PREVALENCE OF ANEMIA AND ASSOCIATED FACTORS AMONG PREGNANT WOMEN OF ITAHARI SUB-METROPOLITAN CITY

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A dissertation submitted to the Department of Nutrition and Dietetics, Central Campus of Technology, Tribhuvan University, in partial fulfilment of the requirements for the degree of B.Sc. in Nutrition and Dietetics.

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Approval Letter

This *dissertation* entitled *Prevalence of anemia among pregnant women and its associated factors in Itahari sub-metropolitian city* presented by **Sarita Rai** has been accepted as the partial fulfilment of the requirement for the **B.Sc. degree in Nutrition and Dietetics.**

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Abstract

Anemia is a global public health problem affecting both developing and developed countries with major consequences on human health as well as social and economic development. It is a major cause of morbidity and mortality during pregnancy in developing countries. The main aim of this study was to determine the prevalence of anemia and associated factors among pregnant women of Itahari sub-metropolitan city. A hospital based cross-sectional study was employed. A consecutive sampling procedure was used to select 211 pregnant women who were attending antenatal clinics in Primary health care centre and Family planning Association of Nepal of Itahari sub-metropolitan city. The data was entered, coded and analysed using SPSS version 20.0 statistical software. Pearson's chi-square test was used to show the significant association between anemia and associated factors.

The present study revealed that the prevalence of anemia among the pregnant women was 18.5% with varying degrees ranging from mild and moderate which were 16.6% and 1.9% respectively. None of the participants were severely anemic (Hb<7gm/dl). The results from this study found that the mean haemoglobin level of participants was 11.5 ± 0.8(gm/dl) with minimum and maximum of 9.2 gm/dl and 15.6 gm/dl respectively. Yearly income (p=0.009), frequency of antenatal visits (p=0.010), mid-upper arm circumference (MUAC) (p=0.046), body-mass index (BMI) (p=0.048) and frequency of egg taken (p=0.042) were found to be statistically significant association with anemia among pregnant women (p-value <0.05). The prevalence of anemia (32.3%) was found to be high in underweight pregnant women. Anemia was found to be mild public health problem in the study area. Thus, nutritional counselling on consumption of iron rich foods during pregnancy and health education about anemia should be given to pregnant women to prevent from anemia.

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List of Abbreviations

Abbreviation	Full form
ANC	Antenatal care
BMI	Body Mass Index
CBS	Central Bureau of Statistics
DHOs	District Health Offices
FPAN	Family Planning Association of Nepal
GFDRE	Government of the Federal Democratic Republic of Ethiopia
Hb	Haemoglobin
HbS	Sickle haemoglobin
HCl	Hydrochloric acid
ICMR	Indian Council of Medical Research
LPG	Liquid Petroleum Gas
MoH	Ministry of Health
MoHP	Ministry of Health and Population
MUAC	Mid-upper arm circumference
NCST	National Guideline on Nutrition, Care, Support, and Treatment
NDHS	Nepal Demographic and Health Survey
NRS	Nepalese Rupee
PHC	Primary Health Care Centre
PIH	Pregnancy Induced Hypertension
PROM	Premature rupture of membrane
RBC	Red blood cells
RDA	Recommended Dietary Allowances
SD	Standard Deviation
SGA	Small for gestational age
SPSS	Statistical for the Package Social Sciences
UNICEF	United Nations Children’s Fund
USA	United States of America
VDC	Village development committee
WHO	World Health Organization

Part I

1. Introduction

1.1 Background of the study

Anemia is defined as a low blood haemoglobin concentration. It affects low, middle and high income countries having significant adverse health consequences, as well as adverse impacts on social and economic development (WHO, 2015). As per the WHO's definition, the haemoglobin cut-off points for anemia during pregnancy is <11.0 g/dl similarly 10.0-10.9 g/dl (mild anemia), 7-9.9 g/dl (moderate anemia) and <7 g/dl (severe anemia) (WHO, 2011). It is a global public health problem affecting approximately two billion people of the world-wide. The most common nutritional deficiency disorder in the world is anemia and iron deficiency is the most common cause of anemia (Lelissa *et al.*, 2015). The prevalence of anemia during pregnancy is alarmingly high having detrimental effects on maternal and child health. The important indicators of quality of health services in a country is maternal mortality and during pregnancy anemia is one of the important causes for maternal mortality (Nivedita and Fatima, 2016).

During pregnancy, there is significant increase in iron requirement over and above the non-pregnant state. Therefore, a high proportion of women become anemic during pregnancy. Anemia promote to establish risk factor for intrauterine growth retardation and subsequent low birth weight, preterm delivery, prenatal death (Mbule *et al.*, 2013). Globally, 41.8% pregnant women and close to one third of non-pregnant women (30.2%) are anemic. Anemia is considered as a severe public health problem when its prevalence among pregnant women is 40.0% or more (Okube *et al.*, 2016). The WHO estimated the prevalence of anemia in female of reproductive age was 17.5% - 40.5% (Mirzaie *et al.*, 2010). In South Asian countries, the incidence of anemia is highest in the world and even among the South Asian countries, WHO estimated that India has the highest prevalence of anemia. Due to anemia about half of the global maternal deaths occur in South Asian countries (Sinha *et al.*, 2012).

Nepal is a landlocked country between India and China having low human development indexes and also one of the least developed countries in the world (Maskey *et al.*, 2014). Over the past decade in Nepal, there is significant decline in infant, child and maternal mortality. The nutritional status of women's has improved with the proportion of underweight women of reproductive age decreasing from 26.7% in 2001 to 18.2% in 2011. Although these achievements, malnutrition rates, especially chronic undernutrition in Nepal remains among the highest in the world. There is another concern that 35% of all women and 39 % of adolescent girls are anemic (MoHP, 2013). Prevalence of anemia is associated with maternity status. Pregnant women are more likely to be anemic (48%) as compared to lactating (39%) and women who are neither pregnant nor lactating (33%). It has shown that anemia is more prevalent in rural areas and terai (36% and 42% respectively) than in urban areas and mountain or hill zone (28% and 27% respectively). The education level of women's does not have a significant impact on their likelihood of suffering from anemia (MoHP, 2012).

In Nepal, many studies had been done on anemia in pregnancy. A study conducted in Briatnagar area by Sinha *et al.* (2012) showed that the prevalence of maternal anemia was 47.25%. Shah and Gupta showed that the prevalence of anemia in adolescent girls in Dharan was 68.8% (Shah and Gupta, 2002). Another study showed that the iron deficiency was found among 20% of relatively healthy non-pregnant women aged 13-35 years (Chandyo *et al.*, 2007). In developing countries, women are always in a state of precarious iron balance during their reproductive years. The three major causes of maternal deaths in Nepal are haemorrhage, eclampsia and infections (Prakash *et al.*, 2015). Even though there is decreasing trend of prevalence of anemia, it still remain as a serious health problem in Nepal. The prevalence of anemia may vary from community to community and even within same region itself (Maskey *et al.*, 2014). The main aim of the present study was to find out the prevalence of anemia and its associated factors among pregnant women of Itahari sub-metropolitan city. This study may help for the great significance in pregnancy outcome and safe motherhood in national level.

1.2 Problem statement and justification

Pregnancy is a dynamic state consequent of the fact that normal fetal development needs the availability of essential nutrients to be continuously supplied to the growing fetus in spite of intermittent maternal food intake. An adult women has about 2000 mg iron in the body, 60-70% of which is present in erythrocytes, with the rest stored in the liver, spleen, and bone marrow. During pregnancy, about 1000 mg more is required, comprising 300 mg for the fetus and placenta, 500 mg for increased maternal haemoglobin, and 200 mg that compensates for excretion (Prakash *et al.*, 2015). Although the requirements of iron are reduced in the first trimester because of the absence of menstruation, they rise steadily thereafter from approximately 0.8 mg per day in the first month to approximately 10 mg per day during the last 6 weeks of pregnancy. Therefore, a high proportion of pregnant women become anemic (Mbule *et al.*, 2013). When there is not adequate monitoring and addressing of anemia in pregnant women, it can result in severe morbidity, mortality and reduces the resistance to blood loss. Anemic mothers are poor anaesthetic and operative risks because of low resistance to common infections and poor wound healing (Siteti *et al.*, 2014).

In Nepal, anemia is a serious public health problem. There are few studies have been done on anemia during pregnancy in eastern Nepal. Since this type of study has not been performed in Itahari sub-metropolitan city recently, this present study will play a vital role to improve the nutritional status of women and the quality of antenatal care in developing countries. The outcome of this study will help to enforce new strategies for the prevention of the problem as well as awareness regarding the life threatening complications. It will help to provide sufficient information about the socioeconomic factors, knowledge and attitude towards anemia and dietary pattern of the respondents. From this study, the interventions measure will be planned and improved based on available information regarding the magnitude and severity of anemia and also its associated risk factors in the geographic areas.

1.3 Purpose of the study

Anemia during pregnancy contributes to 20% of all maternal deaths and it increases the risks of foetal, neonatal and overall infant mortality. It affects more than a quarter of the world's population estimating that 48% of pregnant women worldwide are anemic (Okube *et al.*, 2016). Anemia is the second leading cause of maternal death in Asia accounting 12.8% independent of deaths due to postpartum haemorrhage. In developing countries, anemic pregnant women are prone to severe morbidity and mortality in developing countries. Consequences with milder form of anemia are "silent", without symptoms. Symptoms like fatigue, weakness, loss of normal colour in the skin and in the lips, dizziness and drowsiness may occur in its severe form (Khaskheli *et al.*, 2016). Studies conducted in Malaysia, Vietnam and Nepal found that increased risk of developing anemia is significantly associated with increased gestational age. The cause of anemia during pregnancy in developing countries is multifactorial and includes nutritional deficiencies of iron, folate and vitamin B_{12} and also parasitic infections such as hookworm and malaria (Alene and Dohe, 2014).

One third Nepalese women are suffering from anemia which is the significant cause of morbidity and mortality (MoHP, 2013).

Pregnancy is a period of a significant increase in iron requirement over and above the non-pregnant state. Pregnant women are at higher risk of anemia. Thus, it is important to control iron deficiency anemia and to have awareness programmes regarding anemia in national level. The present study will promote the situation of pregnant women encompassing the study area. It will be more helpful for further studies.

1.4 Objective of the study

1.4.1 General objective

The main objective of this study is to find out the prevalence of anemia among pregnant women and its associated factors (such as socio-demographic, economic, maternal, anthropometric measurement, knowledge, environmental and dietary habits) among pregnant women in Itahari sub-metropolitan city.

1.4.2 Specific objective

The specific objectives of the study are:

a. To estimate anemia based on blood haemoglobin level in pregnant women.
b. To assess the factors associated with anemia among pregnant women.

1.5 Research questions

a. What is the prevalence of anemia among pregnant women in Itahari sub-metropolitan city?
b. What are the factors associated with haemoglobin level of the participants?
c. Is there association between other factors such as (socio-demographic, economic, maternal, environmental, dietary habits, knowledge and anthropometric measurement) and anemia among pregnant women?

1.6 Significance of the study

The findings of the study will contribute to determine the prevalence of anemia and associated factors among pregnant women of Itahari sub-metropolitan city; to aware about the life threatening complications of anemia; to formulate a multipronged strategy to control anemia and to motivate antenatal care providers towards early detection and management of anemia in pregnancy.

1.7 Limitation of the study

Following are the limitations of this study:

a. Types of anemia such as sickle-cell anemia, iron deficiency anemia, etc was not assessed.
b. It may not explain the temporal relationship between the outcome variable and some explanatory variables due to its cross-sectional nature.

Part II

2. Literature review

2.1 Anemia definition

Anemia is defined as a condition in which the number of red blood cells or their oxygen-carrying capacity is insufficient to meet the body's physiologic needs which vary with a person's age, gender, residential elevation above sea level (altitude), smoking, and different stages of pregnancy (WHO, 2011). It occurs at all stages of the life cycle, but is more prevalent in pregnant women and young children. It has been shown to be a public health problem affecting low, middle and high income countries. It has a significant adverse health consequences, as well as adverse impacts on social and economic development (WHO, 2008). It may result from a number of causes, with the most significant contributor being iron deficiency. An estimated 50% of anemia in women worldwide is due to iron deficiency (WHO, 2015). Other important causes of anemia worldwide include infections, other nutritional deficiencies (especially folate and vitamin B_{12}, A and C) and genetic conditions (including sickle cell disease, thalassemia) (WHO, 2014).

Anemia is an indicator of both poor nutrition and poor health and when it is used with other measurements of iron status the haemoglobin concentration can provide information on the severity of iron deficiency (Chowdhury *et al.*, 2015). Anemia resulting from iron deficiency is the most common anemia in South Asia (UNICEF, 2002) which adversely affects cognitive and motor development, causes fatigue and low productivity and, when it occurs in pregnancy, may be associated with low birth weight and increased risk of maternal and perinatal mortality (WHO, 2015). Pregnancy is a period of significant increase in iron requirement over and above the non-pregnant state. The increased iron requirement is due to expansion of maternal red blood cell mass for increased oxygen transport, including transfer of iron, to both the growing fetus and the placental structures, and as a needed reserve for blood loss and lochia at parturition. Due to increased iron requirements, a high proportion of women become anemic during pregnancy (Mbule *et al.*, 2013).

Haemoglobin is a commonly used, well validated and widely accepted indicator for anemia. Mean haemoglobin is one useful way to present this indicator. However, anemia is also commonly presented based on cut-offs. The following cut-offs are used to classify anemia severity:

Table 2.1: Haemoglobin cut-off points to classify anemia severity

	Non-pregnant women of reproductive age 15-49 years	Pregnant women
Non-anemic	≥12 g/dL	≥11 g/dL
Mild anemia	10-11.9 g/dL	10-10.9 g/dL
Moderate anemia	7-9.9 g/dL	7-9.9 g/dL
Severe anemia	<7 g/dL	<7 g/dL

Source: (WHO, 2001)

2.2 Types of anemia

There are many different types of anemia and depending on the types, symptoms of anemia can be mild to severe and the duration of symptoms can lead to a chronic condition. The following is an overview on different types of anemia:

a. Aplastic anemia: It is a rare and serious disease. This type of anemia occurs when bone marrow fails to make enough blood cells (low blood counts) (Paquette and Young, 2008).

b. Hypochromic and Microcytic anemia: If there is an insufficiency of iron for the formation of haemoglobin, the red blood corpuscles are pale and small and the anemia is said to be hypochromic and microcytic (Srilakshmi, 2014).

c. Megaloblastic anemia: It is caused by the deficiency of vitamin B_{12}, folate or both. Both vitamin B_{12} and folate are essential for DNA synthesis. The deficiency of one or both results in failure of DNA synthesis resulting in abnormal cell proliferation which mainly affects haemopoietic tissues and gastrointestinal epithelial cells (Mathew and Aggarwal, 2012).

d. Pernicious anemia: It is a megaloblasatic macrocytic anemia resulting from failure of secretion of intrinsic factor by the stomach not related to total gastrectomy. In the absence of intrinsic factor, dietary vitamin B_{12} is not absorbed and this results in vitamin B_{12} deficiency (Mathew and Aggarwal, 2012).

e. Iron deficiency anemia: Iron is necessary for the formation of haemoglobin. Iron deficiency results in anemia which is the most common form of anemia throughout the world affecting mainly women in their reproductive year, infants and children. It is extremely common in both rural and urban areas in the tropics (Srilakshmi, 2014).

f. Sickle-cell anemia: It is the most important and widely prevalent type of haemoglobinopathy is due to the presence of sickle haemoglobin (HbS) in the red blood cells. The red blood cells with HbS develop 'sickling' when they are exposed to low oxygen tension. It has the highest frequency in black race and in Central Africa where *falciparum* malaria is endemic (Mohan, 2005).

g. Thalassemia: The thalassemia's are a diverse group of hereditary disorders in which there is reduced rate of synthesis of one or more of the globin polypeptide chains (Mohan, 2005).

2.3 Causes of anemia

Anemia during pregnancy is a major clinical health problems in many developing countries. Most of the anemia is due to deficiency of essential nutrients which maintain haemoglobin level like iron, folic acid and vitamin B_{12}, proteins, amino acids, Vitamins A and C, and others vitamins of B-complex group such as niacin and pantothenic acid (Kumar, 2014). Following are the common causes of anemia:

2.3.1 Nutritional deficiencies

Many studies shows that in most of the developing countries like Nepal, anemia is caused due to dietary deficiency of micronutrients. Here, we discuss about iron deficiency, protein deficiency, folic acid deficiency and vitamin B_{12} deficiency.

