TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANC:	Ante-Natal Care
BCC:	Behaviour Change Communication
CSA:	Central Statistics Agency
DD:	Dietary Diversity
DDA:	Dire Dawa Administration
DDHB:	Dire Dawa Health Bureau
DDM:	Dietary Diversity Modification
DDS:	Dietary Diversity Score
DGLV:	Dark Green Leafy Vegetable
E.C:	Ethiopian Calendar
EDHS:	Ethiopian Demographic Health Survey
ENA:	Essential Nutrition Action
EPHA:	Ethiopian Public Health Association
EPHI:	Ethiopian Public Health Institute
EAR:	Estimated Average Requirement
FAO:	Food and Agriculture Organization
FBA:	Food-Based Approach
FBDGs:	Food-Based Dietary Guidelines
FBI:	Food-Based Intervention
FBS:	Food-Based Strategy
FCS:	Food Consumption Score
FV:	Fruits and Vegetables
GA:	Gestational Age
GFDRE:	Government of Federal Democratic Republic of Ethiopia
HDDS:	Household Dietary Diversity Score
HEWs:	Health Extension Workers
HG:	Haemoglobin
ID:	Iron Deficiency
IDA:	Iron-deficiency Anaemia
IFA:	Iron Folic Acid

JBI:	The Joanna Briggs Institute
LBW:	Low Birth Weight
MCF:	Meal Consumption Frequency
MCH:	Mean Corpuscular Haemoglobin
MCHC:	Mean Corpuscular Haemoglobin Concentration
MDD:	Minimum Dietary Diversity
M-DDSW:	Minimum Dietary Diversity Score of Women
MOH:	Ministry of Health
MUAC:	Mid-Upper Arm Circumference
NKS:	Nutritional Knowledge Score
NNS:	National Nutrition Strategy
OF:	Other Fruits
PICO:	Population, Intervention, Comparison, Outcome
PNC:	Post Natal Care
RDA:	Recommended Dietary Allowance
RDI:	Recommended Dietary Intake
RNI:	Recommended Nutrient Intake
RCT:	Randomized Controlled Trial
SF:	Serum Ferritin
TIBC:	Total Iron-Binding Capacity
TIPs:	Trials of Improved Practices
UNISA:	University of South Africa
VARFV:	Vitamin A-Rich Fruits and Vegetables
VCRFV:	Vitamin C-Rich Fruits and Vegetables
WDDS:	Women’s Dietary Diversity Score
WHO:	World Health Organization

CHAPTER 1
ORIENTATION TO THE STUDY

1.1. INTRODUCTION

The aim of the study is to develop a framework for an integrated food-based strategy for improving the iron status of pregnant women in Ethiopia. Globally, iron-deficiency anaemia (IDA) affects 30% women of reproductive age (468 million) and 42% of pregnant women (56 million) (World Health Organisation [WHO] 2014a:2). About 38% of pregnant women who have anaemia, iron deficiency (ID) is responsible for more than half of anaemia cases in pregnancy (WHO 2015:5). In Ethiopia, about 24% of reproductive age women and 29% of pregnant women are estimated to be anaemic. The prevalence in reproductive women varies greatly in different regions, ranging from as high as 59.5% in Somali, 30% in Dire Dawa to 16% in Addis Ababa. Regions in the East of the country; including Dire Dawa, Harari and the Somali Regional States, have the highest prevalence of anaemia in women of reproductive age constituting more than half of the national figure (Central Statistics Agency [CSA] Ethiopia & Inner City Fund [ICF] 2016:195 & 215).

This chapter discusses the overall direction of the research, presenting the magnitude of the problem identified towards the development of the statement of the research problem. The chapter further highlights the research purpose, objectives and hypothesis to be tested based on the problem identified. It further presents the theoretical framework, research methods employed and the ethical consideration followed.

1.2. BACKGROUND TO THE RESEARCH PROBLEM

Despite advances in healthcare, iron deficiency remains a major public health concern (Beck et al 2014:1). Iron deficiency anaemia is a major challenge among women of reproductive age. Iron deficiency may result from inadequate iron intake and absorption, increased iron requirements during growth, and excessive iron losses. Poor dietary intake both in terms of total quantity, intake of low bioavailable iron and improper consumption of dietary inhibitors and enhancers are responsible for iron deficiency (Pasricha, Drakesmith, Black, Hipgrave & Biggs 2013:2607-8). The most common cause of iron deficiency worldwide is a nutritional iron deficiency and inadequate dietary iron intake (Food and Agriculture Organization [FAO]

& WHO 2011:207; Sharlin & Edelstein 2011:11). Up to 50% of iron deficiency cases are the result of insufficient iron intake (Pasricha et al 2013:2608).

Women are at high risk of iron deficiency due to regular loss of iron during menstruation (Rasmussen 2001:599; Scholl 2005:1219). Pregnant women are particularly vulnerable to anaemia because they have dual iron requirements for their own growth and the growth of the foetus (WHO 2014c:2). Abbaspour, Hurrell and Kelishadi (2014:167) indicate that most pregnant women do not receive adequate amounts of iron despite taking fortified food and supplementation. In the developing world, estimates suggest that a significant portion of pregnant women will have depleted iron stores by the end of pregnancy. It is estimated that <50% of women do not have adequate iron stores for pregnancy (Scholl 2005:1248).

Iron deficiency anaemia has negative effects on maternal and perinatal outcomes. The effects of iron deficiency anaemia on maternal outcomes include high maternal mortality, pre-eclampsia, post-partum haemorrhage, perinatal infection, reduced resistance to infection, post-partum cognitive impairment and behavioural difficulties (Abu-Ouf & Mohammed 2015:147; Prakash & Yadav 2015:172; WHO 2001:9). Effect of maternal anaemia on perinatal outcomes include increased risk of low birth weight, neonatal or perinatal mortality, preterm birth, intrauterine foetal death, intrauterine growth retardation, low Apgar scores and small-for-gestational-age babies (Ahankari & Leonardi-Bee 2015:440; Bakhtiar, Khan & Nasar 2007:104; Kumar, Pore & Patil 2012:118; Prakash & Yadav 2015:173; Rasmussen 2001:599; WHO 20011b:1).

Because it disproportionately affects children and women of reproductive ages, iron deficiency hinders social and economic development (Scholl 2005: 1219).

1.3. STATEMENT OF THE RESEARCH PROBLEM

Iron-folic acid (IFA) supplementation has been the backbone of many low-income countries' nutritional strategies to address iron deficiency and iron-deficiency anaemia particularly among pregnant women (Pasricha et al 2013:2609; Peña-Rosas, De-Regil, Garcia-Casal & Dowswell 2015:5). Ethiopia emphasizes that women should receive 180 or more tablets during pregnancy (Fiedler, D'Agostino & Sununtnasuk 2014:6). Despite this emphasis, the Ethiopian Demographic Health Survey [EDHS] 2011 revealed that coverage of iron supplementation is disappointingly low. Only 17% of women received iron supplements during ANC visits (CSA & ICF International 2012:120-187) whilst where 83% of women did not take iron tablets. Among those who received iron supplements, less than 1% took them for 90 days or more during their last pregnancy. This explains why there is still a very high prevalence of anaemia among pregnant women in Ethiopia despite iron supplementation program for the past many years (FAO 2014:76). To combat this, some authors suggested dietary modification during pregnancy. However, reports reveal that Ethiopian family diets are predominantly based on cereals and legumes with low consumption of iron-rich foods as well as fruits and vegetables (Central Statistical Agency and ORC Macro 2006:149 & 154). Dietary studies have shown that most women do not change their diet significantly when they become pregnant (FAO & WHO 2001:10; Milman 2015:3). Moreover, iron poses a particular challenge to Food-Based Approach because it is difficult to achieve adequate absorption of non-hem iron (Blasbalg, Wispelwey & Deckelbaum 2011:6S-8S). The above discussion indicates that Food-Based Approach or iron supplement interventions in Ethiopia are not effective. If the above strategies are implemented the way they are, the prevalence of iron deficiency in Ethiopia will remain high.

1.4. AIM AND OBJECTIVES OF THE STUDY

This section highlights the aim and objectives of the study geared toward addressing the problem of iron deficiency in Ethiopia.

1.4.1. Research Purpose

The aim of the study is to develop a framework for an integrated food-based strategy for improving the iron status of pregnant women in Ethiopia.

1.4.2. Research objectives

The objectives of the study were as follows:

- To establish the effect of combined food-based strategies in the improvement of haemoglobin level; decreasing anaemia and thus the iron status of pregnant women.
- To assess the effect of combined food-based strategies in the improvement of dietary diversity and modification of pregnant women.

- To determine the effect of nutrition education intervention in the improvement of haemoglobin level, decreasing anaemia and thus the iron status of pregnant women.
- To examine the effect of dietary-based vitamin C supplementation intervention in the improvement of haemoglobin level, decreasing anaemia and thus the iron status of pregnant women.
- To describe the dietary pattern and diversity of pregnant women in the study area.

1.4.3. Research hypotheses

Research hypotheses are predictions about the relationships between study variables logically emerging from a theory (Melnyk & Overholt 2011:411). A theory organizes sets of concepts to define and explain some phenomenon (Saldanha & O'Brien 2014:13). Based on the theoretical framework discussed below, the study hypothesis is that Food Based Strategy integrating increased intake of dietary-based ascorbic acid through supplementation of dietary-based vitamin C-rich fruit juices with nutrition education intervention for modification of dietary behaviours and practices increase haemoglobin level; decrease anaemia and thus improve the iron status of pregnant women.

1.5. SIGNIFICANCE OF THE STUDY

Iron deficiency prevention and control strategies must analyse and address dietary behaviours and practices affecting the intake of absorbable iron. Studies have documented the effect of consumption of dietary enhancers and inhibitors on the amount of bioavailable iron. Many of the studies have also analysed interventions like nutrition education and iron supplementation in relation to improving intake of iron. However, strategies focusing on integrated food-based approaches and dietary modifications are hardly recognized. There has been little effort to assess the integrated impact of dietary-based interventions in well-designed trials (Hotz & Gibson 2007:1099). Despite arguments on the influence of dietary factors on iron absorption, lack of consistent evidence bases often bears limitations to food-based approaches (Nair et al 2016:2). Despite the known enhancing effect of vitamin C on non-heme iron absorption, past trials have not shown it to be effective in this role (Food and Agriculture Organization 2014:42). The few studies on dietary intervention resulted inconsistent findings regarding its effect on iron status (Beck, Conlon, Kruger & Coad

2014:3767; Garcia, Diaz, Rosado & Allen 2003:271; Kehoe, Chopra, Sahariah, Bhat, Munshi, Panchal, Young, Brown, Tarwande, Gandhi, Margetts, Potdar & Fall 2015:819).

Besides, review of literature clearly depicts that there are no previous researches conducted in Ethiopia in areas of food-based strategies particularly, which established the efficacy of food-based strategy in improving anaemia and thus an iron deficiency in pregnant women. Even many of the other intervention studies conducted elsewhere did not test combined intervention merely focusing on ascorbic acid interventions. Thus, such limitations posed the inevitability for evidence from more longitudinal studies and randomized controlled trials to investigate associations and effects of combined dietary-based interventions on iron status.

Therefore, this study, to the knowledge of the researcher will be the first of its kind in Ethiopia and developing countries to analyse the effect of integrated food-based strategy as the effective approach in improving iron status and prevent iron deficiency and anaemia during pregnancy. Results and recommendations from the trial of the study will be of great importance in reinforcing policies and practices to design feasible, innovative and cost-effective food-based interventions. The study would also pose conclusions and recommendations for consolidating the existing programs for sustainable prevention and control strategy. Furthermore, the findings of the research will also have great significance for the further academics and research arguments.

1.6. DEFINITIONS OF KEY CONCEPTS

The following are key concepts used in this study and their definitions**:**

1.6.1. **Anaemia** is the lack of functioning red blood cells that leads to a lack of oxygen-carrying ability, causing unusual complications during lifetime (Prakash et al. 2015:166).

1.6.2. **Food-based strategy** is a comprehensive dietary approach to enhance the availability of, access to and utilization of foods with high content and bioavailability of micronutrients, as well as traditional household methods for preparing and processing indigenous foods (Food and Agriculture Organization 2014:20).

1.6.3. **Iron deficiency** is defined as an absence of a sufficient supply of iron to various tissues combined with signs of iron-deficient erythropoiesis (Food and Agriculture Organization 2011:269-70).

1.6.4. **Iron deficiency anaemia:** is when there is an inadequate amount of red blood cells caused by lack of iron (Food and Agriculture Organization 2011:269-270).

1.6.5. **Pregnant Woman** is a female carrying a developing embryo or foetus within her womb (or outside a womb in case of an ectopic pregnancy) (Definition of pregnancy 2016). A woman is considered pregnant when a fertilized egg has implanted in the wall of her uterus (Gold 2005:7) except in ectopic pregnancy which is an abnormality.

1.7. OPERATIONAL DEFINITIONS

1.7.1. **Anaemia** is a state where the blood haemoglobin concentration <11gm/dl (WHO 2011a:3) or haematocrit <37% in pregnant women and under-five children or the haematocrit of <33%, regardless of gestation (WHO 2001:33-38).

1.7.2. **Attrition** is when participants of the study drop out from the sample between one data collection round and another (Sabarwal & Hoop 2014:11).

1.7.3. **Compliance with the intervention** is defined as intake of vitamin C supplementation for more than half of the amount (more than 50 ml) of the juice for each of the 2 of the daily 3 servings; such amount of the supplement should be taken together with foods during meal servings and; for at least 4 days of the week and; for at least 10 weeks of the intervention periods.

1.7.4. **Compliance nutrition education intervention** is defined as completed attendance of 4 of the 5 education sessions.

1.7.5. **Iron deficiency:** serum ferritin concentrations <12µg/L in children under 5 years; <15µg/L in females in all stages of pregnancy (WHO 2001:33-38).

1.7.6. **Iron deficiency anaemia** is ascertained by the presence of anaemia and low serum ferritin <12-15µg/L usually with a low serum transferrin saturation <15-16% (Milman 2015:2).

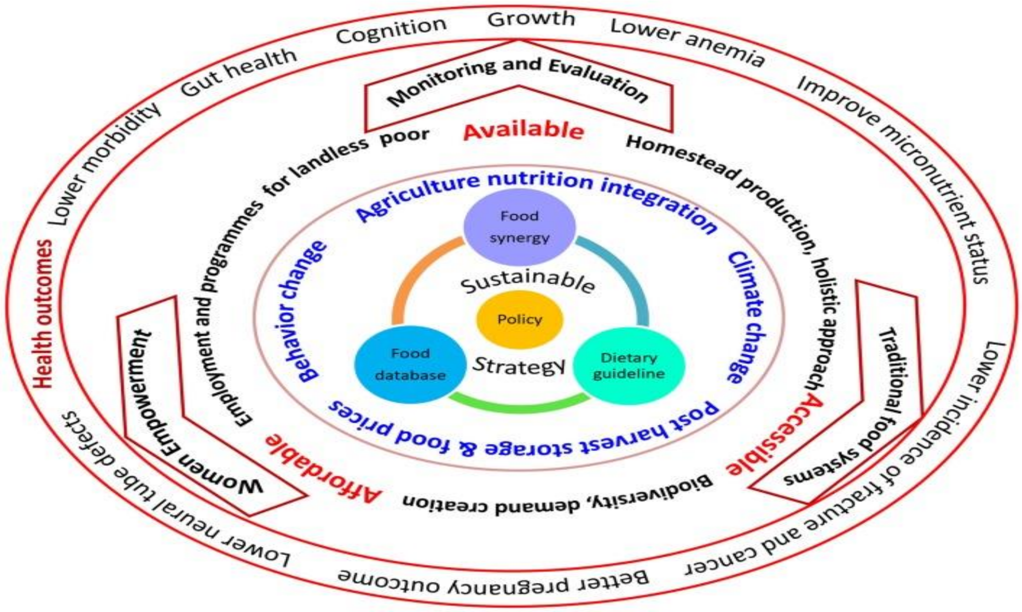
1.7.7. **Iron deficiency without anaemia**: is ascertained by the presence of low serum ferritin <15-30µg/L and often a low serum transferrin saturation <20% (Milman 2015:1).

1.7.8. Low-birth-weight: Babies weighing less than 2500gm at birth (Ahankari & Bee 2015:436).

1.8. THEORETICAL FRAMEWORK

A framework is the set of ideas and approaches that can be used to view and gather knowledge about a particular domain (Saldanha & O'Brien 2014:13). In this study, the researcher applied the conceptual framework for a sustainable strategy of dietary diversification to improve micronutrient status for developing countries displayed in figure 1 (Nair et al 2016:8). The framework focuses on improving the availability, access to and consumption of vitamin and mineral-rich foods; to address micronutrient malnutrition especially for particular groups such women of childbearing age, tracing the paths for the levels of impacts and components interacting at policy, programme interventions, food environment enabled at community level and household dietary diversification and preparation behaviours. Iron poses a particular challenge to food-based interventions because it is difficult to achieve adequate absorption of the non-heme iron found in plant foods.

The study thus analysed these factors focussing on the promotion of dietary diversification for improving the intake of bioavailable iron through proper household dietary consumption and preparation behaviours. Investigation of such levels of impacts of food-based strategies and adoption of a feasible strategy and dietary guidelines can lead to self-sustained success in improving iron status. The researcher analysed the effect of the strategies for improvement of iron status and the framework was useful in explaining the levels of interventions and their impacts.



Nair et al 2016:8

Figure 1.1 Path of achieving the sustainable strategy of dietary diversification to improve micronutrient status: a conceptual framework for developing countries

1.9. RESEARCH METHODOLOGY

Research methodology is a general approach to studying a phenomenon (Saldanha & O'Brien 2014:13). This section introduces the research approach, design, setting and population,

1.9.1. Approach

In this study, the researcher mainly employed a quantitative approach as the main phenomenon representing intervention outcome values based on numerical variables. Though the approach was not a mixed method, some qualitative elements were employed to augment the quantitative findings. More information regarding the research approach is provided in chapter 3.

1.9.2. Research design

The research design is an overall plan or the study protocol for testing the study hypotheses or questions (Melnyk & Overholt 2011:411). The researcher used a parallel randomized controlled trial design The design is thoroughly discussed in chapter 3.

1.9.3. Study setting

Study setting is defined as the physical, social, and cultural site in which the researcher collects the data during the study (Polit & Beck 2012: 588). The study was conducted in Dire Dawa Administration, east Ethiopia.

1.9.4. Study population

The study population was pregnant women who were permanent residents of Dire Dawa Administration were the source population of this study. More information regarding the study population is provided in chapter 3.

1.9.5. Sample and sampling methods

The sample was composed of 65 randomly selected pregnant women. The women were further randomly assigned relevant study groups. Furthermore, twenty-two of the pregnant women were further purposively selected for an in-depth individual interview to explore supplementary qualitative data. Thorough information on sampling and sample size is provided in chapter three.

1.9.6 Data collection methods and procedures

Quantitative data were collected from each study participant at baseline, during follow-up assessment visits and at the end of the 12 weeks interventions through individual face-to-face interviews employing interviewer-administered the structured questionnaire. Comprehensive information on data collection is provided in chapter 3.

1.9.7 Data management and analysis

Data entry and analysis was performed using the Statistical Package for Social Sciences (SPSS) version 21. Steps followed for data management and analysis are provided in chapter 3.

1.10. ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the ethical clearance committee of UNISA. Approval letter for permission to conduct the study was also obtained from Dire Dawa Administration Health Bureau, which also issued cooperation letter to the health centres. Copies of ethical clearance letter from UNISA and approved study proposal abstract were submitted to the Health Bureau and health facilities. All relevant ethical aspects were taken into consideration. The process followed to ensure adherence to ethical principles is discussed in chapter 3.

1.11. SCOPE OF THE STUDY

The scope of this study is limited to testing the effect of food-based strategy on iron status of pregnant women in Dire Dawa. Since the randomized controlled trial design was employed, a generalization of dietary patterns is beyond the scope of this study as Ethiopia is a country of much ethnic and cultural diversity. Estimation of nutrient intakes and development of Food-Based Dietary Data Base were also beyond the scope of this study.

1.12. STRUCTURE OF THE THESIS

This thesis consists of five chapters. The highlight of the structure of the chapters in this thesis is presented here below to guide readers and help them follow and understand the discussions.

Chapter 1: This chapter provides an overview of the study and includes the background to the study; problem statement; objectives of the study; the research hypothesis; definitions of the concepts; significance of the study; theoretical framework; the research methodology; the research setting; data collection and analysis ethical considerations; and scope of the study.

Chapter 2: The second chapter of this thesis reports on an in-depth review of literature related to the effect of food-based strategy in improving haemoglobin level and thus the iron status of pregnant women. The chapter discusses the search protocol and strategy of the review, themes generated and appraised to construct the review and the detailed results of the literature review. Limitations of the literature review are also discussed in the final section of the chapter.

Chapter 3: The third chapter reports on the research methodology. The chapter includes discussions on the research design, study populations, sampling, data collection methods, implementation phases of study intervention, data analysis and ethical issues.

Chapter 4: In the fourth chapter discusses the analysis, presentation and description of the research findings. It also discusses the interpretation of the findings in relation to other studies.

Chapter 5: This chapter presents the food-based strategies developed to improve the iron status of pregnant women based on the research findings discussed in chapter 4.

Chapter 6: The last chapter concludes the research findings based on the research objectives and hypothesis. It also puts forward the recommendations regarding the implementation of an integrated food-based and dietary modification approach on improving the iron status of pregnant women in Ethiopia, limitations and strength of the research.

1.13. CONCLUSION

This chapter described the orientation of the research; background of the study, the research hypothesis and objectives the study aim to achieve, the research design and methodology as well as the considerations for trustworthiness and ethics, the study limitation and significance of the study. The chapter was concluded with a summary of the organisation of the thesis. The next chapter deals with the literature review undertaken for the research.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

The preceding chapter provided an overview of the study focusing on the background of the research problem, hypothesises, objectives, key concepts, theoretical framework and research methodology. This chapter presents the process applied for the development of the literature search protocol and literature reviewed to capture the existing scientific knowledge in relation to the proposed research topic, which is food-based interventions as a strategy to address iron-deficiency and anaemia during pregnancy.

A literature review can be defined as a synthetic review and summary of what is known and what is unknown regarding the topic of a scholarly body of work, including the current work within the existing knowledge (Maggio, Sewell & Artino 2016:297). A systematic review is research undertaken to identify, evaluate, and synthesize the results of individual studies on a particular topic, making reliable data available in a usable form (Stern, Jordan & McArthur 2014:53). The literature review helps the researcher to ‘‘join the conversation’’ by providing context, informing methodology, identifying innovation, minimizing duplicative research, and ensuring that professional standards are met. Literature review helps the researcher to articulate clear goals, show evidence of adequate preparation, select appropriate methods, communicate relevant results, and to engage in reflective critique (Maggio et al 2016:297).

In order to achieve this, the review process must be well developed and pre-planned to reduce researcher bias and eliminate irrelevant or low-quality studies. Typically, a systematic review is planned by developing a protocol, which forms the foundation of the entire process (Butler, Hall & Copnell 2016:1). Therefore, the search protocol applied for this review and detailed discussion of the appraised themes is presented here below.

2.2. SEARCH PROTOCOL AND STRATEGY

Developing a search strategy protocol is an iterative process which involves continual assessment and refinement and provides the foundation for search strategy (Aromataris & Riitano 2014:49). The review protocol provides a predetermined plan to ensure scientific rigour and minimize potential bias. It also serves as a guide throughout the process and helps maintain focus on the chosen topic (Joanna Briggs Institute [JBI] 2015:6).

In this review, the researcher employed the Joanna Briggs Institute (JBI) approach for study selection and appraisal of quantitative (which measures the effectiveness of an intervention) and qualitative (which examines individual meaning and experience) evidence to develop the strategy as discussed by Porritt, Gomersall and Lockwood (2014:47). According to Porritt et al (2014:47) and JBI (2015:6), reviewers should take the following steps for a rigorous literature review and the protocol needs in order to contain their details:

- Formulate a review objective and question.
- Identifying keywords for search.
- Define inclusion and exclusion criteria to select literature.
- Identify databases to be searched.
- Perform a comprehensive search of the literature.
- Select studies for critical appraisal.
- Appraise the quality of the selected studies using one or more standardized tools.
- Extract data according to a template.
- Analyse, synthesize, and summarize data.
- Write up findings and draw conclusions (and in some cases make recommendations for practice, policy, or research).

2.2.1. The review question and aim

Determining the question is one of the first steps in planning a systematic review because it largely establishes the conduct of the review. A clear question will not only guide researchers in conducting a review, but it will also help readers to discern whether or not they should read it (Stern et al 2014:53). Before embarking on the search, the reviewer will need to understand the review question and what information is needed to address it (Aromataris &

Riitano 2014:50). The review question is also used to design the overall study aim. The study aim should be a clear statement of the intention of the review and is typically phrased as a statement (Butler et al 2016:2).

According to Stern et al (2014:53), the good question should incorporate the four elements included in the PICO mnemonic: Population, Intervention, Comparison intervention and Outcome Measures. While a variety of mnemonics exists to help reviewers structure the review question, PICO is the preferred choice for question development in quantitative reviews. Its variants PICOS and PICOT, where *S* stands for *study designs* (indicating which study designs, such as randomized controlled trial or diagnostic study, are eligible to answer the review question) and *T* stands for *time frame* (a period over which outcomes are assessed) can also be used (Stern et al 2014:54).

In this review, the researcher employed PICO and developed the following focused question to design the search strategy: *What is the effectiveness of food-based interventions as a strategy in improving the iron status and thus decreasing anaemia level of pregnant women?* Based on this focused review question, the aim of the review contended on the global and national perspectives of the magnitude and consequence of maternal iron-deficiency anaemia, as well as experiences, challenges and opportunities of food-based strategies and interventions as effective and sustainable approaches to improve iron status and thus addressing iron-deficiency anaemia among pregnant women.

2.2.2. Keywords and search terms

Aromataris and Riitano (2014:50) state that, once the review question and aim are developed, the researcher needs to identify the terms or synonyms, often referred to as keywords or free-text words, articulated in the question and create a logic grid or concept map. In a logic grid for a review of the effectiveness of an intervention, each column represents a discrete concept that is generally aligned with each element of the PICO mnemonic. These lists of keywords then form the basis of the search strategy. As recommended in Butler et al (2016:2), the researcher conducted a brief search of literature before planning the review, to identify search keywords, appropriate databases and the inclusion and exclusion criteria prior to the final review.

In this review, the researcher thus applied the PICO mnemonic framework (Aromataris & Riitano 2014:50) and identified the following search keywords and terms: *iron deficiency, iron-deficiency anaemia, anaemia, anaemia during pregnancy, consequence of anaemia, prevention of anaemia, iron-folic acid supplementation, pregnant women, maternal nutrition, food-based strategies, food-based interventions, dietary intervention, dietary guideline, dietary diversity, dietary practice, dietary knowledge, nutrition education, nutrition counselling, dietary intervention, dietary iron, iron bioavailability, dietary* randomized control trials*, iron intervention, iron absorption, iron intake, dietary iron, ascorbic acid, vitamin C, iron-rich vegetables and fruits and dietary efficacy intervention, east Ethiopia.*

2.2.3. Inclusion criteria

Regardless of whether the review involves quantitative or qualitative research (or both), criteria exist that must be addressed in the protocol such as inclusion criteria and methods. Inclusion criteria determine which research articles will be selected. In order for a reader to understand the focus of the review (and its limitations), the reviewers thus need to be precise in outlining the inclusion criteria (Stern et al 2014:56).

As stated in Stern et al (2014:56) and Porritt et al (2014:48), the researcher considered the following points while developing the inclusion criteria: the types of studies to be included (such as randomised control trials or qualitative studies); the intervention under investigation (such as dietary interventions); the outcome (the effectiveness of dietary interventions); the population (such as pregnant women); publication language and the time period.

In order to limit irrelevant sources, the researcher used the inclusion criteria listed below to identify literature sources relevant to the study:

- Literature with randomized controlled trial and qualitative designs.
- Literature on the dietary and nutrition interventions on iron and anaemia.
- Literature assessing the public health significance of iron-deficiency anaemia.
- Literature assessing the effectiveness of the food-based intervention in improving iron status in pregnant women.
- Literature published in English.
- Literature preferably published from 2010-2017.

2.2.4. Search strategy

Once the focused question and inclusion criteria are developed, the researcher designed the search strategy. The search strategy is one of the most important parts of the systematic review protocol because it outlines a priori strategies that reviewers will use to find, select, appraise and utilize the data (Butler et al 2016:2). Identifying and understanding relevant studies increase the likelihood of designing a relevant, adaptable, generalizable, and novel study that is based on educational or learning theory and can maximize impact (Maggio et al 2016:298).

The researcher applied the three approaches as stated in Aromataris and Riitano (2014:54) and Butler et al (2016:3) for the search strategy namely: identifying and search of relevant databases, examination of reference lists, or hand searching key journals in the area of interest and the grey literature sources. Gray literature often appears in the form of government or institution reports and newsletters and even in blogs, conference proceedings, census reports, or non-independent research papers (Aromataris and Riitano 2014:55).

Accordingly, for this review, the researcher searched various sources are including Google Scholar, Myunisa library, BMC Health Services Research, Pubmed/ MEDLINE, JBI Database, ResearchGate, International and National Organizations' and Universities' Databases. The researcher applied both alternative and the combination of keywords to search literature from the databases. In order to help with the keyword combinations, the three 'Boolean Operators' commands; "AND", or "OR", and "NOT" were used as stated in Aromataris and Riitano (2014:52).

2.2.5. Appraisal and synthesis of literature

According to Porritt et al (2014:48), the purpose of the critical appraisal is twofold. First, reviewer excludes studies which are of low quality and whose results may, therefore, compromise the validity of the recommendations of the review. Second, the reviewer identifies the strengths and limitations of the included studies. The latter is important: an interpretation of the studies' results must be sensitive to the characteristics of the studied populations, as well as to how weaknesses in the study designs have affected those results.

Data synthesis is the final stage of writing a systematic review protocol (Butler et al 2016:6). According to Munn, Tufanaru and Aromataris (2014:49), while synthesized data in a systematic review are the results (or outcomes) extracted from individual research studies relevant to the systematic review question, the synthesis makes up the results section of the review.

After the researcher gathered the appropriate literature that met inclusion criteria; including articles, global and national dietary guidelines, recommendations, protocols, survey reports and books relevant to the proposed study topic, the studies were appraised based on the JBI Checklist for critical appraisal of quantitative studies and randomized control trials as stated in Porritt et al (2014:48-49). Quantitative studies are appraised to identify sources of bias (selection, performance and attrition). While examining the effectiveness of an intervention, randomized control trials are evaluated in terms of their internal validity and external validity. High internal validity means that the differences observed between groups are related to the intervention tested in the trial (Melnyk & Overholt 2011:433; Spieth, Kubasch, Penzlin, Illigens, Barlinn & Siepmann 2016:1343). External validity, on the other hand, refers to the extent to which the results of the study can be generalized to groups, populations, and contexts that did not participate in the study (Porritt et al 2014:48-49)

Once the researcher critically appraised the studies, the researcher then synthesised the data in two stages: an initial overview and the final critical review of their content using the PQRS (Preview, Question, Read, Summarise) system method, as stated in Cronin, Ryan and Coughlan (2008:41). Cronin et al (2008:41) describe that the method not only keeps the reviewer focussed and consistent but also ultimately facilitates easy identification and retrieval of material particularly if a large number of publications are reviewed. The researcher also used indexing and summary form to assist the process keeping records of the sources and full references for further tracing.

From the initial review, the researcher constructed the major themes and subthemes based on the summary of the review and made the synthesis in a direction to the study question and aim. Since the study question emphasizes the effectiveness of dietary interventions in relation to improvements in maternal iron status, the researcher gave particular attention to review dietary theoretical frameworks, research designs, data collection methods, intervention tools and analysis methods; and relate their strengths and limitation with respect to the desired effect size of the interventions; while focussing on nutrition education, dietary vitamin C and iron absorption. This further assisted the researcher to update the data collection and nutrition education tools with respect to their comprehensiveness, relevance and validity. All literature reviewed are sourced and referenced.

2.3. SYSTEMATIZED THEMES

The researcher synthesised the literature review based on the systematized major themes and subthemes that emerged from the appraisal. Table 2.1 depicts the summary of the systematized themes.

Table 2.1: Summary of themes and subthemes of the literature review

S/N	Major themes	Subthemes
1.	2.3.1. Overview of maternal nutrition and iron deficiency	2.3.1.1. Nutrition during pregnancy
		2.3.1.2. Iron for health and pregnancy
		2.3.1.3. Iron requirements during pregnancy
		2.3.1.4. Epidemiology of iron deficiency and anaemia during Pregnancy 2.3.1.4.1. Estimation of iron deficiency and anaemia 2.3.1.4.2. Prevalence of iron deficiency and anaemia 2.3.1.4.3. Determinants of iron deficiency and anaemia
		2.3.1.5. Consequences of maternal iron deficiency on pregnancy and perinatal outcomes 2.3.1.5.1. Maternal consequences of iron deficiency anaemia 2.3.1.5.2. Consequences of maternal iron-deficiency anaemia on perinatal outcomes 2.3.1.5.3. Correlation between maternal and newborn's iron levels
2.	2.3.2. Strategies to address iron deficiency and their challenges	2.3.2.1. Ethiopian National Strategy for Prevention and Control of Iron Deficiency
		2.3.2.2. Iron-folic acid supplementation
		2.3.2.3. Food fortification
		2.3.2.4 Food-based strategies
3.	2.3.3. Interventions of food-based strategies to improve iron status during pregnancy	2.3.3.1. Dietary diversification 2.3.3.1.1. Dietary forms and sources of iron 2.3.3.1.2. Dietary diversification for the promotion of iron intake, absorption and bioavailability 2.3.3.1.3. Dietary patterns during pregnancy in Ethiopia 2.3.3.1.4. Dietary iron intake in Ethiopia
		2.3.3.2. Dietary modification and food preparation
		2.3.3.3. Nutrition education for dietary diversification and modification 2.3.3.3.1. Methods for nutrition education intervention 2.3.3.3.2. Effect of nutrition education
		2.3.3.4. Food-based dietary guidelines
	2.3.4. Overview of vitamin C, iron absorption and bioavailability	2.3.4.1. Vitamin C for health and its dietary sources
		2.3.4.2. Mechanism of Vitamin C for iron absorption
		2.3.4.2. Effect of vitamin C on iron absorption and iron level

2.3.1. Overview of maternal nutrition and iron deficiency

2.3.1.1. Nutrition during pregnancy

The nutritional status and size of a pregnant woman is the result of her past health and nutrition, including her own birth size and subsequent health and societal influences (Darnton-Hill & Mkparu 2015:1745). Poor availability or access to food of adequate nutritional quality or the exposure to conditions that impair absorption and use of nutrients has led to large sections of the world's population being undernourished, having poor vitamin and mineral status or being overweight (WHO 2014a:2). Nutritional status is also influenced by several environmental factors like the level of food insecurity and Human Immune Virus (HIV) infection (WHO 2014a:3). In countries where the prevalence of HIV infection is high, HIV infection has both a direct and indirect impact on the nutritional status of women and children who are infected. Indirectly, the infection effects through alterations in household food security and inappropriate choices of infant-feeding practices in order to prevent mother-to-child transmission. Poor food security increases risk-taking behaviour by women that place them at increased risk of becoming infected with HIV (WHO 2014a:3).

Human pregnancy involves large physiological changes. Blood volume expands in the course of a normal healthy pregnancy, mainly due to a 35% to 50% increase in plasma volume (Kaiser & Campbell 2014:1). Because the expansion in plasma volume is greater than the increase in red blood cell mass, there is a fall in haemoglobin concentration, haematocrit and red blood cell count. Despite this haemodilution, there is usually no change in mean corpuscular volume or mean corpuscular haemoglobin concentration (Soma-Pillay, Nelson-Piercy, Tolppanen & Mebazaa 2016:89). Concentrations of total plasma proteins and many nutrients including vitamins and minerals also decline generally due to normal physiological changes secondary to the expansion of blood volume and changes in renal function. However, most plasma lipids, total cholesterol and high-density lipoprotein cholesterol increase (Kaiser & Campbell 2014:1).

Pregnancy is the vital periods in life when the overall nutrient requirements are increased to meet high demands of both the growing foetus and the mother's own increase in body tissue reserves and metabolic demands (Darnton-Hill & Mkparu 2015:1747; Milman 2015:3; Sharlin & Edelstein 2011:4). However, the increased requirements will depend on existing nutritional status, the rate of weight gain, availability of adequate nutrition and co-existing disease (Darnton-Hill & Mkparu 2015: 1745).

The consumption of more food to meet energy needs and the increased absorption and efficiency of nutrient utilization that occurs in pregnancy is generally adequate to meet the needs for most nutrients when good food choices are made (Kaiser & Campbell 2014:8). However; Tseng and Ahmed (2013:1337) reviewed studies on energy and nutrient intakes of pregnant women in low- and middle-income countries published from 1989 to 2011 and conclude that the problems of unbalanced macronutrient profiles and multiple micronutrient deficiencies are common among pregnant women in developing countries such that multidimensional intervention strategies are needed to improve their nutritional status during pregnancy.

It is therefore critical that expectant mothers enter pregnancy with the best possible macronutrient and micronutrient status as optimal outcomes and consequences of antenatal nutritional deficiencies can be devastating with profound effects on subsequent well-being of the mother herself, child, families, societies and future generations (Darnton-Hill & Mkparu 2015:1745). As adequate nutritional status and good dietary intake during preconception and pregnancy are recognized as major contributors to healthy birth outcomes, under-nutrition and prenatal suboptimal diets with poor energy and micronutrients during pregnancy have been associated with poor foetal growth, pre-term delivery, pre-eclampsia, increased risk of stillbirth, poor infant survival, gestational diabetes and increased risk of chronic diseases in later life (Tseng & Ahmed 2013:1337). For a lactating mother, her micronutrient status determines the health and development of her breastfed infant, especially during the first six months of life (WHO 2013:46).

Accordingly, an adequate dietary intake of macro and micronutrients during a woman's lifetime, beginning during her own foetal development, ensures the future mother enters pregnancy with adequate development and nutrient status. Unfortunately, in low socioeconomic populations, where intergenerational poor nutrition and a hostile environment exist, foetal and early childhood malnutrition and inadequate development increase the reproductive risk for the adult woman (Viteri 2011:10).

2.3.1.2. Iron for health and pregnancy

Iron is one of the most important micronutrients for human populations, given its central role in key biological processes (Burke, Leon & Suchdev 2014:4094). Important iron-containing proteins are haemoglobin and myoglobin (Milman 2015:1). Iron, as a component of haemoglobin in erythrocytes, is required for transportation of oxygen, and in the form of myoglobin, for storage and use of oxygen in muscles (Geissler & Singh 2011:284; Milman 2015:1). Iron is also present as a component of iron-sulphur complexes in enzymes like cytochromes that are responsible for electron transport and energy generation in mitochondrial respiration and citric acid cycle (Geissler & Singh 2011:286). Moreover, it mediates other chemical reactions that are critical for life, forming part of the enzymes implicated in DNA synthesis and cell respiration (Aspuru, Villa, Bermejo, Herrero & López 2011:742). Iron is especially critical during pregnancy for the rapid cell and tissue development involved in foetal growth (Burke et al 2014:4095), optimal cognitive function (Bailey, West & Black 2015:24) and the production of certain enzymes (Soma-Pillay et al 2016:89).

An average individual contains a total of 3-5gm of body iron (Abu-Ouf & Jan 2015:146); about 2gm in adult women (Prakash & Yadav 2015:168). Most body iron in the blood is present in the form of haemoglobin (65-80%) (Clifford, Niebaum & Bellows 2015:1). About 10% is in muscle as myoglobin and the remaining 0-30% is primarily found in storage pools located in the liver and reticuloendothelial (macrophage) system as ferritin and hemosiderin (Geissler & Singh 2011:286). Only about 1% is incorporated in iron-containing enzymes and less than 0.2% in the plasma transport pool binding transferring (Geissler & Singh 2011:286). Ferritin concentration together with that of hemosiderin reflects the body iron stores (Abbaspour, Hurrell & Kelishadi 2014:166). Iron is reversibly stored within the liver as ferritin and hemosiderin and is transported between different compartments in the body by the protein transferrin (FAO 2011:269).

The human body conserves iron in several ways, including recycling of iron after the breakdown of red cells and its retention in the absence of excretion mechanisms, controlled by the hormone hepcidin, which maintains total-body iron within normal ranges avoiding both iron deficiency and excess. Its absorption is limited to 1-2mg daily, and most of the iron needed daily (about 25 mg per day) is provided through recycling by macrophages (Camaschella 2015:1832). The average adult stores about 1-3 gm of iron in his or her body Abbaspour et al 2014:168). Dietary intake of iron is needed to replace iron lost in the stools and urine as well as through the skin. These basal losses represent approximately 0.9 mg of iron for an adult male and 0.8 mg for an adult female (Abbaspour et al 2014:168).

Before it can be absorbed, iron has to be reduced from ferric ($Fe3+$) to ferrous ($Fe2+$) iron by reducing agents (Abbaspour et al 2014:165). It is suggested that dietary iron is also taken up as ferritin, the ubiquitous and highly conserved iron storage molecule of plants and animal cells (Beck, Conlon, Kruger & Coad 2014:3752). The regulation of iron absorption process involves at least three main mechanisms. The most important one is erythropoietin requirements; in such a way that absorption increases with increasing requirements. The second mechanism is dietary iron content, so that absorption decreases as dietary content increases. The third main mechanism is a reduction in the iron pool, which increases its absorption. Once absorbed and inside the entrecote, iron moves on to the plasma and, transported by transferrin, reaches the cells where it will be used, especially in the erythropoietic precursor cells in bone marrow (Aspuru et al 2011:742).

A feedback mechanism exists that enhances iron absorption in people who are iron deficient. In contrast, people with iron overload dampen iron absorption via hepcidin. Iron absorption is controlled by ferroportin, which allows or does not allow iron from the mucosal cell into the plasma (Abbaspour et al 2014:165). Absorption of iron increases during pregnancy (Kaiser & Campbell 2014:1). It is determined by the amount of iron in the diet, its bioavailability and the changes in iron absorption that occur during pregnancy (Prakash & Yadav 2015:165).

The physical state of iron entering the duodenum greatly influences its absorption. At physiological pH, ferrous iron (Fe+2) is rapidly oxidized to the insoluble ferric (Fe+3) form. Gastric acid lowers the pH in the proximal duodenum reducing Fe+3 in the intestinal lumen by ferric reductases, thus allowing the subsequent transport of Fe+2 across the apical membrane of enterocytes. This enhances the solubility and uptake of ferric iron. When gastric acid production is impaired (for instance by acid pump inhibitors such as the drug Prilosec), iron absorption is reduced substantially (Abbaspour et al 2014:165).

2.3.1.3. Iron requirements during pregnancy

The Recommended Dietary Allowance (RDA) or Recommended Nutrient Intake (RNI) is the amount of daily intake nutrient that meets the requirements of almost all (97.5%) of apparently healthy individuals in an age and sex-specific population group based on the nutrient’s Estimated Average Requirement (EAR) plus two standard deviations (FAO 2011:270). The EAR is the amount of nutrient estimated to meet the needs of 50% of individuals in a population (Beck et al 2014:3749). A requirement is an intake level which will meet specified criteria of adequacy, preventing the risk of deficit or excess (FAO 2011:270).

Iron recommendations are difficult to establish for several reasons, including difficulties in assessing iron intakes and the amount of iron needed to maintain iron stores. Iron bioavailability from a typical diet consumed by iron-replete women is used to estimate iron recommendations (Beck et al 2014:3751).

Requirements for iron vary depending on age, physiological status, growth rate, the degree of physical maturity, body composition and activity level. Increased requirements are also noted in patients with malaria, congenital haemoglobinopathies and other causes of haemolysis (FAO 2011:271). The daily requirements of iron are 1-3 mg/day; and these requirements increase during the growth period, in women of childbearing age, and in pregnant women (Aspuru et al 2011:735).

Pregnancy and lactation resulted in increased iron demands. Pregnancy causes a two to three-fold increase in the requirement for iron, 10 to 20-fold increase in folate requirements and a two-fold increase in the requirement for vitamin B12 (Soma-Pillay et al 2016:89). Nearly 300 mg of iron are needed just for the foetus, at least 25 mg for the placenta and nearly 500 mg for the increased volume of red blood cells (Burke et al 2014:4095). Folic acid requirements are increased in pregnancy because of the rapidly dividing cells in the foetus and elevated urinary losses (WHO 2012a:5).

A pregnant woman must have at least 500 mg of stored iron to fulfil the requirements of gestation without the need for iron supplementation. Even though this deposit is present, it will be completely exhausted by the end of gestation. The total iron requirement during pregnancy is 700-1400 mg. Overall requirement is 4 mg-6 mg per day, but this increases to 6-8 mg per day in the last weeks of pregnancy (Prakash & Yadav 2015:166).

The Recommended Dietary Intake (RDI) of iron during pregnancy is 27 mg/day (Saunders et al 2012:11; WHO 214b:3). In terms of absorbed iron, this requirement is 1.14 mg/day (Abbaspour et al 2014:168). This is a significant increase in by about 50% from the 18 mg/day (Darnton-Hill & Mkparu 2015:1753). The total iron intake during pregnancy should not be less than 1000 mg. The requirements are not equally distributed over its duration, where needs are almost negligible in the first trimester and that more than 80% of the total requirements relates to the last trimester (Abu-Ouf & Jan 2015:147; FAO & WHO 2001:209).

It is thus vital to meet this recommendation during the second and third trimester (Sharlin & Edelstein 2011:11). After delivery, the net total demand is approximately 600 mg during normal pregnancy (Milman 2015:3).

2.3.1.4. Epidemiology of iron deficiency and anaemia during pregnancy

This theme highlights the estimation of iron deficiency and anaemia, prevalence of iron deficiency and anaemia and determinants of iron deficiency and anaemia.

2.3.1.4.1. Estimation of iron deficiency and anaemia

An individual's iron status falls on a continuum, ranging from replete iron stores, through to depleted iron stores, iron deficiency (ID) and iron-deficiency anaemia (IDA) (Beck et al 2014:3748). Iron deficiency is depressed levels of total body iron, especially iron stores, with preservation of levels of erythroid iron (Camaschella. 2015:1833). Iron deficiency may be defined as an absence of iron stores combined with signs of iron-deficient erythropoiesis, implying there is an insufficient supply of iron to various tissues (FAO 2011:269). Under these conditions, insufficient amounts of iron are delivered to transferrin, the circulating transport protein for iron, resulting in a reduction in transferrin saturation (FAO 2011:270). Formation of haemoglobin is reduced resulting in a reduction in mean corpuscular haemoglobin. The concentration of transferrin in plasma increases in an effort to compensate (FAO 2011:270).

Functional iron deficiency occurs when there is the insufficient mobilization of erythroid iron in the presence of increased requests, as occurs after treatment with erythropoiesis-stimulating agents. Iron-deficiency anaemia is depressed levels of total body iron in the presence of anaemia (Camaschella. 2015:1833). It occurs when there is an inadequate amount of red blood cells caused by a lack of iron and has no immediate physiological meaning (FAO 2011:270). Anaemia is a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs (WHO 2014b:1; WHO 2011a:1). Nutritional anaemia is a condition in which the haemoglobin content of blood is lower than normal as a result of a deficiency of one or more essential nutrients (FAO 2011:270). However, there are cases where a person may not be anaemic but is mildly or moderately iron-deficient and consequently be functionally impaired (FAO 2011:270).

Serum Ferritin (SF), haemoglobin, mean cell volume, transferrin saturation, transferrin receptor, Total Iron-Binding Capacity (TIBC) and erythrocyte protoporphyrin are measurements commonly used to investigate iron status (FAO 2011:269). However, serum ferritin and haemoglobin are considered by the World Health Organization (WHO) to be the most effective indices for determining population burden of iron deficiency and iron-deficiency anaemia (Pasricha, Drakesmith, Black, Hipgrave & Biggs 2013:2613). Serum ferritin is a good indicator of body iron stores under most circumstances (Abbaspour et al 2014:168). Serum transferrin receptor levels are an indicator of the severity of iron insufficiency only when iron stores are depleted and no other causes of abnormal erythropoiesis are known (WHO 2014c:1). Serum transferrin receptor levels are also most appropriate in areas where infectious diseases and inflammations are prevalent as serum ferritin levels rise during inflammation (WHO 2014c:2).

The normal range for serum ferritin concentrations is within the 15-300µg/L (Geissler & Singh 2011:289). The WHO's criteria used to define depleted storage iron are serum ferritin concentrations of less than 12µg/L in children under 5 years and less than 15µg/L in males and females over 5 years; including all stages of pregnancy (WHO 2001:33-38). Iron deficiency may be classified according to serum ferritin concentration as depleted iron stores (serum ferritin less than 24ng/ml), mild iron deficiency (serum ferritin 18-24ng/ml) and severe iron deficiency (serum ferritin less than 12ng/ml). Iron-deficiency anaemia is usually symptomatic at haemoglobin levels of about 8gm/dl or lower (FAO 2011:270).

The WHO defines anaemia irrespective of the cause as blood haemoglobin concentration less than 110mg/L or haematocrit less than 37% in pregnant women and under-five children or the haematocrit is less than 33%, regardless of gestation (WHO 2013:40; WHO 2011a:3). Anaemia can be classified as mild anaemia (haemoglobin 10 to 10.9gm/dl), moderate anaemia (haemoglobin 7 to 9.9gm/dl), severe anaemia (haemoglobin less than 7gm/dl) and very severe anaemia (haemoglobin less than 4gm/dl) (Prakash & Yadav 2015:265). Iron deficiency with anaemia is ascertained by the presence of anaemia and low serum ferritin less than 12-15µg/L, usually with low serum transferrin saturation less than 15-16%. Iron deficiency without anaemia is ascertained by the presence of low serum ferritin less than 15-30µg/L and often a low serum transferrin saturation less than 20% (Milman 2015:1-2). A typical iron-deficiency anaemia shows the flowing blood values: haemoglobin less than 10 gm percent, red blood cell less than 4 million/mm^3, serum iron usually below 30µg per100 ml, increased total iron-binding capacity to 400µg/100ml and serum ferritin below 15µg/L (Prakash & Yadav 2015:170).

Nevertheless, it can be difficult to measure iron deficiency in populations due to the lack of availability of field-friendly iron biomarkers. In contrast, anaemia is less time-and resource-intensive to assess, and thus, is often used as a surrogate for iron status. However, anaemia is neither a sensitive nor a specific indicator of iron status: a loss of up to 20-30% of body iron would be necessary for some individuals to exhibit anaemia based on haemoglobin cut-offs (Burke et al 2014:4096).

The WHO also classifies the public health significance of anaemia in populations on the basis of the prevalence estimated from blood levels of haemoglobin as: sever if 40% or higher, moderate if 20%-39.9%, mild if 5%-19.9% and normal if equals 4.9% or lower (WHO 2011a:5).

2.3.1.4.2. Prevalence of iron deficiency and anaemia

Micronutrient malnutrition often occurs as part of a cycle of malnutrition and is still a problem of unacceptable proportions in developing countries. Iron deficiency is the most common micronutrient deficiency among pregnant women in the world, leading to iron-deficiency anaemia if not corrected (Burke et al 2014:4096; Pacificier 2016:2260). Iron deficiency affects more than 30% of the world's population, an estimated 2 billion people (WHO 2008:8). Iron-deficiency anaemia affects 30% women of reproductive age (468 million) and 42% of pregnant women (56 million) (WHO 2014a:2). According to the WHO's global estimation for 2011 (WHO 2015a:110), the global prevalence of anaemia among women of reproductive ages is 29%, of whom 39% are in Africa. The mean blood haemoglobin concentration is estimated to be 11.1gm/dl in children, 12.6gm/dl in non-pregnant women and 11.4gm/dl in pregnant women, indicating that, on the average, the population in all groups were above the threshold for mild anaemia (WHO 2015b:5).

A study in Kenya found 57% overall prevalence of anaemia among pregnant women attending the antenatal clinic in the second and third trimesters with a mean haemoglobin concentration of 10.32gm/dl. In terms of severity, mild anaemia was 26.5%, moderate anaemia was 70.7% and severe anaemia was 2.7% (Okube, Mirie, Odhiambo, Sabina & Habtu 2016:22). M'Cormack and Drolet (2012:11) reported a 77% anaemia prevalence among studied pregnant women in Sierra Leone; while review of Tseng and Ahmed (2013:1337-8) reported a 40% prevalence among pregnant women in the Democratic Republic of Congo with the highest prevalence almost in the third trimester of pregnancy, and higher in rural than in semi-urban or urban areas.

The following surveys and studies have witnessed the public health significance of anaemia in Ethiopia. According to the 2016 Ethiopian Demographic Health Survey (EDHS) report (CSA Ethiopia & ICF 2016:195 & 215), about 57% of children aged 6-59 months, 24% of reproductive age women and 29% of pregnant women are estimated to be anaemic (haemoglobin level less than 11gm/dl). About 16.5% of the pregnant women are classified as mildly anaemic (haemoglobin level 10.0-10.9gm/dl), 10.4% as moderately anaemic (haemoglobin level 7.0-9.9 gm/dl), and 2.2% as severely anaemic (haemoglobin level less than 7.0 gm/dl). The prevalence in reproductive women varies greatly by region, ranging from as high as 59.5% in Somali, 30% in Dire Dawa to 16% in Addis Ababa. Regions in the East of the country; Afar, Dire Dawa, Harari and the Somali Regional States, have the highest prevalence of anaemia in women of reproductive age constituting more than half of the national figure (CSA Ethiopia & ICF 2016:195 & 215).

According to the report of the most recent National Micronutrient Survey (Hailu 2016:28-33), more than one in three of pre-school children nationally are anaemic (34.4%), with altitude adjusted mean haemoglobin concentration of 11.4 gm/dl and median serum ferritin values 27.9µg/L; of whom 39.2% and 37.9% are in the Oromia region and Dire Dawa respectively. About 17.7% of non-pregnant Ethiopian women age 15 to 49 are anaemic with an adjusted mean haemoglobin concentration of 12.8 gm/dl; of whom about 19% and 10% are in Oromia region and Dire Dawa respectively. Higher proportions of women in rural areas were anaemic (21.3%) than those in urban areas (Hailu 2016:28-33). However, the survey produced no result regarding the prevalence of anaemia in pregnant women in the country.

A review in Ababaiya and Gabriel (2014:746) also witness the public health significance of anaemia in the country estimating the prevalence to range between 23%-66.5%.

Furthermore, a nation-wide study, which included eight rural districts of Ethiopia, reported that the mean haemoglobin concentration adjusted for altitude among pregnant women was 11.5 gm/dl and ranged from 4.1-16.3gm/dl. Accordingly, the prevalence of any form of anaemia was 33.2% and the magnitudes of mild, moderate and severe anaemia were 19.1%, 13.1% and 1% respectively (Gebremedhin, Samuel, Mamo, Moges & Assefa 2014a:6). Another nationwide survey including women of reproductive age in nine administrative regions of Ethiopia reported that the prevalence rates of anaemia, iron deficiency and iron-deficiency anaemia were 11.3%, 30.4%, 49.7% and 17.0% respectively with the highest in Oromia region (Umeta, Haidar, Demissie, Akalu & Ayana 2008:156).

Different cross-sectional studies have also documented the regional prevalence of anaemia among pregnant women. About 57.2% pregnant women attending Ante Natal Care (ANC) service in rural health centres of Dire Dawa were found to be anaemic, of whom 8.8%, 34.2% and 14.2%) were mild, moderate and severe anaemia, respectively. The mean and standard deviation of the haemoglobin level was 10.3g/dl and ± 2.3 g/dl (Yeshitila 2016:21). Bereka, Gudeta, Reta and Anaya (2017:4) report that 63.8% of pregnant women in Jijiga city, East Ethiopia, were anaemic, of whom 32.9%, 27.1% and 3.8% were mild, moderate and severe anaemic respectively. The prevalence in each trimester was 7.8% in the first, 35.4% in the second and 56.7% in the third trimester, respectively.

Studies in Butajira (Getahun, Belachew & Wolide 2017:3), South Gondar (Derso, Abera & Tariku 2017:4) and Arba Minch (Bekele, Tilahun & Mekuria 2016:4) reported 27.6%, 30.5% and 32.8% prevalence of anaemia among pregnant women attending ANC respectively. Other studies in southern, northern and northwest revealed the overall prevalence of anaemia among pregnant women attending ANC to be 39.94% (Gedefaw, Ayele, Asres & Mossie 2015:158), 36.1% (Gebre & Mulugeta 2015:4) and 21.6% (Alem, Enawgaw, Gelaw, Kena & Seid 2013:140) respectively. Gebremedhin, Enquselassie and Umeta (2014b:47) reveal the prevalence rate of anaemia, iron deficiency and iron-deficiency anaemia among pregnant women in rural Sidama to be 31.6%, 17.4% and 8.7% respectively.

