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ADDIS ABABA UNIVERSITY

**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES
CENTER FOR FOOD SCIENCE AND NUTRITION**

**Low birth weight prevalence and associated factors in selected health centers
in Addis Ababa**




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Declaration

I, the undersigned, declare that, this is original work and has never been presented in any other University as well as research institutes and all the source materials used for writing the thesis have been fully acknowledged.

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Abbreviations and Acronyms

| | |
|--------|---|
| AACAHB | Addis Ababa city Administration health bureau |
| AAS | Atomic absorption spectrometry |
| AES | Atomic Emission spectrometry |
| ANC | Ante natal care |
| BMI | Body mass index |
| COR | Crude Odds Ratio |
| EHNRI | Ethiopian health and nutrition research institute |
| FFQ | Food frequency questioner |
| FMHACA | Food medicine and health authority control agency |
| WDDS | Women dietary diversity score |
| DDS | Dietary diversity score |
| ASF | Animal source food |
| GWG | Gestational weight gain |
| JHU | Johns Hopkins University |
| IQ | Intelligence quotient |
| IUGR | Intra uterine growth retardation |

| | |
|--------|---|
| LBW | Low birth weight |
| MUAC | Middle upper arm circumference |
| ppm | Parts per million |
| RDA | Recommended dietary allowances |
| SPSS | Statistical processing for social science |
| UNICEF | United nations children fund |
| WHO | World health organization |

Abstract

Background: Weight at birth is the most important factor determining neonatal survival and wellbeing both during early life and in adulthood. Globally, about 17% of infants are born with small weight for their age. The incidence is particularly higher in developing nations. Weight at birth is determined by several factors including life style of the mother, physical condition, and weight gain during pregnancy. In addition, micronutrient deficiency, nutrition of the mother affects birth weight and birth outcomes in general.

Methodology: In a prospective cohort design 341 pregnant women (all at first trimester) participated in the study and followed until delivery. Socio-demographic, dietary pattern, maternal morbidity, and anthropometry characteristics were assessed. In addition, intake of Iron folic acid supplementation was captured. Hemoglobin concentration of participating women was measured at first and third trimester. Moreover, serum zinc concentration was determined at first trimester. Birth weight of new born were measured at delivery

Result: Respondents were in the age range of 17-40 with mean 26 ± 4.8 years and The mean weight of study participants were 56.9 ± 9.9 , 59.9 ± 9.8 and 62.5 ± 10.0 kg at first, second and third trimester, respectively. One in ten (10.9%) of women were underweight (BMI <18.5 kg/m²) and 11.7 % of women were MUAC <21 cm at first trimester. Majority of the women (69.8%) had meal three times per day. Only 10.3% of women had snack eating habit. The present study subjects were characterized by intake of starchy staples (100%) followed by fruits and vegetables, and organ meat were the least food groups taken by the study subject. Coffee was the most common beverage consumed by 90% of the participants and 55.8% women took coffee immediately after meal. Majority (57.5%) of women were multiparous. Only 12% of the women were taking IFA before starting the antenatal care follow up. Iron folic acid drop out were 18.5% and 14.3% at second and third trimester, respectively, 55 (16.0%) of women were anemic (Hemoglobin <11.0 g/dl) at first trimester and 56(16.70%) at third trimester. Among 329 newborn weight measured immediately after delivery 46 (14.0%) were under weight (<2.50 kg). Associated Factors of LBW includes, IFA supplementation (OR:0.20, P=0.001), Age of participant (OR:3.469,p=0.028), Weight at first trimester (OR: 7.8, P=0.053), weight gain throughout pregnancy (OR:0.01,P <0.001),dinner eating habit (OR:3.14,P=0.04), MUAC (OR:2.53,P=0.03), BMI of First trimester (OR: 2.53, P=0.02),Employment status of the husband (OR:0.108,P=0.03) ,Hemoglobin at third trimester (OR:0.03,P=0.05), serum Zinc Deficient women (OR: 0.012, P <0.001),Taking milk and Milk product during pregnancy (OR:7.68,P=0.002) and Snack eating habit (OR:0.21,p=0.04).

Conclusion and recommendation: Almost 14.0% of new born were low birth weight, associated factors that affect birth weight are: Age of participants (age <20 years), The dietary pattern (snack and dinner eating habit), nutritional status (taking milk and milk product), Mothers BMI(<18.5 kg/m²), MUAC(<21 cm) , IFA supplementation at second trimester, hemoglobin level, weight at first trimester (<50.0 kg), Inadequate weight gain and participants husband employment status. Health education about micronutrient supplementation and optimal nutrition during pregnancy is needed.

Key words: - low birth weight, pregnancy, risk factors, prevalence of Low birth weight, hemoglobin concentrations, serum Zinc.

Chapter One -Introduction

1.1. Background

Weight at birth is an important determinant factor for growth and development of infants (Tema et al 2006). Low birth weight (LBW) defined by WHO as birth weight <2500g, is associated to infant morbidity and mortality (Jean et al 1978). In addition, it is associated to limitations in attaining optimal physical and mental growth consequently associated benefits during the later life. Moreover, adults born with low birth weight for age or small size for gestational age are at higher risk of development of chronic diseases (Jarvier et al 2004). LBW infants had 40 times greater risk of dying in the neonatal period, a 50 % greater chance of series development problems, e.g. learning disabilities, and mental retardation , IQ point decrease of 5 to 10 point, long term disabilities and premature death (UNICEF 2002,Shrestha et al 2010).

Low birth weight associated to, 40%-80% of neonatal deaths, 98% of which occur in developing countries (Bhutta *et al* 2005). LBW is strongly associated to peri natal morbidity , increased risk of long term disability(Goldenberg *et al* 2007), Increase neonatal hospitalization costs (Petru *et al* 2003), risk of child growth and development disruption (e.g. neurologic disorders, learning disabilities, child hood psychiatric disorders, mental retardation) (Kathleen *et al* 2010, ,Goldenberg *et al* 2007).

The global prevalence of LBW is around 17%. However, estimates vary from 19% in the developing countries to 5-7% in the developed countries (Juvier *et al* 2004).

Maternal weight during pregnancy, maternal dietary intake, micronutrient status, maternal height, hemoglobin level, maternal age, was considered as major determinants of LBW. Example according to Meyer et al, women <158 cm has high risk of delivering a LBW infant compared to women of average height (158 cm-172 cm). Pre-pregnancy weight reflects nutritional stores potentially available to the growing fetus. Sunman (Suman *et al* 2016) reported that maternal nutrition has direct effect on birth weight of new born thus less nourished mother deliver higher percentage of low birth weight babies compared to well-nourished mothers (Suman et al 2016, Amosu *et al* 2014). In addition another study looking at the relationship between maternal hemoglobin and child birth weight reported that mothers with very low concentration of hemoglobin (<7.0 g/dl) had baby weight <2.00kg, whereas babies with weight above 3.00kg

were delivered from mothers with hemoglobin above 10g/dl % (Suman *et al* 2016, Gurangai *et al* 2004). Maternal age, according to M.ferguson MS et al those mothers aged <17 and >35 years the incidence of LBW is high (Ferguse *et al* 1988, Astha *et al* 2017).

Few studies are available in Ethiopia focusing on determining the prevalence of LBW. For example, in Gonder town, Edris And Eraki reported 17.8% of LBW among 393 singleton live births. The authors also reported that maternal age, family income, being single mother were risk factors associated significantly to LBW infant delivery (Edris *et al* 1996). In addition, in Kersa town of Jimma Zone, a 28.3% of LBW delivery was reported and factors such as maternal mid upper arm circumference (MUAC) being less than 23 cm and not attending ANC were significant determinants for LBW (Asefa *et al* 2012).

In Jima (in selected health centers) 22.5% and mothers residing in the urban area had higher risk, multiple gestation and those delivered before 37 weeks as determinants of LBW (Aseffa *et al* 2004). In Jima hospital (2005), 11.02% and those mothers younger than 20 years and ≥ 35 years, short stature mothers (≤ 150 cm), late first ANC visit and complication during pregnancy were the prevalence and association factors of LBW respectively (Gebremariam 2005). The study conducted in Addis Ababa used retrospective data from tertiary teaching hospital (prevalence 8.8%). Clients who visited such hospital are referred from other hospital and both from urban and rural area, which cannot be representative of other clients as they may have different complications. Therefore they are not true reflection of birth weight (Aseffa *et al* 2004).

In Ethiopia there is limited information on birth weight, especially there is no adequate information on the prevalence and determinants of LBW in the study area. Thus it is found useful to conduct a study in selected health center, in Addis Ababa, Ethiopia. In Addition, the risk factors are not well identified. The aim of this study was to determine prevalence of LBW and associated factors. Identifying determinants of LBW and preventing them helps in reducing early childhood morbidity and mortality resulting from LBW. Therefore addressing factors affecting the birth weight of babies contribute to the achievement of decreasing maternal and child mortality rate.

1.2 Statement of the problem

According to WHO report global incidence of LBW is around 17%. Those babies that born below their expected weight (<2500g) are at high risk of disorders /disruption of child growth and development, increase neonatal hospitalization cost ,neurologic disorders, learning disabilities mental retardation (Kathlen *et al* 2010, Goldenberg *et al* 2007). They can suffer from extremely high rates of morbidity and mortality from infectious disease, and are under weight, stunted or wasted beginning in the neonatal period through childhood. Infants weighing 2000-2499g at birth are four times more likely to die during their first 28 days of life than infants who weigh 2500-2999g, and ten times more likely to die than infants weighing 3000-3499g (Javier *et al* 2004, Pojda *et al* 2000).

LBW become major public health problems in most developing countries, being associated with a high incidence of neonatal mortality (Tema 2006, Amosu *et al* 2014). In which 19% of incidence of LBW occurs in developing countries (Javier *et al* 2004). Thus, birth weight has long been a subject of clinical and epidemiological investigations and target for public health intervention. In particular, considerable attention has been focused on the causal determinants of birth weight, and especially of low birth weight (LBW), in order to identify potentially modifiable factors (Tema 2006).