2.3.1.1 Iron deficiency

Iron is needed to support the increased maternal red blood cell mass, and involved in the growth of the fetus and the development of the fetal brain. A higher amount of iron is needed during the last stage of pregnancy to store iron within the body of the fetus. Thus, a high proportion of women are anemic during pregnancy which can lead to premature birth or low birth weight of the infant (Park *et al.*, 2012). Deficiency of iron may occur as a result of the following:

a. Inadequate iron intake: A few foods like greens and processed foods like rice flakes and dates are rich sources of iron. People who do not include these foods in the diet may suffer from anemia. Availability of iron from plant sources is not as good as haem iron (iron present in foods of animal origin). The average cereal-legume based diets is consumed in most developing countries. The availability of iron is very poor in such diets. Only 3-5% of dietary iron is absorbed in normal apparently healthy individual (Srilakshmi, 2014).

b. Increased requirements: During period of accelerated demand like in infancy (rapidly expanding blood volume), adolescences (rapid growth and onset of menses in girls) and pregnancy and lactation can result in anemia. Losses of iron may occur due to excessive sweating in tropical climate (Srilakshmi, 2014).

c. Inadequate absorption of iron: Excessive amounts of phytates and phosphates in the diet and excess consumption of tea can decrease the absorption of iron (Srilakshmi, 2014).

d. Blood losses: Excessive loss of blood during menstruation and childbirth can cause anemia. In rural areas, post-partum haemorrhage on account of poor obstetric spaced pregnancies deplete iron stores with each successive pregnancy. This is reflected in the high incidence of anemia with higher parity (Srilakshmi, 2014).

2.3.1.1.1 Types of dietary iron

There are two distinct types of dietary iron. They are haem and non-haem iron. Haem iron is a constituent of haemoglobin and myoglobin and therefore present in meat, fish and poultry, as well as in blood products whereas the non-haem iron, is a more important source; it is found to varying degrees in all foods of plant origin (WHO, 1989).

2.3.1.1.2 Sources of iron

Organ meats (Liver, heart, kidney) are the rich sources of iron whereas leafy vegetables, pulses, cereals, fish, apples, dried fruits and molasses are the good sources of iron. Milk, wheat, polished rice and potatoes are the poor sources of iron (Manjeshwar, 2009).

2.3.1.1.3 Absorption, transport and storage of iron

Iron is mainly absorbed in the stomach and duodenum. In normal people, about 10% of dietary iron is usually absorbed. Iron metabolism is unique because the iron homeostasis is maintained at the level of absorption and not at the level of excretion. Iron is probably the only nutrient regulated in this manner. Amount of iron absorbed depends on iron status of the body. During iron deficiency conditions, more iron is absorbed and during iron overload conditions, iron absorption decreases. This is called mucosal block theory (Manjeshwar, 2009).

Iron is mostly found in the foods in ferric form (Fe^{3+}), bound to proteins or organic acids. In the acid medium provided by gastric HCl, the Fe^{3+} is released from foods. Reducing substances such as ascorbic acid (vitamin C) and cysteine convert ferric iron (Fe^{3+}) to ferrous form (Fe^{2+}). Iron in the ferrous form is soluble and readily absorbed (Satyanarayana and Chakrapani, 2012). Ferritin and Hemosiderin are the storage proteins of iron. Iron is stored mainly in liver (96%), spleen, bone marrow in the form of ferritin (Also in mucosal cells where ferritin act as a temporarily). Iron storage protein in liver and spleen, mainly in iron excess conditions. Hemosiderin accumulation is the sign of iron overload (Manjeshwar, 2009).

2.3.1.1.4 Factors affecting iron absorption

A diet with high phosphate content decreases iron absorption while low phosphate promotes. Phytate (found in cereals) and oxalate (found in leafy vegetables) interfere with iron absorption. Small peptides and amino acids favour iron uptake. Acidity, ascorbic acid and cysteine promote iron absorption. In iron deficiency anemia, iron absorption is increased to 2-10 times that of normal (Satyanarayana and Chakrapani, 2012).

2.3.1.1.5 Treatment of iron deficiency anemia

a. Oral iron therapy

(i) Iron tablets

Iron tablets contain a percentage of elemental iron that varies with the molecular weight of the iron compounds. Uncoated (compressed) tablets and sugar-coated tablets are the least expensive formulations and disintegrate well in the stomach. However, they become oxidized over time and hence less effective, especially in humid climates (WHO, 1989).

(ii) Combinations with other nutrients

During pregnancy, women tend to become deficient in both iron and folate. It is therefore desirable to combine both haematinics in one tablet. The addition of folate (250 µg) to ferrous sulphate (60 mg of iron) increases the tablet's cost by an insignificant amount if at all (WHO, 1989).

(iii) Dosage

For pregnant women the daily administration of folate (500 µg) with iron (120 mg) is beneficial since anemia during pregnancy is usually caused by a deficiency of both nutrients. A suitable combination tablet, to be taken twice a day, would contain 250 µg of folate and 60mg of iron (WHO, 1989).

(iv) Side-effects

The oral administration of iron can cause gastrointestinal side-effects in some individuals such as epigastric discomfort, nausea, vomiting, constipation, and diarrhoea. The frequency of these side effects is directly related to the dose of iron. It is independent of the specific iron compound used. In addition, iron consumed with a meal is better tolerated than when it is taken on an empty stomach, although the amount of iron absorbed is reduced (WHO, 1989).

b. Parenteral iron therapy

The parenteral route is indicated only when oral administration causes severe vomiting that cannot be stopped by lowering the dose of iron, or in cases of persistent non-compliance. The most commonly used preparation for intramuscular or intravenous administration is Imferon R (iron dextran). The advantage of the intravenous method is that the complete iron requirement can be supplied in a single dose. This technique, known as total dose infusion, has been used especially in obstetric practice where it solves the problem of non-compliance and permits the increased requirement during pregnancy to be met in full. The recommended intravenous dose for adults (including pregnant women) is 500 mg of iron in 10 ml of saline solution given over a period of 10 minutes following a test dose of 1-2 drops. Intravenous infusion must be done only in a hospital. The recommended intramuscular dose is 100 mg of iron in 2 ml of saline solution. Intramuscular administration should be used only when there are no adequate facilities available for intravenous administration (WHO, 1989).

2.3.1.1.6 Prevention of iron deficiency anemia

The four basic approaches to the prevention of iron deficiency anemia are discussed below:

a. Dietary modification

Dietary modification activities require not only information on real food availability by groups at risk but also on dietary patterns, the bioavailability of iron in local diets and cultural aspects and local preferences. Information, education and communication at all levels play key roles in promoting a healthy diet (WHO, 2001).

(i) Local dietary factors

Local dietary factors influencing the bioavailability of dietary iron, including both enhancers and inhibitors, should be identified. Common practices in food selection and preparation (including meal composition and preparation with respect to these factors), iron-rich foods available throughout the year and staples – and their interaction – should be assessed. Appropriate dietary modifications activities should seek to: increase intake of vitamin C – rich foods and others foods that promote iron absorption (e.g. fermented food products); increase, where possible, intakes of locally available haem-iron food products (e.g. meat, liver, etc.); and reduce as much as possible consumption of iron absorption inhibitors (e.g. phytates and iron-binding phenolic compounds) (WHO, 2001).

(ii) Behavioural aspects

Modifying dietary patterns that are usually culturally ingrained and may have existed for hundreds of years is not so easily achievable. Beliefs, preferences, restrictions, taboos, and cultural issues governing food consumption should be understood and appreciated. An approach is needed that is solidly based on formative research, messages that are targeted to specific groups, and a good understanding of the possibilities and limits of behavioural objectives (WHO, 2001).

b. Fortification

Iron fortification can be an effective way of preventing iron deficiency, and does not necessarily require cooperation of the individual. Recent technical developments help to overcome undesirable changes in fortified food and success with salt iodization. This development is especially significant in reaching urban populations. Prerequisites for successful fortification include a suitable food vehicle; a bioavailable iron source compatible with vehicle; careful market research; preparation of appropriate standards and regulations; and long-term commitment (WHO, 2001).

c. Iron supplementation

Iron supplementation is the most common strategy currently used to control iron deficiency in developing countries. This is likely to remain the case until either significant improvements are made in the diets of entire populations or food fortification is achieved. Supplementation programmes, especially for pregnant women, operate in developed as well as in developing countries. The average woman of reproductive age needs about 350-500 mg additional iron to maintain iron balance during pregnancy. All pregnant women (universal supplementation) should be given 60 mg iron and 400 µg folic acid daily during the second half of pregnancy to control iron deficiency anemia. Combination with other micronutrients, folic acid should always be given with iron during pregnancy. In addition, folic acid supplementation prior to pregnancy will also have an impact on maternal folic acid status, which is expected to reduce the risk of neural tube defects (WHO, 2001).

d. Control of viral, bacterial and parasitic infections

Effective, timely curative care could diminish the adverse nutritional consequences of viral and bacterial disease. When it comes to parasitic infestation, it has been established beyond dispute that hookworm (*Ancylostoma* and *Necator)* and *Schistosoma* play a role in the etiology of anemia by causing chronic blood loss. From both a health and a nutritional standpoint it is undesirable to harbour parasites, and recommendations are frequently made that deworming should be done routinely as a part of primary health care (WHO, 2001).

2.3.1.2 Folic acid deficiency

Most cases of megaloblastic anemia are due to folate deficiency in tropical climate associated with malnutrition, infection and pregnancy and is common in the age group 20-30 years (Srilakshmi, 2014). It may occur as a result of the following:

a. Low absorption: This anemia in babies is more frequent in those born to mothers who also have folic acid deficiency. Folate absorption is impaired in pregnancy (Srilakshmi, 2014).

b. Poor dietary intake: It is common among poor vegetarians. This is due to poor intake of milk, fresh fruits and vegetables (Srilakshmi, 2014).

c. Increased requirements: Increased requirements due to pregnancy are believed to be the most frequent cases. When there is cell proliferation in haemolysis there is folic acid deficiency (Srilakshmi, 2014).

d. Infestation and infection: Malarial infection may play a part in pathogenesis of megaloblastic anemia. Chronic infections and parasitic infestation may impair absorption of folic acid (Srilakshmi, 2014).

2.3.1.3 Vitamin B_{12} deficiency

Nutritional vitamin B_{12} deficiency is not very common, even in the populations where intake of it is far below the daily requirement of 0.5 µg - 1 µg. It takes at least 3 years to appear as vitamin B_{12} is stored in the liver. It may occur as a result of the following:

a. Increased requirements: During infancy and pregnancy there is increased requirements of vitamin B_{12} as it is essential for nucleic acid synthesis (Srilakshmi, 2014).

b. Inadequate ingestion: A poor diet lacking in microorganisms and animal foods can lead to vitamin B_{12} deficiency. Vegans are susceptible to it. Chronic alcoholism, poverty, religious taboos and dietary fads can also cause vitamin B_{12} deficiency (Srilakshmi, 2014).

c. Inadequate utilisation: This is due to the presence of vitamin B_{12} antagonists (Srilakshmi, 2014).

2.3.2 Underlying causes

The direct causes of anemia described in the preceding paragraphs are compounded by a variety of indirect factors, primarily related to socioeconomic status. These inadequate dietary diversity, which prevents consumption of a nutritionally adequate diet, BMI, MUAC, dietary habits, lack of knowledge about anemia and its causes and prevention; poor hygiene and sanitation; and lack of access to health services.

A study conducted in Kenya by Okube *et al.* (2016) shows that pregnant women with MUAC of less than 23 cm had higher prevalence of anemia. Similarly, other studies conducted in Pakistan (Baig-Ansari *et al.*, 2008) and Turkey (Karaoglu *et al.*, 2010) revealed that the consumption of fruit two or more times per week is associated with a decreased risk of anemia. Viveki *et al.* (2012) found that increased number of pregnancies and deliveries is positively associated with the risk of developing anemia. Kamruzzaman *et al.* (2015) showed that the undernourished women (BMI<18.5) are more likely to have anemia than women whose BMI is normal, or overweight or obese.

2.4 Signs and symptoms of anemia

The signs and symptoms of anemia vary depending on the cause of anemia which may include: fatigue, weakness, pale or yellowish skin, dizziness, headache, chest pain, shortness of breath and cold hands and feet (MayoClinic, 2016).

2.5 Consequences of anemia

During normal pregnancy the percentage of non-haem iron absorbed from food increases from 7% at 12 week of gestation to 36% at 24 week and 66% at 36 week. These changes enable the healthy pregnant woman to cope with extra demands of pregnancy without becoming anemic, but only if there is adequate iron in her diet (Steer, 2000). The major consequences of anemia in pregnancy are maternal mortality and morbidity as well as low birth weight leading to increased infant mortality (Allen, 2000). It is a known risk factor for many maternal and fetal complications. Poor weight gain, PIH, preterm labors, accidental haemorrhage, eclampsia, premature rupture of membrane (PROM) are the maternal risks during antenatal period. Fetal and neonatal risk include prematurity, low birth weight, fetal distress and neonatal anemia due to poor reserve. Anemia in infants led to have higher prevalence of failure to thrive, poorer intellectual development milestones and higher rates of morbidities and neonatal mortalities as compared to those who are non-anemic (Noronha *et al.*, 2012).

2.6 Nutritional requirements for pregnant women

Pregnancy is a physiologically and nutritionally a highly demanding period. To meet the requirements of the fetus extra food is required during this period. A woman prepares herself to meet the nutritional demands by increasing her own body fat deposits during pregnancy. The requirements of additional foods help to improve weight gain in pregnancy (10-12 kg) and birth weight of infants i.e. about 3 kg (NIN, 2011). During pregnancy some physiological changes occur such as expansion of blood volume; gradual increment of the subcutaneous fat in the abdomen, back and upper thigh; decreased ability to taste saltiness; oedema in the legs and ankles and increment in progesterone and oestrogen levels (Srilakshmi, 2014).

Women having low body weight and poor nutritional status prior to pregnancy results low birth weight infants, premature spontaneous rupture of membranes, infection and anemia. A pre-pregnancy weights of less than 40 kg serves as a useful cut-off to predict women who will deliver low birth weight babies and who are small for gestational age (SGA). Maternal nutrition plays a role in certain types of fetal malformations or spontaneous abortions. Some modifications must be made before pregnancy begins because these abnormalities occur so early in pregnancy. In diabetes, incidence of congenital defects can be reduced almost to normal by bringing the blood glucose under good control prior to pregnancy. Overweight women are more likely to have fetal death, diabetes, hypertensive disorders and labor abnormalities. Thus, a woman should achieve a body mass within 90-120 per cent of ideal weight prior to conception. There is increased in nutritional requirements depending on the nature of metabolic changes of pregnancy and the nutrition reserves of the mother (Srilakshmi, 2014). The RDA of the pregnant mother suggested by ICMR is given in table 2.2.

Table 2.2: ICMR Recommended Dietary Allowances of pregnant women-2010

Nutrient	Normal adult woman	Pregnant woman (for second and third trimester)
Energy (Kcals)		
Sedentary work	1900	+350
Moderate work	2230	+350
Heavy work	2850	+350
Protein (g)	55	82.2
Visible fat (g)		
Sedentary work	20	
Moderate work	25	30
Heavy work	30	
Calcium (mg)	600	1200
Iron (mg)	21	35
Vitamin A (µg)		
Retinol or	600	800
B-carotene	4800	6400

Thiamine (mg)		
Sedentary work	1.0	
Moderate work	1.1	+0.2
Heavy work	1.4	
Riboflavin (mg)		
Sedentary work	1.1	
Moderate work	1.3	+0.3
Heavy work	1.7	
Niacin equivalent (µg)		
Sedentary work	12	
Moderate work	14	+2
Heavy work	16	
Pyridoxine (mg)	2.0	2.5
Ascorbic acid (mg)	40	60
Dietary folate (µg)	200	500
Vitamin B_{12} (µg)	1.0	1.2
Magnesium (mg)	310	310
Zinc (mg)	10	12

Source: (Srilakshmi, 2014)

Energy requirement during pregnancy comprises body weight gain consisting of protein, fat and water. The daily diet of a pregnant woman should contain an additional 350 calories. When the supply of calories are inadequate the fat may be used up to provide the high energy needs of the rapidly growing foetus and to spare the proteins for tissue growth. This results in increase in the ketones in the urine during the first trimester of pregnancy (Srilakshmi, 2014). Vitamin B_{12} levels often falls in the maternal circulation and may be twice as high in the infant circulation as in the mother; correspondingly, the allowance during pregnancy has been substantially raised (Robinson, 1972). Folic acid, taken throughout the pregnancy reduces the risk of congenital malformations and increase birth weight. Similarly, iron helps to meet the high demand of erythropoiesis (RBC formation) and calcium for proper formation of bones and teeth of the offspring and also to prevent from osteoporosis in the mother. Iodine intake ensures proper mental health of growing fetus and infant (NIN, 2011).