2.3.1.4.3. Determinants of iron deficiency and anaemia

The root causes of and factors leading to malnutrition are complex and multidimensional. Although poor dietary intake is a common cause of micronutrient deficiencies, other individual causes including genetics, nutrient and drugs interactions, poor absorption, as well as certain diseases can lead to such deficits (Dunneram & Jeewon 2015:118). The groups most vulnerable to micronutrient deficiencies are pregnant and lactating women and young children, mainly because they have a relatively greater need for vitamins and minerals and are more susceptible to the harmful consequences of deficiencies (WHO 2013:46). Pregnant and adolescent women are particularly vulnerable to anaemia because they have dual iron requirements, for their own growth and the growth of the foetus, and are less likely to access ANC (WHO 2014c:2). Women are also at high risk of iron deficiency due to regular loss of iron from menstruation (Rasmussen 2001:599; Scholl 2005:1219).

Iron deficiency may result from inadequate iron intake and absorption, increased iron requirements during growth, and excessive iron losses. Dietary factors play a major role in the development of iron deficiency and the subsequent development of iron-deficiency anaemia (Beck et al 2014:3748). Poor dietary intake both in terms of total quantity, intake of low bioavailability iron and improver co-consumption dietary inhibitors and enhancers are responsible for iron deficiency (Pasricha et al 2013:2607-8). Iron deficiency anaemia is the most common cause of nutritional anaemia; poor absorption of iron is aggravated by diet rich compounds which prevent absorption of iron thereby resulting in anaemic condition (Prakash & Yadav 2015:168).

Worldwide, the most common cause of iron deficiency is a nutritional deficiency, which is inadequate intake of dietary iron (FAO & WHO 2011:207, Sharlin & Edelstein 2011:11). Most pregnant women don't have adequate amounts of iron intake, despite taking fortified food and supplementation (Abbaspour et al 2014:167) as diets of families in low-income environments are frequently of poor quality with low micronutrient bioavailability (FAO 2014:74), especially iron (Péneau, Dauchet, Vergnaud, Estaquio, Kesse-Guyot, Bertrais, Latino-Martel, Hercberg & Galan. 2008:1). Monotonous diets based on starchy staples lack essential micronutrients and contribute to the burden of malnutrition and micronutrient deficiencies (FAO 2014: 284). Tseng and Ahmed 2013:1338 also collaborate that virtually all women in the reviewed studies had lower than recommended intakes of foliate and nearly two-thirds of them did not meet the recommended intakes for iron.

At least half of the global anaemia burden is assumed to be due to iron deficiency (Burke et al 2014:4096; WHO 2012a:1). Iron deficiency is solely or partly responsible for 75-80% of all anaemia in women of reproductive age (Milman 2015:2) and for more than half of anaemia cases in pregnancy (WHO 2015:5). Iron deficiency is the primary cause, but infections, other nutritional deficiencies (especially folate and vitamins B12, A and C) and genetic conditions (including sickle cell disease, thalassaemia and chronic inflammation) are important causes of anaemia worldwide (Ababaiya & Gabriel 2014:748; WHO 2014b:2). Other most common risk factors related to iron-deficiency anaemia identified in different studies are hookworm infection, malaria, heavy menstrual blood loss, multiparity, illiteracy, lack of awareness, negligence, poor economy, food insecurity, lack of food diversity, changes in dietary behaviour, cultural behaviours, poor health and sanitation and vegetarian eating habits (Adhikari, Koirala, Lama & Dahal 2012:184; Camaschella 2015:1833). Okube et al (2016:23) show that maternal age, employment status, nutritional status (MUAC) and Iron-folic acid (IFA) supplementation during current pregnancy remained significantly and independently associated with anaemia among studied Kenyan pregnant women.

Anaemia during pregnancy can also be physiological due to the combined effect of hemodilution and negative iron balance as there is a disproportionate increase in plasma volume, red blood cell and haemoglobin mass in addition to the marked demand of extra iron especially in the second half of pregnancy (Prakash & Yadav 2015:265). Rasmussen (2001:59) argues that in populations in which the rate of iron or folate deficiency is low among non-pregnant women, the primary cause of anaemia during pregnancy is likely to be plasma volume expansion.

Analogous to the global circumstances, various studies in Ethiopian have also documented these independent predictors of anaemia. According to the 2016 EDHS, anaemia is more prevalent among women who have had six or more births and among women who are using intra-uterine devices and the prevalence decreases with increasing women’s education and household wealth (CSA Ethiopia & ICF 2016:199). Gebremedhin et al (2014b:47-51) reported iron deficiency as the most common cause of anaemia in the country, in addition to factors like poor maternal education, low dietary diversity, poor consumption of animal source foods. Gebre & Mulugeta (2015:5) show that nutrition education and low meal frequency per day have a negative influence on anaemia. Umeta et al (2008:157) conclude that non-heme iron source from the staple diets and heavy menstrual blood loss may account for the high prevalence rate of anaemia, iron deficiency and iron deficiency anaemia among women of reproductive age in Ethiopia.

Yeshitila (2016:24) identifies dietary factors to be the main factors associated with anaemia among pregnant women in Dire Dawa; those pregnant women who ate animal products less than 3 times per week were 1.8 times more likely to be anaemic compared to those women who ate animal products than more than 3 times per week. Those who ate meals less than 3 times per day were 9.1 times more likely to be anaemic compared to those who ate ≥ 3 times per day.

Zerfu, Umeta and Baye (2016a:1485-6) followed a cohort of pregnant women in Arsi to analyse their dietary diversity in relation to risk of anaemia using a 24-hour dietary recall. At enrolment, 37.6% of the pregnant women with inadequate women dietary diversity scores (consumption less than four food groups) were anaemic compared with 19.7% in the adequate group. The proportion of anaemia in the inadequate group continued to increase and reached 44.6% of anaemic women at the end of the follow-up, whereas it remained fairly stable in the adequate group (20.2% at term). After control for baseline differences, pregnant women in the inadequate women dietary diversity scores had a 2-fold higher risk of being anaemic.

Gravidity, mother’s age, family size, iron supplementation, mid-upper arm circumference of less than 23cm and body mass index were significant predictors associated with anaemia among pregnant women in Jijiga, east Ethiopia (Bereka et al 2017:5). Derso et al (2017:4) also find latrine availability, household monthly income, iron supplementation and nutritional status to be significantly and independently associated factors of anaemia; while Bekele et al (2016:5) report factors like monthly income, family size, birth interval, iron tablet supplementation and eating food made from “Enset” and its products.

Gedefaw et al (2015:158) show younger age of 15-24 years, family size greater than five, multigravida, having low income, current clinical illness, intestinal parasitic infection, no history of contraceptive usage, being in third trimesters, history of excessive menstrual bleeding and low body mass index as independent predictors of anaemia among pregnant women in Southern Ethiopia. While Alem et al (2013:140) also identify factors like rural residence, history of malaria attack, hookworm infection and absence of iron supplements to be significantly associated with increased risk of anaemia in northwest Ethiopia.

2.3.1.5. Consequences of maternal iron deficiency on pregnancy and perinatal outcomes

Despite advances in healthcare, iron-deficiency anaemia remains a major public health concern (Beck et al 2014:1). It is one of the most common health complications at all ages of the life cycle. Because it disproportionately affects children and women of reproductive ages (Scholl 2005:1219), iron-deficiency anaemia hinders the progress of nations' social and economic development. Failure to reduce anaemia worldwide consigns millions of women to impaired health and quality of life, generations of children to impaired development and learning, and communities and nations to impaired economic productivity and development (WHO 2014b:1). Throughout pregnancy, iron-deficiency anaemia adversely affects the maternal and foetal well-being and is linked to increased morbidity and foetal death (Abu-Ouf & Jan 2015:147).

2.3.1.5.1. Maternal consequences of iron-deficiency anaemia

Although there are limited researches documenting the extent of the consequence of maternal iron deficiency and iron-deficiency anaemia in Ethiopia, a number of worldwide studies have shown the consequences both on maternal and perinatal health outcomes. Maternal consequences include high maternal mortality, perinatal infection, pre-eclampsia, postpartum haemorrhage, bleeding, reduced resistance to infection, post-partum cognitive impairment, behavioural difficulties and risk of miscarriages (Abu-Ouf & Jan 2015:147; Prakash & Yadav 2015:172; WHO 2014c:1; WHO 2001:9). Anaemia is among the top ten causes of admission for a female in Ethiopia contributing to about 2% of the admissions (GFDRE 2017:21).

Anaemia and other nutritional deficiencies increase maternal morbidity because of their effects on the immune system (Gangopadhyay, Karoshi & Keith 2011: S13). It is estimated that as many as 20% of maternal deaths are directly caused by anaemia through its complications and it is an associated cause in as many as 40% of maternal deaths (WHO 2001:9). If the haemoglobin level is less than 8gm/dl, then the risk of death during delivery increases 2-3 folds (Prakash & Yadav 2015:169). The anaemia, which developed progressively during pregnancy, is shown to be more severe in women who had lower haemoglobin levels in the first trimester (Goswami, Patel, Pandya, Mevada, Desai & Solanki 2013:102).

2.3.1.5.2. Consequences of maternal iron-deficiency anaemia on perinatal outcomes

The WHO defines Low Birth Weight (LBW) as weight at birth less than 2500gm. Low birth weight continues to be a significant public health problem globally (WHO 2014d:1). Overall, it is estimated that 15% to 20% of all births worldwide are low birth weight, representing more than 20 million births a year (WHO 2014d:1). Low birth weight is associated with a range of both short and long term complications including foetal and neonatal mortality and morbidity, poor cognitive development and an increased risk of chronic diseases later in life (WHO 2014d:1). Low birth weight is among the top ten causes of morbidity and mortality for children less than five years of age in Ethiopia contributing for about 4% of the admissions and 5% of child mortality (GFDRE 2017:21 & 23).

Effect of maternal anaemia on perinatal outcomes include increased risk of low birth weight, neonatal or perinatal mortality, preterm birth, intrauterine foetal death, intrauterine growth retardation, low Apgar scores and small-for-gestational-age babies (Ahankari & Leonardi-Bee 2015:440-1; Bakhtiar, Khan & Nasar 2007:104, Prakash & Yadav 2015:173; WHO 2014a:2; WHO 20011b:1). Conversely, haemoglobin concentrations greater than 130 gm/L at sea level may also be associated with negative pregnancy outcomes such as premature delivery and low birth weight (WHO 2013:40).

A prospective cohort study in India resulted that pregnant women with severe anaemia had 9.45, 6.19 and 16.42 higher odds of postpartum haemorrhage, giving birth to low birth weight and perinatal death respectively (Nair, Choudhury, Choudhury, Kakoty, Sarma, Webster & Knight 2016:4). Another study in the same country also showed that birth weight to have a direct correlation with prevalence of anaemia, where increased rates of preterm delivery were seen at both the ends of haemoglobin ranges and the association is statistically significant in all weeks of gestation (Goswami et al 2013:101). Ahankari and Leonardi-Bee (2015:440) also collaborate that women with anaemia during pregnancy are twice as likely to deliver a low birth weight baby compared to those without anaemia during pregnancy. Besides, iron deficiency has a profound effect on infant health and development. Infants with iron-deficiency anaemia test lower in mental and motor development assessments and show effective differences. Neuro-functional studies show slower neural transmission in the auditory system, different motor activity pattering in all sleep-waking states and several differences in the sleep state organization. Persistent sleep and neuro-functional effects could contribute to reducing the potential for optimal behavioural and cognitive outcomes in children with a history of iron-deficiency anaemia (Pacificier 2016:2260).

In the cohort study in Arsi Zone, Ethiopia, Zerfu et al (2016a:1485-6) reported that after controlling baseline differences, pregnant women in the inadequate women dietary diversity scores (consumption less than 4 food groups) had a 2-fold higher risk of being anaemic; a 4-fold higher risk of preterm birth; and a 2-fold risk of LBW than their counterparts in the adequate group. In contrary, Emamghorashi and Heidari (2004:810) show that babies of iron-deficient anaemic mothers were heavier and had greater head circumference than non-anaemic non-iron-deficient mothers, which was associated with the iron supplementation. Rasmussen (2001:599) also report a negative association of anaemia with negative birth outcomes.

2.3.1.5.3. Correlation between maternal and newborn iron levels

Irrespective of maternal iron stores, the foetus obtains iron from maternal transferrin, which is trapped in the placenta and which, in turn, removes, and actively transports iron to the foetus. Gradually; however, such foetuses tend to have decreased iron stores due to depletion of maternal stores (Prakash & Yadav 2015:173). Thus, the mother's iron status prior to and during pregnancy, as well as interventions aimed at maintaining and improving maternal health and iron nutrition, can also change the offspring's iron endowment (Viteri 2011:4).

Studies have reported correlations between maternal iron status and newborn's cord blood haemoglobin and serum ferritin measures (Emamghorashi & Heidari 2004:810; Paiva, Rondó, Pagliusi, Latorre, Cardoso, Gondim 2007:324; Pasricha et al 2013:2607; Shao, Lou, Rao, Michael, Georgieff, Kaciroti, Felt, Zhao & Lozoff 2012: 2006). Shao et al (2012: 2006) report that infants of iron-depleted mothers, as indicated by maternal serum ferritin below an empirically derived threshold of 13.6mg/L, had lower cord-blood serum ferritin than the rest of the sample, concluding that the maternal and neonatal iron statuses would be related only if maternal iron status is compromised.

Similarly, one study conducted in Ethiopia determined that maternal iron-deficiency anaemia may have an effect on the iron stores of new-borns as haemoglobin and ferritin concentrations were significantly lower in new-borns delivered from iron-deficiency anaemia mothers than new-borns delivered from non-anaemic mothers. The new-borns' ferritin and haemoglobin levels had a significant correlation with haemoglobin and ferritin levels of their mothers. Additionally, the new-borns' haemoglobin showed significant correlation with mothers' Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) values (Terefe, Birhanu, Nigussie & Tsegaye 2015:3).

However, a correctional study in Brazil suggest that maternal iron nutritional status at the end of pregnancy does not have an impact on iron levels of the new-borns; as blood samples from pregnant women during labour and from their umbilical cord used for the determination of complete serum iron, total iron binding capacity, serum ferritin and transferrin saturation were statistically similar in new-borns born to anaemic, iron deficient and non-iron deficient pregnant women (Paiva et al 2007:324).

2.3.2. Strategies to address iron deficiency and their challenges

Improving women's, children's and adolescents' nutrition requires a range of diverse policies, programmes and interventions throughout the life-course and across many different sectors including food systems, trade and investment, social protection, food safety and antibiotic resistance, water, sanitation and hygiene (WHO 2013:50). Non-nutrition interventions in the health sector are also needed and should take place within the context of strong and resilient health systems and policies that promote universal health coverage. While non-health related interventions outside the health sector also could have an important impact on nutrition, the evidence for those actions is variable and requires further elaboration (WHO 2013:50).

Main public health strategies and interventions, alone or in combination, to improve iron status in populations, and for correcting iron deficiency and other micronutrient deficiencies in pregnancy include: iron supplementation, fortification of processed or staple food with iron, point-of-use fortification with multiple micronutrients including iron, nutrition counselling that promotes for dietary modification or diversification to improve iron intake and absorption and treatment of preventable causes of iron losses from parasitic infestations such as hookworm and other infections (WHO 2016:4). A new approach is bio-fortification via plant breeding or genetic engineering (FAO 2014:20). In addition, optimizing maternal nutrition before and during pregnancy, prevention of low birth weight and prematurity, and improvements in access to health care, infant feeding, food security, and socioeconomic status are important factors (Pasricha et al 2013:2609).

Consequently, women during pregnancy need to consume additional iron to ensure they have sufficient iron stores to prevent iron deficiency (WHO 2013:40). Thus, the best method for combating iron deficiency in pregnancy is to promote high intakes to enter pregnancy with adequate iron stores. Burke et al (2014:4097) recommend that women had better enter pregnancy with iron stores of at least 500mg before pregnancy; while Sharlin and Edelstein (2011:11) suggest women to have at least 300mg of iron stored. However, it is uncommon for women today to have iron stores of this size (FAO & WHO 2001:209). In the developing world, estimates suggest that a significant portion of pregnant women will have depleted iron stores by the end of pregnancy. It is estimated that less than 50% of women do not have adequate iron stores for pregnancy (Scholl 2005:1248), while over 20% of women in developed countries enter pregnancy with extremely low iron stores (Burke et al 2014:4097).

2.3.2.1. Ethiopian national strategy for prevention and control of iron deficiency

The Ethiopian Health Sector Transformation Plan (2016-2020) targets to reduce the prevalence of anaemia in women of childbearing age and pregnant women from 17% to 12% within the five years (GFDRE 2015:165). The National Nutrition Strategy (NNS) forwards comprehensive set of interventions and initiatives to meet this targets which include: comprehensive and routine nutritional assessment and counselling services, maternal adequate intake of diversified diet, supplementary food for malnourished pregnant/ lactating women, routine iron-folic supplements or multiple micronutrient supplementation, de-worming during second and third trimester, free distribution and use of insecticide-treated mosquito nets (ITNs) and involvement of women groups in nutrition-sensitive agricultural and livelihood programs (GFDRE 2013:17).

2.3.2.2. Iron-folic acid supplementation

Supplementation refers to periodic administration of pharmacological preparations of nutrients as capsules or tablets or by injection (FAO 2011:283). Iron-folic acid (IFA) supplementation has been the backbone of many low-income countries' nutritional strategy to improve iron stores and address iron deficiency and iron-deficiency anaemia particularly among pregnant women (Pasricha et al 2013:2609; Peña-Rosas, De-Regil, Garcia-Casal & Dowswell 2015:5). Given the number of women that enter pregnancy with insufficient iron stores, iron supplementation may be needed to be initiated prior to conception to ensure effective intervention for prevention of maternal iron deficiency (Burke et al 2014:4104; WHO 2012a:2).

The WHO recommends that all women, from the moment they begin trying to conceive until 12 weeks of gestation, should take a folic acid supplement (WHO 2016:7). Daily oral iron-folic acid should be part of routine ANC, begun as early as possible and continued throughout pregnancy. Daily iron supplementation should be considered in the context of other interventions containing iron (fortified foods, multiple micronutrient powders, lipid-based nutrient supplements) (WHO 2016:7). It is preferably provided together with folic acid due to the difficulties in correctly evaluating iron status in pregnancy with routine laboratory methods (FAO & WHO 2001:209). The Ethiopian National Guideline for Control and Prevention of micronutrient deficiencies emphasizes the need of daily iron supplementation for at least 6 months during pregnancy and 3 months postpartum.

The updated suggested scheme for daily iron-folic acid supplementation in pregnant women is that 30-60mg of elemental iron (30mg of elemental iron equals 150mg of ferrous sulfate heptahydrate, 90mg of ferrous fumarate or 250mg of ferrous gluconate) and 400μg (0.4 mg) of folic acid be provided once daily throughout pregnancy in all settings (WHO 2013:41-2). Iron and folic acid supplementation should begin as early as possible. In settings where anaemia in pregnant women is a severe public health problem (40% or higher), a daily dose of 60mg of elemental iron is preferred over a lower dose. If a woman is diagnosed with anaemia at any time during pregnancy, she should be given daily iron (120mg of elemental iron) and folic acid (400µg or 0.4mg) until her haemoglobin concentration rises to normal. She can then switch to the standard antenatal dose to prevent recurrence of anaemia (WHO 2013:41-2; WHO 2012a:5). The standard therapy for iron-deficiency anaemia in adults is a 300 mg tablet of ferrous sulphate (60mg of iron) three or four times per day (Zimmermann & Hurrell 2007:515).

Oral iron is widely available as a single micronutrient supplement in liquid and tablet formulations, as iron-folic acid, or ferrous iron salts (ferrous sulphate and ferrous gluconate) are preferred because of their low cost and high bioavailability in multiple micronutrient preparations (Pasricha 2013:2609).

Various studies have documented the benefit of iron supplementation. About 50% of anaemia in women could be eliminated by iron supplementation (WHO 2015:5). A review of randomised or quasi-randomised trials evaluating the effects of oral preventive supplementation with daily iron and iron-folic acid reported that iron supplementation reduced maternal anaemia at term by 70% and iron deficiency at term by 57% and concluded that supplementation reduces the risk of maternal anaemia and iron deficiency in pregnancy but the positive effect on other maternal and infant outcomes is less (Peña-Rosas et al 2015:2; WHO 2013:40; WHO 2012a:4).

Goswami et al (2013:102) conclude that the haemoglobin concentration falls and severity of anaemia which developed progressively during pregnancy lessens in those who receive iron supplementation as compare to those who will not receive iron supplementation. In the review, Tseng and Ahmed (2013:1338) also report that women who had an iron deficiency at an early stage of pregnancy and did not take iron supplements had a significantly higher prevalence of iron deficiency at delivery, although moderate iron supplementation (up to 60mg/d) did not prevent iron-deficiency anaemia.

A study in Ethiopia revealed that pregnant women who were not on iron-folic acid had 1.90 times increased odds of anaemia (Gebremedhin et al 2014b:48). Gebremedhin et al (2014a:6) also identify that haemoglobin concentration showed a linear increment after the first month of supplementation. While adjusted for the gestational trimester in a linear regression model, every month of supplementation was associated with a significant 0.23gm/dl increment in haemoglobin. Pregnant women in East Ethiopia who lack iron supplementation during pregnancy were 1.30 times more likely to develop anaemia (Bereka et al 2017:5).

Besides, benefits of iron-folic acid extend beyond improving iron stores to lowering risk for the critical outcomes of iron deficiency and iron-deficiency anaemia (WHO 2016:5) which include improving birth outcomes (Emamghorashi & Heidari 2004:810) and reducing prevalence of low birth weight (Passerini, Casey, Biggs, Cong, Phu, Phuc, Carone & Montreso 2012:3). Supplementation of folic acid before conception and during the first trimester of pregnancy is recommended for preventing neural tube defects (Berti, Faber & Smuts 2014:44; Burke et al 2014:4105). Vitamin A helps release iron from iron stores in the body and makes it more available for the body to use. Vitamin A deficiencies, therefore, may manifest as iron deficiencies. The use of vitamin A and iron supplementation may help relieve iron deficiency more than iron alone (Clifford et al 2015:2).

However, it is argued that the overall quality of the evidence for iron supplementation versus no iron was moderate for low birth weight, preterm birth, maternal anaemia and iron deficiency at term. The evidence is of low quality for birth weight, neonatal death, congenital anomalies, maternal death, maternal severe anaemia, and infections during pregnancy (WHO 2012a:1).

Challenges of iron-folic acid supplementation programs

In spite of the implementation of iron-folic acid supplementation program for the past many years, a very high prevalence of anaemia in pregnant women still persists in many countries indicating the insufficiency of the approach (FAO 2014:76). In Ethiopia, anaemia prevalence among women age 15-49 declined from 27% in 2005 to 17% in 2011 but then increased to 24% in 2016 (CSA Ethiopia & ICF 2016:199).

Despite its proven efficacy, the use of daily iron-folic acid supplementation has been limited in some settings. The sustainability and effectiveness of iron-folic acid supplementation interventions have been challenged by many factors related to compliance and coverage for various interacting bottlenecks attributed to the health system, care providers and individual behaviour levels. Many worldwide studies have extensively reviewed such challenges of the sustainability and effectiveness of supplementation programs in many low-income countries (Berti et al 2014:50; Dutta, Patel & Bansal 2014:460; Mithra, Unnikrishnan, Rekha, Nithin, Mohan, Kulkarni, Holla & Agarwal 2014:258; Ogundipe, Hoyo, Truls, Oneko, Manongi, Lie & Daltveit 2012:8; WHO 2016:7; Zimmermann & Hurrell 2007:515). Peña-Rosas et al (2015:2) indicate that implementation of iron supplementation recommendations may produce heterogeneous results depending on the populations' background risk anaemia, as well as the level of adherence to the intervention.

Concerns about the safety of the intervention among women with an adequate iron intake and variable availability of the supplements at the community level may also be the possibility (WHO 2013:41). Potential harmful effects of folic acid, like increased small-for-gestational-age birth rate, hypertension disorders and gestational diabetes mellitus in iron-sufficient women are still debated (Berti et al 2014:44; Burke et al 2014:4105).

There are also issues about the potential adverse effects of population-based iron supplementation for children in malaria-endemic areas. The safety of iron intervention programs for populations in which conditions causing non-physiologic enhanced iron absorption (such as hereditary hemochromatosis; possibly heterozygote, homozygote, and compound heterozygote thalassemia conditions; and chronic hemolytic anaemia) are prevalent is not well understood (Pasricha et al 2013:2613). Uncertainties also exist regarding iron supplementation in chronic infections such as HIV and tuberculosis because of iron deficiency in such cases is often functional; relative iron deficiency in blood as a result of excess storage of iron as ferritin (Gangopadhyay et al 2011: S14).

Various national surveys and studies have also documented these attributes in Ethiopia (Gebre, Mulugeta & Etana 2015:166; Gebremedhin et al 2014a:6; Sadore, Gebretsadik & Hussen 2015:3). Report of the 2016 EDHS reveals that coverage of iron supplementation is at a substandard level where more than half of the women with a child born in the last 5 years (58%) did not take any iron tablets during their most recent pregnancy. Only 5% of women took iron tablets for 90 days or more during their most recent pregnancy, while only 6% of women took deworming medication (CSA Ethiopia & ICF 2016:200). In the survey, Gebremedhin et al (2014a:6) reveal that 66.2% of the pregnant women were not on iron supplementation; whereas, 19.0%, 7.2%, 6.4% and 1.1% took the supplements for 1-30, 31-60, 61-90 and more than 90 days respectively. Sonko (2016:8) reported a higher coverage with 76.7% of the pregnant women in Aleta Chuko woreda took iron-folic acid supplements while attending ANC; suggesting the contribution of health extension program and community-based women development army in promoting the importance of the antenatal care in the community level.

Despite the assumption that iron supplementation is an integral part of ANC, ANC coverage in Ethiopia is poor and lately initiated. According to the EDHS 2016, only 32% of women received the recommended four or more ANC visits during their last pregnancy as recommended by the WHO, while 37% of women in Ethiopia had no ANC visits. Only 20% of women had their first ANC during the first trimester, 26% during their fourth to the fifth month of pregnancy, and 14% during their sixth to the seventh month of pregnancy. Only 42% of the pregnant women said that they took iron supplements during ANC (CSA Ethiopia & ICF 2016:134-5). In the cohort study, Zerfu et al (2016a:1484) also report that almost all of the followed pregnant women attended their first ANC during their second trimester with a mean duration of pregnancy of 25-27 weeks. Furthermore, ANC services are challenged by a shortage of supplies. According to the report on the evaluation of the Health Extension Program (HEP), while folic acid tabs were available only in 8.3% of the health posts, about 91% of health posts also reported stock-outs in the three months preceding the survey (Columbia University 2011:18).

In summary, supplementation is the fastest way to control micronutrient deficiencies in individuals or population groups. Supplementation is, however, a temporary solution and does not address the underlying cause of nutrient deficiency in addition to its programmatic challenges related to the sustainability and effectiveness. To achieve population impact and be the most cost-effective, micronutrient supplements should be distributed through the primary health care system.

2.3.2.3. Food fortification

Food fortification means the addition of nutrients at levels higher than those found in the original food (FAO 2011:282). Biofortification is the process of enhancing the nutrient content of staple crops through traditional breeding and modern technology (Berti et al 2014:52).

Bio-fortification enhances the nutritive value of foods using modern tools of biotechnology (FAO 2011:282). It provides a feasible means of reaching malnourished populations in relatively remote rural areas and delivers naturally fortified foods to people with limited access to commercially marketed fortified foods (FAO 2014:212).

Decisions about which nutrients to add and the appropriate amounts to add to fortify flour should be based on a series of factors like: sensory and physical effects of the fortificant nutrients, nutritional needs and deficiencies of the population, the usual consumption profile of fortifiable staple food, population consumption of vitamin and mineral supplements and costs (Burke et al 2014:). The dietary habits of the population are thus an important consideration in selecting food for fortification (WHO 2001:53).

When selecting a suitable iron compound as a food fortificant, the overall objective is to find the one that has the greatest absorbability, yet at the same time does not cause unacceptable changes to the sensory properties of the food vehicle. Being highly soluble in gastric juices, the water-soluble iron compounds have the highest relative bioavailability of all the iron fortificants and for this reason are, more often than not, the preferred choice (WHO & FAO 2006:97).

Ranges of iron fortificants are available. Ferrous sulfate and fumarate have the highest bioavailability and similar iron content. Ferrous sulfate is cheapest and widely used to fortify flour. Insoluble compounds (ferric pyrophosphate and orthophosphate) have less reactivity with food but poorer bioavailability. Elemental iron compounds have been used but have poor bioavailability and affect the taste at effective concentrations (Pasricha et al 2013:2609).

Food fortification is an attractive strategy because it does not require the target groups to change their diet and because it reaches large numbers of consumers through retail. It is a particularly effective way of tackling deficiencies in densely populated urban areas (Germany 2012:2). Fortification has a role in meeting iron, foliate iodine and zinc needs, and is recommended when dietary iron is insufficient or the dietary iron is of poor bioavailability, which is the reality for most people in the developing world and for vulnerable population groups in the developed world. It is effective at reducing the burden of iron-deficiency anaemia in susceptible populations (FAO 2011:282). Consumption of iron-fortified foods results in an improvement in haemoglobin, serum ferritin, reduced risk of anaemia and iron deficiency (Gera, Sachdev & Boy 2012:312-13). The co-addition of ascorbic acid in a 2:1 molar ratio is recommended in order to enhance iron absorption. In the case of high phytic acid foods, the ascorbic acid: iron molar ratio can be increased to 4:1 (WHO& FAO 2006:111).

Nationally, food fortification is acknowledged to make a significant contribution towards achieving the objectives of the Ethiopian NNP. Fortification of flour, oil and sugar are feasible strategies to contribute to the reduction of micronutrient deficiencies in Ethiopia. Wheat flour fortification is recommended for iron and folic acid, while fortification of oil with vitamins A and D offers the least cost, lowest technology for widest coverage options for providing significant population-wide nutrition protection (GFDRE 2011:39).

According to the Ethiopian National Food Consumption survey (Ethiopian Public Health Institute 2013:35-8), approximately 16% of women of childbearing age at national level reported consuming fortifiable wheat flour product in the 24 hours preceding the interview, compared to over half of the surveyed women reporting consumption of fortifiable oil (56.6%). In rural areas consumption of fortifiable wheat and oil by women of childbearing age was 9% and 47% respectively, compared to 36% and 84% in urban areas. Among those women of childbearing age that reported consuming fortified wheat and oil, the national median intake of fortifiable wheat and fortifiable oil were 100gm/day and 12gm/day. With respect to the regional figures, 19.4% and 33.9% of the women in Oromia Region and Dire Dawa reported consuming fortifiable wheat flour product with a median intake of 112gm/day and 125gm/day respectively. While 64.3% and 63% of the women in Oromia region and Dire Dawa reported consuming fortifiable edible oil with a median intake of 9.9 gm/day and 16.4 gm/ day respectively (Ethiopian Public Health Institute 2013:35-8).

Challenges of food fortification programs

Technically, iron is the most challenging micronutrient to add to foods, because the iron compounds that have the best bioavailability tend to be those that interact most strongly with food constituents to produce undesirable organoleptic changes on the colour and flavour. During prolonged storage, the presence of fortificant iron in certain foods can cause rancidity due to oxidation of unsaturated lipids and subsequent off flavours. In the case of multiple fortifications, free iron produced from the degradation of iron compounds present in the food can oxidize some of the vitamins supplied in the same fortificant mixture (WHO & FAO 2006:97). Moreover, the iron in many fortificants has low bioavailability and this may diminish or even completely negate the effectiveness of an iron fortification intervention. Thus, the progress on improving iron status through iron fortification of foods has been slow in many countries (Miller & Welch 2013:15).

Nationally, opportunities for public health improvements via fortification with micronutrients are defined and limited by the existing poor market linkage, poor distribution and consumption patterns for commercially processed foods; in addition to the coverage of recommended vehicles being not perfect (GFDRE 2011:7&39) posing challenges to Ethiopian fortification.

Iron fortification is also reported to have practically no effect on iron status if the original diet has low bioavailability (Hoppe, Hulthe´n & Hallberg 2008:765). Currently, there is no evidence available to assess the potential benefits or harms of the use of multiple micronutrient powders for home fortification of foods consumed by pregnant women with regard to maternal and infant health outcomes (WHO 20011b:1). Thus, the routine use of this intervention during gestation is not recommended as an alternative to iron-folic acid supplementation in pregnancy (WHO 20011b:1).

In summary, although fortification can be an innovative strategy for addressing micronutrient malnutrition, it may not be a feasible and accessible strategy for resource-poor rural inhabitants in developing countries where commercial food fortification is impractical or even be impossible due to a lack of centralized food processing plants. Resource limitations for governments in developing countries to effectively monitor compliance, especially when there are many small processing companies operating, are the other challenge for the strategies to be sustainable over the long term (Miller & Welch 2013:8 & 12). Furthermore, food fortifications strategies do not address the primary cause of poor micronutrient status. Complementary strategies are thus needed in these contexts that support culturally appropriate dietary modification and community-based interventions (Berti et al 2014:42).

2.3.2.4. Food-based strategies

Consequently, the problems and questions to be raised posing scientific attentions will be: with such global and national significant prevalence and impact of iron deficiency and iron-deficiency anaemia; and with prevention intervention largely backed by an iron-folic acid supplementation program that is still challenged by various limitations; how can a pregnant woman in such unprivileged circumstances manage to get the required amount of iron knowing that normal dietary practices are likely to be insufficient for a good portion of her pregnancy and birth outcome?

This is consequently the appropriate time for a smooth paradigm shift from the traditional disproportionate focuses on less effective supplementation and fortification programs centring on single nutrient to comprehensive strategies and packages of intervention recognizing the multidimensional whole foods and entire dietary diversification approaches for a sustainable prevention and control of micronutrient deficiencies (Nair, Augustine & Konapur 2016:2).

Food-Based Strategies (FBS), also referred to as Dietary Diversification and Modifications (DDM), are defined as changes in food production and food selection patterns, as well as changes in traditional household methods for preparing and processing indigenous foods. The overall goal of the strategies is to enhance the availability of, access to and utilization of foods with high content and bioavailability of micronutrients throughout the year (FAO 2014:20; FAO 2011:270).

Food-based strategies have been recommended as the first priority to meet micronutrient needs (FAO 2014:284). The use of food-based strategies has also several other advantages as they have the potential to prevent coexisting micronutrient deficiencies simultaneously, without risk of antagonistic interactions, while at the same time being culturally acceptable, economically feasible and sustainable, even in poor-resource settings; provided that a participatory research process that focuses on building relationships with the community to involve them in the design and implementation is used. Additionally, dietary diversification and modifications can enhance the micronutrient adequacy of diets for the entire household and across generations. Several additional non-nutritional benefits may also be achieved through the community-based nature of dietary diversification and modifications. These may include the empowerment of women in the community and income generations (FAO 2014:20-1). Dietary diversification and modification have an additional advantage of being more close to the population psyche and culture too (Nair et al 2016:2).

Food-Based Approaches (FBA) are thus optimal to achieve sustainable solutions to multiple nutrient deficiencies. Strategies other than dietary diversification have the disadvantage of targeting the known factors. Addressing the “uncertainty of unknown” is an advantage for an approach aimed at diversification in the diet (Nair et al 2016:2).

However, further recommendations for food-based strategies should in advance analyse the challenges related to dietary factors affecting the absorption and bioavailability of iron. Iron poses a particular challenge to FBA because it is difficult to achieve adequate absorption of the non-heme iron found in plant foods (Blasbalg, Wispelwey & Deckelbaum 2011: S6-S8). Foods that provide highly bioavailable iron (such as meat) are expensive and change of dietary practices and preferences is usually difficult to attain (FAO 2014:20; Zimmermann & Hurrell 2007:515). Furthermore, the strategies bear several issues such as a lack of evidence base, slow returns, lack of measurable endpoints, issues of affordability, and also bears the challenge of breaking the inertia of dietary habituation. Lack of such consistent evidence bases often facade limitations to the strategy (Nair et al A 2016:2).

2.3.3. Interventions of food-based strategies to improve iron status during pregnancy

Food-based strategies encompass comprehensive interventions that aim to increase the amount of; in this present case iron, available for body functions by; (1) increasing the production, availability and access to iron-rich foods; (2) increasing consumption of foods rich in iron through nutrition education programs to change eating behaviour; (3) making iron more easily absorbed and utilized by the body (more bioavailable) and or (4) by breeding new varieties of plants that contain larger amounts and more bioavailable micronutrients (FAO 2014:20; Miller & Welch 2013:4; Ruel 2001: 2-3; WHO 2001:48).

2.3.3.1. Dietary diversification

An essential element to food-based approaches involves dietary diversification – or the consumption of a wide variety of foods across nutritionally distinct food groups. Increased dietary diversity is associated with increased household access to food as well as the increased individual probability of adequate micronutrient intake (FAO 2014:284).

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals (Kennedy, Ballard & Drop 2013:5). Dietary diversity is measured as the number of individual food groups consumed over a given reference period (FAO 2014:284). Dietary diversity scores are simple counts of the number of food groups consumed at the individual or household level (FAO 2014:286). The FAO recommends a reference period of the previous 24 hours (Kennedy et al 2013:10). Data collected using the dietary diversity tool can then be analysed in several different ways to provide a picture of dietary patterns within a community as well as among vulnerable groups (FAO 2014:284).

Dietary diversity can be measured in many different ways. These include the Household Dietary Diversity Score (HDDS), the Minimum Dietary Diversity (MDD) and the Women's Dietary Diversity Score (WDDS) (FAO & FHI 360 2016:4). The HDDS is meant to reflect, in a snapshot form, the economic ability of a household to access a variety of foods. Individual dietary diversity scores aim to reflect nutrient adequacy. The scores have been validated for several age/sex groups as proxy measures for macro and/ or micronutrient adequacy of the diet (Kennedy et al 2013:5). The HDDS is based on 12 food groups, while the Women Dietary Diversity Score (WDDS) is based on nine food groups (FAO 2014:286). Household food insecurity level can be assessed based on WFP's guideline (WFP 2015:9-17) using the Food Consumption Score (FCS) or the "frequency weighted diet diversity score".

The Minimum Dietary Diversity for Women of reproductive age (M-DDSW) is a food group diversity dichotomous indicator of whether or not women 15-49 years of age have consumed at least five out of ten defined food groups the previous day or night. The proportion of women 15-49 years of age who reach this minimum in a population can be used as a proxy indicator for higher micronutrient adequacy, one important dimension of diet quality (FAO & FHI 360 2016:2).

An analysis of dietary diversity by subgroups of a population allows the setting of measurable targets for improvement for the group with the lowest dietary diversity. Likewise, the dietary profile of the higher tertile of dietary diversity can be used as a target to be reached by all pregnant women to increase their level of iron-rich food groups. Information on dietary diversity in two or more time periods is also useful for helping decision-makers to understand the effects of both normal seasonal variations on dietary consumption enabling them to define and plan actions to improve access to the important food groups. Any programme or intervention with a primary objective is to improve the diet of the population or to evaluating the impact of food-based intervention should thus initially understand dietary diversification (FAO 2014:285-89). This will further serve as the main input for the subsequent development of food-based dietary guidelines.

2.3.3.1.1. Dietary forms and sources of iron

Dietary iron can be found in two forms: heme iron and non-heme iron. Heme iron is contained in haemoglobin or myoglobin and is derived almost exclusively from animal source foods like meat, fish, and seafood. Non-heme iron (especially ferric salts) is most frequently found in plant sources like vegetables, wholegrain cereals (legumes, corn, wheat, barley, and others). It can also be found in animal source foods, dairy products, eggs and in iron-fortified foods such as rice, pasta, bread, cereals, cooked spinach, nuts, and seeds (Aspuru et al 2011:4278; Geissler & Singh 2011: 295; Hurrell & Egli 2010:1461, Saunders, Craig, Baines & Posen 2012:11). The iron in meat is about 40% heme and 60% non-heme (Clifford et al 2015:2). Plant foods contain only non-heme iron (Saunders et al 2012:11).

Iron bioavailability refers to the proportion of iron that is taken up and transferred into the body by the intestinal mucosa and is used systemically (Geissler & Singh 2011:295). Although heme iron constitutes a smaller part of dietary iron (5%-10%), it is relatively bioavailable with 20%-30% being absorbed. Absorption of non-heme iron is much more variable with 1%-10% of it is absorbed (Beck et al 2014:3752). The bioavailability of non-heme iron is influenced by various dietary components that either enhance or inhibit its absorption (Clifford et al 2015:12). Because 85-100% of dietary iron is in the non-heme form, this form accounts for most of the physiological control of iron absorption in relation to iron needs. When iron stores are high, absorption of non-heme iron can be minimized more completely and when iron stores are low, non-heme iron is absorbed nearly as efficiently as heme iron (Hunt 2005:376-377).

A standard diet could supply up to 15mg of iron per day (Abu-Ouf & Jan 2015:146). Heme and non-heme iron contributes to 0-2mg and 12-18mg to the total daily iron (Hunt 2005:377). In order to fulfil iron requirements, the daily diet should contain at least 27mg of iron having 25% bioavailability (Milman 2015:3). Because gastrointestinal absorption of iron is limited, the diet must contain between 15 and 30mg/day (Aspuru et al 2011:745). Diets of high iron bioavailability contain generous amounts of meat and foods that enhance iron absorption and low intakes of foods that inhibit iron absorption (Beck et al 2014:3751). According to GAO, Stiller, Scherbaum, Biesalski, Wang, Hormann and Bellows (2013:2948), sesame seeds, soybean milk film, pumpkin seeds, and shitake mushrooms are recommended as iron sources for both rural and urban pregnant women in China.

2.3.3.1.2. Dietary diversification for the promotion of iron intake, absorption and bioavailability

Apart from the overall dimension of dietary diversity, utilizing the effects of favourable food combinations need to be sufficiently elucidated for food-based approaches to succeed (Nair et al 2016:7). Nutritional iron deficiency is common in populations consuming monotonous plant-based diets and where very little iron-rich foods such as animal source foods are consumed (Zimmermann & Hurrell 2007:512). The possible explanations are the fact that: (1) amount of iron is low in cereal and tuber-based diets; (2) the bio-availability of this non-heme iron source is low making it impossible to meet the recommended levels of iron in the staple-based diets (FAO & WHO 2001:10) and (3) In addition, a cereal-based diet decreases iron bioavailability because phytates in grains sequester iron in a poorly absorbable complex (Camaschella 2015:1835).

In addition to its type and amount of body stores, the absorption of dietary iron depends on, the balance between enhancers and inhibitors in the diet (FAO 2011:272). Among dietary inhibitors of iron absorption include phytic acid and polyphenols. Phytic acid is present in cereals, rice, legumes, and lentils. Polyphenols like tannic and chlorogenic acids are found in tea, coffee, red wine, vegetables and herbs. Some proteins present in soybeans also have an inhibitory effect on non-heme iron absorption (Geissler & Singh 2011:295; Hurrell & Egli

2010:1462; Kaiser & Campbell 2014:8; Lo¨nnerdal 2009:1680; WHO 2001:50). Frequent ingestion of antacids and chronic use of proton pump inhibitors also diminishes iron absorption (Prakash & Yadav 2015:166). Calcium can also be a strong inhibitor (Abbaspour et al 2014:167; Milman 2015:2).

Phytate and polyphenols bind with iron to form insoluble complexes in the gut, which are poorly absorbed. Hence, reducing phytate and polyphenols enhance iron absorption (Camaschella 2015:1835; FAO 2014:22). Removal of phytates can also be effective ways of increasing the total amount of iron absorbed from iron-fortified foods. However, the molar ratio of phytic acid to iron needs to be decreased to 1:1 or even to less than 0.5:1, in order to achieve a meaningful increase in iron absorption (WHO & FAO 2006:101-2). Tannins found both in tea and coffee adversely affect iron availability. Coffee and tea consumption at the time of a meal can significantly decrease iron absorption. Tea can cause iron absorption to drop by 60% and coffee can cause a 50% decrease in iron uptake (Clifford et al 2015:2).

Furthermore, enhancers of both heme and non-heme iron absorption include: ascorbic and citric acids found in certain fruit juices, fruits, potatoes and certain vegetables; cysteine-containing peptides ("meat factors") found in meat, chicken, fish and other seafood; and ethanol and fermentation products like vegetables, soy sauce, etc (FAO 2011:271; Geissler & Singh 2011:295; Hurrell & Egli 2010:1462; Kaiser & Campbell 2014:8; Milman 2015:2; WHO 2001:50). Other organic acids such as lactic acid have also been shown to enhance absorption. Additionally, animals source foods (ASFs) can contribute to the alleviation of protein-energy malnutrition and various micronutrient deficiencies. Hence, their inclusion in the diet is an essential strategy for improving the intake of essential nutrients for pregnant women (FAO 2014:25 & 159).

The two main measures available for improving dietary iron bioavailability are reductions of the factors inhibiting iron absorption or/and increasing the number of factors with enhancing effects through dietary diversification (Camaschella 2015:1835; FAO 2014:22; Hoppe et al 2008:768). Pregnant women should thus be promoted to consume iron-rich foods such as lean red meat, fish, poultry, dried fruits, and iron-fortified cereals. To have an effect, foods rich in vitamin C must be eaten at the same meal as the iron source. Pairing plant sources with heme sources of iron during meals not only improves the total iron be eaten but also the percentage of non-heme iron that is absorbed (Clifford et al 2015:2). The available evidence suggests that addition of small amounts of red meat consumed with plant-based meals can lead to intakes of bioavailable iron much higher than the improvements with non-haem iron through the consumption of ascorbic acid-rich foods or fermented foods (FAO 2014:25). Providing some animal-source foods in the diets of the poor who are dependent on staple food crops is, therefore, an important strategy for decreasing iron deficiency in these populations (Miller & Welch 2013:7).

Pregnant women should also be promoted to reduce consumption of foods that inhibit iron absorption, such as whole-grain cereals, unleavened whole-grain bread, legumes, tea, and coffee. Such foods should also be consumed separately from iron-fortified foods and iron supplements (Kaiser & Campbell 2014:8). Drinking tea or coffee within two hours of eating meals should be avoided (FAO 2011:280). Yeshitila (2016:20) reports that 69.8% of the studied pregnant women in Dire Dawa took tea 2-3 per day. However, Gebremedhin et al (2014b:48) reveal that the haemoglobin levels and odds of anaemia were not statistically different across variables like frequency of coffee intake during pregnancy in studied pregnant women in Ethiopia. Besides, dietary studies before and during pregnancy have shown that most women do not change their diet diversity significantly when they become pregnant (FAO & WHO 2001:10; Milman 2015:3).

2.3.3.1.3. Dietary patterns during pregnancy in Ethiopia

Despite these arguments on such dietary factors, the national consumption surveys conducted in Ethiopia on dietary pattern show that family diets were predominantly based on cereals and legumes and consumption of animal source foods as well as fruits and vegetables was very low. According to the 2013 Ethiopia National Food Consumption Survey (Ethiopian Public Health Institute 2013:20), the highest proportion of foods consumed by households come from the cereals/grains group, while consumption of flesh foods (meat and organ meat) and egg were reported among very few. About 60% of women's total diet came from cereals/grains group while the proportion of flesh foods, fruits and vegetables are below 5%. The corresponding figures to Oromia region and Dire Dawa were 60% and 66.8%for cereals, 1.1% and 1.8% for flesh foods and 3.9% and 1.8% for fruits and vegetables respectively (Ethiopian Public Health Institute 2013:20).

Review of secondary data from the 2011 Ethiopian Welfare Monitoring Survey, revealed that mean household diversity score (HHDS) was five food groups out of eleven and Cereals were the most commonly consumed food groups in 96% of the analysed rural and urban households in Ethiopia followed by vegetables (81%) and legumes (76%). Meat and fruits were consumed in only 32.9% and 19.5% of the households respectively. Dire Dawa relatively had a better proportion of consumption of all animal source foods, except for fish as compared to other regions, with 40% of the households consumed meat. However, Dire Dawa had the highest significant difference between the proportions of households with high and low household diversity scores (49.3%) (Workicho, Belachew, Feyissa, Wondafrash, Lachat, Verstraeten & Kolsteren 2016:4-5). Level of household food security has been found to be associated with the risk of anaemia (Ghose, Tang, Yaya & Feng 2016:6).

The dietary pattern has not shown many improvements through years as the 2005 EDHS report showed that most mothers consume foods made from grains (88%), one in two mothers consumed foods made from legumes and nuts and one-third consume foods made from roots or tubers. Smaller proportions of mothers consumed cheese, yoghurt, milk or other milk products (23%) and meat, fish, shellfish, poultry and eggs (14 %) and about 86% of mothers drank tea or coffee. Only 14 % consumed iron-rich foods (CSA Ethiopia and ORC Macro 2006:149&154).

Dietary patterns and diversities of pregnant women across the different regions of the country have no as such variations. In Dire Dawa 60.9%, 64.3%, 57.8% and 68.8% of the studied pregnant women reported eating meat, vegetables, fruits and cereals less than three times per week respectively (CSA Ethiopia and ORC Macro 2006:149&154). Dietary diversity assessment using 24-hours dietary recall method in Southern Ethiopia reported that 52.5% and 71% of the assessed pregnant mothers had cereal-based foods such as barley, wheat, teff and green leafy vegetables within the last 24 hours respectively, while 83.5% had no animal source food like within the last one week. The mean daily intake of almost all the foodstuffs and nutrients fell short of the recommendations (Sonko 2016:6).

Derso et al (2017:4) report that only 18.1% of studied pregnant women Dera District had a meal frequency of four and above in the previous 24-hours preceding the date of survey; while 67% and 55.2% did not consume animal products and vegetables food groups at least once per week respectively. Zerfu et al (2016a:1484) show that pregnant women with adequate women dietary diversity scores (consumption of more than 4 food groups) consistently consumed more dairy, animal-source foods, fruit, and vegetables throughout the follow-up period than those in the inadequate women dietary diversity scores. A study in the northeast region showed 59.9% of pregnant women of had poor dietary practice while 39.9% practised avoiding food during their pregnancy for reasons like it makes the baby big (46.7%), cultural and religious influences (38.6%) and it makes delivery difficult (14.7%) (Alemayehu & Tesema 2015:710). About 67% of pregnant women in west-east Ethiopia were found to have poor dietary practice while 35.8% practised avoiding food during their pregnancy (Daba, Beyene, Garoma & Fekadu 2013b:109).

Ethiopian lactating mothers also have related dietary patterns and diversities. Dietary diversity assessment using 24-hours dietary recall method among lactating mothers in Northern Ethiopia identified that 56.4% of had low dietary diversity, where nearly all women (99.4 %) consumed starchy staples. Only 24.6% and 17.1% consumed fruits and vegetables, and meat respectively (Weldehaweria, Misgina, Weldu, Gebregiorgis, Gebrezgi, Zewdie, Ngusse, Gebrewa & Alemu 2016:5). Haileslassie, Mulugeta and Girma (2013:9-10) also identified that 99.3% of the assessed lactating mothers consumed cereal-based foods (made of teff, wheat, sorghum, millet, and barley) while only 23.5% and 3.8% consumed fruits (banana, lemon and orange) and meat respectively.

Cultural taboos related to food choices and intakes also influence dietary practices during pregnancy. An exploratory qualitative study in Afar region showed that pregnant women in the community abstain from eating much during pregnancy and encourage to limit her diet in quantity and frequency to prevent the fetus from being large and thus avoid difficulty and bleeding during delivery from a large baby. Food groups considered as “good foods” due to their high-fat content like meat, camel milk and yoghurt are tabooed for pregnant women for similar reasons and they increase adherence to the food taboos as they become close to the end of their pregnancy (Hadush, Birhanu, Chaka & Gebreyesus 2017:5-6). Another qualitative study in Arsi revealed that the most common dietary taboos during pregnancy were related to the consumption of green leafy vegetables like cabbage, yoghurt, cheese, sugar cane, and green pepper. Some study participants mentioned that in their culture it is believed that, if a pregnant woman eats leafy vegetables, especially after 8 months of gestation, the leaf passes to the womb and attaches to the baby's head and form what they called "particles" (Zerfu, Umeta & Baye 2016b:4).

Likewise, GAO et al (2013:2938) show that 70.6% of studied pregnant women in Deyang City of China adhered to specific food taboos during their pregnancies while 74% restricted their eating; lamb, mutton, goat, rabbit, beef, eel and duck being the most commonly cited tabooed food items. While 80% of rural pregnant women practised some food avoidance, which was a markedly higher percentage compared to 65.1% in the urban setting.

2.3.3.1.4. Dietary iron intake in Ethiopia

According to the national food consumption survey, iron intake in surveyed adults in Ethiopia appears to be high. The nationally weighted median range for iron intake in women of childbearing age was found to be 43.7mg per day. Intakes were slightly higher in urban versus rural areas (median 55.8mg and 39.6mg). The highest intake was found in women from Addis Ababa (mean 53.7) which was 2.4 times higher than intakes in women from the Somali region (mean 14.5). The median intakes for Oromia region and Dire Dawa are 45mg per day and 31.6mg per day respectively. About 64% of the women nationally, (58.0% and 27% in Oromia region and Dire Dawa respectively) had excessive intakes of whom 59.6% are in rural (Ethiopian Public Health Institute 2013:30&34). Haileslassie et al (2013:9-10) also collaborate that lactating mothers in Northern Ethiopia have a diet with high contents of iron (118mg), vitamin C (23mg) and extreme phytate content (1,872mg).

Furthermore, the survey (Ethiopian Public Health Institute 2013:30) reported that the percentage absorption of iron in the diet was assumed to be low as phytate to iron molar ratios in women of childbearing age were found to be 3.16, and intakes of animal source foods were generally found to be very low. A 5% iron bioavailability was assumed based on a diet characterised by high cereal intakes and low animal protein. This is the lowest category of assumed bioavailability of iron. Taking into consideration the bioavailability of the dietary iron intakes at 5%, the prevalence of inadequate intakes was calculated to be approximately 13% in women of childbearing age at the national level. The prevalence of inadequacy varied considerably across regions, from 84% of women in the Somali region to 14.9% and 33.9% in Oromia region and Dire Dawa respectively (Ethiopian Public Health Institute 2013:30). However, the report did not include specific pregnant women.

Despite excessive intakes of iron higher than the recommended amount for women of childbearing age, the national micronutrient survey reveals 10% of non-pregnant women of reproductive age nationally, (11% and 17% in Oromia region and Dire Dawa respectively) have depleted iron stores (serum ferritin less than 15ug/L); and 16.4 % (14.6% and 27.8% in Oromia region and Dire Dawa respectively) have tissue iron deficiency (serum transferrin greater or equal to 4.4mg/L) (Hailu 2016:36-7). When iron-deficiency anaemia is estimated only from individuals who had depleted iron store and anaemic (serum ferritin less than or equal to 15ug/L and haemoglobin less than 12gm/dL) and deficient in soluble transferrin receptor plus anaemic (serum transferrin greater or equal to 4.4mg/L and haemoglobin less than 12gm/dL), the prevalence is 4.7% and 5.8% respectively. The prevalence of iron-deficiency anaemia based on serum ferritin in the Oromia region and Dire Dawa is 7.7% and 9.3% respectively (Hailu 2016:36-7).

The figures may have increased if the survey would have included pregnant women, as the iron requirement and risk of its deficiency is higher due to their physiological needs. Therefore, it can be forwarded that dietary factors affecting iron absorption may have a significant influence on the iron and anaemia levels. However, the research identified no literature establishing the extent of the effect in Ethiopia. These put the way forward for the country's call for comprehensive strategies and packages of intervention recognizing the multidimensional whole foods and entire dietary diversification approach for sustainable prevention and control of micronutrients deficiencies.

2.3.3.2. Dietary modification and food preparation

The absorption of dietary iron also depends on food preparation practices and techniques (FAO 2011:272). The dietary modification involves changes in food preparation and consumption behaviours and habits for reductions of the factors inhibiting iron absorption or/and increasing the number of factors with enhancing effects (Hoppe et al 2008:768). Common food modification, preparation and processing methods like cooking, fermentation, mechanical processing, soaking, germination/malting and thermal or enzymatic action have enormous potentials both to increase the physicochemical accessibility of micronutrients, decrease the content of anti-nutrients, such as phytate and the Hexa- and Penta-inositol phosphate content or increase the content of compounds that improve bioavailability (Miller & Welch 2013:9; Nair et al 2016:8; WHO 2001:49).

Germination increases the activity of endogenous phytase in cereals, legumes and oilseeds through de novo synthesis; which is the activation of intrinsic phytase. Fermentation can induce phytate hydrolysis via the action of microbial phytase enzymes, which hydrolyze phytate to lower inositol phosphates. Soaking cereals and most legume flours in water can result in passive diffusion of water-soluble sodium, magnesium and potassium phytates (FAO 2014:22; Hotz & Gibson 2007:1097-8). Sprouting grains and seeds and a leavening of bread also reduces phytate. Milling removes about 90% of the phytic acid from cereal grains, but the remaining 10% is still a strong inhibitor (WHO& FAO 2006:102). Although processing the wholegrain removes much of the phytate content, it also removes other beneficial nutrients such as iron and zinc (Clifford et al 2015:12). Germination, fermentation and soaking can also reduce some polyphenols content of some cereal and legume enhancing iron absorption (FAO 2011:17; FAO & WHO 2001:10).