Although few studies were conducted in Ethiopia, There is limitation of literature review and inadequate information related with Prevalence and associated factors on LBW (Edris *et al* 1996), especially in the study area and poor availability of data and evidence for delivering successful intervention to reduce LBW. Takemoto Recommends that further study must be carried to accurately identify potential risk factors that explain the increase in LBW (Takemato *et al* 2016). Therefore this study determines prevalence of LBW and associated factors, from selected health centers, in Addis Ababa, Ethiopia.

1.3 Significance of the study

The study generates information on prevalence of LBW and how maternal anthropometry, gestational weight gain, height, maternal nutritional status, socio-economic and demographic, zinc and hemoglobin level associated to LBW. This can be useful in formulating strategic policies to address LBW incidence of maternal child nutrition and health education. The finding from this study can contribute knowledge on maternal and child health care. The knowledge also useful in the ministry of health and any organization intended to design intervention program in Ethiopia and worldwide.

1.4 Objectives

General objective

- To assess the prevalence of LBW and identify associated risk factors, in selected antenatal care units in Addis Ababa.

Specific objectives

- To determine prevalence of low birth weight in selected antenatal care units in Addis Ababa.
- To identify factors associated with LBW in selected antenatal care units in Addis Ababa.

Chapter Two- Literature review

2.1 Epidemiology of Low birth weight

Weight at birth is an important determinant of growth and development to new born (Tema et al 2006). Low birth weight (LBW) is defined by WHO as birth weight less than 2.500Kg (world health organization 2004).

The global incidence of LBW is around 17%, although estimates vary from 19% in the developing countries to 5-7% in the developed countries (Javier et al 2004). According to UNICEF in south Asia and Nepal, each year between 15 to 30 million infants i.e. Up to 20 % of all infants are born with a low birth weight (UNICEF 2002).

Studies done in Japan, Takemoto et al shows The prevalence of pre-term LBW infants increased from 4.5% in 1979 to 8.3% in 2010 and the prevalence of term LBW infants increased from 2.7% in 1979 to 5.3% in 2010 which may be indicate that preterm births can increase LBW (Takemoto et al 2016).

In Ethiopia, estimate (Tema 2006) shows that the prevalence of low birth weight is 11% and ranges high up to 28.3% in some areas (Aseffa et al 2004 and 2010). A hospital based study in North Ethiopia, Gondar (Edris et al 1996), found that 17.8% of babies were born with LBW, while a similar study in Southwest Ethiopia (Jimma) showed a higher (22.5%) prevalence. The other prospective community based study from Eastern (Kersa-Jima) Ethiopia estimated as high as (28.3%) LBW babies (Aseffa et al 2012).

2.2 Consequences of Low birth weight

Birth weight is most important factor that affects neonatal mortality. In addition to being a Significant determinants of post-neonatal infant mortality and infant and childhood morbidity (Tema 2006). Is associated to infant mortality (Jean et al 1978) and a baby birth weight is an important indicator of health.

Hence LBW infants are at risk of 40 fold greater chance of dying in the neonatal period, a 50 % greater chance of series development problems, e.g. learning disabilities, and mental retardation,

IQ point decrease of 5 to 10 point, long term disabilities and premature death (UNICEF 2002, Sresha et al 2010,). Infants weighing 2.00kg-2.499kg at birth are four times more likely to die during their first 28 days of life than infants who weigh 2.500-2.999kg, and ten times more likely to die than infants weighing 3.00-3.499kg (Javier et al 2004, Pojda et al 2000). It is also known to cause cerebral palsy, more frequent hospitalization for all illness, more hearing and visual disability and more behavioral disorders (Aseffa et al 2004, World health organization 2004).

Globally over the last twenty years the world made extensive progress in reducing mortality among less than 28 days aged children. Despite progress over the past two decades, in 2017 alone, 2.5 millions of neonates died, due to LBW, prematurity and other preventable causes of neonatal death (Aseffa et al 2004, UNICEF 1992). The prevalence of LBW in any population reflects its socio-economic development and it is a good proxy to gauge the developmental status of the country (Rackford et al 2007). Many of those infants who survive suffer cognitive and neurological impairment, increased risk of high blood pressure, obstructive lung disease, cholesterol, renal damage, acute diarrhea, impaired immune function, poor cognitive development (Fonseca et al 1996), increase the risk adult onset of disease like type 2 diabetes and ischemic heart disease (Shresta et al 2010). The increase in survival rates of LBW infants leads to increasing health care costs due to extensive hospital stays. It is estimated that extremely LBW babies are up to six times as costly as normal weight babies (Chang et al 2003).

2.3 Factors associated to Low birth weight

In developing countries , major determinants for LBW are poor maternal nutrition status at conception (Suman et al 2016, Guarengia et al 2004, Dharmalingam et al 2010), low gestational weight gain (Laopaibon et al 2014, Freweini et al 2019) , low short maternal stature (Tema 2006, Jean et al 1978, Rajacford et al 2007), maternal pre-pregnancy weight (Murai et al 2017), maternal age (Takemato et al 2016, Rajacford et al 2007) , hemoglobin level of the mother (Suman et al 2016, Amosu et al 2014). Known factors for pre-term delivery and fetal growth retardation which associated with LBW also includes low maternal food intake and illness specially infection (Gebremariam 2005).

Study done in Jima hospital in 2005 also lists mothers younger than 20 years and >35 years, short stature mother <150cm, late first antenatal visit and complications during pregnancy as factors predisposing to LBW (Gebremariam 2005). According to research done in united states in 1995 cigarette smoking is the largest known risk factor for low birth weight, approximately 20% of all LBW could be avoided if women did not smoke during pregnancy (Villar et al 2003).women who had low mid upper arm circumference (MUAC) measure and low body mass index (BMI) are more likely to give birth to LBW babies than their counterparts (Aseffa et al 2012). TakemotoY.recommends that further study must be carried to accurately identify potential risk factors that explain the increase in LBW (Takemato et al 2016).

2.3.1 Maternal condition and birth outcomes

I. Maternal height

Maternal height influences offspring linear growth over the growing period. These influences likely include genetic and non-genetic factors, including nutrition-related intergenerational influences on growth that prevent the attainment of genetic height potential in low- and middle-income countries.

Adult height is the cumulative result of the interaction between environment and genetics over the growing period. In developing countries, growth failure in the first 1000 days (conception to 2 years) of life is a strong determinant of final adult height. Among adults, short adult is associated with reduced human capital. Short maternal height is associated with low offspring birth size, childhood stunting, and reduced human capital, likely in part due to maternal physical constraints on offspring growth in uterus. Shorter women may have reduced protein and energy stores, smaller reproductive organ sizes, and limited room for fetal development. These influence fetal growth via the placenta and infant growth through breast milk quantity and quality. Beyond this period, correlations between maternal and child heights are expected to be strongly influenced by genetics (Astha et al 2017).

According to Meyer et al .women <158 cm has high risk for delivering a LBW infant compared with women of average height (158 cm-172 cm) (Tema 2006, Jean et al 1978). Dr.astha also said that mothers 145cm-154cm are high risk of giving LBW than those mothers 155cm-164cm.

II. Maternal pre-pregnancy weight

Maternal weight prior to conception reflects nutritional stores potentially available to the growing fetus (Tema 2006, Jean et al 1978). Pre-pregnancy weight (<54 kg) appears to affect gestational age, or the risk of prematurity can increase; gestational age should be controlled in assessing any effect on birth weight (Tema 2006). Studies done in Japan in 2017 shows that among 4.2% prevalence of LBW 6.1% of LBW is from under weight (BMI<18.5 kg/m²) mothers and 3.5% is among normal weight mothers (BMI 18.5-22.9 kg/m²) (Murai 2017). study in India also says undernourished mother (<50kg) can give babies that is under weight(Tailor et al 2004).As Gourangie et al pre-pregnant weight had direct positive linear relationship with the birth weight, among 120 subjects of the study population 88% mothers had pre-pregnant weight of <45kg, and 61% babies had birth weight <2.50kg(Gourangie et al 2004).

III. Maternal Age

According to M.ferguson MS et al those mothers aged<17 and >35 years the incidence of LBW is high (Fergusen et al 1988, Astha et al 2017). A study done in Japan from 1979 to 2010 also shows that the prevalence of LBW infants exhibited a 91.5% increase among 25-34 years old women (from4.14% in 1979 to 7.93% in2010). A relatively smaller increase (27.8%) was observed in the prevalence of LBW infants among mothers ≥35 years old (7.44% in 1979 to 9.54% in 2010) (Takemoto et al 2016). study done in India in 2017 also support this finding which said that LBW babies with increased frequency was found among mothers below 20years and more than 35 years age group (Tailor et al 2004).

IV. Gestational weight gain

Pregnancy weight gain, irrespective of pre-pregnancy body mass index (BMI), is an independent predictor and found to have a significant effect on fetal growth. A desirable gestational weight gain (GWG) is essential for a balanced optimal outcome for both mother and her infant. It supports the growth and development of the fetus (Fekede et al 2016) and reduces the likelihood of morbidity and mortality (Fekede et al 2016). In contrast, inadequate or excessive weight gain may pose health risks on the mother and/or the fetus (Freweini et al 2019). In Japan, pregnant women with BMI from 18.5-25 kg/m² are recommended to limit their weight gain to 7-12 kg during pregnancy (Rasmussen et al 2009). In contrast, the recommended weight gain in the US is 11.3-15.9 kg for women in the same BMI group (Laopaibon et al 2014). Moreover, the recommended weight gain is 9-12 kg for Japanese women with BMI of 18.5 kg/m², compared to 12.7-18.1 kg for the same group in the US. According to the Institute of Medicine (IOM), a normal weight mother with BMI (18.5-24.99 kg/m²) should gain 11.5-16.0 kg, the other non-normal weight women: underweight (BMI < 18.5 kg/m²), overweight (BMI 25.0-29.9 kg/m²), and obese (BMI > 30 kg/m²) are advised to gain between 12.5-18.0 kg, 7-11.5 kg, 5-9 kg with advisable rates of weight gains respectively.