2.7 Food requirements for pregnant women

The pregnant woman should eat a wide variety of foods to make sure that her own nutritional needs as well as those of her growing foetus are met. There is no particular need to modify the usual dietary pattern. However, the quantity and frequency of usage of the different foods should be increased (NIN, 2011). For a pregnant woman whose diet has conformed to the 'Basic Five food' pattern, it is merely a matter of emphasising the more nutrient dense foods within each of the five food groups. Nutrient dense foods are those that give the most nutrients per calorie consumed. A diet containing 3 cups of milk or its equivalent, 2 servings of meat, fish, poultry, eggs or a complete source of protein, a dark green or yellow vegetables and a generous servings of citrus fruits will provide a foundation for a nutritionally adequate diet. Fatty rich foods, fried foods, excessive seasoning, strongly flavoured vegetables may be restricted in case of nausea and gastric distress (Srilakshmi, 2014). Bioavailability of iron can be improved by using fermented and sprouted grams. She should choose foods rich in fibre (around 25 g/ 1000 kcal) like whole grain cereals, pulses and vegetables, to avoid constipation. Plenty of fluids including 8-12 glasses of water per day should be intake (NIN, 2011).

2.8 Assessing anemia, BMI and MUAC

2.8.1 Anemia

The prevalence of anemia in a population is best determined by using a reliable method of measuring haemoglobin concentration. The determination of the prevalence of anemia in a population is relatively simple and inexpensive as compared with the cost and difficulty of biochemically assessing the prevalence of iodine deficiency and vitamin A deficiency. The only methods generally recommended for use in surveys to determine the population prevalence of anemia by haemoglobinmetry are the Cyanmethemoglobin method in the laboratory and the HemoCue system. The Cyanmethemoglobin method for determining haemoglobin concentration is the best laboratory method for the quantitative determination of haemoglobin. It serves as a reference for comparison and standardization of other methods. A fixed quantity of blood is diluted with a reagent (Drakbins solution) and haemoglobin concentration is determined after a fixed time interval in an accurate, well-calibrated photometer (WHO, 2001).

2.8.2 BMI

Body mass indices are generally power-type indices which express weight relative to a power function of height, or height relative to some power function of weight. $Quetelet's\ index = {weight\ in\ kg}\Big/{height\ in\ m^2}$

Many investigators consider Quetlet's index to be the best body mass index for most adult population groups, and it is the least biased by height and easily calculated. Thus to calculate BMI of an individual, their weight and height should be measured. For assessing weight of an individual, the electronic scale which are both accurate and light in weight should be placed on a flat surface and should be zero and then calibrated with standard weights. The subject was asked to stand unassisted in the centre of the platform and to look straight ahead standing relaxed. The subject should wear light underclothing. Then the measurement was recorded (Gibson, 1993). Similarly, for assessing height, a stadiometer can be used. Calibration should be checked occasionally with an object of known length. Then after, the subjects was asked to stand on a horizontal plane without shoes or socks, heels together and back straight. A horizontal plane is lowered firmly unto the head while the subject inhales and reading taken at observer's eye level (WHO, 1979). The cut-off points of BMI according to WHO guidelines is given below:

Table 2.3: The International classification of adult underweight, overweight and obesity according to BMI

Classification	BMI (kg/m2)
	Principal cut-off points
Underweight	<18.50
Normal	18.50-24.99
Overweight	≥25.00
Obese	≥30.00

Source: (WHO, 2000)

2.8.3 MUAC

MUAC is the circumference of the mid-point of the upper arm. MUAC is used to assess the nutritional status of pregnant and post-partum women (within 6 months of delivery) and clients whose weight and height cannot be measured (e.g. if they are too ill to stand or have bilateral pitting oedema). It can also be used to screen for undernutrition at the community level (MoH, 2014). The arm contains subcutaneous fat and muscle; a decrease in MUAC may therefore reflect either a reduction in muscle mass, a reduction in subcutaneous tissue or both. In less industrialized countries, where the amount of subcutaneous fat is frequently small, changes in MUAC tend to parallel changes in muscle mass and hence are particularly useful in the diagnosis of protein-energy malnutrition or starvation. Changes in MUAC measurements can also be used to monitor progress during nutritional therapy (Gibson, 1993). For assessing MUAC of an individual, the subject was asked to stand with his left arm at right angles. With the observer standing behind the subject, a mark was made vertical to the olecranon process and mid-way between the tip of the olecranon and the acromion process. Then, the arm circumference was measured at this point with the arm hanging relaxed (WHO, 1979). The cut-off points of MUAC according to NCST guideline for adolescents and adults is given in table 2.4:

Table 2.4: Classifying nutritional status for pregnant and lactating women (up to 6 months post-partum) based on MUAC

MUAC	Nutritional status
220-299 mm	Normal
190-219 mm	Moderate undernutrition
<190 mm	Severe undernutrition
≥ 300 mm	Overweight and Obesity

Source:(MoH, 2014)

2.9 Anemia prevalence from previous studies

2.9.1 Anemia prevalence from world scenario

Anemia is defined as a decreased concentration of blood haemoglobin and is one of the most common nutritional deficiency diseases observed globally (WHO, 2008). Anemia is global health problem affecting 1.62 billion people globally (McLean *et al.*, 2009). For the year 2011, it is estimated that roughly 43% of children, 38% of pregnant women and 29%of non-pregnant women have anemia globally (WHO, 2015). The prevalence of anemia among pregnant women was lowest in the Americas (24.1%) and Europe (25.1%) and highest in the Africa (57.1%) and South-East Asia (48.2%) respectively (WHO, 2008).

Iron deficiency anemia affects the development of the nation by decreasing the cognitive development of children and productivity of adults (Viveki *et al.*, 2012). Mortality rate was higher in the women with very low haemoglobin level and with associated co-morbidities such as postpartum haemorrhage, renal failure and disseminated intravascular coagulation (Sanghvi *et al.*, 2010). The prevalence of haemoglobin values below the population-specific haemoglobin threshold was used to classify countries by the level of the public health problem (WHO, 2001) as shown in table 2.5:

Table 2.5: Classification of anemia as a problem of public health significance.

Prevalence of anemia (%)	Category of public health significance
≤4.9	No public health problem
5.0-19.9	Mild public health problem
20.0-39.9	Moderate public health problem
≥40.0	Severe public health problem

Source: (WHO, 2001)

Shamah-Levy *et al.* (2013) had shown the national prevalence of anemia in reproductive age Mexican women in 2012 was 11.6% (non-pregnant) and 17.9% (pregnant) respectively. Similarly, the pregnant women of non-Northern European are at high risk of a low haemoglobin level for all cut-off values; they have a higher chance of becoming anemic in pregnancy than women of Northern European descent (Jans *et al.*, 2009). The study conducted in Germany by Bergmann *et al.* (2002) showed that 40.7% of pregnant women were anemic and their low educational level and young maternal age were significant risk factor for iron deficiency. Karaoglu *et al.* (2010) reported 27.1% in pregnant women of East Anatolian province, Turkey were anemic. Moreover, they revealed that having four or more living children, having a low family income and being at the third trimester were independent predictors of anemia in pregnancy. They found significant association between anemia and soil eating (pica). Also, this study suggested consumption of fruit two or more times per week is associated with a decreased risk of anemia.

The Global Burden of Disease project estimated that the major cause of anemia among South Asia are iron deficiency anemia, sickle cell anemia, thalassemia and malaria (Kassebaum *et al.*, 2014). Sub-Saharan Africa is the most affected region, with anemia prevalence among pregnant women estimated to be 17.2 million, which corresponds to approximately 30% of total global cases (Bilimale *et al.*, 2010). The study conducted by Gebre and Mulugeta (2015) found anemia as a moderate public health problem in the study area. They revealed that residence, educational status, iron supplementation during pregnancy, and meal frequency of the woman per day were statistically significant independent predictors for maternal anemia. Similarly, study conducted at Pumwani Maternity Hospital, Kenya revealed that the prevalence of anemia among the pregnant women was 57% and also found that advanced age, employment and MUAC less than 23 cm were significantly and independently associated with anemia during pregnancy (Okube *et al.*, 2016). The prevalence of anemia among pregnant women of Mekelle town was found to be 19.7% (mild public health problem). Parity, meal frequency, dietary diversity and meat consumption were significantly and independently affect anemia of pregnant women (Abriha *et al.*, 2014).

The prevalence of anemia among pregnant women in an urban area of Eastern Ethiopia was found to be 56.8%. The increased number of pregnancies and deliveries is positively associated with the risk of developing anemia. They concluded that age of current pregnancy (trimester) and wealth quintile significantly associated with anemia (Alene and Dohe, 2014). Bekele *et al.* (2016) reported that the prevalence of anemia among pregnant women attending ANC in government health institutions of Arba Minch town was 32.8%. They also revealed that monthly income, family size and birth interval significantly associated with anemia. A study done in rural Uganda found that the prevalence of anemia among pregnant women was 63.1%. It indicates anemia as a severe public health problem. There was a little awareness and functional knowledge about anemia among those pregnant women. Women from households without functional radio were 2.07 times more likely to be anemic compared with women from households where there was a functional radio (Mbule *et al.*, 2013).

From the study conducted by Abriha *et al.* (2014) shows that the pregnant women with lower level of dietary diversity score were around 13 times more likely to develop anemia than those with higher dietary diversity score. Consumption of meat showed significant association with anemia in pregnant women. Pregnant women with habit of eating meat once per week were 2.2 times at higher risk of developing anemia than pregnant women who ate meat more than twice per week. The increased concentration of haemoglobin is with the fact that red meat is an important source of haem iron. Similarly, pregnant women who had meal frequency less than two times per day were 3.9 times at higher risk of developing anemia than those whose meal frequency was more than three times per day. This may be due to the fact that pregnancy is a special period with increased energy and nutrient requirement which can be fulfilled with increased meal frequency.

A study by Xing *et al.* (2009) revealed that an average of 63% of Tibet mothers were anemic and that the gestational age, ethnicity, residence and low income of Tibetans amounted significantly with anemia. Chotnopparatpattara *et al.* (2003) reported that the prevalence of anemia in pregnant women who first attended the prenatal visit was 19.2% (251 cases) among 1,304 pregnant women in Bangkok. The prevalence of anemia in pregnant women was 90.5% in Urban Pakistan (Baig-Ansari *et al.*, 2008) and 89.6% in northern India (Bora *et al.*, 2014). It may be due to high iron demand during pregnancy. Similarly, a study conducted in Aurangabad city, India by Lokare *et al.* (2012) concluded that the percentage of anemia was 97.87% among the pregnant women whose husband are illiterate and also a high prevalence of anemia was observed among pregnant Hindu women (94.3%) as compared with Muslim women (84.9%) and Buddhist women (82.2%). The prevalence of moderate anemia (54.5%) was high in comparison to other degrees of anemia [mild anemia (24.7%) and severe anemia (7.9%)]. In China, the study conducted by Ma *et al.* (2004) concluded that anemia or iron-deficiency anemia in pregnant women may be associated with multiple vitamin deficiencies, especially ascorbic acid, retinol and folic in the last trimester. They found that the subjects with iron-deficiency anemia had higher rates of vitamin C, folate and vitamin B_{12} deficiencies than those in the non-anemic subjects, and especially in the deficient rates of ascorbic acid and folate in the anemia group, which reached 64.04% and 22.70% respectively. Also, they suggested that anemic pregnant women in China should be supplemented with iron and multiple vitamins simultaneously.

Mirzaie *et al.* (2010) found that among 2213 pregnant women only 104 (4.7%) women were anemic in Kerman, Iran. Out of which 4.8% had severe anemia, 15.4% had moderate anemia and 79.8% had mild anemia. The frequency of anemia were 5%, 3.4% and 5.7% in the first, second and third trimester, respectively. Also, the prevalence of anemia was significantly higher in smokers and opium users. Iron deficiency anemia underlies 115,000 maternal deaths per year. In Asia, anemia is the second highest cause of maternal mortality. The risk of death in pregnant women increase even mild and moderate anemia. Iron-folic acid supplementation of pregnant women increases haemoglobin by 1.17 g/dl in developed countries and 1.13g/dl in developing countries (Sanghvi *et al.*, 2010). A study done in Central India by Mahashabde *et al.* (2014) revealed that the adverse consequences of maternal anemia may affect not only the neonate and infant but also increase the risk of non-communicable diseases, when the child grows into an adult and the risk of low birth weight in the next generation.

The work of Lee *et al.* (2006) on Korean pregnant women concluded that a substantial proportion of Korean pregnant women were at risk of anemia. Low maternal haemoglobin was associated with preterm delivery and low birth and height. This result suggested that maternal haemoglobin level was a good predictor for the prognosis of pregnancy outcomes. Also they found that the high prevalence of anemia (30.2%) among 248 pregnant women was probably due to low iron intake and poor dietary habits rather than food insecurity or disease. The assessment of knowledge among pregnant women at Sri Manakula Vinayagar medical college hospital, Puducherry, India reported that only 39.87% of the participants were aware of and understood the terms anemia. Only 44.62% of the participants were aware of their haemoglobin level in the current pregnancy. Knowledge about iron rich foods was poor. At least $1/5^{th}$ of the participants have not received educational information regarding anemia from any source (Nivedita and Fatima, 2016). A study conducted in Bangladesh by Kamruzzaman *et al.* (2015) revealed that the women living in rural areas, those with no education, and women in poor household have significantly higher rates of anemia. Others variables associated with anemia are being non-Muslim, being undernourished (BMI<18.5) and being aged 30-49.

Table 2.6: Prevalence of anemia among pregnant women aged 15-49 years in 2011

Country	Prevalence of anemia (%)
Afghanistan	44
Australia	25
Bangladesh	48
Brazil	32
Bhutan	46
Cambodia	51
Canada	23
China	22

Egypt	30
Germany	25
Haiti	48
India	54
Italy	26
Japan	31
Mexico	21
Nepal	44
Pakistan	50
Singapore	28
Sri Lanka	25
Switzerland	26
Thailand	30
Turkey	28
USA (the)	17
Zimbabwe	34

Source: (WHO, 2015)

2.9.2 Anemia prevalence from national scenario

Anemia has been estimated that more than one third of the world's women are anemic. The majority of this burden occurs in developing countries. It is a common health problem among the women of 18-45 years of age (WHO, 1992). The epidemiology of anemia varies among different regions due to different socio-economic and other influencing factors (Bentley and Griffiths, 2003). Anemia is caused due to multiple factors but iron deficiency account for at least 50% cause of nutritional anemia worldwide. Nepal had the highest prevalence of anemia among the women of reproductive age (WHO, 2008). The prevalence of anemia is associated with maternity status. Haemorrhage, eclampsia and infections are being the three major causes of maternal deaths in Nepal (Sinha *et al.*, 2012). According to MoHP (2012) pregnant women are more likely to be anemic (48%) than women who are breastfeeding (39%) and women who are neither pregnant nor breastfeeding (33%). This could be due to the high demand for iron and folic acid during pregnancy. Women in the Mid-western terai and Eastern terai sub-regions are more likely to be anemic (49% and 45% respectively) than women in the Central mountain and Central hill sub-regions (19% and 20% respectively).

The study conducted by Maskey *et al.* (2014) shows that out of 249 pregnant women, 46.6% were anemic The majority of the women were hindu (81.9%); more than 60% of women were belonged to low socio-economic status and also factors like level of education, age at marriage, poor knowledge about anemia, women having low body mass index and low socio-economic status were significantly associated with anemia. A hospital based retrospective study done by Marahatta (2007) in Nepal Medical College Teaching Hospital revealed that out of 368 anemic mother only 48 (13.0%) women were less than 19 years of age, majority (84.8%) of women were in the age group of 20-35 years and only 8 women (2.2%) were more than 36 years old. Singh *et al.* (2013) reported that the prevalence of anemia was higher in pregnant women at the second trimester (51.1%) and at the age group of 20-35 years (62.79%). Bondevik *et al.* (2000) conducted a hospital based study in the capital of Nepal found that the prevalence of anemia was high (62.2%) out of which 3.6% with severe anemia. They also concluded that the ethnic groups Lama/Sherpa/Tamang, women married to industrial workers or illiterate men, women of short height, teenagers and farmers were at high risk of anemia. Also they revealed that the risk of anemia increased with gestation. Those women who had higher education, work within the service professions and high body mass index were found to be at low risk of anemia.

