of folic acid during the preconceptional and periconceptional stages is not different. In a 2006 study of predictors of folic acid supplementation among Norwegian pregnant women by Nilsen and colleagues, it was found out that, ten per cent of participants (pregnant women) who practiced periconceptional folic acid intake had higher education (Nilsen *et al.,* 2006). The direct relationship between education

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and periconceptional folic acid supplementation can be observed in other studies. According to Medveczky and Puhó (2004), higher maternal education goes together with a higher proportion of periconceptional folic acid supplementation.

The observed consistencies in all the above findings indicate that formal education is a strong determinant of preconceptional and periconceptional folic acid supplementation among pregnant women. It therefore, emphasizes the need for formal education.

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2.7.7 Parity

Many studies have identified parity as one of the predictors of periconceptional folic acid use among pregnant women. For instance, a Norwegian Mother and Child Cohort Study (Nilson *et al.*, 2006) on patterns and predictors of folic acid supplement use among pregnant women, noted, among others, that, lower parity was associated with periconceptional folic acid intake. They concluded that it is an indication that women think of, and use folic acid supplementation knowing it has beneficial effects regarding fertility. Another study that confirms that lower parity is associated with prenatal use of supplements is the study by Popa *et al.* (2013). In their study, nutritional knowledge as a determinant of vitamin and mineral supplementation during pregnancy, they made it clear that primiparity or parity less than two was significantly more likely to result in use of supplements.

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2.7.8 Planned Pregnancy

In their study of predictors of periconceptional folic acid use among pregnant women in Norway, Nilson *et al.* (2006) came out with the finding that about ten per cent of the participants who used folic acid 1 month before pregnancy through to 3 months of pregnancy were women who had planned their pregnancies. Another study that explicitly states the positive relationship between pregnancy planning and supplements use is that of Sen *et al.* (2001). In their study, they tried to ascertain when it was most appropriate to take folic acid supplement. Their conclusion was that those with planned pregnancies were more likely to answer this question correctly. Again, according to Lunet *et al.* (2008) in their study of adequacy of prenatal care as a major determinant of folic acid, iron and vitamin intake during pregnancy in Portugal, not planning a pregnancy accounted for a large proportion of non-use of supplements (RR = 0.81; 95%CI: 0.71-0.92). Another study that reported the positive relationship between pregnancy planning and awareness of folic acid supplement is the study by Kim *et al.* (2017). In their study of Korean women, Kim *et al.* reported that 98% of women who planned their pregnancy was aware of folic acid supplementation. Over 60% had knowledge of its NTDs prevention effects and over 70% had knowledge of the appropriate timing of folic acid use in the prevention of NTDs.

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2.7.9 Obstetric characteristics

A number of obstetric characteristics of a woman may influence her intake of folic acid supplements. For example, a study in France on the topic 'Mental models of pregnancy may explain low adherence to folic acid supplementation guidelines: a cross-sectional international survey' shows

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that in the 'invulnerable mum' mental model, perceived susceptibility to health threats is reduced because the good health of the mother is believed to protect the pregnancy from threat, whereas in the 'invulnerable pregnancy' mental model, perceived susceptibility is reduced because pregnancy is viewed as naturally robust or immune to risk (Fulford *at al.*, 2014). Other findings such as that of Gebre *et al.* (2015) and Taye *et al.* (2015) also found that maternal history of anaemia during pregnancy was significantly associated with compliance to folic acid supplementation ($P < 0.05$). However, a perception that too many tablets would harm the baby and fear of side effects were the major reasons given for noncompliance in their study. This fear of side effects could also partly explain why women who are prescribed folic acid as part of treatments for other sickness do not comply. Besides side effects, majority (58%) of pregnant women who did not comply with folic acid supplementation cited fear that too many tablets would harm the mother (Taye, Abeje, & Mekonen, 2015). This finding is particularly important because it indicates the need to educate pregnant women on the fact that treatment of a disease does not negate the need for folic acid supplementation. There is thus, the need to clearly distinguish the difference between medicines such as antimalarial and folic acid which is a nutritional supplement. This view has been well captured by Taye *et al.* (2015) that increasing female education and increasing knowledge of women about anaemia and iron folate tablets are necessary for increased compliance to iron folate supplementation.

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CHAPTER THREE

METHODOLOGY

This chapter presents the methodology used in conducting this study. Sections discussed include the study design, variable under study, sample size and sample size calculation.

3.1 Study design

This was a descriptive, cross sectional study, where data were collected at one particular point in time from the facilities within the study area. The study was undertaken within a 6-month span (February 2015 to July 2015). Information was sought on the determinants of both past and present use of folic acid supplement among the study participants.

3.2 Study area

This study was undertaken in the Upper East Region of Ghana. This region is one of the ten regions of Ghana, and is made up of 13 administrative districts. Out of the 13, six districts were sampled for this study, using a simple random sampling method.

3.2.1 Profile of the Upper East Region

The Upper East Region is located in the north – eastern corner of the country and between longitude 0° and 1° West and latitudes 10° 30′ N and 11°N. It has two international boundaries; namely Burkina Faso to the North and the Republic of Togo to the East. People of Ghana and these two countries share so much in common: language, socio-cultural and belief systems. There is intense cross border movement of people, goods and

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services at these borders. The challenges of disease surveillance and control in particular and health service delivery in general arising out of this geo-physical and social-cultural associations cannot be over-emphasized. The surface area of the region is 8,842 square kilometres (about 3.7% of the country). Rain fall pattern is short and scanty (800-900mm per annum) and long dry season with dry Harmattan winds and hot periods with average temperature of 43° C. In general, there are yearly food shortages. According to the Ministry of Food and Agriculture (MoFA) data, the period is associated with dry harmattan winds with low humidity and temperatures making the area suitable for the growing of horticultural crops like tomatoes, pepper, onions, watermelons, okro and other leafy vegetables (MoFA, 2017). This is an indication that the Upper East Region is engaged in the cultivation of folate-rich foods.

The Population of the region is estimated to be 1,046,545 with a growth rate of 1.2% which is below the national growth rate of 2.5%. The population density of the region is 118 people/square km (Ghana Statistical Service [GSS], 2012). The population is largely rural (87%) with a settlement pattern that is highly dispersed into 1318 communities. Most communities are inaccessible during the rainy season. Five main languages are spoken in the region namely Gurune, Kusal, Kasem, Buli and Bisa. As at the time of this study, the Upper East Region was divided into thirteen (13) administrative districts (Figure 3.1).

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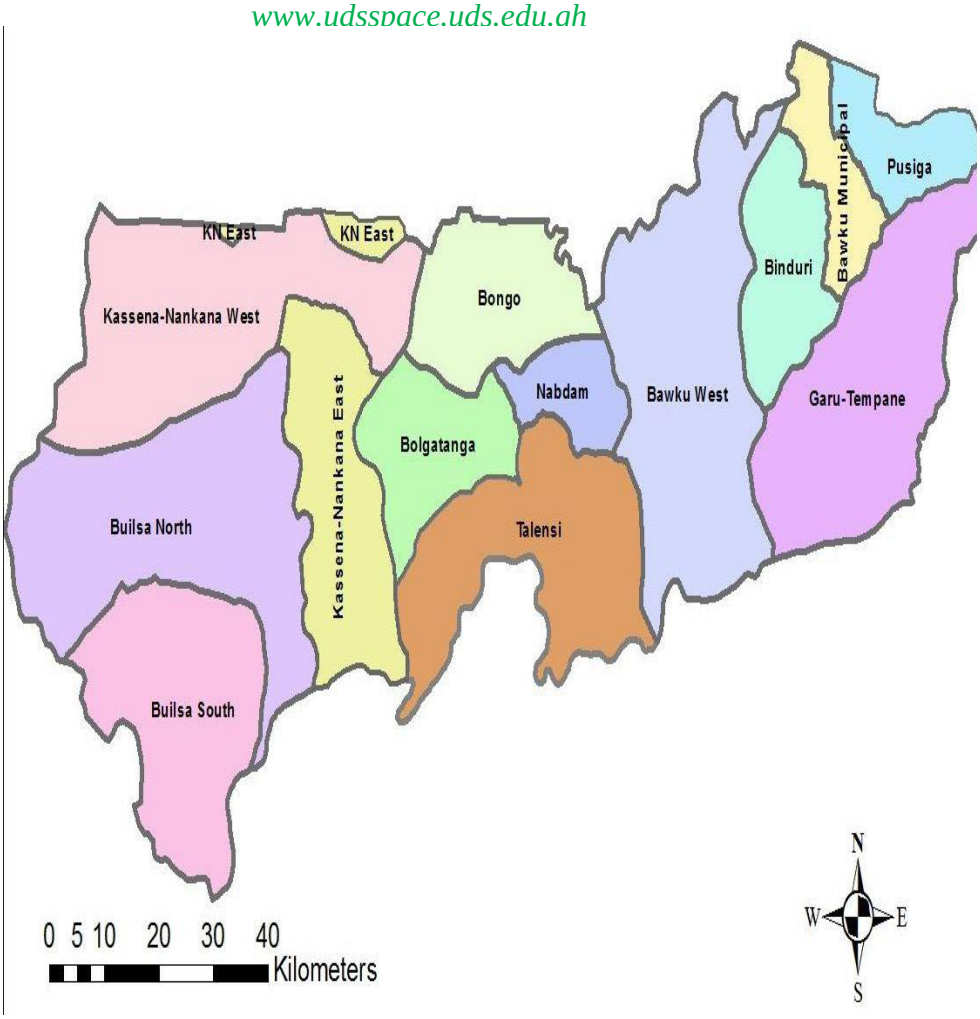

Figure 3. 1 Map of Upper East Region showing Administrative Districts

Source: GHS, Upper East Region (2012).

Environmental Situation: The region's soil is "upland soil" mainly developed from granite rocks. It is shallow and low in fertility, weak with low organic matter content, and predominantly coarse textured. The region is marked by declining soil fertility and high level of environmental and land degradation (bush fires, fragmented land, deforestation for farming, urbanization, continues cropping and over grazing). The fertility of the soils is marked by properties such as;

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1. Soil pH- 5.1-6.8
2. % Organic Matter →1.1 ─ 2.5
3. % Total Nitrogen →0.06 ─ 0.14
4. Available Phosphorus →1.75 ─ 14.75(mg/kg soil)
5. Available Calcium → 43.5 ─ 151.5(mg/kg soil)

Demographics; Age and Sex Distribution of the Population**:** The age structure for the sexes shows that in the region, there are more females than males (MoFA, 2017). This, however, varies by age. The proportion of males aged 0-19 years (56.3%) is higher than that for females (49.0%). Between ages 20 and 64 years, there is a higher proportion of females (45.1%) than males (36.8%), while those 65 years and older are 6.8 per cent males compared to 5.9 per cent females. In the female reproductive age group of 15-49 years, there is an overall excess of females (44.3%) over males (39.2%) of about 13.0 percent (MoFA, 2017).

Rural-Urban Population: The population is primarily rural (84.3%) and scattered in dispersed settlements. With only 15.7 per cent of the population living in urban areas, the region is the least urbanized in the country (MoFA, 2017).

There is a slight increase in the urban share of the population which is due mainly to increase in population of existing urban centres. There is a slight increase in the urban share of the population which is due mainly to increase in population of existing urban centres. According to MoFA (2017), one of the towns that has grown from rural to urban locality since 1984 is Garu. It

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increased in population from 3,104 in 1984 to 130,003 in 2010. The largest growth in urban proportion occurred in Bawku (34,074 population in 1984 to 217,791 population in 2010). Some urban centres however decreased in population (e.g. Navrongo and Paga) (MoFA, 2017).

Labour Force: The region has a large and youthful labour force, which, if properly managed, can become a great economic asset. About 56 per cent (55.7 percent) of the labour force is below 35 years MoFA (2017).

In the region, the labour force aged 15-34 years shrank slightly from 56.4 per cent of the total labour force in 1984 to 55.7 per cent in 2000, while those aged 35-64 increased marginally MoFA (2017)

These changes in the age structure of the labour force need to be taken into account in formulating short/medium and long-term policies and planned programmes.

Agriculture: according to MoFA (2017), agriculture remains the dominant economic activity, employing 80% of the population. It is predominantly on a smallholder basis as occurs in Ghana. About 90% of farm holdings are less than 2 hectares in size, and to a greater extent, are in rice and maize. The main system of farming is traditional. Due to this dependency on agriculture, the region was the poorest of Ghana's ten regions but has moved up to the 9th position, largely due to improvement in the performance of agriculture. Mono cropping is mostly associated with larger-scale commercial farms as it is currently being done under the block farms.

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With agriculture, hunting, mining and forestry being the main economic activities in the region, the area has a poor socioeconomic standing, which has a direct relationship with preconceptional folic acid supplementation as found in this research.

Crops Sub-Sector: The bulk of the source of natural food folate is obtained from a number of food items which the Upper East Region is naturally favoured to cultivate. Naturally the region is blessed to have soils and general environment suitable for different types of crops (MoFA, 2017). (Table 3.1).