V. Hemoglobin level

Most mothers with hemoglobin level <7.0 g/dl had baby weight <2.00 kg, whereas babies with weight above 3.00 kg were delivered from mothers with hemoglobin above 10.0 g/dl (Suman et al 2016, Amosu et al 2014).

VI. Physical activity and birth outcome

A few studies have shown an association of work in the third trimester and preterm births and low birth weight. In one study, a 150-400 g decrease in birth weight occurred in women who continued to work outside the home during the third trimester compared with those who remained at home during pregnancy (Dwarkanat et al 2007). A similar decrease of 181 g in birth weight for babies of women who worked in a heavy mode outside the home during the third trimester was observed by US (Rao et al 2003). Reports from Africa show that hard physical work by women during pregnancy can retard foetal growth and increase foetal neonatal mortality (Naeye et al 1982). In India, studies have demonstrated an inverse relationship between daily

physical activity and birth weight in a cohort of rural women, the majority of whom had high levels of physical activity related to agricultural and domestic activities (Rao et al 2003).

2.3.2 Nutritional requirements during pregnancy and birth outcomes

Pregnancy is a period of rapid fetal growth and cell differentiation for both the mother and the developing fetus. Consequently, it is a period at which the mother is at an increased risk of nutritional deficiency that can have serious consequence to the development of the fetus (Black et al 2001) is also associated with increased demand of all the nutrients like iron, copper, zinc etc, and deficiency of any of these could affect pregnancy, delivery and outcomes of the pregnancy. Pregnant women had significantly lower iron and zinc levels while copper were significantly higher (Shah et al 2001). A research conducted in Ethiopia among pregnant women revealed that the prevalence of micronutrient intake inadequacy was very high. It was indicated that the prevalence of zinc intake inadequacy was 99%, whereas iron intake inadequacy was surprisingly low 4% (Abebe et al 2009). Low maternal zinc nutritional status has been associated with a wide range of complications including low birth weight (LBW), labor and delivery complications, congenital anomalies etc (Shah et al 2001). It was indicated that such dietary deficits could be overcome by regular consumption of cellular animal protein (Abebe et al 2009).

Nutrition plays a major role in maternal and child health. Poor maternal nutrition status has been related to adverse birth outcomes: however the association between maternal nutrition and birth outcome is complex and is influenced by many biologic, socioeconomic, demographic factors, which vary widely in different populations (Wu G et al 2004). Understanding the relation between maternal nutrition and birth outcomes may provide a basis for developing nutritional interventions that will improve birth outcomes and long term quality of life and reduce mortality, morbidity and health care costs (Kathleen et al 2010). Optimal maternal and fetal pregnancy outcomes are dependent upon the intake of sufficient nutrients to meet maternal and fetal requirements (Ramachandrian 2002).

Maternal malnutrition is caused by inadequate dietary intake (calories, proteins, micronutrients,). A mother chronically undernourished will likely give birth to an underweight baby. During pregnancy there is increase in nutrients requirement to take care of fetal, placenta and increase in

maternal weight. The impact of micronutrient deficiency on pregnancy and birth outcome is associated increased maternal morbidity and mortality, abortion ,low birth weight(LBW), premature birth, congenital abnormalities and mental deficiency in early childhood (Horntra et al 2004).

According to Kramer and his colleagues maternal nutrition has direct effect on birth weight of new born, as less nourished mother are found to deliver higher percentage of low birth babies as compared to mother who are well nourished, they also concluded that nutritional status (calories , protein ,and hemoglobin level) of mother can significantly influence the weight of the new born baby and may lead to LBW.women who is well nourished during her pregnancy can easily fulfill the demand of growing fetus. Well nourished fetus will result into a healthy baby with optimum body weight (Amosu et al 2014). It was subsequently recognized that poor growth results not only from a deficiency of protein and energy but also from inadequate intake of micronutrients that are vital during rapid growth phases (Ramachandrian et al 2002, Rao et al 2001).

1. Protein

Proteins are macromolecules consisting of long chains of amino acid molecules. During pregnancy the mother must consume adequate protein to meet the needs of her growing fetus in addition to meeting her own increased needs as she physically grows in size to carry her baby. It is also useful for accretion in maternal tissues like the heart, blood, breast, and uterus and fetal support tissues including the placenta and extra-embryonic membranes (Blumfield et al .2012). vegetarian and vegan women are at high risk for protein deficiency both before and during pregnancy. They need to compensate the lost nutrients by consuming all essential amino acids from plant sources to create the proteins necessary for the fetus's growth. Although it is possible for such mothers to have a healthy pregnancy, careful planning and monitoring to ensure the increased protein demands is essential (kristinseen et al 2015). Maternal protein intake (specifically that from dairy sources) was found to be associated with increased birth weight (Sloan et al 2001). In study in US women, it is found that both low and high protein intakes in the second and third trimesters to be associated with decreased birth weight.

2. Iron

Nutritional iron deficiency is highest in segments of the population that are experiencing peak growth rates, such as infants, young children, and pregnant women (Scholl 2005). The risk of developing iron deficiency is greatest during pregnancy, since maternal iron requirements are substantially higher than average absorbable iron intakes (Allen 2000). If a woman's diet does not contain enough iron to meet these needs; the body can meet fetal requirements only by drawing upon maternal iron stores. The demands of the developing fetus may cause the mother to develop iron-deficiency anemia if she had inadequate iron stores at the beginning of the pregnancy. Estimates from the World Health Organization indicate that, on average, 56% of pregnant women in developing countries are anemic, as are 18% of pregnant women in developed countries (Ster 2000).

There is substantial observational evidence showing that maternal iron-deficiency anemia prior to and in early pregnancy places the mother at increased risk of preterm birth or low-birth-weight delivery (Allen 2000, Ster 2000). Severe anemia (hemoglobin level <80 g/L) is associated with the birth of small babies, as a consequence of both preterm labor and growth restriction. The minimum incidence of low birth weight and preterm birth is found when hemoglobin concentrations are 95–105 g/L (Scholl et al 2000).

3. Folate

Folate is critical to fetal development because it is a cofactor for many essential cellular reactions, including DNA and nucleic acid synthesis. Insufficient maternal folate intake has been linked to low birth weight, IUGR, and preterm birth (Scholl et al 1996). In several studies low folate intake assessed peri-conceptionally through mid-pregnancy was associated with a more than 2- to 4-fold increase in risk of infant low birth weight and/or preterm birth, particularly in low-income populations (Neggers et al 1976).

Supplementation with iron folic acid during pregnancy in addition to improves maternal iron status, ant-partum, it also continues to significantly improve post partum (Christian et al 2009). Furthermore respective of maternal iron store, the fetus manages to obtain and store normal amounts of iron even when the mother is iron deficient.

A placebo-controlled study from Nepal with a high prevalence of iron deficiency demonstrated that a supplement of 60 mg of ferrous iron and 0.4 mg of folic acid daily from 11 wk gestation significantly increased the birth weight (Cogswell et al 2003). A placebo-controlled study from Cleveland demonstrated that 30 mg of ferrous iron daily in pregnancy, started before 20 wk of gestation, gave a significantly higher birth weight compared with the placebo group (Rasmussen et al 2001). The results of these studies suggest that to obtain a maximum effect on birth weight, iron folic acid supplements should be started in early pregnancy (Christian et al 2009, Cogswell et al 2003).

4. Zinc

Low maternal zinc nutrition status has been associated with a wide range of complication including low birth weight (LBW), labor and delivery complication, congenital anomalies, hypertension, placental abruption, premature delivery, increased neonatal morbidity, intra uterine growth retardation, and poor neurobehavioral development (Abebe et al. (2008). In 2004 international zinc nutrition consultative groups estimated that 21.1% of Ethiopian populations were at risk of inadequate dietary zinc intake. Study in southern Ethiopia reported that 54% zinc deficiency prevalence among pregnant women was associated to dietary, socio-demographic, socio-economic (Dardenae 2002). Pregnant women are facing zinc deficiency more than the other groups, due to having fetus which need zinc for proper function. If pregnant woman are zinc deficient, the fetus can experience growth retardation in uterus adversely affecting the child long term immune functions and neurological and behavioral development (Black 2001).

2.3.3 Environmental and lifestyle

Studies indicates that nitrogen monoxide (NO), Ozone and nitrogen dioxide (NO₂) concentration had adverse birth out comes and LBW (Dadvand et al 2014). Furthermore, studies indicate that it is not only traditional chemical pollutants present in an urban atmosphere which can influence these adverse birth outcomes, but that other environmental variables, such as traffic noise (Dadvand et al 2014, Arroyo et al 2016) and temperature in heat and cold waves (Arroyo et al 2016, Ngo et al 2016), may also be related to both PTB and LBW. Although the respective

biological mechanisms whereby traffic noise and ambient temperature increase the impact on LBW are not clear, there is epidemiological evidence to link them to LBW in the short term (Ngo NS et al 2016). With regard to noise levels, little is known about the association between traffic noise and pregnancy outcomes. It has been hypothesized that stress may affect fetal growth through the endocrine system (Arroyo V et al 2016, Ngo NS et al 2016). Moreover, there is evidence to show increased risk of hypertension among subjects exposed to noise, something that could in turn increase the risk of adverse pregnancy outcomes (Dadvand et al 2014, Arroyo et al 2016). An integrated model has recently been published which seeks to explain the short-term effects of traffic noise on various diseases: it includes chronic and acute stress responses which could account for the association between traffic noise and LBW (Arroyo V et al 2016, Ngo NS et al 2016).