A recent study done by Hussein *et al.* (2011) revealed that there exists relationship between maternal mortality and anemia. Also they found that the prevalence of moderate to severe level of anemia explaining 38% of variation in the maternal mortality ratio and 16.3% of variation in the maternal mortality rate in Nepalese population. A study conducted at Janaki Medical College Teaching Hospital by Prakash *et al.* (2015) found that the incidence of anemia in pregnant women was 16.5%, of which moderate anemia was followed by mild anemia. They also concluded that there was no significant relationship between the incidence of anemia and the women's age, numbers of family members, educational level of the women and smoking status of husband. Singh *et al.* (2013) showed that at western part of Nepal, the prevalence of maternal anemia was 41.02%. The majority of the anemic women observed were mildly (67.14%) anemic, whereas 28.57% were moderately and 4.29% were severely anemic.

The work of Makhoul *et al.* (2012) on rural Nepali pregnant women reported that the prevalence of severe anemia did not differ significantly by intake of haem, non-haem and total iron, phytates and tea. Intake of iron supplements was protective against developing severe anemia. Also, they concluded that hookworm infection, lack of iron supplement intake and a diet deficient in heme iron were associated with increased risk of severe anemia and iron deficiency. Another study conducted by Bhandari *et al.* (2016) found that the improper dietary intake pattern in women of reproductive age in Nepal had resulted in the deficiency of essential nutrients. The women who were unemployed and worked in were more likely to be anemic than those who were doing manual work. This could be due to the reason that employment generates income and women are likely to consume iron rich foods. The majority of women in Mountain consumed pulses/legumes thrice a week where as in Terai, majority of women consumed vegetables thrice a week. The women having formal education were 1.4 times more likely to be anemic than the women having informal education and illiterate women. The pregnant women were five times more likely to be anemic than non-pregnant women. Surprisingly, the women who were involved in agriculture were also anemic.

Sinha *et al.* (2012) concluded that in pregnancy anemia is more severe because of increased demand and decrease in intake either due to nausea or a decrease in appetite or lack of knowledge, chronic disease or due to poverty. The study conducted by Ghimire and Ghimire (2013) reported that maternal anemia is significantly associated with maternal and fetal complication. They also revealed that the burden of anemia in pregnant women is still high in eastern region of Nepal.

Table 2.7: Prevalence of anemia among women in Nepal in 2006 and 2011 (NDHS 2006 and 2011)

	Prevalence of anemia (%)	
	2006	2011
Pregnant women	42.4	47.6
Lactating women	40.3	38.9
Non-pregnant women	28.5	33.0
Adolescent girls	39.0	38.5

Source: (MoHP, 2013)

Part III

3. Materials and Methods

3.1 Research design

A hospital based cross-sectional study was conducted from September 2016 to February 2017 in Itahari sub-metropolitan city to assess the prevalence of anemia among pregnant women and its associated factors using semi-structured questionnaire. The anthropometric measurements such as MUAC, height and weight were done by the help of MUAC tape for pregnant women, stadiometer and weighing machine respectively. The haemoglobin measurements of the participants were done by Cyanmethemoglobin method. The participants of the study were 15-49 years pregnant women.

3.2 Study Site

This study was conducted at PHC and FPAN of Itahari sub-metropolitan city, Sunsari, Nepal. The city has 26 wards. It has one PHC and one FPAN. According to National Population and Housing Census 2011, Itahari municipality constituted 33,794 households with 1, 40,517 total populations. The total population comprises 66, 566 males and 73,951 females.

3.3 Target population

The target population for this study was pregnant women who were residing in the study area attending ANC at PHC and FPAN of Itahari sub-metropolitan city, between the ages of 15-49 years.

3.4 Sampling techniques

The sample size of the study was calculated by using formula from creative research system. Total sample size for the study was 216. Five persons were excluded. So, the final sample size for our study was 211. Consecutive sampling technique was used to select the participant’s.

3.6 Sample size calculation

For the sample size calculation, formula from creative research system was given below:

$$n = Z^2(pq)/(d^2)$$

Where, n =sample size

z =95% confidence interval

p =expected prevalence (48%) (MoHP, 2012)

q =1- p (expected non-prevalence)

d = relative desired precision (7%)*

(*7% precision was taken to reduce the sample size due to other financial consideration)

Now, using formula, $n = (1.96^2) \times 0.48 \times 0.52/(0.07^2)$

= 195.68 ~ 196

There might be some non-response condition, so that non response rate was assumed to be 10% and the final sample size was calculated as:

$n = 196 + 10\% \times 196 \quad = 215.6 \sim 216$

Therefore, the total sample size for the study was 216. Five persons were excluded. So, the final sample size was 211.

3.7 Criteria for sample selection

a. Inclusion criteria

- Pregnant women between ages 15-49 years.
- Those who are the resident in the study area.
- Those who are given consent to participate.

b. Exclusion criteria

- Those who are taking iron supplementation.
- Those who are not interested to participate in this study.

3.8 Research variables

Following are the variables of the study which are briefly discussed below:

a. Dependent variable: It included the haemoglobin level of the participants.

b. Independent variables: It included dietary intake, socio-demographic (such as age, family size, ethnicity, religion and education), economic (such as yearly income), maternal (such as age at first marriage, gestational period, number of pregnancies, frequency of ANC visits and deworming tablet), anthropometric measurements (such as MUAC and BMI), knowledge about anemia and balanced diet and environmental conditions (such as cooking fuel, source and purification of drinking water). These variables were used to understand the extent and differentials of anemia among pregnant women and its effect on haemoglobin level.

3.9 Pre-testing

The developed interview schedule was pre-tested in few individuals' in order to establish accuracy and to check for the consistency of tools used in this study.

3.10 Validity and reliability

Validity of an instrument refers to the degree to which an instrument measures what it is supposed to be measuring. In this study, the data collection tools was validated by comparing with standard known weights (for weighing balance). Similarly, the semi-structured questionnaire was checked for consistency and clarity. The data collection tools were pre-tested using standardized instruments. Haemoglobin estimation is performed by Cyanmethemoglobin method which is the best and standardized laboratory method for the quantitative determination of haemoglobin.

3.11 Data collection techniques

a. Data collection for dependent variable
   Haemoglobin estimation was done by Cyanmethemoglobin method (WHO, 2001).

Following are the procedures:

i. 20 μl of whole blood was added to 5 ml of Drabkin's reagent.
ii. After 10 minutes, absorbance (A) was measured against blank at 540 nm.

iii. It was compared with the commercial standard and values were expressed as g%.

Calculation:

$$Concentration\ of\ haemoglobin\ (g/dl) = \frac{Reading\ of\ test\ (A)}{Reading\ of\ standard} \times concentration\ of\ standard$$

b. Data collection for independent variables

i. Measurement of weight

Firstly, the electronic scale was placed on a hard flat surface. Then pressed firmly on the centre of the scales to turn them on. Once the zero appear, the respondent was asked to stand on the scales. The subject was asked to stand on the centre of the scales without support, with their arms loosely by their sides, head facing forward and with their weight distributed evenly on both feet. A reading appeared in a few seconds. The number changed, and then stopped. Once the numbers had stopped, the reading was taken to the nearest 0.1 kg. The subject was asked to step off the scale. Then after the reading was recorded (MoH, 2008).

ii. Measurement of height

First of all, the stadiometer was assembled. Then after, it was pushed closer to the wall so that both stabilisers touched the wall. The subject was asked to stand on the centre of the base with their back to the stadiometer. They were asked to put their feet together and move back until their heels touched the bottom of the stadiometer upright. Their buttocks and upper part of their back touched the stadiometer upright. The respondent’s head should be in the Frankfort plane. This was achieved when the lower edge of the eye socket (the Orbitale) was horizontal with the Tragion. The vertex would be the highest point on their head. If their head was not aligned properly, (and for most respondents it probably won’t be), asked them to raise or lower their chin until it is in the Frankfort plane. They were asked to take a deep breath and hold it. The headboard was lowered until it was in contact with the head. The hair was compressed if needed. The headboard should not bend from the horizontal, nor the respondents head moved. The headboard was hold firmly at its final position and the reading was taken to the nearest 0.1 cm. After the reading was completed, the respondent asked to step away from the stadiometer and the reading was recorded (MoH, 2008).

iii. Measurement of MUAC

The left arm of the respondent was bent to a 90 degree angle. The arm endpoints was found at the tip of the shoulder and tip of the elbow. Thumbs was used to place tape at endpoints. Tape was folded so that the endpoint meet. A mark was made on the arm's midpoint, where the tape was folded. The arm was straightened. The tape was wrapped around the midpoint and threaded it through the window. The tension of the tape was adjusted so that it was not too tight or too loose. The measurement was recorded in mm where the arrows point inward (MoH, 2014).

iv. Other variables

Other variables such as age, family size, ethnicity, religion, education, yearly income, knowledge about anemia and balanced diet, maternal and environmental characteristics and also dietary intake of the participants were done using the semi-structured questionnaire.

3.12 Logistical and ethical consideration

The ethical clearance was obtained from the Nepal Health Research Council and formal permission was also taken from the PHC and FPAN of Itahari sub-metropolitian city. The study obtained an approval from the respective DHOs of Sunsari district. Participation in this study was on voluntary basis. Every respondent was given a copy of the consent form then the written informed consent was secured from the participants after explaining about the objective and purpose of the study to each participants, prior to data collection. Participants were given an assurance of privacy and confidentiality of the information.

3.13 Data analysis

The collected data was checked for completeness and consistency then it was first recorded, edited, organized, coded and entered into Microsoft excel 2013. Then after data was analysed using SPSS version 20. For the description of selected variables, descriptive statistics such as frequency, mean, percentage and standard deviation were used. Pearson's chi-square test was used to find out the association between dependent and independent variables. A p-value of ≤ 0.05 was considered statistically significant. Haemoglobin concentration obtained was compared to the WHO haemoglobin cut-off points to diagnose anemia at sea level. Anthropometric indices were calculated using reference medians recommended by the World Health Organization.

Part IV

4. Results and discussion

A total of 211 (n=211) pregnant women were enrolled in our study. The age group for this study was considered from 15-49 years attending antenatal clinics at PHC and FPAN of Itahari sub-metropolitan city.

4.1 Prevalence of anemia

The mean (±SD) of haemoglobin level were 11.5 (± 0.8) g/dl. The maximum and minimum haemoglobin level were 15.6 g/dl and 9.2 g/dl respectively. In this present study, the prevalence of anemia among participants was found to be 18.5% (n=39) which is lower than the study conducted by MoHP (2012) (48%) and Maskey *et al.* (2014) (46.6%). This may be due the different methods of the estimation of haemoglobin. Out of 211 participants, only 15 (7.1%) were found to be vegetarian which is less than in general population of Nepal which may be one of the reason for this finding. (46.6%). Similarly, figure 4.1 showed that the prevalence of anemia in pregnant women of some other developing countries such as India (89.4%) (Toteja *et al.*, 2006) and Pakistan (90.5%) (Baig-Ansari *et al.*, 2008) is higher than this study. This may be due to the inclusion of more rural villages in the studies from India and Pakistan. Many of the studies had shown that the risk of developing anemia increases with the age of pregnancy (trimester). The study conducted in Saudi Arabia by Rasheed *et al.* (2008) revealed that the prevalence of anemia is higher during the third trimester. Low haemoglobin level at third trimester is in fact not solely depend on the haematinic intake but probably due to physiological expansion of maternal plasma volume. In this present study, none of the participants were found to be in third trimester during pregnancy. Most of the participants 172 (81.5%) were found to be normal and also they were living in an urban setting, which is not endemic for malaria, hookworm infestation and hemoglobinopathies. This could be one of the reason for having low prevlance of anemia in this study.

The prevalence of anemia among pregnant women in this study was slightly lower than in Mekelle town at 19.7% (Abriha *et al.*, 2014) and was slightly higher than in Thailand at 14.1% (Sukrat *et al.*, 2010), in Gondar Northwest Ethiopia at 16.6% (Melku *et al.*, 2014) and in Dhanusha district at 16.5% (Prakash *et al.*, 2015). It may be because of the strengthened health education given on risk factors and prevention of anemia and interventions given at health institutions during ANC follow up in an attempt to reduce the prevalence and severity of anemia among pregnant women. In addition, lower prevalence of anemia among pregnant women can be attributed to gradual improvement of life style and living standards and health seeking behaviour. Out of 39 anemic participants, 35 (16.6%) were found to be mildly anemic, whereas 4 (1.9%) were moderately anemic. None of the participants were found to be severely anemic. The absence of severe anemia among pregnant women has been reported by Nwizu *et al.* (2011). In this present study, mild anemia was common followed by moderate anemia which is consistent with the study done by . Similar findings were also reported in study from Eastern (Maskey *et al.*, 2014) and Western (Singh *et al.*, 2013) part of Nepal. According to WHO classification of the public health importance of anemia (WHO, 2008), it is mild public health problem among the pregnant women in this study.

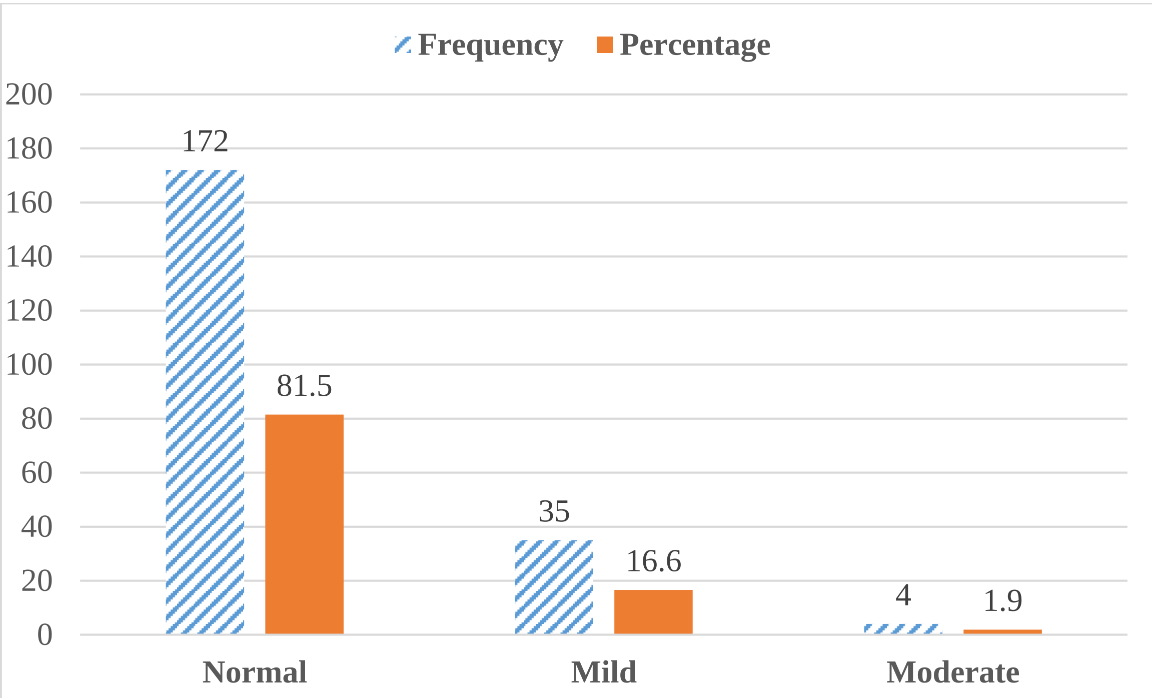

Figure 4.1: Classification of anemia among pregnant women aged 15-49 years (n=211)

4.2 Socio-demographic and economic characteristics with anemia

The mean age (±SD) of the participants (15-49 years) at present was 24.1 (±4.7) years. The maximum and minimum age of the participants were 43 years and 16 years respectively. Table 4.1 shows that out of the 211 participants, 184 (87.2%) and 27 (12.8%) were in the age group of <30 years and ≥30 years respectively. Those participants whose age group was ≥30 years constituted the highest percentage of anemic cases (22.2%) followed by <30 years age group (17.9%). This finding is consistent with the previous studies conducted in Ethiopia (Gebremedhin *et al.*, 2014), Tanzania (Hinderaker *et al.*, 2001), Egypt (Morsy and Alhady, 2014) and India (Lokare *et al.*, 2012) which found that the late pregnancy has significantly increased risk of developing anemia. Generally, it is believed that anemia in pregnancy increases with rising parity and maternal age. Besides the general body weakness with advanced maternal age, older women are expected to be multigravida which may induce anemia by reducing maternal iron reserves at every pregnancy and by causing blood loss at each delivery (Okube *et al.*, 2016). This finding is in contrast with results from other studies conducted by Bondevik *et al.* (2000), and Idowu *et al.* (2005). They revealed that a higher prevalence of anemia was found in young pregnant mothers. The association observed between age of the participants with prevalence of anemia during pregnancy was not significant (p=0.592).