Table 3. 1 Crops Sub-Sector in the Upper East Region of Ghana

Cereals	Legumes	Fibers	Roots & Tubers	Vegetables	Non Traditional Export Crops	Irrigated Crops
Sorghu, Millet, Maize and Rice	Groundnuts, Cowpea, Soybean and Bambara beans	Kenaf, Cotton and Kapok	Sweet Potato and Frafra Potato	Okro, Pepper and Leafy Vegetables	Sesame, Paprika, Cashew, Mangoes	Tomato, Onion, Water/Sweet Melon, Rice, Okro, Pepper and Maize

Source: (MoFA, 2017)

Health Sector: There are 74 health sub-districts with 272 health facilities. Ghana Health Service (GHS) operates about 88% of all health facilities in

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the region. Out of these, 238 are government-owned, 12 are mission-facilities, 21 are privately-owned and 1 is quasi government facility.

The region experienced a sharp increase (over 30%) in the number of health facilities between 2008 and 2012 as indicated in Table 3.2

Table 3. 2 Number of Health Facilities in the Region, 2008-2012

YEAR	2008	2009	2010	2011	2012
Number of Health Facilities	166	178	184	211	272

Source: GHS-Upper East Region (2012.)

There is a high burden of preventable communicable diseases particularly malaria, diarrhoea, acute respiratory infections and intestinal worms. There is also a high prevalence of disorders from vitamin A, iodine and iron (iron deficiency anaemia).

3.3 The study population

Pregnant women accessing antenatal clinic service in facilities in the UER were the study subjects. Inclusion criterion was any pregnant woman who within the study period visited the health facility for antenatal care.

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3.4 Sample size determination

An appropriate sample was determined and taken to represent the population of pregnant women in the study area. To achieve a representative sample and to allow for extrapolation of the results to the entire population of pregnant women in the UER, the following were considered:

i. Confidence level =95%

ii. Margin of error = 5%

The study sample size was then calculated using the formula for simple random sampling and single proportions Leslie, 1965, (as cited in Egessa, 2010):

$n = Z^2 * p * q / d^2$

Where:

n = Sample size

Z = Z value corresponding to a 95% level of significance = 1.96

p = expected proportion of population practicing recommended folic acid intake = 50% =0.5

q = (1 - p) = (1-0.5) = 0.5

d = absolute precision/margin of error/confidence interval= $(5\%)^2$ = $(0.05)^2$=0.0025

Therefore, from the above, sample size was calculated as:

$n = 1.96^2 * 0.5 * 0.5/0.0025$

$n = 0.9604/0.0025 = 384.16 \approx 384$.

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However, as there was need to compensate for non-response (Israel, 1992), the sample size was increased by 12, (3%). Therefore, n=384+ 12 (3% non-response rate) =396 participants.

3.5 Sampling method

The multi-stage random sampling technique was used to select both the facilities where the study was conducted and the respondents for the study. Resource constraints, especially time and funds did not permit a census of the target population, as a result multistage random sampling was chosen since it gave every member of the population an equal chance of being selected, thus, making the final result representative of the entire population. The whole sampling procedure involved 3-stage sampling, where the 13 districts in the UER were used as naturally occurring clusters. First, six (6) Districts were selected at random from the 13 districts of the Upper East Region. To do this, the names of the 13 districts were written on strips of paper, folded and shuffled in a hat. Then using the lottery method, six were randomly picked and studied.

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In the second stage of the sampling, 18 health facilities that carried out ANC services were selected at random; 3 from each of the six previously chosen districts.

For the third stage, 22 pregnant women were extracted from each ANC register of the 18 randomly selected facilities of the 6 districts using, once again, simple random sampling. These were recruited as respondents, giving a total of 396 respondents.

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3.6 Methods and tools for data collection

Structured questionnaires were used to collect data from the sampled population. The appropriate statistical package was used in the analysis of data for this thesis. Interview was used as the method of data collection. The interview was conducted by the researcher and five trained research assistants. These research assistants were recruited and trained to facilitate the data collection process. Information was collected through a face to face interview with interviewer-interviewee encounter where the interviewer read the questions out for the interviewee to provide the answers. A draft set of questionnaires were piloted (pretested) among women attending ANC in one of the facilities. The results of the piloted study were however not included in the study. The feedback from the pilot was used to improve on the clarity of the questions contained in the questionnaire. The final questionnaire was then used for the actual data collection.

The questionnaire was divided into five sections, labeled A, B, C, D and E. Each section sought specific set of information basically relating to folic acid supplementation. Section “A” sought information about the socio-demographic characteristics of the respondent. These included age, marital status, educational status, and so forth. Section B asked questions about the uptake/intake of folic acid supplement and related issues. The respondent’s obstetric history/characteristic was also sought to find out if there was an association between obstetric characteristic and folic acid supplementation. This fell under section C. There was need to also determine the level of knowledge on folic acid and neural tube defects. To do this, a set of

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questions was put to the respondents, and it fell under section D. The final section was labeled section E. The set of questions here sought answers about participants' perception of side effects of supplemental folic acid.

3.7 Variables

Variables were measured on various scales such as nominal, ordinal and interval scales where necessary

1. Preconceptional folic acid supplementation: this variable referred to taking folic acid supplement (tablet) any time before the last 3 months leading up to conception. At this stage, a woman is not contemplating pregnancy, although she is not avoiding it. It was measured by the respondent's answer- "I started taking folic acid long ago even before I contemplated becoming pregnant"

2. Periconceptional folic acid supplementation: this variable referred to taking folic acid supplement (tablet) around the time of pregnancy, (that is 1 to 3 months before conception and lasting at least up to the end of the first trimester).

3. Awareness about folic acid supplementation: awareness simply meant having heard about folic acid supplementation. It was determined by a binary response "yes" or "no" to the question "have you ever heard about folic acid supplement?" The study reported on the percentage of women who were aware of folic acid supplementation. At least 50% awareness among the women was

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regarded as adequate. And less than 50% was regarded as inadequate (Table 4.8).

4. Knowledge on folic acid supplementation: knowledge on folic acid supplementation was determined using a composite score made of 9 knowledge-based questions. It assessed the participant's deeper knowledge about folic acid supplementation beyond just being merely aware. It was measured using a score ranging from 0 to 9. Women who scored in less than 5 questions were regarded as having inadequate level of knowledge on folic acid supplementation. Those who scored at least 5 were considered as having adequate level of knowledge on folic acid supplementation (Table 4.9).

5. Pregnancy planning: This meant if a woman was having unprotected sex with a male partner, and was not avoiding pregnancy prior to becoming pregnant. Women answered "yes" or "no" to the question "was this pregnancy a planned one?"

6. Marital status: This referred to women who were in sexual union and cohabitating with a male sexual partner.

7. Educational status: this meant having a formal education or not. And for those who had education, a follow-up question sought for the level they had attained.

8. Occupational status: either working for an income or not working. For those working, we wanted to know what types of job they were engaged in.

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9. Prevalence of folic acid supplementation: this referred to the percentage of the women who were practicing folic acid supplementation within the population.

10. Obstetric characteristics: A number of indicators were used to assess obstetric characteristic. They included gravidity, parity, child with low birth weight, gestational age at first visit to ANC, abortion/miscarriage in the past, etc.

11. Side effects of folic acid supplementation: this was used to elicit responses about adverse effects of supplemental folic acid.

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3.8 Data analysis and presentation

Data were cleaned and entered into a spreadsheet of the latest version of EpiInfo (version 7). The data was later transferred into IBM SPSS version 22 (IBM Corp. Armonk, NY) where the analysis was finally conducted. The descriptive aspect of the results was presented in frequencies, percentages, tables and charts. For the inferential statistics, cross tabulations with Chi square (χ^2) tests were used to analyze relationships and associations between variables at 95% confidence level. All tests were accepted to be statistically significant at $p<0.05$.

3.9 Quality control

Quality control was undertaken to ensure that the data generated were complete, reliable, accurate and above all reproducible when the same methods are used. These measures contributed towards achieving both internal and external validity of the study.

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All the research assistants who helped in the data collection exercise had prior experience in collection of both quantitative and qualitative data and previous training in data collection. They received a one-day training that focused on participant handling skills such as interviewing skills, content and meaning of questions, correct recording of responses, and orientation to study objectives and procedures. The training basically included explanation of the concept of preconceptional and periconceptional folic acid supplementation and how it works in the prevention of neural tube defects. They were given information on ethical issues such as the need to observe confidentiality and obtain informed consent from participants prior to administering study tools.

The questionnaire was pre-tested in the Talensi and Kpalugu health centres. Talensi and Kpalugu health centres were chosen for the pre testing because clients attending these health centres had similar characteristics as clients in most of the facilities where the research was undertaken. This exercise helped to improve the data collection tools in terms of content and order of the questions in relation to the study objectives and necessary adjustments were made prior to data collection.

Support supervision of the research assistants was done on randomly selected facilities in sessions to observe the conduct of the sessions. Meetings were held to address problems and clarify issues that could hamper collection of good data with assistants who were found to have problems. They were encouraged to phone in and seek clarification if challenges popped up during data collection session. This also boosted their morale in collection of quality data. Checking for completeness and

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accuracy of completed data collection forms was done at the end of each session of data collection and gaps identified such as missing age, educational attainment, etc. were addressed with the respective research assistants. Respondents' phone numbers were sought with their consent. This allowed for the researcher to call specific respondents at a later date when missing responses were identified.

The forms were properly filled by serial number and entry was done by the researcher himself using the latest EPI INFO software, EPI INFO, version 7. Preliminary frequencies were run as well as eye balling to identify missing variables and comparison was done on some randomly picked study subjects' data on the forms and the entered electronic data to check for consistency. The variable names used during formation of the data capture screen were saved in the computer and as a hard copy with an explanation of their meaning. Entry was done and the entered data were intermittently cleaned to avoid any data entry errors and inconsistent entries. Data were backed up by saving it in different folders in the computer and also on a removable pen drive. To be sure that the data would always be available to retrieve, they were sent to the private inboxes of the researcher in yahoo mail, gmail and drop box. The data were thereafter exported to SPSS version 22 (IBM Corp. Armonk, NY) for final editing and analysis. Throughout the analysis stage, each bit of analysed data was backed up in the media aforementioned (other computers and email inboxes).

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3.10 Ethical considerations

In line with the requirement for research specified in the outline for biomedical/clinical trial study protocol, respondents were assured of confidentiality regarding the information they were going to provide. The study only recruited participants after seeking their informed consent and willingness to participate in the study. Responses were also anonymized so that participants' Reports are also analysed so that participants' identities could not be traced to their responses. This was after explaining the purpose of the research to participants. Authorization was sought from the UER Health Directorate as well.

3.11 Limitations of the study

There was a likelihood of over or under reporting for the questions that required recall as participants might try to impress the interviewer. However, in order to reduce the tendency for this to occur, the participants were made to understand that it was in their own interest to provide accurate information since the research finding could be used by health planners to plan for them.

The findings in this report are subject to the inherent limitations of using a survey. Most of the questions in this survey have predefined answers, and this means that the true answer might not be provided as an option for some women. The answers may not, therefore, elicit the actual determinants of folic acid supplementation among the population since there is the likelihood of forgetting due to time lapse.

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Another limitation which may be inherent in this study is the fact that data was not collected to ascertain whether the reported side effects by participants were mainly due to the folic acid supplements they took, or it was as a result of other possible underlying health conditions or medication.

Despite these limitations however, the results will provide valuable insight into the determinants of use of folic acid during preconception and in early pregnancy in the UER of Ghana.

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CHAPTER FOUR

RESULTS AND ANALYSES

To address the objectives of this study, this chapter has been divided into several sub-sections based on the major objectives of the study. The initial part of this chapter presents a description of the socio-demographic characteristics of the study population. The remaining sections contain cross tabulations of determinants of folic acid supplementation for possible relationships.

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4.1 Socio-demographic characteristics of respondents

A total of 376 responses were valid and used in the analysis. Twenty questionnaires were not properly answered and so were not included in the final analysis. The mean age of the sampled population was 27.2 years with a standard deviation of 5.9 years. When the ages were grouped, most of the participants (32.4%) fell within the age brackets of 25-29 years. In this study, this year group is referred to as young maternal age. Information sought about the marital status of respondents revealed that majority (95.5%) were married. Only a small minority 24.8% (n=93) had education up to secondary school and higher. Those had attained Junior High level education as their highest level were 38% (n=143). But there was a proportion of the respondents which had no formal education at all, and they constituted 37.2 (n=140). In other words, as high as 75.2% (n=283) are either illiterate or only had low level of formal education (below SHS), that is, basic education. The summary of the socio-demographic characteristics has been given in the Table 4.1.