A case-control study conducted in Bale Zone of Oromia regional state revealed using firewood/kerosene/ for cooking, Wash hands with water only and not having separate kitchen room were risk factors for LBW(Demelash et al 2015) mothers experience of physical violence or intimate partner violence during pregnancy had LBW newborns(Demelash et al 2015). Lack of social support during pregnancy was also associated with LBW (wado YD et al 2014), history of khat chewing was associated with LBW (Demelash et al 2015)

Use of psychoactive substance (smoking) during pregnancy is also associated with increased small size for gestational as well as increased prematurity rate (Jufar et al 2014).

Chapter Three

Materials and Methods

3.1 Study site and period

The study was conducted in selected antenatal care unit in Addis Ababa, Ethiopia for one year from January 2018 to December 2018.

The study was conducted in Addis ketema, woreda 9 (Koasmeda), and woreda 3 health centers of Addis Ababa. Addis Ababa was founded during reign of Emperor Menelik II in 1886. In 2003; the administrations were changed in to ten sub cities. It lies on the average at 2,355 meters above sea level and over 3,627,934 as 2007, population reside in this administrative city. The city is home of 23.8% of all urban residents in Ethiopia, and estimated population density of 5936.2 per square kilometer. Economic activities in Addis Ababa are diverse. In 2007, the majority of the populations engage in to trades, manufactures and homemakers activities. Most of the Ethiopia ethnic groups are living in Addis Ababa due to its location as a capital city of the country. The health centers were found in Addis ketema sub-city, which provide health service over 327,000 populations. These populations were to Addis ketema, woreda 9 and woreda 3 health centers around 41,000, 35,600 and 31,200 served populations respectively.

3.2 Study design: prospective Cohort follow-up.

3.3 Source population

All pregnant women in Addis ketema sub city, Addis Ababa, attending antenatal care.

3.4 Study population

All first trimester pregnant women attending ANC in Addis ketema health center, woreda 9 (Koasmeda) and Woreda-3 health center at Addis ketema subcity, Addis Ababa.

3.5 Exclusion criteria

Sever sickness, psychiatric disorder and mothers with physical conditions

3.6 Sample size and sampling technique

Three health centers in Addis Ketema sub-city providing ANC service were selected randomly. The sub-city was also selected randomly. A single population proportion formula considering 95% confidence level ($z=1.96$), 5% margin of error, 28.3% expected prevalence of LBW (Aseffa et al (2012) and 10% contingency (non respondent) and lost from follow up was used. A total of 341(see sample size calculation below) first trimester pregnant women visiting the ANC units were invited to participate in the study.

$$n = (Z^2 p \cdot q) / d^2$$

$$n = (1.96)^2 (0.28) (0.72) / (0.05)^2 = (310)$$

$$n = 310$$

$$n = (310) + 31(10\% \text{ contingency}) = 341 \text{ (numbers of participants studied)}$$

n = minimum sample size required for the study.

Z = standard normal distribution ($Z=1.96$) with confidence interval of 95% and $\alpha = 0.05$

P = the prevalence of low birth weight (28.3%) (Aseffa et al (2012) .

d = Absolute precision or tolerable margin of error =5%.

The calculated sample size 341 was proportionally allocated to the numbers of ANC attends among the selected health centers.

3.7 Study variables

Independent variables

Socio-demography

Dietary characteristics

Anthropometric condition of the mother

Hemoglobin status of the mother

Serum zinc concentration

Dependant variable

Birth weight of newborn

3.8 Data collection

Variables such as socio-demographic characteristics of the participating women and dietary information were gathered using interview technique with the administration of a pretested structured questionnaire. In addition, BMI and MUAC of the women were measured. Hemoglobin concentration and serum zinc were also determined.

All the study subjects were followed from the first trimester till delivery, by measuring their weight, MUAC, BMI, their Iron folic acid taking experience (any drop or continue to take), any illness during pregnancy were recorded, These activities were performed at ANC and up on completion of the gestation, the pregnant women were transferred to labor room for delivery. Thereby, all the vital signs, gestational age, clinical examinations and laboratory results were assessed before starting the delivery procedure. The gestational at birth were calculated from last missed menstrual period (LMP) manually.

3.8.1 Socio-demographic

A structured questionnaire (See Annex C) was prepared in English and translated into Amharic and pretested to capture socio-demographic characteristics of study participants. Variables such as but not limited to Age, religion, marital status, education level, job of respondents, monthly income and total amount of money the households spend on food per month were collected. In addition, obstetric maternal history such as parity, trimester and number of children in the family were collected.

3.8.2. Dietary characteristics

Dietary characteristics of participating mothers were collected using a 24 hour recall method (Rosalind S. Gibson (2005)). All foods and drinks that can be consumed by the women were listed and the participants were asked if they consumed the food among the list 24 hrs preceding the survey. Women dietary diversity score (WDDS) and food variety score (FVS) of the

participating women was derived based the 24 hour dietary recall data. A DDS value <3 is considered low and ≥ 6 is high. The study participants were also asked about their usual meal frequency per day. In addition, household food security indicators were collected.

Table1. Aggregation of food groups to create WDDS (Arimod et al 2010)

| s. no | Food groups |
|-------|--|
| 1 | Starchy staples(cereals and white tubers and tubers) |
| 2 | Dark green leafy vegetables |
| 3 | Other vitamin A rich fruits and vegetables |
| 4 | Other fruits and vegetables |
| 5 | Organ meat |
| 6 | Meat and fish |
| 7 | Eggs |
| 8 | Legumes ,nuts and seeds |
| 9 | Milk and milk products |

3.8.3. Anthropometry parameters

Weight, height, MUAC was measured three times (all trimesters) consequently BMI was calculated. Weight of the participating women was measured using digital balances (JHU/MED/2393), Height was measured using measuring board attached with a measuring tape (JHU/MED/2393), A flexible measuring tape was used determine MUAC.

3.8.4 Biochemical analysis

I. Determination of hemoglobin

Hemoglobin concentration was determined from a whole blood using Chemistry machine (Mindray BS-200E) Hemoglobin was adjusted for pregnancy and altitude using hemoglobin level less than 11.0g/dl (during 1st or 3rd trimester) and less than 10.5g/dl (2nd trimester) is defined as anemia.

II. Serum Zinc

Venous blood was drawn from the upper arm of mothers using a stainless steel needle (Changzhou Jinlong Medicalplastic Appliance Co.,Ltd). The whole blood was centrifuged, serum separated, transferred into a vial and stored in -80°C freezer until analysis. Zinc

concentration was determined using Atomic Emission Spectroscopy (MP-AES, Agilent technologies 4200) at Addis Ababa University, after diluting with butanol (n-butanol for synthesis, LOBAL Chemie, 71-36-3).

Principle

Standard solutions were prepared in glass bottles, previously washed with diluted nitric acid (10%) and rinsed with de-ionized water. Pipettes and other materials used for reagent preparation and sample dilution had been previously nitric acid soaked overnight, then rinsed with de-ionized water and dried in an oven.

A graded series of mixed calibration standards were prepared by diluting stock standards with de-ionized water and 6% butanol (60 ml aqueous Butanol and de-ionized water to make 1000ml of solution).

Four milliliters of (4 ml) of aqueous butanol with de-ionized water mixed to 200ppm of serum. The test tube was placed in the auto sampler after mild shaking by using vortex. The measurement is automatically carried out according to the standard calibration method and results are average of two replicates. The instrument was calibrated with blank and a standard. After the initial calibration samples were measured and values reported by the system were the concentration so the final calculation was only for dilution factor.

3.8.5 Regarding follow up

All the study subjects were followed from the first trimester till delivery, by measuring their weight, MUAC, their Iron folic acid taking experience (any drop or continue to take), any illness during pregnancy were recorded, These activities were performed at ANC and up on completion of the gestation, the pregnant women were transferred to labor room for delivery. Thereby, all the vital signs, gestational age, clinical examinations and laboratory results were assessed before starting the delivery procedure. The gestational at birth were calculated from last missed menstrual period (LMP).

3.8.6 Birth weight

Midwives and nurses measured the birth weights of new born immediately after delivery and the weights were registered in delivery registration book and also recorded to the format prepared for the purpose of this research. Similarly, for study participants referred to hospitals, the birth weight was obtained from delivery registration book.

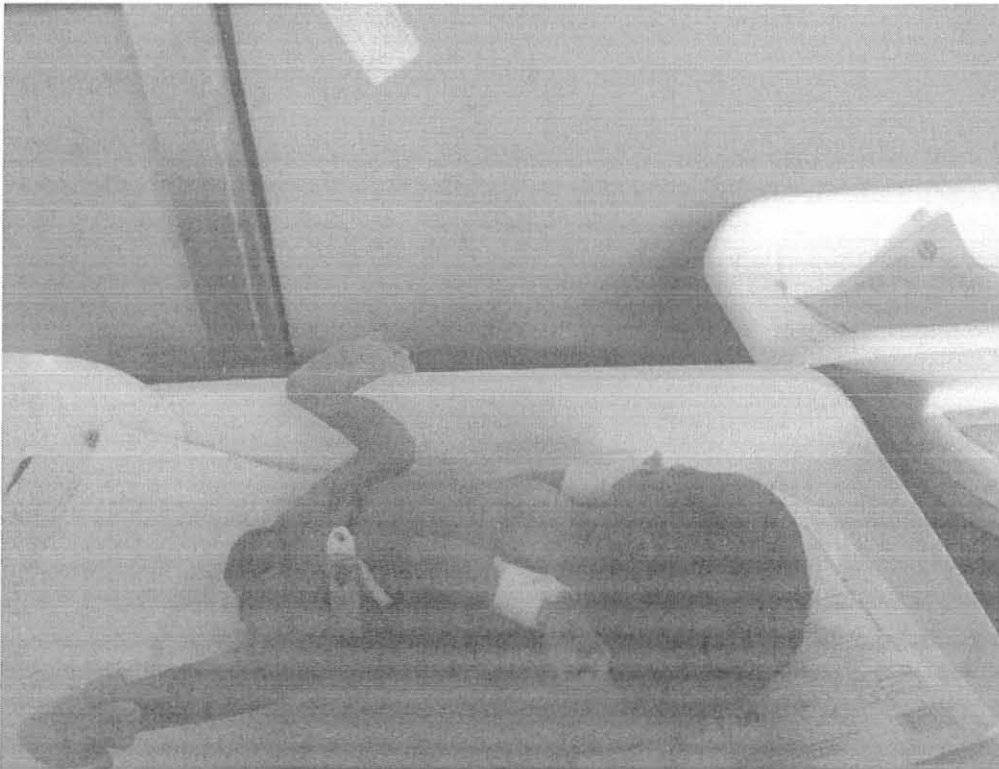


Fig 1: measuring weight of new born at delivery ward in woreda 3 health center.