Out of 211 participants, 117 (55.5%) and 94 (44.5%) had family size <5 and ≥5 respectively. Table 4.1 shows that pregnant women who had family size ≥5 (22.3%) were found to be more anemic as compared to those with family size <5 (15.4%). This finding is consistent with the findings from Arba Minch town, Ethiopia (Bekele *et al.*, 2016) and Shala woreda (Obse *et al.*, 2013) in which the prevalence of anemia was higher among pregnant women with family size >5. The direct relationship of family size with anemia in this study could be associated with food security for large family size. In this present study, there was no statistical significance between family size with anemia (p=0.196). A similar finding was also obtained in the study conducted by Prakash *et al.* (2015).

Table 4.1 shows that the prevalence of anemia observed in this study was high in Dalit (32%) followed by Madhesi/Others (29.4%). Among all the participants, majority of the pregnant women were Janajati 93 (44.1%) followed by Brahmin/Chhetri 76 (36.0%), Dalit 25 (11.8%) and Madhesi/Others 17 (8.1). This study reported that ethnicity was not significantly associated with anemia. Similar finding has also been reported by Gebremedhin and Enquselassie (2011). A study conducted in Nepal by Bhandari *et al.* (2016) revealed that almost all of the ethnic group women were anemic, the women of upper caste and dalit being more anemic. Nguyen *et al.* (2015) highlights the multi-causal etiology of anemia including ethnicity in women of reproductive age. In constrast , a study conducted in Lhasa by Xing *et al.* (2009) revealed that ethnicity amounted significantly to the haemoglobin level and the occurrence of anemia in pregnant Tibetans. This may be due to the fact that ethnicity played an important role in determining the nutritional status of women.

As shown in table 4.1, it was observed that the majority of pregnant women were Hindu (85.3%) followed by Muslim (4.7%), Buddhist (4.7%), Christian (2.4%) and Others (2.8%). Anemia was more common among Muslim (20%) and Christian (20%) pregnant women than among Hindu pregnant women (19.4%). In addition, no association was observed between religion and anemia (p=0.741). This finding was consistent with the finding of Bansal *et al.* (2013) where the prevalence of anemia was much more in women belonging to Muslim religion (92.3%) as compared to Non-Muslim (81.1%) because of large family groups, less health awareness, extreme poverty and overcrowding leading to recurrent infection in this caste resulting into anemia. This is contrary to the finding of Lokare *et al.* (2012) revealed that the prevalence of anemia was highest among Hindu pregnant women than other religions and also found significant association between anemia and religion. This could be explained by the reality that in India, pregnant Hindu women were advised to avoid non-vegetarian diet during pregnancy as it generates heat (Lokare *et al.*, 2012) and also this may be due to different dietary habits and food taboos prevalent in different religions (Rai *et al.*, 2016).

Table 4.1 revealed that higher anemic percentage was found on illiterate group (33.3%) as compared to those educated up to primary (30.6%) followed by secondary (17.5%) and higher secondary and above (10.9%). Similar findings were reported in other studies such as in India (Lokare *et al.*, 2012), in Bangladesh (Kamruzzaman *et al.*, 2015) and in Ethiopia (Gebre and Mulugeta, 2015). The study conducted in Nigeria found that a high prevalence of anemia among un-educated pregnant women can be explained in part by the fact that their diets lack adequate amounts of iron, adherence to cultural taboos that often lead to selection of food types for pregnant women leading to nutritional deficiencies such as iron and vitamin B_{12} deficiency (Anorlu *et al.*, 2006). In this present study, majority 114 (54.0%) of participants had secondary level of education followed by higher secondary and above 55

(26.1%). Consistent with the findings of MoHP (2012) revealed that women in urban areas are more than twice as likely as those in rural areas to have a secondary education or more than a secondary education (38% and 15%, respectively). Lokare *et al.* (2012) found that the pregnancy-related anemia was significantly higher in those with low education levels. They also reported that as literacy level increases the severity of anemia decreases. In this present study, there was no statistical significance between the educational status of participants with anemia which is consistent with the finding of Prakash *et al.* (2015).

The Nepal Living Standard survey 2010/11 showed that nominal average household income per year to be NRS. 2,02,374 (CBS, 2011). In this study, family yearly income of the pregnant women was categorized into three groups: having income less than 2 lakh per year, between 2-5 lakh per year and 5 lakh or more than 5 lakh per year. Most of the participants family had 2-5 lakh (66.8%) yearly income followed by <2 lakh (25.1%) and ≥5 lakh (8.1%). A high prevalence of anemia was found in those pregnant women whose family yearly income was ≥5 lakh. This may be due to their different dietary habits and also may be due to the large consumption of junk foods by them. The study conducted in Nepal by Bhandari *et al.* (2016) revealed that majority of women in all ecological regions consumed junk foods which do not provide adequate nutrition. Also, they found that low production and consumption of vegetables and fruits lead to micronutrient deficiencies which is also one of the risk factors for anemia.

Table 4.1 shows that there was highly significant association between family yearly income and anemia (p=0.009). Similar findings were also reported by other studies conducted in India (Lokare *et al.*, 2012), in Iran (Sadeghian *et al.*, 2013), in Ethiopia (Gebre and Mulugeta, 2015) and in Nepal (Maskey *et al.*, 2014). This finding is also supported by Kamruzzaman *et al.* (2015). They revealed that household economic status (wealth index) is an important predictor of anemia. In Arba Minch town, the study conducted by Bekele *et al.* (2016) reported that pregnant women who had low monthly family income were four times more likely to be anemic as compared to those with high monthly income. This could be explained by the fact that more than 57% of the total expenditure among Ethiopians is spent on food. Many other studies on anemia in pregnancy conducted in Pakistan (Baig-Ansari *et al.*, 2008), in Ethiopia (Haidar, 2010), in Vietnam (Aikawa *et al.*, 2006) and in Nepal (Makhoul *et al.*, 2012) did not consider the effect of wealth index. This may be because the wealth index is calculated from different household assets.

Table 4.1: Socio-demographic and economic characteristics of the participants and anemia (n=211)

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
Age in years				
<30	87.2	151 (82.1)	33 (17.9)	0.592
≥30	12.8	21 (77.8)	6 (22.2)	
Family size				
<5	55.5	99 (84.6)	18 (15.4)	0.196
≥5	44.5	73 (77.7)	21 (22.3)	
Ethnicity				
Dalit	11.8	17 (68)	8 (32)	
Janajati	44.1	77 (82.8)	16 (17.2)	0.116
Brahmin/Chhetri	36.0	66 (86.8)	10 (13.2)	
Madhesi/Others	8.1	12 (70.6)	5 (29.4)	
Religion				
Hindu	85.3	145 (80.6)	35 (19.4)	
Muslim	4.7	8 (80)	2 (20)	
Buddhist	4.7	9 (90)	1 (10)	0.741
Christian	2.4	4 (80)	1 (20)	
Others	2.8	6 (100)	Nill	
Education of the participants				
Illiterate	2.8	4 (66.7)	2 (33.3)	
Primary	17.1	25 (69.4)	11 (30.6)	0.089
Secondary	54.0	94 (82.5)	20 (17.5)	
Higher secondary & above	26.1	49 (89.1)	6 (10.9)	
Yearly income				
<2 lakh	25.1	40 (75.5)	13 (24.5)	
2-5 lakh	66.8	122 (86.5)	19 (13.5)	0.009*
≥5 lakh	8.1	10 (58.8)	7 (41.2)	

* Statistically significant (p<0.05)

4.3 Maternal characteristics with anemia

Table 4.2 shows that the majority 76 (36%) of participants were married at ≥21 years followed by <18 years 73 (34.6%) and 18-20 years 62(29.4%). The result obtained from this study revealed that child marriage was a still a problem with 34.6% of the marriages having happened before 18 years of age. Similar finding has also been reported in a study conducted by Siddalingappa *et al.* (2016). The prevalence of anemia in this study was found to be high in those pregnant women who had married at 18-20 years (21%) as compared to <18 years (19.2%) and ≥21 years (15.8%) respectively. This could be explained by the fact that adolescent girls (10-19 years) are also at increased risk of anemia due to period of rapid growth and developmental process of adolescence which cause higher requirement on both micro and macronutrients especially in girls who attend menarche (WHO, 2005). Ramzi *et al.* (2011) reported that iron status and haemoglobin concentration in adolescence could be a predisposing factor for maternal anemia. This study has shown that there was no significant association between anemia and age at marriage which is supported by Kamruzzaman *et al.* (2015). A study conducted by Alene and Dohe (2014) showed that the majority (49%) of pregnant women had married at 16-18 years followed by <16 years (34.3%) and ≥19 years (16.6%). They also revealed that there was no significant association between anemia and age at marriage. This finding is inconsistent with a study done at Nepal, which found that age at marriage was significantly associated with anemia (Maskey *et al.*, 2014). This could be due to the difference between sociocultural and behaviour characteristics of the participants in this study and previous studies.

In this present study, majority 180 (85.3%) of the participants were in the second trimester of pregnancy and 31 (14.7%) were in the first trimester of pregnancy. None of the participants were from third trimester. A high prevalence of anemia was found at second trimester of pregnancy (18.9%) as compared to first trimester (16.1%). This could be attributed partly due to physiological hemodilution mostly observed early in pregnancy (Siteti *et al.*, 2014). Similar findings were obtained in a studies conducted by Sinha *et al.* (2012) and Singh *et al.* (2013). Although statistically not significant, prevalence of anemia was seen to increase with advancing gestational age which is supported by a study conducted in India by Viveki *et al.* (2012). This contrasts a study done among pregnant women in Ethiopia (Alene and Dohe, 2014), Vietnam (Aikawa *et al.*, 2006) and Nepal (Makhoul *et al.*, 2012) found that increased gestational age is significantly associated with the risk of developing anemia. This could be explained by the fact that when the gestational age increases the mother becomes weak and the iron in the blood is shared with the fetus in the womb therefore decreasing the iron binding capacity of the mother's blood (Alene and Dohe, 2014). The Study conducted by Siteti *et al.* (2014) revealed that the majority of pregnancy related anemia cases were recorded in second trimester of pregnancy. This could be attributed partly to un-planned pregnancies.

Table 4.2 revealed that pregnant women suffering from anemia was 19 (19.6%) in second and above pregnancy as compared to 20 (17.5%) in first pregnancy. This may be due to the fact that multigravidity induce anemia by reducing maternal iron reserves at every pregnancy (Jufar and Zewde, 2014). Majority 114 (54%) were primigravida and 97 (46%) were multigravida. The association observed between gravidity with the prevalence of anemia during pregnancy was not found to be significant (p=0.703). This finding is consistent with the findings from other studies conducted in Ethiopia (Haidar, 2010), India (Nivedita and Fatima, 2016) and Nepal (Makhoul *et al.*, 2012). Abriha *et al.* (2014) revealed that the odds of repeated pregnancies more than two or more were 2.3 times greater among pregnant mothers as compared to those who have less than two number of pregnancies. This is due to the fact that short intervals between births may not provide women with enough time to replenish lost nutrient stores before another reproductive cycle begins (GFDRE, 2013). The study conducted by Viveki *et al.* (2012) and Alene and Dohe (2014) reported that increased number of pregnancies is positively associated with the risk of developing anemia. This could be due to the possibility of sharing of resources with the fetus. This finding was inconsistent with the finding of Idowu *et al.* (2005) where severe anemia is more common among primigravida compared to multigravida. This is because malaria, a major cause of anemia in pregnancy in endemic areas is known to be more severe among primigravida (Miaffo *et al.*, 2004).

The present study revealed that most 148 (70.1%) of the participants attended ANC for the first time as compared to those 63 (29.9%) who had attended ANC for two times and more. The prevalence of anemia was high in those pregnant women who had attended ANC for first time (23%) than those who had two times and more (7.9%). There was statistical significance between number of ANC visits and anemia (p=0.010). Similar finding was obtained from the study conducted by Mangla and Singla (2016), Mbule *et al.* (2013) and Okube *et al.* (2016). A study conducted by Toahaa *et al.* (2015) reported that a mother who did not visit antenatal care at least four times, 0.86 times the risk of experiencing complications of labor compared with women who do not visit antenatal less than four times. They also revealed that lack of antenatal care by pregnant women basically involved many factors such as affordability, availability, maternal employment status, knowledge about pregnancy health, education, attitude towards service and maternal conditions include age and parity. Mbule *et al.* (2013) found that 43.5% of pregnant women had made at least one ANC visit whereas only 6.1% made the recommended minimum of four ANC visits. Due to low rates of ANC visits, most pregnant women miss anemia interventions and health education sessions. Also, the finding of Brhanie and Sisay (2016) showed that pregnant women who has history of ANC follow-up in previous pregnancy has low prevalence of anemia (48.2%) as compared to those who did not have antenatal care follow up previously have high prevalence (94.4%).

Out of 211 participants, majority 198 (93.8%) had not taken deworming tablet at current pregnancy whereas 13 (6.2%) had taken deworming tablet. In addition, no significant association was found between anemia and intake of deworming tablet. The study conducted by Larocque and Gyorkos (2006) reported that one third of all pregnant women in developing countries are estimated to be infected with hookworms. Hookworm infections especially, contribute to anemia by causing blood loss and by affecting the supply of nutrients for erythropoiesis. It is considered to be a leading cause of pathological blood loss in tropical and subtropical countries. This could be one of the reason for finding high prevalence of anemia in those pregnant women who had not taken deworming tablet during pregnancy (18.7%) as compared to those who had taken deworming tablet (15.4%). Another study conducted by Mbule *et al.* (2013) revealed that women who had not received deworming medicine during their current pregnancy were 1.86 times more likely to be anemic compared with those who had received a deworming tablet, the association was however, not found to be statistically significant.

Table 4.2: Maternal characteristics of the participants and anemia (n=211).

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
Age at marriage				
<18 years	34.6	59 (80.8)	14 (19.2)	
18-20 years	29.4	49 (79)	13 (21)	0.725
≥21 years	36.0	64 (84.2)	12 (15.8)	
Gestational period				
First trimester	14.7	26 (83.9)	5 (16.1)	0.715
Second trimester	85.3	146 (81.1)	34 (18.9)	
Number of pregnancies (gravidity)				
First pregnancy	54.0	94 (82.5)	20 (17.5)	0.703
Second and above pregnancy	46.0	78 (80.4)	19 (19.6)	
Frequency of ANC visits				
One time	70.1	114 (77)	34 (23)	0.010*
Two times & more	29.9	58 (92.1)	5 (7.9)	
Deworming tablet				
Yes	6.2	11 (84.6)	2 (15.4)	0.766
No	93.8	161 (81.3)	37 (18.7)	

* Statistically significant ($p<0.05$)

4.4 Anthropometric measurements with anemia

The mean (±SD) weight and height of the participants were 51.1 (± 8.1) kg and 153 (± 4.9) cm respectively. The maximum and minimum weights of the participants were 76 kg and 35 kg respectively. Similarly, their maximum and minimum heights were 170 cm and 140 cm respectively. The mean (±SD) BMI and MUAC of the participants were 21.8 (± 3.3) kg/m^2 and 23.9 (± 2.3) cm respectively. The maximum and minimum BMI of the participants were 36.1 kg/m^2 and 15.1 kg/m^2 respectively. The mean (±SD) MUAC of the participants was 23.9 (± 2.3) cm. Similarly, their maximum and minimum MUAC were 33 cm and 19 cm respectively.

Table 4.3 shows that, the most of the participants 147 (69.7%) had MUAC ≥23 cm and 64 (30.3%) had MUAC <23 cm. Pregnant women having MUAC <23 cm (26.6%) were found to be highly anemic as compared to those who had MUAC ≥23 cm (15%). Statistical analysis showed that MUAC had a significant association on anemia (p=0.046). This finding is consistent with previous studies conducted in Kenya (Okube *et al.*, 2016), Ethiopia (Alene and Dohe, 2014), Jamaica (Charles *et al.*, 2010) and Nepal (Makhoul *et al.*, 2012) which found that MUAC of less than 23 cm significantly increase the risk of developing anemia. This could be due to the fact that the undernourished pregnant women have a higher probability of being deficient of micronutrients and therefore more likely to develop anemia.