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Table 4. 1 Socio-demographic Characteristics of Respondents

Variable	Frequency	Percentage
AGE GROUP		
Younger women (29years or younger)	245	65.2
Older women (30 years or older)	131	34.8
Total	**376**	**100**
MARITAL STATUS		
Married	359	95.5
Not married	17	4.5
Total	**376**	**100**
RELIGIOUS DENOMINATION		
Christians	223	59.3
Muslims	127	33.8
Traditionalists	21	5.6
Others	5	1.3
Total	**376**	**100.**
ETHNICITY		
Major tribe of the study area: (Bisa, Frafra or Gurunshi, Kasem, Kusashi, Moshi and Talensi)	341	90.7
Minor tribe of the study area: (Ashantes, Ga, Ewe and others)	35	9.3
Total	**376**	**100**
HIGHEST LEVEL OF EDUCATION		
At most JHS (having basic education)	143	38
At least SHS (SHS/Tech. + Voc. + Tert.)	93	24.8
No education	140	37.2
Total	**376**	**100**
OCCUPATION		
Government workers	47	12.5
Trader/business woman	134	35.6
Farmers	70	18.6
Unemployed	120	31.9
Others (students and others who wanted anonymity)	5	1.3
Total	**376**	**100**
INCOME LEVEL		
Low income earners (less than Ghc210/month [current minimum wage])	324	86.2
High income earners (At least Ghc210/month)	52	13.8
Total	**376**	**100**

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Also on their occupational status, most of the respondents said they were engaged in trading/business (35.6). The next highest category was the unemployed (31.9%). Only 13.8% of the respondents received a monthly income equivalent to or above the current 2015 Ghana national minimum wage of Ghc210 per month (Essel, 2015). The rest, according to Sachs (2008), referring to the World Bank's standard, fell within the World Bank categorization of extremely poor people, measured at purchasing power parity, earned an income which was between US $1.00 per day and US $2.00 per day.

4.1.1 Socio-demographic characteristics versus periconceptional folic acid supplementation

This question was applicable to only those women who earlier responded that they were taking folic acid supplements.

The ages of the respondents were grouped for the purpose of this analysis. These age groups were cross tabulated with folic acid supplementation to observe the interaction of the responses at multivariate level. The results showed that women who were 25-29 years old supplemented the most (34.3%) compared to all the other categories of ages. Young maternal age 15-19 years and maternal age 35 years and older supplemented the least (7.9%) and (14.5%) respectively compared with other age groups. A chi-square test revealed that there was no statistically significant relationship between age group and current use of folic acid (p=0.18).

The other variable whose association with periconceptional folic acid was assessed was marital status of the respondents. With regards to the relationship between periconceptional supplementation and marital status,

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96.4% of married women supplemented during periconceptional period. The chi-square test did not show a statistically significant relationship between the two groups, with a chi square, $\chi 2$ =2.870, p=0.090.

Of interest also was the relationship between periconceptional folic acid supplementation and educational attainment of the participants. Participants who reported that they were currently supplementing with folic acid were further asked about their educational status. In all, 20% (n=15) of those whose education ended at primary level were taking folic acid supplement during the periconceptional stage. For those who had tertiary education, 44.7% (n=21) supplemented during the periconceptional stage. For JHS, the percentage of those who were taking folic acid during the current pregnancy was 22.1 (n=15) whilst the percentage for those whose education ended at the vocational level and supplementing were 14.3 (n=1). One hundred and forty (140) of the women did not have formal education at all. Of that number, 16.4% (n=23) supplemented during the periconceptional period. To test for association between educational attainment and current folic acid use, a chi square ($\chi 2$) test was computed. The results showed there was a statistically significant relationship between educational attainment and periconceptional use of folic acid supplement ($\chi 2$=17.854, p=0.003).

Regarding periconceptional folic acid supplementation and employment status of the women, those who were employed and were currently taking folic acid supplements were made up of 208 representing 82.9% of employed women who were supplementing. However, 95 women representing 76% of unemployed women were supplementing during the periconceptional stage. A Chi-square test was used to assess the statistical

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significance of the relationship between current supplementation with folic acid and occupational status of the respondents. The results indicated however that, the relationship was not statistically significant, (χ^2 =2.516, p=0.075).

Regarding the relationship between periconceptional folic acid supplementation and income levels, income levels of the respondents were categorized based on the current daily minimum wage and the international poverty line. A cross tabulation showed that, of the 303 women who reported that they were currently supplementing with folic acid, 38.3% (n=116) said they earned incomes below one hundred and sixteen Ghana cedis (Ghc116).

Those who reported supplementing with folic acid and received a monthly income of above the current minimum wage of Ghc210 were 14.9% (n=45). The percentage of respondents who reported taking folic acid during the current pregnancy and receiving a monthly income of between Ghc116 and Ghc210 was 13.5% (n=41), whilst the percentage represented by those who received no income at all and were supplementing was 33.3% (n=101). A chi square test of relationship failed to detect a statistically significant relationship between the variables (χ^2 =3.935, p=0.269) (Table 4.2).

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Table 4. 2 Relationship between periconceptional folic acid supplementation and socio-demographic characteristics

Variable	N	Folic Acid Supplementation During Periconceptional Stage		Test statistic
		Yes n (%)	No n (%)	
Age Group (yrs)				
15-19	36	24 (7.9)	12 (16.4)	χ^2=6.307 p=0.177
20-24	86	68 (22.4)	18 (20.9)	
25-29	122	104 (34.3)	18 (24.7)	
30-34	78	63 (20.8)	15 (20.5)	
At least 35	54	44 (14.5)	10 (13.7)	
Total	**376**	**303**	**73**	
Marital Status				
Married	359	292 (96.4)	67 (91.8)	χ^2=2.870, p=0.090
Not Married	17	11 (3.6)	6 (8.2)	
Total	**376**	303 (80.6)	73	
Educational Levels				
No education	140	23 (16.4)	117 (83.6)	
Primary	75	15 (20)	60 (80)	
JHS	68	15 (22.1)	53 (77.9)	χ^2=17.85, p=0.003
SHS/Technical institute	39	12 (30.8)	27 (69.2)	
Vocation	7	1 (14.3)	6 (85.7)	
Tertiary	47	21 (44.7)	26 (55.3)	
Total	**376**	**87**	**289**	
Occupational Status				
Employed	251	208 (82.9)	43 (17.1)	χ^2=2.516 p=0.075
Unemployed	125	95 (76.0)	30 (24)	
Total	**376**	**303**	**73**	
Income Levels				
No income	132	101 (33.3)	31 (42.5)	χ^2 =3.935, p=0.269
< GHC 116	145	116 (38.3)	29 (39.7)	
Between GHC116 and GHC 210	47	41 (13.5)	6 (8.2)	
Above GHC210	52	45 (14.9)	7 (9.6)	
Total	**376**	**303**	**73**	

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4.1.2 Socio-demographic characteristics versus preconceptional folic acid supplementation

The results in Table 4.3 below show that, the percentage of married women who supplemented with folic acid during preconceptional stage was about 9%. A chi-square test showed there was no statistically significant relationship between marital status and supplementation with folic acid during the preconceptional stage, χ^2 =1.080, p=0.897.

Participants with formal education up to tertiary level supplemented the most during the preconceptional stage (23.8%), whilst those with formal education up to JHS level supplemented the least, (4.3%). There was a statistically significant relationship between preconceptional folic acid supplementation and mothers' educational attainment, χ2=17.322, p=0.004.

With respect to preconceptional supplementation, women who were civil servants supplemented more (19%) than each of the other categories of workers including the unemployed. Preconceptional supplementation was least prevalent among women who were farmers, and this was statistically significant with a chi-square χ^2 =69.287, p<0.001.

Low income earners received an income equal to or not greater than Ghc116. This was the group of women who supplemented the least (5%) during the preconceptional stage. Those women groups who received the highest income of above Ghc210 supplemented the most (22%).

In this regard, the chi-square test showed a very high statistically significant relationship between the variables, χ^2 =41.605, p<0.001.These relationships are summarized in Table 4.3.

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Table 4. 3 Relationship between socio-demographics characteristics and preconceptional folic acid supplementation

Variable	N	Preconceptional Folic Acid Supplementation		Test statistic
		Yes n (%)	No n (%)	
Age of mother in years				
15-19	36	1 (3)	35 (97)	χ^2=6.307, P=0.18
20-24	86	3 (3)	83 (97)	
25-29	122	11 (9)	111 (91)	
30-34	78	6 (8)	72 (92)	
At least 35	54	6 (11)	48 (89)	
Total	**376**	**27 (7)**	**349 (93)**	
Marital status				
Married	292	26 (9)	266 (91)	χ^2=1.080, P=0.897
Not married	11	1 (9)	10 (91)	
Not applicable	73			
Total	**376**	**27**	**276**	
Educational status				
No education	114	6 (5.3)	108 (94.7)	χ^2=17.322, P=0.004
Primary education	59	3 (5.1)	56 (94.9)	
JHS	46	2 (4.3)	44 (95.7)	
SHS/technical school	37	5 (13.5)	32 (86.5)	
Vocational school	5	1 (20.0)	4 (80.0)	
Tertiary	42	10 (23.8)	32 (76.2)	
Not applicable	73		276	
Total	**376**	**27**	**108**	
Occupation				
Unemployed	90	5 (5.6)	85 (94.4)	χ^2=69.287, P<0.001
Farmers	53	2 (3.8)	51 (96.2)	
Trader/ Business woman	113	11 (9.7)	102 (90.3)	
Civil servant	42	8 (19)	34 (81.0)	
Other (students, etc)	5	1	4	
Those not supplementing	73			
Total	**376**	**27**	**276**	
Income level				
Income levels				
No income	101	8 (8)	93 (92)	
< GHC116	116	6 (5)	100 (95)	χ^2=341.605, P<0.001
Between GHC116 and GHC 210	41	3 (7)	38 (83)	
Above GHC210	45	10 (22)	35 (78)	
Not applicable	73	27		
Total	**376**			

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4.2 prevalence of periconceptional and preconceptional folic acid supplementation

Out of the 376 subjects interviewed for this study, a total of 303 representing 80.6% of the women were taking folic acid during the periconceptional stage (Table 4.4).

Table 4. 4 Prevalence of folic acid Supplementation

Variable	Frequency (n)	Percentage (%)
Currently taking Folic acid		
Yes	303	80.6
No	73	19.4
Total	**376**	**100**
When folic acid was taken (Timing)		
Long ago, since when I became capable of becoming pregnant	27	8.9
1 -3 months before I became pregnant	29	9.6
Four weeks or less after I became pregnant	58	19.1
More than 3 months after I became pregnant	165	54.5
Don't know	24	7.9
Not supplementing	73	
Total	**376**	**100**
Type of folic acid taken		
Single drug, containing only folic acid	127	41.9
Combined with other supplements	107	35.3
Don't know	69	22.8
Not Applicable	73	---
Total	**376**	**100**
Source of folic acid used		
Provided at the health facility	284	94
I bought it over the counter	19	6
Not Applicable (not supplementing)	73	---
Total	**376**	**100**

Table 4.4 above clearly depicts that the prevalence of using folic acid supplement during preconceptional period was 8.9%. Only 41.9% (n=127) of respondents said they were taking the supplement as a single dosage

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containing only folic acid, whilst 35.3% (n=107) took the supplement as combined with other multi vitamin supplements, however, 22.8% of those taking folic acid supplements did not know whether it was a single tablet containing only folic acid or it was combined with other supplements.

Out of the total number of women who were currently taking folic acid (303), most of them 94% (n=284) got their folic acid supplement from a health facility, but only 6% (n=19) bought their folic acid supplement over the counter.

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4.3 Obstetric history of the respondents

A number of obstetrics characteristic of a woman may influence her intake of folic acid. In the first part of this section, frequencies of women's responses related to their obstetric characteristics that may influence their use of the folic acid supplement are given. The second part of this section analyses the relationships between the variables.

As reflected in Table 4.5, most women (75.8%) did not go for any pregnancy counseling to prepare them for pregnancy. Majority (68.6%) were multigravidas whilst 70% were multiparous with only 30% of the women being primiparous. Twenty-nine (29) women representing about 11.7% said they have ever given birth to a child with low birth weight (LBW).

With regards to history of birth defects, 4.5% of the respondents said they had a family history of birth defects. Also, 13.8% of respondents had at least a previous pregnancy aborted or miscarried as a direct result of defects in

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the fetus as explained to them by their medical doctor. Two women representing 0.5% were epileptic and said they were taking anti-epileptic/ anti-seizure medications. About 27% of the respondents had unplanned pregnancy while majority (51.4%) reported for ANC within the first trimester of their pregnancy. As low as 15.2% reported for ANC during the first 28 days post conception while 10.9% was ignorant about the gestational age of their pregnancy when they made their first antenatal care visit during their current pregnancy.

On the issue of infertility, 6.1% of the women said they have had to treat infertility at one time or another before the current pregnancy.