3.9 Data quality assurance

Revision of the data collected was conducted during the pre analysis of the research. The completion and responses to each questionnaire and the laboratory results were checked and the results were registered in the appropriate format. Finally the data were analyzed and interpreted accordingly.

3.10 Statistical analysis

After completion of the data collection, laboratory investigation and careful data quality assurance the information obtained from each client were entered into SPSS (statistical package for social science student) version 20. The statistical analysis was performed using parametric tests.

Descriptive statistics was used to present the percentage, frequency, mean, and standard deviation of the occurrence of events for socio-demographic characteristics, anthropometric parameters, dietary pattern, serum zinc concentration, low birth weight prevalence and birth weight(n=329) of newborn.

Bi-variate logistic analysis was done at the first step (Taking each independent variable with the dependent variable at a time). Then the variables which were significant at .25 p-values were taken in the multivariable logistic regression.

3.11 Ethical considerations

An ethical approval was obtained from Institutional Review Board of Addis Ababa University at College of Natural and Computational Sciences. A support letter was also obtained from Addis Ababa City administration Health Bureau. The benefit and risk of the study was explained to participating women and a written consent was obtained.

Chapter Four

Results

The socio-demographic characteristics of the pregnant women ($n=341$) is indicated in table 2. Respondents were in the age range of 17-40 with mean 26 ± 4.8 years. More than half of the women were unemployed (54.8%). Most of the House hold income per month were low, the minimum income of house hold were 500.00 birr and maximum 15,000.00 birr.

Table2. Socio-demographic characteristics of first trimester pregnant women ($n=341$) at Antenatal clinic of Addis Ababa Ethiopia.

| Variable | <i>n (%)</i> |
|--------------------------------------|--------------|
| Age (years) | |
| ≤ 20 | 44 (12.9) |
| 21-34 | 266 (78.0) |
| ≥ 35 | 31 (9.1) |
| Religion | |
| orthodox | 194 (56.9) |
| muslim | 109 (32.0) |
| protestant | 37 (10.9) |
| others | 1 (0.3) |
| Ethnicity | |
| Oromo | 78 (22.9) |
| Amhara | 78 (22.9) |
| Tigre | 14 (4.1) |
| Gurage | 128 (37.5) |
| Silte | 35 (10.3) |
| others | 8 (2.3) |
| Educational level | |
| Illiterate | 69 (20.2) |
| Primary | 133 (39.0) |
| Secondary | 90 (26.4) |
| Diploma, first degree, second degree | 49 (14.4) |
| Marital status | |
| Married | 338 (99.1) |
| Unmarried | 2 (0.6) |
| Divorce | 1 (0.3) |
| Widow | 0 (0.0) |
| occupation | |
| Governmental | 26 (7.6) |

| | |
|------------------|-----------|
| Non-governmental | 55 (16.1) |
| Daily laborer | 29 (8.5) |
| Trader | 37(10.9) |
| Other | 7(2.1) |

Four weeks preceding the survey; almost one third (32.8%) of the present study women borrowed money to buy food, 22.0% reduced meal size due to lack of food in the household, 12.9% skip their meal due to lack of food in the house, and 12.6% of women were hungry due to lack of food in the house, in last four weeks.

Majority of the women (69.8%) had meal three times per day. Only, 15.5% of women ate meals four times per day. Snack eating habit of the women was poor (10.3%). More than half of the women take coffee immediately after meals (55.1%) and take tea with meal (51.3%). Others food security indicating elements in the present study women is indicated in table (3).

Table 3. Information related food eating habit and lifestyle characteristics of first trimester pregnant women at antenatal clinic of Addis Ababa Ethiopia.

| variable | Frequency (%) |
|------------------------|---------------|
| Breakfast eating habit | |
| Daily | 263(77.1) |
| Sometimes | 64(18.8) |
| Not eat | 14(4.1) |
| Lunch eating habit | |
| Daily | 311(91.2) |
| Sometimes | 29(8.5) |
| Not eat | 1(0.3) |
| Dinner eating habit | |
| Daily | 271 (79.5) |
| Sometimes | 63 (18.5) |
| Not eat | 7 (2.1) |
| Snack eating habit | |
| Daily | 35 (10.3) |
| Sometimes | 165 (48.4) |
| Not eat | 141(41.3) |

| | |
|---------------------------------|------------|
| Timing of Coffee intake | |
| Before meals | 7 (2.1) |
| With meals | 30 (8.8) |
| Immediately after meal | 188 (55.1) |
| Approximately 1 hr after meal | 82 (24.0) |
| Timing of tea intake | |
| Before meals | 20 (5.9) |
| With meals | 175 (51.3) |
| Immediately after meal | 94 (27.6) |
| Approximately 1 hour after meal | 18 (5.3) |

The dietary pattern of the present study women in the 24 hours preceding the interview is dominated by starchy staples (100%), followed by other fruits and vegetables (76.2%), and legumes ,nuts and seeds (69.8%), (table 4). Considerable percent of study populations consumed other vitamin A rich fruits and vegetables (64%). However, organ meat was not taken by the study participants (0.0%). The women’s dietary diversity score (WDDS) in the present study were medium 4-5 food groups (48.7%) and few women had high DDS ≥ 6 (15.2%).

Table 4. Dietary pattern of pregnant women attending antenatal clinics in health centers of Addis Ababa, Ethiopia 2019.

| s.no | Food groups | <i>n</i> (%) |
|------|--|--------------|
| 1 | Starchy staples(cereals and white tubers and tubers) | 341 (100) |
| 2 | Dark green leafy vegetables | 78 (22.9) |
| 3 | Other vitamin A rich fruits and vegetables | 221 (64.8) |
| 4 | Other fruits and vegetables | 260 (76.2) |
| 5 | Organ meat | 0.0 (0%) |
| 6 | Meat and fish | 90 (26.4) |
| 7 | Eggs | 63 (18.5) |
| 8 | Legumes ,nuts and seeds | 238 (69.8) |
| 9 | Milk and milk products | 98 (28.7) |

More than half of the women were multiparous (57.5%). A quarter of women experienced sickness two weeks preceding the interview.

Only about 12% of the study participants were taking their iron folic acid supplementation during early pregnancy prior to visiting the health centers for ANC follow up. Half of the women had no information to take iron folic acid before starting ANC follow up (55.7%). About 18.5% and 14.3% participating women dropped iron and folic acid tablet intake at second and third trimester, respectively. The prevalence of LBW (<2.5 kg) was 14.0%.

The information regarding weight, height, body mass index, middle upper arm circumference (MUAC) is indicated in table (5). The average MUAC of the participants was 24.5±3.6 cm. About 11.7% of women had lower MUAC measurement (<21cm) in the first trimester and one in ten (10.9%) women were under weight BMI (<18.5kg/m²) in the first trimester. And the average Gestational weight gain (GWG) was 5.7±2.59.

Table 5, information regarding Anthropometry, hemoglobin and serum at all trimesters of pregnant women attending antenatal clinics in health centers of Addis Ababa, Ethiopia 2019

| | first | | | Second | | | Third | | |
|--------------------------|---------|-------|-------------|--------|-------|------------|-------|------|-------------|
| | mi n | max | Mean(sd) | Min | Max | Mean(sd) | Min | max | Mean(sd) |
| Height(cm) | 142.0 | 178.0 | 1.58(5.64) | | | | | | |
| Weight(kg) | 38.0 | 95.0 | 56.93(9.93) | 39.0 | 95.0 | 59.9(9.86) | 39.0 | 97.0 | 62.5(10.0) |
| MUAC(cm) | 18.5 | 34.0 | 24.5(2.85) | 20.0 | 36.0 | 25.9(2.89) | 20.0 | 37.0 | 27.06(2.98) |
| BMI (kg/m ²) | 14.8 | 35.9 | 22.5(3.64) | 15.4 | 35.76 | 23.6(3.62) | 16.0 | 36.5 | 24.7(3.7) |
| Weight gain | | | | -0.5 | 18 | 3.0(1.7) | -3 | 9.0 | 2.67(1.85) |
| Hemoglobin value(g/dl) | 7.0 | 16.2 | 12.92(1.57) | | | | 7.6 | 16.4 | 12.83(1.57) |
| Serum Zinc(µg/dl) | 21 | 254 | 66.9(1.21) | | | | | | |

Most of the mothers complete their ANC follow up (97.9%); only (2.1%) lost from follow up. Most babies born at term (93%) followed by 2.3% of preterm , 1.2% post term, 0.9% abortion and (0.6%) of still birth.

Relationships between potential risk factors to low birth weight in the present study are indicated in table 6, 7, 8. Age, employment status of the husband, weight, weight gain during pregnancy,

MUAC, BMI, IFA supplementation, hemoglobin and zinc status, eating habit (snack and Dinner), taking Milk and Milk product were factors significantly affects birth weight.

Those participants age < 20 had three times risk of giving low birth weight baby, when compared to 21-34 year age group (OR:3.469,p=0.028),further more Participants whose husbands were employed reduce the risk of low birth Weight by about 90% when compared with participants whose husband were unemployed (OR:0.108, p=0.03).