In this study, the participants were classified by BMI categories as underweight, normal and overweight. Most of the participants 146 (69.2%) had normal BMI followed by overweight 34 (16.1%) and underweight 31 (14.7%) respectively. The prevalence of anemia was high in underweight pregnant women (32.3%) as compared to those who were normal (17.8%) and overweight (8.8%). Similar findings were obtained from other studies conducted in Thailand (Liabsuetrakul, 2011) and Ethiopia (Gedefaw *et al.*, 2015). There was statistically significant difference between BMI and anemia (p=0.048). This could be explained by the fact that women who are underweight during pregnancy is the possibility that their bodies won’t get enough in the way of nutrition and also they are at high risk of anemia. This finding was consistent with the finding of Kamruzzaman *et al.* (2015), Charles *et al.* (2010) and where the incidence of anemia are strongly associated with low BMI. Another study conducted by Qin *et al.* (2013) reported that the anemia status and body weight have certain correlations which implies that the changing trend in body weight and composition in a population may alter underlying causes of anemia. In Nepal, Prakash *et al.* (2015) revealed that the highest number of pregnant women had normal BMI was found to be statistically significant with anemia which is contrary to this findings. This indicates that pregnant women regardless of their BMI need a special attention for prevention and treatment of anemia.

Table 4.3: Anthropometric measurements of the participants and anemia (n=211)

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
MUAC				
<23	30.3	47 (73.4)	17 (26.6)	0.046*
≥23	69.7	125 (85)	22 (15)	
BMI				
Underweight	14.7	21 (67.7)	10 (32.3)	
Normal	69.2	120 (82.2)	26 (17.8)	0.048*
Overweight	16.1	31 (91.2)	3 (8.8)	

* Statistically significant (p<0.05)

4.5 Knowledge of the participants

Table 4.4 shows that majority 168 (79.6%) of the participants had no knowledge regarding anemia while 43 (20.4%) had good knowledge regarding anemia. Similarly, those participants who had no knowledge about anemia were found to be more anemic (20.8%) as compared to those who had knowledge about anemia (9.3%). In this study, the participants knowledge regarding anemia was not found to be statistically significant with anemia status. This can be related to the fact that majority of pregnant women who had poor knowledge about anemia and iron rich foods are more anemic as they supposedly do not eat foods that are rich in iron. In addition, despite the affordability, it may be difficult to access such foods due to certain intra-household decisions on food consumption. A similar finding was also obtained in study conducted by Yadav *et al.* (2014) which revealed that knowledge regarding cause of anemia, sign and symptoms of anemia, proper diet to prevent anemia was poor among pregnant women. Balasubramanian *et al.* (2016) also showed that there is lack of knowledge among antenatal mothers regarding anemia and its complications. They suggested that creating awareness about health education can grossly reduce the incidence of anemia in antenatal population and thereby prevents anemia related mortality and morbidity. The finding of George *et al.* (2016) reported that majority 139 (92.4%) of the women knew meat, fish, green leafy vegetable and jiggery are rich in iron. They also revealed that 82.67% of the women have good awareness regarding anemia which is inconsistent with the finding of this study. This difference may be because of the variation in study sample where this study was conducted in pregnant group.

In this present study, majority 187 (88.6%) of the participants had good knowledge about balanced diet as compared to those 24 (11.4%) who had no knowledge about balanced diet. Those participants who had poor knowledge about balanced diet were likely to be found more anemic (25%) than those who had good knowledge about balanced diet (17.6%). There was no statistical significant between knowledge about balanced diet among participants with anemia. This could be due to the fact that women with poor knowledge about balanced diet have higher probability of being deficient of micronutrients and therefore more likely to develop anemia. A study conducted by Bhandari *et al.* (2016) reported that women consuming foods from five or more food groups out of ten have a greater likelihood of meeting their micronutrient needs than women consuming foods from fewer food groups. Similarly, the finding of Patimah *et al.* (2016) found that knowledge and attitude about balanced diet had no association with microcytic hypochromic anemia. They also found that the practices of balanced diet had a significant association with microcytic hypochromic anemia. Ismail and Manju (2014) reported that there is a definite role of nutritional deprivation in the development of anemia and lack of balanced diet especially deficient in protein group has much stronger association with the type of anemia.

Table 4.4: Knowledge of the participants and anemia (n=211)

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
Knowledge about anemia				
Yes	20.4	39 (90.7)	4 (9.3)	0.082
No	79.6	133 (79.2)	35 (20.8)	
Knowledge about balanced diet				
Yes	88.6	154 (82.4)	33 (17.6)	0.382
No	11.4	18 (75)	6 (25)	

4.6 Environmental characteristics and anemia

Table 4.5 revealed that most of the participants 162(76.8%) used LPG as cooking fuel while 49 (23.2%) used firewood/others. A high prevalence of anemia (26.5%) was seen in those pregnant women who used firewood/others as cooking fuel. There was no statistical significance between cooking fuel with anemia. This finding is supported by Wilunda *et al.* (2013). A study conducted in India by Page *et al.* (2015) and revealed that the household use of biomass fuel for cooking may increase the risk of anemia in pregnant women and this result is biologically plausible because of the potential role of biomass smoke in triggering systemic inflammation which is also a well-known cause of anemia. Bishwajit *et al.* (2016) also found that women utilizing biomass fuel for cooking were more likely to be anemic.

This study shows that majority 97 (46%) of the participants used tap water followed by hand pump (39.8%) and others (14.2%). The prevalence of anemia was found to be high in those pregnant women who used others such as river water, pond etc. as source of drinking water (20%) as compared to those who used hand pump (19%) followed by tap water (17.5%). This may be due to the fact that the others source of drinking water such as river, pond, etc is contaminated with different parasites. People become infected with water-borne diseases which is also one of the risk factor for developing anemia. In addition, no significant association was found between anemia and source of drinking water. A similar finding was also obtained in a study conducted by Zhao *et al.* (2014). They revealed that drinking spring or river water was associated with anemia. Alene and Dohe (2014) reported that half (56.5%) of the pregnant women used a protected well/tanker as a source of drinking water and the remaining (40%) drank water from a river.

Similarly, most of the participants had not purified their drinking water (67.8%). The prevalence of anemia was found to be more in those participants who had purified their drinking water (18.2%) as compared to those who had not purified (19.1%). There was no statistically significant difference between the purification of drinking water and anemia. This is contrary to the finding of Zhao *et al.* (2014) where drinking unboiled water was associated with anemia.

Table 4.5: Environmental characteristics of the participants and anemia (n=211)

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
Cooking fuel				
LPG	76.8	136 (84)	26 (16)	0.098
Firewood/Others	23.2	36 (73.5)	13 (26.5)	
Source of drinking water				
Tap	46.0	80 (82.5)	17 (17.5)	
Hand Pump	39.8	68 (81)	16 (19)	0.941
Others	14.2	24 (80)	6 (20)	
Purification of drinking water				
Yes	32.2	55 (80.9)	13 (19.1)	0.870
No	67.8	117 (81.8)	26 (18.2)	

4.7 Dietary habits and anemia

Table 4.6 shows that the majority 196 (92.9%) of the participants were non-vegetarian whereas 15 (7.1%) were vegetarian. The prevalence of anemia was high in non-vegetarian participants (19.4%) as compared to vegetarian (6.7%). There was no statistical significance between eating habits and anemia. This is contrary with the finding of Saunders *et al.* (2013) revealed that vegetarians are at high risk of developing anemia. They also reported that vegetarians who eat a varied and well-balanced diet are not at any greater risk of iron deficiency anemia than non-vegetarians.

In the present study, most of the participants had two times meal per day (73.5%) than those who had more than two times (26.5%). The prevalence of anemia was higher among pregnant women having a meal frequency more than two times per day (19.6%) as compared to pregnant women who had meal a frequency of two times per day (18.1). In addition, no significant association was found between the frequency of meal taken per day and anemia This finding is in contrast with the finding of Gebre and Mulugeta (2015) where they found pregnant women having a meal frequency of less than three times per day more anemic as compared to those who had meal frequency of more than two times per day. A study conducted by Abriha *et al.* (2014) also reported that pregnant women who had meal frequency less than two times per day were 3.9 times at higher risk of developing anemia than those whose meal frequency was more than three times per day. This might be due to the fact that pregnancy is a special period with increased energy and nutrient requirement which can be fulfilled with increased meal frequency.

The majority 168 (79.6%) of the participants consumed meat 1-3 times a week followed by those who consumed meat everyday 28 (13.3%). Only 7.1% of the participants did not consume meat. A high prevalence of anemia was found in those who consumed meat 1-3 times a week (21.4%) as compared to others. Consumption of meat did not show significant association with anemia. A study conducted by Abriha *et al.* (2014) revealed that pregnant women with habit of eating meat once per week were 2.2 times at higher risk of developing anemia than pregnant mothers who ate meat more than twice per week. Salem *et al.* (2016) reported that decreased frequency of eating red meat, white meat and liver per week significantly increase risk for iron deficiency anemia among Egyptian and Yemeni pregnant women. This can be explained as liver and meat are very rich in heme iron. Karaoglu *et al.* (2010) also found no significant association between meat consumption and anemia. They also revealed that the meat consumption was reported to be 21 kg/capita/year for Turkey, 124 kg/capita/year for USA and about 100 kg/capita/year for European countries. These data might explain the lower anemia prevalence among those developed countries. Samuel *et al.* (2013) revealed that the prevalence of anemia was independently associated with high intake of anemia, fish and poultry.

Most of the participants 109 (51.7%) consumed fruit 1-3 times a week were found to more anemic (19.3%) as compared to those who consumed fruit everyday (17.6%). There was no statistically significant difference between frequency of fruit taken with anemia. This might be due to the fact that low intake of fruits leads to deficiency of minerals and vitamins which may increase bio-availability of iron then affects iron status. Studies conducted in Pakistan (Baig-Ansari *et al.*, 2008) and Turkey (Karaoglu *et al.*, 2010) reported that consumption of fruit two or more times per week is associated with a decreased risk of anemia.

In this study, majority 129 (61.1%)of the pregnant women consumed egg 1-3 times a week followed by those who did not consume egg (25.6%) and those who consumed egg everyday (13.3%) respectively. The prevalence of anemia was higher among those who do not consume egg (29.6%). Statistical analysis showed that frequency of egg taken had significant association on anemia (p=0.042). A study conducted by Bermúdez-Millán *et al.* (2009) revealed that egg consumers had higher intake of protein, fat, vitamin K and E, selenium, beta carotene, lutein and Zeaxanthin, cholesterol, total polyunsaturated fatty acids and docosahexoenoic acid. The finding of this study was consistent with the finding of Baig-Ansari *et al.* (2008) where the incidence of anemia was significantly associated with never consuming eggs or consuming eggs less than twice a week during pregnancy.

Most 173 (82%) of the pregnant women consumed milk and its products 1-2 times per day as compared to those who do not consume milk and its products (5%). In this study, the prevalence of anemia was higher among pregnant women who had not consumed milk and its products.(40%). This could be explained by the fact that pregnant women who are not consuming milk and its products have higher probability of being micronutrient deficiencies such as thiamine, riboflavin and vitamin B_{12} which increases the risk for developing anemia. There was no statistically significant difference between frequency of milk and its products taken with anemia. A study conducted in China by Shi *et al.* (2014) revealed that riboflavin deficiency is one of the most common vitamin deficiencies in developing countries especially those with rice as the staple food coupled with insufficient milk and meat intake. They also reported that low intake of riboflavin is associated with increased risk of anemia. Therefore, they suggested that correcting riboflavin deficiency may reduce the prevalence of anemia in pregnant women.

Table 4.6 also shows that majority 204 (96.7%) of the participants consumed green leafy vegetables 1-2 times per day than those who consumed it for once a week (3.3%). Those pregnant women who consumed green leafy vegetables 1-2 times per day were found to be more anemic (18.6%). Statistical analysis showed that frequency of green leafy vegetables taken had no significant association on anemia. This finding is supported by Jufar and Zewde (2014). A study conducted by Salem *et al.* (2016) revealed that the prevalence of anemia was low in those pregnant women who are consuming green vegetables >2 times per week (45.5%) as compared to those who are consuming it ≤2 times per week (86.6%). The finding of this study was inconsistent with the finding of Panigrahi and Sahoo (2011) where inadequate intake of green leafy vegetables and pulses are significantly associated with anemia.

The findings from this study revealed that majority 201 (95.3%) of the participants were not forbid for foods during pregnancy followed by those who had forbid for foods during pregnancy (4.7%). Although there was no statistical significant association between foods that were forbid during pregnancy and anemia, this study found out that there was high incidence of anemia among pregnant women who had forbid for foods during pregnancy (40%). A study conducted by Arzoaquoi *et al.* (2015) found that food restrictions affect the nutritional status of pregnant women.

Table 4.6 represents that the majority 131 (62.1%) of the participants drank tea one time per day followed by those who did not drink tea (44%) and those who drank tea two times per day (36%) respectively. The prevalence of anemia was found to be high in those pregnant women who drank tea for two times per day (27.8%). This may be due to the fact that the tea contain polyphenolic compounds (tannin and gallic acid) which bind iron in the gut lumen and form chelates, thus inhibiting iron absorption This study had not shown significant association of maternal anemia with the frequency of tea consumption per day. The finding of this study is supported by Jufar and Zewde (2014). Studies conducted by Baig-Ansari *et al.* (2008) and Manik *et al.* (2015) revealed that the greater the quantity of tea consumed during pregnancy, the lower the mean haemoglobin concentration. Temme and Hoydonck (2002) reported that tea consumption does not influence iron status in Western populations in which most people have adequate iron stores as determined by serum ferritin concentrations. In this present study, most of the participants drank black tea (42.7%) as compared to those who drank milk tea (36.5%). Anemia were found to be more prevalent (19.5%) among those participants who drank milk tea than those who drank black tea (16.7%). In addition, no statistical significant association was observed in types of tea taken and anemia.

Table 4.6: Dietary characteristics of the participants and anemia (n=211)

Variables	Percentage (%)	Non-anemic n (%)	Anemic n (%)	p-value
Eating habits				
Vegetarian	7.1	14 (93.3)	1 (6.7)	0.221
Non-vegetarian	92.9	158 (80.6)	38 (19.4)	
Frequency of meal per day				
Two times	73.5	127 (81.9)	28 (18.1)	0.794
More than two times	26.5	45 (80.4)	11 (19.6)	
Frequency of meat taken				
Everyday	13.3	26 (92.9)	2 (7.1)	
1-3 times a week	79.6	132 (78.6)	36 (21.4)	0.093
0	7.1	14 (93.3)	1 (6.7)	
Frequency of fruit taken				
Everyday	48.3	84 (82.4)	18 (17.6)	0.762
1-3 times a week	51.7	88 (80.7)	21 (19.3)	
Frequency of egg taken				
Everyday	13.3	25 (89.3)	3 (10.7)	
1-3 times a week	61.1	109 (84.5)	20 (15.5)	0.042*
0	25.6	38 (70.4)	16 (29.6)	
Frequency of milk and its products taken				
1-2 times per day	82.0	144 (83.2)	29 (16.8)	
Once per week	15.6	25 (75.8)	8 (24.2)	0.272
0	2.4	3 (60)	2 (40)	
Frequency of green leafy vegetables taken				
1-2 times per day	96.7	166 (81.4)	38 (18.6)	0.771
Once per week	3.3	6 (85.7)	1 (14.3)	
Forbidden foods during pregnancy				
Yes	4.7	6 (60)	4 (40)	0.072
No	95.3	166 (82.6)	35 (17.4)	

Frequency of tea taken				
One time	62.1	111 (84.7)	20 (15.3)	
Two times	17.1	26 (72.2)	10 (27.8)	0.215
0	20.9	35 (79.5)	9 (20.5)	
Types of tea taken				
Black tea	42.7	75 (83.3)	15 (16.7)	
Milk tea	36.5	62 (80.5)	15 (19.5)	0.835
0	20.9	35 (79.5)	9 (20.5)	

* Statistically significant ($p<0.05$)

Part V

5. Conclusions and recommendations

5.1 Conclusions

The main objective of this study was to determine the prevalence of anemia among pregnant women and its associated factors in Itahari sub-metropolitan city. The finding of this present study has shown that the prevalence of anemia among pregnant women was 18.5%. Anemia is found to be a mild public health problem in the study area. The number of ANC visits during pregnancy, yearly income, MUAC, BMI and frequency of egg taken were significantly associated with anemia during pregnancy. This study found out that there was high prevalence of anemia among pregnant women with age ≥30 years (22.2%), having family size ≥5 (22.3%) and illiterate group (33.3%). The finding of this study concluded that those who were at second trimester of pregnancy, multigravida and had first ANC visit were found to be more anemic. Anemia were found to be more prevalent among those pregnant women who had poor knowledge about anemia and balanced diet. Similarly, those who had not taken deworming tablet at current pregnancy, used firewood/others as cooking fuel and drank river, ponds, etc water were more likely to be anemic. Most of the participants were non-vegetarian (92.9%) and had two times meal per day (73.5%). In this study, pregnant women who had not consumed egg, milk and its products were found to be more anemic. Most of the participants 204 (96.7%) consumed green leafy vegetables 1-2 times per day. Similarly, those who had consumed fruit 1-3 times a week, meat 1-3 times a week and drank tea for two times per day were found to be more anemic. This finding revealed that the greater the quantity of tea consumed during pregnancy, the lower the mean haemoglobin concentration.