Arif, Bangash, Khan and Abid (2011:19-20) reported that soaking and malting drastically reduced the phytic acid content of Barely by 14.84% and 33.50% respectively. Furthermore, the total iron also reduced during malting which was 2.10 mg/100g, 1.81 mg/100g and 1.11 mg/100g in raw, soaked and malted barley respectively. Narsih, Yunianta and Harijono (2012:1432) also concluded that treatment with the combination of soaking for 24-hour and germination for 36 hour increases the nutritional value of sorghum.

In the review to evaluate aspects of vitamin C, Pacier and Martirosyan (2015:96-7) illustrate that food storage and preparation are the other major factors that can make a huge difference on vitamin C content. Because vitamin C degrades when heated and during storage, the processing and preparation procedures should be considered when estimating dietary intake of vitamin C (Lykkesfeldt et al 2014:17). Akdaş and Bakkalbaş (2017:883) reported that ascorbic acid content of kales, a cruciferous vegetable, decrease after cooking with the lowest observed for stir-frying, followed by boiling, microwaving, and steaming.

Decreases in the amount of ascorbic acid content after steaming, boiling, microwaving, and stir-frying were 2.9%, 53.1%, 10.6%, and 54.9% respectively. El-Din, Abdel-Kader, Makhlouf and Mohamed (2013:699) revealed that cooking treatments lead to a significant deleterious on the vitamin C contents of Brassica vegetables. Boiling for 6 minutes caused 64.5% decrease in broccoli, 70.7% in white cabbage and 66.82% in cauliflower. Birlouez-Aragon Fieux, Potier de Courcy and Hercberg (cited in Frei, Birlouez-Aragon and Lykkesfeldt 2012:826) also report that steam cooking vegetables preserve their vitamin C content while frying or pan-cooking results in a substantial loss. Lynch and Cook (1980:38) also showed that very little ascorbic acid remained in baked foods and no enhancement of iron absorption occurred.

Pacier and Martirosyan (2015:97) summarize that, the best ways to ensure proper vitamin C intake are: consume fruits, vegetables and juices high in vitamin C; choose fresh and/or frozen products over canned when available; consume fresh produce/juice within a week of purchasing; eat foods raw or cook by steaming; and store produce not intended for immediate use in freezer.

Besides, it has been demonstrated that cooking meat at 70°c or 120°c increased non-heme iron absorption by 0.9% and 2% respectively (Nair et al 2016:7), and cooking in iron pots can increase iron intake (Ruel 2001:4). However, foliate is destroyed by cooking (Prakash & Yadav 2015:175).

In conclusion, although sometimes difficult to achieve, such changes in dietary preparation habits can bring about important sustainable improvements, not only in iron status but also for nutrition in general (WHO 2001:49). Hoppe et al (2008:765) agree that the daily average percentage of iron absorption from diet increases almost eightfold after the dietary modifications; and when considering a diet with very low bioavailability, the amount of stored iron increase by380 mg even without changing the iron intake. The study thus concludes that dietary modifications are preferable as long-term measures to improve effectively iron status in a population where the original diet has low bioavailability.

2.3.3.3. Nutrition education for dietary diversification and modification

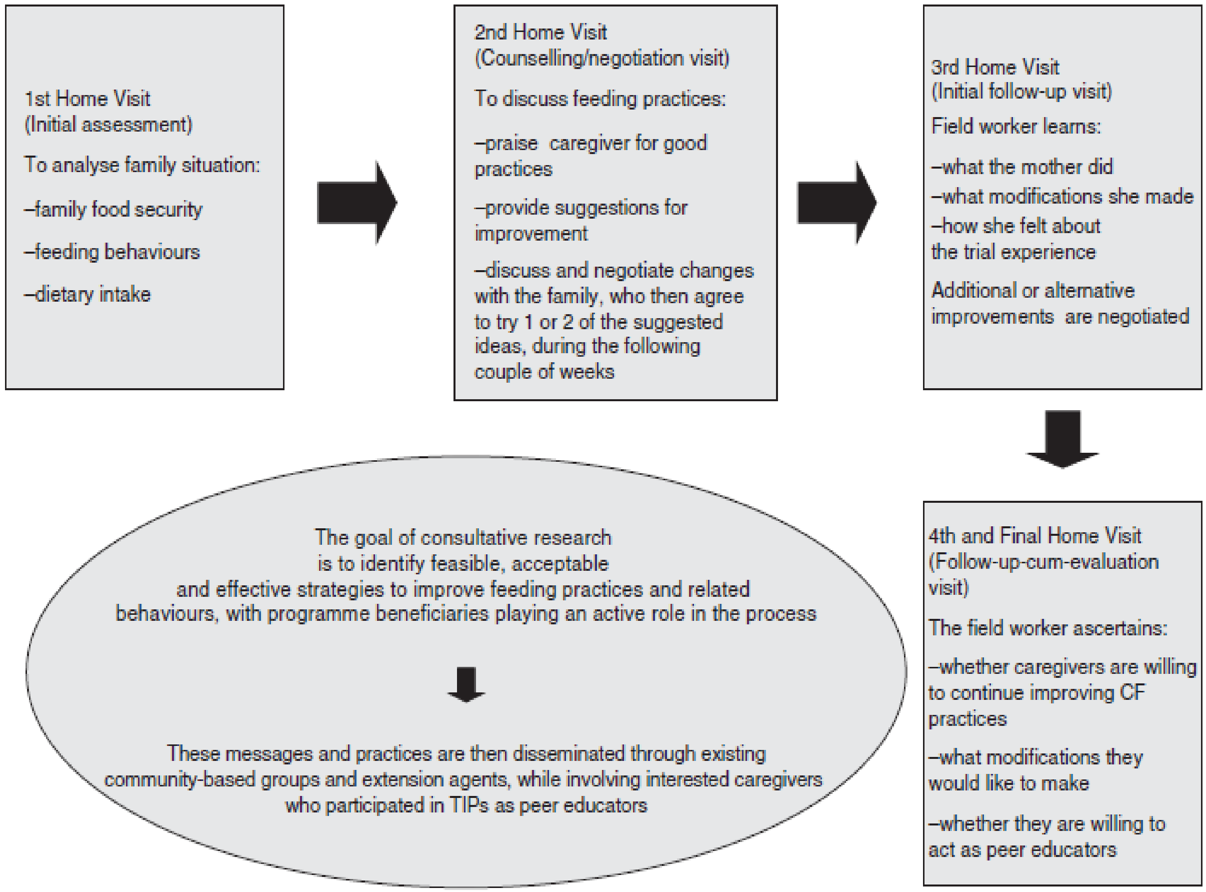
Iron deficiency prevention and control strategies and interventions must also analyse and address dietary knowledge and attitudes affecting the number of dietary enhancers and inhibitors consumptions and food modification processes. Effects of addressing such dietary factors would be potentiated if interventions are integrated with gestational and household nutrition education for proper food preparation and consumption practices. Nutrition education is the other major social intervention that impacts the demand for and consumption of iron-rich foods (WHO 2001:48); to promote household dietary modification and fortification of staple or routinely consumed foods with iron and for treatment of preventable causes of iron losses such as hookworm infestation (WHO 2016:4).

According to Contento IR (cited in Dunneram and Jeewon 2015:119), nutrition education which consists of 3 phases has been defined as “any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food and nutrition-related behaviours conducive to health and well-being. Nutrition education is delivered through multiple venues and involves activities at the individual, community, and policy levels”. Nutrition education is any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food-related behaviours conducive to health and well-being. Nutrition education ‘s main goal is to make people be aware of what constitutes a healthy diet and ways to improve their diets and their lifestyles. This involves activities at the individual, community, and policy levels and can be done through different channels and through multiple venues (McNulty 2013:5).

2.3.3.3.1. Methodology for nutrition education intervention

For educational interventions to effective, a carefully selected and small number of specific key messages about practices that can feasibly be adopted by the target population should be applied. In this study, the nutrition education intervention was conducted based on the Trials of Improved Practices (TIPs) Methodology adopted from FAO (FAO 2014:292) and cognitive model of health education (WHO 2012b:32) The TIPs methodology is a formative research technique used to promote behaviour change. Trials of improved practices are based on a process of trial and evaluation that uses several interactive information-gathering methods with mothers (figure 2.1). According to social cognitive theory, three main factors affect the likelihood that a person will change health behaviour: self-efficacy, goals and outcome expectancies. If individuals have a sense of self-efficacy, they can change behaviour even when faced with obstacles. As an individual adopts a new behaviour, this causes changes in both the environment and the individual. According to this theory, self-efficacy is considered the most important personal factor in behaviour change and an important construct in other health behaviour theories as well (WHO 2012b:32).

The key messages were chosen based on a needs assessment and formative research with the target group in order to identify the dietary behaviours and practices most in need of improvement and amenable to change. The researcher needs to obtain a good understanding how the local household and community environments interact influencing maternal dietary and nutrient intakes and how such influences can be involved in order to be supportive for maintaining the desired behaviour changes. Potential interventions and dietary guidelines which are culturally sensitive, accessible and integrated with local resources, as well as affordable and convenient for pregnant women will then be generated from the iterative process. The following figure shows the steps involved in the trials of improved practices implementation phase (FAO 2014:293).



FAO 2014:293

Fig 2.1 Implementation of the Trials of Improved Practices (TIPs) methodology

2.3.3.3.2. Effect of nutrition education

Many experimental studies have acknowledged the effect of nutrition education on dietary modification, nutrient intake and iron status. Dietary counselling and education were shown to improve maternal knowledge (Fahmida, Kolopaking, Santika, Sriani, Htet & Ferguson 2015:459; Ickes, Baguma, Brahe, Myhre, Adair, Bentley & Ammerman 2017:6) and intake of iron-rich foods like fish (Bosaeus, Hussain, Karlsso, Andersson, Hulthén, Svelander, Sandberg, Larsson, Ellegård & Holmäng 2015:12). GAO et al (2013:2950) collaborate that culturally sensitive nutrition education sessions are necessary for both urban and rural pregnant women.

Nutrition education intervention for 3 months among pregnant women in Nigeria reported that there were significant effects of the intervention on the knowledge of the women on the importance of fruits and vegetable consumption. The findings also revealed a positive effect of the intervention on increased consumption as the pregnant women apparently consumed more fruits and vegetables than they were doing before the intervention (Okueso & Anetor 2016:9-10).

A quasi-experimental intervention among a random sample of 100 pregnant women attending urban health centres in Western Iran implemented nutritional education program containing two to four lessons for small groups of between six to ten women. Accordingly, the awareness level of pregnant women about healthy nutrition increased significantly from 3% before intervention to 31% after the nutritional education intervention. The significant difference was independent of maternal characteristics of age and levels of literacy and in obese mothers in particular (Fallah, Pourabbas, Delpisheh, Veisani & Shadnoush 2013:177). A study which evaluated the effect of nutritional educational guideline among rural pregnant women with iron-deficiency anaemia concluded that there was a highly statistically significant increase in overall knowledge and knowledge related practice toward healthy nutritional habits and subsequently the prevalence of anaemia decreased by 24% after intervention (ElHameed, Mohammed & ElHameed 2012:1216).

Al-Tell, El-Guindi, Soliman and El-Nana (2010:112-16) show that nutrition education using principles of Health Promotion Model/Health Belief Model has a significant relationship with perceiving the risk of anaemia, changing eating practices and improvement in haemoglobin level of pregnant women. The result revealed a significant improvement in mean haemoglobin level of 10.94 ± 0.54 at second trimester (24-26 weeks) and of 11.39 ± 0.86 at third trimester (after 36 weeks) in more than one two third of study group. While about two third of the control group had a significant decrease in mean haemoglobin level of 9.61 ± 0.61 at second and 9.53 ± 0.72 at third trimesters respectively.

Savita, Nath and Sharan (2013:216-8) assessed the impact of nutrition education intervention among post-adolescent girls in India employing a 30-minute short lecture supported with a visual display of foods such as rich sources, enhancers and inhibitors of iron absorption. Accordingly, 30% of the subjects scored low nutrition knowledge (<17), 42.3% scored medium (17-23) and 27.5% scored high (>23) before the intervention. One month later, the knowledge level was reassessed using the same questionnaire and revealed that 95.5% scored high and 4.4% scored medium. About 52%, 39% and 54%

provided a correct response about dietary enhancers, inhibitors and processing before the intervention, which one month later increased to 82%, 84% and 70% respectively. The overall knowledge scores obtained by each studied group at pre and post education programme increased significantly at 1% level reflecting that the retention of knowledge is quite satisfactory one month after the education intervention that could help to combat micronutrient malnutrition.

An intervention study that assessed the effectiveness of nutrition education among anaemic Malaysian adolescents found a difference in the mean knowledge score by 18.3 after the intervention of nutrition education was given for one hour per week for 3 months (Yusoff, Daud & Ahmad 2013:470). A Kenyan study also concludes that nutrition education significantly improved nutrition knowledge among primary school pupils and the positive relationship between nutrition knowledge, nutrient intake and haemoglobin levels was statistically significant (Gitau, Kimiywe, Waudo & Mbithe 2013:121).

Yusoff, Daud and Ahmad (2012:195-6) tested the effect of nutritional education with and without iron supplementation on knowledge, attitudes and haemoglobin status of Malaysian anaemic adolescents. The nutrition education consisted of four lectures in three months period and the supplementation contained a capsule with 250mg ferrous gluconate, 1 mg folic acid and 50mg vitamin C for 3 months. The resulted showed that there was a significant improvement in knowledge and attitudes scores of the respondents by 15.22 and 3.34 respectively in the nutrition education groups. Mean haemoglobin levels significantly increased in all groups except the controls, and in the nutrition education groups from 10.78 gm/dl to 11.28gm/dl. The compliance rate for the supplementation group was 89.3%. Similar findings were also reported by another combined intervention of iron-folate (60mg of elemental iron plus 0.5mg folic acid) and calcium tablets supplementation on alternate days for 3 months supported with lectures on nutrition and good eating habits which declared an increment of haemoglobin by 19.55gm/dl and increased food intake during the study period in the experimental anaemic Indian adolescent girls (Bhanushali, Shirode, Joshi & Kadam 2011:41).

A comparative study which explored and compared knowledge, attitudes and behaviours of anaemic and non-anaemic urban pregnant women in Sierra Leone reported that participants scored low (64% correct) on a 10-item anaemia knowledge questionnaire. About 45% of the women did not provide correct information about anaemia with only a few being able to identify specific elements of inadequate nutrition as causes of anaemia. While 40% provided erroneous information regarding improving iron status, about 53% were able to correctly identify preventive and treatment options for anaemia like eating nutritionally sufficient diets that included green leafy vegetables and protein-rich foods and intake of iron supplements. Less than half of the women were participating in behaviours to reduce their risk of being anaemic and their attitudes towards perceived anaemia threats were not very different based on one's anaemia status (M'Cormack & Drolet 2012:11-2).

A quasi-experimental design among adolescent girls in Southern Benin consisting of four weeks of nutrition education combined with an increase in the content and bioavailability of dietary iron for 22 weeks also showed that nutrition knowledge scores and mean intakes of nutrients, including dietary iron, absorbable iron, and vitamin C were significantly higher in the intervention group than in the control group. Mean haemoglobin and serum ferritin values were also significantly higher in the intervention group than in the control group (122 versus 11.2gm/dl and 32 versus 19 µg/L respectively). Whereas the prevalence of anaemia (32% versus 85%) and iron-deficiency anaemia (26% versus 56%) were significantly lower in the intervention group than in the control group (Alaofe, Zee, Dossa & O'Brien 2009:30).

Another study that assessed the efficacy of nutrition education tools among adolescent Indian girls reported an increment of 12.3% in the mean scores (from 46.7% to 58.8%) of dietary habits and nutrition knowledge in the intervention group; and no difference in the mean scores after 3 months of intervention, showing that there was retention of the knowledge gained (Rao, Vijayapushpam, Rao, Antony & Sarma 2007:1083).

Coming to the national literature, no literature assessing the effect of nutrition education on anaemia in Ethiopia through a randomized controlled trial was identified to best efforts of this review. However, a before-after cross-sectional study conducted among pregnant women in Akaki Kality Sub-city, Addis Ababa, compared nutrition knowledge and healthy dietary practice right before pregnant women receiving nutrition education from their ANC providers after four weeks of the nutritional education intervention. The result revealed that the overall mean knowledge and practice score for appropriate nutrition among the pregnant women were 5.5 ± 2 out of 9 and 6.2 ± 2 out of 11 respectively. After nutrition education intervention, the proportion of pregnant women with knowledge on proper nutrition during pregnancy increased from 53.9% to 97%; while the pregnancy-specific dietary practice of the pregnant women increased from 46.8% to 83.7% (Zelalem, Endeshaw, Ayenew, Shiferaw & Yirgu 2017:6-7).

Alemayehu and Tesema (2015:710) through the cross-sectional survey reveal that nutrition information and dietary knowledge have a positive impact on the dietary practices of pregnant mothers in northeast Ethiopia. In contrary, Gebremedhin et al (2014b:48) show that the haemoglobin level and odds of anaemia were not statistically different across variables like receiving nutrition education during pregnancy. The EDHS 2011 generally indicates that the percentage of women who took iron tablets increased with educational status (CSA Ethiopia & ICF International 2012:173 & 184).

Gebremedhin et al (2014a:3-4) measured comprehensive knowledge of anaemia using a composite index constructed based on multiple indicators and revealed that nearly half (51.4%) of the surveyed pregnant women had comprehensive knowledge of anaemia. About 72.0% of pregnant women had ever heard of anaemia and 67.9% and 57.6% managed to tell at least one of the major symptoms and causes of anaemia respectively. While 62.5% mentioned at least one of the consequences of maternal anaemia like increased risks of maternal death (42.1%), serious maternal illness (40.5%) and foetal death (16.2%), only 38.4% claimed to be informed about the significance of iron supplementation during the recent pregnancy mainly from health extension workers. Besides, an assessment of knowledge among pregnant mothers in west-east Ethiopia found 80.7% of the respondents to have no Knowledge about food sources of iron (Daba, Beyene, Fekadu & Garoma 2013a:5).

While nutrition education as a public health intervention is clearly valuable and valued among populations at nutritional risk, iron nutrition education is not yet well integrated into the programmatic agendas and there are few instances of documented substantial impact from isolated approach alone (Stoltzfus 2011:760S). About 58.3% of studied pregnant women who attended ANC in Dire Dawa reported that they did not get health education about nutrition (Yeshitila 2016:20). Sonko (2016:6) also collaborates that about 43% of

Ethiopian mothers in the studied woreda did not get counselling particularly on dietary practice and feeding options while attending ANC; while Daba et al (2013b:109) reported that 42.2% of studied pregnant women in west-east Ethiopia received no nutritional information during their pregnancy.

2.3.3.4. Food-based dietary guidelines

Food-Based Dietary Guidelines (FBDGs) are information communication tools involving the translation of recommended nutrient intakes or population targets into recommendations of the balance of foods that populations should be consuming for a healthy diet. From a nutrition education standpoint, there are two aspects of Food-Based Dietary Guidelines: developing the actual guidelines and then communicating them. To communicate these Food-Based Dietary Guidelines to consumers in an understandable, consumer-friendly format, countries have developed visual devices such as nutrition pyramids (Hawkes 2013:6-8). Food-based dietary guidelines recognize that people eat foods, not nutrients, and focus on giving simple practical advice on the appropriate combination of foods that can meet nutrient requirements rather than on how each specific nutrient is provided in adequate amounts (FAO 2011:270). The primary purpose of dietary guidelines is to educate population groups on what constitutes a healthy diet (Miller & Welch 2013:18).

The guidelines include evidence-based nutrition recommendations with its intended purpose, target group and distribution channels established based on the national health and nutrition agenda of the specific country. Food-based dietary guidelines have evolved to include messages to support healthy lifestyles and may include recommendations for food groups, and specific recommendations to target various age groups like pregnant women or could be directly applied for the general population (Andrade & Juan Andrade 2016:2). These guidelines ought to be practical and can be considered as an integral component of the country's comprehensive plan to reach the goals specified in the national nutrition policy.

Despite an intensive search of the literature, the researcher identified no National food-based dietary guideline for pregnant women in Ethiopia particularly addressing micronutrients and iron deficiencies.

2.3.4. Overview of vitamin C, iron absorption and bioavailability

2.3.4.1. Vitamin C for health and its dietary sources

Vitamin C (ascorbic acid) is a simple low-molecular-weight carbohydrate with an ene-diol structure that has made it ubiquitous and essential water-soluble electron donor in nature. It is synthesized by all species except for higher-order primates including humans, as well as, guinea pigs, and some bat, fish, and bird species (Lykkesfeldt, Michels & Frei 2014:16). Vitamin C is a water-soluble vitamin contributing as an electron donor in several important biological reactions in the body (Hansen, Tveden-Nyborg & Lykkesfeldt 2014:3819). In all its known biologic functions, vitamin C acts as a reductant, i.e., it donates an electron to a substrate while itself being oxidized to an ascorbyl radical, a relatively stable free radical (Lykkesfeldt et al 2014:16). The biologic role of vitamin C is related to its reduced form, ascorbate, and can be separated into enzymatic and non-enzymatic functions. The best known enzymatic function of vitamin C is probably as a cofactor for ferrous and 2-oxoglutarate dependent dioxygenases in collagen synthesis (Lykkesfeldt et al 2014:16). The other important enzymatic function is hydroxylation of amino acids and non-enzymatic functions such as increasing gastric iron absorption (Hacisevkđ 2009:245; Pacier & Martirosyan 2015:91).

In addition to its roles in the above enzymatic processes, ascorbate is a powerful antioxidant (Lykkesfeldt et al 2014:16). As an antioxidant, vitamin C has two primary actions. First, it reacts with and inactivates free radicals in the water-soluble compartments of the body, areas such as the cytosol, plasma, and extracellular fluid. Second, it regenerates oxidized vitamin E (Hacisevkđ 2009:245; Lykkesfeldt et al 2014:16). Ascorbic acid is a strong reducing agent and readily oxidizes reversibly to dehydroascorbic acid in cellular metabolism protecting cellular components from oxidative damage (Hacisevkđ 2009:245). It helps to reduce oxidative stress in the body (Pacier & Martirosyan 2015:98). Studies have also provided evidence for further benefits. One to three glasses of orange juice a day appears to provide an improvement in antioxidant, cardiovascular, and insulin sensitivity biomarkers as well as increase vitamin C concentrations in plasma and breast milk (Turner & Burri 2013:179). In the review, Frei et al (2012:825) indicate that the highest plasma levels of vitamin C are associated with the greatest health benefits for coronary heart disease, stroke, and cancer, as well as all-cause mortality. A cohort study concluded that lower intake of vegetables was associated with an increased risk of having a small-for-gestational-age baby, LBW and short length-for-gestational age (Ramon, Ballester, Iniguez, Rebagliato, Murcia, Esplugues, Marco, Hera & Vioque 2009:565).

As with most nutrients, there are always questions about optimal intake. When proposing for an increased intake of vitamin C, not only potential health benefits but also potential risks need to be considered (Frei et al 2012:826). This can vary dramatically when considering age, health, lifestyle and gender (Pacier & Martirosyan 2015:94). Based on the vitamin C intake required to achieve near saturation of plasma and leukocytes with minimal urinary excretion, and adjusted for body mass, an RDA of 75 and 90 mg/day for women and men, respectively, was established by the United States Institute of Medicine (IOM) in 2000. In addition, the RDA for pregnant and breastfeeding women >19 years was set at 85 mg/day and 120mg/day, respectively (Lykkesfeldt et al 2014:17).

Fruit and vegetables are good sources of vitamin C, and about 90% of the daily intake in the general population comes from these sources (Lykkesfeldt et al 2014:17). Citrus contains large amounts of vitamin C and appreciable amounts of carotenoids (some capable of converting to vitamin A), foliate, and fibre; but no fat, sodium or cholesterol. (Turner & Burri 2013:174). The content varies between species, but citrus fruit, kiwi, mango, and vegetables such as broccoli, tomatoes, and peppers are all rich sources of vitamin C. Other good sources of vitamin C include tomatoes, strawberries, melons, dark green leafy vegetables and potatoes (Clifford et al 2015:2). Cruciferous vegetables, especially kale, are also a good source of ascorbic acid for the diet (Akdaş & Bakkalbaş 2017:883). El-Din et al (2013:699) report that among Brassica vegetables, Broccoli has the highest concentration of ascorbic acid, followed by cauliflower and lowest ascorbic acid level in white cabbage.

Frei et al (2012:826) concluded that a daily intake of 200mg of vitamin C may be achieved without the need for supplementation through the consumption of the recommended five to nine servings of fruit and vegetables. Accordingly, a diet including 5 to 9 servings of fruit and raw or steam-cooked vegetables and 200mL of fresh orange juice could provide the 200mg vitamin C dose proposed. Lykkesfeldt et al (2014:17) also collaborate that a total of 5-9 servings of fresh, minimally processed, or frozen fruit and vegetables per day is estimated to be equal to about 200mg of vitamin C. As stated in Turner and Burri (2013:174-76), consumption of 100gm of orange and lemon provides 53-88mg and 29-61mg of vitamin C respectively; and meets 44%-110% and 24%-76% of the RDA of pregnant/lactating women respectively. While drinking 500ml/day of orange juice for two weeks (~250mg ascorbic acid/day) increases plasma vitamin C concentrations in adults by 40%-64%. Pacier and Martirosyan (2015:97) also collaborate that raw orange with the weight of 180gm and one cup of orange juice (249gm) provide 95.8mg and 83.7mg of vitamin C and meets 127.7% and 111.6% of the RDA of women respectively.

The concentration of ascorbic acid in mango juice (fruit pressing) and tomato fruits consumed in Mettu town in Ethiopia were calculated and found to be 1000.5 ±100.5mg/100 ml and 600.8 ± 50.5mg/100ml respectively (Motora 2017:60). The concentration of ascorbic acid in five fruits consumed in Jimma town community in Ethiopia were calculated and found to be different in each fruit; with papaya, orange, lemon, mango and tomato having 1673.02 ± 136.12mg/100ml, 141.34 ± 22.07mg/100ml, 199.81 ± 126.58mg/100ml, 1104.46 ± 204.56mg/100ml and 542 ± 101.55mg/100ml ascorbic acid respectively (Bekele & Geleta 2015:61).

2.3.4.2. Mechanism of Vitamin C for iron absorption

Vitamin C facilitates the conversion of ferric (Fe3+) to ferrous (Fe2+) iron, the form in which iron is best absorbed (Saunders et al 2012:13). Vitamin C enhances non-heme iron absorption by forming an iron-ascorbate, although its effect in a complete diet is less than from a single meal. Low molecular weight organic acids have the potential to enhance non-heme iron absorption by forming soluble ligands within the gut, but there are no data from in vivo isotope studies (FAO 2014:22). Vitamin C, in addition to the iron, may increase the acid environment of the stomach and increase absorption (Prakash & Yadav 2015:166).

However, a larger dose of vitamin C that is obtainable from certain tropical fruits may be effective in promoting iron absorption. So the consumption of high vitamin C foods with as many meals as possible is likely to be useful for overall iron status, particularly among low-income groups (FAO 2014:42). It is also documented that ascorbic acid reverses the inhibiting effect of phytates and polyphenols (Siegenberg, Baynes, Bothwell, Macfarlane, Lamparelli, Car, MacPhail, Schmidt, Tal & Mayet l99l:540), and has an influence on iron absorption from meals containing other absorption promoters like meat (Lynch & Cook 1980:34).

The consumption of a glass of freshly pressed orange juice or whole orange is recommended to improve the iron absorption from plant foods. Vegetables high in vitamin C (bitter gourd, cauliflower, sweet peppers) or additionally in citric, malic and tartaric acids, such as potatoes, tomatoes, or cabbage are good alternatives for improving iron absorption (GAO et al 2013:2948).

2.3.4.3. Effect of vitamin C on iron absorption and iron level

The addition of vitamin C and the removal of phytates can be effective ways of increasing the total amount of iron absorbed from iron-fortified foods (Camaschella 2015:1835; FAO 2014:25; WHO& FAO 2006:101). As iron absorption is substantially greater when the body has a need, as in the case of pregnancy, it seems reasonable to assume that the bioavailability of iron from vitamin C-enhanced vegetarian meals will be considerably greater when the long-term vegetarian has an increased need for iron as shown by a low ferritin level (Saunders et al 2012:1115).

Although vitamin C is known to improve the absorption of iron (which is actually common in plant foods but poorly absorbed from them), past human trials have not shown it to be effective in this role (FAO 2014:42) and different studies on dietary intervention resulted in inconsistent findings.

Beck et al (2014:3754-3768) reviewed reports and studies addressing dietary determinants the efficacy of dietary interventions in young women living in industrialized countries. The review reveals that majority of the reviewed cross-sectional studies observed no relationship between iron status, and intakes of ascorbic acid, fruit, vegetables, fibre, phytate and total iron (as the type of iron appears to be a more important determinant of iron status than total dietary intake). Tea intake appears to only impact on iron status in women with marginal iron status. However, most of the studies observed a positive association between iron status and meat or heme iron intake.

The findings on heme iron intake are consistent with recommendation of FAO and WHO (2001:202) which suggest that adding a small portion (50gm) of meat, poultry, or fish will increase the total iron content as well as the amount of bioavailable iron for most staple diets thus lowering prevalence of iron deficiency. Reddy, Hurrell and Cook (2006:578) also collaborate the positive association of iron status with meat but no association with ascorbic acid. Other intervention studies also showed no effect of ascorbic acid on iron status (Garcia, Diaz, Rosado & Allen 2003:271; Hunt, Gallagher & Johnson l994:1384).

A study employing a 24-hour dietary recall among adolescent girls also found no significant association of haemoglobin status with vitamin C intake, despite mean intake of vitamin C being 122mg/day which is higher than the RDA (75mg/day). However, the mean consumption of vitamin C rich foods and overall intake of fruits and vegetables is slightly higher in subjects with normal haemoglobin status as compared to those with below normal haemoglobin level. The study reasoned that a diet consisting of varied fruits and vegetables with different levels of vitamin C and fibre, the effects of these components counteract each other, leading to an unchanged haemoglobin concentration (Safwan & Asar 2017:3-4).

Beck et al (2014:3767-8) also explain that in diets containing a range of fruit and vegetable combinations, the effects of differing levels of ascorbic acid and fibre may counteract one other, leading to no change in serum ferritin concentration. Beck et al (2014:3754-68) also the reason that the studies reviewed have been limited by their cross-sectional study designs, small sample sizes and the inclusion of participants with normal rather than low iron stores, therefore, possibly having insufficient power to show an effect. Besides, some of the studies have not been undertaken for long enough for the effect to be observed too. Interventions should be at least for 12-16 weeks' duration to allow adequate time for red blood cell turnover (red blood cells have a life span of 90-120 days). Furthermore, not all the dietary intervention studies have controlled for other factors that may affect iron status including blood loss and supplement use.

Hunt et al (l994:1384) also reason insubstantial statistical power for not determining the apparent differences in iron absorption and serum ferritin levels. While Garcia et al (2003:271) state that other factors had a stronger influence on iron status than did twice-daily 25 mg of ascorbic acid intake as the women in the communities had a high intake of non-heme iron and phytate.

Consequently, Beck et al (2014:3767-8) suggest that ascorbic acid appears to increase iron status in iron-deficient women only when consumed together with substantial amounts of iron. Thus, recommend a combination of approaches (e.g. increased meat and ascorbic acid intake, decreased intake of iron absorption inhibitors and considered the timing of enhancers and inhibitors of iron absorption) to get the most effective dietary means of addressing iron deficiency in young women living in industrialized countries.

In contrast, some studies found positive associations. A randomized double-blind, placebo-controlled, primary-prevention trial showed that higher consumption of fruits, vegetables and vitamin C from fibber-poor fruits, vegetables and juices was associated with higher serum ferritin and haemoglobin concentration in premenopausal women; indicating that fibre content in fruits and vegetables has an influence in groups in whom non-heme absorption is higher because of their low iron status (Péneau et al 2008:1300). The consumption of 25 mg ascorbic acid as limeade twice daily with meals substantially improved iron absorption and iron status of non-pregnant, non-lactating, iron-deficient women in Mexico (Diaz, Rosado, Allen, Abrams & Garcia 2003:439).

The enhancement of iron absorption from vegetable meals is also shown to be directly proportional to the quantity of ascorbic acid present. The WHO suggests that each meal should preferably contain at least 25mg of ascorbic acid and possibly more if the meal contains many inhibitors of iron absorption (FAO & WHO 2001:202). In one comparison study, individuals who consumed 24 mg of vitamin C daily had 35% higher iron absorption levels than those who consumed 51mg of vitamin C daily (Pacier & Martirosyan 2015:91). Ballot, Baynes, Bothwell, Gillooly, Macfarlane, Macphail, Lyons, Derman, Bezwoda, Torrance & Bothwell (1987:334) report that iron absorption would significantly be higher with the addition of citric acid together with ascorbic acid.

Lynch and Cook (1980:40) suggest that ascorbic acid is effective in promoting food iron absorption only if taken with the meal and from the high molar ratio of ascorbic acid to iron. When added to the meal at a molar ratio to iron of 2:1, ascorbic acid increased iron absorption by 291% in the iron-deficiency anaemia women and by 270% in iron-depleted women (Thankachan, Walczyk, Muthayya, Kurpad & Hurrell 2008:845). Ballot et al (1987:331) show that several fruits had a different effect on iron absorption from rising meal due to their variation in ascorbic and citric acid.

These inconsistent findings designate that measuring the effectiveness of programmes thus requires indicators of outcomes that go beyond the biochemical serum and blood levels of micronutrients and clinical outcomes, to include social outcomes changes in dietary attitudes and health-seeking behaviours (FAO 2014:77).

2.4. LIMITATION OF LITERATURE REVIEW

Despite the intensive search to best efforts of this review, the researcher found limited studies that assessed the main interest of the topic of this research. The researcher did not come across any experimental study assessing the effectiveness of food-based interventions on iron status conducted in Ethiopia. Besides, the researcher did not found any study assessing the effect of vitamin C on iron absorption and iron level as well as study employing randomized control trials for any population group in Ethiopia. Many of the previous studies conducted in the country employed cross-sectional study design emphasizing on the magnitude of maternal anaemia and characterizing dietary patterns of the population based on haemoglobin levels; hardly examining the effects of food-related determinants of iron-deficiency anaemia during pregnancy. This has posed a limitation on methodological reviews of randomised controlled trials related to the research topic.

Furthermore, most of the reviewed literature conducted globally employing randomised controlled trials included adolescents and women of reproductive ages as participants limiting evidence on the effectiveness of food-based interventions in maternal iron status. Although the researcher tried to include literature dating five years back, limited literature was found which assessed the interest of the topic of the study both at global and Ethiopia levels. The review is therefore obligated to include old literature, some in the 1980s and 1990s, based on their relevance and significance.

2.5. CONCLUSION

In this chapter, the researcher presented reviewed literature to capture in detail the existing scientific body of knowledge about food-based strategies as an approach to improve iron levels of pregnant women within the global and national context of prevention and control of iron deficiency and iron-deficiency anaemia. Prior to the review, the researcher developed the search strategy and protocol based on The Joanna Briggs Institute (JBI) approach to study selection and appraisal. Employing PICO mnemonic, the developed focused question of the review was; *what is the effectiveness of food-based interventions as a strategy in improving the iron status and thus decreasing anaemia level of pregnant women?* Based on this focused review question, the aim of the review contended on the global and national perspectives of the magnitude and consequence of maternal iron-deficiency anaemia, as well as experiences, challenges and opportunities of food-based strategies and interventions as effective and sustainable approaches to improve iron status and thus addressing iron-deficiency anaemia among pregnant women

The researcher them systematized the literature review based on the major themes appraised mainly: an overview of maternal nutrition and iron deficiency, strategies to address iron deficiency and iron deficiency anaemia at the population level, interventions of food-based strategies to improve iron status during pregnancy and overview of vitamin C and iron absorption. Focussing on the topic of the study, the literature review then provides detailed insight into the magnitude of maternal iron deficiency and maternal iron deficiency anaemia as global and national public health problems, their consequences posed to pregnant women in at-risk populations and the opportunities, challenges and experiences of feasible strategies to sustainably address the problems from Ethiopian and the study area perspectives. The researcher offered a meticulous centre of emphasis is to review past experiences of literature with experimental designs measuring the effectiveness of combined dietary diversification with including dietary vitamin C and nutrition education intervention on iron absorption and bioavailability.

The researcher thoroughly reviewed global and national roughly dietary guidelines, recommendations, protocols, survey reports, books and articles searching various sources. Nevertheless, despite intensive search to best efforts of this review, limited researches are found which assessed the main interest of the topic of this study and no experimental study conducted in Ethiopia is reviewed. Many of the previous researches in the country emphasized on the magnitude of maternal anaemia and characterizing dietary patterns of the population; hardly examining the effects of food-related determinants of iron deficiency anaemia during pregnancy.

The researcher can thus conclude that the proposed study is the first of its kind to employ randomised controlled trial design and assess the effectiveness of food-based strategies in improving the iron status of pregnant women in Ethiopia.

The next chapter discusses the research methodology the researcher employed to address the research hypothesises and objectives including the research design, research setting, study population, sampling methods and data collection methods and procedures.

CHAPTER 3

RESEARCH DESIGN AND METHOD

3.1. INTRODUCTION

Chapter two discussed the literature reviewed emphasizing on the process applied for the development of the literature search protocol and the literature reviewed to capture the existing scientific knowledge in relation to the research topic. This chapter presents the research methodology employed by the researcher to address the study objectives and hypothesis. Research methodology is a general approach to studying a phenomenon (Saldanha & O'Brien 2014:13). The chapter presents the research approach, research design, Research methods, Ethical considerations and internal and external validity of the study.

3.2 RESEARCH APPROACH

The study followed a quantitative approach. The quantitative approach is the research that use numbers and computation of numerical values to unravel relationships or differences between variables and serve as the basis for making the conclusions and generalizations of the study. Quantitative models derived from data analysis are used to predict outcomes (University of Southern California 2015:1). The quantitative approach focuses on establishing a causal relationship or statistical difference to explain or predict a phenomenon; measuring the effects of the intervention (Howlett, Rogo & Shelton 2014:33). As the study focused on to assess the effects of an integrated food-based and dietary modification approach on improving the iron status of pregnant women in Ethiopia, the quantitative design was considered the most appropriate approach. However, some qualitative elements were embedded to enhance the quantitative data by exploring the socio-cultural influences on maternal dietary practices and supplement.

3.2. RESEARCH DESIGN

The study employed a randomized controlled trial design. A randomized controlled trial is a research design which focuses on evaluation in which the population receiving intervention and a control group is chosen at random from the same eligible population to test the extent to which specific, planned impacts are being achieved and compared for these different groups after set periods of time (White, Sabarwal & Hoop 2014:1). It measures the difference or association between the predictor and response variables among the randomly selected intervention and control groups (Howlett, Rogo & Shelton 2014:38). The strength of a randomized controlled trial is that it provides a very powerful response to questions of causality, helping studies and programme implementers to know that what is being achieved is as a result of the intervention and not anything else (Sabarwal & Hoop 2014:1). As there are different interventions to randomised control trial design, the researcher specifically used a parallel-randomized controlled intervention. Parallel randomised control trial intervention is the most commonly used intervention in randomised controlled trial where the subjects are randomised to one or more arms of different therapies treated concurrently (Chan 2003:173). The arms of therapies include intervention group and the control group. Intervention group is defined as those subjects or participants exposed to the levels of the independent variable; also called the experimental or treatment group. Control or comparison groups are those who receive standard care or a comparison intervention that is different from the experimental intervention (Melnyk & Overholt 2011:414). To ensure that the participants do not know the group in which they are allocated in randomised control trials, blinding is done.

Blinding in randomised control trial is that the recipients are blinded (not aware) about whether they are receiving the treatment or the placebo. In some nutrition evaluations, double blinding is impossible. Without blinding, the potential for a biased response is even more likely if the outcome of interest is behavioural (Westinghouse effect). A second principle is that the measures of the outcomes must also be blind to what the recipients received in order to avoid biases in measurement associated with the measurers' expectations (Habicht, Pelto & Lapp. 2009:22).

As this study was intended to test the effect of food-based strategies, the researcher employed a parallel randomized single blind-controlled trial with three arms. Enrolled study participants were randomly allocated to one of the two intervention groups or a control group. The participants did not know whether they are belonging to the intervention or control group. Data collectors and supervisors were also blinded to the intervention allocation groups.

3.3. RESEARCH METHODS

Research methods are the techniques used to do research representing the tools of the trade and provide the researcher with ways to collect, sort and analyse data (Walliman 2011:7). The section will cover study setting, study population and sampling, data collection, data management and data analysis.

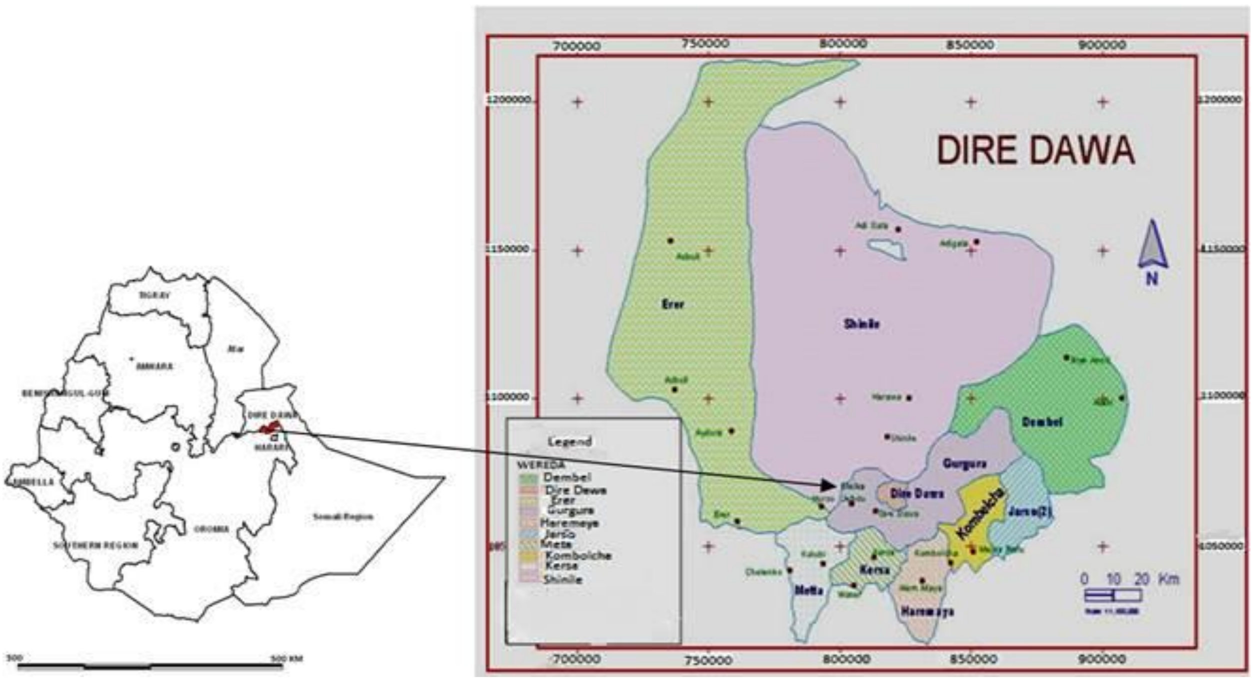
3.3.1. Study setting

The study was conducted in Dire Dawa Administration (DDA), East Ethiopia. Dire Dawa Administration is located in the eastern part of Ethiopia, 515km away from the capital city, Addis Ababa. The administration is bordered by Oromia Regional State in the north, northeast and northwest, and Somali Regional State in the south, southeast and southwest. According to the national population projection of CSA for 2018, it has a total population of 466,000. About 27.6% of the population is female in reproductive ages and 12% are children under five years of age (GFDRE 2017:2).

Dire Dawa Administration has a total land area of 1233km^2 and is 1000-3000m above sea level. There are 34 kebeles where 9 are urban. Three-quarter of the population lives in the urban area and the rest are rural dwellers. Regarding the ethnic composition of the administration, 73.61% are Oromo, 27% are Somali and 0.21% is Amhara. Islam is the dominant religion making 99.5% (GFDRE 2008:106 & 112). Subsistence trade and agriculture are the main economy source. Cereals, mainly Sorghum and maize are the major food crops produced in the area.

According to the 2009 Ethiopian Callander report of the Federal Ministry of Health (GFDRE 2017:8), the health utilization for the outpatient attendance per capita of the administration was 1.3%. The antenatal care coverage for 4+ visits was 46.1% and 57.8% for early post-natal care. The total number of expected pregnancies were 15,005, while 71.3% of the deliveries were attended by skilled attendants. About 5.3% of the newborns had low birth weight (GFDRE 2017:40 & 48). There are 34 health posts, 15 health centres, 7 hospitals and 49 private clinics in DDA. These health facilities are organized under 9 operational woredas of the Dire Dawa Administration Health Bureau.

Dire Dawa administration is among those having the highest prevalence of anaemia in women of reproductive age in the country. According to the 2016 EDHS report, about 30% of reproductive women are anaemic, of whom 21%, 7.9% and 1.3% are with mild, moderate and severe anaemia respectively (CSA Ethiopia & ICF 2016:215 & 217). Regarding the coverage of iron supplementation, 39.5% of the surveyed women did take any iron tablets during their most recent pregnancy, while only 7.5% of women took iron tablets for 90 days or more during their most recent pregnancy (CSA Ethiopia & ICF 2016:215 & 217).



Source: Dire Dawa City Administration, 2017

Fig 3.1 Map of Dire Dawa Administration

3.3.2 Study population and Sampling

This section covers aspects related to the study population, sample, sampling and ethical issues related to sampling.

3.3.2.1 Study population

Population (theoretical population) is the entire group of people/subjects which the researcher wishes to generalize the results. A study population is a group of people/subjects to which the study has access to be included in the study (Melnyk & Overholt 2011:426). Typically, if the county is large and diverse, it is reasonable to assume that the study population is an acceptable substitute for the theoretical population. However, if the focus of the work is strongly influenced by regional factors, such as climate, culture, or access to services, the choice of a study population could severely limit generalizability to the theoretical population (Melnyk & Overholt 2011:426). Thus, for this study, the researcher used the study population. The study population was the pregnant women who were permanent residents of Dire Dawa Administration.

3.3.2.2 Sample size

The sample is a frame that includes many more potential subjects that are required and can be included for the study (Melnyk & Overholt 2011:427). To estimate a sample size which will ethically answer the research question of a randomized controlled trial with a reliable conclusion, the following information should be available: the type of comparison (Superiority trial to show that a new experimental therapy is superior to a control treatment or Equivalence trials with equal effect), type of design configuration, effect size (the accepted difference between two groups that a researcher wants to observe in a study), the error and power of the test and the type of the primary outcome (continues or proportion outcome). There are three usual ways to get the effect size: from past literature, if no past literature is available, one can do a small pilot study and from clinical expectations (Chan 2003:173).

The sample size was calculated using a power calculation with equal group sample sizes allocation ratio of 1:1 for both interventions and control groups and assuming a 95% significance level (two-sided Z $\alpha/2 = 1.96$) and 80% test power (Noordzij, Tripepi, Dekker, Zoccali, Tanck & Jager 2010:1390). Anaemia prevalence was taken as the main outcome of the intervention, but other variables like dietary diversity and nutrition knowledge were also considered to obtain the maximum sample size, which can demonstrate the expected intervention effect for the test power.

Taking a 57% anaemia prevalence among pregnant women attending ANC in health centres in Dire Dawa Administration (Yeshitila 2016:21); with an anticipated 25% intervention effect (lower prevalence of anaemia) the study wished to detect between the intervention and control groups by the end of the intervention and allowing for up to 10% non-attrition and non-compliance rate, the calculated total sample size was 195.

3.3.2.3 Sampling method and randomization

Sampling is the process of selecting a group of people or elements to which the researcher wants to conduct the study (Burns, Grey & Grove 2013: 351). In this study, random sampling was used. Random sampling ensures that participants are selected independently of the other members and that each member of the population has an equal chance of inclusion into the study (Polit & Beck 2017:313). Apart from random sampling, the researcher also used random assignment. Random assignment refers to how individuals or groups are assigned to either a treatment group or a control group. Randomised control trials typically use both random sampling (since they are usually aiming to make inferences about a larger population) and random assignment (an essential characteristic of a randomised control trial) (Sabarwal & Hoop 2014:1).

In this study, from the health facilities in the nine operational woredas of the Administrative Health Bureau, two operational woredas were selected using simple random sampling technique. The four health centres under the selected operational woredas, namely Legahare health centre, Gende Gerada health centre, Biya Awale health centre and Kalicha health centre were then included to recruit the study participants. All pregnant women who came for attending their first antenatal care visit at the selected health centres who meet inclusion criteria were approached.

The study employed the following criteria to screen for eligibility and enrol of pregnant women in the study intervention:

- Mild and moderately anaemic pregnant women with haemoglobin levels between ≥7 gm/dl and <11 gm/dl.
- Permanent residents of Dire Dawa Administration.
- Pregnant women who were attending routine ANC visits and who were attending their first ANC visit at the randomly selected health centres.
- Pregnant women who were within the first and second trimester of pregnancy to allow adequate intervention follow-up weeks before labour.

- Pregnant women who consented to participate and signed informed consent. Women who were less than 18 years were not requested to sign the informed consent due to ethical issues thus were not eligible to participate.

The study followed the following criteria to exclude pregnant women from participation:

- Severe and very severe anaemia with haemoglobin levels less than 7 gm/dl.
- Any diagnosed medical, surgical, or obstetric problems likely to affect iron absorption (such as celiac disease, bleeding disorders).
- Prescriptions for routine take of medications known to interfere with iron absorption like antacids.
- Dietary preferences and patterns excluding consumption of either meat (vegetarians) or fruits and vegetables or both.

For this intervention study, a total of 329 pregnant women who fulfilled the inclusion criteria were screened for anaemia. Out of those, 197 pregnant women were identified to be anaemic (Hg less than 11gm/dl), with 195 of them had haemoglobin level between 7gm/dl and 11gm/dl and 2 were severely anaemic (Hg less than 7gm/dl). Two pregnant women who were severely anaemic were excluded. Therefore, a total of 195 pregnant women was recruited. Randomization of the pregnant women into either of the two interventions groups or the control was done by simple random sampling employing lottery method. Folded pieces of papers with written numbers “1”, “2” and “3” at a ratio of 1:1 were put into a box and the number picked by the woman determined the participant’s allocation group as 1 for interventions group 1, 2 for interventions group 2 and 3 for the control group. Therefore, 65 pregnant women were randomly assigned to each of the three study groups. Figure 3.2 summarises the entire process from initial sampling to randomisation.

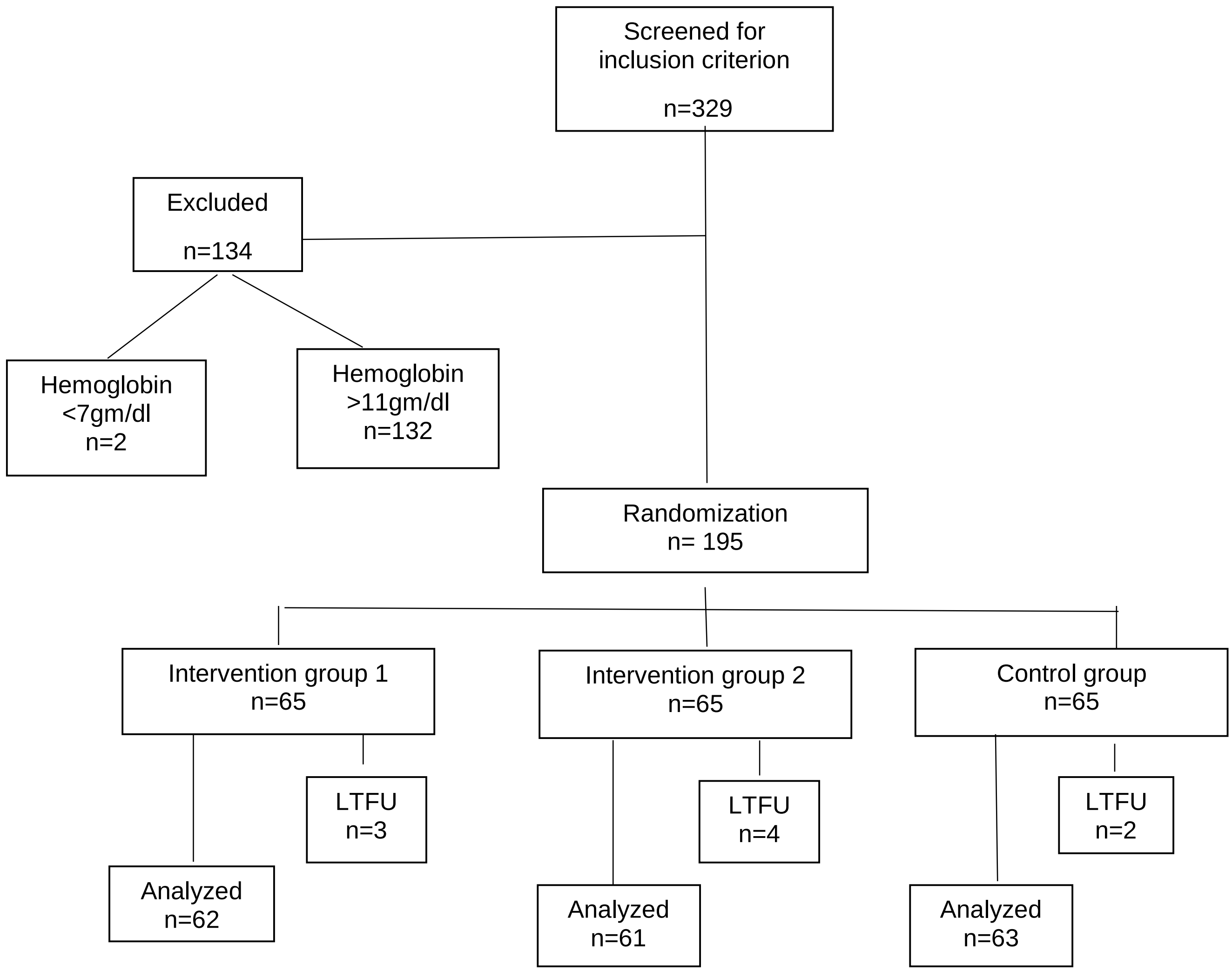


Fig 3.2: Enrolment, randomization & follow up of pregnant women in RCT, Dire Dawa 2018.

Furthermore, twenty-two of the pregnant women, who were inclusive to the random control trial, were selected purposively and further involved in in-depth to explore supplementary qualitative data. The participating women were identified by their household numbers and agreed appointment dates were set by data collectors ahead of the subsequent home visit. Data collectors were blinded to intervention allocations and participant cores were used to link records of data collected at different stages. Supervisors were responsible for ensuring an equal number of contact occasions were made data collectors and delivery HEWs with each participant in the intervention groups.

3.3.2.4 Ethical issues related to sampling

Prior to sampling, pregnant women who came for ANC visit at the selected health centres were approached by the nurses and midwives providing the routine antenatal care service of the health centres. These health workers initially provided explanations on the purpose of the study, the reason for selecting the woman, types and settings of data collection and the potential benefits of the study result to maternal and child health programme using the participant information sheet (annexe 6) produced for the study. After getting consents from women, the nurses and midwives screened the women for anaemia level and medical conditions stated under the study inclusion criteria. Data collectors then screened consenting women for eligibility based on the inclusion and exclusion criteria after further detailed explanations on the study protocol, blood samples to be collected for analysis of haemoglobin level and ethical issues using both participant information sheet and informed consent form (annexe 6). Those fulfilling the inclusion criteria were then sampled to be eligible. Furthermore, eligible participants were enrolled in the study subsequent to a signed informed consent (annexe 7). Pregnant women who were less than 18 years were not requested to sign the informed consent due to ethical issues thus were not eligible to be sampled.

3.3.3 Data collection

This section presents the development and testing of the data collection instrument, Data collection process and ethical consideration related to data collection.

3.3.3.1 Development and testing of the data collection instrument

Data collection instruments employed in this randomised control trial study were adopted from the Ethiopian Demographic Health Survey (EDHS) (CSA Ethiopia & ICF 2016:373), Ethiopian National Micronutrient Survey (Hailu 2016:63) and the FAO's guideline for assessing nutrition-related knowledge, attitudes and practices on anaemia (Macías & Glasauer 2014:118-128) and the guideline for measuring Minimum Dietary Diversity of Women (M-DDW) (FAO & FHI 360 2016:23).

The validity of a questionnaire expresses the degree to which it measures what it purports to measure (Bolarinwa 2015:195). The data collection instruments adopted for this randomized controlled trial study have already been applied and validated by the sources which maintained their internal validity. Furthermore, parts of the instrument containing qualitative semi-structured questions were developed for this particular study. The qualitative questions were also further modified during the data collection process based on newly emerging responses and themes.

The questionnaires, which were initially produced in English, were translated to Oromifa and Amharic languages, which are the commonly spoken languages in the study area, and back-translated to English by another translator to see the consistency of questions and avoid misinterpretation. The translated tools were then pretested before the actual data collections were done on pregnant women who were not included in the sample.