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Table 4. 5 Obstetric history of respondents

Obstetric Characteristics	Frequency	Percentage
Pregnancy counseling		
Yes	91	24.2
No	285	75.8
Total	376	100
Gravidity		
Multigravida	258	68.6
Primigravida	118	31.4
Total	376	100
Parity (a)		
Parous	247	65.7
Nulliparous	129	34.3
Total	376	100
Parity (b)		
Primiparous	74	19.7
Multiparous	173	46
Nulliiparous	129	34.3
Total	376	100
Child with low birth weight		
Yes	29	7.7
No	218	58
Nulliparuous	129	34.3
Total	376	100
Pregnancy planning		
Planned	273	72.6
Not planned	103	27.4
Total	376	100
Gestational age at first visit to ANC		
Periconceptional period	193	51.4
Outside periconceptional period	142	37.8
Don't know	41	10.9
Total	376	100
Abortion/miscarriage due to fetal malformation	52	13.8
Yes	324	86.2
No	376	100
Total		
Family history with a birth defect		
Yes	17	4.5
No	359	95.5
Total	376	100
Treated infertility in the past		
Yes	23	6.1
No	353	93.9
Total	376	100

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4.3.1 Obstetric characteristics versus periconceptional folic acid supplement use

Obstetric characteristics were cross tabulated with folic acid supplement use during the periconceptional period. Out of 91 women who have had pregnancy counseling, 28 (30.8%) were taking folic acid supplement during periconceptional stage. Nine women representing 69.2% had pregnancy counseling but only supplemented outside the periconceptional stage. About 79% (n=226) of the women did not have pregnancy counseling and did not supplement within the period of periconception.

The Chi-square test was used to assess the statistical significance of the relationship between variables. The results showed that there was a statistically significant relationship between current use of folic acid and pregnancy counseling (P=0.008)

The relationship between the periconceptional use of folic acid and gravidity was also assessed in a cross tabulation and a test statistic. Results showed that 84.9% (n=219) of women who practiced periconceptional folic acid supplementation were multigravida. Chi-square test showed there was a statistically significant relationship between gravidity and current use of folic acid (χ^2=9.709, p=0.002).

To determine the association between periconceptional folic acid supplementation and parity, results of cross tabulations showed the following. Parous women who were taking supplemental folic acid during periconceptional period were 247. Of this number, 24% (n=61) supplemented while parous women who were not practicing

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periconceptional folic acid supplementation 186 (75.3). This showed that parous women supplemented about 4% more than nulliparuous women. However, the chi-square test failed to show the presence of a relationship between the variables (χ^2 =0.983, p=0.322).

In the same vein, analysis of the relationship between periconceptional folic acid supplementation and pregnancy planning (planned or not planned) also revealed that, out of the 273 women who had planned their pregnancy, majority, 84.2% (n=230) practiced periconceptional folic acid supplementation. A chi-square test showed that the relationship between pregnancy planning and periconceptional folic acid supplementation is statistically significant (χ2 =8.551, p=0.003). It means periconceptional folic acid supplementation is associated with pregnancy planning.

In terms of ANC visit and supplementation, the most frequent group of women (58.6% [n=17]) to supplement during periconceptional stage were those who went for their first ANC visit during the first three months of their pregnancy. The next group was those who had their first ANC visit during the time right after conception (62.1% [n=36]). There was a statistically significant relationship between current use of folic acid and gestational age at first visit to ANC (χ2 =111.035, p<0.001).

Out of a total of 85 women who were aware of neural tube defects, those who supplemented in periconceptional period were 91.8% (n=78); and of 291 women who were not aware of neural tube defects, 66 women constituting 22.7% did not supplement. A relationship test showed that there

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was a statistically significant relationship between the variables, ($\chi 2$ =8.774, p= 0.003). (Table 4.6).

Complaint about side effects did not have statistically significant relationship with current folic acid supplementation ($\chi 2$ =2.193, p=0.14).

Table 4. 6 Relationship between periconceptional folic acid supplementation and obstetric characteristics of respondents

Obstetric Characteristic	N	Periconceptional Folic Acid Supplementation		P-Value
		Yes n (%)	No n (%)	
Pregnancy Counseling				
Yes	91	28 (30.8)	63 (69.2)	χ^2=3.931,
No	285	59 (20.7)	226 (79.3)	p= 0.047
Total	376			
Gravidity				
Multigravida	258	219 (84.9)	39 (15.1)	(χ^2=9.70,
Nulligravida	118	84 (72.1)	34 (28.8)	p=0.002
Total	376	293	73	
Parity				
Parous	247	61 (24.7)	186 (75.3)	χ^2 =0.983 p=0.322
Nulliparuous	129	26 (20.2)	103 (79.8)	
Pregnancy Planning				
Planned	273	230 (84.2)	43 (15.8)	$\chi 2$ =8.551 p=0.003
Not planned	103	73 (70.9)	30 (29.1)	
Total	376			
Trimester of First ANC Visit				
First trimester	193	169 (87.6)	24 (12.4)	$\chi 2$
Beyond first trimester	183	134 (73.2)	49 (26.8)	=13.121, P=0.004
	376			
Experience Side Effects with folic acidSupplement?				
Yes	71	14 (19.7)	57 (80.3)	χ^2 =3.191, P=0.074
No	232	71 (30.6)	161 (69.4)	
Those not supplementing	73			
Total	376			

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4.3.2 Obstetric characteristics versus preconceptional folic acid supplementation

As can be seen from Table 4.7, with regards to preconceptional supplementation, of the 82 women who had pregnancy counseling, 15 women representing 18.3% also practiced preconceptional folic acid supplementation. A chi-square test for association showed that pregnancy counseling was associated with preconceptional folic acid supplementation, (χ^2=18.354, P= 0.001).

Regarding gravidity, the result showed that, out of 19 women who practiced preconceptional folic acid supplementation, 7.4% were multigravida. The chi-square test showed there was a statistically significant relationship between preconceptional folic acid supplementation and gravidity (χ^2 =12.317, p=0.031).

Table 4. 7 Relationship between preconceptional folic acid supplementation and obstetric characteristics

		Preconceptional Folic Acid Supplementation				p-value
Variable	N	**Yes**	**n(%)**	**No**	**n(%)**	
Gravidity						
Multigravida	258	19	(7.4)	239	(92.6)	χ^2=12.317,
Nulligravida	118	8	(6.9)	110	(93.1)	p=0.031
Total	**376**	**27**		**349**		

The results for preconceptional folic acid supplementation showed that fewer parous women 6.8% (n=17) supplemented during preconceptional

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stage compared to non-parous women, 12.5%, (n=1) who supplemented. A chi-square test showed no statistical significant relationship between the two variables (χ^2 = 6.115, p = 0.191).

As far as preconceptional folic acid supplementation and parity were concerned, the parity status and associated supplementation were as follows: primiparous, 8.1% (n = 5), secundiparous, 7.9 (n = 5), and multiparous, 8.1% (n = 7). The chi-square statistic for the preconceptional supplementation and parity was (χ^2 = 6.242, p = 0.620), showing the absence of statistical significant relationship between preconceptional folic acid supplementation and parity. It can be observed that as the number of births gradually increased, there was a trend towards increased preconceptional folic acid supplementation. Primiparous women who supplemented in periconception constituted 82.7%, (n = 62), secundiparous constituted 85.9%, (n=63) and multiparous women constituted 86%, (n = 86). There was no statistically significant relationship when a chi-square test was computed (χ^2 = 0.381, p = 0.827).

The interaction between preconceptional folic acid supplementation and pregnancy planning showed that preconceptional supplementation was more prevalent among women who had planned their pregnancy (10.4%, [n = 24]) than among those who did not 4.1% (n = 3). There was a statistically significant relationship between preconceptional supplementation and pregnancy planning (χ2 = 27.243, p < 0.001). In other words, preconceptional folic acid supplementation was associated with pregnancy planning.

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The percentage of women who supplemented during preconceptional stage (33.3% [n=9]) was greater than each of the other categories of women who supplemented at any stage of the growth of the pregnancy. The relationship test results showed a statistically significant relationship between preconceptional folic acid supplementation and the gestational age at first visit to ANC ($\chi 2 = 120.742$, $p < 0.001$).

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4.4 Awareness and knowledge of folic acid supplementation

Of the 376 women who were asked about their awareness of folic acid supplement, a greater percentage, 59.3% (n = 223) of the participants demonstrated that they were aware than they knew all the nitty-gritty of folic acid supplementation. So, as far as this study is concerned, there is high prevalence of awareness of folic acid supplementation among the pregnant women in the Upper East region. Table 4.8 shows the frequency of awareness of folic acid among the pregnant women in the Upper East Region.

Table 4. 8 Awareness of folic acid among respondents

Awareness of Folic Acid	**n (%)**
Aware	223 (59.3)
Not aware	153 (40.7)
Total	**376 (100)**

Table 4.9 presents the analysis of the level of knowledge about folic acid supplementation among the respondents. The results indicate that the number of women who scored zero (0) is 109, representing 29% of the total respondents. From the results, 205 women, representing 54.5% scored less

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than five of the knowledge-based questions. Therefore, 54.5% of the population had inadequate level of knowledge about folic acid supplementation. Furthermore, 28 women, representing 7.4%, scored all the points for the nine questions. However, considering the decision rule set in this study, only 171 women representing about 45.5% (Table 4.9) of the sample exhibited adequate level of knowledge of the supplement.

Table 4. 9 Level of knowledge on folic acid supplementation among pregnant women

Scores	Number of women	Percentage
0	109	29.0
1	41	10.9
2	9	2.4
3	16	4.3
4	30	8.0
5	47	12.5
6	48	12.8
7	26	6.9
8	22	5.9
9	28	7.4
Total	**376**	**100.0**

The percentages of those who had adequate knowledge of folic acid supplementation and those who had inadequate knowledge about folic acid supplementation is depicted in Fig 4.1

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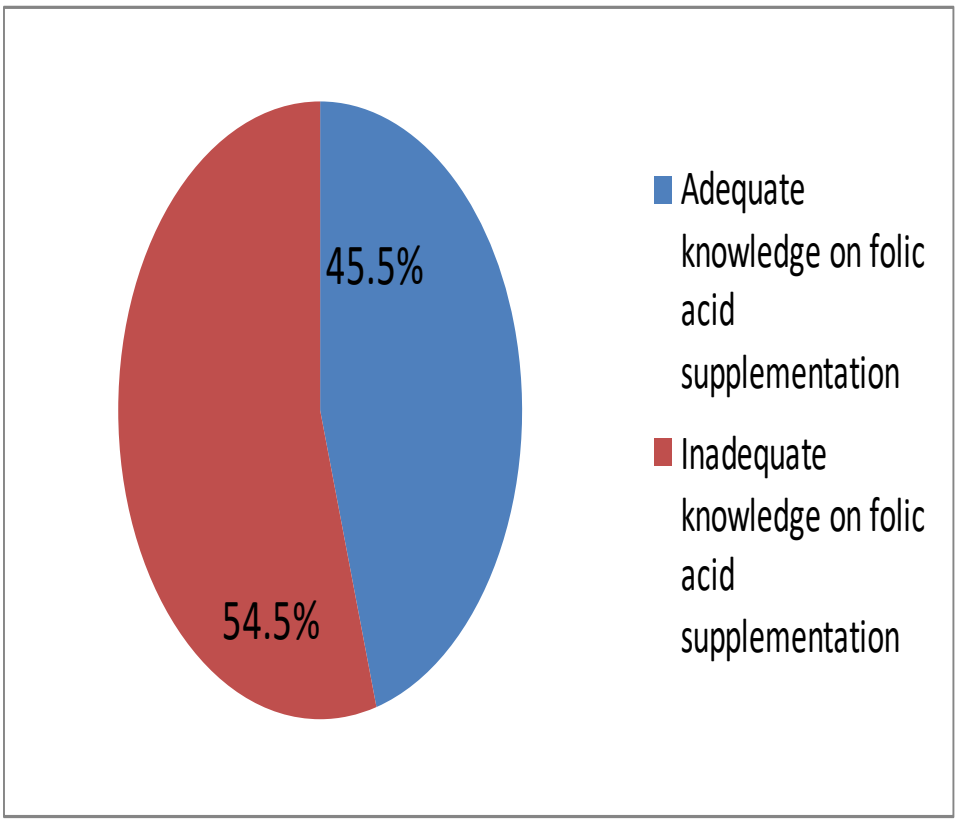

4.4.1 Knowledge of folic acid supplement versus periconceptional supplementation

All 171 women who exhibited adequate knowledge of folic acid supplementation (Table 4.10) were asked about the time they started supplementing in order to determine the number of those who supplemented during periconceptional stage. The results showed that only 32.7% (n=56) supplemented during the periconceptional stage. The chi square test of association showed that there was a statistically significant relationship between periconceptional folic acid supplementation and the level of knowledge of the supplement ($\chi 2 = 16.288$, $p<0.001$).

In terms of awareness, 223 women, representing about 59.3% of them, were aware of folic acid. Of that number, 29.6% (n=66) were taking folic acid

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supplement during the periconceptional period. This means that more than 70% of the women who were aware of folic acid supplementation did not supplementing during the periconceptional stage. A chi-square test showed that there was a statistically significant relationship between awareness and periconceptional folic acid supplementation ($\chi 2 = 12.852$, $p<0.001$).

Selected variables that were composited and used to assess knowledge level of folic acid supplementation in this research included ability to physically identify the folic acid tablet, ability to identify the folic acid supplement by its name, knowledge of the role of folic acid in preventing neural tube defects, knowledge of common food sources of folate, and the knowledge of the quantity of folic acid supplement to take per day (Appendix I).

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Table 4. 10 Relationship between knowledge and awareness on folic acid supplement and Periconceptional folic acid supplementation

Variable	N	Taking Folic Acid Supplement During Periconceptional Stage				Test Statistic
		Yes	(%)	No	(%)	
Aware of folic acid						
Yes	223	66	(29.6)	157	(70.4)	$\chi2$=12.852, p<0.001
No	153	21	(13.7)	132	(86.3)	
Total	376	87		289		
Level of knowledge						
Adequate	171	56	(32.7)	115	(67.3)	$\chi2$=16.288, p<0.001
Inadequate	205	31	(15.1)	174	(84.9)	
Total	376	87		289		

4.4.2 Awareness of folic acid supplement and preconceptional folic acid supplementation

Now, in order to determine the proportion of women who were aware and supplemented with folic acid during preconceptional stage, all the 223 women who were aware were further asked about the time that they started supplementing (Table 4.11). It was revealed that, out of the 223 women who were aware, only 11.9% (n=24) supplemented during the preconceptional stage. To test for statistical significance of the relationship, a chi-square test was conducted. There was a statistically significant relationship between preconceptional supplementation and awareness of folic acid ($\chi2$ =6.751, p=0.009).

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Table 4. 11 Relationship between awareness of folic acid and preconceptional supplementation

Variable	N	Taking Folic Acid During Preconceptional Stage		Test Statistic (P- value)
		Yes (%)	No (%)	
Aware of folic acid				
Yes	120	3 (11.9)	117 (88.1)	$\chi 2$ =6.751,
No	102	3 (2.9)	99 (97.1)	p=0.009
Not applicable	154			
Total	**376**			

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4.5 Side effects associated with folic acid supplementation

This study set out to find out side effects that were perceived by respondents to be associated with the intake of folic acid. It was revealed that about 303 women who took folic acid gave different accounts regarding their experience of side effects. Out of these, 23.4% (n=71) reported that they experienced some side effects after taking in their folic acid supplement. But 76.6% of the women (n=232) said they did not experience any side effects after taking in their folic acid supplement (Figure 4.2).

4.5.1 Types of side effects experienced after supplementing with folic acid supplement.

Common side effects experienced by the respondents were dizziness, nausea, sleep disorders and bad smell. Thirty-four (34) women, representing 9.0% had experienced dizziness, 19 (5.1%) had experienced nausea. With those women left, 11 (2.9%) had experienced sleep disorders whilst 7 (1.9%) complained of having experienced bad smell. The others did not experience any side effects (n=232) or did not take the supplement (n=73) Figure 4.2

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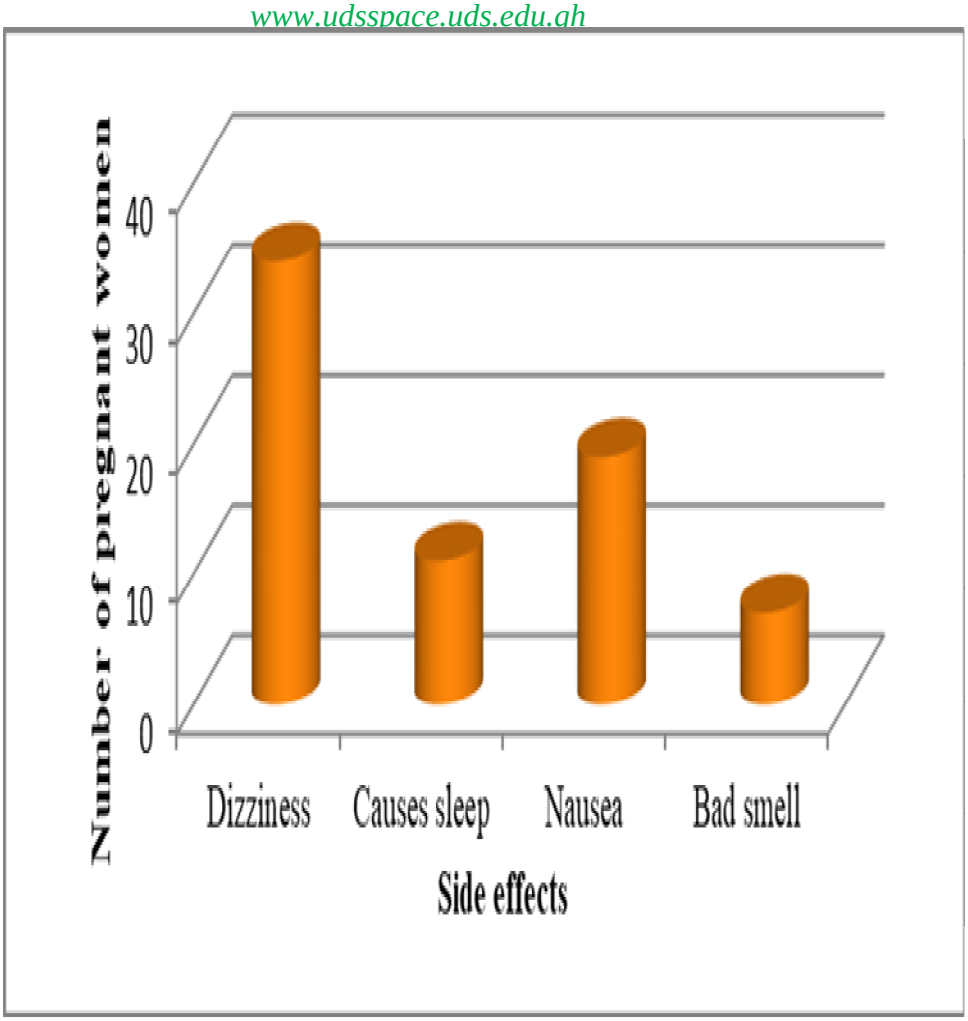

Figure 4. 1 Side effects experienced by pregnant women who took folic acid supplement

All the women who were supplementing with folic acid were categorized as younger mothers and older mothers. Women aged less than 30 years were categorized as younger mothers whilst those who were 30 years and older were categorized as older mothers. They were asked about their experience regarding side effects of the supplement. Out of 197 younger mothers who were supplementing, only about 25% (n=50) complained of one or more side effect. Out of 106 older mothers who were supplementing, only 20% (n=21) had experienced one type of side effect or another.

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Chi-square test was computed to assess the relationship between side effects of folic acid and age of the mother. No relationship was noted between side effects and age of the mother ($\chi 2=1.19$, $p=0.28$).

The relationship between marital status and side effects was also assessed. Of the 303 women who were taking folic acid, 11 women were not married and all of them did not experience side effect with supplementation. However, out of 292 women who were married and taking folic acid, only a small percentage (24.3% [n=71]) experienced side effect. A chi-square test was used to assess the relationship between the two variables and it could not detect a statistically significant relationship between the variables ($\chi 2=3.493$, $p=0.062$) (Table 4.12).

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Table 4. 12 Association between socio-demographic variables and side effects experienced

Variable	N	Experience of Side effect of folic acid Supplementation		Chi-square coefficient	p-value
		Yes n (%)	No n (%)		
Mothers age group					
Younger	197	50 (25.4)	147 (75.6)	1.19	0.275
Older	106	21 (19.8)	85 (80.2)		
Total	303	71 (23.4)	99 (32.7)		
Marital status					
Married	292	71 (24.3)	221 (75.7)	3.493	0.62
Not married	11	0 (0)	11 (100)		
Total	303	71(23.4)	232 (76.6)		
Education					
Up to JHS	104	25 (24)	79 (76)	0.032	0.857
At least SHS	199	46 (23.1)	153 (76.9)		
Total	303	71 (23.4)	232 (76.6)		

Analysis of 303 women who were supplementing

4.5.2 Association between periconceptional folic acid use and side effects

Chi square test was conducted to determine the associations between periconception folic acid supplementation on one hand, and reported side

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effects on another. In all, 19.7% (n = 14) out of 71 participants who were supplementing during the periconceptional stage reported that they had experienced some side effects. On the other hand, 80.3% (n = 57) of the participants who took folic acid supplements outside the periconceptional stage complained that they had experienced side effects. It is observed that, although the Chi square test did not indicate the presence of an association ($\chi 2 = 3.191$, P = 0.074), a very large proportion of the participants who reported side effects were those who supplemented outside the periconceptional period. These were more than those who supplemented during the periconceptional period (57 vs. 14 respectively).

Participant who took folic acid supplements but did not experience any side effects were 232 in number. Of that number, 30.6% (n = 71) took their folic acid supplements during the periconceptional stage, whilst 69.4% (n = 161) took their folic acid outside the periconceptional stage (Table 4.1.3).

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Table 4. 13 Association between periconceptional FA use and side effects

		TOOK FA DURING PERICONCEPTION				P-value
Variable	N	**Yes**	**n(%)**	**No**	**n(%)**	
EXPERIENCED SIDE EFFECTS						
YES	71	14	(9.7)	57	(80.3)	χ^2=3.191,
NO	232	71	(30.6)	161	(69.4)	p=0.074
NOT APPLICABLE	73					
Total	**376**	**85**		**218**		

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4.5.3 Association between preconceptional folic acid use and side effects

A total of 71 participants complained of side effects after taking in the folic acid supplement. Of that number, only 11.7% (n = 8) supplemented during preconceptional stage. As high as 88.7% (n = 63) supplemented outside the preconceptional stage. But there were those who did not experience side effects after using the supplement 7.3% (n = 17), and those who supplemented outside the preconceptional stage and so did not experience side effects 92.7% (n = 215). A Chi square test did not find statistically significant relationship between the variables ($\chi^{2\,=}$ 1.115, P = 0.291) (Table 4.14)

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Table 4. 14 Association between preconceptional FA use and side effects

Variable	N	Preconceptional Folic Acid Supplementation		Test statistic
		Yes n (%)	No n (%)	
EXPERIENCED SIDE EFFECTS				
YES	71	8 (11.3)	63 (88,7)	χ^2=1.115,
NO	232	17 (7.3)	215 (92.7)	P=0.291
NOT APPLICABLE	73			
TOTAL	376	25		

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CHAPTER FIVE

DISCUSSION

As has been stated earlier, this thesis is the report of a work undertaken to assess the determinants of folic acid supplement use among pregnant women in the Upper East Region of Ghana. This chapter presents a summary of the findings from the data collected and analysed, and also discusses these findings in relation to previously published work. In doing this, an attempt has been made to explain the implications of the results in this study.

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5.1 Summary of key findings

- Majority (65.2%) of the women were of a young maternal age and they were mostly married (95.5%). Although it can be said that 62% had formal education up to at least JHS, majority 75.2% (n=283) were in the low education category of JHS or none at all. More than thirty-one percent of participants had no employment. Majority of the mothers were low income earners receiving less than the minimum wage of Ghc210.00 per month at the time of the study.
- The prevalence of preconceptional folic acid supplementation was low (8.9%), whilst prevalence of periconceptional folic acid supplementation was high (80.6%).
- The socio-demographic characteristics which had relationship with preconceptional folic acid supplementation were: educational status, occupational status and income level.

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- Most women (75.8%) did not go for any pregnancy counseling to prepare them for pregnancy.
- Preconceptional folic acid supplementation was associated with gravidity (χ^2 =12.317, p=0.031), and this is statistically significant. There was however, no statistically significant association between preconceptional folic acid supplementation and parity (χ^2=6.115, p=0.191).
- Awareness level on folic acid supplementation was high and adequate (59.3%).
- The level of knowledge on folic acid supplementation was however low and inadequate (45.5%).
- Only 23.4% (n=71) of respondents reported having experienced side effects after taking in a folic acid supplement. These reported side effects could have however been that of the other multivitamins supplements consumed alongside folic acid supplementation.
- Periconceptional folic acid supplementation was associated with educational attainment (χ^2=17.85, p=0.003)
- There was an association between periconceptional folic acid consumption and pregnancy counseling (χ^2 =6.962, p=0.008), gravidity (χ^2=9.709, p=0.002), pregnancy planning (χ2 =8.551 p=0.003), gestational age at first visit to ANC (χ2 =13.121, P=0.004) and being aware of neural tube defects (χ2 =8.774, p= 0.003).

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5.2 Preconceptional and periconceptional folic acid supplementation

Distinctions are made regarding preconceptional and periconceptional folic acid supplementation. The former means supplementing with folic acid long before a woman contemplates a pregnancy. The latter meaning supplementing with folic acid 1-3 months before a woman becomes pregnant and continuing for at least, throughout the first trimester (i.e. during the period from right before conception to early pregnancy (Shawet al., [1995]).

Prevalence of periconceptional folic acid supplementation was 80.6%. However, with regards to preconceptional folic acid supplementation, the prevalence of folic acid use, as found in this study stood at only 8.9 per cent. Based on this finding, the prevalence of preconceptional supplementation with folic acid in the Upper East Region was very low, and the level of preconceptional folic acid supplementation is inadequate. One possible explanation of the low preconceptional supplementation could be that as a precondition for preconceptional supplementation, women need to be aware and knowledgeable about folic acid supplement and its use, as well as the consequence for not supplementing. This study has demonstrated that the levels of awareness could be said to be high or adequate, but level of knowledge was inadequate. Again, since the supplement is only provided for free during ANC attendance, then the women needed to have the financial capability to buy the supplement over the counter, in order to be able to practice preconceptional supplementation. Given that most of the women had poor knowledge about folic acid supplementation and were also

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financially poor, it just goes to explain why the level of preconceptional supplementation with folic acid was low and inadequate.

Another reason for the low use of folic acid supplement in the preconceptional period could be as a result of the low number of women (n=91, 24.2%) who went for a pregnancy counseling prior to becoming pregnant compared with those who did not go for pregnancy counseling (75.8% [n=285]). A cross tabulated analysis showed that women who went for pregnancy counseling and supplemented were 11.2% more than those who missed out on pregnancy counseling. It goes without saying that pregnancy counseling has a beneficial effect on preconceptional folic acid supplementation.

The preconceptional use of folic acid supplement as observed in the current study compares in many ways with a number of findings cited in the literature, (Braekke and Staff, 2003; FFI, 2011; Friberg and Jørgensen, 2015; Nelson *et al.* 2013; Ogundipe *et al.* 2012; Rofail *et al.* 2012; Zeng *et al.* 2011). Ogundipe and colleagues (2012) reported a prevalence of 17.2%, Braekke and Staff, (2003) reported 17% prevalence in an Oslo study among pregnant women. Friberg and Jørgensen, (2015) on their part reported 10.4% prevalence. Nelson *et al.* (2013) writing on the relationship between awareness and supplementation with folic acid among Canadian women, discovered that although most women in their study understood the benefits of folic acid supplementation, a little over a third of them did not take folic acid supplements prior to becoming pregnant, and less than half supplemented according to national guidelines. Wu *et al.* (2007) on their part found in their survey on knowledge and use of folic acid for the

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prevention of birth defects amongst Honduran women that 45% of patients were familiar with folic acid. Of that number, 30% knew the appropriate timing of intake and 25% reported proper pre-natal supplementation. Zeng *et al.* (2011) reported in their study on folic acid awareness and intake among women in areas with high prevalence of neural tube defects in China that among 33, 025 participants in their study, 57% had heard of folic acid but only 15 % knew all of the core information. The intake rate was as low as 12%; only 8% took the recommended dose and only 4% of non-pregnant women took folic acid.

All of the findings in the above are a confirmation that preconceptional folic acid supplementation is low, not only in the Upper East Region of Ghana but also in many other countries across the world. This is a characteristic of women who do not plan their pregnancies.

Perhaps, the high prevalence of periconceptional supplementation reported in this present study could be attributed to the fact that every pregnant woman accessing ANC in the sampled facilities at the time of this study was given the supplement free of charge, as part of the routine care to improve maternal and child health (Saaka, 2012). This way, because financial barriers have been removed, it is expected that utilization would be high, especially considering that unemployed women and women of low socioeconomic status supplemented the least.

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5.3 Socio-demographic characteristics and folic acid supplementation

The second objective of this study was to determine the relationship between socio-demographic characteristics of the respondents and folic acid

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supplementation among pregnant women in Upper East Region of Ghana. Socio-demographic characteristics included in the analyses of this study included education, marital status, maternal employment status and income level.

Most of those who supplemented with folic acid fell within the ages of 25-29 years, which is similar to a number of findings related to this topic. In an Israeli study Amitai *et al.* (2004) found an increased awareness, knowledge and utilization of preconceptional folic acid, where awareness (90%) and utilization (35%) were significantly higher in the 25-29-year age bracket.

Other studies in which age as a variable was categorically implicated as a determinant of low intake of folic acid include that of Peake *et al.* (2013) and Lunet *et al.* (2008).

However, studies whose results contrasted the finding of the current study regarding age included that of Friberg and Jørgensen (2015) and Nilsen *et al.* (2006). For these two studies, folic acid knowledge and supplementation were possible among women of advanced age greater than 30 years. Differences in the findings could be due to differences in the socioeconomic status of the study participants.

With respect to education, being educated up to tertiary level recorded the highest percentage (23.8) in terms of folic acid supplementation, showing that higher education was associated with the use of folic acid during the preconception and periconception periods. This finding is consistent with a number of findings that education is a positive predictor of folic acid knowledge and supplementation. For example, in a report, Lunet *et al.*

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(2008) stated that higher schooling was identified as being associated with increased use of folic acid (RR = 1.42; 95%CI: 1.18-1.70). Ray *et al.* (2004) have also outlined some predictors of reduced use of periconceptional folic acid supplements and implicated low levels of maternal formal education. In another study with a similar conclusion, Amitai *et al.* (2004) stated that ratios of awareness, knowledge and utilization were highest among women with post-university education at 93%, 84%, and 46%, respectively.

In a similar fashion, Popa *et al.* (2013) made a conclusion that women with higher education were almost three times more likely to use folic acid supplement, compared with those who have lower levels of education. Another study with similar categorical conclusion regarding education and use or non-use of folic acid stated that among other things, that, socio-demographic factors significantly associated with the non-use of antenatal Iron and folic acid supplements include lack of education by the mother (Nisar *et al.* 2014). A study by Nilsen *et al.* (2006) also found that about ten per cent of all women who supplemented with folic acid were women with high level of education. In another study, Medveczky and Puhó (2004), argued that higher maternal education goes together with a higher proportion of periconceptional folic acid supplementation. Finally, Friberg and Jørgensen, (2015) in their study 'Few Danish pregnant women follow guidelines on periconceptional use of folic acid' also made an assertion that education greater than 3 years was a predictor of supplementation with folic acid by their study population.

In their study, Nilsen *et al.* (2006) also had results similar to the results of this present study and their conclusion was that maternal education and

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marital status were strong predictors of use of folic acid supplements. Women with the highest educational level had an RR of 6.0 of use of folic acid supplement compared with women with the lowest educational level, whereas married women had an RR of 2.4 of use of folic acid supplement relative to single women.

This study assessed the relationship between marital status and folic acid supplement use. The results showed that of the total of 292 women who said they were currently taking folic acid supplement during the preconceptional period, only a small percentage of them (9%) were married. A test of association between marital status and preconceptional use of folic acid supplement could not detect statistically significant association between groups, (χ^2 =1.080, p=0.897). The finding in this current study differs from the study by Mcdonnell *et al.* (1999) that being married is a positive predictor of awareness of periconceptional folic acid and that marriage could facilitate exposure to the folic acid message by raising awareness of issues that have a bearing on pregnancy and children.

Other studies with equally different findings to this present study include that of Nilsen *et al.* (2006) who found that being married is two times more likely to result in the use of folic acid in the preconception and periconception periods than not being married. Also, in a 2008 study, Lunet *et al.* (2008) found that, use of folic acid was less prevalent in single women. One possible reason could be that married women have their partners encouraging and reminding them to take their supplement.

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Other studies with similar variant findings in the literature regarding the relationship between marital status and use of folic acid include the study by Ray *et al.* (2004) in which the authors outlined a number of significant predictors of non-use of periconceptional folic acid including lack of a partner.

One possible reason for the difference in findings between the current study and that of the previous studies could be that, even though formal education has been unequivocally shown to be associated with folic acid supplementation, majority (87.5%) of the participants in the current study have been found to have only a low level of education.

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5.4 Obstetric characteristics and folic acid supplementation

The obstetric characteristics of the pregnant women were analysed and two variables that came up strongly in the literature and compared with the findings of this study were parity and planned pregnancy.

With regards to preconceptional supplementation, out of the 82 women who had pregnancy counseling, 15 women representing 18.3% of women who had had pregnancy counseling also practiced preconceptional folic acid supplementation. Having to go for pregnancy counseling was however not associated with preconceptional folic acid supplementation.

Regarding periconceptional folic acid supplementation, majority (82 [90.1%]) of the women took a folic acid supplement during the periconceptional stage; 9 women representing 9.9% had pregnancy counseling but did not supplement. It implies that those who had pregnancy

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counseling used the folic acid supplement more than those who did not have pregnancy counseling, and this was statistically significant (χ^2 =6.962, p=0.008).

To determine the association between periconceptional and preconceptional folic acid supplementation and parity, results of cross tabulations showed the following. Parous women who were taking supplemental folic acid during periconceptional period were 211 (84.7%) against parous women who were not practicing periconceptional folic acid supplementation (38 [15.3%]). However, this difference in proportions was not significant statistically (χ^2 =0.117, p = 0.733). This finding contrasts the findings by Nilson *et al.* (2006) which noted, among others, that, lower parity was associated with periconceptional folic acid intake. The findings in this study confirms the finding in a study in which multiparity was considered a positive predictor of folic acid supplementation knowledge (Friberg and Jørgensen, 2015).

From the analysis, interaction between preconceptional folic acid supplementation and pregnancy planning showed that preconceptional supplementation was more prevalent among women who had planned their pregnancy than in those women who did not plan their pregnancy, and this was statistically significant (χ2 =27.243, p<0.001). Analysis of pregnancy planning and periconceptional folic acid supplementation revealed that, pregnancy planning was significantly associated with current use of folic acid supplement.

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This relationship could be because women who had planned their pregnancy and supplemented were 51.8% more than those who did not plan their pregnancy but supplemented (75.9% vs. 24.1%). This implies that those who planned their pregnancy supplemented more than those who did not plan their pregnancy. The finding in this study parallels findings in earlier studies. In a study, Ray *et al.* (2004) found that, among other things, significant predictors of reduced periconceptional folic acid use included not having to plan a pregnancy.

In other studies, (Nilson *et al..*, 2006 and Barrett *et al..*, 2015) have similar conclusions that not planning a pregnancy is a risk factor for non-use of folic acid supplement during the periconceptional period. In their study Nilson *et al.* (2006) found that planned pregnancy and IVF, which is consistent with planned pregnancy, were strongly related to periconceptional use (adjusted RRs of 2.4 and 2.0, respectively). Again, on their part, Barrett *et al.* (2015) identified three groups of women in relation to pre-pregnancy health and care: 1) The "prepared" group, who had high levels of pregnancy planning and mostly positive attitudes to micronutrient supplementation outside of pregnancy, carried out pre-pregnancy activities such as taking folic acid and making changes to diet and lifestyle. 2) The "poor knowledge" group, who also had high levels of pregnancy planning, did not carry out pre-pregnancy activities and described themselves as having poor knowledge. Elsewhere in their interviews they expressed a strong dislike of micronutrient supplementation. 3) The "absent pre-pregnancy period" group, had the lowest levels of pregnancy planning and also expressed anti-supplement views. Even discussing the pre-pregnancy

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period with this group was difficult as responses to questions quickly shifted to focus on pregnancy itself. Knowledge of folic acid was poor in all groups (Barrett *et al.*, 2015).

According to this study, having gone for pregnancy counseling prior to conception is associated with use of folic acid in the preconception period (p=0.002). This finding is consistent with other findings. In a Chinese study with migrant women, preconception counseling (PCC) was associated with higher consumption of folic acid supplements during the preconception period (adjusted odds ratio [AOR] = 2.65, 95% CI: 1.66-4.23). The consistence in these findings could be that counselors might be aware of the beneficial effects of periconceptional use of folic acid and might have been integrating it in the counseling services they provide to women.

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5.5 Gestational age at first visit to ANC and folic acid supplementation

In terms of ANC visit and periconceptional folic acid supplementation, the largest group of women (89% [n=121]) to supplement were those who went for their first ANC visit during the first three months of their pregnancy. The next group was those who had their first ANC visit during the time right before conception (84.2% [n=48]). A test of association showed that there was a highly statistically significant relationship between current use of folic acid and gestational age at first visit to ANC (χ^2 =13.121, P=0.004). It implies that an early and more frequent engagement with ANC could enhance periconceptional folic acid supplement use.

This finding agrees with a number of other studies cited in the literature. In one study, those women who had greater engagement with prenatal care

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were found to have better nutritional knowledge and used supplements more (Popa *et al.,* 2013). On their part, Nisar, *et al.* (2014) in a study of non-use of iron and folic acid supplements among Pakistani women, discovered that non-use of antenatal care (ANC) services accounted for up to 13.39% of all 6,266 surveyed women. Furthermore, a study of adequacy of prenatal care as a major determinant of folic acid, iron and vitamin intake during pregnancy had a similar conclusion that the use of all types of supplements studied was positively associated with the adequacy of prenatal care (Lunet *et al.,* 2008). Again, another study whose findings parallel the findings in this study concludes that women with more frequent ANC visits have significantly greater odds of using folic acid and both folic acid and iron supplements (Ogundipe *et al.,* 2012).

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5.6 Awareness / knowledge and folic acid supplementation

The forth objective of this study was to assess the relationship between use of folic acid supplement and awareness and knowledge about the supplementation. This study found that there was a high (59.3% [n=223]) level of awareness of folic acid supplementation among the study participants.

This finding is consistent with the study by Zeng *et al.* (2011) who reported high level of awareness of folic acid supplementation (57%). This study is also corroborated by an earlier study, French *et al.* (2003) where the level of awareness in a study in Vancouver, Canada, was very high (95%).

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There are however some studies with contrasting low levels of awareness of folic acid. In a Honduran study, Wu *et al.* (2007) reported that 45% of women were familiar with, and therefore aware of folic acid. In addition, Nawapun and Phupong, (2006) in a Thai women study reported that only 16% of participants in their study were aware of folic acid supplementation.

When questions were asked to gain an insight into the respondents' deeper knowledge about folic acid supplementation, they showed lower levels of knowledge (45.5%) than they did of awareness (59.3%). This study showed that there was inadequate level of knowledge of the folic acid supplementation, a finding that agrees with a number of findings of other studies. For instance, in a study reported by Zeng *et al.* (2011) involving women in a setting with high prevalence of neural tube defects in China, it was established that although as high as 57% of their study participants had heard of folic acid, only 15 % knew the core information about it. Another study with similar corroborating results is that of Wu *et al.* (2007) involving Honduran women, which found that 30% knew appropriate timing of consumption of folic acid supplement and 25% reported proper pre-natal supplementation (Wu *et al.*, 2007).

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However, in a Danish study whose results are incongruent with the findings of this study, that sought to describe how pregnant women followed guidelines of periconceptional folic acid supplementation, it was reported that more than 80% of the participants in the study demonstrated knowledge about recommendations before their current pregnancy (Friberg & Jørgensen, 2015). This Danish finding clearly conflicts the findings of this study. The difference in findings between the previous study and the current

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study could be attributed to the low level of education in the current setting. Another study whose findings contrast the findings of this study is the study in British Columbia in which 76.3% of surveyed women identified folic acid as the one vitamin specifically associated with reduction of birth defects (Morin *et al.,* 2001).

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5.7 Side effects and folic acid supplementation

The specific side effects which have been reported in this current study include sleep disorders, dizziness and nausea. This finding compares with findings of other studies cited in the literature. For example, according to Gebreamlak *et al.* (2017), when the women in their Ethiopian study were asked to name the side effects which prevented them from complying to supplement with IFA, heartburn, vomiting, constipation and diarrhea were stated. In the same vein, in a South Indian study that assessed pregnant women's compliance with IFA therapy Mithra *et al.* (2013) reported that vomiting was among the reasons for women not complying. This finding by Mithra and co-workers also confirms the findings in this current study which found among others that nausea was a side effect cited by the women in this study. One reason for the similarities in the findings of these studies could be that all these studies were undertaken in the developing countries with subjects whose perceptions and persuasions might be similar.

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5.7.1 periconceptional folic acid use and side effects

As observed in the analysis, supplementation with folic acid during the periconceptional stage was not associated with reported side effects ($\chi 2$ = 3.191, P = 0.074)

5.7.2 preconceptional folic acid use and side effects

Analysis of use of folic acid supplements during preconceptional stage showed that side effects are not associated with folic acid supplementation in the preconceptional stage. ($\chi^{2 =}$ 1.115, P = 0.291)

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CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken to assess the prevalence of folic acid supplementation in pregnant women accessing ANC and to determine the relationship between various factors and folic acid supplementation in pregnant women in the Upper East Region of Ghana. Based on the main finding, as presented below, the following conclusions and recommendations were made.

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6.1 Novel contributions and main findings of this study

- Prevalence of preconceptional folic acid supplementation, which has the tendency to capture all women of child bearing age (WIFA) is very low, while the prevalence of periconceptional folic acid supplementation is very high (8.9% vs. 80.6%) in the Upper East Region.

- More than 54% of the supplementing group of pregnant women missed the recommended starting time for periconceptional folic acid supplementation. This means that they have missed the window of opportunity for the prevention of potential possible occurrence or recurrence of a pregnancy that could be affected by neural tube defects, preventable by folic acid supplementation.

- Majority (94%) of the folic acid supplement was gotten from the health facility, probably because of the policy of universal free access to the supplement by pregnant women at ANC.

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- Young maternal age (15-19 years) is a risk factor for non-use of both preconceptional and periconceptional folic acid supplementation. Also maternal age 35 years and older is a risk factor for not supplementing.
- High income earners practiced preconceptional folic acid supplementation more than low income earners.
- More than 75% of the women did not go for pregnancy counseling despite its positive association with periconceptional folic acid supplementation.
- Pregnancy planning was positively associated with folic acid use both in preconceptional and periconceptional stages.
- Early booking at the ANC was associated with folic acid supplement use.

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6.2 Conclusions

This study showed that there was very low prevalence of preconceptional folic acid supplementation among pregnant women who were accessing ANC in health facilities in the Upper East Region. On the other hand, there was high prevalence of periconceptional folic acid supplementation among pregnant women in the region.

Age of the mother, a mother's marital status, her educational status, her type of work and her level of income were associated with folic acid supplementation. Maternal age 19 years or younger as well as old maternal age 35 years or older were a risk factor for not using folic acid supplement.

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Having a formal education, belonging to other categories of jobs other than farming and receiving a high income were associated with folic acid supplementation.

Obstetric characteristics of a mother, such as having to go for pregnancy counseling, having to plan a pregnancy, early booking at ANC, higher gravidity, higher parity and gestational age at first ANC visit were associated with folic acid supplementation.

There was high prevalence of awareness of folic acid supplementation among the pregnant women in the region. The level of knowledge of folic acid supplementation was however found to be low and inadequate. The dominant perceived side effect of using folic acid supplement was dizziness. No relationships were detected between perceived side effects of supplemental folic acid and any variables.

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6.3 Recommendations

On the basis of the conclusions of this study, the following recommendations are made:

- There should be vigorous effort by the GHS, through its public health, health education and MCH units as well as NGOs in health to provide education on preconceptional folic acid supplementation. Schools could be a good starting point to get the students aware even before they complete education and start having pregnancy.

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- More efforts should be made by health care providers and NGOs in health, to encourage the start of supplementation at the appropriate timing. Young mothers (aged 15-19 years) and mothers aged 35 years or older are at an increased risk of not supplementing compared to those ages that fall in between the two (2) groups. There should be targeted programmes aimed at changing the approach of those women towards pregnancy.

- Poverty alleviation programmes should be pursued by government and other civil society organisations to increase the incomes of the economically disadvantaged mothers because earning a high income as found in this current study is positively associated with increased compliance to folic acid supplementation.

- Pregnancy planning should be encouraged by the Ghana Health Service and other civil society organizations that are interested in maternal and child health since it will enable mothers to know the time of onset of their pregnancy and adopt the appropriate health practices (including folic acid supplementation) that would encourage a healthy pregnancy. This can be done by identifying all the stakeholders within the spectrum of healthcare provision. For example, there should be a multi-sectoral linkage between the National Population Council and the MOH/GHS, which should seek to deepen collaboration to enhance pregnancy planning.

- The GHS should sensitise women to appreciate the importance of early visit to the health facility as soon as they suspect a pregnancy.

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This will afford them (the women) the opportunity to have an early booking at the ANC and hence start taking their free routine folic acid supplements at the appropriate time. This is in line with the finding of this research that early booking at the ANC is associated with periconceptional folic acid supplementation.

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APPENDICES

APPENDIX 1

QUESTIONNAIRE

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GRADUATE SCHOOL, TAMALE

MPhil. COMMUNITY HEALTH AND DEVELOPMENT

FACILITY-BASED SURVEY FOR WOMEN ATTENDING ANC

The questions in this survey are designed for pregnant women attending ANC.

Guidance for introducing yourself and the purpose of the interview:

- My name is ----------, an MPhil Community Health and Development student from the University for Development Studies, Tamale.
- You have been selected by chance from all women accessing antenatal care in this facility to participate in this interview. The purpose of this interview is to obtain information about maternal use of folic acid during preconceptional and periconceptional periods as recommended by health experts.
- Your participation in this survey is voluntary and the information that you give will be confidential. The information will be used to produce a thesis purely for academic purposes, but will not include your name. There will be no way to identify that you gave this information.
- Could you please spare some time, (about 30 minutes) for this interview? Consent given □

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NAME OF SURVEYOR **……..** **PHONE NUMBER OF SURVEYOR……..** **NAME OF FACILITY …….** DOES **RESPONDENT** LIVE IN THIS REGION? ……	
BASIC INFORMATION BI	
BI 1.	Date of survey……/……/…….. DD /MM/ YYYY
BI 2.	Town/village ……
BI 3.	District/municipality ……..
SECTION A. DEMOGRAPHICS DM	
DM1 .	What is your age?
DM2	What is your marital status? 1=Married. 2=Divorced. 3=Widowed. 4=Never married.
DM3	Religion

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.	1=Christian. 2=Muslim. 3=Traditionalist 4=Other	
DM4	Ethnicity	
DM5	Highest level of education. 1=Primary. 2=JSS 3=Secondary or technical school. 4=Vocational school. 5=Tertiary/post secondary. 99=No education.	
DM6	What is your occupation? 1=Government worker. 2=Trader/business woman. 3=Farmer. 4=Unemployed. 5=Other. (Specify)……NB:	
DM7	Income brackets. 1= less than GHC 116 a month. 2= between 116 and GHC 210 a month. 3= less than GHC 210 a month. 4=Above GHC 210 a month 99= No income.	
SECTION B UPTAKE/INTAKE		
T1.	Are you currently taking this drug for your pregnancy? (***please show the drugs in your possession***). 1=Yes. (if yes, go to T2)	

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	2=No. **(IF NO, SKIP TO SECTION C)**	
T2	Can you identify this drug if it is mixed up with others such as this? (***please show the mixed drugs in your possession***). 1=if a woman **correctly** points to folic acid. (AFTER ANSWERING, **GO TO T3**) 2=if a woman **doesn't** point to folic acid. (AFTER ANSWERING, **SKIP TO SECTION C) NB: THIS QUESTION HAS BEEN ALTERED A BIT IN SPSS.**	
T3	What is the name of this drug?	
T4.	When did you start taking this drug? 1= **Long ago**, since when I became capable of becoming pregnant. 2= 1 to 3 months **before** I became pregnant 3=four weeks or less **after** I became pregnant. 4=More than 3 months **after** I became pregnant. 99= Don't know	
T5.	This drug, (folic acid), are you taking it as a single drug containing **only** folic acid or is it **combined** with other supplements all in one drug? 1=Single drug, containing only folic acid. 2=Combined with other supplements. 99=Don't know	
T6.	The folic acid you are currently taking is it provided at the health facility or did you buy it? 1=Provided at the health facility.	

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	2=I bought it over the counter.	
SECTION C. OBSTETRIC HISTORY/CHARACTERISTICS		
G1.	Have you ever had pregnancy counseling to prepare yourself for pregnancy? 1=Yes 2= No	
G2.	Have you ever been pregnant before this pregnancy? 1= Yes. (IF YES, GO TO G3) 2= No (**IF NO,GO TO G6**)	
G3.	Have you given birth before? 1=Yes 2=No	
G4.	How many times did you give birth before this pregnancy? 1=Once 2=Twice 3= More than two times.	
G5.	Have you ever given birth to a child with low birth weight? ***(less than 2.5 kg).*** 1=Yes 2=No.	
G6.	Is this a planned or an unplanned pregnancy? 1=Planned 2=Unplanned	
G7.	How long did it take you to seek ANC services (go for weighing), after you suspected you were pregnant?	

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	1=About 4 weeks or less. 2= About 1to 3 months. 3= More than 3 months. 99= Don't know	
G8.	Have you ever had a miscarriage/abortion because the fetus is **NOT** well formed? 1=Yes 2=No	
G9.	Have you or any member of your family ever had a child/children with a birth defect? 1=Yes 2=No	
G10.	Have you ever treated infertility? 1=Yes 2=No	
G11.	Do you have any health problems such as epilepsy? 1=Yes 2=No. **(IF NO, GO TO SECTION D**).	
G12.	Are you taking any medicines to treat it? 1=Yes. 2=No.	
SECTION D. KNOWLEDGE OF FOLIC ACID AND NTD		
K1.	Please can you identify this tablet *(if you see it anywhere)*? 1=Yes 2=No. **(IF NO, SKIP TO K3)**	
K2.	What is it called, *which patients are normally supposed to*	

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	take it? 1=Folic acid supplement, *(taken by pregnant women*). (**AFTER ANSWERING**, **GO TOK4**). 2= Paracetamol **(AFTER ANSWERING, GO TOK3**). 3=Other. (Specify)……(**GO TO K3)** 99=Don't know (after answering, **GO TO K3**)	
	ASSESSMENT OF AWARENESS	
	Have you ever heard of folic acid? 1=Yes. (Go to **K4**). 2=No. (**SKIP TOK10**)	
K4.	What was your source of information about folic acid? 1=Midwife/Nurse. 2=Doctor. 3=Husband/family member/friend. 4=I read about it. 5=Radio/TV/newspaper. 6=Other (specify)……	
K5.	Can you identify any uses of folic acid from the following? **(a woman can chose** more than 1 answer**).** 1=Treatment of diarrhea. 2= Prevention of neural tube defects, ***(disease of the spine & brain)*.** 3=Treatment of infertility/barrenness	
K6.	Which one of the following is a food source of folate (folic	

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	acid)? 1=Green leafy vegetables. 2= Animal products. 99= Don't know.	
K7.	Do you know you needed to start taking folic acid since the time you became capable of becoming pregnant? 1=Yes 2=No	
K8.	How frequently are you supposed to take your folic acid supplement? 1=Once a day 2= Twice a day 99= Don't know	
K9.	How many tablets (**of this drug)** are you supposed to take in a day? 1=One 2= Two 99= Don't know	
K10.	Have you ever heard about Neural Tube Defects (***disease of the spine and brain*)** 1=Yes. **(GO TO K11)** 2=No **(IF NO, SKIP TO SECTION E**).	
K11.	Can you say which one of the following is **a kind of Neural** Tube Defect (NTD)? 1=HIV.	

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	2= Spina bifida, (***disease of the spine***). 3=Malaria. 99=Don't know.	
SECTION E. SIDE EFFECTS		
S1.	Are you currently taking other medications apart from the folic acid supplements? 1= Yes. (**IF YES, GO TO QUESTION S2).** 2=No. (**IF NO, END OF INTERVIEW).**	
S2.	Do you experience any side effects when you take your folic acid supplement? 1=Yes. (Go to s3). 2=No. (**IF NO, END OF INTERVIEW).**	
S3.	What are the side effects that you experience when you take your folic acid supplement? (**Choose as many answers as applicable**) 1=Dizziness. 2=I have a feeling of nausea. 3=It makes me sleep. 4=It has bad smell 5=Other. (Specify)……..	

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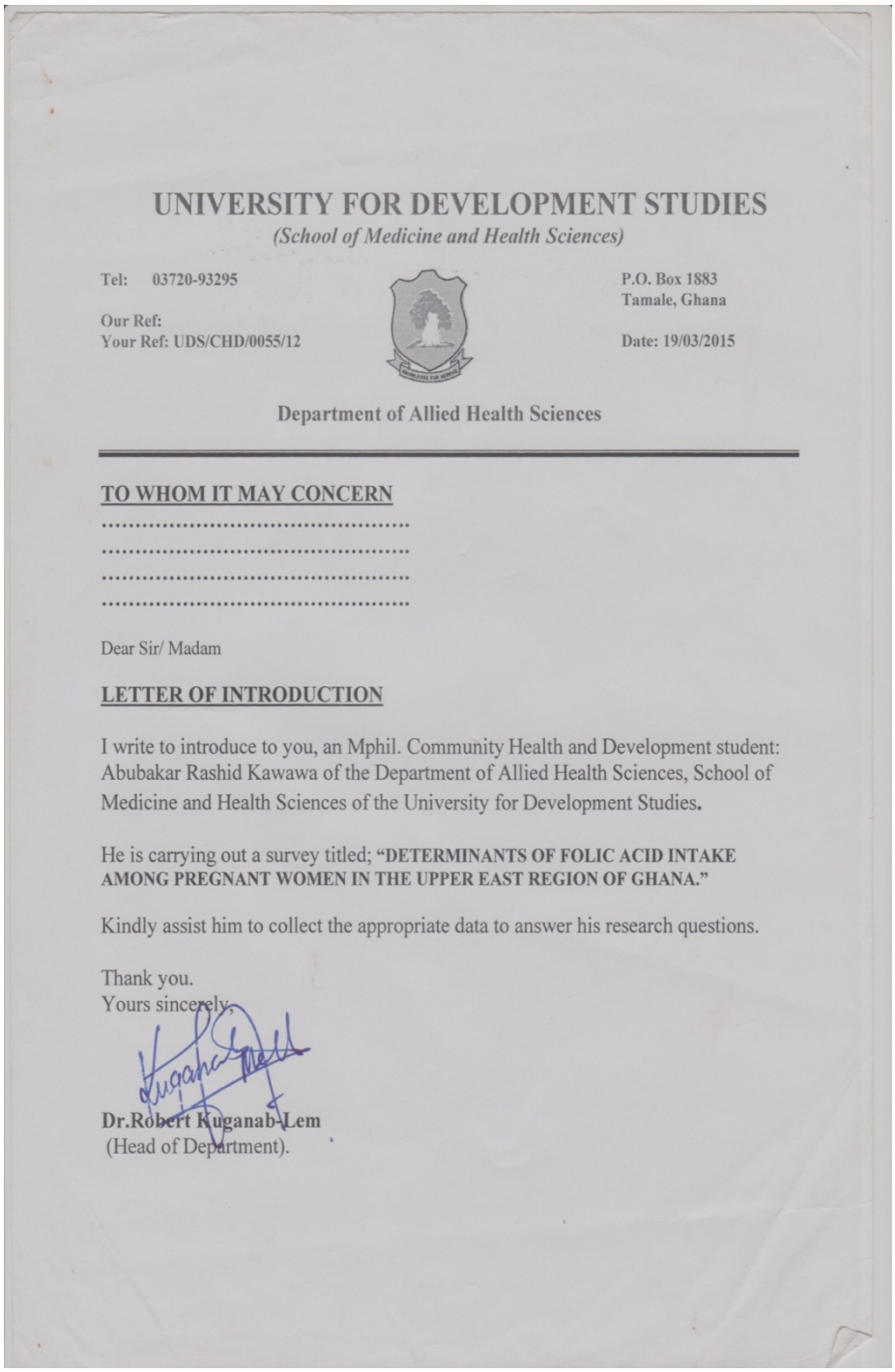
APPENDIX II

Sample introductory letters



UNIVERSITY FOR DEVELOPMENT STUDIES

(School of Medicine and Health Sciences)

Tel: 03720-93295

Our Ref:
Your Ref: UDS/CHD/0055/12

P.O. Box 1883
Tamale, Ghana

Date: 19/03/2015

Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

.....
.....
.....
.....

Dear Sir/ Madam

LETTER OF INTRODUCTION

I write to introduce to you, an Mphil. Community Health and Development student: Abubakar Rashid Kawawa of the Department of Allied Health Sciences, School of Medicine and Health Sciences of the University for Development Studies.

He is carrying out a survey titled; **"DETERMINANTS OF FOLIC ACID INTAKE AMONG PREGNANT WOMEN IN THE UPPER EAST REGION OF GHANA."**

Kindly assist him to collect the appropriate data to answer his research questions.

Thank you.
Yours sincerely,

Dr.Robert Kuganab-Lem
(Head of Department).

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Our Core Values
People Centred
Professionalism
Team Work
Innovation
Discipline
Integrity
Ref GHS/UE/HR-
Your Ref.No

GHANA HEALTH SERVICE
Your Health · Our Concern

13/4/15

Regional Health Directorate
Ghana Health Service
Private Mail Bag
Bolgatanga, UER
GHANA
7TH APRIL, 2015
Tel: (03820) 22335
Fax: (03820) 24390
E-mail ghs-uer@4u.com.gh

MUN/DISTRICT DIRECTORS OF HEALTH SERVICES
BAWKU, BAWKU WEST, BOLGA, G/T, KNM, AND TALENSI

RE: LETTER OF INTRODUCTION
MR. ABUBAKAR RASHID KAWAWA

This is to introduce to you the above named Mphil. Community Health and Development student of the School of Medicine and Health Sciences of the University for Development Studies, Tamale. He is requesting for permission to carry out a survey in your district.

I am by this letter granting him permission and entreat that you accord him the necessary assistance needed.

Attached is a copy of a letter to that effect from his Head of Department.

Thank you.

DR. J. KOKU AWOONOR-WILLIAMS
REGIONAL DIRECTOR OF HEALTH SERVICES (UER)

The letter would be photopied to the selected facilities (NHC, WMH, & KHCHC)

HIO
21-4-15

HIO
support him

Kindly support him - Selected facilities

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(School of Medicine and Health Sciences)

Tel: 03720 92295

Our Ref:
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P.O. Box 1883
Tamale, Ghana

Date: 19/03/2015

Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

THE DISTRICT DIRECTOR
GHANA HEALTH SERVICE
BANKU WEST - ZEBILLA

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Dr.Robert Kuganab-Lem
(Head of Department).

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Our Ref:
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P.O. Box 1883
Tamale, Ghana

Date: 19/03/2015

Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

THE REGIONAL DIRECTOR
GHANA HEALTH SERVICE
BOLGA, UPPER EAST.

Dear Sir/ Madam

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Yours sincerely,

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(Head of Department).

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Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

THE DISTRICT DIRECTOR
GHANA HEALTH SERVICE
BAWKU

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Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

THE DISTRICT DIRECTOR
GHANA HEALTH SERVICE
TALENSI

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Date: 19/03/2015

Department of Allied Health Sciences

TO WHOM IT MAY CONCERN

THE DISTRICT DIRECTOR
GHANA HEALTH SERVICE
KASENA NANKANE MUNICIPAL

Dear Sir/ Madam

LETTER OF INTRODUCTION

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TO WHOM IT MAY CONCERN

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GHANA HEALTH SERVICE
GARU TEMPANE

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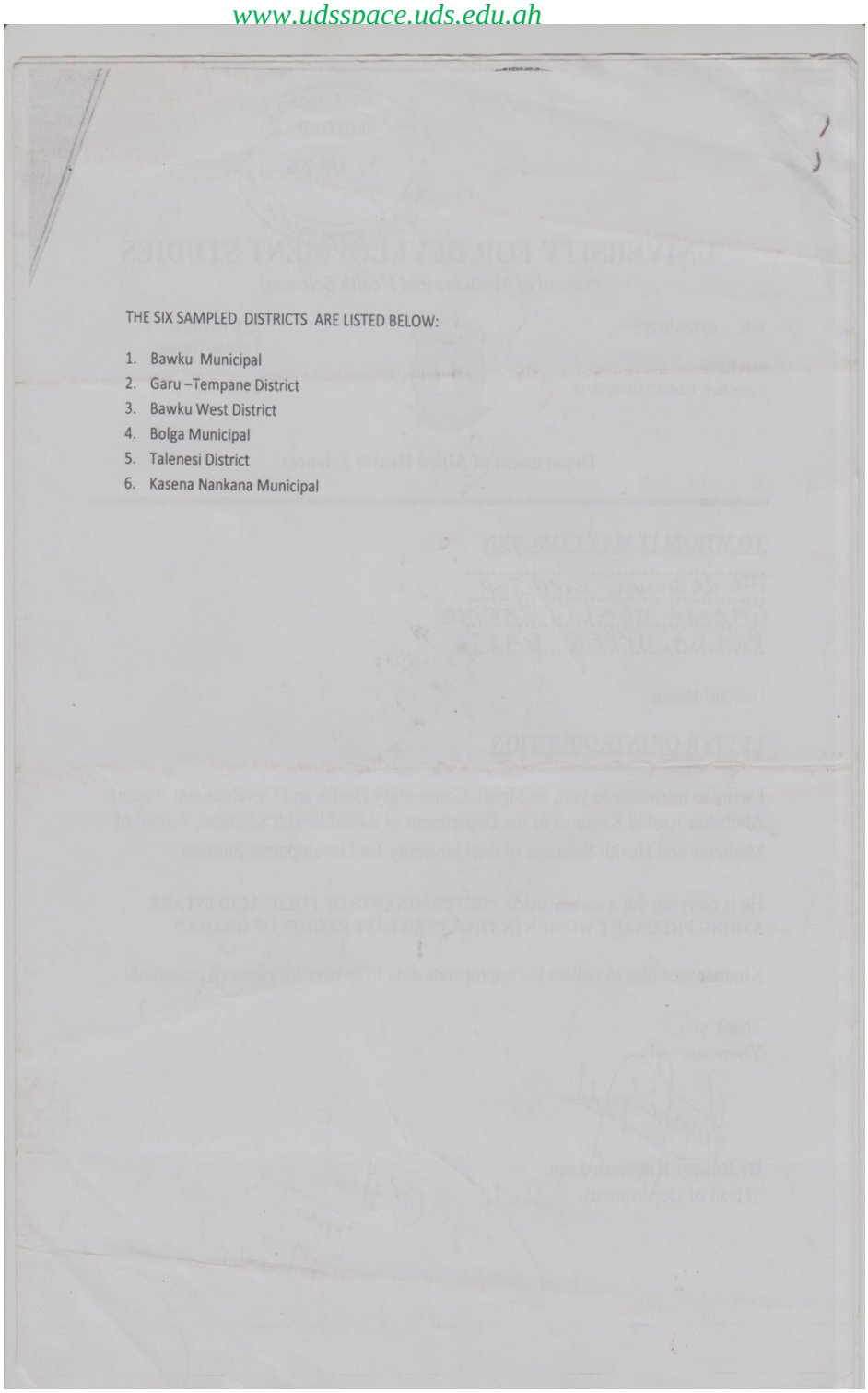

THE SIX SAMPLED DISTRICTS ARE LISTED BELOW:

1. Bawku Municipal
2. Garu –Tempane District
3. Bawku West District
4. Bolga Municipal
5. Talenesi District
6. Kasena Nankana Municipal

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