Thus, improving nutritional and economic status of women would contribute to reduce the prevalence of anemia in this population. Others associated factors should deserve more attention. Awareness creation and nutritional counselling on consumption of iron – rich foods during pregnancy would also help to prevent anemia in the pregnant women. Also, this emphasizes the need for continuing strengthening of interventions on factors associated with anemia.

5.2 Recommendations

The results of this study suggest that following recommendations:

1. Similar studies should be conducted in future and are needed on the prevention of iron deficiency anemia.
2. Determination of the nutrient intake by pregnant women in specific age and different ethnic groups should be needed for further work.
3. Strategies and policies should be designed by Government of Nepal to enhance women education to make them independent in socioeconomic and cultural decision, which directly or indirectly affects women health status.
4. A regular review of factors which may contribute to the prevalence of the maternal anemia be undertaken in future.
5. Pregnant women as well as adolescents' girls should be provided health education about the importance of anemia free pregnancy.
6. Motivation towards early detection and management of anemia in pregnancy should be given to the antenatal care providers.
7. ANC follow-up should be given top priority.
8. Pregnant women with special emphasis on those from low income group and large family size should be given nutritional counselling on consumption of foods which is rich in iron.
9. Services of extension nutritionists in an integrated programme should be enlisted by Government of Nepal for the management of anemia in pregnant women.

Part VI

6. Summary

Anemia is defined as a decreased concentration of blood haemoglobin. Globally, it affects more than a quarter of the world's population. It is estimated that 41.8% of pregnant women worldwide are anemic. A high proportion of women become anemic during pregnancy because the demand for iron and other vitamins is increased due to physiological burden of pregnancy. The inability to meet the required level for these substances either as a result of dietary deficiencies or infection give rise to anemia. It is of great concern because it increases risk of maternal death during the prenatal period. In Nepal, 48% of pregnant women are suffering from anemia and it is a moderate public health problem. The present study is mainly focused to assess the prevalence of anemia and associated factors among pregnant women of Itahari sub-metropolitan city. A hospital based cross-sectional survey was conducted at PHC and FPAN of Itahari sub-metropolitan City. Haemoglobin estimation was performed using Cyanmethemoglobin method. The height, weight and MUAC of the participants were measured. Further, information regarding socio demographic and economic variables, lifestyle variables and dietary habits were obtained using well designed questionnaire. All the collected data were first recorded, edited, organized, coded and entered into MS Excel 2013 and then it was analysed using SPSS version 20. Chi-square test of significance was performed to find out the factors associated with anemia at 95% confidence interval.

In this study, out of 211 participants, 39 (18.5%) were anemic while 172 (81.5%) were non-anemic. There is a mild public health significance of anemia among the pregnant women in the study area. Among 39 anemic pregnant women, 35 (16.6%) were mildly anemic whereas 4 (1.9%) were moderately anemic and none of the participants were severely anemic. The mean (±SD) haemoglobin level of the participants was 11.5 (± 0.8)gm/dl. The minimum and maximum haemoglobin level were 9.2gm/dl and 15.6gm/dl respectively. The majority (87.2%) of the participants age were <30 years. Anemia were found to be more prevalent (22.3%) among the pregnant women who had family size ≥5. Regarding the ethnicity, most of participants were Janajati 93 (44.1%). The prevalence of anemia observed in this study was high in Dalit (32%) and illiterate group (33.3%). Among all the participants, 85.3% followed Hinduism. Most of the participants family had 2-5 lakh (66.8%) yearly income followed by <2 lakh (25.1%) and ≥5 lakh (8.1%). This study had shown significant assocoaition of maternal anemia family yearly income (p=0.009).

This study revealed that child marriage was a still a problem with 34.6% of the marriages having happened before 18 years of age. The majority 180 (85.3%) of the participants were in the second trimester of pregnancy and 31 (14.7%) were in the first trimester of pregnancy. None of the participants were from third trimester. The percentage of anemia was highest in the second trimester of pregnancy (18.9%) and also second and above pregnancy (19.6%). The number of ANC visits was statistically associated with anemia (p=0.010). Pregnant women who had attended ANC for first time (23%) had higher prevalence of anemia. Most of the participants 198 (93.8%) had not taken deworming tablet at current pregnancy were found to be more anemic. Anemia were found to be more prevalent in underweight pregnant women (32.3%) and having MUAC <23 cm (26.6%). Statistical analysis showed that MUAC and BMI had a significant association on anemia. Those participants who had poor knowledge about anemia and balanced diet were found to be more anemic. Those who were using firewood/others as cooking fuel had the highest anemia proportion (26.5%). Similarly, pregnant women using others such as river water, pond etc. as source of drinking water (20%) also found to be more anemic.

In this present study, the majority 196 (92.9%) of the participants were non-vegetarian. The prevalence of anemia was highest among pregnant women having a meal frequency more than two times per day (19.6%). Those participants who consumed meat 1-3 times a week and fruit 1-3 times a week were found to be more anemic. Statistical analysis showed that frequency of egg taken had significant association on anemia (p=0.042). A high prevalence of anemia was found in those who were not consuming egg, milk and its products (29.6% and 40% respectively). Similarly, those who had eaten green leafy vegetables 1-2 times per day were more anemic. The majority 201 (95.3%) of the participants were not forbid for foods during pregnancy. The prevalence of anemia was found to be high in those pregnant women who drank tea for two times per day (27.8%). Regarding the types of tea, pregnant women who drank milk tea (19.5%) were found to be more anemic. In addition, no statistical significant association was observed in types of tea taken and anemia.Thus, improving the level of education, economic and nutritional status of pregnant women would contribute to reducing the prevalence of anemia in this population.

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Appendices

Appendix A

Semi-structured questionnaire

A. General information

1. Code no. :__________ 2. Date of interview:__________

3. Name of respondents:__________ 4. Age:__________

5. Address: __________ 6. Contact no. : __________

7. Value of haemoglobin level: __________

B. Anthropometric measurements

1. Weight (kg) ☐ 2. Height (cm) ☐

3. MUAC (cm) ☐ 4. BMI (kg/m^2) ☐

5. Classification of BMI:

a. Normal ☐ b. Overweight ☐ c. Obese ☐ d. Underweight ☐

C. Socio-demographic and economic status

1. How many members are there in your family?

a. 3 ☐ b. 4 ☐ c. 5 ☐ d. above 5 [specify]

2. What is the total numbers of male/s and female/s in your family?

a. Male/s ☐ b. Female/s ☐

3. Which ethnic group do you belong?

a. Brahmin/Chhetri ☐ b. Janajati ☐ c. Madhesi ☐ d. Dalit ☐ e. Others [specify]

4. What is your religion?

a. Hindu ☐ b. Buddhist ☐ c. Muslim ☐ d. Christian ☐ e. Others [specify]

5. What is your education level?

a. Primary ☐ b. Secondary ☐ c. Higher secondary ☐ d. Bachelor & above ☐

e. Illiterate ☐

6. What is your husband education level?

a. Primary ☐ b. Secondary ☐ c. Higher secondary ☐ d. Bachelor & above ☐

e. Illiterate ☐

7. What is your Occupation?

a. Housewife ☐ b. Service ☐ c. Business ☐ d. Agriculture ☐ e. Others [specify]

8. What is your husband's occupation?

a. Service ☐ b. Business ☐ c. Agriculture ☐ d. Others [specify]

9. What is the main source of income of your family?

a. Service ☐ b. Business ☐ c. Agriculture ☐ d. Others [specify]

10. What is your family income per annum?

a. < 2 lakh ☐ b. 2-5 lakh ☐ c. > 5 lakh ☐

11. What is the source of fuel for cooking in the house?

a. LPG ☐ b. Kerosene ☐ c. Firewood ☐ d. Gobargas/bio-gas ☐ e. Others [specify]

12. What type of toilet is there in your house?

a. Open ☐ b. Pit ☐ c. Indian toilet ☐ d. European toilet ☐

13. What is the type of your house?

a. Hut ☐ b. Semi-pucca ☐ c. Pucca ☐

D. Maternal status

1. What was your age when you got married?

a. < 18 ☐ b. 18-20 ☐ c. ≥ 21 ☐

2. What is your gestational period?

a. 1st trimester ☐ b. 2nd trimester ☐ c. 3rd trimester ☐

3. Is this your first pregnancy?

a. Yes ☐ b. No ☐

(i) If no, what was your age at first pregnancy?

a. < 19 ☐ b. 19-21 ☐ c. ≥ 22 ☐

(ii) What is the number of pregnancy?

a. < 3 ☐ b. 3-5 ☐ c. ≥ 6 ☐

(iii) What is the number of deliveries?

a. 1 ☐ b. 2-4 ☐ c. ≥ 5 ☐

(iv) What is the total number of your live male/s and female/s children?

a. Male/s ☐ b. Female/s ☐

4. Have you received antenatal care during current pregnancy?

a. Yes ☐ b. No ☐

If yes, what is the frequency of your antenatal care visit?

a. 1 ☐ b. 2 ☐ c. 3 ☐ d. 4 ☐ e. > 4 ☐

E. Health, Knowledge and Practices status

1. During last three to six months did you have known medical illness?

a. Yes ☐ b. No ☐

If yes, then what it is? ________________

2. Have you taken deworming tablet recently?

a. Yes ☐ b. No ☐

3. Do you know about anemia?

a. Yes ☐ b. No ☐

(i) If yes, do you have any knowledge about anemia symptoms?

a. Not aware of any anemia symptoms ☐

b. Aware of some anemia symptoms ☐

4. Do you know about balanced diet?

a. Yes ☐ b. No ☐

5. Where do you go when you are sick?

a. Shamans ☐ b. Hospital ☐ c. Self-prescription ☐ d. Others ☐

6. What is the source of your drinking water?

a. Tap ☐ b. Common tap ☐ c. Hand Pump ☐ d. Well ☐ e. Others [specify]

7. Do you purify your drinking water?

a. Yes ☐ b. No ☐

(i) If yes, how often do you purify your drinking water before drinking?

a. Always ☐ b. Sometimes ☐ c. Never ☐ d. When needed ☐

(ii) What kind of method do you use for purification of your drinking water?

a. Filtration ☐ b. Boiling ☐ c. Sodis ☐ d. Others [specify]

F. Dietary habits status

1. What type of food do you consume?

a. Veg ☐ b. Non-veg ☐ c. Mixed ☐

2. What is your staple food?

a. Rice ☐ b. Wheat ☐ c. Maize ☐ d. Millet ☐ e. Others [specify]

3. What kind of salt do you used for consumption?

a. Crystal salt ☐ b. Iodized salt ☐ c. Others [specify]

4. How many times do you have meal per day?

a. One time ☐ b. Two times ☐ c. Three times ☐ d. More than three times ☐

5. How often do you take meat?

a. Everyday ☐ b. 1-3 times a week ☐ c. 4-6 times a week ☐

6. How often do you take fruit?

a. Everyday ☐ b. 1-3 times a week ☐ c. 4-6 times a week ☐

7. How often do you take egg?

a. Everyday ☐ b. 1-3 times a week ☐ c. 4-6 times a week ☐

8. How often do you take milk and milk products?

a. More than two times per day ☐ b. Once per day ☐ c. Once per week ☐

d. Less than once per week ☐

9. How often do you take green leafy vegetables?

a. More than two times per day ☐ b. Once per day ☐ c. Once per week ☐

d. Less than once per week ☐

10. Is there any forbidden foods for pregnancy?

a. Yes ☐ b. No ☐

If yes, then what it is? ________________

11. Do you have pica?

a. Yes ☐ b. No ☐

12. Do you drink tea/coffee?

a. Yes ☐ b. No ☐

(i) If yes, how often do you drink it?

a. One time ☐ b. Two times ☐ c. Three times ☐ d. More than three times ☐

(ii) What type of tea/coffee do you drink it?

a. Black tea/coffee ☐ b. Milk tea/coffee ☐ c. Others ☐

13. Do you drink alcohol?

a. Yes ☐ b. No ☐

If yes, how much do you drink it?

a. ≤ 20 ml/day ☐ b. > 20 ml/day ☐ c. Occasionally ☐

14. Do you smoke cigarette?

a. Yes ☐ b. No ☐

If yes, how many stick/s of cigarette do you smoke per day?

a. ≤ 5 ☐ b. 6-10 ☐ c. More than 10 ☐

Appendix B

प्रश्नावली

क) सामान्य जानकारी

१) कोड न ____________________ अन्तरवार्ता मिति : ____________________

२) सहभागीको नाम : ____________________ ३) उमेर : ____________________

४) ठेगाना : ____________________ ५) सम्पर्क न ____________________

६) हेमोग्लोविनको मात्रा : ____________________

ख) Anthropometric measurements (शारीरिक नपाई))

१) तौल (kg) ☐ २) उचाई (cm) ☐ ३) MUAC (cm) ☐ ४) BMI (kg/m^2) ☐

५) BMI को वर्गीकरण

(i) Overweight ☐ (ii) Obese ☐ (iii) Underweight ☐ (iv) Normal ☐

ग) जनसांख्यिक/सामाजिक तथा आर्थिक अवस्था

१) तपाईंको परिवारमा कति जना सदस्यहरु हुनुहुन्छ ?

(i) ३ ☐ (ii) ४ ☐ (iii) ५ ☐ (iv) ५ भन्दा माथि ☐

२) तपाईंको परिवारमा कति-कति जना महिला तथा पुरुष सदस्यहरु हुनुहुन्छ ?

(i) महिला/हरु ☐ (ii) पुरुष/हरु ☐

३) तपाईं कुन जातीय वर्गमा पर्नुहुन्छ ?

(i) ब्राम्हण/क्षेत्री ☐ (ii) जनजाति ☐ (iii) मधेसी ☐ (iv) दलित ☐ (v) अन्य ____________________

४) तपाईं कुन धर्म मान्नुहुन्छ ?

(i) हिन्दु ☐ (ii) बौद्ध ☐ (iii) क्रिश्चियन ☐ (iv) इस्लाम ☐ (v) अन्य ____________________

५) तपाईंको शैक्षिक योग्यता कति छ ?

(i) प्राथमिक ☐ (ii) माध्यमिक ☐ (iii) उच्च माध्यमिक ☐ (iv) स्नातक तथा सो भन्दा माथि ☐

(v) निरक्षर ☐

६) तपाईंको श्रीमान्‌को शैक्षिक योग्यता कति छ ?

(i) प्राथमिक ☐ (ii) माध्यमिक ☐ (iii) उच्च माध्यमिक ☐ (iv) स्नातक तथा सो भन्दा माथि ☐

(v) निरक्षर ☐

७) तपाईंको पेसा के हो ?

(i) घरगृहिणी ☐ (ii) व्यवसाय ☐ (iii) नोकरी ☐ (iv) कृषि ☐ (v) अन्य ________________

८) तपाईंको श्रीमान्‌को पेसा के हो ?

(i) व्यवसाय ☐ (ii) नोकरी ☐ (iii) कृषि ☐ (iv) अन्य ________________

९) तपाईंको परिवारमा प्रमुख आम्दानीको स्रोत के हो ?

(i) व्यवसाय ☐ (ii) नोकरी ☐ (iii) कृषि ☐ (iv) अन्य ________________

१०) तपाईंको परिवारमा वार्षिक आम्दानी कति हुन्छ ?

(i) २ लाखभन्दा कम ☐ (ii) २ देखि ५ ☐ (iii) ५ लाख भन्दा बढी ☐

११) तपाईंको घरमा खाना पकाउने इन्धनको स्रोत के हो ?

(i) एल.पि.जि. ग्याँस ☐ (ii) मट्टीतेल ☐ (iii) दाउरा ☐ (iv) गोबर ग्यास ☐ (v) अन्य ____________

१२) तपाईंको घरमा कस्तो प्रकारको चर्पी प्रयोग गर्नुहुन्छ ?

(i) खुला मैदान ☐ (ii) खाल्डो ☐ (iii) भारतीय चर्पी ☐ (iv) यूरोपेली चर्पी ☐

१३) तपाईंको घर कस्तो प्रकार छ ?

(i) छाप्रो ☐ (ii) कच्चि ☐ (iii) पक्का ☐

(घ) मातृत्व अवस्था

(१) तपाईंको विवाह हुँदा उमेर कति थियो ?

(i) ≤ १८ ☐ (ii) १८ देखि २० ☐ (iii) ≥ २१ ☐

(२) तपाईंको गर्भ अवधि (gestational period) कति हो ?

(i) पहिलो तीन महिनाको अवधि ☐ (ii) दोस्रो तीन महिनाको अवधि ☐ (iii) तेस्रो तीन महिनाको अवधि ☐

(३) तपाईंको यो पहिलो गर्भावस्था हो ?

(i) हो ☐ (ii) होइन ☐

(I) यदि होइन भने, तपाईंको उमेर पहिलो गर्भावस्थामा कति थियो ?

(i) < १९ ☐ (ii) १९ देखि २१ ☐ (iii) ≥ २२ ☐

(II) तपाईंको यो कतियौं गर्भावस्था हो ?

(i) < ३ ☐ (ii) ३ देखि ५ ☐ (iii) ≥ ६ ☐

(III) तपाईंको यो कतियौं सुत्केरी (Deliveries) हो ?

(i) १ ☐ (ii) २ देखि ४ ☐ (iii) ≥ ५ ☐

(IV) तपाईंको जीवित कति-कति जना केटी तथा केटा बच्चा/हरु छन् ?

(i) केटी/हरु ☐ (ii) केटा/हरु ☐

४) अहिलेको गर्भावस्थामा तपाईंले डाक्टरी जाँच (Antenatal Care) गर्दै हुनुहुन्छ ?

(i) गरेको छु ☐ (ii) गरेको छुइन ☐

यदि गर्नुहुन्छ भने, तपाईं कतियौं पटक डाक्टरी जाँचको लागि जानुभयो ?

(i) १ ☐ (ii) २ ☐ (iii) ३ ☐ (iv) ४ ☐ (v) ४ भन्दा ज्यादा ☐

(ङ) स्वास्थ्य, ज्ञान तथा अभ्यासको अवस्था

(१) पछिल्लो तीनदेखि ६ महिनासम्म तपाईंलाई कुनै बिमार भएको थियो ?

(i) थियो ☐ (ii) थिएन ☐

यदि थियो भने, कुन बिमार ____________________

(२) तपाईंले जुकाको औषधि भर्खरै लिनु भएको छ ?

(i) छ ☐ (ii) छैन ☐

(३) तपाईंलाई रक्तअल्पताको बारेमा थाहा छ ?

(i) छ ☐ (ii) छैन ☐

(I) यदि छ भने तपाईंलाई रक्तअल्पताको लक्षणबारे कुनै जानकारी छ ?

(i) रक्तअल्पताको लक्षणबारे कुनै पनि जानकारी छैन ☐

(ii) रक्तअल्पताको लक्षणबारे केही जानकारी छ ☐

(II) तपाईंलाई रक्तअल्पताको नकारात्मक परिणाम बारे जानकारी छ ?

(i) नकारात्मक परिणाम बारे कुनै पनि जानकारी छैन ☐
(ii) नकारात्मक परिणाम बारे केही जानकारी छ ☐

(४) तपाईंलाई सन्तुलित भोजनबारे जानकारी छ ?

(i) छ ☐ (ii) छैन ☐

(५) तपाईं बिरामी हुँदा कहाँ जानुहुन्छ ?

(i) धामी/झाँक्री ☐ (ii) अस्पताल ☐ (iii) आफ्नो निर्देशनमा ☐ (iv) अन्य ________

(६) तपाईंको पिउने पानीको मुख्य स्रोत के हो ?

(i) घरमा भएको धारा ☐ (ii) सार्वजनिक धारा ☐ (iii) कल ☐ (iv) इनार ☐ (v) अन्य ________

(७) तपाईंले पिउने पानीको शुद्धीकरण गर्नुहुन्छ ?

(i) गर्छु ☐ (ii) गर्दिन ☐

(I) यदि गर्नुहुन्छ भने, तपाईं प्राय कतिपटकसम्म सुद्धीकरण गर्नुहुन्छ ?

(i) सधैं ☐ (ii) कहिले-कहिले ☐ (iii) कहिल्यै पनि गर्दिन ☐ (iv) चाहिएको बेलामा ☐

(II) तपाईं कसरी पिउने पानीको शुद्धीकरण गर्नुहुन्छ ?

(i) छानेर ☐ (ii) उमालेर ☐ (iii) सोडिस ☐ (iv) अन्य ________

च) भोजन वा सोस"ग सम्बन्धित बानी बेहोरोका अवस्था

१) तपाईं कुन प्रकारको खाना खानु हुन्छ ?

(i) शाकाहारी खाना ☐ (ii) मांसाहारी खाना ☐ (iii) दुवै ☐

२) तपाईंको प्रमुख खानाको स्रोत के हो ?

(i) चामल ☐ (ii) गहुँ ☐ (iii) मकै ☐ (iv) कोदो ☐ (v) अन्य ________

३) तपाईंको कुन प्रकारको नुन प्रयोग गर्नुहुन्छ ?

(i) ढिके नुन ☐ (ii) आयोडिन युक्त नुन ☐ (iii) अन्य ☐

४) तपाईं दिनमा कति पटकसम्म खाना लिनुहुन्छ ?

(i) १ पटक ☐ (ii) २ पटक ☐ (iii) ३ पटक ☐ (iv) ३ पटक भन्दा ज्यादा ☐

५) तपाईं मासु प्राय कति पटकसम्म लिनुहुन्छ ?

(i) सधैं ☐ (ii) हप्ताको १ देखि ३ पटक ☐ (iii) हप्ताको ४ देखि ६ पटक ☐

६) तपाईं फलफूल प्राय कति पटकसम्म लिनुहुन्छ ?

(i) सधैं ☐ (ii) हप्ताको १ देखि ३ पटक ☐ (iii) हप्ताको ४ देखि ६ पटक ☐

७) तपाईं अण्डा प्राय कति पटकसम्म लिनुहुन्छ ?

(i) सधैं ☐ (ii) हप्ताको १ देखि ३ पटक ☐ (iii) हप्ताको ४ देखि ६ पटक ☐

८) तपाईं दूध तथा दूधबाट बन्ने पदार्थ प्रायः कति पटकसम्म लिनुहुन्छ ?

(i) दिनमा दुई वा दुईभन्दा ज्यादा ☐ (ii) दिनमा एक पटक ☐ (iii) हप्तामा एक पटक ☐

(iv) हप्तामा एक पटक भन्दा कम ☐

९) तपाईं हरियो साग, सब्जी प्रायः कति पटकसम्म लिनुहुन्छ ?

(i) दिनमा दुई वा दुईभन्दा ज्यादा ☐ (ii) दिनमा एक पटक ☐ (iii) हप्तामा एक पटक ☐

(iv) हप्तामा एक पटक भन्दा कम ☐

१०) तपाईंलाई गर्भावस्थामा कुनै निषेधित खाना छ ?

(i) छ ☐ (ii) छैन ☐

११) तपाईं गर्भावस्थामा अखाद्य कुरा (जस्तै माटो, ढुङ्गा) खानु हुन्छ ?

(i) खान्छु ☐ (ii) खाँदिन ☐

१२) तपाईं चिया/कफी पिउनुहुन्छ ?

(i) पिउँछु ☐ (ii) पिउँदिन ☐

(I) यदि पिउनुहुनछ भने, दिनमा कति पटकसम्म पिउनुहुन्छ ?

(i) एकपटक ☐ (ii) दुई पटक ☐ (iii) तीन पटक ☐ (iv) तीन पटकभन्दा ज्यादा ☐

(II) तपाईं कस्तो प्रकारको चिया/कफी पिउनुहुन्छ ?

(i) कालो चिया/कफी ☐ (ii) दूध चिया/कफी ☐ (iii) अन्य ____________________

१३) तपाईं मदिरा पिउनुहुन्छ ?

(i) पिउँछु ☐ (ii) पिउँदिन ☐

यदि पिउनुहुनछ भने, कति मात्रामा पिउनुहुन्छ ?

(i) ≤ 20ml/दिन ☐ (ii) > 20ml/दिन ☐ (iii) विशेष अवसरमा ☐

१४) तपाईं धुम्रपान गर्नुहुन्छ ?

(i) गर्छु ☐ (ii) गर्दिन ☐

यदि गनुहुन्छ भने, दिनमा कति पटकसम्म धुम्रपान गर्नुहुन्छ ?

(i) ≤ ५ खिलि ☐ (ii) ६ देखि १० खिलि ☐ (iii) १० खिलि भन्दा ज्यादा ☐

Appendix C

CONSENT FORM

केन्द्रिय प्रविधि क्याम्पस

हात्तिसार, धरान

<u>रगतमा हेमोग्लोबिन जाँच गराउनको लागि सूचित मन्जुरीनामा पत्र</u>

नाम र थर :	
उमेर र लिंग :	
ठेगाना :	
जाँच गराएको मिति :	

<u>गराइने जाँचहरु र अन्य विवरण :</u>

- हेमोग्लोबिनको जाँचका लागि गरिने रगतको नमुना
- खाने कुराको विवरणको लागि प्रश्नको उत्तर
- उचाइ र तौल

<u>विगतमा यदि तल उल्लेखितमध्येका कुनै अवस्था तपाइ /तपाईको छोरीसंग मेल खाएमा यो जाँच गराउनु हुदैन ।</u>

- कुनै रोग प्रतिरोधात्मक क्षमता कमजोर बनाउने औषधि सेवन गरेको भएमा
- कुनै प्राण घातक रोग लागेको भएमा
- रगतको मात्रा बढाउने औषधि सेवन गर्दै गरेको भएमा

<u>बुदाँहरु</u>

- यो पढाईको लागि मात्र हो
- यो जाँच गराउँदा हुनसक्ने संभावित असरहरुको बारेमा मलाई जानकारी गराइएको छ ।
- हेमोग्लोबिन जाँचका लागि गरिने रगत जाँचको बारेमा माथि उल्लेखित जानकारीहरु बुझ्रेर सो जाँच गराउनका लागि म सहमत छु ।
- सम्बन्धित सम्पूर्ण जाँचहरु पूर्णतया गोप्य राखिनेछ ।

<u>सहभागि</u>

दस्तखत :________________ मिति : ________________

जाचकिको दस्तखत र मिति :________________ परिणाम हेर्ने मिति :______________

Appendix D

Map of survey site (Itahari sub-metropolitan city)

Source: **http://www.holidaytravelreports.com/Travel/Itahari.aspx**

Appendix E

Table 8.1: Distribution of different forms of anemia based on different study variables

Variables	Type of anemia		
	Non-anemic n (%)	Mild n (%)	Moderate n (%)
Age in years			
<30	151 (82.1)	29 (15.8)	4 (2.2)
≥30	21 (77.8)	6 (22.2)	Nill
Family size			
<5	99 (84.6)	16 (13.7)	2 (1.7)
≥5	73 (77.7)	19 (20.2)	2 (2.1)
Ethnicity			
Dalit	17 (68)	7 (28)	1 (4)
Janajati	77 (82.8)	14 (15.1)	2 (2.2)
Brahmin/Chhetri	66 (86.8)	9 (11.8)	1 (1.3)
Madhesi/Others	12 (70.6)	5 (29.4)	Nill
Religion			
Hindu	145 (80.6)	31 (17.2)	4 (2.2)
Muslim	8 (80)	2 (20)	Nill
Buddhist	9 (90)	1 (10)	Nill
Christian	4 (80)	1 (20)	Nill
Others	6 (100)	Nill	Nill
Education of the participants			
Illiterate	4 (66.7)	2 (33.3)	Nill
Primary	25 (69.4	11 (30.6)	Nill
Secondary	94 (82.5)	16 (14)	4 (3.5)
Higher secondary & above	49 (89.1)	6 (10.9)	Nill
Yearly income			
<2 lakh	40 (75.5)	12 (22.6)	1 (1.9)
2-5 lakh	122 (86.5)	17 (12.1)	2 (1.4)

Age at first marriage			
<18 years	59 (80.8)	14 (19.2)	Nill
18-20 years	49 (79)	10 (16.1)	3 (4.8)
≥21 years	64 (84.2)	11 (14.5)	1 (1.3)
Gestational period			
First trimester	26 (83.9)	5 (16.1)	Nill
Second trimester	146 (81.1)	30 (16.7)	4 (2.2)
Number of pregnancies			
First pregnancy	94 (82.5)	19 (16.7)	1 (0.9)
Second and above pregnancy	78 (80.4)	16 (16.5)	3 (3.1)
Frequency of ANC visits			
One time	114 (77)	30 (20.3)	4 (2.7)
Two times & more	58 (92.1)	5 (7.9)	Nill
Deworming tablet			
Yes	11 (84.6)	2 (15.4)	Nill
No	161 (81.3)	33 (16.7)	4 (2)
MUAC			
<23	47 (73.4)	15 (23.4)	2 (3.1)
≥23	125 (85)	20 (13.6)	2 (1.4)
BMI			
Underweight	21 (67.7)	10 (32.3)	Nill
Normal	120 (82.2)	22 (15.1)	4 (2.7)
Overweight	31 (91.2)	3 (8.8)	Nill
Knowledge about anemia			
Yes	39 (90.7)	3 (7)	1 (2.3)
No	133 (79.2)	32 (19)	3 (1.8)
Knowledge about balanced diet			
Yes	154 (82.4)	31 (16.6)	2 (1.1)
No	18 (75)	4 (16.7)	2 (8.3)
Cooking fuel			
LPG	136 (84)	22 (13.6)	4 (2.5)
Firewood/Others	36 (73.5)	13 (26.5)	Nill

Source of drinking water			
Tap	80 (82.5)	13 (13.4)	4 (4.1)
Hand Pump	68 (81)	16 (19)	Nill
Others	24 (80)	6 (20)	Nill
Purification of drinking water			
Yes	55 (80.9)	13 (19.1)	Nill
No	117 (81.8)	22 (15.4)	4 (2.8)
Eating habits			
Vegetarian	14 (93.3)	1 (6.7)	Nill
Non-vegetarian	158 (80.6)	34 (17.3)	4 (2)
Frequency of meal per day			
Two times	127 (81.9)	25 (16.1)	3 (1.9)
More than two times	45 (80.4)	10 (17.9)	1 (1.8)
Frequency of meat taken			
Everyday	26 (92.9)	2 (7.1)	Nill
1-3 times a week	132 (78.6)	32 (19)	4 (2.4)
0	14 (93.3)	1 (6.7)	Nill
Frequency of fruit taken			
Everyday	84 (82.4)	17 (16.7)	1 (1)
1-3 times a week	88 (80.7)	18 (16.5)	3 (2.8)
Frequency of egg taken			
Everyday	25 (89.3)	3 (10.7)	Nill
1-3 times a week	109 (84.5)	18 (14)	2 (1.6)
0	38 (70.4)	14 (25.9)	2 (3.7)
Frequency of milk and its products taken			
1-2 times per day	144 (83.2)	27 (15.6)	2 (1.2)
Once per week	25 (75.8)	6 (18.2)	2 (6.1)
0	3 (60)	2 (40)	Nill

Frequency of green leafy vegetables taken			
1-2 times per day	166 (81.4)	34 (16.7)	4 (2)
Once per week	6 (85.7)	1 (14.3)	Nill
Forbidden foods during pregnancy			
Yes	6 (60)	4 (40)	Nill
No	166 (82.6)	31 (15.4)	4 (2)
Frequency of tea taken			
One time	111 (84.7)	18 (13.7)	2 (1.5)
Two times	26 (72.2)	9 (25)	1 (2.8)
0	35 (79.5)	8 (18.2)	1 (2.3)
Types of tea taken			
Black tea	75 (83.3)	15 (16.7)	Nill
Milk tea	62 (80.5)	12 (15.6)	3 (3.9)
0	35 (79.5)	8 (18.2)	1 (2.3)

Photo gallery

Plate 1: The participant's information was taking through semi-structured questionnaire.

Plate 2: Determining haemoglobin concentration in a well-calibrated photometer.

Plate 3: By using stadiometer, the participant's height was measured.

Plate 4: By the help of electronic weight scale, the participant's weight was measured.

Plate 5: Collecting the haemoglobin data with PHC interns.

Plate 6: Photo glimpse with PHC staffs and participants.