Note: *As the researcher had further developed part of the instrument for this particular study, the instrument has no copyright issues and no permission will be required to reproduce, translate, display or distribute the questionnaire.*

The final developed and refined data collection instrument (annexe 1) had three major sections with each section designed for the specific process of the study namely: to collect the baseline data, during follow-up assessment visits and at the end of the study was as follows:

Interview-administered questionnaire: this questionnaire was constructed under 10 sections. The first seven parts contained structured questions which assessed the participant's background socio-demographic profiles, reproductive history, ANC visits and iron-folic acid intakes, nutrition knowledge and attitude on iron deficiency and anaemia, iron-rich foods, vitamin C-rich foods, enhancers and inhibitors of iron absorption, food preparation methods and dietary modification behaviours. Other two parts included structured questions assessing past 24-hour and past 7-days dietary diversity and food consumption of the participating pregnant women, and households' food security levels. One part of the instrument inculcated semi-structured questions exploring socio-cultural influenced maternal dietary practices and patterns at the community level.

Intervention follow-up instrument: this questionnaire inculcated questions assessing intervention adherence and compliance; iron-folic acid intakes and changes in dietary diversity and modification behaviours; changes in food consumption with emphasis to consumption of iron-rich foods, vitamin C-rich foods and inhibitors of iron absorption; and food preparation and modification practices of the studied pregnant women during the study's intervention period. ***Checklist*** which was used for reporting of participants' intervention records, haemoglobin levels, gestational age and anthropometry at baseline and end of the study.

3.3.3.2 Preparation for data collection

The following items are discussed under data collection process namely: data collectors and data collection approach

3.3.3.2.1 Data collectors

Two data collectors and one supervisor were assigned for each of the 4 health centres for data collection. Data collectors were experienced health professionals from the health centres with a minimum of a diploma in Nursing. Supervisors were also experienced health professionals with a Bachlor of Science degree in Nursing and Master of Public Health. Data collectors and one supervisor were native speakers of Oromifa and Somalifa language. Blood sample collections and analysis were performed by the laboratory technicians of the respective health centres who were also BSc holders.

All data collectors and supervisors, after signing a confidentiality agreement (annexe 8), were trained for five days on the study protocol and data management prior to data collection. The training was supported by practical sessions on anthropometric measurements, demonstrations of food groups using pictorial diagrams and application of household equipment for estimating the proportion of food intakes. All data collectors and supervisors were involved in practical field visits during the pretesting of the data collection instrument before the actual data collections were conducted.

In addition, four Health Extension Workers (HEWs), who were not the actual data collectors, were also recruited and trained, who were responsible to deliver study intervention packages (vitamin C supplementation and nutrition education) to each study participant through home visits every two weeks. One Bachelor of Science holder nurse was recruited to supervise the delivery of intervention packages. The intervention packages delivering health extension workers were anonymous to the actual data collectors and were also blinded to the women in the groups.

3.3.3.2.2 Data collection approach

The study was conducted from March to September 2018. Quantitative data were collected from each study participant at baseline, during follow-up assessment visits and at the end of the 12 weeks' interventions through individual face-to-face interviews employing interviewer-administered structured questionnaire. The baseline data were collected on the same day of enrolment at the respective health centres levels where the study participants attended their ANC visits whereas follow-ups and end line data were collected at each participant residence level during home visits. Study participants in intervention group 1 were intervened with daily supply of vitamin C-rich fruit (mango and orange) juice providing about 90mg/day of vitamin C divided into three doses combined with nutrition education intervention. Study participants in intervention group 2 were intervened with only nutrition education intervention; while those in the control group were without any intervention but on their routine ANC. Follow-up home visits for collecting data on intervention compliance were conducted every two weeks during the 2^{nd}, 4^{th}, 6^{th}, 8^{th} and 10^{th} weeks of enrolment. Pictorial diagrams and household equipment were also used to support the collection of data on dietary consumption.

Qualitative data were collected only at baseline using semi-structured interview guides. Interviews were not audiotaped, but rather detailed written notes were taken for the qualitative interview responses. Laboratory technicians collected and analysed blood samples for haemoglobin levels at the laboratories of the respective health centres at baseline and by end of the study intervention. Participants were followed for 12 intervention weeks.

3.3.3.3. Data collection procedure

The following is a detailed procedure followed to collect different types of data from the beginning of the study throughout until the end of 12 intervention weeks.

3.3.3.3.1 Socio-demographic characteristics, reproductive history and ANC follow-up assessment

An interview-administered structured questionnaire was employed to collect data on the participant's socio-demographic characteristics, reproductive history, ANC utilization and iron-folic acid tablet use at the baseline.

3.3.3.3.2 Nutritional knowledge and attitude on iron-deficiency and anaemia assessment

Maternal nutritional knowledge and attitude on iron-deficiency and anaemia and attitude were assessed and computed based on the number and percentage of correct answers to questions in 14 categories. The correct responses in each category were summed up to compute the total Nutritional Knowledge Score (NKS) of the participant. The level of nutritional knowledge was constructed as a percentage of the maximum total nutritional knowledge score, which was 57. The pregnant women were scored as having "poor knowledge" (<30% or NKS <18); "average nutritional knowledge" (30%-70% or NKS 18-40); and "good knowledge" (>70% or NKS >40) respectively. The data on nutritional knowledge scores were collected at baseline and end of the study intervention.

3.3.3.3.3 Knowledge and practice on food preparation and preservation methods and dietary modification behaviours

For this study, pregnant women were considered to have knowledge of food preparation and preservation methods and dietary modification behaviours on dietary iron and vitamin C when answered for at least one method and dietary modification behaviour. Pregnant women were considered to practice when had ever used or started using during the intervention at least one proper method and dietary modification behaviour. The data were collected at baseline, during follow-ups and end of the study intervention.

3.3.3.3.4 Dietary diversity and food consumption frequency assessment of pregnant women

Dietary recall for the 24-hour approach was used to assess dietary diversity and food consumption frequency of the study participants based on FAO's guidelines (FAO & FHI 360 2016:2; Kennedy et al 2013:21-28). The pregnant women were asked to spontaneously recall and list all the foods and drinks they had consumed in the previous 24 hours' period prior to the interview and then probed to ascertain that no meal or snack was left out. Detailed lists of all ingredients of dishes, "wot", sauces and soups consumed were gathered for further classification of the mixed dish. Furthermore, the frequency and number of portions of each food consumed were collected and recorded. Utensils commonly used at households like plates, bottles and cups, which were identified to the participants a day before the interview, were used to estimate the portions of foods consumed.

The listed foods were then categorized into ten food groups to calculate the Minimum Dietary Diversity for Women (M-DDSW) and analyse dietary diversity. The food groups used to construct the Minimum Dietary Diversity Score of Women (M-DDSW) in this study were developed from the list of food items according to the FAO guidelines (FAO & FHI 360 2016:2; Kennedy et al 2013:8) and adopted based on food items commonly consumed in Ethiopia (Hailu 2016:83; Workicho et al 2016:3). The food groups were also further categorized to analyse consumption specific food groups including of iron-rich and vitamin C-rich foods.

The ten main food groups constructed were:

1. Grains, white roots and tubers
2. Pulses (beans, peas and lentils);
3. Nuts and seeds
4. Dairy products (milk, yoghurt, cheese)
5. Flesh foods or Iron-rich animal foods (meat, fish, poultry, and liver/organ meat)
6. Eggs;
7. Dark green leafy vegetables
8. Other vitamin A-rich fruits and vegetables
9. Other vegetables
10. Other fruits.

In order to calculate the minimum dietary diversity of women score, a respondent who consumed at least one food item in a food group at least once in the past 24-hour recall period irrespective of the frequency was scored as 1. The final minimum dietary diversity of women score for the pregnant woman was then calculated by summing the number of food groups consumed by the individual pregnant women. In this study, the minimum and maximum minimum dietary diversity of women score were 1 and 10 respectively. Pregnant woman with minimum dietary diversity of women of 5 and more (consumed 5 and more food groups) was then declared to had "high dietary diversity", while with minimum dietary diversity of women of less than 5 (consumed less than 5 food groups) was categorized to had "low dietary diversity".

The study also employed a 7-days dietary recalls method to assess the frequency of consumption for each specific food group. The frequency of consumption for specific food group for the past 7-days was then calculated by summing up the number of days of the past week on which at least one food item in food group was consumed at least once in a day irrespective of the frequency. In this study, the minimum and maximum frequency of consumption for a specific food group were 1 and 7 respectively. Mean frequency consumption (MFC) was then computed for analysis and comparisons. In addition to the 10 food groups, tea/coffee consumption was included in the 7-days consumption assessment.

Data dietary diversity and food consumption frequency were collected at baseline and end of the study at the participant household level. As the data were collected at random days of the week, all days of the week excluding fasting and feasting days were equally represented. Furthermore, qualitative data on maternal dietary practices and patterns at the community level were gathered to explore socio-cultural influences and dietary taboos affecting maternal dietary preferences during pregnancy.

3.3.3.3.5 Household dietary diversity and food insecurity level assessment

The 7-days recall approach measuring household dietary diversity score was used to assess the household dietary diversity and food insecurity level at baseline. The women were asked to recall and list foods and drinks consumed by any member of their family consumed in the past week prior to the interview. The listed foods were then categorized into nine food groups to calculate the household dietary diversity score. The food groups used to construct the household dietary diversity score in this study are developed from the list of food items according to the FAO guidelines (Kennedy et al 2013:8) and adopted based on food items commonly consumed in Ethiopia (Workicho et al 2016:3). The nine main food groups constructed were: the main staples (cereals and tubers); pulses; fruits; vegetables; meat and fish; diary; sweets; oil and condiments.

In this study, a household which consumed a food group at least once in a week period irrespective of the frequency is scored as 1. The household dietary diversity score was then constructed as the sum of numbers of food groups consumed over the past 7 days. The minimum and maximum HDDS were 1 and 9 respectively. Despite the lack of established cut-offs in terms of number of food groups to indicate adequate or inadequate HDDS (Workicho et al 2016:3), in this study, those households who consumed 5 and more food groups were categorized as “high HDDS”, while those in the “low HDDS” category were with less than 4 food groups consumed in the previous 7 days.

Household food insecurity level was assessed based on WFP’s guideline (WFP 2015:9-17) using the Food Consumption Score (FCS) or the “frequency weighted diet diversity score”. The score was calculated by summing the frequency of consumption of the food groups consumed by a household during the 7-days before the interview. Based on the FCS, household’s food security level was classified as “Poor” (<21); “Borderline” (21-35); and “Acceptable” (>35) respectively.

3.3.3.3.6 Haemoglobin measurement

Haemoglobin measurements were taken twice at enrolment and the other at the end of the study from all participants using a portable Hemocue® photometer (AB Leo Diagnostics, Helsinborg, Sweden). Blood samples collections and analysis were performed at health centres levels by their respective laboratory technicians based on the WHO recommendation (WHO, UNICEF & United Nations University 2001:33-43) and pregnant women with values less than 11.0 g/dl were considered to be anaemic.

3.3.3.3.7 Anthropometric measurements

Maternal weight, gestational age and mid-upper arm circumference (MUAC) were measured during ANC visit at baseline. The pregnant women were weighed using electronic scales with a weighing capacity of 10 to 140kg. Measurements were taken twice and the average of the two readings was considered provided that the difference between the two readings did not exceed 0.1kg and the result was recorded to the nearest 0.1kg. Mid-upper arm circumference of the left arm was measured to the nearest millimetre with a non-stretchable measuring tape. ANC care providers at the health centres estimated gestational age based on the Last Menstrual Period (LMP) and fundal height palpation.

3.3.3.3.8 Compliance to study interventions assessment

In this study, a study participant was considered to be compliant to vitamin C-rich fruit juice supplementation intervention when the participant: consumed more than half of the amount (more than 50ml) of the juice for each of the 2 of the daily 3 servings; such amount of the supplement was taken together with foods during meal servings and; for at least 4 days of the week and; for at least 10 weeks of the intervention periods. A study participant was considered to be compliant to nutrition education intervention when four of the five education sessions were fully attended for the whole duration of the sessions. Data collectors collected the data on intervention compliance every two weeks during follow-up home visits.

3.3.3.3.9 Effect or outcome of study intervention assessment

Effects of the study interventions were assessed based on changes in:

1. Haemoglobin levels as a measure of iron status.
2. Anaemia prevalence determined based on haemoglobin levels.
3. Nutritional knowledge score on iron deficiency and anaemia.
4. Minimum Dietary Diversity Score for Women.
5. Frequency consumption of iron-rich foods.
6. Frequency consumption of vitamin-c rich fruits and vegetables (dietary iron enhancers).
7. The frequency of consumption of dietary iron inhibitors (tea/coffee).
8. The practice of proper food preparation and preservation methods.

3.3.3.4 Phases of study interventions

The study intervention was conducted in two distinct phases namely, pre-intervention and Implementation of study interventions.

3.3.3.4.1 Phase 1- pre-intervention

During the pre-test phase of the study, the following activities were done:

- *Formative dietary assessment*

a formative dietary assessment was conducted which identified the common local foods consumed and modifications were made on the lists of food items included for construction of food groups to assess dietary diversity. The assessment also identified locally available vitamin C-rich fruits and vegetables such as mango, orange, lemon and papaya were not socio-culturally challenged and economically cost effective which would be promoted through food-based strategy to address iron-deficiency and anaemia.

- *Development of food-based intervention packages* – dietary-based v*itamin C-rich fruit juice supplementation*

Labelled and packed vitamin C-rich fruit juices, which provided 10mg of vitamin C per 100ml were identified from legal markets. After sensory preferences were assessed, mango and orange juices were then selected for intervention. The fruit juices were purchased from licenced suppliers registered and certified by the Trade and Revenue Bureaus. Determination of the amount of vitamin C relied mainly on the packed labels as there was no regional laboratory facility Dire Dawa or nearby regions to perform the nutrient analysis.

- *Development of food-based intervention packages - development of a nutrition education tool*

The nutrition education intervention package method was based on the recommended methodology of FAO (Food and Agriculture Organization 2014:292) and cognitive model of health education (WHO 2012b:32) to improve participant's nutritional knowledge and safe behaviours to follow a healthy balanced diet supported with action-oriented change plans considering the existing environmental factors. The framework of the developed tool also relied on nutrition education component of food-based strategy and contained key messages which centrally focussed on improving nutritional knowledge, practices and dietary modification behaviours for prevention of iron deficiency and anaemia during pregnancy. The messages promoted proper dietary diversification, increased consumption of iron-rich foods and vitamin-c rich fruits and vegetables, dietary modification and household food preparation and preparation methods for improved consumption of iron enhancers and reduced consumption dietary inhibitors of iron absorption. The key messages were adopted from the Ethiopian Health Extension Program's (HEP) package for ANC service delivery and Essential Nutrition Action (ENA). The tool was pretested and organized to include participatory sessions with practical demonstrations and pictorial diagrams of food groups that encouraged two ways communication (annexe 2).

The key messages of the nutrition education package organized in five sessions were:

1. Session 1: Prevalence, trends and effects of anaemia iron deficiency and anaemia during pregnancy.
2. Session 2: Causes and prevention of anaemia.
3. Session 3: Iron-rich foods, enhancers and inhibitors of iron absorption.
4. Session 4: Dietary advice for pregnant women to improve dietary diversity and modification for optimal intake bioavailable iron in the diet.
5. Session 5: Household food preparation and preservation techniques to decrease dietary inhibitors and increase dietary enhancers of iron absorption.

3.3.3.4.2 Phase II – Implementation of study interventions

The following were done during the intervention phase:

- *Intervention with vitamin C-rich fruit juices supplementation*

The pregnant women recruited only in intervention group 1 were supplemented with diet-based vitamin C-rich fruit juices. The pregnant women were supplied to consume 300ml/day of fruit juice providing 30mg/day vitamin C three times in a day to be consumed together with foods at times of major meals at breakfast, lunch and dinner. The minimum dose of 25mg ascorbic acid to be consumed three times per day is recommended by the Food and

Agriculture Organization (FAO 2011:272) for such dietary intervention. The provision was made for five days per week from the time of recruitment for a total of 12 weeks until the end of the intervention. Refiling of supplies was done every 2 weeks by the recruited and trained Health Extension Workers (HEWs).

Prior to the intervention, the women were provided with orientations supported with demonstrations on how to prepare and drink the juice with meals, measure amount of consumption using glasses and bottles, properly store leftovers and record and report their daily consumptions compliances. In cases of illiterate women, one additional literate family member was given the orientation to help the women in recording and reporting of daily consumptions. Along the supplementation of vitamin C-rich fruit juices, intervention group 1 participant were also delivered with nutrition education intervention in ways discussed hereafter.

- *Intervention with nutrition education*

Pregnant women enrolled in both intervention group 1 and intervention group 2 were delivered with nutrition education intervention based on tool discussed earlier. The intervention comprised of five sessions organized through a one-to-one individualized session delivered at each woman's residence level during home visits. One session at a time was delivered at the 2^{nd}, 4^{th}, 6^{th}, 8^{th} and 10^{th} weeks of enrolment. Each session covered 30 minutes and was also supported with teaching aids like the pictorial presentation of food groups, supplementary readings for those who were literates and food preparation demonstrations.

Side by side to delivering the key messages of the daily session, the women were assisted to assess their status and make their own plan to modify dietary practices and behaviours based on the lessons learnt. In addition, the participants were assisted to evaluate the progress made based on the plan made and challenges encountered during the subsequent sessions. Furthermore, along with the nutrition education, the women were also advised to continue any iron supplementation they were prescribed as part of their regular ANC visit. The recruited and trained Health Extension Workers (HEWs) facilitated the nutrition educations sessions.

- *Follow-ups for compliances study interventions*

Pregnant women recruited in intervention group 1 and intervention group 2 were visited every two weeks since enrolment. Data collector's paid regular individual home level follow-up visits and collected data on the compliance of study interventions using the compliances assessment instruments. Women recruited in intervention group 1 were assessed for their complete participation at each session of the nutrition education intervention as well as for their compliance on the intakes of vitamin C-rich fruit juices. They were spontaneously probed to describe their daily intakes in relation to the amount taken at every three servings and the number of servings consumed. Data collectors then verified their intakes using compliance reports recorded by the women or family member in case of illiterates and then by counting empty sachet and recorded the finds on the separate follow-up reporting tool. Refilling of the vitamin C-rich fruit juices supplies was then made based on the counted remained balance. Likewise, women recruited in intervention group 2 were assessed for their complete participation at each session of the nutrition education intervention.

At each follow-up visit, data collectors also re-checked the women for the study inclusion criteria were not still violated; whether the pregnancy was not terminated, had no medical admissions for serious illness and had no prescriptions affecting iron absorption. Data on iron-folic acid intake were also collected. Finally, end-line data was collected from all women in each study arm 12 weeks after enrolment.

3.3.3.5 Ethical considerations related to data collection

Prior to data collection, Ethical clearance was obtained from the ethical clearance committee of UNISA (annexe 3). Request for approval of data collection was the submitted to Dire Dawa Administration Health Bureau (annexe 4), and approval letter for permission to conduct the study was also obtained from Dire Dawa Administration Health Bureau, which also issued cooperation letter to the health centres (annexe 5). Copies of ethical clearance letter from UNISA and approved study proposal abstract were submitted to the Health Bureau and health facilities.

Participating women have been informed about the purpose and protocols of the study, types of data to be collected and the anonymity of results generated to be used solely for the study purpose and the ethical consideration (annexe 6). Data collectors also gave detailed information on the stages of data collection and the purpose of blood sample collection and medical history check-ups at every follow-up visits. Only those women who issued written consent (annexe 7) were then re-checked for inclusion criteria and data collection. Women identified with severe anaemia at and medical problems were referred for further investigation and treatment. Informed consents were also obtained from each participant prior to home visits and at each subsequent follow-up data collection. Individual interviews conducted at residences were based on the setting preferences of the participant's.

All data collected were kept confidential and used for the purpose of the research only. Participant and questionnaire codes were used to track records while anonymity of data collected was maintained. All data collection procedures in the study followed recommended guidelines and protocols outlined by the Federal Ministry of Health of Ethiopia. The researcher strongly believes that the study presented no risk or harm to the participants. There were be no cost or payments provided to the participant for participating in this study.

3.3.4 Data quality control and analysis

This section focuses on data quality control, data management and data analysis

3.3.4.1 Data quality control

All questionnaires were translated into the local languages and back-translated to English by another translator to see the consistency of questions. The questionnaires were pretested tested before the actual data collection. All interviews were conducted in the local languages preferred by the study participant.

During data collection, supervisors collected completed questioner, checked for its completeness and handed over to the principal investigator on daily basis. The researcher also checked the data for accuracy and completeness. Data cleaning and coding then followed before analysis. Data imputations were conducted missing data.

All equipment was calibrated with standard weights and quality control tests were carried out on HemoCue meters on daily basis. All experimental samples were clearly and accurately labelled, and codes rather than names were used to track data from the different measurements. Data collectors and supervisors were blinded to the women's intervention allocations. Furthermore, the researcher was responsible for the overall follow up and management of the research project and made a weekly visit to check the completeness and quality of the data collection and study protocol.

3.3.4.2 Data management

Prior to data analysis, the researcher cleaned the data for completeness and missing values. Continues variables were checked for normality using the Kolmogorov-Smirnov test, values of skewness and kurtosis. Means with standard errors are used to summarize and analyse differences in continuous variables; while proportions are used for categorical data.

Independent differences of in means of the outcome of continuous variables including nutritional knowledge score, haemoglobin level, minimum dietary diversity of women (M-DDSW) score, consumption of iron-rich foods, consumption of vitamin C-rich foods and dietary modification practices between the 3 study groups at baseline and after the end of interventions were tested using ANOVA.

The paired-samples t-test was used to test changes with-in means of each group between baseline and end of intervention to analyse treatment effect of the study interventions. Independent level of effect of dietary vitamin C supplementation on means of the continuous outcome variables was compared using independent student's t-test between intervention group 1 and intervention group 2. The effect of the food-based strategy was further analysed comparing intervention group 1 with the control group using independent student's t-test. Fisher's exact test and Chi-square test were used to test independence in the distribution of categorical variables between the three intervention groups, while McNemar test was employed to test changes in proportions of each group between baseline and end of the intervention. In all comparisons, differences were considered statistically significant at $P<0.05$.

3.3.3.3 Data analysis

Data entry and analysis was performed using the Statistical Package for Social Sciences (SPSS) version 21. All continuous variables were checked for normality using the Kolmogorov-Smirnov test, skewness and kurtosis. Socio-demographic data were analysed using descriptive analysis. Means and standard deviations were presented and analysed for continuous variables and frequencies and proportions for all categorical variables.

Independent t-tests and ANOVA for continuous variables and Chi-square test or a Fisher's exact test for categorical variables were used to compare and test for independence in the distribution of the study endpoints between the randomly assigned groups at baseline and end of interventions. Paired t-test was applied to compare intervention effects and changes in means in each study group before and after study interventions, while McNemar test was employed to test changes in proportions between baseline and end of the intervention. In all comparisons, differences were considered statistically significant at probability value less than 0.05 ($P< 0.05$).

The main study endpoints were analysed and compared both as continues data using means and standard deviation, and categorical data using proportions. Iron status for the pregnant women was computed based on the level of haemoglobin concentration and level of anaemia. Dietary profiles based on food groups consumed by a majority of the study participants were used to annualize dietary diversity and consumption patterns of pregnant women in the study area. Mean haemoglobin level and M-WDDS were compared across the study groups and over intervention duration to analyse the effect of food-based strategy on iron status and dietary diversification respectively. Independent level of effect of dietary vitamin C supplementation on means of the continuous outcome variables was compared using independent student's t-test between intervention group 1 and intervention group 2. The effect of food-based strategy was further analysed comparing intervention group 1 with the control group using independent student's t-test.

Qualitative data was analysed manually using the thematic framework analysis method. Response codes were constructed based on themes emerged and the saturation of information determined termination of the analysis.

3.4. INTERNAL AND EXTERNAL VALIDITY OF THE STUDY

Internal and external validity are quality indicators of quantitative studies including randomised controlled trials. High internal validity means that the differences observed between groups are related to the intervention tested in the trial. The internal validity of a clinical trial is directly related to appropriate design, conduction, and reporting of the study. The main threats to internal validity occur from the selection and screening of samples, attrition, compliance, missing data and measurement error (Spieth et al 2016:1343). External validity, on the other hand, refers to the extent to which the results of the study can be generalized to groups, populations, and contexts that did not participate in the study (Porritt et al 2014:48-49).

This study employed a parallel randomized controlled trial design. As stated in Spieth et al (2016:1341-2), with respect to study design, randomized controlled trials, as well as analysis of quantitatively synthesized randomized controlled trial data, are considered the gold standard for evaluating efficacy in clinical research and constitute evidence for medical treatment. Randomization is a powerful tool to ensure validity in parallel-designed studies.

Screening of pregnant women for eligibility using the inclusion criterion to be enrolled in this study was conducted only after the women issued their consent. Therefore, the study controlled internal validity due to attrition. Screening of anaemia and medical conditions stated in the exclusion and inclusion criterions were performed by health professionals who are accredited by Dire Dawa Health Bureau and engaged in health care delivery. This thus controlled the internal validity of this study enrolling the appropriate samples. This study also adopted data collection instrument which already been applied and validated by the sources which maintained internal validity.

Supervisors also regular assessed each data collector and HEWs and checked consistencies in data collection between follow-ups to control differences between individual interviewers. However, the generalizability of the findings of this study may be limited affecting its external validity as the analysed dietary factors affecting the iron status of pregnant women vary across the different dietary patterns and socio-cultural profiles of the country.

3.5. CONCLUSION

This chapter presented the research methodology employed by the researcher to test the effect of food-based strategy in improving haemoglobin levels thus the iron status of pregnant women in Dire Dawa. The chapter discussed in detail the study design, population, sampling, research setting, data collection and analysis. Sections of the chapter also discussed the phases of the study intervention employed to test the research hypothesis and measurements employed to analyse the changes in the intervention effects across the study groups before and after the food-based interventions.

The next Chapter 4 will present the analysis, presentation and description of the randomised control trial research findings in Dire Dawa. The chapter reports the results towards the outcome variables of the randomized controlled trial of the study. Chapter 4 also includes interpretations of the findings in line with consistent or contrary results of previous researches conducted nationally and in other countries.

CHAPTER 4

PRESENTATION AND DESCRIPTION OF THE RESEARCH FINDINGS

4.1. INTRODUCTION

In chapter three, the researcher discussed the research design and method the study employed to address the study objectives and hypothesis. Chapter four presents the research results. By the end of the intervention, 186 participants completed the 12 weeks intervention. Nine participants were lost to follow-up: three from intervention group 1, four from intervention group 2, and two from the control group. All the women terminated their participation as they relocated their residence and address due to the ethnically based insecurity crisis that occurred in the study area during the period. Since the participants were lost to follow-up before the 4th week of intervention, their data were not included in the final analysis. However, the background characteristics of the non-compliant women were not different. The study thus resulted in 95.3% compliance rate that did not significantly vary among the intervention groups. The research results will be discussed based on 186 women who completed the study, not the initial sample of 195.

4.2. RESEARCH RESULTS

The research results will focus on the following aspects: Sample characteristics, Enrolment gestational age and anthropometry, Maternal haemoglobin at enrolment to intervention, Anaemia during pregnancy, Maternal haemoglobin level and anaemia prevalence at end of the intervention, Maternal dietary preference and dietary diversity during pregnancy, Maternal past 24-hours and 7-days dietary diversity during pregnancy, Effect of nutrition education on the consumption of vitamin C-rich foods, Effect of nutrition education on consumption of iron-rich foods during pregnancy, Effect of nutrition education on maternal dietary modification behaviours during pregnancy, Effect of nutrition education on nutritional knowledge of iron-deficiency and anaemia during pregnancy, Effect of nutrition education on knowledge and practice of food preparation and preservation methods, Food-based strategies, haemoglobin and anaemia level (iron status) during pregnancy, Food-based strategies, haemoglobin and anaemia level (iron status) during pregnancy, Household dietary diversity and food security, Community dietary practices and patterns and socio-cultural influences.

4.2.1. Sample characteristics

This section presents the Socio-demographic characteristics, Household characteristics and Reproductive history**.**

4.2.1.1. Socio-demographic characteristics

Table 4.1 depicts the baseline socio-demographic characteristics of the study participants. The mean age of the pregnant women was 26.43 ± 0.37 years, while majority 142 (76.3%) were in between 21-30 years age group. About half of the pregnant women (51.1%) were illiterates and only 11 (5.9%) completed higher education. About 76.3% (142) were Oromo ethnically and Muslim (87%) was the dominant religion among the participants. Almost all of the pregnant women (99.5%) were married, while only 1 woman was single. The unemployment rate among the pregnant women was 31.2% while 43.5% were housewives. Almost all of the women (99%) had no smoking history, 96.8% had no history of alcohol intake and the majority (52%) did not chew chat respectively. The intervention groups had no significant differences in their socio-demographic characteristics except for occupation.

4.2.1.2 Household characteristics

The mean family size was 3.7 ± 0.13 and the largest size was 11 (0.5%). Majority of the women (73%) had family size <5. The average number of under-five children was 0.82 ± 0.05 child per household. About 96.7% of the women were not heads of their households. About 59% of the women did not know the amount of their family monthly income, while the average household monthly income reported was 1,204 ETH birr. Public tap (47.3%) was the main source of drinking water for the households, followed by pond/spring water sources (29.6%) and private pipelines (23.1%). About 69 (37%) of the households did not have private latrines. The intervention groups had no significant differences in their household characteristics as depicted in table 4.1 and 4.2.

Table 4.1 Baseline characteristics of pregnant women in RCT, Dire Dawa 2018

Variable		Intervention group			Total	*P value*
		Int grp 1 n (%)	Int grp 2 n (%)	CG n (%)	n (%)	
Age	<= 20	7 (11.2)	7 (11.5)	10 (15.9)	24 (12.9)	0.27
	21 – 30	52 (83.9)	44 (72.1)	46 (73)	142 (76.3)	
	31+	3 (4.8)	10 (16.4)	7 (11.1)	20 (10.8)	
Educational status	Illiterate	26 (41.9)	35 (57.4)	34 (54.)	95 (51.1)	0.72
	Read and write	15 (24.2)	10 (16.4)	14 (22.2)	39 (21)	
	Primary school	10 (16.1)	8 (13.1)	5 (7.9)	23 (12.4)	
	Secondary school	7 (11.3)	4 (6.6)	7 (11.1)	18 (9.7)	
	Higher education	4 (6.5)	4 (6.6)	3 (4.8)	11 (5.9)	
Ethnicity	Oromo	52 (83.9)	44 (72.1)	46 (73.0)	142 (76.3)	0.60
	Somali	4 (6.5)	8 (13.1)	7 (11.1)	19 (10.2)	
	Amhara	2 (3.2)	6 (9.8)	6 (9.5)	14 (7.5)	
	Others	4 (6.5)	3 (4.9)	4 (6.3)	11 (5.9)	
Religion	Muslim	55 (88.7)	53 (86.9)	54 (85.7)	162 (87.1)	0.74
	Orthodox	7 (11.3)	7 (11.5)	7 (11.1)	21 (11.3)	
	Protestant	0 (0)	1 (1.6)	2 (3.2)	3 (1.6)	
Marital status	Married	62 (100)	60 (98.4)	63 (100)	185 (99.5)	0.36
	Single	0 (0)	1 (1.6)	0 (0)	1 (0.5)	
Occupation	Unemployed	9 (14.5)	22 (36.1)	27 (42.9)	58 (31.2)	0.02
	Gov employee	5 (8.1)	3 (4.9)	3 (4.8)	11 (5.9)	
	Gov employee	30 (48.4)	25 (41)	26 (41.3)	81 (43.5)	
	Others	18 (29.0)	11 (18)	7 (11.1)	36 (19.4)	
Chat history	No	32 (51.6)	26 (42.6)	39 (61.9)	97 (52.2)	0.10
	Yes	30 (48.4)	35 (57.4)	24 (38.1)	89 (47.8)	
Alcohol history	No	61 (98.4)	59 (96.7)	60 (95.2)	180 (96.8)	0.61
	Yes	1 (1.6)	2 (3.3)	3 (4.8)	6 (3.2)	
Smoking history	No	61 (98.4)	61 (100)	62 (98.4)	184 (98.9)	
	Yes	1 (1.6)	0 (0.0)	1 (1.6)	2 (1.1)	
HH head	Husband	62 (100)	60 (98.4)	63 (100)	185 (99.5)	0.36
	She	0 (0.0)	1 (1.6)	0 (0.0)	1 (0.5)	
HH drinking water source	Public tap	32 (51.6)	28 (45.9)	28 (44.4)	88 (47.3)	0.85
	Private tap	15 (24.2)	14 (23)	14 (22.2)	43 (23.1)	
	Spring	15 (24.2)	19 (31.1%)	21 (33.3)	55 (29.6)	
HH private latrine	No	17 (27.4)	23 (37.7)	29 (46.0)	69 (37.1)	0.10
	Yes	45 (72.6)	38 (62.3)	34 (54)	117 (62.9)	

4.2.1.3 Reproductive history

Majority of the women (74%) had a history of previous pregnancy, while only 49 (24%) were primigravids. The mean gravida and parity were 1.89 ± 0.14 and 2.14 ± 0.12 respectively. About 20 (10.8%) and 19 (10.2%) of the women reported having a history of stillbirth and abortion respectively. Out of the multi-gravida mothers, the majority (52%) of them delivered their last birth at the health centre and health professionals attended the majority of those births (59.7%). The mean age at first pregnancy reported was 21.37 ± 0.59 years. Furthermore, 78 (42%) women had ever used family planning methods. As depicted in Table 4.2, the studied women in the intervention groups did not differ in their reproductive characteristics at enrolment except for stillbirth and abortion.

Table 4.2 Baseline reproductive characteristics of pregnant women in RCT, Dire Dawa 2018

Variable		Int grp 1 n = 62	Int grp 2 n = 61	CG n = 63	Total n = 186	*P value*
		Intervention group				
		Mean ± SE				
Age		26.18 ± 0.51	26.64 ± 0.76	26.48 ± 0.62	26.43 ± 0.37	0.87
Family size		3.6 ± 0.17	4.1 ± 0.23	3.5 ± 0.27	3.7 ± 0.13	0.23
<5 child		0.81 ± 0.09	0.92 ± 0.09	0.73 ± 0.1	0.82 ± 0.05	0.36
Gravida		1.80± 0.18	1.84 ± 0.19	2.03 ± 0.32	1.89 ± 0.14	0.77
Parity		1.9 ± 0.17	2.35 ± 0.16	2.19± 0.3	2.14 ± 0.12	0.29
Still birth		0.12 ± 0.05	0.04 ± 0.03	0.29 ± 0.07	0.15 ± 0.03	0.00
Abortion		0.1 ± 0.04	0.07 ± 0.04	0.31 ± 0.09	0.15 ± 0.03	0.01
Age at first pregnancy		21.06 ± 0.44	21.76 ± 1.89	21.38 ± 0.50	21.37 ± 0.59	0.90
Gestational age wk		21.9 ± 0.43	21.64 ± 0.43	22.03 ± 0.34	21.86 ± 0.24	0.79
MUAC cm		22.62 ± 0.26	23.2 ± 0.19	22.10 ± 0.26	22.63 ± 0.14	0.01
Weight kg		52.15 ± 0.86	54.52 ± 0.75	51.53 ± 1.08	52.72 ± 0.53	0.05
		n (%)	**n (%)**	**n (%)**	**n (%)**	
IFA prescribed (BL)	No	19 (30.6)	20 (32.8)	23 (36.5)	62 (33.3)	0.78
	Yes	43 (69.4)	41 (67.2)	40 (63.5)	124 (66.7)	
IFA terminated (EL)	No	42 (97)	37 (90)	31 (77)	110 (89)	0.01
	Yes	1 (3)	4 (10)	9 (23)	14 (11)	

4.2.1.4 Antenatal care history and **iron-folic acid** *(IFA) tablets intake*

Among the pregnant women with a history of previous pregnancy, 29 (16%) women did not have any ANC visit during their previous pregnancy, while 38% claimed to have an incomplete number of visits. Only 24 (13%) had completed a number of ANC visits (4 visits). The ANC coverage in Ethiopia is poor and lately initiated. According to the EDHS 2016, only 32% of women received the recommended four or more ANC visits during their last pregnancy as recommended by the WHO, while 37% of women in Ethiopia had no ANC visits (CSA Ethiopia & ICF 2016:134-5).

Various studies have documented the benefit of iron supplementation on anaemia prevention and control (Goswami et al 2013:102; Peña-Rosas et al 2015:2; Tseng & Ahmed 2013:1338; WHO 2015:5; WHO 2013:40; WHO 2012a:4). A study in Ethiopia revealed that pregnant women who were not on iron-folic acid had 1.90 times increased odds of anaemia (Gebremedhin et al 2014b:48). Pregnant women in East Ethiopia who lack iron supplementation during pregnancy were 1.30 times more likely to develop anaemia (Bereka et al 2017:5). Besides, benefits of iron-folic acid intake extend beyond improving iron stores to lowering risk for the critical outcomes of iron deficiency and iron-deficiency anaemia (WHO 2016:5) which include improving birth outcomes (Emamghorashi & Heidari 2004:810) and reducing the prevalence of low birth weight (Passerini et al 2012:3).

The WHO recommends that daily oral iron-folic acid intake should be part of routine ANC, begun as early as possible and continued throughout pregnancy. However, many factors related to compliance and coverage for various interacting bottlenecks attributed to the health system, care providers and individual behaviour levels have challenged the sustainability and effectiveness of iron-folic acid supplementation interventions. Many worldwide studies have extensively reviewed such challenges of the sustainability and effectiveness in many low-income countries (Berti et al 2014:50; Dutta et al 2014:460; Mithra, et al 2014:258; Ogundipe et al 2012:8; WHO 2016:7; Zimmermann & Hurrell 2007:515).

Likewise, prescription of iron-folic acid supplementation during ANC was not complete for the studied pregnant women in Dire Dawa. About 55% of the pregnant women who had ANC visit were not prescribed with iron-folic acid tablets during their previous pregnancy. Compliance to complete intake of iron-folic acid is also the other challenges of prevention and control of anaemia during pregnancy. In this study, only 37% reported that they had completed the amount prescribed during their previous pregnancy.

National surveys and studies have also documented similar figures in Ethiopia. Report of the 2016 EDHS revealed that coverage of iron supplementation was at a substandard level where more than half of the women with a child born in the last 5 years (58%) did not take any iron tablets during their most recent pregnancy (CSA Ethiopia & ICF 2016:200). Only 42% of the pregnant women said that they took iron supplements during their last ANC visit

(CSA Ethiopia & ICF 2016:135). Gebremedhin et al (2014a:6) reveal that 66.2% of the pregnant women were not on iron supplementation during their pregnancy.

Regarding iron-folic acid intake at the current pregnancy (table 4.2), 124 (68%) of the studied pregnant women have prescribed iron-folic acid tablets during their current ANC visits and the difference between the groups was insignificant (p=0.78). By the end of the intervention, 14 (11.3%) of the women stopped iron-folic acid intake as prescribed, about 97% in intervention group 1 and 90% in intervention group 2 had taken iron-folic acid as prescribed. The difference between the three groups in women with complete iron-folic acid intake was significant at the end line (p=0.01). More women in the control group had incomplete intake than the other two intervention groups. However, intervention group 1 and 2 had an insignificant difference at end line (p = 0.16).

Bereka et al (2017:4) showed that 73.8% of the women used iron-folic acid during their current pregnancy, but no figure on the full compliance rate. Sonko (2016:8) reported a higher coverage with 76.7% of the pregnant women in Aleta Chuko woreda took iron-folic acid supplements while attending ANC; suggesting the contribution of health extension program and community-based women development army in promoting the importance of ANC in the community for the higher coverage.

In contrary, lower compliance rates were reported in some national surveys and studies in Ethiopia (Gebre, Mulugeta & Etana 2015:166; Gebremedhin et al 2014a:6; Sadore, Gebretsadik & Hussen 2015:3). In the 2016 EDHS, only 5% of women took iron tablets for 90 days or more during their most recent pregnancy (CSA Ethiopia & ICF 2016:200). Gebremedhin et al (2014a:6) showed that only 6.4% and 1.1% took the supplements 61-90 and more than 90 days respectively.

The possible explanation for the higher compliance rate of iron-folic acid intake in this study could be due to the effect of the study intervention. The findings collaborate that the nutrition education intervention of this study could be attributed to the positive effect on increasing compliance of iron-folic acid intake among pregnant women in Dire Dawa; as women in both intervention group, 1 and intervention group 2 had significantly higher compliance than those in the control. Nevertheless, this study did not identify a significant difference in iron-folic acid intake among intervention group 1 and intervention group 2 at end of the intervention (p = 0.16), also suggesting the effect of counselling provided to the pregnant women through their routine ANC visits was controlled throughout the intervention groups in this study.

4.2.2. Enrolment gestational age and anthropometry

At enrolment to the study intervention, the mean duration of pregnancy (gestational age) was 21.86 ± 0.24 weeks. The mean gestational ages for intervention group 1 and intervention group 2 were 21.90 ± 0.43 weeks and 21.64 ± 0.43 weeks respectively, while the control had 22.03 ± 0.39 weeks. All of the study participants were enrolled during their second trimesters of pregnancy, of whom 43 (23.1%) were less than 20 weeks of gestation, majority 112 (60.2%) were between 20-24 weeks and 31 (16.7%) were above 24 weeks. All of the women were enrolled at their first ANC visit attendance. The mean weight and MUAC measurements at enrolment were 52.7 ± 0.53kg and 22.6 ± 0.14cm respectively.

Pregnant women in Ethiopia initiate ANC lately. According to the EDHS 2016, only 20% of pregnant women had their first ANC during the first trimester (CSA Ethiopia & ICF 2016:134-5). A consistent finding was also reported in Zerfu et al (2016a:1484) that almost all of the pregnant women enrolled to the cohort study attended their first ANC during their second trimester with a mean duration of pregnancy of 25-27 weeks. Yeshitila (2016:20) also reported that majority of the pregnant women in Dire Dawa started ANC after 4 months in their current pregnancy, while 20.3% of them were in the first trimester.

As described in table 4.2, the study participants in the three intervention groups did not significantly differ in their gestational age (p=0.79) and weight (p=0.05). However, women in the intervention group have higher MUAC (p=0.01) than the control.

4.2.3. Compliance to study intervention

Compliance and duration of intervention are some of the major determinants of the internal validity of interventional studies. This study resulted in a compliance rate where 95.4% of the followed pregnant women completed the 12 weeks intervention. The compliance rate in intervention group 1 and intervention group 2 was 95% and 94% respectively; while the control had 96.9% (figure 4.1). The compliance rate in the three intervention groups had no significant difference by the end of the intervention ($p<0.05$).

4.2.4. Maternal haemoglobin at enrolment to intervention

This study assessed haemoglobin and anaemia levels to determine iron status among the intervened pregnant women. The result revealed that the mean haemoglobin level of the pregnant women in Dire Dawa at enrolment was 9.52 ± 0.04gm/dl. The mean haemoglobin level for intervention group 1 and intervention group 2 was 9.49 ± 0.07gm/dl and 9.50 ± 0.08gm/dl respectively, while the control had 9.56 ± 0.08gm/dl. The haemoglobin level did not show a significant difference between the groups at baseline ($p=0.83$) as shown in table 4.3.

Nevertheless, Yeshitila (2016:21) reported higher level that showed a mean haemoglobin level of 10.3 ± 2.3gm/dl among pregnant women who attended ANC in health centres of Dire Dawa. Zillmer et al (2017:3) reported 12.46 ± 1.35gm/dl for pregnant women residing in rural areas of the Oromiya region of Ethiopia. Another national wide study, which included eight rural districts of Ethiopia, reported that the mean haemoglobin concentration in pregnant women was 11.5 ± 4.1-16.3gm/dl. (Gebremedhin, Samuel, Mamo, Moges & Assefa 2014a:6).

The discrepancy of the mean haemoglobin level of the pregnant women is possibly due to the inconsistency of the study populations. This study; however, enrolled pregnant women who were anaemic, which is the possible explanation for the lower haemoglobin level reported in Dire Dawa. All the above-stated studies employed cross-sectional designs, which sampled non-anaemic pregnant women who were obvious to increase the mean haemoglobin level.

4.2.5. Anaemia during pregnancy

Anaemia is a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs (WHO 2014b:1; WHO 2011a:1). Anaemia is less time and resource intensive to assess, and thus, is often used as a surrogate for iron status (Burke et al 2014:4096). The WHO defines anaemia irrespective of the cause as blood haemoglobin concentration less than 11gm/dl (WHO 2013:40; WHO 2011a:3). Anaemia can be classified as mild (haemoglobin 10 to 10.9gm/dl), moderate (haemoglobin 7 to 9.9gm/dl), severe (haemoglobin less than 7gm/dl) and very severe anaemia (haemoglobin less than 4gm/dl) (Prakash & Yadav 2015:265).

This study also showed that the prevalence of anaemia of among pregnant women in Dire Dawa was 59.9%, of whom 58 (29.4%) had mild anaemia, 137 (69.5%) were moderately anaemic and only 2 (1.1%) were severely anaemic. During enrolment to this intervention study, figure 4.1, (after excluding the non-compliant participants), about 128 (68.8%) of the total enrolled women were moderately anaemic and 58 (31.2%) had mild anaemia. Majority of the women in each intervention group were also moderately anaemic. About 74% and 71% of the pregnant women in intervention group 1 and intervention group 2 respectively and 62% in the control were moderately anaemic. The intervention groups had no significant difference at enrolment with the level of severity of anaemia (p=0.31).

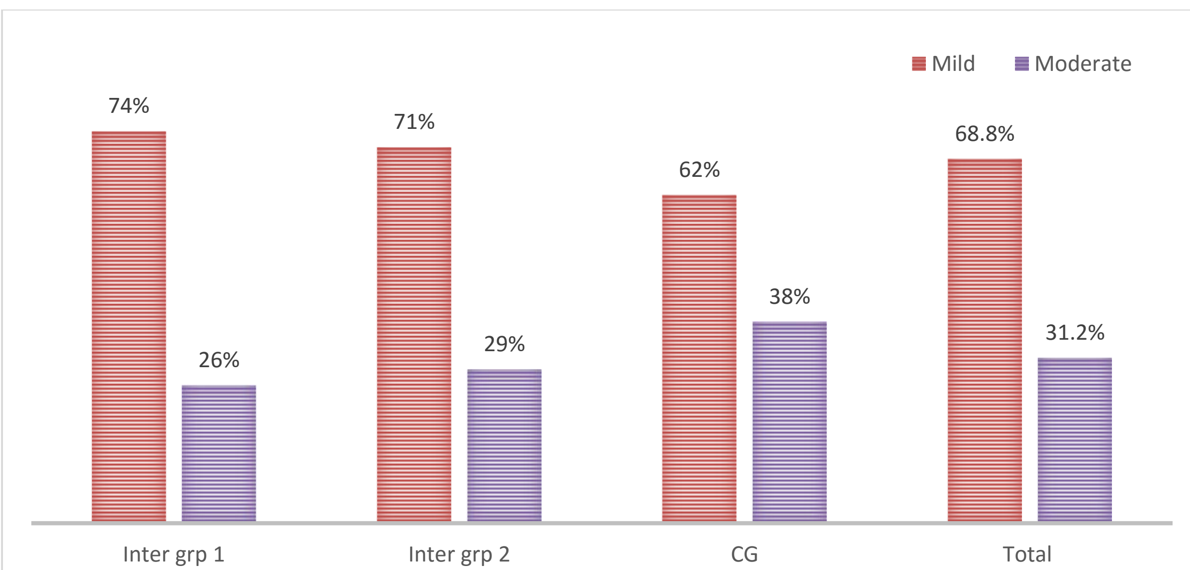


Figure 4.1 Baseline anaemia status of pregnant women in RCT, Dire Dawa 2018

These findings are consistent with the finding of Yeshitila (2016:21) which reported the prevalence of 57.2% among pregnant women who attended ANC in health centres of Dire Dawa. Bereka et al (2017:4) also resulted that 63.8% of pregnant women in Jijiga city, East Ethiopia, were anaemic, of whom 32.9%, 27.1% and 13.8% were mild, moderate and severe anaemic respectively.

Studies conducted in African countries also reported a high prevalence of anaemia among pregnant women. A study in Kenya found 57% overall prevalence of anaemia among pregnant women attending the antenatal clinic in the second and third trimesters with a mean haemoglobin concentration of 10.32gm/dl (Okube, et al 2016:22). M'Cormack and Drolet (2012:11) reported 77% anaemia prevalence among studied pregnant women in Sierra Leone; while a review of Tseng and Ahmed (2013:1337-8) reported 40% prevalence among pregnant women in the Democratic Republic of Congo.

The WHO classifies the public health significance of anaemia in populations on the basis of the prevalence of anaemia estimated from blood levels of haemoglobin as: sever if 40% or higher, moderate if 20%-39.9%, mild if 5%-19.9% and normal if equals 4.9% or lower (WHO 2011a:5). Therefore, this study concludes that the public health significance of anaemia among pregnant women in Dire Dawa is severe. The EDHS 2016 (CSA Ethiopia & ICF 2016:195 & 215) considered Dire Dawa, as one of the regions with the highest prevalence of anaemia in women of reproductive age. A Review in Ababaiya and Gabriel (2014:746) also witness the public health significance of anaemia in the country estimating the prevalence to range between 23%-66.5%.

Iron deficiency may result from inadequate iron intake and absorption, increased iron requirements during growth, and excessive iron losses. Dietary factors play a major role in the development of iron deficiency and the subsequent development of iron-deficiency anaemia (Beck et al 2014:3748). At least half of the global anaemia burden is assumed to be due to iron deficiency (Burke et al 2014:4096; WHO 2012a:1). Iron deficiency is solely or partly responsible for 75%-80% of all anaemia in women of reproductive age (Milman 2015:2) and for more than half of anaemia cases in pregnancy (WHO 2015:5).

Other most common risk factors related to iron-deficiency anaemia identified in different studies are hookworm infection, malaria, heavy menstrual blood loss, multiparty, illiteracy, lack of awareness, negligence, poor economy, food insecurity, lack of food diversity, changes in dietary behaviour, cultural behaviours, poor health and sanitation and vegetarian eating habits (Adhikari, Koirala, Lama & Dahal 2012:184; Camaschella 2015:1833). Okube et al (2016:23) show that maternal age, employment status, nutritional status (MUAC) and iron-folic acid supplementation during current pregnancy remained significantly and independently associated with anaemia among studied Kenyan pregnant women.

Analogous to the global circumstances, various studies in Ethiopian have also documented these independent predictors of anaemia. Gebremedhin et al (2014b:47-51) report iron deficiency as the most common cause of anaemia in the country. Anaemia is more prevalent among women who have had six or more births and the prevalence decreases with increasing women's education and household wealth (CSA Ethiopia & ICF 2016:199).

Gravidity, mother's age, family size, iron supplementation, mid-upper arm circumference of less than 23cm and body mass index were significant predictors associated with anaemia among pregnant women in Jijiga, East Ethiopia (Bereka et al 2017:5). Derso et al (2017:4) also found latrine availability, household monthly income, iron supplementation and nutritional status to be significantly and independently associated factors of anaemia; while Bekele et al (2016:5) report factors like monthly income, family size, birth interval, iron tablet supplementation and eating food made from "Enset" and its products.

Gedefaw et al (2015:158) show younger age of 15-24 years, family size greater than five, multigravida, having low income, current clinical illness, intestinal parasitic infection, no history of contraceptive usage, being in third trimesters, history of excessive menstrual bleeding and low body mass index as independent predictors of anaemia among pregnant women in Southern Ethiopia. While Alem et al (2013:140) also indented factors like rural residence, history of malaria attack, hookworm infection and absence of iron supplements to be significantly associated with increased risk of anaemia in northwest Ethiopia.

4.2.6. Maternal haemoglobin level and anaemia prevalence at end of the intervention

By the end of the intervention, as displayed in table 4.3, the overall mean haemoglobin level of the studied pregnant women in Dire Dawa was 9.84 ± 0.08gm/dl. Controlling for baseline differences, the mean haemoglobin level of pregnant women in intervention group 1 and intervention group 2 was 10.26 ± 0.15gm/dl and 9.9 ± 0.13gm/dl respectively, while the control group had 9.36 ± 0.07gm/dl. The intervention groups had statistically significant differences in their haemoglobin levels by the end of the intervention (p=0.00). Intervention group 1 had significantly higher haemoglobin level compared to intervention group 2 (p=0.04) and the control (p=0.00) and their differences were by 0.361 ± 0.17gm/dl and 0.90 ± 0.17gm/dl respectively. Intervention group 2 had 0.54 ± 0.17gm/dl significantly higher mean haemoglobin level than the control.

Results of the paired-sample t-test for change in mean haemoglobin level from enrolment and by end of the intervention for each group is displayed in table 4.3. From the result, the overall mean haemoglobin level of the studied pregnant women in Dire Dawa significantly increased by 0.322 ± 0.056gm/dl from the enrolment level. Intervention group 1 and intervention group 2 also had significantly increased haemoglobin level at the end (p=0.00). The difference from enrolment level for intervention group 1 was 0.77 ± 0.11gm/dl and for intervention group 2 was 0.398 ± 0.073gm/dl. However, the mean haemoglobin had significantly decreased by -0.193 ± 0.05gm/dl in the control group.

Table 4.3 Haemoglobin level of pregnant women at enrolment and end of intervention in RCT Dire Dawa, 2018

Variable		Intervention group			Total	*P value*
		Int grp 1 n = 61	Int grp 2 n= 62	CG n = 63	n = 186	
Hemoglobin gm/dl	Baseline	9.49 ± 0.07	9.50 ± 0.08	9.56 ± 0.08	9.52 ± 0.04	0.83
	End	10.26 ± 0.15	9.9 ± 0.13	9.36 ± 0.07	9.84 ± 0.08	0.00
	Change	0.77 ± 0.11	0.39 ± 0.07	-0.19 ± 0.05	0.32 ± 0.06	0.00
	Int grp 1 difference		0.361 ± 0.17	0.90 ± 0.17		0.04, 0.00
	Int grp 2 difference			0.54 ± 0.17		0.00

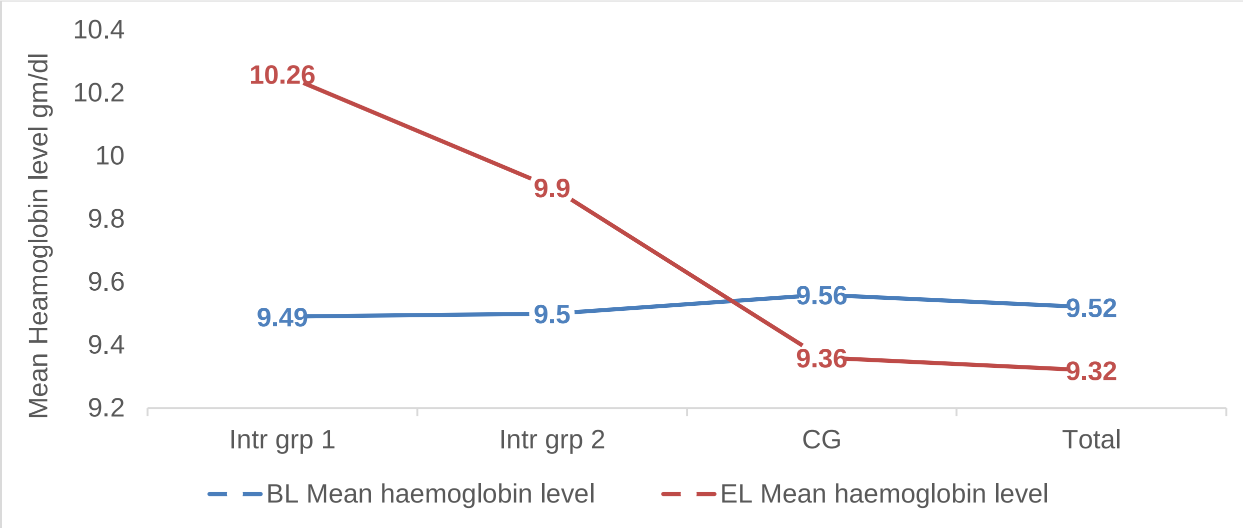


Figure 4.2 Mean plot of haemoglobin level of pregnant women at baseline and end of intervention in RCT, Dire Dawa 2018.

Concerning the anaemia level at the end of the intervention, the prevalence of anaemia in the study participants was 84% which significantly decreased by 16% from baseline (figure 4.3). About 119 (64%) women had mild anaemia, while 37 (19%) women were moderately anaemic (figure 4.4). The level of anaemia significantly differs across the groups. About 18 (29%) women in intervention group 1 and 12 (19.7%) women in intervention group 2 were not anaemic (Hg >10.9 g/dl) by the end of the intervention. However, all women in the control group were still anaemic (Hg <11.0 g/dl) (figure 4.3). Besides, the level of anaemia (p=0.45), and proportion of non-anaemic women (p=0.23) did not significantly differ between intervention group 1 and intervention group 2.