Table 6.relationships between socio-demographic and birth weight.

| Items | Variables | COR(CI) | P-V | AOR(CI) | P-V |
|------------------------------|------------------|-------------------|---------|-------------------|--------|
| Age (in year) | ≤ 20 | 2.365(0.687-8.14) | 0.054* | 3.469 (1.57-4.33) | 0.028* |
| | 21-34 | 2.382(0.985-5.76) | 0.045 | 1.96(0.12-6.76) | 0.273 |
| | ≥35 | 1 | 1 | | |
| Level of education | Illiterate | 1 | 1 | 0.411(0.06-2.74) | 0.359 |
| | Primary | 2.02(0.95-4.32) | 0.06* | | |
| | Secondary | 2.92(1.16-7.32) | | | |
| | higher education | 2.64(0.89-7.81) | | | |
| Employment status of husband | Not employed | 0.12(0.35-0.411) | <0.001* | 0.108(0.015-0.76) | 0.026* |
| | Employed | 1 | | 1 | |
| Parity | Primi-parous | 0.67(0.36-1.26) | 0.217* | 0.591(0.18-1.92) | 0.383 |
| | Multi-parous | 1 | 1 | | |

The likelihood of low birth weight is reduced by about more than two times for those participants who have MUAC greater than 21cm when compared to those participants who have less than 21cm MUAC in the first trimester.(OR: 2.53, p= 0.028), in addition having weight less than 50.0 kg had almost seven times risk of giving low birth weight newborn in comparing with weight 50.0-69.9.0 kg(OR: 7.8, p=0.053), further more gaining weight greater than 6.0 kg throughout

the pregnancy can reduce the risk of giving low birth weight baby (OR:0.01, p< 0.001). taking IFA supplementation reduce the risk of low birth Weight by about 80% when compared with participants who didn't take iron folic acid (OR:0.207, p=0.001) supplementation at second trimester where other factors are kept constant. Other factors like: BMI < 18.5kg/m², hemoglobin < 11.0 mg/dl (OR: 0.03, p=0.05) and serum zinc < 56 mg/dl (OR: 0.012, p=0.001) were also identified factors affects birth weight.

Table7. Association of Anthropometry and birth weight.

| Items | Variables | COR(CI) | P-V | AOR(CI) | P-V |
|---|-------------|--------------------|---------|--------------------|---------|
| Weight (kg) | <50.00 | 0.350(0.113-1.086) | 0.016* | 7.89(0.469-133.17) | 0.053* |
| | 50.00-69.90 | 0.867(0.280-2.67) | | | |
| | ≥70.00 | 1 | 1 | | |
| Weight gain(kg) | <6.0 kg | 1 | 1 | 0.01(0.021-1.22) | 0.001* |
| | 6-9.0 kg | 2.488(1.112-5.566) | 0.026* | | |
| | 9.12.5 kg | 2.445(1.23-6.55) | 0.043* | | |
| | ≥12.5 kg | | | | |
| BMI at first trimester (kg/m ²) | <18.50 | 1 | 1 | 2.533(1.426-4.500) | 0.017* |
| | 18.5-24.99 | 5.043(1.804-14.09) | 0.002* | | |
| | 25.00-29.9 | 0.001(000) | 000 | | |
| | ≥30.00 | 0.0001(000) | 000 | | |
| MUAC of first trimester | <21 cm | 0.246(0.115-0.527) | 0.001* | 2.533(0.195-3.294) | 0.028* |
| | >21 cm | 1 | 1 | | |
| Second trimester MUAC | <21 cm | 0.147(0.041-0.532) | 0.003* | 0.133(0.012-1.448) | 0.098 |
| | >21 cm | 1 | 1 | | |
| Third trimester MUAC | <21 cm | 0.075(0.013-0.44) | 0.003* | 0.786(0.027-22.51) | 0.88 |
| | >21 cm | 1 | 1 | | |
| IFA supplementation at first trimester | No | 1 | 1 | | |
| | Yes | 1.579(0.535-4.66) | 0.408 | | |
| IFA supplementation at second trimester | No | 1 | 1 | 0.207(0.035-0.380) | <0.001* |
| | Yes | 5.133(2.58-10.21) | <0 001* | | |
| IFA supplementation at third trimester | No | 1 | 1 | 1.51(0.240-9.515) | 0.661 |
| | Yes | 0.435(0.129-1.470) | 0.180* | | |
| First trimester hemoglobin (g/dl) | <11.0 | 1 | 1 | 38.10(0.597-2.433) | 0.086 |
| | >11.0 | 2.398(0.612-9.39) | 0.209* | | |
| Third trimester hemoglobin (mg/dl) | <11.0 | 1 | 1 | 0.03(0.001- | 0.054* |
| | >11.0 | 3.755(1.05-13.38) | 0.041* | | |

| | | | | | |
|-----------------------|--------|-------------------|--------|--------------------|--------|
| | | | | 1.06) | |
| Serum zinc (µg/dl) | < 56.0 | 0.009(0.001-0.65) | 0.001* | 0.012(0.001-0.101) | 0.001* |
| | ≥ 56.0 | 1 | 1 | | |

Association of house hold food security participants eating habit and dietary diversity is indicated in table 8. Study participants that sometimes ate dinner had three times likely to give birth to a low weight child compared to women with the habit of eating dinner often (OR: 3.14, p=0.04), similarly those ate their snack everyday reduce risk of giving low birth weight by almost 80%, when compared to those who didn't eat their snack daily (OR: 0.21, p=0.04). Participants those didn't take milk and milk product during pregnancy has seven times chance of giving low birth weight when compared to those who use milk and milk product during pregnancy (OR:7.68,p=0.002) where other factors are kept constant.

Table 8. Association of house hold food security, pregnant mothers eating habit and birth weight.

| Items | Variables | COR(CI) | P-V | AOR(CI) | P-V |
|---|-----------|--------------------|--------|--------------------|---------|
| Number of meals per day | ≤3 times | 0.207(0.049-0.881) | 0.033* | 0.183(0.013-2.83) | 0.225 |
| | 4-5 times | 1 | 1 | | |
| Dinner eating Habit | Always | 1 | 1 | 3.14(1.305-7.559) | 0.038** |
| | Sometimes | 0.422(0.211-0.84) | 0.05** | | |
| | Not eat | | | | |
| Snack eating habit | Always | 2.827(0.807-9.90) | 0.104* | 0.217(0.017-2.542) | 0.045** |
| | Sometimes | 2.85(1.43-5.66) | 0.003* | | |
| | Not eat | 1 | 1 | | |
| Coffee drinking habit | No | 2.706(0.625-11.71) | 0.183* | 7.46(2.56-22.02) | 0.077 |
| | Yes | 1 | 1 | | |
| Reduce food intake in the last 4 weeks | No | 2.069(1.05-4.05) | 0.034* | 0.288(0.06-1.36) | 0.117 |
| | Yes | 1 | 1 | | |
| Skip meals due to lack of food in the house | No | 3.58(1.69-7.60) | 0.001* | 2.411(0.52-11.02) | 0.257 |
| | Yes | 1 | 1 | | |

| | | | | | |
|--|-----|---------------------|--------|-------------------|--------|
| Hungry because of food not available in the house. | No | 2.65(1.22-5.75) | 0.01* | 0.58(0.134-2.51) | 0.46 |
| | Yes | 1 | 1 | | |
| Milk and milk product | No | 1.427(0.737-2.7630) | 0.29* | 7.68(2.056-28.6) | 0.002* |
| | Yes | 1 | 1 | | |
| Meat and fish | No | 0.617(0.285-1.337) | 0.221* | 0.767(0.199-2.95) | 0.699 |
| | Yes | 1 | 1 | | |
| Others vitamin A rich fruits and vegetables | No | 1.43(0.720-2.841) | 0.306* | 2.03(0.658-6.28) | 0.217 |
| | Yes | 1 | 1 | | |

Chapter Five

5.1 Discussion

Pregnancy is a period of rapid fetal growth and cell differentiation for both the mother and the developing fetus. Consequently, it is a period at which the mother is at an increased risk of nutritional deficiency that can have serious consequence to the development of the fetus. Low birth weight is attributed to several health complications and significantly limits productivity in humans. An overwhelming number of infants are born being low weight annually. People in poor resource settings are especially affected. The present study determined prevalence of low birth weight in selected health centers at ANC in Addis Ababa. In addition, factors associated to low birth weight has been identified. A Longitudinal (prospective cohort follow up) was used and three health centers in Addis Ketema sub-city providing ANC service were selected randomly. A total of 341 first trimester pregnant women visiting the ANC units were invited to participate in the study, socio-demographic characteristics of the participating women and dietary information were gathered using interview technique with the administration of a pretested structured questionnaire. Participants were followed till delivery by checking their Anthropometry, hemoglobin status and serum zinc and 329 new born weights was taken at delivery room.

In current study, the average MUAC of the participants was 24.5 ± 3.6 cm. About 11.7% of women had lower MUAC measurement (<21 cm) and about one in ten (10.9%) women were under weight BMI ($<18.5 \text{kg/m}^2$) in the first trimester. The women's dietary diversity score (WDDS) in the present study were medium 4-5 food groups (48.7%), and few women had high DDS (15.2%). Most of the mothers complete their ANC follow up (97.9%); only (2.1%) lost from follow up. Most babies born at term (93%) followed by 2.3% of preterm , 1.2% post term, 0.9% abortion and (0.6%) of still birth. The prevalence of LBW in current study was 14.0%. Age, employment status of the husband, weight, weight gain during pregnancy, MUAC, BMI, IFA supplementation, hemoglobin and zinc status, dinner and snack eating habit and taking milk and milk product during pregnancy were factor significantly affect birth weight.