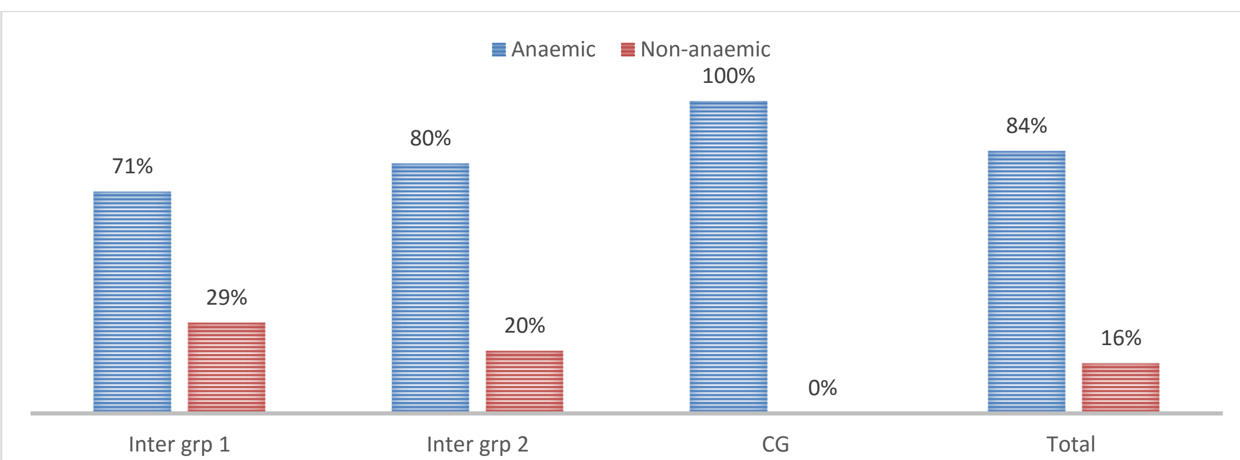


Figure 4.3 End-line prevalence of anaemia of pregnant women in RCT, Dire Dawa 2018

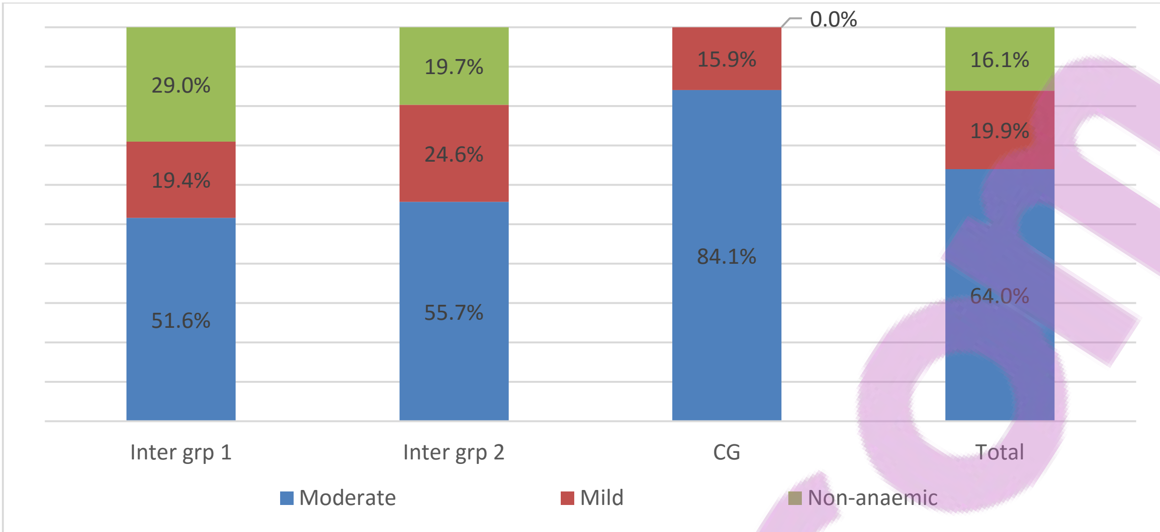


Figure 4.4 End-line level of anaemia of pregnant women in RCT, Dire Dawa 2018

4.2.7. Maternal dietary preference and dietary diversity during pregnancy

Pregnancy is the vital period in life when the overall nutrient requirements are increased to meet high demands of both the growing foetus and the mother's (Darnton-Hill & Mkparu 2015:1747; Milman 2015:3; Sharlin & Edelstein 2011:4). The consumption of more food to meet energy needs and the increased absorption and efficiency of nutrient utilization that occurs in pregnancy is generally adequate to meet the needs for most nutrients when good food choices are made (Kaiser & Campbell 2014:8).

However, the majority of the pregnant women 100 (53.8%) in this study did not change their dietary practices from their pre-pregnancy dietary consumption pattern after they knew they were pregnant. If any changes were made, still the majority of the women decreased either their meal portion or/and diversity during their pregnancy. From those women who changed dietary practices, 48 (55.8%) of the women decreased either their meal portion or/and diversity from their pre-pregnancy and only 17 (19.8%) reported increasing meal frequency, portion and diversity. Likewise, Daba et al (2013b:109) and Alemayehu and Tesema (2015:710) showed that 35.8% and 40% of pregnant women avoiding food during their pregnancy. Conversely, some dietary studies before and during pregnancy have shown that most women do not change their diet diversity significantly when they become pregnant (FAO & WHO 2001:10; Milman 2015:3).

Staple foods (grains and cereals) dominate the dietary preference after a pregnancy of the studied pregnant women in Dire Dawa. Common food group preferably added during the pregnancy were cereals and pulses (61.8%) followed by dairy products (42.4%). The common food group less preferred and reduced during the pregnancy was meat/fish (26.3%) followed by nuts and seeds (21%).

Supplemental qualitative data was analysed from 22 study pregnant women on their dietary preferences during pregnancy. Almost all of the foods preferred during pregnancy were made of cereals mainly ‘engera’ (made from a combination of Tef and Sorghum/maize), wheat bread, pasta and macaroni. Commonly preferred sauce/ stew/ wot which accompany engera and bread were “abish wot”, potato wot, and shiro wot. These foods were preferred as they were considered to give more energy, easily afforded and due to their cultural values. The other preferred food group was fruits and vegetables. Fruits and vegetables were taken to be palatable easily digested and good to self-treat nausea. Milk was the other preferred kind mainly due to its acceptance for improvement of bone growth of the foetus. Foods less preferred during pregnancy were eggs, fatty meat/ oily dishes and spicy foods. The aroma and taste of these foods, as the mothers reported, would induce nausea and vomiting.

At the baseline interviews, not part of the 24-hour dietary recall, 94 (50.5%) of the pregnant women reported that vitamin C-rich fruits and vegetables (VCRFVs) were commonly part of their diets. However, only 16 (17%) reported that they commonly consumed vitamin C-rich fruits and vegetables together with other dishes during meal times, while the rest 78 (83%) usually consumed hours before or after. Less than about 20% in each intervention group took vitamin C-rich fruits and vegetables together with other dishes during meal times and the difference was insignificant among the three groups (p=0.73).

About 26.9% (50) of the pregnant women never took tea/ coffee during their pregnancy period, of whom 26% were in intervention group 1, 25% were in intervention group 2 and 30% were in the control group. The women in the three intervention groups did not significantly vary in their preference of tea/coffee intake at baseline (0.76). About 40.9% (76) of women had the usual intake (for more than five days of a week). Among the mothers with tea/ coffee intake, majority 114 (83%) of the mothers commonly preferred to and took tea/ coffee immediately after/before or together with meals. Only 22 (17%) avoided taking those drinks within 2 hours of mealtime. About 13% (6) and 20% (9) in intervention group 1 and intervention group 2 avoided taking those drinks within 2 hours of mealtime and the difference among the intervention groups was insignificant at baseline (p=0.50). The summery in table 4.4 shows that the intervention groups had no significant difference at baseline in the dietary preferences.

Table 4.4 Baseline dietary preference of pregnant women in RCT, Dire Dawa 2018

Variable		Intervention groups			Total	*P value*
		Int grp 1 n (%)	Int grp 2 n (%)	CG n (%)	n (%)	
Dietary change since pregnancy	No	29 (47)	33 (54)	38 (60)	100 (54)	0.32
	Yes	33 (53)	26 (46)	25 (40)	86 (46)	
Usually, eat VCRF since pregnancy	No	29 (47)	28(46)	35 (56)	94 (51)	0.49
	Yes	33 (53)	33 (54)	28 (44)	92 (49)	
VCRF intake with a meal	No	26 (79)	28 (85)	24 (86)	78 (83)	0.73
	Yes	7 (21)	5 (15)	4 (13)	16 (17)	
Tea/coffee intake +/-2hr mealtime	No	41 (87)	36 (78)	37 (84)	114 (83)	0.50
	Yes	6 (13)	9 (20)	7 (24)	22 (17)	

4.2.8. Maternal past 24-hours and 7-days dietary diversity during pregnancy

At enrolment, the overall mean of Meal Consumption Frequency (MCF) per day for the past 24-hours of the studied pregnant women was 3.02 ± 0.07 per day. The mean MCF in intervention group 1 was 3.13 ± 0.10, in intervention group 2 was 3.10 ± 0.11, and in the control was 2.82 ± 0.13 (table 4.7). Majority of the studied women (74.8%) testified that 24-hours prior to the interview, from day to night, they consumed meals 3 per day at breakfast, lunch and dinnertime. Only 3.8% and 1.6% replied for once and six times meals consumption per day respectively. The reported 24-hours MCF and consumption practice were as the usual days for 182 (97.8%) of the women.

The baseline findings of the present study also showed that both the past 24-hours (table 4.5) and past 7-days (table 4.6) dietary diversity of the pregnant women in Dire Dawa was dominated by cereals, other vegetables and pulses. The past 24-hours dietary diversity of the pregnant women in Dire Dawa was dominated by grains/cereal foods (98.9%) and other vegetables (81.7%). About 51% and 33% of the women consumed dairy products and pulses respectively. Food groups consumed less were nuts/seeds (6.5%) and eggs (13%) respectively. Iron-rich food groups (meat/fish) were consumed by 24% of the women, while dark green leafy vegetables (DGLVs) were by 25% and other vitamin A-rich fruits and vegetables (OVARFVs) by 25%. Other fruits (OFs) and other vegetables (OVs) were consumed by 20% and 82% of the women respectively. At baseline, consumptions of the specific food groups were not statistically different across the intervention groups except for nuts (p<0.05) (table 4.5).

Table 4.5 Past 24-hours dietary diversity for consumption of specific food group by pregnant women in RCT, Dire Dawa 2018

Variable		Intervention group			Total n = 186	*P value*
		Int grp 1 n = 61	Int grp 2 n= 62	CG n = 63		
			%			
Staple foods	Baseline	100	100	97	99	0.14
	End	100	97	100	100	0.14
Pulses	Baseline	36	28	37	33	0.54
	End	69	64	43	59	0.01
Nuts	Baseline	7	12	2	7	0.08
	End	15	23	2	13	0.00
Dairy	Baseline	44	51	57	51	0.32
	End	50	54	53	53	0.87
Flesh foods	Baseline	23	26	22	24	0.85
	End	31	44	28	34	0.14
Egg	Baseline	21	10	8	13	0.07
	End	18	25	11	18	0.15
DGLVs	Baseline	36	18	21	25	0.05
	End	74	61	24	53	0.00
OVARFVs	Baseline	29	25	24	26	0.77
	End	86	67	40	64	0.00 (0.02)
OVs	Baseline	77	90	78	82	0.11
	End	95	93	84	91	0.07
OFs	Baseline	24	25	13	20	0.17
	End	100	85	21	68	0.00

The intervention participants were also assessed for their past 7-days food frequency consumption and diversity (table 4.6). In addition to the 10 food groups analysed in the 24-hour dietary recall, the consumption of tea/coffee/cola was also included. Accordingly, the past 7-days dietary diversity of the women were dominated by grain/cereals with a mean consumption of 5.94 ± 0.13 days. The mean day of consumption was lowest for nuts/ seeds. The mean frequency intake of dark green leafy vegetables and other fruits was 2.01 ± 0.11 and 1.9 ± 0.11 days respectively. Meat groups (iron-rich foods) were consumed on average for 1.20 ± 0.10 days of the week. The result also revealed that tea/coffee/cola was consumed on average for 4.73 ± 0.16 days of the week.

These findings regarding the dietary diversity the pregnant women are consistent with the 2013 Ethiopia National Food Consumption Survey (Ethiopian Public Health Institute 2013:20) which also showed that 66.8% women's total diet in Dire Dawa came from cereals/grains group, while proportion of flesh foods (1.8%), and fruits and vegetables (1.8%) is low (Macro 2006:149 & 154). Consistent findings were also reported in other regions of Ethiopia. Dietary diversity assessment using 24-hours dietary recall method in southern Ethiopia also reported that 52.5% of the assessed pregnant mothers had cereal-based foods, while 83.5% had no animal source foods (Sonko 2016:6).

Pregnant women nutritional status had a positive linear relationship with the intake of diversified diet (Ndung'u & Nyanchoka 2018:2019). Nutritional iron deficiency is common in populations consuming monotonous plant-based diets and where very little iron-rich foods such as animal source foods are consumed (Zimmermann & Hurrell 2007:512). Plant sources such as wholegrain cereals (legumes, corn, wheat, barley, and others) and dairy products are known sources of non-heme iron (Aspuru et al 2011:4278; Geissler & Singh 2011: 295; Hurrell & Egli 2010:1461); and do not contain heme iron (Saunders et al 2012:11). Such foods are also sources of inhibitors of iron absorption mainly phytic acid and polyphenols like tannic and chlorogenic acids (Geissler & Singh 2011:295; Hurrell & Egli 2010:1462; Kaiser & Campbell 2014:8; Lo¨nnerdal 2009:1680; WHO 2001:50).

Furthermore, adequate nutritional status and good dietary intake during preconception and pregnancy are recognized as major contributors to healthy birth outcomes (Tseng & Ahmed 2013:1337). Optimal outcomes and consequences of antenatal nutritional deficiencies can also be devastating with profound effects on future generations as well (Darnton-Hill & Mkparu 2015:1745). Zerfu, et al (2016a:1484) reported that pregnant women with adequate dietary diversity had significantly higher weight, higher weight gain and gave birth to heavier babies. Umeta et al (2008:157) conclude that non-heme iron source from the staple diets may account for the high prevalence rate of anaemia, iron deficiency and iron deficiency anaemia among women of reproductive age in Ethiopia.

These should, therefore, pose the concern if pregnant women in Dire Dawa enter pregnancy with the best possible macronutrient and micronutrient status, especially with appropriate intake of iron, which may favour for improved pregnancy outcomes. The review in Tseng and Ahmed (2013:1337) also conclude that the problems of unbalanced macronutrient profiles and multiple micronutrient deficiencies are common among pregnant women in developing countries.

By the end of the intervention, as shown in table 4.5 and table 4.6, the past 24-hours and past 7-days dietary diversity with respect to the consumption of specific food groups did not statistically differ between intervention group 1 and intervention group 2. Nevertheless, the control group had lesser consumption of cereals, pulses, nuts, dark green leafy vegetables, vitamin A-rich FVs and other fruits compared to the other two groups ($p<0.05$).

The results, therefore, show that the food-based interventions of this randomized controlled trial were effective in improving the consumption of specific food groups during pregnancy among pregnant women in Dire Dawa.

Table 4.6 Past 7-days dietary diversity for mean days consumption of specific food group by pregnant women in RCT, Dire Dawa 2018

Variable		Intervention group: Int grp 1 n = 61	Int grp 2 n= 62	CG n = 63	Total n = 186	*P value*
		Mean ± SE				
Staple foods	Baseline	6.1 ± 0.1	6.7 ± 0.1	5.1 ± 0.3	5.9 ± 0.1	0.00
	End	6.4 ± 0.1	6.6 ± 0.1	5.1 ± 0.3	6.1 ± 0.1	0.00
Pulses	Baseline	2.4 ± 0.2	2.8 ± 0.2	1.1 ± 0.2	2.1 ± 0.1	0.00
	End	3.4 ± 0.1	4.1 ± 0.2	1.3 ± 0.2	2.9 ± 0.1	0.00
Nuts	Baseline	0.9 ± 0.1	1.5 ± 0.2	0.54 ± 0.2	0.98 ± 0.1	0.001
	End	1.8 ± 0.2	3.6 ± 0.2	0.5 ± 0.2	2.9 ± 0.2	0.00
Dairy	Baseline	2.5 ± 0.2	3.2 ± 0.2	3.1 ± 0.3	2.9 ± 0.1	0.07
	End	3.4 ± 0.2	3.7± 0.1	3.3 ± 0.2	3.1 ± 0.1	0.06
Flesh foods	Baseline	1.2 ± 0.1	1.3 ± 0.2	1.1 ± 0.2	1.2 ± 0.1	0.66
	End	1.3 ± 0.2	2.4 ± 0.2	1.1 ± 0.2	1.6 ± 0.1	0.00
Egg	Baseline	0.97 ± 0.1	1.4 ± 0.2	1.5 ± 0.2	1.3 ± 0.1	0.06
	End	1.08 ± 0.2	1.05 ± 0.2	1.04 ± 0.2	1.03 ± 0.1	0.14
DGLVs	Baseline	2.3 ± 0.2	1.8 ± 0.2	1.95 ± 0.2	2.0 ± 0.1	0.20
	End	5 ± 0.1	4.5 ± 0.1	1.4 ± 0.2	3.6 ± 0.1	0.00
OVARFVs	Baseline	2.3 ± 0.2	1.9 ± 0.2	1.8 ± 0.2	2.0 ± 0.1	0.07
	End	4.6 ± 0.1	4.5 ± 0.1	1.3 ± 0.2	3.5 ± 0.1	0.00
OVs	Baseline	4.7 ± 0.1	4.5 ± 0.2	5.0 ± 0.2	4.8 ± 0.1	0.09
	End	5.5 ± 0.1	4.8 ± 0.2	3 ± 0.3	4.4 ± 0.1	0.00
OFs	Baseline	2.2 ± 0.2	1.9 ± 0.1	1.6 ± 0.2	1.9 ± 0.1	0.10
	End	5.6 ± 0.1	5.2 ± 0.2	1.4 ± 0.2	4.1 ± 0.2	0.00
Tea/coffee	Baseline	5.3 ± 0.2	4.5 ± 0.3	4.4 ± 0.3	4.7 ± 0.2	0.06
	End	2.7 ± 0.1	2.6 ± 0.2	3.5 ± 0.4	2.9 ± 0.1	0.03
	Change	-2.6 ± 0.1	-1.9 ± 0.1	0.9 ± 0.2	-1.8 ± 0.1	0.00

4.2.9. Effect of nutrition education on maternal dietary diversity during pregnancy

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is a proxy for nutrient adequacy of the diet of individuals too (Kennedy et al 2013:5). Increased dietary diversity is associated with increased household access to food as well as the increased individual probability of adequate micronutrient intake (FAO 2014:284).

Dietary diversity is measured as the number of individual food groups consumed over a given reference period (FAO 2014:284). Dietary diversity scores are simple counts of the number of food groups consumed at the individual or household level (FAO 2014:286). The FAO recommends a reference period of the previous 24 hours (Kennedy et al 2013:10). Data collected using the dietary diversity tool can then be analysed in several different ways to provide a picture of dietary patterns within a community as well as among vulnerable groups (FAO 2014:284). An analysis of dietary diversity by subgroups of a population allows the setting of measurable targets for improvement for the group with the lowest dietary diversity. Likewise, the dietary profile of the higher tertile of dietary diversity can be used as a target to be reached by all pregnant women to increase their level of iron-rich food groups (FAO 2014:285-89).

The baseline findings of the present study showed that the overall past 24-hour mean of the Minimum-Dietary Diversity Score of Women (M-DDSW) for pregnant women in Dire Dawa was 3.78 ± 0.1. The highest and lowest M-DDSW was one (2.2%) and seven (2.7%) respectively. The mean M-DDSW was 3.95 ± 0.15 for intervention group 1; 3.84 ± 0.16 for intervention group 2 and 3.57 ± 0.18 for the control (table 4.7).

Table 4.7 Past 24-hour dietary diversity of pregnant women in RCT, Dire Dawa 2018

Variable		Intervention group			Total	*P value*
		Int grp 1 n=61	Int grp 2 n=62	CG n=63	n=186	
24-hours MCF	Baseline	3.13 ± 0.10	3.10 ± 0.11	2.82 ± 0.13	3.02 ± 0.07	0.11
	End	3.06 ± 0.04	3.13 ± 0.12	2.9 ± 0.12	3.03 ± 0.05	0.18
M-DDSW	Baseline	3.95 ± 0.15	3.84 ± 0.16	3.57 ± 0.18	3.78 ± 0.1	0.24
	End	6.37 ± 0.16	6.23 ± 0.19,	3.81 ± 0.14	5.46 ± 0.13	0.00
	Change	2.42 ± 0.14	2.39 ± 0.24	0.24 ± 0.13	1.7 ± 0.12.	0.00 (0.07)

When the M-WDDS was further categorized, the past 24-hours dietary diversity of the majority of the intervened pregnant women was low (figure 4.5). About 71.5% of the pregnant women had “low dietary diversity” (M-WDDS <5) and 28.5% had “high dietary diversity” (M-WDDS 5+). About 68% of the participants in both intervention group 1 and intervention group 2 had “low dietary diversity” respectively; while in the control group were 79% at enrolment (figure 4.4). At baseline, the women in the M-WDDS category had no significant difference among the groups (p=0.24) (table 4.8).

A consistent finding was also reported by a study in the northeast region of Ethiopia, which showed 59.9% of pregnant women of had poor dietary practice (Alemayehu & Tesema 2015:710). Daba et al (2013b:109) also showed that about 67% of pregnant women in west-eastern Ethiopia had poor dietary practice.

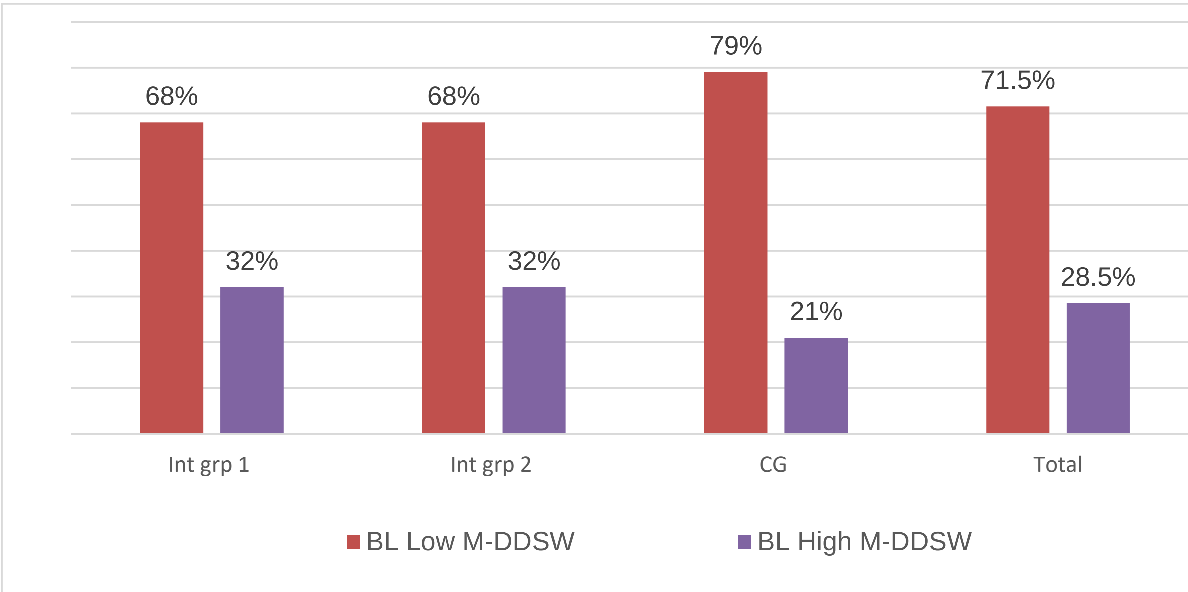


Figure 4.5 Baseline dietary diversity level of pregnant women in RCT, Dire Dawa 2018

Findings of this study by the end of the intervention show that nutrition education intervention has a positive effect in improving dietary diversity of pregnant women in Dire Dawa. By the end of the 12 weeks intervention, both the past 24-hours and 7-days dietary diversity of the pregnant women showed significant differences across the intervention groups and the changes from their baselines were significant except for the control group as depicted in table 4.7, 4.8 and figure 4.6.

Though the past 24-hours mean MCF per day showed no statistical difference across the groups at end-line (p=0.18) and the change was insignificant from the baseline (p=0.71). The overall past 24-hours mean MCF was 3.03 ± 0.69 (table 4.5). Majority of the women (98.9%) still reported that their 24-hours MCF and diversity were as the usual days.

Table 4.7 summarizes the Minimum Dietary Diversity Score of Women for past 24-hours during the intervention periods. The overall past 24-hours mean M-DDSW at end line significantly increased to 5.46 ± 0.13 and had significant difference among the intervention groups (p=0.00). Mean M-DDSW by the end-line in intervention group 1 was 6.37 ± 0.16 and in intervention group 2 was 6.23 ± 0.19, while for the control was 3.81 ± 0.14. Both intervention group 1 and intervention group 2 had significantly higher mean M-DDSW than the control (p=0.00). Intervention group 1 had 2.56 ± 0.23 higher mean M-DDSW than the control and intervention group 2 had 2.42 ± 0.23 higher mean M-DDSW than the control. However, the difference was insignificant between intervention group 1 and intervention group 2 at end-line (p=0.54).

Paired-samples T-tests were used to compare the changes from the respective baseline figures for each intervention group. Compared to the baseline value, overall past 24-hours mean minimum dietary diversity of women score of pregnant women significantly increased by 1.7 ± 0.12. The past 24-hours mean M-DDSW significantly increased from baseline by 2.42 ± 0.14 and 2.39 ± 0.24 in intervention group 1 and intervention group 2 respectively with p-values of 0.00. However, the change was insignificant in the control group (p=0.07). Besides, the correlation of the change was significant at p-value of 0.00 for intervention group 1 (correlation coefficient =0.6) and control (correlation coefficient =0.83), but not for intervention group 2 (p=0.59).

Furthermore, as shown in table 4.8, intervention group 1 and intervention group 2 had a significantly higher proportion of women who had “high dietary diversity” than the control at end of the intervention (p=0.00). About 90% and 79% of women in intervention group 1 and intervention group 2 had “high dietary diversity” respectively, while the proportion was 22% in the control. About 78% of women in the control group were still in the “low dietary diversity” at the end line. Moreover, intervention group 1 also had a significantly higher proportion of women in the “high dietary diversity” category compared to intervention group 2 by the end of the intervention (p=0.04).

In comparison to enrolment, the proportion of women who had “high dietary diversity” significantly increased by 58% in Intervention group 1 and 46% in intervention group 2. However, the change was insignificant for women in the control group. At enrolment, about 32% of the participants both in intervention group 1 and in intervention group 2 had “high dietary diversity” respectively; while in the control group were 21% (table 4.8).

The possible explanation for the observed higher difference in intervention group 1 than in intervention group 2 in the proportion of pregnant women with high dietary diversity could generally be attributed to the additional intervention of dietary-based vitamin C supplementation to intervention group 1. Further detailed explanations are discussed under section 4.3.15, which elaborate that combined dietary intervention through food-based strategy is more effective in improving dietary diversity than nutrition education intervention alone.

Table 4.8 Dietary diversity level of pregnant women at baseline and end of intervention in RCT, Dire Dawa 2018

Variable		Intervention group				
		Int grp 1 n = 62	Int grp 2 n= 61	CG n = 63	Total n = 186	*P value*
		n (%)				
M-DDSW	BL Low M-DDSW	42 (68)	41 (68)	50 (79)	133 (71.5)	0.24
	EL Low M-DDSW	6 (10)	13 (21)	49 (78)	68 (37)	0.00
	BL High M-DDSW	20 (32)	20 (32)	13 (21)	53 (28.5)	0.24
	EL High M-DDSW	56 (90)	48 (79)	14 (22)	118 (63)	0.00
	Change	58%	46%	-	42.5%	0.04

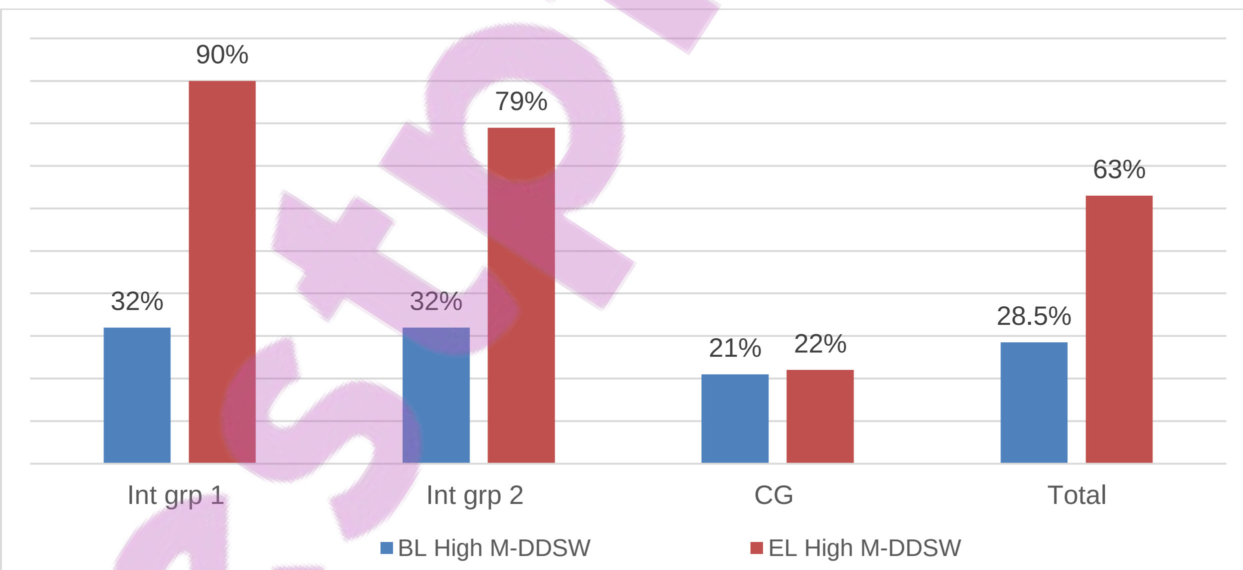


Figure 4.6 Pregnant women with high dietary diversity at baseline and end of intervention in RCT, Dire Dawa 2018

The observed positive effect of nutrition education on improving maternal dietary diversity during pregnancy in Dire Dawa is also consistent with findings of other interventional studies. Zelalem (2017:6-7) reported that while the pregnancy-specific dietary practice of the pregnant women in Adiss Ababa, Ethiopia significantly increased from 46.8% to 83.7% after nutrition education intervention. ElHameed et al (2012:1216) concluded that nutritional educational significantly increased knowledge related practice toward healthy nutritional habits among rural pregnant women with iron-deficiency anaemia. Al-Tell et al (2010:112-16) showed that nutrition education has significant relationship changes in dietary practices of pregnant women.

Another interventional study conducted among adolescent girls (Alaofe et al 2009:30; Bhanushali et al 2011:41; Rao et al 2007:1083) and primary school pupils (Gitau et al 2013:121) also resulted in the significant positive effect of nutrition knowledge on dietary practices and nutrient intakes. Although the cross-sectional design was employed, Alemayehu and Tesema (2015:710) showed that nutrition information and dietary knowledge have a positive significant relationship with dietary practices of pregnant mothers in Northeast Ethiopia.

4.2.10. Effect of nutrition education on the consumption of vitamin C-rich foods

At baseline, consumptions of the specific food groups were not statistically different across the intervention groups ($p>0.05$) as shown in table 4.5. By the end intervention (table 4.5), the study groups had a significant difference in their past 24-hours consumption of another vitamin A-rich FVs, dark green leafy vegetables and other fruits. The proportion of women who consumed these food groups in the past 24-hours hours were significantly higher in intervention group 1 and intervention group 2 than the control group.

All of the women in intervention group 1 (100%) and 85% in intervention group 2 consumed other fruits in the past 24-hours. About 74% and 61% consumed dark green leafy vegetables and about 86% and 67% consumed another vitamin A-rich FVs in intervention group 1 and intervention group 2 respectively. In contrast to enrolment, the difference in the consumption of other fruits, another vitamin A-rich FVs and dark green leafy vegetables significantly increased for women in both intervention group 1 and intervention group 2. However, the change from enrolment was insignificant for all food groups for the women in the control group (table 4.5). Coming to the past 7-days dietary diversity at end-line, women in intervention group 1 and intervention group 2 also had significantly higher mean days of consumption OFs, another vitamin A-rich FVs and dark green leafy vegetables than the control group at end-line (table 4.6).

Other fruits, other vitamin A-rich fruits and vegetables and dark green leafy vegetables food groups are good sources of vitamin C (FAO & FHI 360 2016:15-16). Fruit and vegetables are good sources of vitamin C, and about 90% of the daily intake in the general population comes from these sources (Lykkesfeldt et al 2014:17). Citrus fruits, mango, and vegetables such as broccoli, tomatoes, and peppers are all rich sources of vitamin C. Other foods which are good sources of vitamin C include tomatoes, strawberries, melons, and potatoes (Clifford et al 2015:2).

Therefore, the proportion of pregnant women in this randomized controlled trial who consumed vitamin C-rich FVs in the past 24-hours hours and 7-days were significantly higher in intervention group 1 and intervention group 2 than the control group, as their consumption was higher for other fruits, other vitamin A-rich fruits and vegetables and dark green leafy vegetables.

One of the other noticeable findings of this study was that the consumption of vitamin C-rich FVs was significantly higher in intervention group 1 than intervention group 2 at end of the intervention. Intervention group 1 had 15% and 19% higher proportion of women than intervention group 2 who consumed OFs (p=0.00) and other vitamin A-rich fruits and vegetables (p=0.02) in past 24-hours. For the past 7-days consumption, intervention group 1 had higher mean consumption days for other fruits (p=0.04) and dark green leafy vegetables (p=0.01) too.

This difference between intervention group 1 and intervention group 2 is also consistent with the previous result shown in section 4.3.9, which also showed that intervention group 1 had a significantly higher proportion of women in the "high dietary diversity" category compared to intervention group 2 by the end of the intervention. Yet again, the possible explanation for this difference between the two intervention groups could be due to the addition of vitamin

C-rich fruit juice supplementation intervention to intervention group 1. Further detailed explanations are also discussed in section 4.3.15 attributing the difference to the effect of food-based strategy. Zerfu et al (2016a:1484) also showed that pregnant women with adequate women dietary diversity scores (consumption of more than 4 food groups) consistently consumed more fruit and vegetables.

This study can thus collaborate that, the nutrition education intervention was effective in increasing the consumption of vitamin C-rich foods during pregnancy among pregnant women in Dire Dawa. Pregnant women in intervention group 1 and intervention group 2 had a significantly higher consumption of C-rich foods than the control group in both the past 24-hours and 7-days dietary intake. This study also elaborate that combined dietary intervention through food-based strategy is more effective in improving consumption of vitamin C-rich foods during pregnancy among pregnant women in Dire Dawa than nutrition education intervention alone, as pregnant women in intervention group 1 had a significantly higher consumption of C-rich foods than intervention group 2.

Consistent with the findings of this randomized controlled trial study, nutrition education intervention for 3 months among pregnant women in Nigeria also reported that there were significant effects of the intervention on the knowledge of the women on the importance of fruits and vegetable consumption. The findings also revealed a positive effect of the intervention as the pregnant women apparently consumed more fruits and vegetables than they were doing before the intervention (Okueso & Anetor 2016:9-10). Although conducted among adolescent girls, a quasi-experimental study in Southern Benin also showed that nutrition knowledge scores and mean intakes of nutrients and vitamin C were significantly higher in the intervention group than in the control group (Alaofe et al 2009:30).

However, the researcher identified no past intervention study which analysed the effect of nutrition education on the consumption of vitamin C-rich foods during pregnancy in Ethiopia.

4.2.11. Effect of nutrition education on consumption of iron-rich foods during pregnancy

Dietary iron can be found in two forms: heme iron and non-heme iron. Heme iron is contained in haemoglobin or myoglobin and is derived almost exclusively from animal source foods like meat, fish, and seafood. Non-heme iron (especially ferric salts) is most frequently found in plant sources (Aspuru et al 2011:4278; Geissler & Singh 2011: 295; Hurrell & Egli 2010:1461, Saunders et al 2012:11). Heme iron is relatively bioavailable with 20%-30% being absorbed, while the absorption of non-heme iron is much more variable with 1%-10% of it is absorbed (Beck et al 2014:3752). The iron in meat is about 40% heme and 60% non-heme (Clifford et al 2015:2).

Even though, as discussed in the previous section, pregnant women in intervention group 1 had significantly higher consumption of another vitamin A-rich FVs and dark green leafy vegetables food groups; which are good sources of folate (FAO & FHI 360 2016:15-16), this study found no significant difference in the proportion of women with past 24-hours consumption of meat/ fish (iron-rich foods) among the 3 groups by the end of the intervention (p=0.14) (table 4.5). About 69% of women in intervention group 1, 56% in intervention group 2 and 71% in the control did not consume meat/ fish (iron-rich foods) in the past 24-hours. FAO (2014:20) and Zimmermann and Hurrell (2007:515) also collaborate that foods that provide highly bioavailable iron (such as meat) are expensive and change in their dietary practices and preferences is usually difficult to attain. The qualitative result of this study, as discussed in section 4.3.17, also complements that most of the interviewed pregnant women consider meat/fish to be expensive for pregnant women in Dire Dawa.

However, intervention group 2 had a significantly higher mean consumption of meat (iron-rich foods) during past 7-days by the end of the intervention (p=0.00) (table 4.6). The mean was significantly higher than intervention group 1 by 1.1 ± 0.28 and 1.33 ± 0.28 higher than the control. This higher consumption of meat may possibly also explain the observed increment of haemoglobin in intervention group 2. Other studies also observed a positive association between iron status and meat or heme iron intake. Reddy et al (2006:578) also reported the positive association of iron status with meat. FAO and WHO (2001:202) suggest that adding a small portion (50gm) of meat, poultry, or fish will increase the total iron content as well as the amount of bioavailable iron for most staple diets thus lowering prevalence of iron deficiency.

This finding of the study thus further consolidate the conclusion that the nutrition education intervention was effective in increasing the consumption of mean consumption of meat/ fish (iron-rich foods) among pregnant women in Dire Dawa and can play a significant role in the prevention and control of iron deficiency and anaemia through food-based strategies. Bosaeus et al (2015:12) also reported that dietary education increased intake of iron-rich foods like fish. The quasi-experimental study among adolescent girls also showed that nutrition knowledge scores and mean intakes of nutrients, including dietary iron and absorbable iron, were significantly higher in the intervention group than the control group (Alaofe et al 2009:30). Nevertheless, the researcher identified no past intervention study, which analysed the effect of nutrition education on consumption of iron-rich foods during pregnancy in Ethiopia.

4.2.12. Effect of nutrition education on maternal dietary modification behaviours during pregnancy

The two main measures suggested for improving dietary intake of iron bioavailability are reductions of dietary factors inhibiting iron absorption or/and increasing dietary factors with enhancing effects (Camaschella 2015:1835; FAO 2014:22; Hoppe et al 2008:768). The bioavailability of non-heme iron is influenced by various dietary components that either enhance or inhibit its absorption (Clifford et al 2015:12). The intake of dietary enhancers and inhibitors of iron absorption in relation to dining time or together with foods containing non-heme iron thus affects the amount of bioavailable iron.

Tannins found both in tea and coffee adversely affect iron availability. Coffee and tea consumption at times of meals can significantly decrease iron absorption. Tea can cause iron absorption to drop by 60% and coffee can cause a 50% decrease in iron uptake (Clifford et al 2015:2). Drinking tea or coffee within two hours of eating meals should thus be avoided (FAO 2011:280). Tea or coffee should also be consumed separately from iron-fortified foods and iron supplements (Kaiser & Campbell 2014:8). To have an enhancing effect, foods rich in vitamin C must be taken together with foods containing iron (Clifford et al 2015:2).

Pregnant women should thus be promoted to modify their dietary behaviours in the intake of tea/coffee and vitamin C-rich foods; to avoid the intake of tea/coffee together with meals and increase the intake of vitamin C-rich foods together with meals. Hoppe et al (2008:765) agree that the daily average percentage of iron absorption from diet increases almost eightfold after the dietary modifications; and when considering a diet with very low bioavailability, the amount of stored iron increase by 380 mg even without changing the iron intake.

This study showed that nutrition education had a significant positive effect on the modification of such maternal dietary behaviours towards intake of dietary enhancers and inhibitors of iron among pregnant women in Dire Dawa. All of the women in intervention group 1 (100%) and a majority in intervention group 2 (93%) modified their dietary behaviour and commonly consumed vitamin C-rich fruits and vegetables together with other dishes during mealtimes and were significantly higher than the control group ($p<0.05$). Although the difference between intervention group 1 and intervention group 2 was not significant at end-line ($p=0.057$), their changes from their respective baseline values (table 4.4) significantly increased ($p<0.05$). However, the control group had no significant change in their modification behaviours from enrolment ($p>0.05$).

The nutrition education intervention of this study also resulted in changes in the modification of dietary behaviours towards tea/coffee intake. At enrolment, about 73% of the women took tea/ coffee during their pregnancy period. Yeshitila (2016:20) also reported that 69.8% of the studied pregnant women in Dire Dawa were taking tea/coffee 2-3 times per day.

At baseline, as shown in table 4.6, the past 7-days mean intake of tea/coffee in intervention group 1 and intervention group 2 was 5.26 ± 0.18 days and 4.51 ± 0.31 days respectively. The control group had 4.43 ± 0.16 days. The three groups had an insignificant difference at baseline ($p=0.06$).

Nevertheless, after the nutrition education intervention, the control group had significantly higher mean intake of tea/coffee during the past 7-days than the other two intervention groups ($p=0.03$) with mean days of 3.48 ± 0.4 days. However, intervention group 1 and intervention group 2 had no significant difference in mean intake of tea/coffee at the end line ($p=0.88$). The past 7-days mean intake of tea/coffee in intervention group 1 and intervention group 2 at end-line was 2.68 ± 0.14 days and 2.62 ± 0.17 days respectively. Compared to the baseline, the mean intake of tea/coffee significantly decreased in intervention group 1 and intervention group 2 by -2.6 ± 0.1 days and -1.9 ± 0.1 days respectively ($p=0.00$) and intervention group 1 had higher change from baseline than intervention group 2 had, which could again be attributed to the effect the combined dietary interventions of food-based strategies in intervention group 1 other than nutrition education intervention alone. However, the control group showed no significant change from baseline (table 4.6).

Furthermore, the proportion of women who avoided intake of tea/coffee immediately after or together with meals significantly increased in intervention group 1 and intervention group 2 than the control at end-line too, which were 59 (95%) and 56 (92%) respectively ($p<0.05$). However, the proportion did not vary in intervention group 1 and intervention group 2 ($p>0.05$).

4.2.13. Effect of nutrition education on nutritional knowledge of iron-deficiency and anaemia during pregnancy

Iron-deficiency prevention and control strategies and interventions must analyse and address dietary knowledge and attitudes affecting the dietary behaviours. In this study, nutrition education intervention implemented for pregnant women was found to be effective in improving and retaining nutritional knowledge of iron-deficiency and anaemia among pregnant women in Dire Dawa. Table 4.9 and 4.10 summarize the nutritional knowledge on iron-deficiency and anaemia of the pregnant women before and end of the intervention.

4.2.13.1. Nutritional knowledge on iron-deficiency and anaemia at enrolment

Before the intervention, 69 (37.1%) of the studied pregnant women claimed to had never heard about iron-deficiency and anaemia; while 117 (62.9%) had previously ever heard. Inclusive to those women who had ever heard about iron-deficiency and anaemia, 42% did not know sign and symptom of anaemia; 58% did not state at least one cause of iron-deficiency and anaemia; 52% did not know at least one effect of anaemia on pregnant women; and 57% did not mention at least one strategy to prevent and control iron-deficiency and anaemia. Majority of the women (62%) identified a headache followed by pallor (20.5%) as a sign and symptom. Heavy bleeding (32.5%) was commonly mentioned cause followed by poor iron in the diet (17.9%). Difficulty during delivery (21.4%) was the common maternal consequence of anaemia mentioned. The commonly stated prevention and control strategies were eating foods rich in iron (24.8%). Majority of the studied women (52%) did not know about the benefit of taking iron-folic acid supplements during pregnancy.

Regarding nutritional knowledge of dietary iron, 59% of the pregnant women did not know iron-rich foods, while 41% mentioned at least one food as a good source of iron. About 25% of women mentioned Tef, while only 9% and 6% knew meat/fish and green leafy vegetables and fruits as rich sources of bioavailable iron respectively. About 47% knew at least one vitamin C-rich food, where mango (24%) was the commonly mentioned food to be rich in vitamin C followed by orange (16.7%).

Majority of the women did not know dietary sources of enhancers of iron absorption (88.2%), only 8.6% and 3.2% mentioned flesh foods and vitamin C-rich FVs respectively as good sources of dietary sources of enhancers of bioavailable iron absorption. Almost none of the women (95.7%) knew dietary sources of inhibitors of iron absorption. Only 1.6% and 1.1% stated grain cereals and tea/coffee/cola respectively as one of the dietary sources of inhibitors bioavailable iron.

Almost all of the pregnant did not know how foods containing dietary enhancers, vitamin C-rich fruits and vegetables (97.3%) and dietary inhibitors (98.4%) of iron absorption should be taken during meals to improve absorption of bioavailable iron. However, about 54.8% discussed balanced diet as consuming diversified and nutrient-rich foods. Majority of the women (82.7%) supported that a woman should eat a balanced diet during pregnancy.

Therefore, the overall computed mean nutritional knowledge score (NKS) of the pregnant women in Dire Dawa at baseline was 6.04 ± 0.4. With regard to the intervention groups, the mean NKS for intervention group 1, intervention group 2 and the control were 6.50 ± 0.74, 6.38 ± 0.69 and 5.25 ± 0.64 respectively. Almost all of the women in all of the intervention groups had poor nutritional knowledge. Categorically, 96% of the studied women had “poor nutritional knowledge” (NKS <30%), while 4% had “average nutritional knowledge” (NKS 30%-70%) on dietary iron and anaemia. None of the study participants had “good nutritional knowledge” (NKS >70%) at baseline. Both the mean NKS (p=0.37) and levels of nutritional knowledge (p=0.59) did not show any difference among the study groups at enrolment.

4.2.13.2. Nutritional knowledge by end of the intervention

By the end of the intervention, 178 study participants (95.7%), reported that they had heard of iron-deficiency and anaemia; and only 8 (12.7%), who were all in the control group, still claimed that they had never heard about those. Furthermore, the intervention groups had a statically significant difference from the control in all the variables related to the nutritional knowledge on iron-deficiency and anaemia by the end of the study intervention and the differences from baseline figures were also significant (p=0.00) (table 4.10).

Intervention group 1 and intervention group 2 had significantly higher proportions of women with knowledge in all of the nutritional categories than the control (p=0.00). All of the pregnant women (100%) in intervention group 1 and intervention group 2 had mentioned at least one sign and symptom, cause, consequence on pregnancy and prevention and control strategy of anaemia. Besides, all of the pregnant women (100%) in intervention group 1 and intervention group 2 also had nutritional knowledge on dietary sources of enhancers and inhibitors of iron absorption, vitamin C-rich foods, iron-rich foods, and how diets that contained enhancers (VCRFVs) and inhibitors (tea/coffee) of iron absorption would be taken during meal at the end, and the difference from than the control and their baseline increased significantly (p=0.00). However, pregnant women in the control group showed no significant change from baseline as almost all of them still did not know vitamin C-rich foods, iron-rich foods and dietary sources of enhancers and inhibitors of iron absorption and by the end of the intervention.

At end of the intervention, the overall mean Nutritional Knowledge Score (NKS) was 30.83 ± 1.2 and statistically differ across the intervention groups (p=0.00). The mean NKS for intervention group 1 and intervention group 2 were 42.55 ± 0.75 and 41.93 ± 0.79 respectively, while the control group scored 8.56 ± 0.48. The intervention group 1 and intervention group 2 had a statistically significant higher mean score than the control group (p=0.00) but their difference was insignificant (p=0.53)

The change from their respective baseline Nutritional Knowledge Score (NKS) also significantly improved in both intervention group 1 and intervention group 2 than the control. The mean NKS significantly increased from the baseline by 36.04 ± 0.93 for intervention group 1 and significantly increased by 35.56 ± 0.85 for intervention group 2 (p=0.00). Although the control group also had a significant change from enrolment, the difference was only by 3.3 ± 0.3 (p=0.00), which may possibly show the influence of the routine ANC counselling. Nevertheless, the difference in the mean NKS between intervention group 1 and intervention group 2 was not statistically significant (p>0.05) by the end of the intervention,

Besides, both intervention group 1 and intervention group 2 had a significantly higher difference than the control of the level of nutritional knowledge by the end of the intervention (p=0.00). The proportion of women who had “average nutritional knowledge” (NKS 30%-70%) and “good nutritional knowledge” (NKS >70%) were significantly higher in both intervention group 1 and intervention group 2 compared to the control group. None of the pregnant women in both intervention group 1 and intervention group 2 had “poor nutritional knowledge” (NKS <30%). In contrary, 97% of the pregnant women in the control group still had “poor nutritional knowledge” by the end of the intervention. About 69% and 77% of women in intervention group 1 and intervention group 2 respectively had “good nutritional knowledge” by the end of the intervention. However, a significantly higher proportion of women in intervention group 1 had “average nutritional knowledge” compared to intervention group 2 (p<0.05). Compared to the baseline, the change in the proportion of women who had “average nutritional knowledge” and “good nutritional knowledge” from the baseline was also significant in both intervention group 1 and intervention group 2.

Table 4.9 Nutritional knowledge score on iron-deficiency and anaemia of pregnant women in RCT, Dire Dawa 2018

Variable		Intervention group			Total	*P value*
		Int grp 2 n= 62	Int grp 2 n= 61	CG n = 63	n = 186	
NKS	Baseline	6.50 ± 0.74	6.38 ± 0.69	5.25 ± 0.64	6.04 ± 0.40	0.37
	End	42.55 ± 0.75	41.93 ± 0.79	8.56 ± 0.48.	30.83 ± 1.2	0.00
	Change	36.05 ± 0.93	35.56 ± 0.85	3.3 ± 0.3	24.8 ± 1.2	0.00

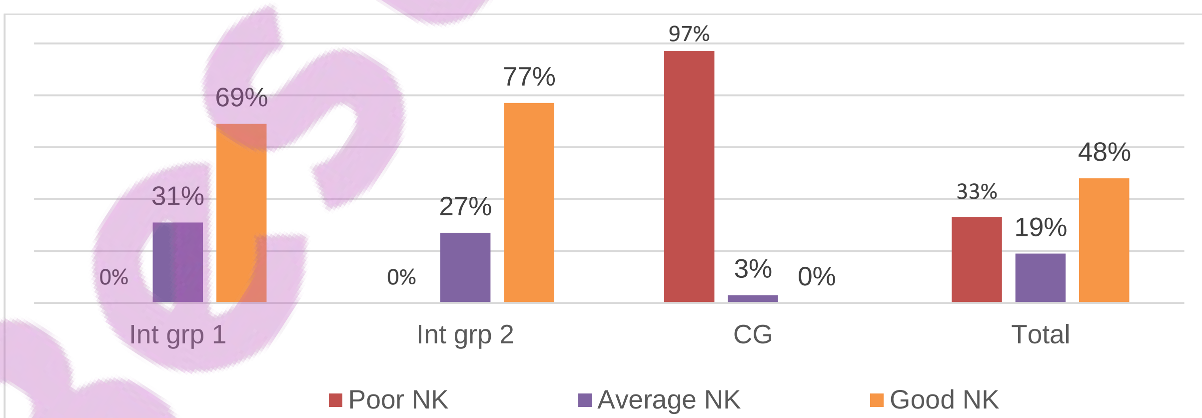


Figure 4.7 Level of nutritional knowledge on iron-deficiency and anaemia of pregnant women at end of intervention in RCT, Dire Dawa 2018

Table 4.10 Nutritional knowledge on iron-deficiency and anaemia of pregnant women in RCT, Dire Dawa 2018

Variable		Intervention groups			Total	*P value*
		Int grp 1	Int grp 2	CG		
		%				
Heard of anaemia (Yes)	Baseline	53	61	75	63	0.04
	End	100	100	81	94	0.00
Sign and symptom (Yes)	Baseline	53	59	62	58	0.07
	End	100	100	67	89	0.00
Cause (Yes)	Baseline	45	44	38	42	0.69
	End	100	100	44	81	0.00
Risk on pregnancy	Baseline	44	52	46	48	0.17
	End	100	100	49	83	0.00
Prevention & control (Yes)	Baseline	39	44	48	43	0.64
	End	100	100	52	84	0.00
Iron-rich foods (Yes)	Baseline	42	43	40	41	0.85
	End	100	100	40	80	0.00
Sources of enhancers (Yes)	Baseline	14	26	10	13	0.01
	End	100	100	10	71	0.00
Sources of inhibitors (Yes)	Baseline	10	7	0	5	0.12
	End	100	100	0	66	0.00
Vitamin C-rich foods (Yes)	Baseline	55	44	43	47	0.34
	End	100	100	43	81	0.00
VCRF intake with meal (Yes)	Baseline	7	2	0	3	0.07
	End	100	100	0	66	0.00
Tea/coffee intake +/-2hr mealtime (Yes)	Baseline	0	4	0	2	0.05
	End	100	100	0	66	0.00
Balanced diet (Yes)	Baseline	61	53	51	55	0.65
	End	100	100	0	66	0.00
Poor nutritional knowledge	Baseline	94	97	97	96	0.59
	End	0	0	97	33	0.00
Average nutritional knowledge	Baseline	6	3	3	4	0.59
	End	31	23	3	19	0.00
Good nutritional knowledge	Baseline	0	0	0	0	
	End	69	77	0	48	0.00

The findings of this study thus show that the nutrition education intervention of this study significantly improved the nutritional knowledge on iron-deficiency and anaemia of pregnant women in Dire Dawa. The findings are also consistent with many experimental studies, which have also acknowledged the positive effect of nutrition education on improving maternal nutritional knowledge. Fahmida et al (2015:459) and Ickes et al (2017:6) collaborate that dietary counselling and education significantly improve maternal knowledge. A quasi-experimental intervention among pregnant women attending urban health centres in western Iran reported that the awareness level of the pregnant women about healthy nutrition increased significantly from 3% before intervention to 31% after the nutritional education intervention (Fallah et al 2013:177). ElHameed et al (2012:1216) also concluded that there was statistically highly significant increase in overall knowledge toward healthy nutritional habits among pregnant women after nutrition education.

The researcher identified no randomized controlled trial study, which analysed the effect of nutrition education on nutritional knowledge of pregnant women in Ethiopia to best efforts of the review. Nevertheless, one before-after cross-sectional study conducted among pregnant women in Addis Ababa revealed that proportion of pregnant women with knowledge on proper nutrition during pregnancy increased from 53.9 to 97% after nutrition education intervention (Zelalem et al 2017:6-7).

4.2.14. Effect of nutrition education on knowledge and practice of food preparation and preservation methods

The dietary modification also involves changes in food preparation methods for reductions of intake of dietary factors inhibiting iron absorption (Hoppe et al 2008:768). The absorption of dietary iron also depends on food preparation practices and techniques (FAO 2011:272). Food preparation and processing methods have enormous potentials both to increase the physicochemical accessibility of micronutrients, decrease the content of anti-nutrients, such as phytate and the hexa- and penta-inositol phosphate content or increase the content of compounds that improve bioavailability (Miller & Welch 2013:9; Nair et al 2016:8; WHO 2001:49). In the review to evaluate aspects of vitamin C, Pacier and Martirosyan (2015:96-97) illustrate that food storage and preparation are the other major factors that can make a huge difference on vitamin C content.

Effects of anaemia prevention and control strategies would thus be potentiated if interventions addressing knowledge on dietary factors were integrated with gestational and household nutrition education for proper food preparation and preservation practices. This study shows that nutrition education intervention was effective in improving maternal knowledge and practice on food preparation and preservation methods among pregnant women in Dire Dawa.

Before the intervention, the majority of pregnant women (87%) did not know any food preparation methods and techniques employed to improve the amount of bioavailable dietary iron in diets. About 91% did not know food preparation methods to reduce the number of dietary inhibitors of iron absorption intake. Majority of the women did not know how green leafy vegetables and fruits be cooked (77%) and properly stored (72%) while their vitamin c and nutrient contents would be reserved. Besides, about 94%, 92% and 87% women in intervention group 1, intervention group 2 and the control group respectively never practised any food preparation and preservation method at enrolment. The intervention groups had no difference in their knowledge and practice of proper food preparation and preservation methods at baseline ($p>0.05$).

By the end of the intervention, the proportion of pregnant women who knew food preparation methods and nutrient preservation techniques were significantly higher in both intervention group 1 and intervention group 2 compared to the control group ($p=0.00$). All women in intervention group 1 and intervention group 2 knew at least one food preparation method and nutrient preservation techniques to improve the amount of bioavailable dietary iron in diets, reduce the intake of amount of dietary inhibitors of iron absorption and vitamin C preservation techniques by the end of the. Although intervention group 1 and intervention group 2 showed no significant difference on knowledge on food preparation method preservation techniques at the end, the change from their baseline was significant for each group, but not for the control. Still, 81% and 78% in the control group did not know any food preparation method and preservation techniques respectively.

The result also showed women intervention group 1 and intervention group 2 had a significant difference in the practice of food preparation and preservation methods compared to the control at end of the intervention (p=0.00). About 95% and 93% of women in intervention group 1 and intervention group 2 respectively practised at least one food preparation method while preparing cereal and legume-based diets. The result also showed a significant increase in practice for both in intervention group 1 and intervention group 2 from the baseline was significant, which were 6% and 8% respectively. However, the change in the practice of food preparation methods and nutrient preservation techniques was insignificant from the baseline in the control group, as 83% of the women still never practised any method at end-line. Intervention group 1 and group 2 showed no significant difference in practice at the end too (p=0.00).

Cooking foods in iron pots can increase iron intake (Ruel 2001:4). Germination, fermentation and soaking can also reduce some polyphenols content of some cereal and legume enhancing iron absorption (FAO 2011:17; FAO & WHO 2001:10). Arif et al (2011:19-20) reported that soaking and malting drastically reduced the phytic acid content of Barely by 14.8% and 33.5% respectively. About 81% of women in intervention group 1 and 85% in intervention group 2 had practised cooking foods in iron pots and soaking/malting.

El-Din et al (2013:699) revealed that cooking treatments lead to a significant deleterious on the vitamin C contents of Brassica vegetables. Boiling for 6 minutes caused 64.5% decrease in broccoli, 70.7% in white cabbage and 66.8% in cauliflower. Akdaş and Bakkalbaş (2017:883) report that the ascorbic acid content of kales and cruciferous vegetable decrease after cooking. Because vitamin C degrades when heated and during storage, the processing and preparation procedures should be considered when estimating dietary intake of vitamin C (Lykkesfeldt et al 2014:17). In this study, about 91% of women in intervention group 1 and 88% in intervention group 2 had practised proper cooking of DDLVs and vegetables 2-3 minutes close to serving time.

Such changes in dietary preparation habits have also an advantage which can bring about important sustainable improvements, not only in iron status but also for nutrition in general (WHO 2001:49). In line to this argument, the finding of this randomized controlled trial study, as reported in section 4.3.8, showed that pregnant women in both intervention group 1 and intervention group 2 had a higher consumption of pulses at the end line, which may be attributed to the increased food preparation practice. Pulses are known a good source of protein, but also contain anti-nutrients which reduce absorption of dietary iron. Such modifications in food preparation practices may thus improve the intake of proteins from pulses while reducing the anti-nutrients contributing to the overall improvement of nutrient intake during pregnancy.

This study thus collaborates that modifications in food preparation and preservation behaviours through nutrition education intervention should be part of long-term strategies to effectively improve iron status in pregnant women. Modifications in traditional household methods for preparing and processing indigenous foods is one of the goals of food-based strategies (FAO 2014:20; FAO 2011:270).

4.2.15. Food-based strategies (FBS), haemoglobin and anaemia level (iron status) during pregnancy

Food-Based Strategies (FBS), also referred to as Dietary Diversification and Modifications (DDM), are defined as changes in food production and food consumption patterns, as well as changes in traditional household methods for preparing and processing indigenous foods. The overall goal of the strategies is to enhance the availability of, access to and utilization of foods with high content and bioavailability of micronutrients throughout the year (FAO 2014:20; FAO 2011:270).

Food-based strategies have been recommended as the first priority to meet micronutrient needs (FAO 2014:284). The use of food-based strategies has also several other advantages as they have the potential to prevent coexisting micronutrient deficiencies simultaneously. However, further recommendations for food-based strategies should in advance analyse their significance related to affecting the absorption and bioavailability of iron, thus reduction of anaemia.

4.2.15.1. Effect of nutrition education as a component of food-based strategies on maternal haemoglobin and anaemia level during pregnancy

Findings of this study, as discussed in section 4.3.6, showed that by the end of the intervention, pregnant women in both intervention group 1 and intervention group 2 had significantly higher haemoglobin level compared the control. Intervention group 1 and intervention group 2 also had significantly increased haemoglobin levels from the enrolment levels at the end. The proportion of women with anaemia also decreased significantly in both intervention group 1 and intervention group 2 compared to the control.

This study thus identifies that nutrition education provided through food-based strategy approach was effective in improving maternal haemoglobin level during pregnancy in Dire Dawa. The study also identifies that the nutrition education intervention provided through food-based strategy approach was effective in reducing anaemia during pregnancy in Dire Dawa.

Nutrition education as component of food-based strategy focuses on increasing intake of bioavailable iron through improved consumption of foods rich in iron; through changes in dietary diversity; promotion of proper dietary behaviours and household food preparation and preservation methods resulting modifications in the intake of dietary enhancers and inhibitors of bioavailable iron and improving the overall nutritional knowledge in prevention and control of anaemia.

The observed effect of nutrition education intervention in improving maternal haemoglobin level and reducing anaemia during pregnancy in this study may, therefore, be explained through the positive effects of the intervention on improvements in nutritional knowledge, dietary diversification, consumption of vitamin C rich fruits and vegetables and proper dietary modification behaviours and practice of household food preparation and preservation methods among the pregnant women. As discussed in the previous sections of this chapter, pregnant women in intervention group 1 and intervention group 2 had significantly higher nutritional knowledge, significantly higher dietary diversification, consumed more vitamin C rich foods, modified their dietary behaviours and consumed dietary enhances of iron absorption (vitamin C rich foods) together with meal, avoided consumption of dietary enhances of iron absorption (tea and coffee) together with meal and had significantly higher dietary modification food preparation knowledge and practice than the control group by the end of intervention.

Other intervention studies also reported consistent findings on the effect of nutrition education on maternal haemoglobin level and anaemia. ElHameed et al (2012:1216) evaluated the effect of nutritional educational guideline among rural pregnant women with iron-deficiency anaemia and found that there was a highly statistically significant increase in overall knowledge and knowledge related practice toward healthy nutritional habits and subsequently the prevalence of anaemia decreased by 24% after intervention.

Al-Tell et al (2010:112-16) showed that nutrition education had a significant relationship with perceiving the risk of anaemia, changing eating practices and improvement in haemoglobin level of pregnant women. The result revealed a significant improvement in mean haemoglobin level of 10.94 ± 0.54gm/dl at second trimester (24-26 week) and of 11.39 ± 0.86gm/dl at third trimester (after 36 weeks) in more than one two third of study group. While about two third of the control group had a significant decrease in mean haemoglobin level of 9.6 ± 0.61gm/dl at second and 9.5 ± 0.72gm/dl at third trimesters respectively.

Although not in pregnant women, a Kenyan study also concluded that nutrition education significantly improved nutrition knowledge among primary school pupils and the positive relationship between nutrition knowledge, nutrient intake and haemoglobin levels was statistically significant (Gitau et al 2013:121). Nutrition education intervention employing quasi-experimental design among adolescent girls in Southern Benin reported that mean haemoglobin and serum ferritin values were also significantly higher in the intervention group than in the control group (122gm/L versus 112gm/L and 32µg/L versus 19µg/L respectively). Whereas the prevalence of anaemia (32% versus 85%) and iron-deficiency anaemia (26% versus 56%) were significant, lower in the intervention group than in the control group (Alaofe, Zee, Dossa & O'Brien 2009:30).

This research identified no RTC assessing the effect of nutrition education on maternal haemoglobin and anaemia level in Ethiopia. However, one cross-sectional study reported that nutrition education had a negative influence on anaemia (Gebre & Mulugeta 2015:5). In contrary, Gebremedhin et al (2014b:48) show that the haemoglobin level and odds of anaemia were not statistically different across variables like receiving nutrition education during pregnancy. The disparity of the findings from this study could be due to the cross-sectional study design employed in Gebremedhin et al (2014b:48).

4.2.15.2. Effect of dietary diversity and modification as a component of food-based strategies on maternal haemoglobin and anaemia level during pregnancy

An essential element to food-based strategy involves dietary diversification or the consumption of a wide variety of foods across nutritionally distinct food groups (FAO 2014:284). Strategies other than dietary diversification have the disadvantage of targeting the known factors. Addressing the "uncertainty of unknown" is an advantage for an approach aimed at diversification in the diet (Nair et al 2016:2). Any programme or intervention with a primary objective is to improve the diet of the population or to evaluating the impact of food-based intervention should thus initially understand effects of dietary diversification and modification (FAO 2014:285-89).

This study shows that haemoglobin and anaemia levels have a significant relationship with dietary diversity of pregnant women in Dire Dawa. Before the interventions, the mean haemoglobin level did not show significant difference among those women with "low dietary diversity" (9.54 ± 0.05gm/dl) and "high dietary diversity" (9.44 ± 0.08gm/dl) with a p-value of 0.31 (section 4.3.9).

However, the difference in the haemoglobin level between the two groups was significant by the end of the interventions. Pregnant women with "high dietary diversity" had 0.802 ± 0.15gm/dl significantly higher mean haemoglobin level than those with "low dietary diversity" ($p<0.05$). With regard to the intervention groups, women with "high dietary diversity" had 1.29 ± 0.48gm/dl significantly higher mean haemoglobin level than those with "low dietary diversity" ($p=0.021$) in intervention group 1. Women with "high dietary diversity" had 0.68 ± 0.32gm/dl significantly higher mean haemoglobin level than those with "low dietary diversity" ($p=0.021$) in intervention group 2. Furthermore, dietary diversity had a negative relationship with anaemia among pregnant women in Dire Dawa, which was also significant ($p<0.05$) at the end of the intervention. All of the non-anaemic women had "high dietary diversity" in both intervention group 1 and intervention group 2.

Zerfu et al (2016a:1486) followed a cohort of pregnant women in Arsi to analyse their dietary diversity in relation to risk of anaemia using a 24-hour dietary recall. The study showed that women with inadequate WDDS (consumption less than four food groups) had lower mean haemoglobin level (10.96 ± 0.14gm/dl) than women with adequate WDDS (12.19 ±

0.13gm/dl) at the end of the follow-up with a p-value of 0.001. Although a cross-sectional design was employed, Yeshitila (2016:24) identified dietary factors to be the main factors associated with anaemia among pregnant women in Dire Dawa. Gebremedhin et al (2014b:47-51) reported low dietary diversity as one of the factors related to anaemia.

The positive effect of dietary diversification in improving maternal haemoglobin level and thus reducing anaemia during pregnancy identified in this study is evidently explainable from the findings. As elaborated in FAO (2014:284), increased dietary diversity is associated with increased household access to food as well as the increased individual probability of adequate micronutrient intake. The consumption of dark green leafy vegetables, another vitamin A rich FVs and other fruits is significantly higher for women with "high dietary diversity" than with "low dietary diversity" ($p<0.05$) in both intervention group 1 and intervention group 2. From the result shown in section 4.3.10 intervention group, 1 and intervention group 2 had **a** significantly higher consumption of dark green leafy vegetables, another vitamin A-rich FVs and other fruits from the baseline too,

The nutrient adequacy of the diets is similarly expected to improve with dietary diversification. Vitamin A-rich FVs and dark green leafy vegetables, which are also good sources of folate (FAO & FHI 360 2016:15-16), while dark green leafy vegetables, another vitamin A-rich FVs and Other fruits are good sources of vitamin C which to enhance iron absorption. Ascorbic acid (vitamin C) and citric acids found in fruit and certain vegetables and cysteine-containing peptides ("meat factors") found in meat are also enhancers of both heme and non-heme iron absorption (FAO 2011:271; Geissler & Singh 2011:295; Hurrell & Egli 2010:1462; Kaiser & Campbell 2014:8; Milman 2015:2; WHO 2001:50).

Zerfu et al (2016a:1485-6) also collaborate the negative relationship of dietary diversity and anaemia during pregnancy. At enrolment, 37.6% of the pregnant women with inadequate women dietary diversity score (WDDS) were anaemic compared with 19.7% in the adequate group. The proportion of anaemia in the inadequate group continued to increase and reached 44.6% of anaemic women at the end of the follow-up, whereas it remained fairly stable in the adequate group (20.2% at term). The study also reported that pregnant women in the inadequate WDDS had a 2-fold higher risk of being anaemic after the baseline differences were controlled.

Additionally, dietary diversification and modifications can enhance the micronutrient adequacy of diets for the entire household and across generations. Several additional non-nutritional benefits may also be achieved through the community-based nature of dietary diversification and modifications. These may include the empowerment of women in the community and income generations (FAO 2014:20-1).

4.2.15.3. Effect of dietary vitamin C intervention as a component of food-based strategies on maternal haemoglobin level and anaemia during pregnancy

Apart from the overall dimension of dietary diversity, utilizing the effects of favourable food combinations need to be sufficiently elucidated for food-based approaches to succeed (Nair et al 2016:7). Programs need to focus on comprehensive strategies and packages of intervention recognizing the multidimensional whole foods and entire dietary diversification approaches for sustainable prevention and control of micronutrient deficiencies (Nair et al 2016:2).

This study analysed the isolated effect of dietary-based vitamin C supplementation intervention as a component food-based strategy on haemoglobin and anaemia level, by comparing intervention group 1 who were intervened with the addition of dietary vitamin C intervention along with the nutrition education intervention and taking among pregnant women enrolled in intervention group 2 who were provided with only nutrition education intervention as a control group.

Consequently, even though intervention group 1 and intervention group 2 had significantly higher difference than the control in the outcome variables by the end of this study, as discussed in section 4.3.6, intervention group 1 had significantly 0.361 ± 0.17gm/dl higher mean haemoglobin level compared to intervention group 2. The difference from the control was also higher in intervention group 1 by 0.90 ± 0.17gm/dl than intervention group 2 had from the control (0.54 ± 0.17gm/dl). Intervention group 1 also had higher change in mean haemoglobin from baseline (0.77 ± 0.11gm/dl) than intervention group 2 had (0.398 ± 0.073gm/dl).

Furthermore, the prevalence of anaemia significantly decreased more in intervention group 1 (29%) than in intervention group 2 (14.8%). The level of statistical significance for the difference in the proportion of anaemia between intervention group 1 and intervention group 2 was also slightly higher than the 0.05 which suggested the existence of lower proportion of anaemia in intervention group 1.

The observed significantly higher improvement in an increase of haemoglobin level and reduction of anaemia during pregnancy in intervention group 1 than intervention group 2 are thus attributed to the effect of additional dietary-based vitamin C supplementation intervention in intervention group 1. Furthermore, the higher difference intervention group 1 had from the control than intervention group 2 had from the control can also be attributed to the effect of a combined intervention of food-based strategy than the standalone nutrition intervention as elaborated in later paragraphs of this section.

Although the available evidence suggests that addition of small amounts of red meat consumed with plant-based meals can lead to intakes of bioavailable iron much higher than the improvements with non-haem iron through the consumption of ascorbic acid-rich foods (FAO 2014:25), the two intervention groups in this randomized controlled trial study did not significantly differ in their past 24-hours consumption of meat/fish both at enrolment and end of intervention, signifying the effect of the dietary-based vitamin C supplementation intervention.

Though cross-sectional study design was employed, Yeshitila (2016:24) however identified that those pregnant women in Dire Dawa who ate animal products less than 3 times per week were1.8 times more likely to be anaemic compared to those women who ate animal products than more than 3 times per week. The report also showed that those pregnant who ate meals less than 3 times per day were 9.1 times more likely to be anaemic compared to those who ate ≥3 times per day.

Vitamin C (ascorbic acid) facilitates the conversion of ferric (Fe^{3+}) to ferrous (Fe^{2+}) iron, the form in which iron is best absorbed (Saunders et al 2012:13). Vitamin C enhances non-heme iron absorption by forming an iron-ascorbates (FAO 2014:22). Vitamin C, in addition to the iron, may increase the acid environment of the stomach and increase absorption (Prakash & Yadav 2015:166). It is also documented that ascorbic acid reverses the inhibiting effect of phytates and polyphenols (Siegenberg et al l99l:540), and has an influence on iron absorption from meals containing other absorption promoters like meat (Lynch & Cook 1980:34).

Even though this study identified no intervention study which analysed the effect of dietary vitamin C intervention on haemoglobin level and anaemia among pregnant women, different studies on dietary intervention resulted from inconsistent findings. Past human trials have not shown vitamin C intervention not to be effective in this role (FAO 2014:42).

Beck et al (2014:3754-3768) reviewed reports and studies addressing dietary determinants the efficacy of dietary interventions in young women living in industrialized countries. The review revealed that the majority of the reviewed cross-sectional studies observed no relationship between iron status and intakes of ascorbic acid total iron. The review reasoned that the type of iron appears to be a more important determinant of iron status than total dietary intake.

A study employing a 24-hours dietary recall among adolescent girls also found no significant association of haemoglobin status with vitamin C intake, despite mean intake of vitamin C being 122mg/day which is higher than the RDA (75mg/day). The study reasoned that a diet consisting of varied fruits and vegetables with different levels of vitamin C and fibre, the effects of these components counteract each other, leading to an unchanged haemoglobin concentration (Safwan & Asar 2017:3-4).

Beck et al (2014:3767-8) also explain that in diets containing a range of fruit and vegetable combinations, the effects of differing levels of ascorbic acid and fibre may counteract one other, leading to no change in serum ferritin concentration. However, this study conducted the dietary intervention through supplementation of vitamin C-rich fruit juice with low fibre content thus counteracting this limitation.

Beck et al (2014:3754-68) also the reason that the studies reviewed have been limited by their cross-sectional study designs, small sample sizes and the inclusion of participants with normal rather than low iron stores, therefore, possibly having insufficient power to show an effect. Besides, some of the studies have not been undertaken for long enough for the effect to be observed too. Interventions should be at least for 12-16 weeks duration to allow adequate time for red blood cell turnover (red blood cells have a life span of 90-120 days).

In contrary, this study employed randomized controlled trial design enrolling anaemic pregnant women who were intervened for 12 weeks duration. The observed positive intervention effect would thus be due to the control of such factors mentioned as limitations of the other studies. Furthermore, not all of those dietary intervention studies had controlled for other factors that may affect iron status including supplement use. The intervention groups in this study, however, did not significantly vary in iron-folic acid intake at both enrolment and end of the intervention.

The enhancement of iron absorption from vegetable meals was also shown to be directly proportional to the quantity of ascorbic acid present. The WHO suggests that each meal should preferably contain at least 25mg of ascorbic acid and possibly more if the meal contains many inhibitors of iron absorption (FAO & WHO 2001:202). The minimum dose of 25mg ascorbic acid to be consumed three times per day is also recommended by the Food and Agriculture Organization (FAO 2011:272) for such intervention. Ballot et al (1987:331) show that several fruits had a different effect on iron absorption from rising meal due to their variation in ascorbic and citric acid. Lynch and Cook (1980:40) suggest that ascorbic acid is effective in promoting food iron absorption only if taken with the meal and from the high molar ratio of ascorbic acid to iron.

The pregnant women in intervention group 1 were supplemented to take 300ml of the juice providing 30mg ascorbic acid three times in a day at times of meals at breakfast, lunch and dinner (90mg/day). Results on dietary modification (section 4.3.12) also show that the women took the juice together with a meal to enhance absorption of bioavailable iron and decreased intake of tea/coffee together with a meal. In one comparison study, individuals who consumed 247mg of vitamin C daily had 35% higher iron absorption levels than those who consumed 51mg of vitamin C daily (Pacier & Martirosyan 2015:91).

As stated in Turner and Burri (2013:174-76), consumption of 100 gm of orange and lemon provides 53-88mg and 29-61mg of vitamin C respectively; and meets 44%-110% and 24%-76% of the RDA of pregnant/lactating women respectively. While drinking 500ml/day of orange juice for two weeks (~250mg ascorbic acid/day) increases plasma vitamin C concentrations in adults by 40%-64%. Pacier and Martirosyan (2015:97) also collaborate that raw orange with the weight of 180gm and one cup of orange juice (249gm) provide 95.8mg and 83. mg of vitamin C and meets 127.7% and 111.6% of the RDA of women respectively.

Consistent with the findings of this study, some studies found positive associations but among non-pregnant women. A randomized double-blind, placebo-controlled, primary-prevention trial showed that higher vitamin C from fibber-poor fruits, vegetables and juices was associated with higher serum ferritin and haemoglobin concentration in premenopausal women; indicating that fibre content in fruits and vegetables has an influence in groups in whom non-heme absorption is higher because of their low iron status (Péneau et al 2008:1300). The consumption of 25mg ascorbic acid as limeade twice daily with meals substantially improved iron absorption and iron status of non-pregnant, non-lactating, iron-deficient women in Mexico (Diaz, Rosado, Allen, Abrams & Garcia 2003:439).

In divergent from the Miller and Welch (2013:7), which concluded that providing some animal-source foods in the diets of the poor who are dependent on staple food crops is the important strategy for decreasing iron-deficiency, this study however elaborates that the dietary based vitamin C intervention is also an important strategy for addressing iron-deficiency and anaemia in pregnant women whose dietary pattern is dominated by plant source foods with less consumption of animal-source foods.

4.2.15.4. Effect of dietary combined interventions of food-based strategies on maternal haemoglobin level and anaemia and dietary diversity during pregnancy

This study also analysed the effect of the combined dietary intervention (FBS) with the addition of dietary vitamin C intervention along with the nutrition education intervention among pregnant women enrolled to intervention group 1 compared to the only nutrition education intervention provided to intervention group 2.

The findings of this randomized controlled trial research not only showed the effect of dietary vitamin C intervention in improving haemoglobin level and reducing anaemia during pregnancy in Dire Dawa, but the effect would also be more potentiated if nutrition education interventions are combined with dietary interventions through food-based strategy. This study shows that combined dietary intervention or in other words food-based strategy, have a significantly higher effect on haemoglobin level and anaemia during pregnancy than standalone nutrition education interventions. As discussed previously, the difference in haemoglobin level intervention group 1 had from the control was significantly higher than the difference in haemoglobin level intervention group 2 had from the control by the end of the study interventions. Intervention group 1 also had higher change in mean haemoglobin from baseline (0.77 ± 0.11gm/dl) than intervention group 2 had (0.398 ± 0.073gm/dl). Furthermore, the prevalence of anaemia significantly decreased more in intervention group 1 (29%) than in intervention group 2 (14.8%).

Camaschella (2015:1835), FAO (2014:25); and WHO& FAO (2006:101) also collaborate that the addition of vitamin C combined with dietary modification through nutrition education for the removal of phytates can be effective ways of increasing the total amount of iron absorbed. Consequently, Beck et al (2014:3767-8) suggest that ascorbic acid appears to increase iron status in iron-deficient women only when consumed together with substantial amounts of iron. Thus, recommend a combination of approaches (e.g. increased meat and ascorbic acid intake, decreased intake of iron absorption inhibitors and considered the timing of enhancers and inhibitors of iron absorption) to get the most effective dietary means of addressing iron deficiency in young women living in industrialized countries.

The positive effect of the combined intervention is also shown from one of the other noticeable findings of this study. The results showed that intervention group 1 also had a significantly higher proportion of women in the “high dietary diversity” category compared to intervention group 2 by the end of the intervention (p=0.04). The consumption of vitamin C-rich FVs was significantly in higher intervention group 1 than intervention group 2 at end of the intervention. Intervention group 1 had 15% and 22% higher proportion of women than intervention group 2 who consumed other fruits (p=0.00) and another vitamin A-rich FVs (p=0.02) in past 24-hours. For the past 7-days consumption, intervention group 1 had higher mean consumption days for other fruits (p=0.04) and DGLFs (p=0.01) too.

Although the possible explanation for this difference between interventions group 1 and intervention group 2 could be due to the additional intervention of vitamin c-rich fruit juice supplementation, pregnant women intervention group 1 had also significantly decreased intake of coffee, which indicates for other explanations from food-based strategy perspectives. These other explanations could be attributed the added advantages and values of interventions of food-based strategy. As elaborated in Nair et al (2016:2) too, packages of food-based strategy encompass comprehensive interventions that recognize the multidimensional entire whole foods approaches resulting in sustainable behaviour change on dietary diversification.

The use of food-based strategy has also several other advantages as they have the potential to be culturally acceptable, economically feasible and sustainable, even in poor-resource settings. Food-based strategies have an additional advantage of being more close to the population psyche too. Several additional non-nutritional benefits may also be achieved through the community-based nature of food-based strategy. These may include the empowerment of women in the community and income generations (FAO 2014:20-1). As also collaborated in the qualitative findings of this study in section 4.3.17, food-based strategies also influenced cultural taboo foods among pregnant women in Dire Dawa.

As elaborated in Nair et al (2016:2) too, this randomized controlled trial study recognise that, it is consequently the appropriate time for a smooth paradigm shift from the traditional disproportionate focus on less effective single nutrient approach to comprehensive strategies and packages of intervention addressing the entire dietary diversification for sustainable prevention and control of iron deficiency and anaemia during pregnancy in particular and micronutrient deficiencies in general. The study also acknowledges that combined dietary interventions through food-based strategies are more effective and should be promoted than vertical behaviour modification interventions. Even though nutrition education intervention is effective in improving maternal iron levels and anaemia during pregnancy, more potentiated effects would be achieved if nutrition education interventions are combined with dietary-based interventions through food-based strategies.

4.2.16. Household dietary diversity and food security

The household dietary diversity score (HDDS) is meant to reflect, in a snapshot form, the economic ability of a household to access a variety of foods. The score has been validated as proxy measures for macro and/ or micronutrient adequacy of the diet (Kennedy et al

2013:5). Only at enrolment, the past 7-days dietary recall of the studied women for food intakes of any member of the family was constructed into the 9 food groups.

Accordingly, the mean household dietary diversity score (HDDS) of the households was 4.78 ± 1.48. Majority of the households (67%) had “low HHDS” (less than 5 food groups per week). Staple foods, pulses and Oil dominated the past 7-days dietary diversity of the households.

Regarding the household’s food security situation, the result revealed that the mean food consumption score (FCS) of the households for the past 7 days prior to the interview based on the 9-food groups was 29.4 ± 9.6. According to the WFP’s classification of food insecurity level, the households were thus characterized to have a “Borderline” (21-35) food insecurity level. The result also revealed that the studied households did not differ in their household dietary diversity score (HDDS) and FCS at enrolment across the study groups (p=0.11).

These findings are consistent with the 2013 Ethiopia National Food Consumption Survey (Ethiopian Public Health Institute 2013:20) which also reported that Ethiopian family diets were predominantly based on cereals and legumes and consumption of animal source foods as well as fruits and vegetables was very low. The review in Workicho et al (2016:4-5) also showed cereals were the most commonly consumed food groups in 96% of the analysed rural and urban households in Ethiopia and Dire Dawa had the highest significant difference between the proportions of households with high and low household diversity scores (49.3%). However, in contrast to the finding of this study, Workicho et al (2016:4-5) found that Dire Dawa relatively had a better proportion of consumption of all animal source foods, compared to other regions, with 40% of the households consumed meat.

The reported household dietary pattern did not differ from the dietary pattern of the pregnant women in Dire Dawa, as both were dominated by staple foods and pulses and the consumption patterns of meat, fruit and vegetables were low. The findings clarify that pregnant women in Dire Dawa have a family based dietary pattern with no especial feeding priorities for women during pregnancy.

Household food insecurity can lead to inadequate intake of micronutrients and decreased intake of enhancers of bioavailable iron. This is consistent with the findings of this study in which the pregnant women in Dire Dawa had low consumption of animal-source foods. Ghose, et al (2016:6) also reported that level of household food security was associated with risk of anaemia, which is again consistent with the findings of this study as the majority of the intervened anaemic pregnant women had “low HHDS”.

4.2.17. Community dietary practices, patterns and socio-cultural influences

This study also explored community-level maternal dietary practices and socio-cultural influences employing in-depth interviews. In this community, cereals and legumes dominated the dietary patterns of women during pregnancy. From cereals. Tef, Sorghum, Maize, Barly, Abish and Wheat were the most commonly used to prepare foods. Bean, Kidney bean, and peas from legumes dominated stews/ wots. Dishes were usually served as a combination of enjera or bread with legume-based stews/wot. The community thus encourage pregnant women to eat such foods. The main reason stated was that these food groups would give more energy and would be better for the health and growth of both for the mother and the foetus. The other main reason mentioned was that these cereals and legumes were predominantly harvested locally thus were economically accessible.

One participant aged 28 who had 2 children explained “women more energy and nutrient foods during pregnancy as her health conditions affect the growth of the baby in her womb. So pregnant women should eat foods made from cereals as these are the foods source of good energy we have.”

Food that was not commonly eaten by pregnant women in this community were raw meat, fish, uncooked vegetables and fruits. Although pregnant women were encouraged to eat meat, fish and fruits particularly at early months of pregnancy due to their nutrient values, most women would not afford to include them in their regular diets. Fruits were not also commonly harvested in the community, which limited their consumption. Raw meat and uncooked vegetables were avoided during pregnancy. These foods were taken to be sources of intestinal parasitic infection and women would not take medications for such infections during pregnancy.

Elaborating the issues, a pregnant women aged 22 who had 1 child explained “It is good to eat meat and vegetables. However, I have heard that I cannot take medication if I got infected with intestinal infections as my foetus will be hurt. It is very common that people got infected with tapeworm and amoebiasis after eating raw meat and vegetables. Therefore, I will not eat such foods and so will not another pregnant woman."

Various socio-cultural factors influence dietary preference and pattern of a pregnant woman in Dire Dawa. Social understandings and perceptions about the energy and nutrient quality of food groups strongly influence maternal dietary patterns. This community encourage women to eat cereals and pulses during pregnancy mainly reasoning that these food groups would give more energy and would be better for the health and growth of both for the mother and the foetus.

The influences of these cultural believe and perceptions are even plainly discernible on dietary patterns at the different trimesters of pregnancy. Pregnant women in this community are not encouraged to eat more food and diets considered to have high nutrient value during the ending months of pregnancy. Eating more foods and diets providing high calorie and nutrients, so assumed to be "heavy diets", during late pregnancy is believed to increase the weight of the foetus which would pose problems during labour and delivery. It was also culturally accepted that "heavy diets" during late pregnancy would progress labour thus leading to premature delivery.

Women were thus tabooed to eat porridge made of barley and millet, green vegetables, fruits like mango and fatty flesh foods during the late months of pregnancy, as such foods were among those considered to be "heavy diets" at the. Some of the participants also stated that drinking more fluids during late pregnancy was tabooed in some community as it was also believed that it would increase blood volume and weight of the foetus causing problems during labour and delivery.

A 27-year-old pregnant woman discussed, "we do not eat "genfo" made from cereals at late months. This food has high energy and makes the foetus grow fat and the women will have a problem during delivery. Drinking many fluids is not also good. It increases the blood volume of the mother and makes the foetus fat."

The community encourage pregnant women to eat more food and "heavy diets" only during mid-trimester of pregnancy as such diets were considered to support the health and growth of the baby and strength of the mother. Many of the interviewed pregnant women also agreed that eating more food during the early months of pregnancy would not be helpful as it might even worsen nausea and vomiting.

Many of the participants also argued that it was common for pregnant women to eat more food during their mid- trimesters due to regain of appetite. They explained that most women would encounter pregnancy-induced morning sickness, nausea, vomiting and anorexia during the early months and it would be in the mid-term that most women would have a good appetite to eat.

Arguing on the importance of eating more food during mid-term, a mother explained, “it is in the mid months of pregnancy that the baby in the womb grows more and the body parts are formed. That is when pregnant women need to eat more to support her baby.”

However, some of the interviewed women disputed that eating more food during the last weeks of pregnancy would be good as it would give the mother more energy and strength during labour.

Cultural misconceptions and taboos also influence the dietary practice of pregnant women in this community. Pregnant women were tabooed to eat lentil, cabbage, banana, yoghurt, ‘genfo’ (porridge made from maize), and ‘atmit’ (soup made of cereals) especially during the late months of pregnancy. Main reason explored was that these foods were misperceived that a pregnant woman who would eat such foods at the end months of pregnancy, the foods would pass to the foetus, stuck on its head and mouth upon delivery, and would kill the baby at birth.

A pregnant woman from Legahare Health Centre aged 30 explained, “I have seen many of my friend who used to eat bananas, cabbage and yoghurt while pregnant gave birth to babies with the white sticky thing on the babies’ heads and faces. Two of my friend lost the babies immediately after birth and we saw that the babies died as the white thing stuck on their mouth and nose and prevented breathing.”

Similar socio-cultural taboos related to food choices and intakes also influence dietary practices during pregnancy in other communities of Ethiopia. An exploratory qualitative study in Afar region showed that pregnant women in the community abstain from eating much during pregnancy and encourage to limit her diet in quantity and frequency to prevent the foetus from being large and thus avoid difficulty and bleeding during delivery from a large baby. Food groups considered as “good foods” due to their high-fat content like meat, camel milk and yoghurt are tabooed for pregnant women for similar reasons and they increase adherence to the food taboos as they become close to the end of their pregnancy (Hadush et al 2017:5-6). Another qualitative study in Arsi revealed that the most common dietary taboos during pregnancy were related to the consumption of green leafy vegetables like cabbage, yoghurt, cheese, sugar cane, and green pepper. Some study participants mentioned that in their culture it is believed that, if a pregnant woman eats leafy vegetables, especially after 8 months of gestation, the leaf passes to the womb and attaches to the baby’s head and form what they called “particles” (Zerfu, et al 2016b:4).

A study in the Northeast region showed 59.9% of had poor dietary practice while 39.9% of pregnant women practised avoiding food during their pregnancy for reasons like it makes the baby big (46.7%), cultural and religious influences (38.6%) and it makes delivery difficult (14.7%) (Alemayehu & Tesema 2015:710). About 35.8% of pregnant women in West east Ethiopia were found to have poor dietary practice while practised avoiding food during their pregnancy (Daba et al 2013b:109). Likewise, GAO et al (2013:2938) showed that 70.6% of studied pregnant women in Deyang City of China adhered to specific food taboos during their pregnancies, while 74% restricted their eating and 80% practised some food avoidance.

Accordingly, like many other communities in Ethiopia, socio-cultural perceptions and taboos influence the dietary practice of pregnant women in Dire Dawa particularly at the different stages of pregnancy. The consumption of fruits, vegetables, fatty fleshes and fluids are apparently influenced by these socio-cultural misperceptions and taboos.

4.3. CONCLUSION

In this chapter, the findings of the research were described, presented and analysed towards addressing the hypothesis and main objectives of the study intervention. The researcher constructed the descriptions and interpreted the analyses based on changes in the outcome variables put to answer the study hypothesis before and after the study intervention, which included: haemoglobin levels, anaemia prevalence, minimum dietary diversity of women score (M-DDSW), frequency of consumption of iron-rich foods, frequency of consumption of vitamin-c rich fruits and vegetables, frequency of consumption dietary iron inhibitors and enhancers through dietary modification behaviours, nutritional knowledge and attitude on iron deficiency and anaemia, and food preparation and preservation practice.

This chapter also discussed results providing possible explanation attributed to the observed independent difference between the intervention groups and for significant associations between studied variables. Although few types of research, which addressed the interesting hypothesis of this study conducted in Ethiopia were identified, the findings of the study were compared and interpreted with other similar researches. Therefore, the next chapter discusses the conclusion and recommendations of this research generated based on descriptions and interpreted results of chapter four.

CHAPTER 5

DEVELOPMENT OF FRAMEWORK FOR INTEGRATED FOOD-BASED STRATEGY

5.1. INTRODUCTION

In Chapter 4 the data analysis, presentation and interpretation of the research findings were reported. In Chapter 5 these findings are presented towards addressing the research objectives and hypothesis. The chapter also discusses the process used to develop a framework for an integrated food-based strategy to improve the iron status of pregnant women based on these research findings. Description of the proposed strategy is also tailored inline to the food-based strategy's interventions identified by this research to effective, their targets at different levels of the stake, their implementations and monitoring to mitigate consequences of iron-deficiency and anaemia during pregnancy.

5.2. OVERVIEW OF RESEARCH FINDINGS

For this intervention study, a total of 329 pregnant women who fulfilled the initial inclusion criteria were screened for anaemia. Out of those, 197 pregnant women were identified to be anaemic (Haemoglobin less than 11 gm/dl). Accordingly, the prevalence of anaemia of among pregnant women in Dire Dawa was 59.9%, of whom 29.4% had mild anaemia, 69.5% were moderately anaemic and only 1.1% were severely anaemic. After excluding the severely anaemic, 195 pregnant women were recruited and randomized into two treatment groups and one control group at 1:1 ratio.

Pregnant women in intervention group 1 were intervened with dietary-based vitamin C supplementation and nutrition education. Pregnant women in intervention group 2 were intervened with only nutrition education; while pregnant women in the control group were without any intervention. At the end of the intervention, 186 participants completed the 12 weeks' intervention and were included in the final analysis resulting 95.3% compliance rate, which did not significantly vary among the intervention groups.

At enrolment to the study intervention, the mean duration of pregnancy (gestational age) was 21.86 ± 0.24 weeks. The mean age of the pregnant women was 26.43 ± 0.37 years, the majority were (142) were Oromo (76.3%) ethnically and Muslim (87%) was the dominant religion. The mean family size was 3.7 ± 0.13. The mean family size was 3.7 ± 0.13. The mean gravida and parity were 1.89 ± 0.14 and 2.14 ± 0.12 respectively. All of the study participants were enrolled during their second trimesters of pregnancy while attending ANC visit. About 68% of the studied pregnant women were prescribed iron-folic acid tablets during their ANC visits but 11.3% stopped intake as prescribed by the end of the intervention. The intervention groups had no significant differences in their baseline characteristics.

At enrolment, the mean haemoglobin level of the pregnant women in Dire Dawa at enrolment was 9.52 ± 0.04gm/dl. By the end of the study, the overall mean haemoglobin level significantly increased to 9.84 ± 0.08gm/dl. Intervention group 1 had significantly higher haemoglobin level compared to intervention group 2 by 0.361 ± 0.17gm/dl and the control by 0.90 ± 0.17 gm/dl respectively. Intervention group 2 had 0.54 ± 0.17gm/dl significantly higher mean haemoglobin level than the control. The difference from enrolment level for intervention group 1 was 0.77 ± 0.11gm/dl and for intervention group 2 was 0.398 ± 0.073gm/dl. However, the mean haemoglobin had significantly decreased by -0.193 ± 0.05gm/dl in the control group.

By the end of this randomized controlled trial study, the prevalence of anaemia was 84% which significantly decreased by 16% from baseline. About 29% of women in intervention group 1 and 19.7% of women in intervention group 2 were not anaemic. However, all women in the control group were still anaemic.

Staple foods (grains and cereals) dominate the dietary preference of the pregnant women after pregnancy. At enrolment, the overall mean MCF per day for the past 24-hours was 3.02 ± 0.07 per day and did not significantly change at end-line. Both the past 24-hours and past 7-days (table 4.6) dietary diversity of pregnant women in Dire Dawa was dominated by cereals, other vegetables and pulses. At baseline, iron-rich food groups (meat/fish) were consumed by 24% of the women, while dark green leafy vegetables was by 25% and vitamin A-rich FVs by 25%. Other fruits and other vegetables were consumed by 20% and 82% of the women respectively. Tea/coffee was consumed on average for 4.73 ± 0.16 days of the week. The overall past 24-hour mean of minimum dietary diversity of women score (M-

DDSW) for pregnant women in Dire Dawa was 3.78 ± 0.1. About 71.5% had "low dietary diversity" (M-WDDS < 5) and 28.5% had "high dietary diversity" (M-WDDS 5+).

Although the dietary diversity and consumptions food groups were not statistically different across the intervention groups except for nuts at baseline, the minimum dietary diversity of women score (M-DDSW) and both the past 24-hours and past 7-days consumption of specific food groups statistically increased in intervention group 1 and intervention group 2 than the control by the end of the intervention. The control group had lesser consumption of cereals, pulses, nuts, dark green leafy vegetables, vitamin A-rich fruits and vegetables and other fruits compared to the other two groups. Furthermore, intervention group 1 and intervention group 2 had significantly higher proportion of women who had "high dietary diversity" than the control, while intervention group 1 also had a significantly higher proportion of women in the "high dietary diversity" category and a higher proportion of women who consumed other fruits and another vitamin A-rich FVs compared to intervention group 2. Compared to the baseline value, the overall past 24-hours mean M-DDSW of pregnant women significantly increased by 2.42 ± 0.14 and 2.39 ± 0.24 in intervention group 1 and intervention group 2 respectively. However, the change was insignificant in the control group. However, this study found no significant difference in the past 24-hours consumption of meat/ fish (iron-rich foods).

The results of this randomized controlled trial study also showed that nutrition education has a significant positive effect on the modification of such maternal dietary behaviours towards intake of dietary enhancers and inhibitors of iron among pregnant women. Intervention group 1 and intervention group 2 had significantly higher proportion of women who modified their practice and commonly consumed vitamin C-rich fruits and vegetables together with other dishes during mealtimes, significantly lesser mean intake of tea/ coffee during the past 7-days and significantly increased the proportion of women who avoided tea/coffee intake immediately after or together with meals than the control group by the end of the intervention.

The study interventions are also found to be effective in improving and retaining nutritional knowledge of iron-deficiency and anaemia among pregnant women in Dire Dawa. Intervention group 1 and intervention group 2 had significantly higher proportions of women with knowledge in all of the nutritional categories, higher mean nutritional knowledge score, significantly higher change from baseline nutritional knowledge scores and a higher proportion of women who had average and good nutritional knowledge than the control by the end of the intervention. None of the pregnant women in both intervention group 1 and intervention group 2 had “poor nutritional knowledge”, in contrary 97% of the pregnant women in the control group still had “poor nutritional knowledge” by the end of the intervention.

Moreover, this study analysed the effect of the combined dietary intervention (FBS) with the addition of dietary vitamin C intervention along with the nutrition education among women enrolled to intervention group 1 compared to the only nutrition education intervention provided to intervention group 2. The comparison between the two intervention groups also analyses the isolated effect of dietary vitamin C intervention on haemoglobin and anaemia level.

Intervention group 1 had significantly 0.361 ± 0.17gm/dl higher mean haemoglobin level; higher change in mean haemoglobin from baseline; significantly decreased prevalence of anaemia; significantly higher proportion of women in the “high dietary diversity” category; and higher proportion of women who consumed other fruits and another vitamin A-rich FVs in past 24-hours compared to intervention group 2. Their differences can thus be attributed to the effect of additional dietary vitamin C intervention in the intervention group

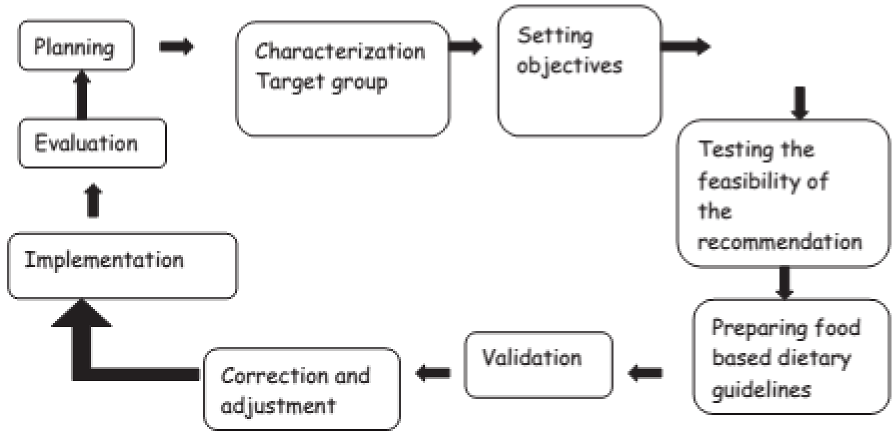
The qualitative results of this study also showed that various socio-cultural factors influence dietary preference and pattern of a pregnant woman in Dire Dawa. Social understandings and perceptions about the energy and nutrient quality of food groups strongly influence maternal dietary patterns. The influences of these cultural believe and perceptions are plainly discernible on dietary patterns at the different trimesters of pregnancy. Pregnant women in this community are not encouraged to eat more food and diets considered to have high nutrient value during the ending months of pregnancy. Eating more foods and diets providing high calorie and nutrients, so assumed to be “heavy diets”, during late pregnancy is believed to increase the weight of the foetus which would pose problems during labour and delivery. It was also culturally accepted that “heavy diets” during late pregnancy would progress labour thus leading to premature delivery.

Cultural misconceptions and taboos also influence the dietary practice of pregnant women in this community. Pregnant women were tabooed to eat lentil, cabbage, banana, yoghurt, ‘genfo’ (porridge made from maize), and ‘atmit’ (soup made of cereals) especially during the late months of pregnancy. Main reason explored was that these foods were misperceived that a pregnant woman who would eat such foods at the end months of pregnancy, the foods would pass to the foetus, stuck on its head and mouth upon delivery, and would kill the baby at birth.

5.3. DEVELOPMENT OF FRAMEWORK FOR INTEGRATED FOOD-BASED STRATEGY

The overall goal of food-based strategies, also referred to as dietary diversification and modifications (DDM), is to enhance the availability of, access to and utilization of foods with high content and bioavailability of micronutrients throughout the year (FAO 2014:20; FAO 2011:270). Food-based dietary guidelines provide guidelines for food consumption for the general population and if desired could be developed for specific population groups (Sirichakwal, Sranacharoenpong & Tontisirin 2011:1). In general, food-based dietary guidelines aim to assist the healthy population in following nutrition and related health recommendations (Albert, Samuda, Molina, Regis, Severin, Finlay & Prevost 2007:344). Food-based strategies and guidelines are tools for communication and education to create demand for healthy diets and desirable eating behaviours leading to nutritional well-being and prevention of diet-related (FAO & WHO 2006:7).

The development of food-based strategies is a comprehensive process. The researcher adopted the methodology to develop this food-based strategy from the steps for developing food-based guidelines stated in Pena and Molina (Cited in Albert et al 2007:345). Figure 5.1 shows the steps adapted to develop this framework for food-based strategies.



Source: Pena and Molina (Cited in Albert et al 2007:345).

Figure 5.1 Steps followed for the development framework for a food-based strategy to improve the iron status of pregnant women

5.3.1. The process of development of an integrated food-based strategy

Basic data and information needed for formulation and development of guidelines include food, nutrition, health problems and issues; food consumption pattern, dietary culture, habit and; basic health and education services including the infrastructure and current practices in food and nutrition education (Sirichakwal et al 2011:1). National policies and strategies are also the bases for the development of strategies to meet the specific health needs of a nation's population.

5.3.1.1. Ethiopian national strategy for prevention and control of iron deficiency

The Ethiopian Health Sector Transformation Plan (2016-2020) targets to reduce the prevalence of anaemia in women of childbearing age and pregnant women from 17% to 12% within the five years (GFDRE 2015:165). The National Nutrition Strategy (NNS) forwards comprehensive set of interventions and initiatives to meet this targets which include: comprehensive and routine nutritional assessment and counselling services, maternal adequate intake of diversified diet, supplementary food for malnourished pregnant/ lactating women, routine iron-folic supplements or multiple micronutrient supplementation, de-worming during second and third trimester, free distribution and use of insecticide-treated mosquito nets (ITNs) and involvement of women groups in nutrition-sensitive agricultural and livelihood programs (GFDRE 2013:17).

These strategic directions formulated the base for development of the food-based strategy framework. However, to the knowledge of the researcher, no national food-based strategy addressing iron deficiency and anaemia during pregnancy is identified and reviewed in this study.

5.3.1.2. Targets of the framework for integrated food-based strategy

Primary target groups of the food-based strategy are pregnant and reproductive age women who will have the biggest impact on reaching the intended outcomes which, in this study, improving iron status and thus reducing iron deficiency and anaemia during pregnancy. The secondary target groups identified are people or groups that can influence and support the sustained dietary behaviour and practice of the pregnant and reproductive age women including health professionals and health care service providers involved in maternal dietary counselling and family members involved in household dietary modification practices. The tertiary target groups of the strategy are those who have indirect influences in reinforcing sustained dietary behaviour and practice of the pregnant and reproductive age women by enabling the supportive policy-environment system. Thus included are politicians and high-level government officials at the different levels of health care service delivery system, influential religious and community leaders, non-governmental stakeholders and community structures.

5.3.1.3. Characterization of the primary target groups

The analysis and interpretation of this research identified the characteristics of the pregnant women in terms of prevalence of anaemia, nutritional knowledge on iron deficiency and anaemia, dietary consumption patterns, dietary modification practices, food preparation practices and socio-cultural influences on maternal diets. The framework for the food-based strategy is thus formulated and directed based on these findings.

5.3.1.4. Objectives of the framework for integrated food-based strategy

The main objective of the framework is to prevent and control iron deficiency and anaemia and their consequences during pregnancy by designing integrated food-based strategy focussing on nutritional knowledge, dietary diversification, dietary modification, food preparation and preservation methods which will improve the iron status of pregnant women.

5.3.1.5. Testing the effect of key components of the proposed integrated food-based strategy in improving iron status of pregnant women

This randomized controlled trial study intervened integrated food-based strategies among pregnant women in Dire Dawa. Accordingly, the conclusions of this study in relation to the research objectives, which are the effects of the interventions of food-based strategies on iron status and, which formulated the key components of the developed framework are discussed as follows.

5.3.1.5.1. Effect of nutrition education intervention as a component of food-based strategy on maternal haemoglobin level and anaemia prevalence (iron status) during pregnancy

This study concludes that the nutrition education intervention provided through food-based strategy approach was effective in improving maternal haemoglobin level during pregnancy in Dire Dawa. The study also concludes that the nutrition education intervention provided through food-based strategy approach was effective in reducing anaemia during pregnancy in Dire Dawa. Pregnant women in the two intervention groups with the nutrition education intervention had significantly higher mean haemoglobin level and lower prevalence of anaemia than the control after the intervention.

5.3.1.5.2. Effect of dietary diversity and modification as a component of food-based strategy on maternal haemoglobin level and anaemia prevalence (iron status) during pregnancy

This study concludes that haemoglobin and anaemia levels have a significant relationship with dietary diversity during pregnancy in Dire Dawa. Pregnant women with “high dietary diversity” had 0.802 ± 0.15gm/dl significantly higher mean haemoglobin level than those with “low dietary diversity”. Furthermore, dietary diversity has a significant negative effect on anaemia prevalence during pregnancy in Dire Dawa. All of the non-anaemic women had “high dietary diversity” in both intervention groups of the study.

5.3.1.5.3. Effect of dietary-based vitamin C supplementation intervention as a component of food-based strategy on maternal haemoglobin level and anaemia prevalence (iron status) during pregnancy

This study analysed the isolated effect of dietary vitamin C intervention on haemoglobin and anaemia level by comparing intervention group 1 with intervention group 2. Intervention group 1 had significantly 0.361 ± 0.17gm/dl higher mean haemoglobin level compared to intervention group 2. Intervention group 1 also had higher change in mean haemoglobin from baseline (0.77 ± 0.11gm/dl) than intervention group 2 had (0.398 ± 0.073gm/dl). Furthermore, the prevalence of anaemia significantly decreased more in intervention group 1 (29%) than in intervention group 2 (14.8%).

Consequently, the study concludes that dietary-based vitamin C supplementation provided through food-based strategy approach was effective in improving maternal haemoglobin level during pregnancy in Dire Dawa. The study also concludes that the dietary-based vitamin C supplementation intervention provided through food-based strategy approach was effective in reducing anaemia prevalence during pregnancy in Dire Dawa.

5.3.1.5.4. Effect of integrated interventions of food-based strategy on maternal haemoglobin level and anaemia (iron status) during pregnancy

Most importantly, the study concludes that integrated dietary-based interventions as a component of food-based strategy have significantly more positive effect than standalone nutrition education intervention in improving maternal haemoglobin level, reducing the prevalence of anaemia, improving dietary diversification, increasing consumption of vitamin C-rich fruits and vegetables (dietary enhancers of iron absorption), adoption of dietary modification behaviours and improving practice of food preparation and preservation methods among pregnant women in Dire Dawa. Pregnant women within intervention group 1 intervened with dietary-based vitamin C supplementation integrated with nutrition education had a significantly higher difference in mean haemoglobin level and lower anaemia prevalence from the controls than pregnant women in intervention group 2 with the nutrition education intervention only had with the controls. The significant change in mean haemoglobin level from baseline was higher for pregnant women in intervention group 1 than in intervention group 2. Furthermore, pregnant women intervened within intervention group 1 had a significantly higher proportion of pregnant women with high dietary diversity, higher consumption of vitamin C-rich fruits and vegetables, the higher practice of dietary modifications behaviours on enhancers and inhibitors of iron than the control.

5.3.1.5.5. Effect of nutrition education as a component of food-based strategy on maternal dietary diversity during pregnancy

From the findings of this study by the end of the interventions, the study concludes that the nutrition education intervention was also effective in improving dietary diversity of pregnant women in Dire Dawa. Pregnant women in the two intervention groups with the nutrition education intervention had significantly higher mean minimum dietary diversity of women score (M-DDSW) and a significantly higher proportion of women who had “high dietary diversity” than the control after the intervention.

5.3.1.5.6. Effect of nutrition education as a component of food-based strategy on consumption of iron-rich and vitamin C-rich foods

The study concludes that the nutrition education intervention was effective in increasing the consumption of vitamin C-rich foods during pregnancy among pregnant women in Dire Dawa. Pregnant women in the two intervention groups with the nutrition education intervention had significantly higher consumption of another vitamin A-rich fruits and vegetables, dark green leafy vegetables and other fruits than the control after the intervention. However, the nutrition education intervention showed no significant effect on the consumption of meat/ fish (iron-rich foods) after the intervention.

5.3.1.5.7. Effect of nutrition education as a component of food-based strategy on maternal dietary modification behaviours during pregnancy

This study concludes that nutrition education was effective in the modification of maternal dietary behaviours towards intake of dietary enhancers and inhibitors of iron among pregnant women in Dire Dawa. Significantly higher proportion of pregnant women in intervention group 1 and intervention group 2 with the nutrition education intervention modified their dietary behaviour and commonly consumed vitamin C-rich fruits and vegetables together with other dishes during mealtimes and avoided intake of tea/coffee immediately after or together with meals and had significantly decreased past 7-days mean intake of tea/coffee than the control by the end of intervention.

5.3.1.5.8. Effect of nutrition education as a component of food-based strategy on nutritional knowledge of iron-deficiency and anaemia during pregnancy

This study concludes that nutrition education was effective and significantly improved the nutritional knowledge on iron-deficiency and anaemia of pregnant women in Dire Dawa. Pregnant women in the two intervention groups with the nutrition education intervention had significantly higher mean Nutritional Knowledge Score (NKS) and good nutritional knowledge level than the control after the intervention.

5.3.1.5.9. Effect of nutrition education as a component of food-based strategy on knowledge and practice of food preparation and preservation methods

This study concludes that nutrition education was effective in improving knowledge and practice of food preparation and preservation methods among pregnant women in Dire Dawa. A significantly higher proportion of pregnant women in the two intervention groups with the nutrition education intervention knew and practised at least one food preparation and preservation method than the control after the intervention.

5.3.1.6. Development of an integrated food-based strategy for improving the iron status of pregnant women

This study thus developed the following food-based strategy framework to improve the iron status of pregnant women and thus could be employed to direct national and local nutritional strategies and intervention, health care service delivery approaches and community-based dietary intervention to prevent and control iron deficiency and anaemia and their consequences during pregnancy. The framework is also used to forward feasible recommendation may also be considered at different levels of program designing and implementation with respect to iron deficiency and anaemia among pregnant women.

Figure 5.2 displays the framework for integrated food-based strategy developed directed by the research findings and conclusions on the research objectives.

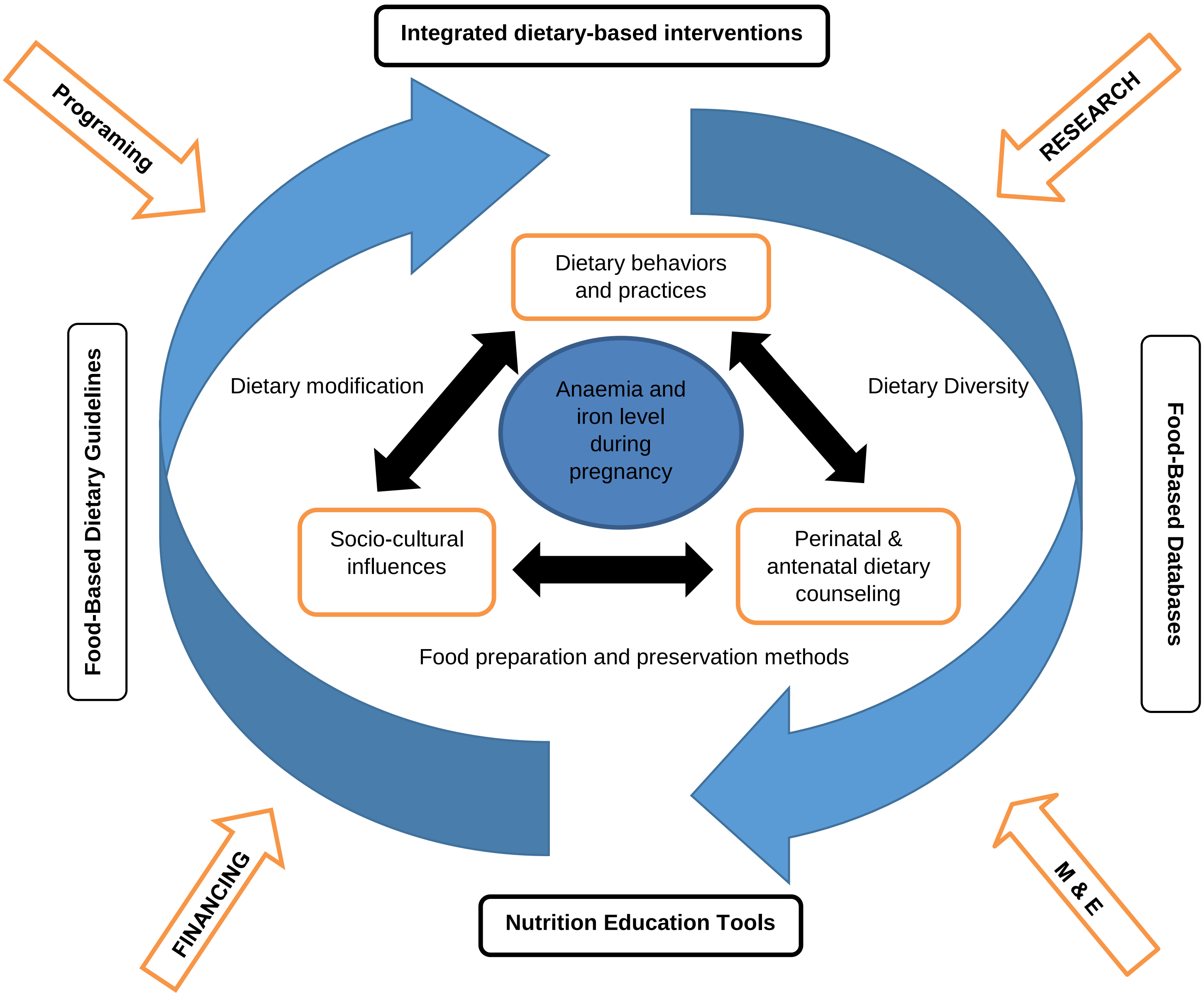


Figure 5.2 An integrated food-based strategy developed for improving the iron status of pregnant women in Dire Dawa, 2018

Inline to the developed framework, for integrated food-food based strategies to be effective in improving iron status and thus in reducing prevalence of anaemia among pregnant women, the strategy should focus on interventions recognizing and addressing the dietary behaviours and practices of pregnant and reproductive age women, adequacy of nutrition information provided by health care service providers through perinatal & antenatal dietary counselling and the existing socio-cultural influences on maternal dietary preferences at the different stages of pregnancy. When integrated at these levels, the integrated strategies will be effective in improving dietary diversity, dietary modification and adoption of food preparation and preservation methods

Therefore, nutrition education interventions should be delivered based on tools designed focusing on food-based approaches which should influence dietary behaviour and practices before and during pregnancy periods. Pregnant and reproductive age women should be delivered with adequate nutrition information containing key messages that promote improved intake of bioavailable iron through consumption of more diversified diets and increased intake of foods rich in dietary sources of enhancers of bioavailable iron absorption like vitamin C rich fruits and vegetables, dark green leafy vegetables and flesh foods (meat, organs meat and fish). Nutrition education tools should also deliver message to improve knowledge and practices on proper dietary modification behaviours and adoption of food preparation and preservation methods, which are essential components of food-based strategies to decrease intake of foods rich in inhibitors of bioavailable iron absorption, adopt and practice food preparation methods that decrease amount of inhibitors of bioavailable iron absorption in plant-based foods like cereals and grains, and and practice household preservation technics to preserve the amount of iron, vitamin C and nutrients in foods.

The key messages of the nutrition education tool should promote Pregnant and reproductive age women to:

- Eat more diversified food to increase protein, energy and micronutrient intakes:
    - Eating 2 to 3 servings of meat, fish, nuts or legumes.
    - Eating 2 to 3 servings of dairy (milk, eggs, yoghurt, cheese).
    - Eating 3 servings of whole grain bread, cereals, or other carbohydrates.
    - Eating 2 servings of green vegetables; 1 serving of yellow vegetables.

    - Eating 3 servings of fruits.
- Eat more amounts of foods rich in iron such as animal source 2-3 times a day.
- Eat or drink more amounts of foods which enhance iron absorption such as vitamin C-rich fruits and vegetables like orange juice, pineapple, mango, cabbage, carrots, or cauliflower.
- Eat or drink more amounts of Vitamin C fruits and vegetables combined with plant foods rich in iron like Teff, Beans, Millet, Wheat, Sorghum Groundnuts, Rice and green leafy vegetables like Spinach, Sweet potato, Cabbage.
- Eat or drink Vitamin C fruits and vegetables at the time of meals i.e during meals
- Eat less amount of foods that inhibit iron absorption such as plant source foods.
- Decrease intake of tea, coffee or cocoa from what was in her pre-pregnancy days.
- Avoid drinking tea, coffee, milk or cocoa together or immediately after a meal.
- If taken, separate tea, coffee, milk or cocoa from mealtime – take one or two hours after a meal. This is because that effect of such foods in inhibiting iron absorption will decrease as most of the foods eaten will be digested by this time.
- Avoid alcohol use and smoking.
- Practice food preparation techniques to decrease inhibitors of iron in plant-source diets like:
    - Soak cereals and legumes like peas, beans, kidney beans, millet, wheat, and Sorghum in cold water before cooking. Pour off the water and use new water to cook them.
    - Fermentation of grain and cereals
    - Malting
    - Thermal processing
- Practice food preparation techniques to preserve iron and vitamin C contents like:
    - Cook foods in cast iron pots or pans to enhance their iron contents.
    - Cook beans with tomatoes.
    - Cook vegetables 2-3 minutes close to serving time as possible to avoid loss of nutrients.
    - Vegetables should be served firm to the bite, pleasantly crunchy and crisp-tender to avoid overcooking.

An integrated food-based strategies should also address health care providers and the general public environment as these are the centres for delivering nutrition information. Maternal health care providers should be trained on the nutrition education tools developed based on food-based strategy and deliver adequate prenatal and antenatal dietary counselling to pregnant and reproductive age women concerning risks associated with anaemia, proper dietary diversity and modification during pregnancy, weight gain, iron-folic acid intake and other key messages. Maternal health care providers and health facilities should also be equipped with nutrition education tool guidelines and supportive teaching aids and materials.

For the food-based strategy to be more effective and sustainable, integrated dietary-based interventions and key messages of nutrition education tools should also be tailored locally to be well feasible to the cultural, social and economic environments in which pregnant and reproductive age women live. The strategy should be supported with activities like social mobilization, community-based awareness promotion campaigns and mass media communications targeting family members, influential religious and community leaders to address socio-cultural influences posing dietary misconsumption and taboos at different stages of pregnancy.

Engaging policy makers and other stakeholders for creating evidence-based policy is a major prerequisite for a food-based strategy to materialize. The prioritized policy decisions would spearhead the major change, which needs to be ingrained in the population (Naier et al 2016:7). Based on the developed food-based strategies of this study (figure 5.1), national nutritional policies and strategies addressing iron deficiency and anaemia should properly design and put in place food-based databases and food-based dietary guidelines that shows the dietary consumption pattern of the population segmented to the priorities of pregnant and reproductive-aged women. Modifications in prioritizing policy decisions are the need of the hour. For adopting the sustainable strategy, there is a need to generate evidence through a food database and dietary guidelines (Naier et al 2016:13). National nutritional policies and strategies guided based on gaps in dietary intakes derived from such evidence should strive to design appropriate integrated dietary-based interventions and nutritional education tools tailored to addressing the whole food-based approach of pregnant women.

Furthermore, for effective implementation of such food-based strategy, appropriate programming should be supported with sustainable financing system and monitoring and evaluation frameworks involving all stakeholders and partners at all levels. Continuous development of the strategies should also be consolidated based on evidence generating from scientific and implementation researches. The framework considers that scientific evidence from researches are essential to further validate and disseminate the food-based strategy.

5.3.1.7. Review, correction and adjustment of the strategy

If food-based guidelines are correct technically, but they are not understood, remembered, and applied by the target for whom they are intended, they will not fulfil their purpose. The guidelines should be tested with representatives of the target population to determine whether or not the messages were understood, relevant, acceptable, and persuasive (Albert et al 207:346).

After the development, the proposed strategy framework inculcating the intervention modalities and the nutrition education tool was disseminated to health experts at Dire Dawa Administration Health Bureau, health professionals providing maternal and child care services at health centres and hospitals, nutrition program experts in non-governmental organizations and researchers. These panel of experts were instructed to assess the determine whether or not the strategy, its interventions and messages were:

- Clearly understood, locally relevant, acceptable, feasible and persuasive.
- User-friendly which can easily be used health workers and relevant stakeholders.
- Result oriented and feasible to be monitored with clear indicators.
- Cost-effective in terms of availability of resources and health system capacity.
- Adoptable and can further be validated.

A forum was then organized to review the strategy framework involving 2 health experts from Dire Dawa Administration Health Bureau, 14 health professionals providing maternal and child care services at health centres and hospitals and 1 nutrition program expert from a non-governmental organization. Written feedback on the review was also obtained from 2 researchers.

The main feedbacks obtained from the reviews were that all reviewers agreed that the developed strategy contained interventions and messages tailored towards an integrated food-based approach are easily understood, locally feasible, relevant and implementable. They agreed that the strategy addresses effective interventions that could easily be locally adopted. However, the main suggestion forwarded in the framework was that it should better be translated into the different local languages and checked for its consistency. The reviewers also recommended that the strategy lacks communication strategy and data on the dietary pattern of the administration based on reports of food-based databases; which were, of course, are considered to be beyond the scope of the strategy and limitations of the availability of food-based databases in Dire Dawa and national food-based dietary guidelines for pregnant women. Most importantly, the reviewers recommended that the strategy should be further validated by subsequent research for its scale-up.

Based on all inputs and feedbacks of the reviewers, the strategy was corrected and further developed as presented in the previous section of this chapter. The final draft of the strategy will be redistributed to the relevant stockholders after the completion of this research project.

5.3.2. Implementation approaches of the

Implementation of the developed strategy demands multisectoral approach requiring the stake, coordination, collaboration and full participation at all levels from policy makers down to the grass-roots community level.

The stake of policymakers and program designers:

- should properly design and put in place food-based databases and food-based dietary guidelines that shows the dietary consumption pattern of the population segmented to the priorities of pregnant and reproductive-aged women.
- should redirect and design food-based dietary guidelines based on the proposed interventions of this food-based strategy to address iron deficiency and anaemia among pregnant and reproductive-aged women.
- should redirect and design integrated dietary-based intervention packages based on the proposed interventions of this food-based strategy framework to address iron deficiency and anaemia among pregnant and reproductive-aged women.

- should redirect and design nutrition education tools with key messages based on the proposed interventions of this food-based strategy framework to address iron deficiency and anaemia among pregnant and reproductive-aged women.
- should redirect and design proper monitoring framework and health care financing systems for this food-based strategy framework to be implemented properly and produce sustainable effects in prevention and control of iron deficiency and anaemia among pregnant and reproductive-aged women.

The stake of Dire Dawa Administration and health facilities:

- should adopt and redirect locally feasible integrated dietary-based intervention packages and nutrition education tools based on the proposed interventions of this food-based strategy framework to address iron deficiency and anaemia among pregnant and reproductive-aged women.
- should eliminate this food-based strategy framework to all relevant stakeholders.
- should create familiarization forums among all relevant stakeholders to introduce and properly implement this food-based strategy framework for all relevant stakeholders.
- Should provide training for health care providers on the components of this food-based strategy framework.
- Should avail the nutrition education tool guidelines and supportive teaching aids and materials for health care providers at the health facility and community level.
- Should design proper monitoring framework and health care financing systems for this food-based strategy framework to be implemented properly and produce sustainable effects in prevention and control of iron deficiency and anaemia among pregnant and reproductive-aged women.

The stake of health care providers:

- should mobilize pregnant and reproductive-aged women and the community for full participation and ownership.
- should be committed and professional ethics to deliver adequate prenatal and antenatal dietary counselling
- should properly document, report and monitor the results of interventions

The stake of research institutions, universities and non-governmental organizations:

- should be engaged in implementation researches to further validate and consolidate this framework based on scientific evidence.
- should be engaged in monitoring, evaluation and support for the sustained financial system.

5.3.3. Monitoring and evaluation of the strategy

Monitoring and evaluating the effectiveness of the strategy and its intervention will be done through a review of accomplishment reports, review of nutritional and haematologic surveillance data, dietary surveys and implementation research. Joint planning involving all stakeholders and partners to design monitoring and evaluation framework needs to be drawn up during the initial implementation stage of strategy.

The following indicators can be employed for monitoring and evaluation of the effectiveness of the strategy:

- Prevalence of iron deficiency among pregnant and reproductive age women.
- Prevalence of iron-deficiency anaemia among pregnant and reproductive age women.
- Prevalence of anaemia among pregnant and reproductive age women.
- A number of health workers trained on the framework for integrated food-based strategies and nutrition education tool.
- A number of health facilities providing prenatal and antenatal dietary counselings based on the framework for integrated food-based strategies and nutrition education tool.
- A number of pregnant and reproductive age women provided with prenatal and antenatal dietary counselings based on the framework for integrated food-based strategies and nutrition education tool.
- Adequacy of information provided to pregnant and reproductive age women through prenatal and antenatal dietary counselings by maternal health care providers.
- The compliance rate of iron-folic acid intake among pregnant and reproductive age women.
- Level of dietary diversity among pregnant and reproductive age women.

- Level of consumption of iron-rich foods among pregnant and reproductive age women.
- Level of consumption of vitamin C-rich fruits and vegetables among pregnant and reproductive age women.
- A number of social mobilization and community advocacy activities on socio-cultural influences.
- Availability and accessibility of dietary guidelines adopted based on the framework for integrated food-based strategies and nutrition education tool.
- A number of data quality assurance activities conducted.
- Availability of updated food-based databases and food-based dietary guidelines and policy.
- Level of engagement, collaboration, participation and involvement of the community and relevant stakeholders.
- Availability of continues nutritional and haematologic surveillance data information management system.
- Implementation resecrhes and studies conducted and level of utilization of findings and recommendations.
- Availability of sustained financing mechanism for implementation.

Consequently, for the monitoring and evaluation system of the developed strategy framework to be effective, there needs to be a proper information management system for timely and appropriate utilization of reports, feedbacks and feedforwards integrating the relevant stakeholders at all level. The monitoring and evaluation system needs to be supported with regular supportive supervision, quarterly and annual review workshops and timely dissemination of results.

5.3.4. Resources and budget

Vital stakes of Dire Dawa Administration Health Bureau, health facilities, non-governmental organizations and other partners need to be designing sustainable health care financing for implementation of the strategy. Systems should be in place to mobilize and advocate the community to fully participate and engage at levels of program designing, implementation and progress monitoring so that ownership would create for sustainable resource mobilization and building the capacity of the health care financing.

5.4. CONCLUSION

This chapter presented the overview of the findings of the research and the process applied to develop integrated food-based strategy framework for improving the iron status of pregnant women based on the conclusions made on the effects of the study interventions. The chapter also discussed the developed integrated food-based strategy and interpreted the recommended interventions of the strategy, the implementation approach, validation process and its monitoring mechanisms. The next chapter presents the conclusions and recommendations of the research.

CHAPTER 6

CONCLUSIONS, AND RECOMMENDATIONS

6.1. INTRODUCTION

Chapter 6 concludes the findings and interpretations of this research based on the detailed analyses and discussions of chapter 4 and chapter 5. The conclusions discussed in this chapter are presented towards answering the research objectives and hypothesis. The chapter also discusses the feasible recommendations forwarded to address the research problem.

6.2. RESEARCH DESIGN AND METHOD

The study mainly applied a quantitative approach employing a parallel randomized single-blinded controlled intervention with three arms with an allocation ratio of 1:1 and tested the research hypothesis; whether food-based strategies integrating increased intake of dietary-based ascorbic acid through supplementation of vitamin C-rich fruits with nutrition education intervention for modification of dietary behaviours and practices increased haemoglobin level; decreased anaemia and thus improved iron status of pregnant women in Dire Dawa. A qualitative approach was also employed to explore the socio-cultural influences on maternal dietary practices and supplement the quantitative data.

The study enrolled 195 pregnant women while attending their first ANC at 4 randomly selected health centres in Dire Dawa, who were randomly allocated to one of the two intervention groups or control group and were followed for 12 intervention weeks. Study participants in intervention group 1 were intervened with nutrition education and daily supply of vitamin C-rich fruit (mango and orange) juice providing about 90mg/day of vitamin C divided into three doses. Study participants in intervention group 2 were intervened with only nutrition education; and the control with no intervention. Total of 186 participants completed the randomized controlled trial resulting in 95.3% compliance rate, which did not significantly vary among the intervention groups. Independent differences and changes in means of haemoglobin level, M-DDSW, MFC of iron and vitamin C rich foods, nutritional knowledge score and dietary modification practices and proportions on the anaemia prevalence were compared between and analyzed within the study groups at baseline and end of the study intervention were analysed to measure the treatment effect of this randomized controlled trial research.

6.3. SUMMARY OF THE RESEARCH FINDINGS

6.3.1. Maternal haemoglobin level and anaemia prevalence at end of the intervention

The overall mean haemoglobin level of the studied pregnant women in Dire Dawa was 9.84 ± 0.08gm/dl. The mean haemoglobin level in intervention group 1 and intervention group 2 was 10.26 ± 0.15gm/dl and 9.9 ± 0.13 m/dl respectively, while the control group had 9.36 ± 0.07gm/dl. Controlling baseline difference, intervention group 1 had significantly 0.361 ± 0.17gm/dl higher haemoglobin level compared to intervention group 2 (p=0.04) and significantly 0.90 ± 0.17gm/dl higher than the control. Intervention group 2 had 0.54 ± 0.17gm/dl significantly higher mean haemoglobin level than the control.

Compared to the enrolment, the overall mean haemoglobin level of the studied pregnant women in Dire Dawa significantly increased by 0.322 ± 0.056gm/dl by the end of the intervention. Intervention group 1 and intervention group 2 also had significantly increased haemoglobin level by 0.77 ± 0.11gm/dl and 0.398 ± 0.073gm/dl respectively. However, the mean haemoglobin had significantly decreased by -0.193 ± 0.05gm/dl in the control group.

Concerning the anaemia level at the end of the intervention, the prevalence of anaemia among pregnant women in Dire Dawa significantly decreased by 16%. The level of anaemia significantly differs across the groups. About 18 (29%) women in intervention group 1 and 12 (19.7%) women in intervention group 2 were not anaemic (Hg >10.9 g/dl) by the end of the intervention. However, all women in the control group were still anaemic (Hg <11.0 g/dl).

6.3.2. Maternal dietary preference and dietary diversity during pregnancy

Staple foods (grains and cereals) other vegetables and pulses dominate the dietary preference after pregnancy and the past 24-hours and past 7-days dietary diversity of the pregnant women in Dire Dawa.

By the end of the 12 weeks intervention, both the past 24-hours and 7-days dietary diversity of the pregnant women showed significant differences across the intervention groups and the changes from their baselines were significant except for the control group. For the past 24-hours, intervention group 1 had 2.56 ± 0.23 higher mean minimum dietary diversity of women score (M-DDSW) than the control and intervention group 2 had 2.42 ± 0.23 higher mean M-DDSW than the control. Furthermore, intervention group 1 and intervention group 2 had a significantly higher proportion of women who had “high dietary diversity” than the control at end of the intervention. Moreover, intervention group 1 also had a significantly higher proportion of women in the “high dietary diversity” category compared to intervention group 2 by the end of the intervention.

6.3.3. Maternal consumption of iron-rich and vitamin C-rich foods during pregnancy

At baseline, the past 24-hours and past 7-days consumptions of these specific food groups were not statistically different across the study groups. During the past 24-hours, iron-rich food groups (meat/fish) were consumed by 24% of the women in Dire Dawa, while dark green leafy vegetables were by 25% and vitamin A-rich FVs by 25%. Other fruits and other vegetables were consumed by 20% and 82% of the women in Dire Dawa respectively.

By the end intervention, the proportion of pregnant women in this RCT who consumed vitamin C-rich food groups (another vitamin A-rich fruits and vegetables, dark green leafy vegetables and other fruits) in the past 24-hours and 7-days were significantly higher in intervention group 1 and intervention group 2 than the control group and had significantly increased difference from enrolment. Moreover, the consumption of vitamin C-rich FVs was significantly higher in intervention group 1 than intervention group 2 at end of the intervention. However, the change from enrolment was insignificant for all food groups for the women in the control group. However, this study found no significant difference among pregnant women in Dire Dawa with their past 24-hours consumption of meat/ fish (iron-rich foods) among the 3 groups by the end of the intervention.

6.3.4. Maternal dietary modification behaviours during pregnancy

By the end of this randomized controlled trial, all of the women in intervention group 1 and majority in intervention group 2 modified their dietary behaviour and commonly consumed vitamin C-rich fruits and vegetables together with other dishes during mealtimes and were significantly higher than the control group. Although the difference between intervention group 1 and intervention group 2 was not significant at end-line, their changes from their respective baseline values significantly increased. However, the control group had no significant change in their modification behaviours from enrolment.

Furthermore, the proportion of women who avoided the intake of tea/coffee immediately after or together with meals significantly increased in intervention group 1 and intervention group 2 than the control at end-line too. Nevertheless, after the nutrition education intervention, the control group had significantly higher mean intake of tea/coffee during the past 7-days than the other two intervention groups.

6.3.5. Nutritional knowledge of iron-deficiency and anaemia during pregnancy

At end of the intervention, the overall mean Nutritional Knowledge Score (NKS) of pregnant women in Dire Dawa was 30.83 ± 1.2 and statistically differ across the study groups. Intervention group 1 and intervention group 2 had statistically significant higher mean NKS than the control group but their difference was insignificant. The changes from the respective baselines NKS were also significantly improved in both intervention group 1 and intervention group 2 groups than the control.

Moreover, the proportion of women who had "average nutritional knowledge" and "good nutritional knowledge" were significantly higher in both intervention group 1 and intervention group 2 compared to the control group. None of the pregnant women in both intervention group 1 and intervention group 2 had "poor nutritional knowledge" in contrary 97% of the pregnant women in the control group still had "poor nutritional knowledge" by the end of the intervention.

6.3.6. Knowledge and practice of food preparation and preservation methods

After the study interventions, pregnant women who knew and practised food preparation methods and nutrient preservation techniques were significantly higher in both intervention group 1 and intervention group 2 compared to the control group. About 95% and 93% of women in intervention group 1 and intervention group 2 respectively practised at least one food preparation method while preparing cereal and legume-based diets. However, the change in the practice of food preparation methods and nutrient preservation techniques was insignificant from the baseline in the control group, as 83% of the women still never practised any method at end-line.

6.4. CONCLUSIONS

This randomized controlled trial study concludes the research hypothesis as such the food-based strategies which integrated increased intake of dietary-based ascorbic acid through supplementation of vitamin C-rich fruits integrated with nutrition education intervention for modification of dietary behaviours and practices increased haemoglobin level; decreased anaemia prevalence and thus improved the iron status of pregnant women in Dire Dawa. Furthermore, the study also concludes that integrated dietary-based interventions as a component of food-based strategy have significantly more positive effect than standalone nutrition education intervention in improving maternal haemoglobin level, reducing the prevalence of anaemia, improving dietary diversification, increasing consumption of vitamin C-rich fruits and vegetables (dietary enhancers of iron absorption), adoption of dietary modification behaviours and improving practice of food preparation and preservation methods among pregnant women in Dire Dawa.

6.5. RECOMMENDATIONS

Based on the analysed effects of food-based strategies in improving the iron status of pregnant women in Dire Dawa, the following recommendations are forwarded to address iron deficiency and anaemia during pregnancy in Dire Dawa.

- Strategies and programs for prevention and control of iron deficiency and anaemia, thus improving iron status during pregnancy should better incorporate integrated food-based strategies rather than standalone vertical interventions like nutrition education interventions.
- For nutrition education intervention to be effective in improving iron status, dietary diversity, dietary modification behaviours and nutritional knowledge of pregnant women, tools with messages tailored based on integrated food-based strategy framework should better be properly utilized.

- Key messages promoting dietary diversity and modification should better be included in dietary counselling and nutrition education programs addressing iron deficiency and anaemia during pregnancy.
- Key messages promoting consumption of vitamin C-rich fruits and vegetables supported by dietary counselling should better be included in dietary counselling and nutrition education programs addressing iron deficiency and anaemia during pregnancy.
- Nutrition education interventions and dietary counselling should better be consolidated as part of the routine prenatal and antenatal dietary counselling services of pregnant and reproductive age women.
- Key messages promoting proper dietary behaviours in the consumption of dietary inhibitors that is tea/coffee should better be included in dietary counselling and nutrition education programs addressing iron deficiency and anaemia during pregnancy.
- Key messages in promoting proper household food preparation and preservation methods should better be included in dietary counselling and nutrition education programs addressing iron deficiency and anaemia during pregnancy.
- Strategies and programs for prevention and control of iron deficiency and anaemia should further analyse the socio-cultural influences and dietary taboos to address proper dietary diversity during pregnancy.

In summary, based on the aforementioned recommendations, the researcher recommends that further interventional researches be conducted in the future to analyse the effect of food-based strategy in improving the iron status of pregnant women from the context of the different dietary patterns in the different regions of the country to forward nationally feasible prevention and control strategies. The researcher also recommends that further researches be conducted to validate and further develop the integrated food-based strategy framework and nutrition education tool developed based on the findings of this randomized controlled trial research.

6.6. CONTRIBUTIONS OF THE STUDY

Therefore, this study, to the knowledge of the researcher is the first of its kind in Ethiopia and developing countries, which analysed and showed the positive effect of integrated food-based strategy in improving iron level, and thus effective approaches to prevent and control iron deficiency and anaemia during pregnancy in Dire Dawa. The study is also the first of its kind, which employed randomized controlled trial design with three study arms, which enabled the analysis of the effect of integrated dietary-based interventions as well the effect individual interventions on the iron level. The nutrition education intervention employed in this study was based on nutrition education tool consisting of key nutritional messages developed for this research purpose. The findings of the study showed that the developed tool was effective in improving nutritional knowledge, dietary diversification and modification. Therefore, the developed tool can further be validated and tested for further study interventions and implementation of food-based strategies. Unlike many of the other studies, this research also focussed on dietary behaviours and dietary modification practices and food preparation and preservation methods influencing the intake of bioavailable iron. Based on the findings of the study, the researcher developed a framework for an integrated food-based strategy to improve the iron status of pregnant women with a feasible recommendation on the effective interventions, which would be employed to improve iron status, and thus for prevention and control of iron deficiency and anaemia during pregnancy and among women in reproductive ages. The findings of this research also laid the foundation for future scientific arguments. Results and conclusions of the research may be used as a baseline for a subsequent randomized controlled trial to be conducted in Ethiopia and other developing countries.

6.7. LIMITATIONS OF THE STUDY

The sample size calculation was based on the proportion of anaemia prevalence despite the main outcome variable was mean of the mean of haemoglobin level due to lack of reference literature. However, the employed sample size allowed to identify the required effect in change of haemoglobin.

Although not inherent to the limitation of the research method, this study used haemoglobin levels to assess the iron status of the pregnant women as there were no laboratory facilities which analyse serum ferritin levels in the study area or in neighbouring regions. Abbaspour et al 2014:168 state that serum ferritin is a good indicator of body iron stores under most circumstances. Besides, serum transferrin receptor levels are also most appropriate in areas where infectious diseases and inflammations are prevalent as serum ferritin levels rise during inflammation (WHO 2014c:2). This may have limited this study in showing the expected levels of iron status among the studied pregnant women based on levels of haemoglobins. However, Beck et al (2014:3748) state that an individual's iron status falls on a continuum, ranging from replete iron stores, through to depleted iron stores, iron deficiency and iron-deficiency anaemia; and haemoglobin is considered by the WHO to be the most effective indices for determining population burden of iron deficiency and iron-deficiency anaemia (Pasricha et al 2013:2613). Anaemia is also less time-and resource-intensive to assess, and thus, is often used as a surrogate for iron status (Burke et al 2014:4096).

Furthermore, it is recognized that haemoglobin levels decrease as pregnancy progress, but this randomized controlled trial research managed to enrol pregnant women in their second trimesters due to their late initiation of antenatal care service; which may have limited the observed change in haemoglobin. However, dietary interventions such as this randomized controlled trial would also be effective in showing an effect in iron levels when the intervention considered level of iron absorption. Iron absorption increase with increasing requirements and reductions in the iron pools. The requirements are not equally distributed over pregnancy duration, where needs are almost negligible in the first trimester and that more than 80% of the total requirements relates to the last trimester (Abu-Ouf & Jan 2015:147; FAO & WHO 2001:209). It is thus vital to meet this recommendation during the second and third trimester (Sharlin & Edelstein 2011:11), which may be taken as the strength of this randomized controlled trial research.

Most importantly, the findings of this randomized controlled trial research on dietary diversity and specific foods consumptions patterns may have been compromised by the prevailed peace insecurity in the study area during the study period. Dire Dawa like many regions of Ethiopia was in sustained peace insecurity due to ethnically based conflicts for so many months which clearly affected the economy of the community, which may have an effect on dietary consumption.

Although the research planned to collect data on vitamin C supplementation intervention compliance weekly, the data were collected every two weeks due to the prevailed peace insecurity in Dire Dawa during the study period which limited frequent home visits imposing for recall biases. However, the research employed records even to be recorded by a family member to verify intake compliances and control such limitations.

Generalizability of the findings of the study may also be limited due to the different contexts of the dietary patterns in the different regions of the country. Such diversities in the type of local foods, dietary practices and other food-related factors across the different socio-cultural setting of the country may pose limitations to the generalization of results and recommendations. However, the effects of the study intervention can be applied as the study employed a randomized controlled trial.

The strength of this research was that the research had three arms testing effects of two interventions. Comparisons of treatment effects among the combined and single interventions and again respectively with the control group analysed the validity of the reported treatment effects. The study also analyzed qualitative data to supplement the randomized controlled trial findings.

6.8. CONCLUDING REMARKS

This research was conducted with the requirements for the degree of **DOCTOR OF LITERATURE AND PHILOSOPHY** in the subject of **Health Studies** at the **UNIVERSITY OF SOUTH AFRICA.**

The research was conducted in Dire Dawa Administration, east Ethiopia. Employing randomized controlled trial, the research is the first of its kind in Ethiopia and developing countries which tested the effect of food-based strategy on iron levels and concludes that food-based strategies are effective in improving the iron status of pregnant women in Dire Dawa and thus be considered as feasible strategies to address iron deficiency and anaemia during pregnancy. The study is also of its kind which developed a framework for integrated food-based strategy with a feasible recommendation on the effective interventions in Ethiopia. The research findings and recommendations also laid the foundation for future studies.

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Title of the study: Food-based strategies to improve iron status of pregnant women: randomized controlled trial.		
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ANNEXE 1: DATA COLLECTION INSTRUMENTS

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203	□□□□□ □□□□ □□? 1. □□□□ 2. □□□□ 3. □□□□ 88. □□ □□ (□□□□/□)-------------------	
204	□□□□□□□ □□□□□□? 1. □□□□□ 2. □□□□□□□□ 3. □□□□□□□□□ 4. □□□□□ 88. □□ (□□□□/□) -----------	
205	□□□□□ □□□□? 1. □□□□□ 2. □□□□□□□ 3. □□□□□□□ 4. □□□□□ □□□□□□□	
206	□□□□□ □□□□□? 1. □□□□□ 2. □□□□ □□□□□ 3. □□□□□□□□ □□□□□ 4. □□□□ 5. □□□□ 6. □□□□ □□□□□ 7. □□□□ 8. □□□□ □□ 88. □□ (□□□□/□) ------------------------------	
207	□□□□□□ □□□□? |___|___|	
208	□5 □□□ □□□□ □□□□□□ □□□□? |___|___|	
209	□□□□□□□ □□□□ □□? --------------- □□ 1. □□□□ □□ □□□□ 2. □□□□□□ 99. □□□□ □□□□□□□	
210	□□□□□□ □□□□□ □□ □□? 1. □□ 2. □□□□ 88. □□ (□□□□/□) ---------------------------------	
211	□□□□ □□□□□ □□ □□□□? 1. □□□□□ □□□□ 2. □□□□ □□□□ 3. □□□□□ □□ 88. □□ (□□□□/□) --------------------	
212	□□□□□□ □□□□ □□□□ □□ □□? 1. □□□□ 2. □□	
□□□ 3□- □□□□-□□□□□ □□□□ □□□□ □□□□□□□ □□□□□ (□□□□□ □□□□□ □□□□□□□ □□□□□ □□□□□□ □□ □□ □□□□□□)		
301	□□□□□ □□□□ □□□□□□ □□□□ □□ □□□□□□ □□□□□□? 1. □□□□□□ 2. □□□□□□	
302	□□□□ □□□□ □□□□□□ □□ □□□□□□□ □□□□ □□ □□□□□□□? |_ _||_ _|	0-›□.□ 407
303	□□□□ □□□□□□□ □□□□ □□□□□□ □□ □□ □□□□□□? |_ _||_ \]	
304	□□□□ □□□□□□□ □□□□ □□□□□□ □□□□ □□ □□□□□□? |_ _||_ _|	
305	□□□□ □□ □□□□ □□□□□□□□? |_ _||_ _|	
306	□□□□□□□□ □□ □□ □□□□□? 1. □□ □□□□ 2. □□□□□□ 3. □□□□ 4. □□□□ □□ □□ 88. □□ (□□□□/□) -------------------------------	
307	□□□□□□□□ □□ □□ □□□□□□? 1. □□□□ □□□□□ 2. □□.□.□ 3. □□□□□□□ □□□□□ □□□□□ 4. □□□□□□□□ □□□□□ □□□□□ 5. □□□□/□□□□□ 6. □□□□ 88. □□ (□□□□/□) ----------------------------	
308	□□□□□□□ □□ □□□□□ □□□□□ □□□□□ □□□□ □□□□? |_ _||_ _|	

[illegible] 4[illegible]- [illegible] ([illegible])		
401	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 403
402	[illegible]? |_ _||_ _| 88. [illegible]	
403	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 406
404	[illegible]? 1. [illegible] 2. [illegible]	2->[illegible].[illegible] 406
405	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible]/[illegible] ----------------------------------	
406	[illegible]-[illegible]? 1. [illegible] 2. [illegible]	
407	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 88. [illegible] ([illegible]/[illegible]) ---	
408	[illegible] [illegible]? |_ _||_ _| [illegible] 99. [illegible]	
409	[illegible]? |_ _||_ _|	
410	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 413
411	[illegible]? 1. [illegible] 2. [illegible]	2->[illegible].[illegible] 413
412	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible]/[illegible] --------------------------------------	
413	[illegible]-[illegible]? 1. [illegible] 2. [illegible]	
414	[illegible]? 1. [illegible] 2. [illegible]	
415	[illegible]? 1. [illegible] 2. [illegible]	
416	[illegible]? 1. [illegible] 2. [illegible]	
[illegible] 5[illegible]- [illegible] ([illegible]) [illegible]- [illegible]/[illegible] *([illegible])* [illegible]/[illegible]		
501	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 507
502	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible]/[illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 88. [illegible] ([illegible]/[illegible])--	

503	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] ([illegible]) 4. [illegible] 12 [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 88. [illegible] ([illegible]/[illegible]) ---	
504	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 88. [illegible] ([illegible]/[illegible])-------------------------------------	
505	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 10. [illegible] 88. [illegible] ([illegible]/[illegible]) -------------------------	
506	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 10. [illegible] 11. [illegible] ([illegible]) 88. [illegible] ([illegible]/[illegible]) -------------------------------------	
507	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] ([illegible]) 6. [illegible] 88. [illegible] ([illegible]/[illegible]) ---	
508	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 88. [illegible] ([illegible]/[illegible])------------------------------	
509	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible] ([illegible]/[illegible])-------------------------	
510	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible]/[illegible] 6. [illegible] 88. [illegible] ([illegible]/[illegible])---	
511	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4, [illegible] 5. [illegible] 2-3 [illegible] 88. [illegible] ([illegible]/[illegible]) ------------------------------	
512	[illegible]?	

	1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible] ([illegible]/[illegible]) ---	
513	[illegible]? 1. [illegible] 2. [illegible] 88. [illegible] ([illegible]/[illegible])----------------------------------	
514	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 2-3 [illegible] 5. [illegible] 2-3 [illegible] 6. [illegible] 2-3 [illegible] 7. [illegible] 2-3 [illegible] 8. [illegible]/[illegible] 9. [illegible] 88. [illegible] ([illegible]/[illegible]) ---	
[illegible] **6**[illegible]**-** [illegible] **(**[illegible]**)**		
601	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible]/ [illegible] 4. [illegible] 5. [illegible] 2-3[illegible] 88. [illegible] ([illegible]/[illegible])-------------------------------	
602	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 604
603	[illegible]?	
604	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 606
605	[illegible]?	
606	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 701
607	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible] ([illegible]/[illegible])---------------------------------------	
[illegible] **7**[illegible]**-** [illegible] **(**[illegible]**)**		
701	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible]	
702	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible]	
703	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible]	2 [illegible] 3-›[illegible].[illegible] 705
704	[illegible]?	
705	[illegible]? [illegible]?	
706	[illegible]? [illegible]?	

707	[illegible]? [illegible]?	
708	[illegible]? [illegible]? 1. [illegible] 2. [illegible] 3. [illegible]	

[illegible] **8**[illegible]**-** [illegible] **(**[illegible]**)**

[illegible]**-** [illegible]

801	[illegible]? [illegible]?
802	[illegible]? [illegible]?
803	[illegible]? [illegible]? [illegible]?
804	[illegible]? [illegible]? [illegible]?
805	[illegible]? [illegible]?
806	[illegible]? [illegible]?
807	[illegible]? ([illegible]) 8071. [illegible]? [illegible]? 8072. [illegible]? [illegible]?

	8073. [illegible]? [illegible]?	
808	[illegible]? [illegible]?	
809	[illegible]? [illegible]?	
810	[illegible]? [illegible]?	
811	[illegible]? [illegible]?	
[illegible] **9**[illegible]- [illegible] **([illegible].[illegible] 901 - [illegible].[illegible] 910** [illegible]**)**		
901	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 904
902	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 88. [illegible] ([illegible]/[illegible])---	
903	[illegible]? 1. [illegible] 2. [illegible] ([illegible])--- [illegible]? -- ---	
904.	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 10. [illegible] 11. [illegible] 12. [illegible] 13. [illegible] 88. [illegible] ([illegible]/[illegible]) ---------------- [illegible]? --- -- --------------------------	

905	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 8. [illegible] 9. [illegible] 10. [illegible] 11. [illegible] 12. [illegible] 13. [illegible] 14. [illegible] 88. [illegible] ([illegible]/[illegible]) ---------------- [illegible]? ---	
906.	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 908
907	[illegible]? 1. [illegible] 2. [illegible]/[illegible] 3. [illegible] 88. [illegible] ([illegible]/[illegible]) ----------------	
908	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible]	1->[illegible].[illegible] 910
909	[illegible]? 1. [illegible] 2 [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 2 [illegible] 88. [illegible] ([illegible]/[illegible]) --------------------------	
910	[illegible]? 1. [illegible] 2 [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 2 [illegible] 88. [illegible] ([illegible]/[illegible]) -------------------------	
911	[illegible]? 1. [illegible] 2. [illegible]	
[illegible] **9.1**[illegible]- [illegible]**24** [illegible] ([illegible])		
[illegible] 24 [illegible] [illegible]24 [illegible]		
912	[illegible] [illegible]24 [illegible]? |__||__|	
913	[illegible]? 1. [illegible] 2. [illegible]	1->[illegible].[illegible] 915
914	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 88. [illegible] ([illegible]/[illegible]) -----------------------------	
[illegible]- [illegible] 24 [illegible] [illegible]24 [illegible]/[illegible] [illegible] 1 [illegible]/[illegible] [illegible]/[illegible] [illegible]/[illegible] [illegible]/[illegible] [illegible]/[illegible] 2 [illegible] (1)[illegible] [illegible] (0) [illegible]/[illegible] [illegible]/[illegible]		
915	[illegible] [illegible]24 [illegible]	

	[illegible]- [illegible] ? [illegible] ? [illegible] [illegible] ? [illegible] [illegible] ?

[illegible] 1[illegible]- [illegible]24 [illegible]	
[illegible]	[illegible] ([illegible])
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	

[illegible] 2[illegible]- [illegible]24 [illegible],[illegible]		
[illegible].[illegible]	[illegible]	[illegible] = 1 [illegible] = 0
1	[illegible]- [illegible] ([illegible]...[illegible]) [illegible]- [illegible]	
2	[illegible]- [illegible]	
3	[illegible]- [illegible]	
4	[illegible]- [illegible]	
5	[illegible]- [illegible] ([illegible]) [illegible]	
6	[illegible]- [illegible] ...[illegible]	
7	[illegible]- [illegible]	
8	[illegible]- [illegible] ([illegible])[illegible]	
9	[illegible]- [illegible]	
10	[illegible]- [illegible]	
	[illegible]	

[illegible] 9.2[illegible]- [illegible]7 [illegible] ([illegible])		
[illegible] 7 [illegible] [illegible]- [illegible] (✓) [illegible]/[illegible]		
916	[illegible]	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○
	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○
	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○
	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○

[illegible] 10[illegible]- [illegible] ([illegible])	
[illegible]	
1001	[illegible] 1 [illegible]? 1. [illegible] 2. [illegible] (1-10 [illegible]) 3. [illegible] (10 [illegible])
1002	[illegible] 1 [illegible]? 1. [illegible] 2. [illegible] (1-10 [illegible]) 3. [illegible] (10[illegible])
1003	[illegible] 1 [illegible]? 1. [illegible] 2. [illegible] (1-10 [illegible]) 3. [illegible] (10[illegible])
1004	[illegible] 1 [illegible]? 1. [illegible] 2. [illegible] (1-10 [illegible]) 3. [illegible] (10[illegible])
[illegible] 10.2 [illegible]- [illegible]7 [illegible] ([illegible])	
[illegible] 7 [illegible] [illegible]- [illegible] (✓) [illegible]/[illegible]	
1005	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○
	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○
	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○
	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○

[illegible] 11[illegible]- [illegible]	
[illegible]- [illegible] • [illegible] • [illegible] ([illegible]) • [illegible] • [illegible] (vegetarian [illegible]) • [illegible]	[illegible]? 1. [illegible] 2. [illegible] [illegible]/[illegible] [illegible]/[illegible] [illegible]/[illegible]
[illegible]	
[illegible] [__|__|__]__]__]	
[illegible] |__]__]__]__] [__|__|__]__|__] [illegible]	
[illegible] |__]__]__]__] [__|__|__]__|__]	
[illegible]	|__||__|
[illegible]	[__|__][__|__][__|__|__] ([illegible]/[illegible]/[illegible])
[illegible] |__]|__]	[illegible] __________
[illegible] ______________	[illegible] ___________________
[illegible]	[illegible] |__]|__]

[illegible] 11.1[illegible]- [illegible] ([illegible])		
1111	[illegible] [illegible]24 [illegible]? |__||__|	
1112	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 1115
1113	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 88. [illegible] ([illegible]/[illegible]) --------------------------	
1114	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 6. [illegible] 7. [illegible] 88. [illegible] ([illegible]/[illegible]) --	
1115	[illegible]? 1. [illegible] 2. [illegible]/[illegible] 3. [illegible] 88. [illegible] ([illegible]/[illegible]) -----------------------------	

1116	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible]	1-›[illegible].[illegible] 1118
1117	[illegible]? 1. [illegible] 2 [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 2 [illegible] 88. [illegible] ([illegible]/[illegible]) --------------------------	
1118	[illegible]? 1. [illegible] 2 [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 5. [illegible] 2 [illegible] 88. [illegible] ([illegible]/[illegible]) -----------------------	
1119	[illegible]? 1. [illegible] 2. [illegible]	1-›[illegible].[illegible] 1120
1120	[illegible]? ([illegible]/[illegible]) 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible]([illegible]) ---	
1121	[illegible]?	

[illegible] 11.2[illegible]- [illegible] ([illegible])

1122	[illegible]? |__||__|	
1123	[illegible]? [illegible]-[illegible]/[illegible] (✓) [illegible]/[illegible]/[illegible]/[illegible]	

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
[illegible]	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○
	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○
	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○
	[illegible] ○	[illegible] ○	[illegible] ○	[illegible] ○	[illegible] ○	[illegible] ○	[illegible] ○

1124	[illegible]/[illegible]	
	[illegible] 0 [illegible] |__||__| [illegible]	
	[illegible] 1 [illegible] |__||__| [illegible]	
	[illegible] 2 [illegible] |__||__| [illegible]	
	[illegible] 3 [illegible] |__||__| [illegible]	
1125	[illegible]/[illegible]	
	[illegible] |__||__| [illegible]	
	[illegible] |__||__| [illegible]	
	½ - ¾ [illegible] |__||__| [illegible]	
	¾ [illegible] |__||__| [illegible]	
	[illegible] |__||__| [illegible]	
1126	[illegible] (4 [illegible]) [illegible]? 1. [illegible] 2. [illegible] 3. [illegible]	

1127	[illegible]? 1. [illegible] 2. [illegible]	
1128	[illegible]? 1. [illegible] 2. [illegible] ([illegible]- [illegible] 2 [illegible] 4 [illegible])	
1129	[illegible]- [illegible]? 1. [illegible] 2. [illegible] 3. [illegible]/[illegible] 4. [illegible] 5. [illegible] 6. [illegible] 88. [illegible]/[illegible] -------------------------	
1130	[illegible]?	
[illegible] **11.3**- [illegible]-[illegible] [illegible] **(**[illegible]**)**		
1131	[illegible] -[illegible] -------- [illegible]? 1. [illegible] 2. [illegible]	2 › [illegible]. 1133
1132	[illegible]? 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] 88. [illegible] ([illegible]) ----------------------------------	
1133	[illegible]-[illegible]?	
1134	[illegible]-[illegible]?	
1135	[illegible]-[illegible]? [illegible]?	

[illegible]/[illegible]/[illegible] **------------------------------** [illegible] **-** [illegible]
[__|__]__|__]__|__|__] ([illegible]/[illegible]/[illegible])

[illegible]

1501. [illegible]? |__|__] [illegible]

[illegible]/[illegible])

1502. [illegible]

1[illegible]. [illegible] [__|____| . |____] [illegible]/[illegible]

2[illegible]. [illegible] [__|____| . |____] [illegible]/[illegible]

[illegible] [__|____| . |____] [illegible]/[illegible]

1□. □□□ [__|___| . |__] □□□/□□□□

2□. □□□ [__|___| . |__] □□□/□□□□

□□□□ □□□ [__|___| . |__] □□□/□□□□

1503. □□□□□ □□□

1□. □□□ |___|___] □.□□□

2□. □□□ |___|___]| □.□□□

□□□□ □□□ |____|____] □.□□□

1504. MUAC [_____|___| □.□

DATA COLLECTION INSTRUMENT- OROMIFA VERSION

GAAFATAMU TOKKO

Title of the study: Food-based strategies to improve iron status of pregnant women: randpmzed controlled trial.	
Kutaa 1:- Ibsa qo'anaa hirmaata	
101	Maqaa dhabbata fayyaa ○ K/HC [01] ○ G/G/HC [02] ○ L/H HC [03] ○ B/A/HC [04]
102	Lakkofsa qo'anna hirmaata Koodii [__]__]__]__]__[__|
103	Naanno hordofi qo'anna hirmaata
	Maqaa naano isheen jiraatu [__]__]__]__]__[
	Lakkofsa bilbila hirmaata qo'anaa [__]__]__]__]__[__|__|__]__|__] Yoo hin qabane
	Lakkoffa bilbila fira dhiyeena [__]__]__]__]__[__|__|__]__|__]

	Kaayyoo qo'anchaa icitumaa faayidaa fi hirmaatudhaaf waayee mirga ishe ikkan ibsi qodhameef qo'annaati hirmaatu . hirmaatudhaaf haayamamtuddha 1. Eyee: Mallatoo _________________ 2. Hayyamamtu hintane:- Haayamtu yoo hin taan taane hirmatu galatoom saati gaffatamu adda kuta.
	Koodii gafata]___[___] Mallatoo _________________
	Guyya gaafatamuu itt godhame [___|___][___|___][___|___|___] (guyaa/Battia/Woga)
	Maqaa too'ata___________________ Mallatoo _________________
	Laakkofsa galme gaafatamu |__]__]__]__]__[__| Koodii |___]|__]

Gabatee qudunfa odeefanoo hirmaata					
Bifa odeefano	**Daawii 1faa**	**Daawi 2ffa**	**Daawii 3 faa**	**Daawii 4faa**	**Daawii 5faa**
Guyya					
Umrii ulfa ishee (torbee)					
Hama Heemogilobni (gm/dl)					
MUAC					
Hama ulfaatina hirmatu (kg)					
IFA fudhachudiffteni (✓ / x)					
Kaawii hordofi fudhanna kudura juusii (✓/x)					
Hama ulfatina da'madhalate (kg)					
Qo'anati kimaatu dhiiftee (✓ / x)					

Qojeelcha :- Gaffilen hunda akkaata qajeelfamni kayyametti guutame xumurmu qaba.

Kutta 2 : Waaye odeefano hawaasafi iconomi ilaalchise gaffatamu (Hirmaatota qo'ancha hundaaf jalqabaa qo'anchati qofa kan gaafatamu).		
G/ L	**Gafi fi filanoo debbii**	**Gaman -> darbi**
201	Umrii kee maqaa |___]|___]	
202	Sadarkan barnnotaa ke meqqa? 1. Hin barabane 2. Dubisuf bareesu 3. Sadarkaa jalqaba 4. Sad 2Ffaa 5.Sad Olaa	
203	Lamii kee maal? 1 . Oromoo 2. Somaalee 3. Amaara 88. Kan biro ibsi---------------	
204	Amanta keemaalii? 1. Muslima 2. Ortodocsi 3. Protestant 4. Kaatolik 5. kan biro obsi-----	
205	Sirna fuudha? 1. Tan heerumtee 2. Tan hion beersumne 3. Tan adda baatee 4. Heerumutee tan jalaadue	
206	Bifa hojja ishe? 1. Hinqabdu 2. Hojjatu guyyaa 3. Hojatu motuma 4. Daldaltu 5. Baratu 6. Haadha manaa 7. Qotee bultuu 8. Hojii dhuunfa 88. Kan biro ibs------------	
207	Baayina matti? |___]|___]	
208	Daa'ima wagaa 5 gadi? |___]|___]	
209	Gali jian kan maatii ketti?	

	------------------- birri 1. Galiin tokkole hinjir 2. Hin beku 99. Deebi hinkennine	
210	Aban manaa maati eenyu? 1. Dhirsa 2. Ishee 88. Kan biro ibsi-------------------------	
211	Argama bisha dhugaati mana? 1. Bonba umata 2. Bonba kankottii 3. Bishan burqa 88. Kan biro ibsi-	
212	Manifincaani maati kan dhunfa jira? 1. Hinjiru 2. Jiira	
Kuta 3: Waaye odeefana hala dahuumsa illaalcisee gaffatamu (Hirmaatota qo'anchaa hundaaf jalqabaa qo'anchiati qofa kan gaffatamu).		
301	Qusana maati kanan dura fayadamtee beekta? 1. Hinbeku 2. Nan beeka	
302	Ulfa amaa jiru kanaan addeti yeroo meqaaaf ulfootee? [___][___]	0-› gaafi lakk 407
303	Ulfa'ina keessa ti da'ma lubbun jiru maqaa deeseta? [___][___]	
304	Ulfa'ina keessati da'ima lubbun jiru meqqa deesta? [___][___]	
305	Yero garaa bahinsi si muddatee? [___][___]	
306	Da'ima isadhuma eessati dhaltee 2 hospital 1. Dhaabbata fayya 2. Hospitala 3. Mana ishe 4. Mana nama biro 88. Kan biro ibsi---------------------------	
307	Da'maisa dhuma eentusideessise 1. Ogeessa faya 2. HEW 3. Deesiftu bartu qaromte 4. Deesiftu bartun hin qaroomne 5. Hiriyaa/ maati 6. Humaa 88. Kan biro ibsi-	
308	Yero jalqaba ulfooftu umrii keemeeqa? [___][___]	

Kuta 4: Hordofii dahuumsa duraafi odeefannoo haala fudhanaa iron-folic acid ilaalchisee gafatamu (Hirmaatota qo'anchaa hundaaf jalqabaa qo'anchiati qofa kan gaffatamu).		
401	Armaan dura ulfa ke kan durati hordofii dahuumsa dura goote? 1. Hin goone 2. Godheera	1-› gaafi lakk 403
402	Yo hordofi goteetu ; si'a meeqafi gooteeta? [___][___] 88. Hin yadadhu	
403	Ulfa keekan waqti durati iranifudachaa turte? 1. Hin fudhane 2. Fudheera	1-› gaafi lakk 406
404	Fudhaaturte; Iranisiif kenname hunda haal sii ajajameen fudhate xumurtteeeta? 1. Hin xumure 2. Xummure fudheera	2-› gaafi lakk 406
405	Irani hunda fudhate yo kinfudhane sababin ijo adda kute maali? 1. Dhukkuba dugaatu namuudate 2. Dhandhama isa hin jirane 3. Fudhachu hin barbane 4. Nan dagadhe 88. Kan biro ibsi--------	
406	Waqti ulfa ke kanduratii akkamit akka nyachuu qabdu tajaa jila gorsa sirna nyaata argate turte? 1. Hinargane 2. Argadhe	
407	Irani fudhachu fayaf fayida maal qaba? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Da'imni dhalatu hin dhini qaama akka hin muddane itisuf 3. Da'imadhalatuf gudina samu fayatif 88. Kan biro ibsi--------------------	
408	Ama imoo waaye ulfa kee kan amaa sigaafadhi. Ulfa kee kan amma irrati hordafi yoo jalqabdu yero meeqafa? [___][___] Torbaan 99. Hin yaadadhu	
409	Yeroo meeqata kana ma hordofif dhufte? [___][___]	
410	Ulfa kee kan ammati araani fudhataata? 1. Hin fudhane 2. Fudhatara	1-› gaafi lakk 413
411	Yoo fudhataa jiraate/ Aryan hala siif ajajamen fudhataata? 1. Fudhataa hin jiru 2. Fudhataara	2-› gaafi lakk 413
412	Firee hunda yoo fudhataa hin jiraane. Sababi maalitif adda kute?	

	1. Dhukku dugatu namuudate 2. Dhandhama isa hin jalane 3. Fudhachu hin barbane 4. Nan dagadhe 88. Kan biro ibsi--	
413	Ulfa kee kan ammatti yeroo waqti hordofi dahumsa dura akkamiti akka nyaachu qabdu waaye gorsa sirna-nyaata argatata? 1. Hinarganne 2. Argadheera	
414	Sigaara niaarsita? 1. Hin arsu 2. Ni aarsa	
415	Dhugati alkoliin ni dhugada? 1. Hin dhuga 2. Nan dhuga	
416	Caatin niqamaata? 1. Hinqama'u 2. Nan qama'a	

Kutaa 5: Waayee hirdhina dhiiga ilaalchse gaafatamu (Hirmaatota qo'anicha hundaaf jalqaba qo'annaa fi dhuma qo'annatti kan gaafatamu). **Qajeelfama;- Gaafileedhaaf deebiwan deebiwan adda- adda bahan gaafatamtuuf akka dubistu. Deebilee kenname kessa tokkolee deebifne (hin beeku) jedhu filanoo kitabii.**		
501	Dhukubaa hirdina dhiga dhageete beekta? 1. Hin beeku 2. Nan beeku	**1-›** gaafi lakk 507
502	Nan beeka yoo jete, namni dhukuba dhiiga qabu mallaton inniagarsiisu maal-maal fa'a? (Kan isheen deebsitee hunde katabi). 1. Hin beeku 2. Gogaan qunca'au 3. Bowoo 4. Fedhi nyaata hirdhatu 5. Qubbin ita'u 6. Dhukkubif saaxilamu 7. Dadhabin qaama 8. Hafura qal'atu 9. Humna dhabiinsa 88. Kan biro ibsi----------	
503	Waan hirdhina dhiiga geessan ykn fidan maal fa'a? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Nyaata keessati hammi iraan hirdhatu 3. Dhigani baay'een dhagal'u (marsa laguu) 4. Nyaata keessa Vaaytaminin akka A, B, foleti hirdhafu 5. Guddina irraa fi yeroo kitaanii fedhiin hama ayirani dabalu 6. Ayiraanii nyaata kessaa jiran kan balessa baay'esu 7. Nyaata gosa heduu walitii makkanii nyaachuu dhiisu 8. Dhukubii sanylin darban 9. Raamolee garaa fi dhukkuba booke buusa 10. 88. Kan biro ibsi--------------------	
504	Hirdhinni dhigga daa'iman dhalatu fi ijoolee irra rakkoon geessu maali? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Guddinna samutiin fi qaamaa qancaru 3. Dhukuba fi du'af saaxila bahu 88. Kan biro ibsi--------------------	
505	Rakkon hirdhinii dhigga hawota ulfa irra geesu maali? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Ulfatin da'ama dhaatu hirdahatuu 3. Yeroo dahuumsaati rakkachuu 4. Dahuumsa yeroo hin eegane 5. Yeroo dahumsa dhigni dhangala'u 6. Dandeeti hojjatu dhabuu 7. Dhukubaan qabamuu Daa'imni dhalate du'u danda'a 8. Daa'imni dhalate du'u danda'a 9. Daaima du'aa dhaluu 10. Yeroo d ahummsa haati du'u danda'a 88. Kan biro ibsi--	

506	Hirdhina dhigga akkamiti ittisu danda'ama? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Nyaata Ayiraanii dhaan badhaadhe baayinaa nyaachu 3. Nyaata kuduraa fi mudura Baay'ina nyaachu 4. Karaa siri nyaata qophessu fayyadamuu 5. Nyaata Ayiraanii of kkessa qabu nYaachuu 6. Buna shaayi kan kan fakkatu fudhachuu dhlisuu 7. IFA fudhachuu 8. Yeroo dhukkubiin mudame hatatamaan yaalamu 9. Agoobara sirree fayyadamu 10. Qulqullina dhuunfaa fi naannoo eegachuu 11. Harma hoossisudhan (daaimadhaaleteef) 88. Kan biro ibsi--	
507	Nyaanni ayiraanii badhaadhe maa faa? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Xaafi 3. Fooni 4. Qurxumi 5. Kuduraafi mudura (Maangoo, Paapaya) 6. Nyaata baala magariisa kan akka raafuufi shaana 88. Kan biro ibsi------------	
508	Nyaanni vitamina'C badhaadhe maal fa'a? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Mango 3. Burtukan 4. Loomi 5. Paapaye 6. Ananasi 88. Kan biro ibsi---------------------	
509	Ayiraanii nyaata irraa argamu kan dabalu gosa nyaayaa kami fa'a? (Kan isheen deebiftee hunda katabi). 1. Hinbbeku 2. Fooni beeyladotaafi bu'aa foonii 3. Quxxumii 4. Kudura Vitamina C Dhaan badhaadhe, firafreefi fi nyaata baala magariisa 88. Kan biro ibsi--------------------------------	
511	Ayiraanii yaata irra argamu kan hirdhisu gosa nyaata kan faa? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Sanyii midhaanii 3. Dhedheedhii nyaata 4. Annaaniif bu'aa annanii 5. Shayii/buna 6. Kookakola 88. Kan biro ibsi-----------------------	
512	Ayiraanii nyaata irra argamu akka dabalu: wantoota Ayiranii hirdhisan kan akka buna shaayii, kokakola fi anaan qabaan fudhatamu qaban yoomi? 1. Hin beeku 2. Axxuma nyaata nyaatun dura 3. Nyaata wojiin bakka tokkotii 4. Nyaata booda 88. Kan biro ibsi--------	
513	Ayiraanii dabaluuf kudraf mudura Vitamina C nbadhaadhe fudhachuf yeroo nyaata kam irrati fudhatamu qaba? 1. Hin beeku 2. Nyaataan dura 3. Nyaata wajjin bakka tokko 4. Nyaatan booda 88. Kan biro ibsi-------------------------------	
514	Nyaata madaalamaa jechun maal jechuu dha? 1. Hin beeku 2. Nyaa gosa hedhuu madalchisani fudhachuu 88. Kan biro ibsi-------------------------------	
515	Haati takka yeroo ulfaa akkamit soramu qab qabdii? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Hana nyaata hirdhisuu 3. Nyaata madaalma nyaachuu 4. Guyyatti nyaata fooni yeroo 2-3 nyaachuu 5. Kuduraa fi baala fi raafu nyaachuun dura daqiqaa 2-3 bilchisu	

	6. Dhedheedhii fi sanyi midhaani guyyati yeroo 2-3 nyaachuu 7. Nyaata annani guyyati yeroo 2-3 nyaachu 8. Bunaafi shayidhisu (hirdhisu) 9. AlKoli fi sigaara fudhachu dhisu 88. Kan biro ibsi-------------------------------	

Kitaa 6: Beekumsa haala nyaata Ayiraani dhaan badhaadhe qopheessuu ilaalchisee (Hirmaatota qo'anicha hundaaf jalqaba qo'annaa fi dhuma qo'annatti kan gaafatamu).		
601	Mala nyaaata hamma ayirani dabaalu qophessuu beektaa? (Kan isheen deebiftee hunda katabi). 1. Hin beeku 2. Nyaa distisibilati tolchuu. 3. Dhedheedhii fi sanyi midhaani bilcheessun dura Cuuphu (boqolchu) 4. Nyaata adda – addaa wolitti makkanii bilcheesu 5. Nyaata kuduraafi baala raafuunyaachuunduradaqiqaa 2-3 bilchesu 88. Kan biro ibsi-------------------------------	
602	Nyaata kuduraaf mudura fi baalaf raafu vitaamina C akka keessa hin banneeti qopheessuf akkamit akka qopheesu qaban beekta? 1. Hin beeku 2. Nan beka	1-› gaafi lakk 604
603	Nan beeka yoo jete akkamit akka qophaa'u qaban nati him?	
604	Nyaanni kuduraa mudura vitaaminni C keessa akka hin banet ykn himiisa akka hiedhaneet haala akkamitin akka kawamu beekta? 1. Hin beeku 2. Nan beka	1-› gaafi lakk 606
605	Nan beeka yoojet akkamit akka kaayamu qabu nati him?	
606	Dhedheedhii fi sanyi midhaan wantoota hama ayiraanii keessatti argaman hirdhissuf maala gargaran beekta? 1. Hin beeku ` 2. Nan beeka	1-› gaafi lakk 701
607	Nan beeka yoo jete; malli nyaata itti qopheessu maal fa'a? 1. Cuuphuu 2. Boqolchuu 3. Irshoodhaan waal nyaachisuu 4. Aduun gogsuu 88. Kan biro ibsi----	
Kutaa 7: Waaye hirdhinna dhiigaafi sirna nyaata ilaalchise gaafatu (Hirmaatota qo'anicha hundaaf jalqaba qo'annaa fi dhuma qo'annatti kan gaafatamu).		
701	Dhiibaa hirdhinna dhiiga hangam fayyaaf/ miidha qaba siti fakata? 1. Hin beeku 2. Gad-aana 3. Jiddu-galeessa 4. Ol'ana	
702	Dhiibaan hirdhinna dhiga hangam fayyaaf /miidha qaba siti fakata 1. Hin beeku 2. Gad-aana 3. Jiddu-galeessa 4. Ol'ana	
703	Ji'oota ulfaa hundaati nyaata dabalataa nyaachuun faayidaa qaba jetee yaada? 1. Hin fayyadu 2. Nifayyada 3. Iti hin amanu	2-› gaafi lakk 705
704	Hinfayya yoo jette sababin ijo kee maali?	
705	Nyaani woqtii ulfaati nyachuu barbaadu maal fa'a? Maliif?	
706	Nyaanni woqtii ulfaati nyaachuu hin barbaane maal fa'a? Maliif?	
708	Haati ulfaa waqti ulfaati nyaata akaammi nyaachuun hin qabdu jetee yaada? Maalii dhaaf?	
709	Haati ulfaa wogti ulfaati nyaata ayiraaniin badhaa qopheesitee nyaachuun itti ulfaata jettee yaada? 1. Itti hin ulfaatu 2. Itti ulfaata 3. Baay'ee itti ulfaata	
Kutaa 9: Wogti ulfaati nyaata gahaa maleefi fudhannaa nyaata ilaalchisee gaafatamu (Gaafiin lakk 901 – 911, hirmaatota qo'annaa hundaaf jalqaba qo'annichaa qofa		

	kan gaafatamu kan hafe garuu jalqaba qo'annaa fi dhuma qo'annatti kan gaafatamu).	
901	Ulfa ta'uu kee hanga beekte irra jelqabdu naamusa nyaate jijiirtee? 1. Hin jijiire 2. Jijjirrra	1-› gaafi lakk 904
902	Yoo namusa nyaataa jijiirtee haala akkamiitin? (Kan isheen deebiftee hunda katabi). 1. Hamma nyaata hunda hirshiseera 2. Hama nyaataa dabaleera 3. Bifa nyaataa hirdhseera 4. Bifa nyaata dabaleera 5. Yeroo nyaata hirdhiseera 6. Yeroo nyaata daballera 7. Hamma nyaata, bifa fi yeroo dabaleera 8. Hamma nyaata bifa fi yeroo hirdhirseera 88. Kan biro ibsi-----------	
903	Ulfaa'uu kee dura nyaanni iti hin nyaanne. Garuu kan yeroo amma nyaatu jira? 1. Hin jiru 2. Nijira(gosa nyaata)____________________ Maaliif?_--	
904	Nyaani ulfa ta'uu kee beekte jalqabdee baayi'inaa nyaatu kami fa'a? (Kan isheen deebiftee hunda katabi). 1. Nyata gesa midhaanii fi hundee 2. Dhedheedhi 3. Nyaata gar tokko fi gar lama kan akka atara fi baa gela 4. Anan aniifi bu'a annanii 5. Foon beeyladootaa fi bu'aa fooni akkasumas qurkumii 6. Killeee/bouphaa/ 7. Nyaata baala magariisa 8.Kuduraa fi mudura viitamina 9. Kuduroota biro 10. Muduroota bir 11. Shaayi 12. Buna 13. Kookakola 88. Kan biro ibsi------- Maaliif?---	
905	Ulfa ta'uu kee hangaa beektee jalqabde A Hin nyaanne hoo maal fa'a? (Kan isheen deebiftee hunda katabi). 1. Nyata gesa midhaanii fi hundee 2. Dhedheedhi 3. Nyaata gar tokko fi gar lama kan akka atara fi baa gela 4. Anan aniifi bu'a annanii 5. Foon beeyladootaa fi bu'aa fooni akkasumas qurkumii 6. Killeee/bouphaa/ 7. Nyaata baala magariisa 8.Kuduraa fi mudura viitamina 9. Kuduroota biro 10. Muduroota bir 11. Shaayi 12. Buna 13. Kookakola 88. Kan biro ibsi--------- Maaliif?---	
906	Kuduraa fi cuunafa /juusi/ Vitamina C tiin badhaadhe kan akka Burtkaana, papaya fakkatan baayina fayadamta? Yokiin baayina nyata? 1. Hin nyaadhu 2. Nan nyaadha	1-› gaafi lakk 908
907	Kudurafi cuunfa/ juusi/ vitamina C tiin badhadhe yoo kan nyaat taatei saatii nyaataa isa kam irrati baayiinaa bfayyadamat? 1. Nyaata dura 2. Yeroo nyaadhu/nyaata wajin 3. Nyaata yoguu nyadhe booda 88. Kan biro ibsi-------------------	
908	Buna shaari fi kokakola ni dhugdaa? 1. Hin dhugu 2. Darbe- darbee nan dhuga 3. Baayinaan dhuga 4. Guya-guyaan dhuga	1-› gaafi lakk 910
909	Annanii fi bu'aa annanii yeroo baay'ee kan fayyadamtu sa'aati nyaata isa kam irrati? 1. Nyaachuu koon sa'ati 2 ykn 2.ol durs 2. Hanguma nyaachu koo durse 3. Yeroo nyadhu 4. Hanguma nyaachuu booda 5. Nyaadhe sa'ati 2 ykn booda 88. Kan biro ibsi------------------	

910	Nyaata gosa midhaani yoking dheddhhedhi yoogguu qopheesitu . Wantota hama ayraani hirdhisuu wanta dhangagaa hirdhisuuf mala nyaata qopheesu kan akka cuuphu wal nyaachisuu, boqolchuu fayyadamta/ 1. Nan fayyadama 2. Hin fayyadamu	
911	Gosa nyata dhedhi yoga tolchite, nyata hanga gara hirahisuufi wanta keessa keef hin barbachifne hirdhisu fayyadamu jalqabde? 1. Eyye 2. Hin jalqabne	
Kutaa 9:1 Odeeffannoo namusa nyaataa kan saati 24 ilaalchise gaafatamu (Hirmaatoo qo'anichaa hundaaf jalqaba qo'annaa hundofuu fi dhuma qo'annatti kan gaafatamu).		
Amaa`waaye za'aati 24 darbe keessatti jechuun kaleessa ganama jalqabe za'aati 24 keessatti hallinyaataa kee akkam akka ture sigaafadha.		
912	Kaleesaa guyaa fi halkan sa'aati 24 keessaati yero meqa nyaate? _|	|_ _||_
913	Haalli nyaatu kee kan dura irra adda ture? 1. Miti/lakk/ 2. Eeyye adda ture	1-› gaafi lakk 915
914	Haalli nyyynna keeti kan duraa irraa adda yoo ture, haala malin adda ture? Yookiin maalif adda ture? 1. Guyyaa ayyaana ture 2. Guyyaa qabayaa ture 3. Guyyaa soomaana ture 88. Kan biro ibsi----------	
Qajeelfama: Gaafilee itti aanu gaafachuu dhaan hirmaataan qo'annaa saatii 24 keessatti jechuun , hirmaatuun kaleessa ganama jalqabde saatii 24 keessati nyaata nyaatu akka addaan baafte yookiin tokkooni tokko dubbatu gaafadhu. Nyaata nyaate hundaa fi dhugde tokkoon tokko akkasumas hamma isaa gabateer asi jala jiru keessati bakka ta'uu qabu ti galmeesi haati nyaata makkamaa kan akka itoo/waxii/sugoo yoo kan nyaateetu nyaata makkama keessa faayida ykn bu'aa ijo jiran akka ibsitu gaafadhu. Hamma nyaata beeku dhaaf kan mana keessa jiran kan nyaata irra caalati ibsu dhaaf odeefanoo fakii fayyadami haati deebiin ishee kan biro hin jiru hanga jetuuf akkaan gaffadh dhuma isaa irratis gabatee irrati nyaata ibsame irrati garee umi garee nyaata keessa tokko yoo kan nyaateetis ykn garee nyata keessa jiru kessa tokko yoo kan nyaateetu(1), woma yoo kan hin nyaane(0) jechuudhaan galmeesi.		
915	Gaafilee:- Ciree/Faxiiira? Maal nyaate fi dhugde? Ciree/Faaxiira? Booda laaqana dura maal nyate fi dhugde? Laaqana irrati maal nyaate fi dhugde? Irbaata dura maal nyaate fi dhugde? Irbaata irrati maal nyaate fi dhugde? IRbaata booda maal nyaate fi dhugde?	

Gabate 1:- Naamasa nyaata kan sa'aati 24 fi ibsa dhugduu fi hamma isaa.	
Yeroo nyaata	**Ibasa dhugdoo fi nyaata nyaate akkasumas hama isaa (gm)**
Faxxiira/ ciree	
Faxiira booda	
Laaqana	
Irbaata dura	
Irbaata	
Irbaaata booda	

Gabatee 2: - Naamusa nyaataa kanza'aatin 24 fi odeefannosafarahedduminanyaataa.		
Gaafii Takk	**Gareenyaataa fi fakkeenaawan.** **Eyee = 1** **Himjiru = 2**	
1	**Gosamidhaani -** Xaafii, boqqolloo, ruuza, qamadii, bishingaa, garbuu, ajjaa, abishii, daagursaa fi kanneenirraa kanqophaa'ugosanyaataa (paastaa, mokoroonii, biddeena, marqa, qixxaa/xoroshoo/ fi kan kana fakkaatan. **Hundeewan –** Dinnichaa, hundee-diima, Dinnichaasukkaara, booyee, kaasava, fi nyaataa biro kanhundeewanirraaqoph.	
2	**Dhedheedhi –**Baaqelaa, shumburaa, atara, axura-atara, boleqee fi kanirraanyaataa hojjatamu.	
3	**Daraara** – Ocholoonii, dhadhaaocholoonii, gumabaalqulaa.	
4	**Annanniifikanannanirraaargamu–**Shalala, itituu, oo'ituu, yokiinkaneen biro kanargamaannaniita'e.	
5	**Foonbee yladootafiargama akkasumas fi qurxumii -** Foonsangaa, foonboyee, foonhoola, foonre'ee, foon lukkuu, tiruu, kale, garaacha, dhigawoddame, qurxumiihoo'aa yookkin fireeshyookkin qurxumii goggayookkin qurxumii galaanaa kkasumas nyaataa kanninirraa hojjatama kamiyu.	
6	**Killee (Buuphaa) –** Killeelukkuukandaakiyee, kanrumicha, kanguchii fi kalleefekkatan.	
7	**Nyaabaala magariisa –** Shaana, shaanamaramaa, fosoliya, qosxaa.	
8	**Kuduraafi muduraVitaamina A dhaanbadhaadhe –** Kaarota, baalqula, mango (kanbiichaate), papaya, gishxaa, kokii, mixaaxisha, kanneen biro fi kan kana irraa hojjataman juussiikamiiyyuu.	
9	**Mudura biro –** Ximaaatima, shunkurtaa, qaachee, boqolloomagariisa, zukunii, salaaxaa, shaanadarrara, ujuree.	
10	**Kuduroota biro –** Burtukaana, loomii, mandariina, ananaasii, pomii, muzii, habiih, woyinni, injoorii, kan biro fi kaneenirraa kanhojjataman dhugaati juussii kamiiyu.	
	Eda 'ama qaxii hedumina namusa nyaataa	

Kutaa 9.2: Odeefannoo naamusa nyaata ilaalchise kan guyyoota safata (Hirmaatota qo'anna hundaaf jalqaba qo'anna yeroo hordofi daawii qo'anaa fi dhuma qo'annaati kan gaafatamu).	
Ama guyyoota **7 barban** keessati haali nyaata keeti akkam akaa ture si gaafaha. **Qajeelfama**:- Gabatee keessati guyya sirri taate (✓) godhi.	
916	Nyaata siif ibsu keessa guyyaa yookiin gosa nyaata siif ibsu keessa torbaab darbe keessati guyya 7 keessa guyyaa meeqa akka nyaateneti himta?

	Sanyii midha ni fi hunde	Dhe dhee dhi	Garto kee kan akkaata	Ann ani fi arga ma anna nii	Fooni fi qurxu mi	Buup ha (kille)	Baa la ma gari	Kudura fi mudura vitamin A, badhad he	Kudur a biro	Mud ura biro	Sha ayii Bun a koka
Guyyota	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○
	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○
	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○

	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○

Kutaa 10:- waayee naamusa nyaata maatii fi deefanno wobii nyaata gaafatamu (Hirmaatota qo'anchaa hundaaf jalqabaa qo'anchiati qofa kan gaffatamu).	
Ama immo haala nyaanaa maati keeti sigaafadhii.	
1001	Ji'a 1 kan darbe keessati wanti nyaatan manaa dhabamee beeka? 1. Hinbeeku 2. Eyya darbee darbee (1-10 guyya) 3. Eyye baayinaan (guyyota10)
1002	Maatii kee keessa ji'a /Baati? Darbe keessati sababii nyaat mana dhabuu tin nyaata hin barbaane nyaate jiraa? 1. Hin jiru 2. Eyya darbee darbee (1-10 guyya) 3. Eyye baayinaan (guyyota 10)
1003	Ji'a darbe keess yoking ji'a/ dorbe keessati miseensa maati keeti ta'ee ati nyaata osooo hin nyaatin agabuu (somaan) bule ole jira? 1. Hin jiru 2. Eyya darbee darbee (1-10 guyya) 3. Eyye baayinaan (guyyota 10)
1004	Ji'a darbe keessati si'I ta'e miseensa maatii kee keessaa nyata oso hin nyaatin bule jira? 1. Hin jiru 2. Eyya darbee darbee (1-10 guyya) 3. Eyye baayinaan (guyyota 10)
Kuta 10.2:- Odeefanno naamusa nyaata maatii ilaalchisee kan guyyaa 7 gaafatamu(hirmaatoota qo'anna hunda jalqabe qo'annati yero daawii hordof fi dhuma qo'anati kan gaafatamu	
Ama guyyootan darbe keessati nyaata maatii keeti akkam akka ture si gaafadha. **Qaajeelfama**:- geengoo keessati guyyaa sirri taate () godhi.	
1005	Ama nyaata siif tokkoon tokkon ibsu keessa torbaan darbe keessati atis taate miseensa maati kee kamiiyyuu keessa mana qofa keessati yeroo maqaa akka nyaattan nati nati himta?

	Saanyii midhaan fi hundee	Dhedh eedhi	Kudur oota	Mudura	Fooni fi Qurxu me	Argam annanii	Mi'aawa	Zayita	Qimama fi meefana
Guyyota	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○	4 ○
	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○	5 ○
	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○	6 ○
	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○	7 ○

Kutaa 11- Odeefannoo hordofii qo'annaa hirmaata walitti qabiinsa daawiin yoggguu godhamu gaafataman.	
Qajeelfamaa - Hirmaatun qo'anichaa ulaagalee qo'anna guutu ishee irra deebii mirkanees: • Hayamtuu ta'uu ishee irra deebii mirkaanees. • Ulfa (Ulfi ishee adda hin cinne) • Qoricha ayireeni hinfudhatu • Sirna nyaata irrati foon nyaachuu dhisuuf hin murteesine • Dhukubsatee mana yaata ciifte yaatama hinsirtu	Ulaagalee hin guutane? 1. Eyye 2. Hin guutane Ulaaga yoo guute hordofi odeefano gaafatamu ishee guti. Ulaaga yoo hin guune odefanno hordofi gafatamu guuti/odeefanno qo'ana to'ichaatiif gabasa godhi.
Naanno hirmaata qa'anna	
Lakkofsa mana jireenya	[__|__|__]__]__]
Lakkofsa biibila hirmaata	[__]__]__]__]__] [__|__|__]__|__] Yoo hin qabane
Lakkofsa biibila fira dhiyyeena	[__]__]__]__]__] [__|__|__]__|__]

Lakkofsaa hordofi daawi	|_ _||_ _|
Guyya gaafatamuu itt godhame	[__|__][__|__][__|__|__] (Guyaa/Battii/Wogga)
Koodii gaafatama |__]|__]	Mallattoo ______________________
Maqaa too'ata ________________	Mallattoo ______________________
Laakkofsa galme gaafatamu |__]__]__]__[__|	Koodii |__]|__]

Kutaa 11.1 - Gaafii hirmaana qo'anicha gageesu yaalil fi raawii qo'anna ilaalchise (gaafii hordoftoota qo'anichaa hundaaf daawii yeroo hordofi qo'an chatiifi dhuma qo'anichati gaafataman).		
1111	Kaleesa guyafi halkan keesa sa'atii 24ti sia meeqa nyaate? |_ _||_ _|	
1112	Gaafi armaan durasi godhe booda jijira sirna nyaata fled jira? 1. Lakki 2. Hin Jira /Eyye	1-› gaafi takk 1115
1113	Sirna nyaata kee irrati jijiiraa yoo fide,yookin yoo goote hamma nyaataafi nyaannaa guyyaa irratti jijjirama kan fide haala akkamiitin? (deebii ishee hunda galmeesi). 1. Bifa nyaata dabaleera 2. Hama nyaata dabaleera 3. Hanga nyaata fiyero dabalexra 4.Hama nyaatafi yero hirdhiseera 5. Hama nyaata hirdhiseera 6. Hama nyaata fi yeroo hirdhiseera 7. Jijiira hinqabu 88. Kan biro ibsi-------------------------	
1114	Naamusa nyaataa kee irratti jijiirama yoo yoo fide gosa nyaata nyatu irratti isoonati fide jira (deebii hunda galmeesii) 1. Kuduraafi mudura akkasumas nyaata baala baayise nyaadha 2. Kuduraafi mudura akkasumas nyaata baala nyaachuu hirdhiseera 3. Nyaata fooni qurxumi gbaayisee nyaadha 4. Nyaata fooni qurxumi nyaachu hirdhiseera 5. Nyaata dheedhi kan akka, atara, baqeela bayisee nyaadha 6. Nyaata dheedhi kan akka, atara, baqeelanyaanyu hirdhisera 7. Jijiramni to kkollee hin jiry 88. Kan biro ibsi----------------------	
1115	Gafii arman dura si godhe boda kuduraf nyaataa baala yoo kan nyaafu ta'e yeroo baay'e kan nyaatu yero nyaata kami? 1. Nyaata dura 2. Yero nyaata nyadha/nyaata wajin 3. Nyaatan booda 88. Kan biro ibsi --------------------------	1-› gaafi takk 1118
1116	Armaan dura gafatamu sigodue boda; buna,shayi, kokakola halli fodhanna keeti akkam? 1. Itti dhiisera 2. Hirdhiseera 3. Dabalera 4. Jijiramhin qabu	
1117	Buna, Shayi, Kokakola, Yerobay'e kan dhugdu yero kami? 1. Nayachu dura sa'ati 2 durse 2. Nyachu dura 3. Nyata wajiin 4. Nyata booda 5. Yadhe sa'ati 2 boda 88. Kan biro ibsi ------------------------	
1118	Armaandura gaafatamu sigodhe boda annanifibu'a anna kan fayyadamtu sa'at; nyata kamirati? 1. Yero nyadhu sa'ati 2 durse 2. Nyata dura 3.Yero nyadhu 4. Nyata boda 5. Nyaadhe sa'aati 2 yokiin boda 88. Kan biro ibsi ------	
1119	Ayman dura gafatamu s.godhe boda, gosa nyata dhedhi yoga tolchite, nyata hanga gara hirahisuufi wanta keessa keef hin barbachifne hirdhisu fayyadamu jalqabde? 1. Eyye 2. Hin jalqabne	1-› gaafi takk 1120
1120	Gosa nyataa qophesu Kam fayadamu jalqabde? (Maala nyata qopheesu). 1. Zafazafu 2. Irshoon wal nyachisu 3. Boqolti godhu 4. Aduun gogsu 88. Kan biro ibsi -------------	
1121	Faryamu yoo hin jalqabne sababin mal ture?	

<table>
<tr><td colspan="2">Kuta 11.2 - Hordofifiyalii fudhama juusi ilalchise hirmattonni qofti wa'ec rawwana juusi ilaalchises garedhan gafi gafatamaan (dhuma hordofi fIdggwi gaafatamuti kan gaafataauu).</td></tr>
<tr><td>1122</td><td>Arman duraa gafatamu sl godhe boda kudura jusilorban sikemame hataa sibarsifne irrati hundeefte guyya meeqaf fudhe jere yaada? Yanga hagam akka fudha ta'e him: |___||___|</td></tr>
<tr><td>1123</td><td>Ama guyyoota torbanii keessati guyya hundaafu goyya guyyadhan hangaa hamamil fi yeromeqa akka fudhatu natihimi qajeelfama. Hunda isafu guyya guyyadhan hanga hamam akka fudhate gafadhu. Akkasumas lakkofsa gabate srri(√) godhi. Baayina eda'ma isas ibsi.</td></tr>
</table>

	Wixata	Kibxata	Robi	Kamis	Jimata	Dilbada	Sanbata
Guyyati yero fudhana	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○	1 ○
	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○	2 ○
	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○	3 ○
Guyyati hama afudhana	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○	0 ○
	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○	< ½ ○
	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○	½ - ¾ ○
	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○	> ¾ ○
	Hunda ○	Hunda ○	Hunda ○	Hunda ○	Hunda ○	Hunda ○	Hunda ○

<table>
<tr><td>1124</td><td>Eda'ama guyyaa yeruu fudhaannaa hundaa ibsi.</td></tr>
<tr><td></td><td>Guyyati yeroo "0" guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Guyyati yeroo "1" guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Guyyati yeroo "2" guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Guyyati yeroo "3" guyyoota |___||___| tiif</td></tr>
<tr><td>1125</td><td>Eda'ama hama fudhaannaa guyyoota hundaa ibsi.</td></tr>
<tr><td></td><td>Hama hamamiiyuu kan hinfudhane guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Hama walakaa gad guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Hama 1/2 – 3/4 gad guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Hama >¾ gad guyyoota |___||___| tiif</td></tr>
<tr><td></td><td>Hama hundaa guyyoota |___||___| tiif</td></tr>
<tr><td>1126</td><td>Guyyoota baay'eef (guyyoota>3) kan fudhate yeroo nyaata kami irratti?
1. Nyaataan dura 2. Nyaata wojjiin 3. Nyaata erganyaadheen boda</td></tr>
<tr><td>1127</td><td>Guyyoota baay'eedhaaf kudura juusi (cuunfaa) fudhachuuf akkamiti akka qopeheessaa turte nati himi. Haala sif ibsiteen karran itti qopeheessaa turte sirriidha?
1. Sirrii miti 2. Sirriidha</td></tr>
<tr><td>1128</td><td>Odeefanno argeme irrati hundaa'uudhaan, fudhannaancuunfaa loomii akka qajeelfama raawannati, hirmaatuun torbeedhaaf fudhatesirriidha?
1. Sirrii miti
2. Sirriidha (Qajeelfama – fudhannaan hitmaatuu guyyati yerro 2fi lemaa olfi hama, walakaa ol yoo xiqaate goyyoota 4fi, guyyoota baay'eedhaa kan fudhate nyaata wojiin yoota'e)</td></tr>
<tr><td>1129</td><td>Qajeelfama –Akka qajeelfamati guyyootiin itti hinfudhane yoo jiraate qofa kan qaafatamu.

Akka qajeelfamati guyyoota itti hinfudhaneetti sababiin maal ture?
1. Nan dagadhe 2. Dhandhamni isaa nati hintole
3. Nama birootiif kenne (qoode) 4. Dhukuba dugdaatu na muudate
5. Fudhachuu hin barbane 88. Kan biro ibsi--------------------------</td><td></td></tr>
<tr><td>1130</td><td>Amma booda akka qajeelfamati aka fudhatuuf maaltu fooyya'uu qaba jeta?</td><td></td></tr>
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Kuta 11.3 - Qo'anna wara gageesuuf garedhan qo'anna tokkofi lama hirmatota qofaf waye hordofi sirna nyata rawwachu ilaal chise gaafi gaaafatamu (dhuma aqo'abucgatujab gafatu)		
1131	Barnota ogessi fayya qo'anna kuta asirna nyata kuta saganta _____ kuta isahunda hordofte? 1. Hin hordofne 2. Hordofeera	2-› gaafi takk 1133
1132	Hin hordofne yoo jjete sababiin hordefu baate maal ture? 1. Nan dagadhe 2. Hojin nati bay'ate 3. Hordofuu hinbarbane 4. Yeron wan naf hin mijoofneef 88. Kan biro ibsi -----------------------	
1133	Aman booda barnota sirna nyata hordofuf marha fooya jeta?	
1134	Barnota sirna nyata kenu iratti irra caalati hordofu aman bodas maaltu foyya'u qaba jeta?	
1135	Manga Amati barnoni ogeesifayya qo'annadhan siif kenc namusa nyata keeirratti fide jetee yaada? Akkaamiti?	

Adde _______________ turtii wajiin tureef hirmaana damaqaa akkasumas deebii keef bay'ee sigalatonfana. Daawi hordofl ittianuuf hanga wal agaruti ngaya ta.

GAAFATAMU 2FFAA

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1502. Hama Heemogilobni (gm/dl)

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1 ffaa. [___|___| . |__] gm/dl

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1503. Hama ulfaatina hirmatu (kg)

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ANNEXE 2: NUTRITION EDUCATION TOOL

ENGLISH VERSION

1. Instructions for nutrition educators

- Greet the household and the mother upon entrance to the house.
- Introduce yourself properly.
- Congratulate the mother for her willingness to participate in the study project.
- Explain the purpose of the visit.
- Ask the participant if the time is appropriate for the education session. If the participant insists for alternative schedule:

- Arrange the next appointment.
- Thank the participant for her time.
- Complete the information on the follow-up checklist.
- Submit the completed checklist to the supervisor on the same day.

➢ Invite the mother to select a comfortable and non-destructive setting.

➢ Explain the approaches and duration of the session.

➢ The main role of the educator is to lead and facilitate a two-way discussion. The mother should be encouraged to discuss her experiences and problems. The educator is then responsible to give detailed explanations and clear any misinformation and ambiguities.

➢ Employ all the teaching aids and pictorial presentation whenever appropriate.

➢ The session must be conducted in the local language preferred by the participant.

➢ Avoid using technical and medical words.

➢ Make sure that any ambiguities from previous sessions are cleared before proceeding to the next one.

➢ Always acknowledge the participation and correct responses and don't discourage any incorrect ideas.

➢ Before the end of each session:
  - Recap the main points of the session.
  - Ask the participant for any clarifications.
  - Ask a few questions to see whether the main objectives of the session are properly addressed to the mother.

➢ Upon completion of each session:
  - Thank the mother for her participation.
  - Arrange the appointment for the next session.
  - Complete the participant core, session number, session date, appointment date and signature on the follow-up checklist.
  - Submit the completed checklist to the supervisor on the same day.

2. Messages for sessions of nutrition education

SESSION 1 (Session code- NES1): Prevalence, trends and effects of anaemia iron deficiency and anaemia during pregnancy.

Session time: 30 minutes.

Objectives: By the end of the session, the participant would be able to:

- ✓ Tell what anaemia is.
- ✓ Know the signs and symptoms of anaemia.
- ✓ Know population groups at risk and most affected by iron deficiency and anaemia.
- ✓ Know the effects of anaemia during pregnancy and childhood.

Lead and facilitate discussion on the following core points.

Core discussion messages:

1.1. What is iron deficiency and anaemia?

- o Explain the importance of iron for health and pregnancy.

1.2. Signs and symptoms of anaemia

Make the discussion by elaborating the points with examples.

Palour	Tiredness
Body weakness/Less energy	Dizziness
Headache	Breathlessness/ Difficulty of breathing
Decreased appetite	Rapid heartbeat
More likely to become sick (less immunity to infections)	

1.3. What population groups at risk and most affected by iron deficiency and anaemia?

Discuss why these groups are most risk.

- o Children due to the increased requirement for growth.
- o Adolescents to an increased requirement for growth.
- o Women in reproductive ages 15-49 years due to iron loss during menstruation.
- o Pregnant women to an increased requirement for growth of the baby.
- o People living in malaria-endemic areas.

1.4. Effects and consequences of anaemia during pregnancy and childhood

On children

- o Delay of mental and physical development
- o Increased mortality and morbidity

On pregnant women

- o Risk of dying during or after pregnancy
- o Difficult delivery and labour

- Low birth weight
- Premature delivery
- Perinatal mortality
- Haemorrhage
- Decreased productivity
- Increased risk of risk of infection

At the end, lead the participant to discuss her attitude about the magnitude of anaemia as a problem and help her perceive her risk of being anaemic.

Thank the participant for her attention and participation.

SESSION 2 (Session code- NES2): Causes and prevention of anaemia.

Session time: 30 minutes.

Objectives: By end of the session, the participant would be able to:

- ✓ Know the causes of anaemia during pregnancy.
- ✓ Know the strategies and intervention for prevention and control of anaemia during pregnancy.
- ✓ Make plans to healthy dietary behaviours to prevent anaemia.

Approach: Lead the participant to recap what she learnt from the previous session NES1. Ask the participants if she has any question from the previous session NES1 and makes sure that any ambiguities from the previous session are cleared before proceeding.

- Now discuss the core points on the causes and prevention of anaemia during pregnancy.

Core discussion messages:

2.1. Anaemia is caused by many factors

- Poor dietary iron intake that is the intake of food sources poor in iron (most common cause, that is, 50% of anaemia)
- Poor dietary diversity: eating more plant food sources and less animal food sources
- Poor dietary intake of fruits and vegetables rich in vitamin C, A, B12, folate like orange, mango, carrot, cabbage, lemon etc.

- Poor dietary practices and behaviours: high intake of iron inhibitors in the diet (eating more cereals and grains), drinking tea, cocoa and milk together will meal, avoiding foods due to cultural taboos etc.
- Malaria
- HIV/AIDS
- Bacterial or viral infectious disease (e.g., chronic diarrhoea; TB)
- Helminthic infections (e.g. hookworm, schistosomiasis)
- Genetic blood disorders (e.g., sickle cell trait, thalassemia)
- Heavy bleeding during menstruation
- Increased requirement for growth and reproduction like during childhood, adolescence and pregnancy.

2.2. How can anaemia during pregnancy be prevented and controlled?

- Good dietary practices
  - Eating diversified food groups.
  - Eating iron-rich foods like animal source foods.
  - Eat or drink fruits rich in vitamin C during or right after meals.
  - Eating less food with high content of iron inhibitors in the diet (eating less cereals grains and pulses).
  - Avoiding drinking tea, cocoa and milk together will meal.
  - Practising proper dietary preparation techniques to decrease dietary inhibitors of iron in cereals grains and pulses) and preserve iron and vitamin C contents.
  - Avoiding cultural taboos related to foods.
- Taking iron supplements as prescribed during ANC visit.
- Eating foods fortified with iron.
- Good personal hygiene and sanitation practices to avoid infections.
- Seek health-care for the treatment of diseases and infections.
- Using be nets during pregnancy.
- Continue breastfeeding (for infants 6–23 months old).

The participant should now be invited to ask questions for clarification on any aspect of the session. Ask the participant about what actions she will take to protect herself from getting anaemia.

Assist the mother make her own plan to modify her healthy behaviours to prevent anaemia.

Thank the participant for her attention and participation.

SESSION 3 (Session code – NES3): Iron-rich foods, enhancers and inhibitors of iron absorption.

Session time: 30 minutes.

Objectives: By the end of the session, the participant would be able to:

- ✓ Know the best sources food rich in iron.
- ✓ Know the best sources food rich in vitamin C.
- ✓ Know the food sources that enhance iron absorption.
- ✓ Know the food sources that inhibit iron absorption.
- ✓ Make plans to modify dietary diversity behaviours to increase intake of food sources that enhance iron absorption and decrease intake of food sources that inhibit iron absorption to prevent anaemia.
- ✓ Initiate proper dietary practice to increase intake of food sources that enhance iron absorption and decrease intake of food sources that inhibit iron absorption.

Approach: Lead the participant to recap what she learnt from the previous session NES2. Ask the participants if she has any question from the previous session and makes sure that any ambiguities from the previous session are cleared before proceeding.

- Now discuss the core points on Iron-rich foods, enhancers and inhibitors of iron absorption.

Core discussion messages:

- Iron-rich foods from animal sources include red meat, organ meat (liver), fish, chicken etc.
- Iron-rich foods from plant sources: Teff, Beans, Millet, Wheat, Sorghum Groundnuts, Rice and green leafy vegetables like Spinach, Sweet potato, Cabbage.
- Iron from animal food sources is more readily absorbed.
- Iron from plant food sources is less readily absorbed.
- Food items that enhance iron absorption include Meat, poultry, fish, and seafood as well as Vitamin C or ascorbic acid-rich fruits and juices.
- Good source of vitamin C is: Pineapple, Mango, Oranges, Lemon juice, Cabbage tomato, carrots, spinach, Potatoes and some other tubers.

- Food items that inhibit iron absorption include Cereal grains, Pulses and legumes (beans, peas, lentils), Egg, tea, coffee, cocoa, and calcium, particularly from milk and milk products.

The participant should now be invited to ask questions for clarification on any aspect of the session.

Assist the mother to identify locally available foods rich in iron and assist her to make her own plan to modify her dietary practices.

Thank the participant for her attention and participation

SESSION 4 (Session code – NES4): Dietary advice for pregnant women to improve dietary diversity and modification for optimal intake bioavailable iron in the diet.

Session time: 30 minutes.

Objectives: By the end of the session, the participant should be able to:

- ✓ Know the proper dietary practices advised for pregnant women to improve dietary diversity and modification for optimal intake bioavailable iron in the diet.
- ✓ Make plans to modify dietary and healthy behaviours to prevent anaemia.
- ✓ Make plans to modify dietary diversity behaviours to increase dietary intake of iron.
- ✓ Initiate proper dietary diversity practice to increase dietary intake of iron.

Approach: Lead the participant to recap what she learnt from the previous session NES3. Ask the participants if she has any question from the previous session and makes sure that any ambiguities from the previous session are cleared before proceeding.

- Now discuss the core points on dietary practices.

Core discussion messages:

- Adding at least one additional meal from what used to be in her non-pregnant state.
- Not avoiding food types totally during the pregnancy period.
- Eat more diversified food to increase protein, energy and micronutrient intakes:
  - Eating 2 to 3 servings of meat, fish, nuts or legumes.
  - Eating 2 to 3 servings of dairy (milk, eggs, yoghurt, cheese).
  - Eating 3 servings of whole grain bread, cereals, or other high complex carbohydrates.
  - Eating 2 servings of green vegetables; 1 serving of yellow vegetables.
  - Eating 3 servings of fruits.

- Eat more amounts of foods which are rich in iron such as animal source 2-3 times a day.
- Eat or drink more amounts of foods which enhance iron absorption such as Vitamin C fruits and vegetables like orange juice, pineapple, mango, cabbage, carrots, or cauliflower.
- Eat or drink more amounts of Vitamin C fruits and vegetables combined with plant foods rich in iron like Teff, Beans, Millet, Wheat, Sorghum Groundnuts, Rice and green leafy vegetables like Spinach, Sweet potato, Cabbage.
- Eat or drink Vitamin C fruits and vegetables at the time of meals i.e during meals
- Eat less amount of foods that inhibit iron absorption such as plant source foods.
- Decrease intake of tea, coffee or cocoa from what was in her pre-pregnancy days.
- Avoid drinking tea, coffee, milk or cocoa together or immediately after a meal.
- If taken, separate tea, coffee, milk or cocoa from mealtime – take one or two hours after a meal. This is because that effect of such foods in inhibiting iron absorption will decrease as most of the foods eaten will be digested by this time.
- Avoid alcohol use and smoking.
- Take IFA tables daily as prescribed and should not stop unless informed by health professionals.
- Using Iodized salt.
- Practice proper food preparation techniques to decrease the inhibiting effect of cereals and legumes on iron absorption.
- Properly store Vitamin C fruits and vegetables.

The participant should now be invited to ask questions for clarification on any aspect of the session.

Assist the mother to make her own plan to modify her dietary practices.

Thank the participant for her attention and participation

SESSION 5 (Session code – NES5): Household food preparation methods and nutrient preservation techniques.

Session time: 30 minutes.

Objectives: By the end of the session, the participant would be able to:

- ✓ Know the different food preparation methods to decrease the amount of dietary inhibitors of iron absorption in grains, cereals and legumes.

- ✓ Know the different preservation methods to preserve the amount of vitamin C in foods.
- ✓ Start practising the different food preparation and nutrient preservation techniques at the household level.

Approach: Lead the participant to recap what she learnt from the previous session NES2. Ask the participants if she has any question from the previous session and makes sure that any ambiguities from the previous session are cleared before proceeding.

- Now discuss the core points on food preparation techniques.

Core discussion messages:

- Vegetables contain many minerals and vitamins like iron and vitamin C that can be easily lost during cooking. Many are heat sensitive and may be destroyed by either high heat or prolonged cooking.
- Vegetables and fruits should be stored at the appropriate temperature because their vitamin C could be destroyed by high heat.
- Vegetables and fruits should be consumed while fresh to maintain their iron and vitamin C contents.
- Different food preparation methods can be practised to decrease inhibitors of iron in plant source diets thus increase intake of bioavailable iron.
- Food preparation techniques to decrease inhibitors of iron in plant source diets include:
    - ➢ Soak cereals and legumes like beans, Beans, Millet, Wheat, and Sorghum in cold water before cooking. Pour off the water and use new water to cook them.
    - ➢ Fermentation
    - ➢ Malting
    - ➢ Thermal processing
- Food preparation techniques to preserve iron and vitamin C contents:
    - ➢ Cook foods in cast iron pots or pans to enhance their iron contents.
    - ➢ Cook beans with tomatoes.
    - ➢ Cook vegetables 2-3 minutes close to serving time as possible to avoid loss of nutrients.

- Vegetables should be served firm to the bite, pleasantly crunchy and crisp-tender to avoid overcooking.

Demonstration: Finally, if the mother is willing, prepare and conduct a demonstration session.

The participant should now be invited to ask questions for clarification on any aspect of the session.

Assist the mother to make her own plan to modify her household food preparation techniques to decrease dietary inhibitors of iron and preserve iron and vitamin C losses.

Conclusion: Summarize in short the key messages of the nutrition education from NES1 to NES5 and invite her to ask any questions for clarification.

Finally, on behave of Wegderes Ketema, Prof AH Mavhandu-Mudzusi and UNISA, **thank** the mother for her successful completion of the nutrition education intervention and for her active participation in the research.

NUTRITION EDUCATION TOOL – AMHARIC VERSION

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ANNEX 3: ETHICAL CLEARANCE LETTER BY UNISA

UNISA university of south africa

RESEARCH ETHICS COMMITTEE: DEPARTMENT OF HEALTH STUDIES

REC-012714-039 (NHERC)

15 February 2017

HSHDC/625/2017
Mr W Ketema
Student: 5853-612-4
Supervisor: Prof AH Mahvandu-Mudzusi
Qualification: PhD
Joint Supervisor: -

Dear Mr W Ketema

Decision: Ethics Approval

Name: Mr W Ketema

Proposal: Food-based strategies to improve iron status of pregnant women: randomized controlled trial.

Qualification: DPCHS04

Thank you for the application for research ethics approval from the Research Ethics Committee: Department of Health Studies, for the above mentioned research. Final approval is granted for the duration of the research period as indicated in your application.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the Research Ethics Committee: Department of Health Studies on 15 February 2017.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*

2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the Research Ethics Review Committee, Department of Health Studies. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Open Rubric

3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

4) *[Stipulate any reporting requirements if applicable].*

Note:

The reference numbers [top middle and right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the Research Ethics Committee: Department of Health Studies.

Kind regards,

Prof L Roets
CHAIRPERSON
roetsl@unisa.ac.za

Prof MM Moleki
ACADEMIC CHAIRPERSON
molekmm@unisa.ac.za

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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ANNEX 4: DATA COLLECTION PERMISSION REQUEST LETTER TO DIRE DAWA ADMINISTRATION HEALTH BUREAU

Date: 20/2/17

To: Dire Dawa Administration Health Bureau
Dire Dawa:

Sub: Request for permission to conduct research at health facilities under Dire Dawa Administration Health Bureau.

"Food-based strategies to improve the iron status of pregnant women: a randomized controlled trial."

Dear Sir/ Madam,

I, Wegderes Ketema Bekele, am doing research with Prof. AH Mavhandu-Mudzusi, a professor in the Department of Health Studies at the University of South Africa, towards a Doctor of LITT and PHIL in Health Studies. The aim of the study is to determine the effect of food-based strategies in improving the iron status of pregnant women. The reason to do this research is that little is known about the topic. The study will be conducted at randomly selected health facilities under Dire Dawa Administration Health Bureau.

Dire Dawa Administration is selected due to its known high prevalence of iron deficiency and anaemia among pregnant women. Thus, findings and recommendations from the study will be helpful to formulate locally feasible food-based strategies and interventions for prevention and control of iron deficiency and anaemia during pregnancy.

The study will entail a randomized single blind controlled trial. Pregnant women in the Administration will be enumerated from randomly selected health centres while attending ANC visits. After written consent is obtained, the women will be screened using a medical history and blood tests to check their haemoglobin level and anaemia status and a total of 195 consenting anaemic women with Hg <11gm/dl and fulfilling the study inclusion and exclusion criterion will be included in the study. The participants will then be randomly distributed to one of the three study groups: those in intervention group 1 will be provided with nutrition education combined with daily supplementation of fruit juices containing 90mg/day vitamin C divided into three doses; those in intervention group 2 will be provided with only nutrition education and those in the control groups will be without any intervention. The study interventions will last for 12 weeks after enrolment. The mothers in the intervention groups will also be participated to attend group and individual nutrition education and demonstration sessions at the health facility and home levels each lasting 30 minutes to help them modify household food preparations. The study will involve interviews administered by data collectors who will be recruited for this research purpose only, asking questions regarding their socio-demographic characteristics, reproductive history, nutritional knowledge on iron deficiency and anaemia, dietary diversity and food consumption, and household dietary practices. Besides, there will also be home visits and follow-ups interviews to assess subsequent changes in their study intervention outcomes. In order to analyze the study outcomes, blood samples to check haemoglobin level and anaemia status and anthropometric measurements like weight and MUAC measurements will also be collected from the mothers at the beginning and end of the study. This study will not have any consequence neither to women nor to their babies and surroundings. The study protocol is approved by Ethical clearance committee of UNISA and all the information collected will be confidential and used for the study purpose only.

Your office will be provided with the final results and feedbacks. If there is any questions or concern about the study, you can contact the researcher (Wegderes Ketema Bekele) at the following number: 0913-701962 or you can also contact Prof AH Mavhandu-Mudzusi: (the student supervisor) through 0124292055/ 0824062494. The copies of ethical clearance approved by UNISA and abstract of the research proposal is attached with this letter for further information.

Thank you in advance for all the support and cooperation your office is to offer.

Yours sincerely

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Wegderes Ketema Bekele

Principal Researcher

ANNEXE 5: APPROVAL LETTER FOR DATA COLLECTION BY DIRE DAWA ADMINISTRATION HEALTH BUREAU

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ANNEXE 6: PARTICIPANTS INFORMATION SHEET

Department of Health Sciences
University of South Africa
Akaki Camps, Ethiopia

Dear prospective study participant,

“Food-based strategies to improve the iron status of pregnant women: a randomized controlled trial.”

My name is Wegderes Ketema Bekele and I am doing research with Prof. AH Mavhandu-Mudzusi, a professor in the Department of Health Studies, towards a Doctor of LITT and PHIL in Health Studies at the University of South Africa. We are inviting you to participate in a study entitled **“Food-based strategies to improve the iron status of pregnant women: a randomized controlled trial.”**

I am conducting the study in order to determine the effect of food-based strategies in improving the iron status of pregnant women in Dire Dawa. The reason to do this research is that little is known about the topic.

You are enumerated as a participant as you are among the pregnant women living in Dire Dawa and you come for your first ANC visit at this health centre which is randomly selected for this research. There will be another 194 pregnant women who will also be participating in the study. You will be explained in detail on the ethical issues of the research and If you are consenting in written to take part in the study, you will be screened using a medical history and blood tests to check your haemoglobin level and anaemia status and will be included if you meet the study inclusion criterion. The study will last for 12 weeks.

The study will involve interviews administered by data collectors who will be recruited for this research purpose only, asking questions regarding your socio-demographic characteristics, reproductive history, nutritional knowledge on iron deficiency and anaemia, dietary diversity and food consumption, and household dietary practices. Besides, data collectors will also pay you home visits and follow-ups interviews to assess subsequent changes in study intervention outcomes. In order to analyse the study outcomes, blood samples to check haemoglobin level and anaemia status and anthropometric measurements like weight and MUAC measurements will also be collected from you at the beginning and end of the study. (*Depending on the randomization: if you are included the study intervention group; you will be given fruit supplementations three times per day since your time of enrolment till the end of pregnancy/attend five individual nutrition education and demonstration sessions at your home level each lasting for 30 minutes).*

Please note that you are totally free and have the right to accept or refuse to participate. If you decide to refuse, for whatever reason, there will not be any repercussion to you in any way now or in future. However, your participation will help the study address the problems that many of pregnant women in this area are facing. No incentives will be received by participating in the study. If you accept, your full participation, compliance and complete information throughout the study is so valuable for the study to meet its objectives. We assure you that all information collected will be kept confidential and will be used for the research purpose only. You are free to quit at any moment of the research, without any prior notice or justification. This study will not have any consequence neither to you nor to your baby and surroundings. The study is approved by the Ethical committee of UNISA and approval letter is obtained from Dire Dawa Administration Health Bureau. You have also the right to ask any questions and be informed about the results.

If you have any questions or concern about the study, you can contact the researcher (Wegderes Ketema Bekele) at the following number: 0913-701962 or you can also contact Prof AH Mavhandu-Mudzusi: (the student supervisor) through 0124292055/ 0824062494.

Thank you for taking the time to read this information sheet and you are kindly asked to sign a consent form to certify your informed and voluntary participation. Thank you also for agreeing to be part of the study.

Thank you

____

Wegderes Ketema Bekele
Principal Researcher

ANNEXE 7: INFORMED CONSENT FORM

This is to certify that I………………………………………………………agree of my free will to participate in this research project, which focus on the **“Food-based strategies to improve the iron status of pregnant women: a randomized controlled trial.”**

All the information that is entailed in the research project and the ethical issues have been explained to me in full. I understand that the information that I will share will be used for research purposes only and that nowhere will my identity be made known in any research report or publication. My participation is voluntary. I can participate in part or whole and I can withdraw at any stage or time by the reason known by me, without being restricted anyhow or penalised. I understand that I will not be paid for participating.

I understand that agreeing in participating means that I am willing to: take part in the face-to-face interview, participate and adhere to the study interventions, give my blood samples for analysis of the iron status and take part in group educations and household follow-ups till the end of my pregnancy. I also have the right to be informed about the results.

I also understand that if I have any questions or concern about the study, I should contact the researcher (Wegderes Ketema Bekele) at the following number: 0913-701962. I can also contact Prof AH Mavhandu-Mudzusi: (the student supervisor) through 0124292055/ 0824062494.

Participant identification N°: |__||__||__||__||__|__|

Participant‘s signature Date

Data collector’s signature Date

Supervisor’s signature Date

ANNEXE 8: CONTRACT AGREEMENT FOR DATA COLLECTION

CONTRACT SIGNED BY AND BETWEEN

Wegderes Ketema

St. No 58536124

Researcher, UNISA

Tell- 0913701962

Dire Dawa, Ethiopia

(Hear after referred as “the Researcher”)

AND

The individual below stated health workers operating under Dire Dawa Administration Health Bureau and individual consulting health professionals (Hear after referred as “the Data Collector”)

1. Introduction

- This research entitled **“Food-based strategies to improve the iron status of pregnant women: randomized controlled trial”** is conducted by “the Researcher” with Prof. AH Mavhandu-Mudzusi, a professor in the Department of Health Studies, towards a Doctor of LITT and PHIL in Health Studies at the University of South Africa.
- The aim of the study is to determine the effect of food-based strategies in improving the iron status of pregnant women.
- The study will be conducted in Dire Dawa Administration.
- The Administration is selected due to its known high prevalence of iron deficiency anemia among pregnant women. Thus, findings and recommendations from the study will be helpful to formulate locally feasible food-based strategies and interventions in the prevention and control of iron deficiency and anaemia during pregnancy.
- The study will entail a randomized single blind controlled trial. Pregnant women in the will be enumerated from randomly selected health centres in the Administration.
- After written consent is obtained, the study participants will then be randomly distributed to one of the study groups and will be followed for 12 intervention weeks.
- The study is approved by the Ethical clearance committee of UNISA and through acceptance approval of Dire Dawa Administration Health Bureau.

- The study fund is supported through the Masters & Doctoral Experimental Bursary Of the University Of South Africa.
- Payment to the "Data Collector" is as per the rate agreed in this contract.

2. The responsibility of the "Data collector"

"The Data Collector") abides these conditions in the stated terms:

2.1. Ethical considerations

- Offers a detailed explanation to the potential study population about the purpose of the study, types of data to be collected and the need for their medical history and blood sample to check for inclusion criteria, importance and benefits of participating to the study.
- Offers a detailed explanation to the potential study participants about their voluntarily right to participate, their right to withdraw from participation any time they want, their right not be forced to give any information if they do not want to and the confidentiality of the data to be collected.
- Obtains written consent form only those who will be willing to participate.
- Strictly maintains the anonymity and confidentiality of interventions and data collected throughout the study.
- Offers any information and explanation for study participants for unclear issues except for confidentiality of data collated.

2.2. Data collection

"The Data Collector")

- Abides by the data collection procedure and guideline issued by the study design.
- Timely conducts interview administered using the structured questionnaire provided for the allocated number of study participants at the beginning of the study.
- Timely collects adherence data through home visits at the 2nd, 4th, 6th 8th and 12th weeks after enrolment using the structured questionnaire provided for the allocated number of study participants.
- Timely collects and records anthropometric measurements from the mother at baseline.
- With pertinent to laboratory Technicians: collects a venous sample from each participant mothers at baseline and 12th weeks after enrolment at the health centre level as per

the recommended procedure, maintains quality and timely analyse the samples for haemoglobin level at the health centre's laboratory and record the results.

- With pertinent to intervention package delivery HEWs: Provides weekly home level deliveries of supplies and conduct nutrition education sessions (total of five individualized/ follow-up sessions each for 30 minutes based on the tool) for intervention groups.
- Collects completed questioners, checks for its consistency and handovers it to the supervisors on daily basis.
- Recollects data for incomplete questioners upon the request of the supervisors.
- Re-conducts home visits and re-attends unsuccessful nutrition education sessions upon the request of the supervisors.
- Advises the mothers for any recommended services like continuing any iron supplementation, regular ANC visit and other medical issues.

3. The responsibility of the "Researcher"

- Provides the training on the study design, data collection procedures and guidelines and ethical considerations.
- Avails all the necessary data collection materials, tools and stationary.
- Timely deliver all the necessary supplies and equipment.
- Supervisors, follows and monitors the quality of data collection procedures and timely progress of the study.
- Issues payments to the "Data Collector" as per the rate agreed in this contact

4. Termination

The "Data Collector" or the "Researcher" shall not be entitled to cede, assign or transfer any of his/her responsibilities under this contract without the prior written consent of both parties.

I the "Data collector" has individually read the contact conditions and hereby agree to abide by them and has individually signed hear below:

On behave of the "Data Collector "	On behave of the "Researcher"
Name ______________	Name ______________
Signature _____________	Signature _____________
Date___________________	Date___________________