Optimal maternal and fetal pregnancy outcomes are dependent upon the intake of sufficient nutrients to meet maternal and fetal requirements (Ramachandrian et al (2002). Maternal

malnutrition is caused by inadequate dietary intake (calories, proteins, micronutrients,). A mother chronically undernourished will likely give birth to an underweight baby. During pregnancy there is increase in nutrients requirement to take care of fetal, placenta and increase in maternal weight (Edris et al 1996, Astha et al 2017). In the current study Low birth weight were significantly associated with low maternal body mass index ($BMI < 18.5 \text{ kg/m}^2$) as a result of low body weight in relation to height. This could be attributed to limited maternal weight gain particularly at first trimester and other factors that can be associated with decrease in weight. This finding were also similar with the study done in Japan in 2017 shows that among 4.2% prevalence of LBW ,6.1% of LBW is from under weight ($BMI < 18.5 \text{ kg/m}^2$) mothers (Laopaiboon et al 2014). Similarly, Women who had low mid upper arm circumference (MUAC) measure ($< 21 \text{ cm}$) were more likely to give birth to LBW babies than their counterparts. Additionally, Mellese S. et al (2019) also identified that MUAC less than 220mm, lack of nutritional counseling are factors associated with LBW from Hawasa (Melese et al 2019). In addition study done in Jima ,kersa also reported that being poor and having MUAC less than 23cm were determinants of LBW(Aseffa et al 2012), this finding aligns also with a studies based on the Ethiopian demographic health survey analysis, which concluded that maternal nutritional status is significantly associated with low birth weight(Betew et al 2014). Therefore, nutritional intervention, health education about adequate nutrition throughout pregnancy is needed.

Maternal weight prior to conception reflects nutritional stores potentially available to the growing fetus (Tema 2006, Jean et al 1978). Pre-pregnancy weight ($< 54 \text{ kg}$) appears to affect gestational age, or the risk of prematurity can increase (Tema 2006). In current study, pregnant mothers whose weight less than 50.0kg had seven times risk of giving low birth weight newborn in comparing with weight 50.0kg-69.9.0 kg. This finding supported by Study in India indicate that undernourished mother ($< 50 \text{ kg}$) can give babies that is under weight (Tailor et al 2004). Similarly As Gourangie et al pre-pregnant weight had direct positive linear relationship with the birth weight, among 120 subjects of the study population 88% mothers had pre-pregnant weight of $< 45 \text{ kg}$, and 61% babies had birth weight $< 2500 \text{ gm}$ (Guarangie et al 2004).

Pregnancy weight gain, irrespective of pre-pregnancy body mass index (BMI), is an independent predictor and found to have a significant effect on fetal growth. A desirable gestational weight

gain (GWG) is essential for a balanced optimal outcome for both mother and her infant. It supports the growth and development of the fetus (Fekede et al 2016) and reduces the likelihood of morbidity and mortality (Fekede et al 2016). In contrast, inadequate or excessive weight gain may pose health risks on the mother and/or the fetus. In the current study, more than 63% of women gained inadequate gestational weight gain. According to the United States Institute of Medicine (IOM), this leads to a risk of giving LBW. This result was also similar to Fekede et al., 69.3% women gained inadequate weight gain in Eastern Ethiopia Harari (Fekede et al 2016). Similarly, Freweini (Freweini et al 2019) from Mekele also reported that weight gain has a significant effect on infant birth weight. Additionally, Amosu from India also reported that weight gain of 7kg and below was associated with 12.12% LBW incidence, while mothers who gained 9kg and above, recorded the lowest LBW incidence of 0.39% (Amosu et al 2014).

This study also revealed that the age of the mother was significantly associated ($p < 0.05$) with low birth weight. A study done in India in 2017 also supports this finding in which LBW babies with increased frequency were found among mothers below 20 years and more than 35 years age group (Tailor et al 2004). Similarly, according to Ferguson and his colleagues in South Africa, those mothers aged < 17 and > 35 years the incidence of LBW is high (Ferguson et al 1988, Astha et al 2017). Additionally, a study done in Jimma also supports this finding in which mothers age less than 20 years and greater than 35 years had a high risk of giving LBW (Seid et al 2019).

Iron requirement during pregnancy significantly increases, associated with maintenance of normal maternal metabolic processes and ensuring iron stores to the developing fetus. This condition leads pregnant women at special risk of anemia. Thus, iron supplementation in addition to intake of high iron diets is important. Low hemoglobin during pregnancy is associated with birth of small babies, as a consequence of both preterm labor and growth restriction and also cause maternal death (Ster et al 2000). In the present study, 16.7% pregnant women were anemic (hemoglobin < 11.0 g/dl). Similarly, Melaku U. et al (2008) reported 17.1% of anemia prevalence among women of reproductive age from nine districts of Ethiopia (Melaku et al 2008). In addition, a study conducted in Addis Ababa, Tikur Anbessa specialized hospital also reported 21.3% of anemia prevalence (Jufar et al 2014). The latter is higher than the current finding. The difference may be due to the study site, Tikur Anbessa hospital is a tertiary referral

hospital in which patients comes with referral from other health centers, and also can be from out of Addis Ababa with different complications. Nationally also reported that anemic mothers whose hemoglobin level less than ($<11.0\text{g/dl}$) during pregnancy had 15% more risk of giving small sized baby than non-anemic mothers (Tadesse et al 2016). Anemia is associated with multiple poor outcomes. It overstresses the mother by causing medical problems like palpitations, tachycardia, breathlessness, increased cardiac output leading on to cardiac stress which can cause de-compensation and cardiac failure which may be fatal. It also leads to several adverse peri-natal outcomes in the form of preterm and small for gestational age babies and increased peri-natal mortality rates (Scholl 2005, Allen 2000). Also affect fetal mean birth weight, Apgar score at birth, mean length and hemoglobin levels. The results of these studies suggest that to obtain a maximum effect on birth weight, iron supplements should be started in early pregnancy (Christian et al 2003, Cogswell et al 2003, Rasmussen et al 2001).

Folate is critical to fetal development because it is a cofactor for many essential cellular reactions, including DNA and nucleic acid synthesis. Insufficient maternal foliate intake has been linked to low birth weight, IUGR, and preterm birth (Scholl et al 1996). In several studies low foliate intake assessed peri-conceptionally through mid-pregnancy was associated with a more than 2- to 4-fold increase in risk of infant low birth weight and/or preterm birth, particularly in low-income populations (Neggers et al 1997, Aseffa et al 2012). Supplementation with iron folic acid (IFA) during pregnancy in addition to improves maternal iron status, ante partum, it also continues to significantly improve post partum (Christian et al 2009). Furthermore irrespective of maternal iron store, the fetus manages to obtain and store normal amounts of iron even when the mother is iron deficient. The current study also indicates that IFA supplementation during pregnancy reduce risk of giving LBW by about 80%. Similar evidence reported in studies conducted in Addis Ababa (Enqusillasse et al 2000) where iron utilization during pregnancy was found to be protective for LBW. It was also supported by double blind randomized community trial study undergone in Nepal which show that Iron supplementation during pregnancy increased birth weight by 37 gram on average (Christian et al 2009).

The impact of micronutrient deficiency on pregnancy and birth outcome is associated increased maternal morbidity and mortality, abortion ,low birth weight(LBW), premature birth, congenital

abnormalities and mental deficiency in early childhood(Horntra et al 2004). Low maternal zinc nutritional status has been associated with a wide range of complications including low birth weight (LBW), labor and delivery complications, congenital anomalies etc (Shah et al 2001). Pregnant women are facing zinc deficiency more than the other groups, due to having fetus which need zinc for proper function. If pregnant woman are zinc deficient, the fetus can experience growth retardation in uterus adversely affecting the child long term immune functions and neurological and behavioral development (Black 2001). Zinc deficiency among study participants in current study was 33.9 %, and it was significantly affects the birth weight of new born. It was indicated that such dietary deficits could be overcome by regular consumption of cellular animal protein (Abebe et al 2009).

The prevalence of Low Birth Weight (LBW) among the new-born delivered in current study was 14.0%. This finding was in line with the study done in hospital based study in Gonder north Ethiopia ,(Edris et al 1996), found that 17.8% of babies were born with LBW and in south west Ethiopia Jima hospital also reported 11.0% of LBW , while a similar study in Southwest Ethiopia (selected health centers in Jima) showed a higher (22.5%) prevalence. The other prospective community based study from south west (Kersa-Jima) Ethiopia estimated as high as (28.3%) LBW babies (Aseffa et al 2004). The national prevalence of LBW babies, as reported small size (29.3%), is high and comparable to findings of local studies. Promisingly, it has also showed a declining trend between 2000-2011, (33.4% to 27.9% and 29.3%) respectively. Yet, huge discrepancy between findings of institution based studies. These difference could be due to study site, sample size and study methods as the later was conducted at all nine regions of Ethiopia both in rural and urban, and it was conducted by in-depth analysis of the Ethiopian demographic and health survey dataset using representative data collected from all regions in the country. There can be a difference in Educational status, income and dietary habit among the rural and urban.

5.2 Limitation of the study

Due to inconvenience of taking data pre-pregnancy weight of the women were not known. Also few women blood sample was not collected for Serum Zinc. Private clinics were not included in the study.

Chapter Six Conclusion and Recommendation

6.1 Conclusion

Among 329 birth weights measured almost 14.0% were born with LBW and the LBW is associated with different factors like dietary pattern of mothers during pregnancy, Age of participants (<20 years), underweight mothers (having BMI< 18.5 kg/m², MUAC <21 cm) and weight < 50.0kg, inadequate weight gain during pregnancy, being anemic (hemoglobin <11.0 g/dl), zinc deficiency (<56 µg/dl), not taking iron folic acid supplementation properly and timely. Employment status of the mothers' husband also affects birth weight of the newborn, in which those mothers husband who had job has low chance of giving low birth weight when compared to those who didn't have job. Even though, most mothers have ANC follow up only few starts IFA supplementation at early pregnancy (12.0%) due to lack of information and Fear of Epigastria Burning. More than half women had inadequate weight gain throughout pregnancy (63.9%), the mean weight gain was 5.7(2.59).

6.2 Recommendation

Optimal maternal and fetal pregnancy outcomes are dependent upon the intake of sufficient nutrients to meet maternal and fetal requirements. Pregnant women should increase adequate nutrient dense food frequently and always to gain recommended gestational weight gain. Women should seek ANC as soon as they felt pregnant or intended that they are pregnant and should adhere to recommended supplements like IFA to prevent congenital abnormalities(i.e. neural tube defect), both mother and neonatal anemia and hence prevent associated adverse effects on child development and cognition. It is also vital for ANC attendants to follow up the proper supplementation and adherence. The health educators must also teach the mothers about adequate nutrition throughout pregnancy. Further research is needed to identify and investigate why mothers not start IFA supplementation early at pregnancy and factors affecting GWG.

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Annex A: Informed consent to participant

Date :

Title: Low birth Weight prevalence and associated factors.

Name of researcher: Birtukan Alemu

I am writing to invite you to participate in an in depth interview and clinical specimen collection that I am conducting to determine how different factors can affect the weight of new born. The research has several objectives: 1. Determines prevalence of low birth weight, 2. Identify factors associated with LBW and evaluates relation between risk factors (socio-demography, socio-economic, dietary, maternal hemoglobin level) and LBW.

Participation is voluntary: right to withdraw without negative consequences

You are going to be a prospective research participant and you are not under any obligation to participate in this research project: there is no negative consequence to deciding not to participate.

If you agree to participate, you are not obligate to answer specific questions or to provide information you do not wish to give. You have the right to not answer specific questions but continue as a participant. If you choose to participate and have agreed to have the interviews: yet, you can withdraw from the interview by stating that you have decided to withdraw.

In addition, you can withdraw from the project up until the point when provide the summary report of the interviews. There will be no negative consequences to withdrawing from the research project. You can state your intention to withdraw from the project by contacting me, Birtukan Alemu (the researcher), whose contact information is provided at the end of this form. If you choose to withdraw from the project please indicate whether you want the previously collected data to be destroyed or returned to you.

Procedure

If you agree to participate, we will be asking you some basic information, collect data on the type and amount of food you consume during the day, and collect blood (5 ml) by health

professionals and you are going to be followed till your delivery and your newborn will also be measured.

Potential harms

There are no harms associated with participating in this research. Indeed, any potential risks that may arise will be considered and treated by seeking appropriate measures to reduce the level of harm.

Potential benefits

This research may help any authorized body understand more about nutrition in pregnancy and its effects on neonatal birth weight to foster an intervention which might be very important to promote maternal health and child survival.

Confidentiality

Your participation in this research will be kept in confidence. Confidentiality of your data is assured. All data will be transcribed by me and/or a research assistant and we will both be bound by confidentiality. We will keep data in a secure and locked place until the project is complete. No identifying information will be included in any document resulting from this study. All the data obtained will remain confidential even after completion and dissemination of the findings of this study. Do not hesitate to ask us any questions regarding the objectives or the process of the investigation.

Contact information

Birtukan Alemu

Cell phone: +251922958512

e-mail: birtalex99@gmail.com

Thank you for considering this request!!!!

Annex B: consent from participant

I agree to participate in this research project, understanding that I am doing so voluntarily, that confidentiality will be maintained, and that I have the right to with draw from the study at any point using the means outlined in the invitation to participate.

I would like to have a copy of the summary report from the research data (please put a check mark here) -----

Signature -----

Date -----

Annex C. Questionnaire

ADDIS ABABA UNIVERSITY COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

CENTER FOR FOOD SCIENCE AND NUTRITION

Questionnaire for low birth weight prevalence and associated factors among selected health center in Addis Ababa, Ethiopia

Name of respondent.....

Card number.....

Mobile number....., gestational age (in weeks ultrasound).....

Name of interviewercode no

Respondent residence

Date of interview..... time started.....time finished.....

Questionnaire checked.....

| No | questions | choices | |
|-----|--------------|--|--|
| 101 | Age in years | | |
| 102 | Religion | 1. Orthodox 2. Muslim 3. Protestant 4. Other, specify | |
| 103 | Ethnicity | 1. Oromo 2. Amhara 3. Tigrian\ 4. Gurage 5. Silte 6. Others specify | |

| | | | |
|-----|---|--|--|
| 104 | Educational status | <ol style="list-style-type: none"> 1. Illiterate 2. Informal education 3. Formal Educations (grades completed) | |
| 105 | Marital status | <ol style="list-style-type: none"> 1. married 2. single 3. widow 4. divorced | |
| 106 | Parity | | |
| 107 | Trimester | <ol style="list-style-type: none"> 1. 1st 2. 2nd 3. 3rd | |
| 108 | Do you have job | <p>0.no</p> <p>1. yes</p> | |
| 109 | If yes | <ol style="list-style-type: none"> 1.governmental employee 2.non-governmental organization 3.self employed 4.daily laborer 5. trader/merchant | |
| 110 | How much do you approximately earn per month in birr | <p>.....</p> <p>Etb</p> | |
| 111 | Do your husband has job | <p>0. No</p> <p>1. Yes</p> | |
| 112 | If yes to 111, how much did he earn per month |in birr | |
| 113 | Approximately , how much money do you spend on food per month |in birr | |
| 114 | Have you ever suffered any | 0. No | |

| | | | |
|-----|--|---|--|
| | illness during your pregnancy | 1. Yes | |
| 115 | If yes specify the illness (probe)... | | |
| 116 | Have you had any abortion | 0. No 1. Yes | |
| 117 | In the past four weeks, did you have reduced meal size because of lack of food in the house? | 0. No 1. Yes | |
| 118 | In the past four weeks, did you have skip meals because of lack of food in the house? | 0. No 1. Yes | |
| 119 | In the past four weeks were you hungry because of lack of food in the house? | 0. No 1. Yes | |
| 119 | In the past four weeks did you borrow money to buy food to your house? | 0. No 1. Yes | |
| 120 | Are you taking zinc supplementation? | 0.no 1. yes | |
| 121 | If yes, how often did you take? | 1.one tablet daily 2.two tablets daily 3.one tablet three times per week 4. Three tablets per week 5. if other please specify | |
| 122 | Are taking iron /folic acid supplementation? | 0.no 1.yes | |
| 123 | If yes, how often do you take it? | 1.one tablet daily 2.two tablets daily 3.one tablet three times per week 4. Three tablets per week | |

| | | 5. if other please specify | |
|-----|---|--|---|
| 124 | If yes for how long did you taking and continue to take iron/folic acid | Forweeks/month | |
| 125 | Number of meals per day | ----- | |
| 126 | How often do/did you eat the following meals? | | |
| | A. breakfast | 1.Always 2.sometimes 3.do not eat | |
| | B. lunch | 1.Always 2.sometimes 3.donot eat | |
| | C. dinner | 1.Always 2.sometimes 3.donot eat | |
| | D. snack | 1.Always 2.sometimes 3.donot eat | |
| 127 | Are you smoking ? | 0. no 1. yes | |
| 128 | Have chew chat (Khat)? | 0. no 1. yes | |
| 127 | Food item | Have you ever eaten food prepared from? 0.no 1.yes | Have you eat in the last 24-hours foods Prepared from? 0. no 1. yes |
| | Teff | | |
| | Sorghum | | |
| | Millet | | |
| | Maize | | |

| | | | |
|--|--------------------|--|--|
| | Wheat | | |
| | Rice | | |
| | Barley | | |
| | Cassava | | |
| | Sweet potato | | |
| | potato | | |
| | Bean | | |
| | Pea | | |
| | Lentils | | |
| | Ground nut | | |
| | Carrot | | |
| | tomato | | |
| | Onion | | |
| | Leafy vegetables | | |
| | Spinach | | |
| | Cabbage | | |
| | Eggs | | |
| | Beef | | |
| | Sheep | | |
| | Goat | | |
| | ox/cow | | |
| | Chicken | | |
| | Liver | | |
| | Kidney | | |
| | Heart | | |
| | Fish | | |
| | Milk/ milk product | | |
| | Oils | | |
| | Fats / butter | | |
| | Papaya | | |
| | Mango | | |
| | Lemon | | |
| | Orange | | |

| | | | |
|-----|--|--|--|
| | Banana | | |
| | Avocado | | |
| | Honey | | |
| | Sugar | | |
| | Beverages | | |
| | Beer | | |
| | liquor | | |
| | Local liquor? /areke/ | | |
| | Tella | | |
| | Wine | | |
| 128 | Drink Coffee | | |
| | How often? A.Before meal B.with meal C .immediately after meal d.approximately 1 hour after meal | | |
| 129 | Drink tea | | |
| | How often? A .before meal b. with meal c. immediately after meal d .approximately 1 hour after meal e. do not know | | |

Anthropometric and hemoglobin follow

| No. | | 1 st trimester | 2 nd trimester | 3 rd trimester | Remark |
|-----|----------------------------------|--------------------------------|------------------------------------|------------------------------------|--|
| 134 | Age | | | | |
| 135 | Weight in kg | | | | |
| 136 | Height in cm | | | | |
| 137 | MUAC (cm) | | | | |
| 138 | BMI (kg/m ²) | | | | |
| 139 | Hemoglobin (g/dl) | | | | |
| 140 | Iron /folic Acid supplementation | Start taking 0.no 1. yes | Continue taking 0. no 1. yes | Continue taking 0. no 1. yes | Reason not taking/ drop out Iron/folic acid |

Biochemical Analysis

Respondent name.....

Card number..... Mobile no

Name of the interviewer.....CodeNo.....Age.....

Date of sampling Time of sampling Temperature
.....

Name of laboratory technicianSignature.....

| Sample code | Serum zinc (μ /dl) | remark |
|-------------|-------------------------|--------|
| | | |
| | | |
| | | |
| | | |
| | | |

New born baby weight record form

| Mothers no | code | Neonate code no | Place of delivery | Weight in Kg | remark |
|---------------|------|-----------------|-------------------|--------------|--------|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |