VALIDATION OF DIETARY DIVERSITY AS INDICATOR OF MICRONUTRIENT ADEQUACY OF DIET OF PREGNANT WOMEN AT JIMMA TOWN SOUTH WEST ETHIOPIA, 2015

BY

MULISA AMARE (BSc PH)

RESEARCH TO BE SUBMITTED TO JIMMA UNIVERSITY, COLLEGE OF PUBLIC HEALTH AND MEDICAL SCIENCES, DEPARTMENT OF POPULATION AND FAMILY HEALTH; IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR MASTER'S DEGREE IN HUMAN NUTRITION

JIMMA ETHIOPIA

JUNE 2015

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Mulisa Amare (BSc PH)

Research to be submitted to Jimma University**,** college of Public Health and Medical Sciences, Department of population and family health; in partial fulfillment of the requirements for master's degree in Human Nutrition.

Advisors

Mekitie Wondafrash (MD, DFSN)

Alemayehu Argaw (BSc, MSc)

Jimma Ethiopia

June 2015

Abstract

Background: Micronutrient deficiencies among women are a global problem and are most severe for women in developing countries. Current methods used to assess micronutrient deficiencies primarily rely on biochemical diagnostic tests of blood or urine, which, although considered the gold standard, are often difficult, time consuming, and expensive to collect and analyze, and are thus not generally widely used in community settings for monitoring and evaluation of nutrition improvement programs. Therefore, validates these simpler measures of dietary diversity as proxy measures micro nutrient adequacy of diet is important

Objective: To validate dietary diversity as indicator of micronutrient adequacy of diet of pregnant women in Jimma town southwest Ethiopia.

Method: community based cross-sectional study design was conducted on pregnant women of 99 Sample sizes in Jimma town. Simple Random sampling technique was applied with structured questionnaire for socio demographic characteristic and quantitative interactive 24-hour recall for dietary intakes. Data were entered in to food processor software for nutrition analysis exports to Microsoft excel then into SPSS version 20.0 used for data analysis. For all statistical tests P -values < 0.05 considered significant. DDS was calculated and analysis of nutrient adequacy ratio of each selected micronutrient and mean adequacy ratio of nutrient were assessed the overall nutrient adequacy. Correlations between four food group indicators and MAR was assessed. Receiver operating curve (ROC) analysis was used to test the performance of each indicator as a predictor of MAR to determine the DDS cut-off point that give maximized sensitivity and specificity.

Result: Pearson's correlations between food group indicators and MAR indicate that r values range from (r=0.307-0.4260) were all highly significant with ($p<0.0001$). ROC analysis confirmed that the predictive power of the dietary diversity indicators with mean adequacy ratio (MAR) cutoff point summarized by the area under the curve (AUC) which was(AUC > 0.7) predictive power for all dietary diversity indicators and significant (P-value ≤ 0.001) . General from all five or above dietary diversity score of nine-food group and six or above dietary diversity score of 13-food group was the best cutoff to maximized sensitivity and specificity to measure micronutrient adequacy of pregnant women.

Conclusion and recommendation: correlation between dietary diversity score and MAR was Positive and significant among pregnant women in study area. Therefore, study supports that use of simple dietary diversity indicators are promising tools for assessing the micronutrient adequacy of the diet among pregnant women. In furthermore validation of dietary diversity indicators against micronutrient adequacy at different study place and in different season needed to develop cutoff point at country level.

Acknowledgement

First, I would like to thank Almighty God for giving me the patience, wisdom, and strength I needed to prepare this proposal and for always supporting me in every phase of the work.

I would like to give my heartfelt thanks and appreciation to my Dr Mekitie wondafrash and Mr Alemayehu Argaw for their unreserved cooperation and constructive comments.

I would also like to express my gratitude to Jimma University Department of population and family health for timely arrangement of the proposal.

I would like to extend my special heartfelt to JU ENGINE Project for their financial support to conduct this research

I would like to extend my special heartfelt to my family for their moral and financial help to write this proposal.

Lastly, not the least I would like to extend my thanks to Jimma town health Office as well as all kebeles health extension and study participant their unreserved cooperation.

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Acronyms

ANC - Antenatal care

AUC -Area(s) under the curve

CV -Coefficient of Variation

DDS -Dietary Diversity Score

EAR -Estimated Average Requirement

DDS - Dietary Diversity Score

EDHS - Ethiopia Demographic and Health Survey

FAO -Food and Agriculture Organization

FGI-6 -Food Group diversity Indicator consumed from 6 groups

FGI-9 -Food Group diversity Indicator consumed from 9 group

FGI-13 -Food Group diversity Indicator consumed from 13 groups

FGI-21 - Food Group diversity Indicator consumed from 21 groups

FVS -Food Variety Score

MAR -Mean Adequacy Ratio

MDG -Millennium Development Goal

MND -Micro-Nutrient Deficiencies

NAR -Nutrient Adequacy Ratio

NGO - Nongovernmental organization

NPNL -Non-pregnant non-lactating

RAE -Retinol Activity Equivalent

RE -Retinol Equivalent

RNI -Recommended Nutrient Intake

ROC -Receiver-operating characteristic

WDDP -Women's Dietary Diversity Project

SD - Standard Deviation

WHO - World Health Organization

CHAPTER ONE

Introduction

1.1 Backgrounds

Micronutrients has critical role in cellular and humeral immune responses, cellular signaling and function, work capacity, reproductive health, learning and cognitive functions(1). In resource-poor environments across the globe, low quality, monotonous diets are the norm and the risk for a variety of micronutrient deficiencies is high. The high nutrient demands of pregnancy put women to develop micronutrient deficiency(2).

Pregnant women are vulnerable group as their nutritional requirements increase to support growth and as well as maternal metabolism and tissue accretion. During this time, inadequate stores or intake of micronutrients can have adverse effects on the mother, such as anemia, hypertension, complications of labor and even death and also can be affected fetus, resulting in stillbirth, pre-term delivery, intrauterine growth retardation, congenital malformations, reduced immune competence and abnormal organ development(3).

Micronutrients are not equally concentrated in all foods. Red meat, poultry, fish, eggs, milk and internal organs, such as liver contain several micronutrients (vitamin A, iron and zinc), while vitamin B2 is high in milk ,Iron and several B-vitamins are high in cereals, however, milling of grains result in losses of these micronutrients(4). In resource-poor, low quality, monotonous diets are the common, which grain or tuber-based staple foods dominate, and diets lack vegetables, fruits, and animal- source foods(5).

Dietary diversification is one of the main strategies advocated internationally for the improvement of micronutrient intake and status, especially in undernourished individuals(6).Dietary diversity ensure health, adequate intake of nutrients, improve bioavailability of important micronutrients and also thought to decrease the chances of both deficiency and excess and to decrease the chances of unhealthy levels of toxicants(7).

Dietary diversity is the number of foods consumed across and within food groups over a reference time widely recognized as being a key dimension of diet quality. It reflects the concept that increasing the variety of foods and food groups in the diet helps to ensure adequate intake of essential nutrients, and promotes good health(8).

Dietary diversity assessment is essential to identify nutrients adequacy from diets, so that, the simple assessing of adequacy of the food and nutrient intakes to establish an appropriate intervention designed and define their public health importance (9)

1.2 Statement of Problem

Micronutrient deficiencies are direct and indirect causes of maternal and child mortality, morbidity, and disability(10). The impact of poor maternal micronutrient status is transmitted inter generationally from mother to child, resulting in less optimal fetal growth and development(11).

The World Health Organization (WHO) estimates that over two billion people are at risk of vitamin A, iodine and/or iron deficiency globally. other micronutrient deficiencies of public health concern include zinc, foliate and the B vitamins (1). Micronutrient deficiency conditions are widespread in developing and in developed countries. These are silent epidemics of vitamin and mineral deficiencies affecting people of all genders and ages, as well as certain risk groups(12). An estimated 19 million pregnant women are vitamin A deficient due to poor diets (13) and in 2011, 29 %(496 million) of non-pregnant women and 38% (32.4 million) of pregnant women aged 15–49 years were anemic. The prevalence of anemia was highest in south Asia, central, and West Africa. While half causes of anemia are due to iron deficiency(14).

2011EDHS report that the level of night blindness among pregnant women was 22 percent which considered a public health problem by WHO and 22 percent of pregnant women are anemia(15) Severe iodine deficiency in Ethiopian women leads to 50,000 stillbirths annually and the country's goiter rate has increased from 26% in 1980 to almost 40% in 2009 (16)

Micronutrient deficiencies during pregnancy have been associated with maternal health, adverse pregnancy outcomes and link with chronic disease risk in adulthood and old age. Prenatal maternal micronutrient deficiency in influencing the growth and development of the heart, kidney, lung, and pancreas, and the mechanisms involved, which may then lead to an increased risk of chronic disease later in life. Micronutrient deficiencies during fetal life have risk of chronic diseases and related biomarkers in later life(17).

Micronutrient assessment should emphasize simple, non-invasive approaches that can be used to measure the risk of nutrient shortages, as well as to monitor and evaluate the effects of a nutrition intervention. Dietary assessment method is one approach that used to identify any nutritional deficiencies by measuring the food consumption of individuals. Weighed food record has been used as the most precise method available for estimating the usual food and nutrient intake of individuals. However, the method is time consuming and expensive and difficult for subjects are not literate or cannot use the scales (18).

Dietary assessment an important factor in understanding dietary practices and nutritional status and, helps inform policy and practice aimed at improving health and developmental outcomes in many populations. In Poor access to clinics and hospitals, measuring dietary intake is one of the most efficient and informative means of understanding the health of a community. In Africa and other less-developed regions, dietary assessment has often relied on respondents to recall types and amounts of foods consumed by populations of interest(19).

Assessing individual dietary intake in resource poor settings, such as the quantitative twenty-four hour recall or interviewer assisted diet history are time consuming and costly to administer, require highly trained enumerators and involve complex data analysis. Low literacy levels, coupled with low access to computer and cell phone technology limit the types of newly developed dietary assessment tools which can be used in many areas(20).

Nutritional epidemiology would like to rapid, economic, easy to administer and applicable tool to range of populations, irrespective of age, educational level or ethnicity with a non-invasive manner, for identification of nutrition problems and evaluation of nutrition policies and interventions, such as the elaboration of food guides, with the objective of improving the population's nutritional status(18).

Food base analysis is a key issue to investigate the linkages between nutrition and disease. Diet scores or diet indices were the first methods used in nutritional epidemiology to assess the effect of nutrients or foods that may exert on health(21). Dietary diversity, an important aspect of diet quality, is a simple count of food items or food groups used in the household or by the individual over a certain period. Overall nutritional quality of the diet improved with increasing number of food items and food groups(22).

Dietary diversity scores are proxy indicators for micronutrient adequacy of diets of individuals. Dietary diversity score positive association with micronutrient adequacy of diets of women in reproductive age. In addition, the dietary diversity score was found to be a useful indicator of some specific nutrient adequacy in women (23).

Studies in different age groups have shown that an increase in individual dietary diversity score were related to increased nutrient adequacy of the diet. Dietary diversity scores have been validated for several age/sex groups as proxy measures for macro and/or micronutrient adequacy of the diet. Scores have been positively correlated with adequate micronutrient density for infants and young children(24)(25)(26)(27), adolescents and adults(28) (29)30) . however there is no currently international consensus on which food groups to include in the scores at the individual level for different age/sex groups(31).

Across all five sites of the women dietary diversity project, each of the eight food group diversity indicators were positively and significantly associated with the mean probability of adequate intake of the micronutrients examined. However, none of the specific indicators performed the best across all five sites, this suggesting there is not a single indicator recommended for global use, but rather that food group diversity indicators should be developed for specific contexts (13).

Since the dietary diversity assessment is from a single qualitative 24-h recall validation of the indicator that attains the best sensitivity and specificity with identification of micronutrient deficiencies is important and can be used to dietary analyses in future studies.

CHAPTER TWO

Literature

Women living in developing countries are particularly at risk for malnutrition during pregnancy due to socio-economic constraints, poor diet quality, high intensity of agricultural labour, and frequent reproductive cycle (32) .Maternal intakes of micronutrients such as zinc, iron, magnesium, calcium, riboflavin and vitamin C have important effects on growth of the foetus and perinatal outcomes(33).

Women dietary diversity project -II researchers identified two candidate indicators for consideration with dichotomous indicator based on the 9-point food group score currently in use by FAO and USAID. Women consuming foods from five or more food groups have a greater likelihood of meeting their micronutrient needs than women consuming foods from fewer food groups. Indicators were also strongest when consumption amounts (<15 g) of a food group did not count in dietary diversity scores(34)

The result of study from five resource-poor Settings on simple food group diversity as an indicator predict Micronutrient Adequacy of Women's Diets show that higher FGI scores were associated with higher MPA and the pattern was consistent across sites. The size of the correlations ranged from (r=0.21 to 0.53) when energy was not controlled and 0.12 to 0.46 when energy intake was controlled for non- pregnant non- lactate (NPNL). the area under curve (AUC) five countries women dietary diversity project at MPA > 0.50 cutoff point was range (0.68-0.76) for Burkina Faso,(0.75) for Mali (.0.69-0.77) for Mozambique ,(0.72-0.75) for Bangladesh and (0.63-0.71) for Philippines . the area under curve (AUC) at MAP ≥0.60 cutoff point were (0.69-0.79) for Burkina Faso, (0.68-0.71) in Mali,0.63-0.74) in Mozambique,(0.78-0.84) and (0.64-0.73) for Bangladesh and (35).

Study done in south Africa show that the consumption cereals and tubers was the most highly with (99.2%) , followed by flesh foods (93.1%) , dairy (87.3%) were also highly and Eggs, vegetables, fruits and vitamin A rich vegetables were consumed in moderation (by slightly above half of the participants). Vitamin A rich vegetable and the fruit/juice groups were reported by less than 50% of the group, indicating low/ inadequate consumption of these food groups. that cereals and starchy foods, especially maize based foods top the list of foods consumed by South Africans, especially the black populations(6)

A study done on women 19-69 years in Alexandra South Africa show that a mean food group consumption were 6.70 (± 2.22) and strong significantly positive relation between the nutrient adequacy measured (NAR and MAR) and DDS the measures of variability (r^2) (ranging from 0.43 to 0.88),but not with food variety score (FVS)(30)

A study of National Food Consumption Survey (NFCS) in South Africa on which dietary diversity indicator is best to assess micronutrient adequacy children 1-9 years show that the correlation between the MAR for each age all groups, and urban and rural groups with DDS groups were all highly significant at ($P < 0.0001$). When using the food group indicator G6, DDS of 4 provided the highest sensitivity and DDS of two had the highest specificity. DDS of three would hence provide the best compromise of 87.70% sensitivity, 42.15% specificity, and the lowest total misclassifications at 24.94. For indicators G9 and G13, the highest sensitivity was at DDS 5 with the highest specificity at DDS 3. A DDS of four would hence provide the best compromise while also having the lowest total number of miss- classifications. For G21, the highest sensitivity was at DDS 6 and the best specificity was at DDS 3. A DDS of 5 would yield the best compromise and have the least misclassifications(36).

A study conducted Iran to assess dietary diversity as proxy indicators typically using correlational and/or sensitivity and specificity analysis. A significant positive correlation was found between dietary diversity scores and the nutrient adequacy ratios of macro- and micronutrients among adolescents in Tehran. In the study, around 100% of girls consumed cereals, 50% consumed other vegetables, and only 19.98% of participants used vitamin A rich fruits(23).

Study done in Mozambique on women show that all diversity indicators were positively and significantly associated with estimated micronutrient intakes. Correlation coefficients for significant associations were low to moderate in size, ranging from 0.10 to 0.35. distribution of MPA for all women shows a wide range across the possible values of 0- 1.0, with sufficient variability to explore associations with diversity indicators and each food group five out of eight diversity indicators had correlations over 0.30 with vitamin C intakes. Correlations over 0.30 were most prevalent for FGI-9R (3 out of 11 micronutrients) and FGI-21R (4 micronutrients). When all women in the sample were grouped together, 58% estimates of prevalence of adequate intake ranged from very low (5-17 percent) for iron, calcium and riboflavin; to low (19-30 percent) for folate, vitamin B12 and niacin; to moderate (43-64 percent) for thiamin, vitamin B6 and zinc; to relatively high (74-83 percent) for vitamins A and C (8).

Cross-sectional study conducted in Tehran, Iran by using two 24-hour recalls show that the mean probability of adequacy across 14 nutrients was calculated using the Dietary Reference Intakes. Whole grain diversity score mostly correlated with protein and vitamin B2 ($r = 0.35$, $p < 0.05$). Fruit diversity score was correlated with vitamin C ($r = 0.44$, $p < 0.05$). Dairy diversity score was correlated with calcium intake ($r = 0.54$, $p < 0.05$). Meat diversity score was correlated with protein intake ($r = 0.34$, $p < 0.05$). Dairy diversity score had the strongest association with improved nutrient adequacy(37). .

Study conducted in Mali shown that mean DDS was (7.8) with DDS ranged from 4 to 10 different food groups. The proportion of subjects below recommended nutrient intake was high for calcium (80%), vitamin A (70%), iron (49%) and vitamin C (48%). Mean MAR was 0.87 for the total sample. A diet that covers the recommended intake for all nutrients has a MAR of 1, and 10% of the sample reached this value(22).

The mean MPA in the Mali data was 0.47 and FGI-6R and FGI-9R were the only indicators above an AUC of 0.70. In terms of balance between sensitivity and specificity, the best cutoff for FGI-6R and FGI-9R was ≥ 5 food groups. The cutoff point for operationalizing the indicators, a cutoff of ≥ 5 food groups would be the consistent choice for both FGI-6R and FGI-9R at either an MPA of > 50 percent or > 60 percent. At an MPA > 50 percent, FGI-21R had the best balance of sensitivity and specificity at a cutoff of ≥ 6 food groups. the AUC of 50% MPA cutoff point of 6 9,13 and 21 food group indicator were 0.673 ,0.736,0.679,00.718 respectively and the AUC of 60 % cut off point of 6,9,13,21 food group indicator were (0.624,o.653,0.569,0.618) respectively (38).

The overall mean DDS among subjects was 5.81 with a standard deviation of 1.4. 92.1% of the subjects consumed foods from cereal product, 46.4% ate foods from Vitamin A vegetables and tubers group. From total study subject 37.9% ate from dark green leafy vegetables, 9.7% ate from other fruits, 0.4% from organ meat, 33.4 from other meat, 4.6% from eggs, 57.1% from fish, 63.5% from legumes, nuts and tubers, 27.0% from milk and dairy products and 99.0% consumed from foods with oils and fats(39).

Study done in per-urban female community of yoff, Senegal show that measure of food diversity were positive associated with nutrient adequacy of calcium, iron, zinc, vitamin A, vitamin C, thiamine, riboflavin and vitamin B6 by using three 24-hour recalls. These results suggested that diversity indicators were good predictors of nutrient adequacy. Foods with little or no nutritional content such as condiments and spices were also part of the score, which may have weak association between these individual food score and nutrient Adequacy(40).

Study conducted in Metropolitan Cebu, Philippines dietary diversity as a measure of the micronutrient adequacy of women's among non-pregnant non-lactate women, all dietary diversity indicators were positively and significantly correlation with MPA for both groups of NPNL and lactating women. Among NPNL women, correlations ranged from(r= 0.21 to 0.45). Correlations for FGI-9 and FGI-13 were very similar, whereas FGI-21 had somewhat higher correlations. Among lactating women, correlations were slightly lower with correlation of FGI-9R (r=0.32), FGI-13R (r=0.30) and FGI-21R (r=0.39)(41).

Studies conducted on non-breastfed children 24–71 month in Philippines show that correlation coefficient for DDS and Mean probability of Adequacy (MPA) were significant for all nutrients except calcium and vitamin B-12. Correlations using the 10-g cut-off point were similar to the no-gram minimum. Energy intake was significantly and positively associated with MPA(24)

Study conducted in rural Bangladesh on non-pregnant non-lactate and lactate women show that diversity indicators were positively and significantly associated with estimated average requirement of each micronutrient. Correlations were stronger for NPNL women, ranging from 0.39-0.52 (0.32-0.46 controlling for energy) as compared to a range of 0.28-0.41 for lactating women (0.15-0.35) controlling for energy). The AUC of this study were AUC for 50% cutoff point were range ,(AUC ,0.684-0.746) and the AUC 60% cutoff point MPA (0.66 - 0.760) (42)

Studies done in Haryana North West India on children of 5-8years using two days 24-hour recall show that correlation coefficients for DDS and mean MPA were significant with ((r = 0.21) and PA vitamin A, PA vitamin C and mean MPA. These associations remained significant for PA vitamin A and PA vitamin C, and increased for PA iron and mean MPA(r = 0.11 to r = 0.29) and (r = 0.21 to r =0.27, respectively; $p < 0.01$) after adjusting for energy intake, age and sex(26)

Systematic review of different study indicates that inadequate intakes of multiple micro-nutrients are likely to be common among women living in resource-poor settings in sub-Saharan Africa, South and South-East Asia, and Latin America. Inadequate intakes are more common among pregnant than NPNL women due to the higher EAR and RNI for pregnant compared with NPNL women (39).

Study from five sites of women dietary diversity project Prevalence of adequacy was below 50% for 5 of 11 micronutrients in Mali, 6 in Mozambique, 7 in Burkina Faso and Bangladesh, and 9 in the Philippines. Considering results by micronutrient, prevalence of adequacy was below 50% in at least 4 of 5 sites for riboflavin, niacin, folate, vitamin B-12, calcium, and iron(35).

Cross sectional study Puttlam and Kurunegala districts in Sri Lanka on elderly people of > 60 years show mean DDS was 4.4 and 0.39 (39 percent) Mean adequacy ratio (MAR) of 12 nutrients MAR (0.39 with $p<0.01$) . Positively significantly, correlations between dietary diversity indicators and the nutrient adequacy expressed as NAR for each nutrient and MAR, as an overall score for the nutritional adequacy .the correlation coefficient of DDS with MAR ($r=0.48$) with dietary diversity scores correlated with almost all nutrients except for vitamin D(43).

Study conducted in Burkina Faso on women of reproductive age group shown that prevalence of adequacy was very low for vitamin B-12, foliate, riboflavin, and niacin (PA: 4–20%) . It was low for iron, calcium, and thiamin (PA: 26–44%) and moderate for vitamin B-6, vitamin A, vitamin C, and zinc (PA: 60–71%). The MPA across the 11 micronutrients was low (0.38). Consumption of some food subgroups was significantly associated with a lower risk of low MPA (MPA , 0.5)(44).

Study conducted in Islamabad, Pakistan mean dietary diversity score of study population was 6.17±0.99 ranging from 3–9. Linear regression show that association existed between dietary diversity score, and total weight gain for pregnant women in their second and third trimesters(45)

Study done in Kenya show that the mean DDS was 4.3 (± 1.0) with range from 2 to 6 food groups. The main food group consumed 100% Cereals, tubers and roots, 100 % Other vegetables,46.65 Legumes, nuts and seeds ,39.9% Meat, Poultry and fish and only 6.6% Yellow or orange vegetables, tubers or fruit. Overall, the mean MAR was 0.74 and Nutrient Adequacy Ratio (NAR) of different nutrients was energy (0.619004), protein (0.740113), Calcium (0.407287), Iron (1.020861), Zinc (0.670493), Vitamin A (0.892923), Thiamine (0.794444), Riboflavin (0.661198) and Vitamin C (0.95545)(46)

Study done in Ethiopia Sidama zone the dietary diversity score was very low 75.8% of the subjects consuming four or fewer types of foods per day and 99% of the women had inadequate intakes based on the US FNB EAR for zinc (i.e. 9.5mg/day). The prevalence of inadequate intakes of calcium 74% based on the EARs from the corresponding requirements for pregnancy set by international agencies. In marked contrast, relatively few women only 4% were at risk of inadequate intakes of iron, using the EAR for iron set by the US FNB (i.e. 22mg/day)(47).

Community-based, cross-sectional study conducted in Sidama zone, Southern Ethiopia shown that (78.4%) consumed roots and tubers (mainly enset), (52.7%) cereals (mainly maize) and (52.2%) legumes (mainly broad bean and kidney bean). Only (28.4%) and (25.6%) reported consumption of pro-vitamin A and pro- vitamin A-rich foods respectively. Based on ANOVA and logistic regression analyses, the level of DD and consumption of foods from animal source in the reference period were positively associated with VA status. Women with low DDS had 1.94 (95% CI 1.17-3.19) times increased odds of VAD compared to women with high DDS(48).

Significance of the study

Since no international consensus currently on which food groups to include in the scores and others type's micronutrient assessment tool are expensive, time consuming, not appropriate at community level validate these simpler measures of dietary diversity, as proxy measures micro nutrient adequacy of diet is important in order to achieve sustainable improvements in micronutrient status in the developing world.

Dietary diversity approaches also used to asses multiple micronutrient deficiencies simultaneously. It is Simple, cost effective, community based and culturally acceptable tools which is important for policies and programs to plan, monitors evaluation and intervention of micronutrient.

The finding of this research is used as base line data for others researcher.

CHAPTER THREE

OBJECTIVES

3.1 General objective

To validate dietary diversity as an indicator of micronutrient adequacy of the diet of pregnant women in Jimma town southwest Ethiopia.

3.2 Specific objective

- To assess correlation of dietary diversity with mean adequacy ratio of micronutrient intake among pregnant women of Jimma town
- To test the usefulness of a simple dietary diversity score as a predictor of adequate micronutrient intake of pregnant women

- To identify food group cut-off points that increased mean adequacy of micronutrient intake among pregnant women of Jimma town

Hypothesis

HO: - dietary diversity is not an indicators micronutrient adequacy of the diet

HA: -dietary diversity is an indicators micronutrient adequacy of the diet.

Null hypothesis is true AUC ≤ 0.5

CHAPTER FOUR

METHODS AND MATERIAL

4.1 Study area and period

Jimma town is located 357 Kms South West of Addis Ababa and has total surface area of 4,623 hectares. Location of town is 1676 altitude, 7.6 latitude, and 36.83 longitudes. The town is divided in to 17 kebeles and has one zone hospital and one specialized hospital, four health government health centers,26 private clinics . The town is bounded by karsa wereda in East, in manna West ,karsa and manna in North and saka in South and town has 34191 households with total population of 174778 (51%) are females and (49 %) males, pregnant women 5243 ,28664 under five and 5418 under one year children .The study conducted march 1-15/ 2015

4.2 Study design

Community based cross sectional study design was applied April 2015

4.3 Population

4.3.1 Source of population

All pregnant women of selected kebeles of Jimma town

4.3.2 Study population

All randomly selected pregnant women from selected kebeles

4.4 Sample size and Sampling technique/ procedure

4.4.1 Sample size

Sample size calculated by using Sample size estimation for correlations with pre-specified confidence interval and power.

Medcalc viewer software were used to calculated sample size

Sample size was determined By using correlation coefficient of (0.26) study in done in Mozambique(Wiesmann et al . 2009), at the significance level of 95% (α = 0.05) and power 80% (β = 0.2)

$$n= \frac{(Z\alpha+z\beta)^2}{\frac{1}{4}\left[\log e\left(\frac{1+r}{1-r}\right)\right]2} + 3$$ formula from (49)

$$n= \frac{(.05+0.2)^2}{\frac{1}{4}\left[\log e\left(\frac{1+0.26}{1-0.26}\right)\right]^2}+3$$

$$n=90$$

Where

n=sample size

r= (.26) Correlation between dietary diversity score and mean probability of adequacy micronutrient study for Mozambique(8),

Zα = desired precision (half the width of the 95 % confidence interval)

Zβ = power 80% (β = 0.2)

Finally by adding non-response rate of 10% the total sample size were 99 pregnant included.

Final simple size n=99

4.4.2 Sampling technique/ procedure

First rule of thumb was applied to selectect seven kebeles from thirteen kebele of Jimma town and simple random sample was applied to obtain sample size from total list of pregnant from selected kebele by apply proportional sample allocation .

Data was collected by visited each house of pregnant women with the guide of urban health extension.

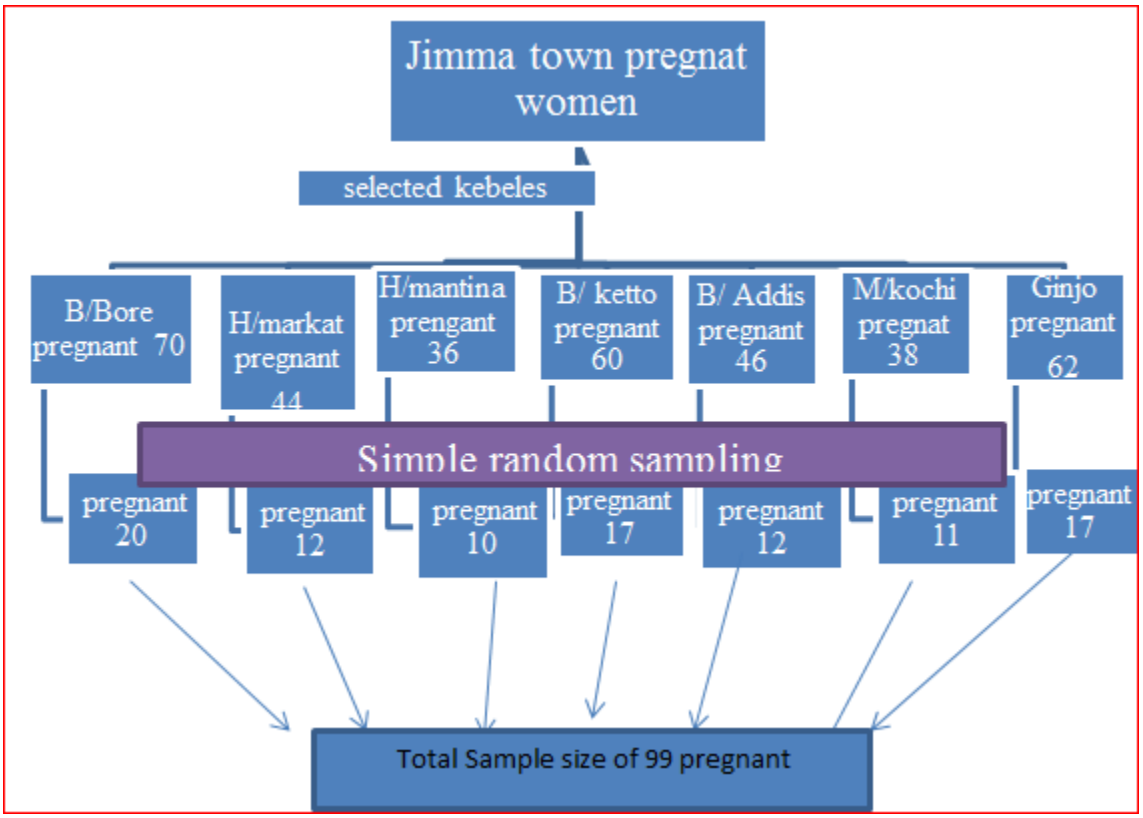

Figure 1 schematic presentation of sampling procedures

4.5 Inclusion and exclusion criteria

4.5.1 Inclusion criteria

All pregnant women who were resident of Jimma town

4.5.2 Exclusion criteria

Pregnant women who have mental illness or severely illness during the survey

Pregnant women on fasting the day before the survey

4.6 variables

Mean Adequacy Ratio (MAR) and nutrient Adequacy ratio (NAR)

Dietary diversity

Demographic and socio-economic characteristic

Age, Education status, Family income, Parity and Trimester / Weeks of pregnancy, occupation status, marital status,

4.7 Data Collection Procedures and Techniques

Demographic and socio-economic characteristics information was collected by structure questionnaire.

Dietary intakes

Before actual data collection were under taken food weighed record were done on 10% study population and calculate average portion size to assembling and calibrating compiling photographs of portion sizes commonly used utensils in the house . Sets of local utensils such as glasses, cups, ladles and spoons were purchase and calibrated to measure the amount of food or drink that used by pregnant women. Graduated actual foods such as bread, fruits (e.g., oranges and mangoes) and vegetables (e.g., sweet potatoes, avocados, etc.) were developed by measure the total weight actual of the food then measured then non-edible part after eat the edible portion and estimated the edible portion separately with dietary weight scale which measure up to 2000g(2kg) and labeled on each food also developed to assist in quantifying food portions. All the equipment required for the recall was assembled before data collection. .

Two day before data collection the supervisors visited the house of each participant explain the purpose of the study and advices the respondents to eat their food separately in next day and try to measure their food and drink by home utensils without change ,increase or decrease the amount of food which they plan to eat.

The interactive 24-h recall interview technique adapted from an interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries(50).

Two 24-h interactive a recalls were used on separate days, with a minimum of one week between the two recall days. Confidentiality assured while data collection and neutral questions such as "When did you get up in the morning and "Did you eat or drink will be asked and avoid signs such as surprise, approval, or disapproval for what the respondent eating while interview.

First pass: a list of all the foods and drinks (excluding water) consumed during the previous 24-hour period was collected by reminded that cover all the food and beverages, including for any snacks and drinks consumed between meals.

Second pass the interview: interviewer was overview, in chronological order for each of the responses made by the respondent in stage 1. Detailed description of each food and drink consumed were recorded by compared food and drink intakes with photographs of calibrated food, compared the household utensils with calibrated utensils or compared food intakes with the calibrated weighted actual food of different size to estimated portion sizes of foods consumed. For homemade mixed dishes record details information about name of mixed dish descriptive list of all ingredients method were records.

Recall Review: at this stage, opportunities given to respondents to provide additional information and prompt for information about foods or drink not mentioned.

Converting portion sizes to weight equivalents

Direct weighing—recording the weight in grams of actual foods such as injera, bread by show the graduated actual food model.

For food such as (e.g., sugar cane, banana, mango, Avocado) show the graduated actual food model record the weight (in grams) each food items.

Volume equivalents—for those food items recording by a volume of water equivalent to the volume of actual food or drink etc. the volume was converted into weight equivalents of the actual food or beverage consumed using the specific gravity whereas specific gravity (g/mL) = mass (g)/ volume (mL).

Calculating Nutrients Intakes:

This were done by three step

first step each food consumed database were prepared from Ethiopian food composition table, Ethiopian traditional recipes, Tanzania food composition table and other research reference values for analyzed zinc to get comprehensive set of food composition values(51) by entered 100g of nutrient values into EASH food processer software nutrient database.

Second step: convent each food or drink into which as record in house hold measurement and different calibrated utensils into equivalent weight in gram.

Third step: food, intake data were recorded in to ESHA food processor software for each respondent with complete description of all the recipes and the amounts eaten in grams. The EASH food processor can convert the food consumed into nutrient values for each individual as well as calculate the percentage of nutrient adequacy ratio for each individual pregnant woman.

Dietary diversity score

Four type of food group dietary diversity score (DDS)were calculated from the number of food groups consumed at least once in a period of 24 hour as described in (52).

Table0-1 Food Groups indicators used to measures dietary diversity score

FGI-6	FGI-9	FGI-13	FGI-21
All starchy staples	All starchy staples	All starchy staples	Grains and grain products
			All other starchy staples
All legumes and nuts	All legumes and nuts	All legumes and nuts	Cooked dry beans and peas
			Soybeans and soy products
			Nuts and seeds
All dairy	All dairy	All dairy	Milk/yoghurt
			Cheese
Other animal source foods	Organ meat	Organ meat	Organ meat
	Eggs	Eggs	Eggs
	Flesh foods and other miscellaneous small animal protein	Small fish eaten whole with	Small fish eaten whole with bones
		All other flesh foods and miscellaneous small animal protein	Large whole fish/dried fish/shellfish and other
			Beef, pork, veal, lamb, goat, game meat
			Chicken, duck, turkey, pigeon, guinea hen, game
			Insects, grubs, snakes, rodents and other small
Vitamin A-rich fruits and vegetables	Vitamin A-rich dark green leafy	Vitamin A-rich dark green leafy vegetables	Vitamin A-rich dark green leafy vegetables
	Other vitamin A-rich vegetables and fruits	Vitamin A-rich deep yellow/orange/red	Vitamin A-rich deep yellow/orange/red vegetable
		Vitamin A-rich fruits	Vitamin A-rich fruits
Other fruits and vegetables	Other fruits and vegetables	Vitamin C-rich vegetables	Vitamin C-rich vegetables
		Vitamin C-rich fruits	Vitamin C-rich fruits
		All other fruits and vegetables	All other vegetables
			All other fruits

Nutrient adequacy

The selection of a set of micronutrients based on availability of nutrient data in Ethiopian food composition tables and Ethiopian traditional food recipes. The following nutrients were selected vitamin A, thiamin, riboflavin, niacin, vitamin C, iron, and zinc and calcium for the purposes this study .

The nutrient adequacy ratio (NAR, %) were calculated for each of nine micronutrients. To compute MAR, first Nutrient Adequacy Ratio (NAR) calculated for eight micronutrients as given below.

$$\text{NAR } \% = \frac{\text{Actual nutrient intakes (per Day)}}{\text{reccomended daily allonce of nutrient}}$$

$$\text{MAR}\% = \frac{\text{Sum of nurient Adequacy ration all selecte micronutrient}}{\text{Total numbers of selected micro nutrient}}$$

For both NAR and MAR, a value of 100% is the ideal since it means that the intake is the same as the requirement.

For (NAR) and MAR, $\geq$ 100% considered as 100% adequate.

Bioavailability of nutrient- Bioavailability adjustments were made for calcium, iron, and zinc to make the bioavailability adjustments is to derive estimates of absorbed amount to reflect more accurately between dietary intake and requirements based on result

Bioavailability adjustments

For Zinc phytate zinc ratio if < 18 percent zinc absorption 30% and phytat zinc ratio if > 18 percent zinc absorption 22%(53)

Calcium absorption values were calculated Grains, Roots, tuber, legumes (25%) ,Fruits and vegetables (45%) , High oxalate foods(5%) ,all other groups(32%)

Iron absorption calculated by 11% absorption for animal source foods 6% Plant foods.

4.8 Data quality control

Questionnaires were prepared first in English by the investigator and then translated to Amharic and Afaan Oromo by another individual who has an experience in translation then another individual translated back to English.

3 days training were given to data collectors .On day 1 the purpose of the interactive 24-hour recall was explained as well as the details about the data collection arrangements, on day 2, details of the 24-hour recall interviews and associated questionnaires were discussed, with some practice interviews and role-playing etc. On day 3, a field exercise conducted, with emphasis on the procedures used to estimate portion size and Potential problems also discussed.

Calibrating a set of local household utensils and variety of graduated food models was used

Pilot test for interactive 24-hour recall was conducted on 5% pregnant women of Awetu mandara kebele of Jimma town.

Close supervision and data were checked every days during surveys for completeness and proper collection.

4.9 Analysis and presentation

All food consumed by pregnant entered into ESHA food processor software that can change food intakes into nutrient values then export nutrient values into Microsoft excel then into SPSS system for windows version 20.0 for analysis. Descriptive statistics was done for each DDS, Nutrient Adequacy Ratio (NAR) and MAR. For all statistical tests, values of $P < 0.05$ considered significant. Correlation tests were done for assess the relationship between dietary diversity indicator and MAR.

ROC analysis performed to determine the DDS cut-off point that give maximized sensitivity and specificity using MAR as the gold standard to assess micro nutrient adequacy. The categories used to summarize accuracy of AUC in ROC analysis were as follows: 0.9–1 Excellent, 0.8–0.9 Good, 0.7– 0.8 Fair, 0.6–0.7 Poor, and less than or equal to 0.5 as Fail. Sensitivity and specificity results were calculated using Mean Adequacy Ratio (MAR) as a gold standard to define dietary diversity score 'truly measure micronutrient adequacy. Finally, the result was displayed using graphs, tables and chart

4.10 Operational definitions

Dietary Diversity Score (DDS): calculated by summing the number of food groups consumed by the individual respondent over the 24-hour recall period.

Food group is defined as a grouping of food items that have similar caloric and nutrient qualities.

Nutrient Adequacy is defined when the Nutrient Adequacy Ratio 100% or above

Nutrient Adequacy Ratio is the amount of nutrient intakes from the average of food in two 24 hours recall divided to recommended nutrient intakes (RNI).

Mean Adequacy Ratio: calculated by the total sum of NAR all selected nutrient by total numbers selected nutrient.

Vitamin A-rich fruits and vegetables: were defined as food containing ≥ 120-microgram (μg) retinol equivalents (REs)/100 grams (g) (≥ 60 μg retinol activity equivalents [RAEs]/100g)

Vitamin C-rich fruits and vegetables: were defined as food group containing ≥ 9 milligrams (mg)/100g.

Sensitivity: indicates the proportion of pregnant women truly at risk (low MAR) who correctly classified.

Specificity: indicate the proportion of pregnant women not at risk of nutrient inadequacy (high MAR) and who were correctly classified by DDS.

4.11 Ethical considerations

Ethical clearance obtained from ethical review committee of Jimma University. A formal letter permission and obtained from of JU college of Public Health and medical sciences, department of population and family health written to Jimma town health office to obtain their co-operation. Then permission and support letter written to each health center from woreda health office and permission and support letter written from health centers to each selected kebele health extension. At the time of data collection, the purpose of the study explained to the pregnant and a verbal consent obtained from the participants to confirm whether they are willing to participate in the study. Those not willing to participate have the right to do so. Confidentiality of respondents ensured throughout the research process.

4.12 Dissemination plan

The findings of this study presented to will be JU, Copy of the study submitted JU college of public health, population and family health department .Finding also distributed MOH ,Jimma zone health department, and health office .The findings will be also present in different seminars, meetings and workshops. All effort will made to publish the thesis in scientific journals

Chapter 5

Result

Demographic and socio –economic characteristics of study population

Study population response rates were 100% with 47.5% age between 25-29 and mean age 25 years± 4.2 SD). Most women were Oromo in ethic group (71.7%), Muslim religion (61.6%) and 51.5 % of the respondent education level were college and above follows 32 % high school. Majority of the respondent were house wives (56.6), 49.5% were third trimesters and 40% were second trimester's pregnancy as described in table 1below.

Table 0-1-demographic and Socio- economic characteristics of pregnant women in Jimma town 2015 G.C

Ethnicity		Frequency (N)	Percent
	Oromo	71	71.7 %
	Amara	11	11.1 %
	Gurage	9	9.1 %
	Yem	3	3.0 %
	daworo	3	3.0 %
	others	2	2.0 %
	Total	99	100.0 %
Religion			
	Muslim	61	61.6 %
	Orthodox	28	28.3 %
	Protestant	10	10.1 %
	Total	99	100.0 %
Educational status			
	not takes formal education	11	11.1 %
	elementary (1-8)	18	18.2 %
	high school (9-12)	22	22.2%
	college and above	48	48.5%
	Total	99	100.0 %
occupation status			
	house wife	56	56.6 %
	Gov. employee	18	18.2 %
	merchant	15	15.2 %
	daily laborer	4	4.0 %
	others	6	6.1 %
	Total	99	100.0 %
Age			
	15-19	8	8.1 %
	20-24	32	32.3 %
	25-29	47	47.5 %
	30-34	7	7.1 %
	35-39	5	5.1 %
	Total	99	100.0 %
Pregnancy period			
	first trimesters	10	10.1 %
	second trimester	40	40.4 %
	third trimester	49	49.5 %
	Total	99	100.0 %

The consumption of different food groups using nine-dietary diversity score show that all pregnant women had consumed some kind from starch stable food group(cereal/roots/tubers) in addition, others vegetables and fruits food group . Nearly 70 percent of pregnant women also consumed from legumes/nuts food group, 28% of pregnant women consumed meat and fish food group, 39% of pregnant women used vitamin A rich dark green vegetables, 38% used other vitamin A rich fruit and vegetables. Only eggs (13%) consumed, and 4% consumed organ meat during the survey period (figure 2 below shows).

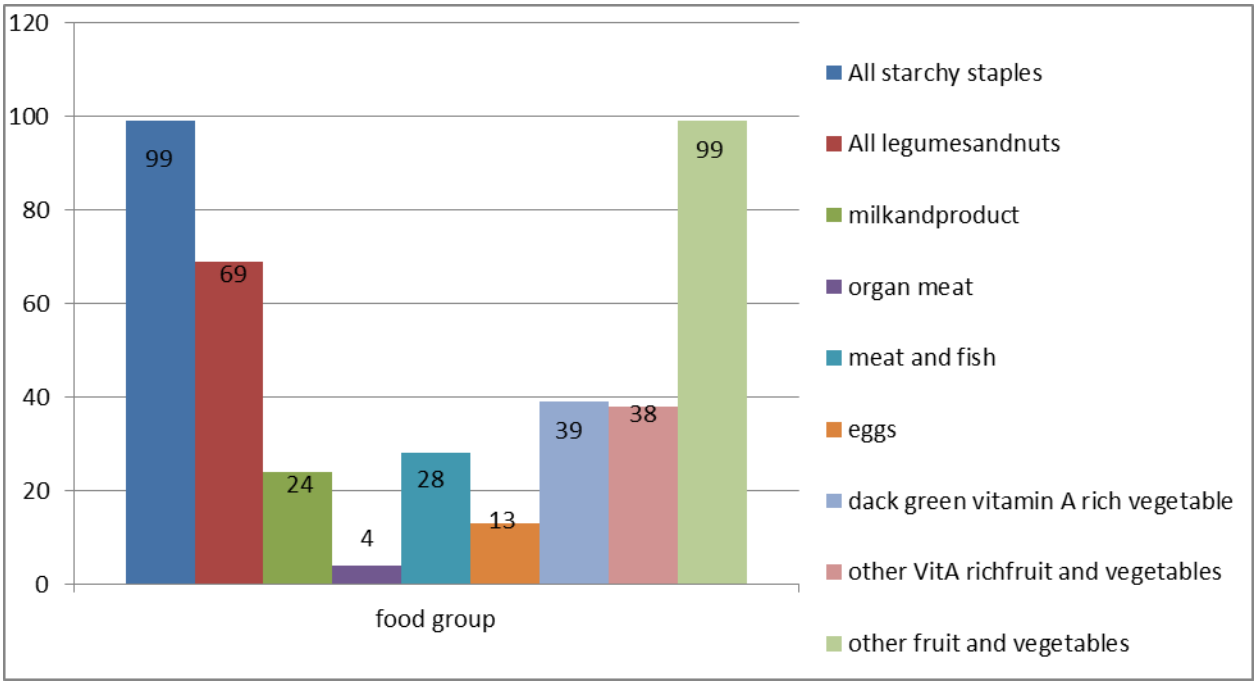

Figure 2 food group consumed by pregnant women from 24 hours recall Jimma town 2015 G.C

Median daily intakes all macronutrient and micronutrient were below the recommend daily intakes. The median intakes of carbohydrate (83% of NAR), and vitamin B2 (91% of NAR) those with median intakes was > 75 % of recommend daily intakes (RDI). Media intakes of vitamin A (65%NAR), vitamin B1 (52 % NAR), vitaminB3 (60% NAR) are those media above 50% of recommended daily intakes whereas median intakes of calcium (15% NAR) and zinc (24 %NAR) was below 25 % of recommended daily intakes (Table 2 below)

Table 0-2 descriptive summary of macronutrient and micro nutrient BY percent of nutrient adequacy ratio (NAR %) among pregnant women in Jimma town 2015 G.C

	CHO (NAR)%	Prote (NAR) %	Fat (NAR) %	Vit A (NAR) %	Vit B1 (NAR) %	Vit B2 (NAR) %	Vit B3 (NAR) %	Vit C (NAR) %	Ca (NAR) %	Fe (NAR) %	Zn (NAR) %
Mean	82.50	55.01	46.01	62.02	57.38	81.04	63.73	39.52	17.60	39.56	26.40
Median	83.00	50.00	40.00	65.00	52.00	91.00	60.00	31.00	15.00	38.00	24.00
SD	15.92	19.23	21.15	35.61	25.70	22.33	28.72	28.28	9.97	21.78	13.98
Minimum	39.00	23.00	16.00	7.00	9.00	20.00	15.00	3.00	6.00	6.00	7.00
Maximum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	58.00	100.0	78.00

The mean of both macronutrients and micronutrients intakes were below the recommended values for pregnant women.

The mean of Nutrient Adequacy Ratio (NAR) of Energy (0.69), carbohydrate (0. 82),protein(0.64),Vitamin A(0.62) , vitamin B1(0.57) vitamin B2 (0.81), and vitaminB3(0.64) which was greater than half of RDI. The mean Nutrient Adequacy Ratio (NAR) of vitamin C (.40) Iron (0.40), Zinc (0.26) were lower than half of RDI and calcium (0.18) that was less than 25% of the AI (figure 2 below)

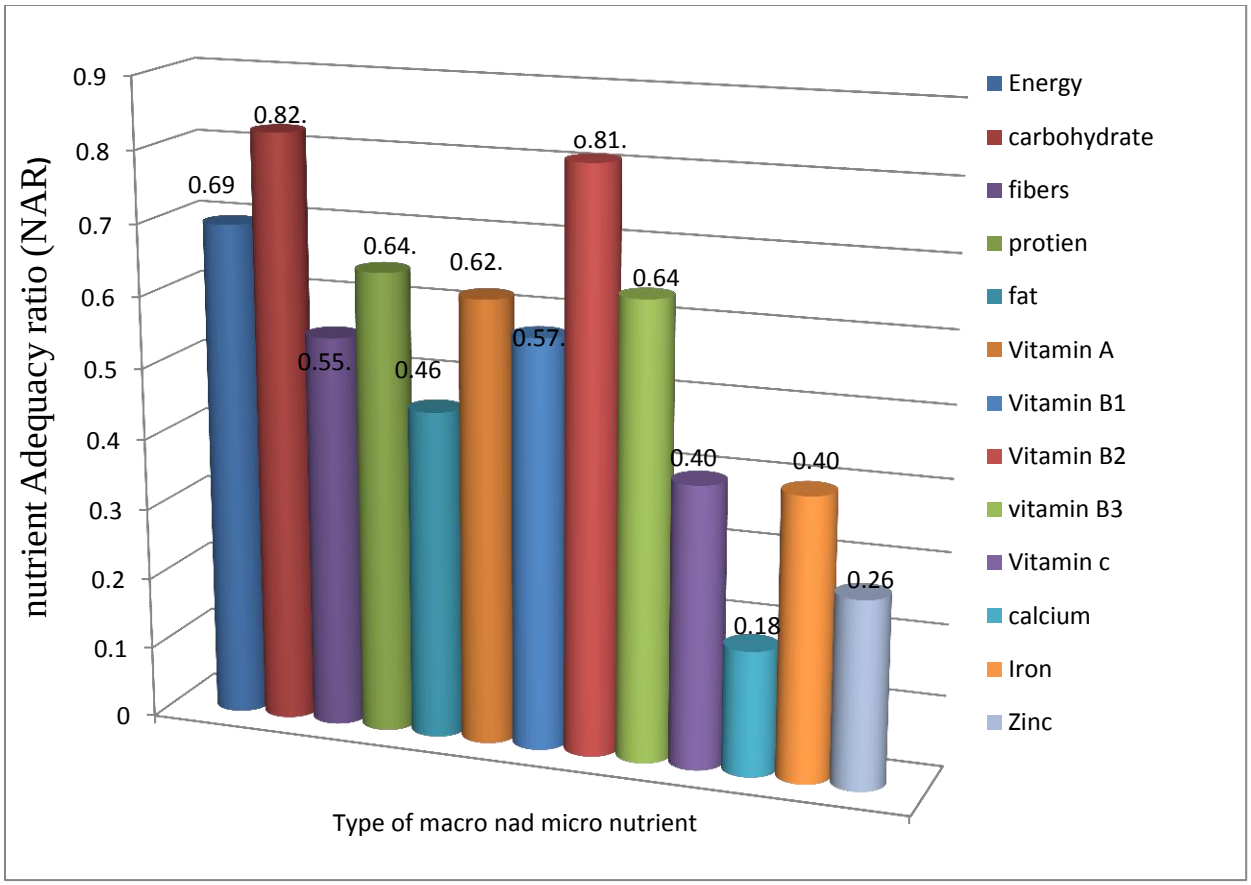

Figure 3 Nutrient adequacy ratios (NAR) of macronutrient and micronutrient among pregnant women of Jimma town 2015 G.C

The mean and SD of six food group indicator was (3.9±0.92) with ranging 2-6, mean and SD nine food group indicator is (4.13±1.07) with range2-7, mean and SD of thirteen food group score was (5.19±1.35) with ranging 3-9 and mean, SD of twenty-one food group score is (5.89±1.46) with ranging 3-10. Mean adequacy ratio (MAR) and SD of nine nutrients of the study population was (.55±12) with ranging from 0.29-0.84 (table 3 below).

Table 0-3 descriptive summary of dietary diversity score and mean adequacy ratio among pregnant women 2015 G.c

	Food group indicators of 6	Food group indicators of 9	Food group indicators of 13	Food Group indicators of 21	Mean Adequacy Ratio (MAR)
Mean	3.9394	4.1313	5.1919	5.8889	55.1391
Median	4.0000	4.0000	5.0000	6.0000	53.8000
Std. Deviation	.92381	1.07520	1.35283	1.45608	12.09618
Minimum	2.00	2.00	3.00	3.00	29.55
Maximum	6.00	7.00	9.00	10.00	84.00

The correlations of all different food group indicators and over all mean adequacy ratio (MAR) of micronutrient had positive and significant. Correlation coefficient with overall nutrient adequacy score MAR with food group indicators (r=0.337), (r=0.426), (r=0.343), (r=0.307) for food group indicator 6, 9, 13, 21 respectively and p-value of (p<.0001 significant level). Nine-food group indicator was higher correlations than other food group indicators (Table 4 below).

Table 0-4 correlation of dietary diversity and mean adequacy ratio (MAR) among pregnant women Jimma town 2015 G.C

		Food group 6	Food group 9	Food group 13	Food group 21	(MAR)
(MAR)	r	.337**	.426**	.343**	.307**	1.000
	p-value	.000	.000	.000	.001	
**. Correlation is significant at the 0.01 level (1-tailed).						

Assuming an adequacy of the diet with MAR of≥ 0.50, the best cut-off point, AUC of were (AUC= 0.721, AUC=0.789, AUC=0.748, AUC= 0.749) for the (6, 9, 13, 21 food group indicators) respectively which were significant for all food group (p-value≤.001). Overall, nine food group indicator had the highest AUC (0.789 and p-value<.0001, 95% CI) (table 5 below).

Table 0-5 Area under curve (AUC) food groups indicators of at ≥0.50 mean adequacy ratio (MAR) among pregnant women Jimma town 2015 G.C

Type of food group indicators	Area	Std. Error[a]	p-value	95% Confidence Interval	
				Lower Bound	Upper Bound
Food Group6	0.721	0.053	.000	0.618	0.825
Food group 9	0.789	0.047	.000	0.697	0.880
Food Group 13	0.748	0.053	.000	0.644	0.851
Food Group 21	0.749	0.051	.000	0.649	0.849

Null hypothesis: true area = 0.5

The overall performance of each indicator at ≥ 0.5MAR cutoff) summarized by the area under the curve (AUC) with sensitivity and specificity as shown figure 4 below

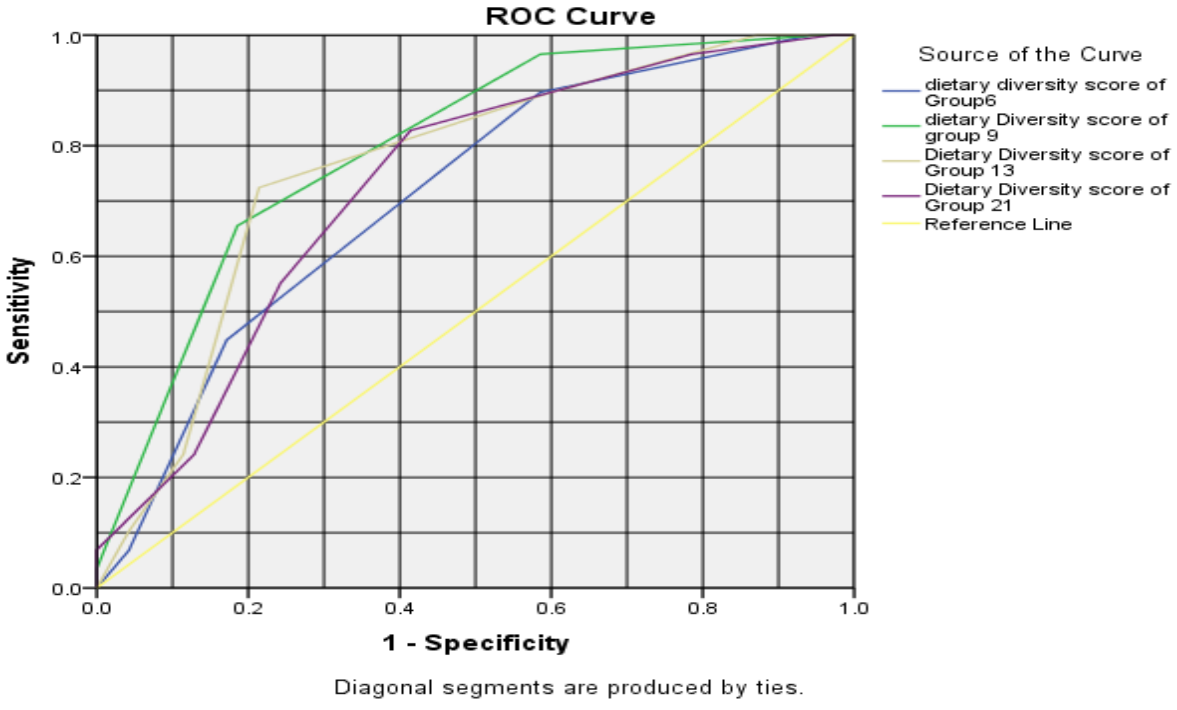

Figure 4 ROC of food group indicators at ≥0.50 of mean adequacy (MAR) as golden standard.

Result shown that from six foods, group indicators four dietary diversity score cut off point was the best cut off point with 90% sensitivity, 41% specificity at ≥0.50 MAR cutoff point that was maximizing the balance between sensitivity and specificity. From nine-food group indicators five dietary diversity score was the best cutoff point with 65.5 % sensitivity, 81% at ≥0.50 MAR cut off point that was maximizing the balance between sensitivity and specificity. From thirteen-food group indicators six dietary diversity score was the best cutoff point with 72% sensitivity, 79% specificity at ≥0.50 MAR cut off point and six dietary diversity score were the best of 21 food group indicators with 83% sensitivity, 59% specificity at 50% MAR cut off point that was maximized both sensitivity and specificity. From over all five dietary diversity, score of nine foods group or six- dietary diversity score of 13-food group were the best cut of point, which optimized sensitivity and specificity at≥ 0.50 of MAR (table 6 below).

Table 0-6 sensitivity and specificity of for each dietary diversity score at ≥ 0.50 mean adequacy ratio (MAR) among pregnant women Jimma town 2015 G.C

Type of food group	DDS cut of point	Sensitivity	Specificity
Food Group6	≥2.00	100%	000
	≥3.00	100%	5.7%
	≥4.00	89.7%	41.4%
	≥5.00	44.8%	82.9%
	≥6.00	6.9%	95.7%
Food Group 9	≥2.00	100%	000
	≥3.00	100%	4.3%
	≥4.00	96.6%	41.4%
	≥5.00	65.5%	81.4%
	≥.00	27.6%	92.9%
	≥7.00	3.4%	100%
	≥8.00	.000	100%
Food Group 13	≥2.00	100%	0.000
	≥3.00	100%	0.000
	≥4.00	100%	13%
	≥5.00	89.7%	40%
	≥6.00	72.4%	78.6%
	≥7.00	24.1%	88.6%
	≥8.00	10.3%	95.7%
	≥9.00	3.4%	98.6%
	≥10.00	.000	100%
Food Group 21	≥2.00	100%	000
	≥3.00	100%	000
	≥4.00	100%	2.9%
	≥5.00	96.6%	21.4%
	≥6.00	82.85	58.6%
	≥7.00	55.2%	75.7%
	≥8.00	24.1%	87.1%
	≥9.00	6.9%	100%
	≥11.00	.000	100%

Different dietary diversity score cut of point that maximized sensitivity and specificity. Five dietary diversity score of nine-food group or Six dietary diversity score cut off point of thirteen-food group was the best from over all food groups with sensitivity and specificity as shown (figure 5 below).

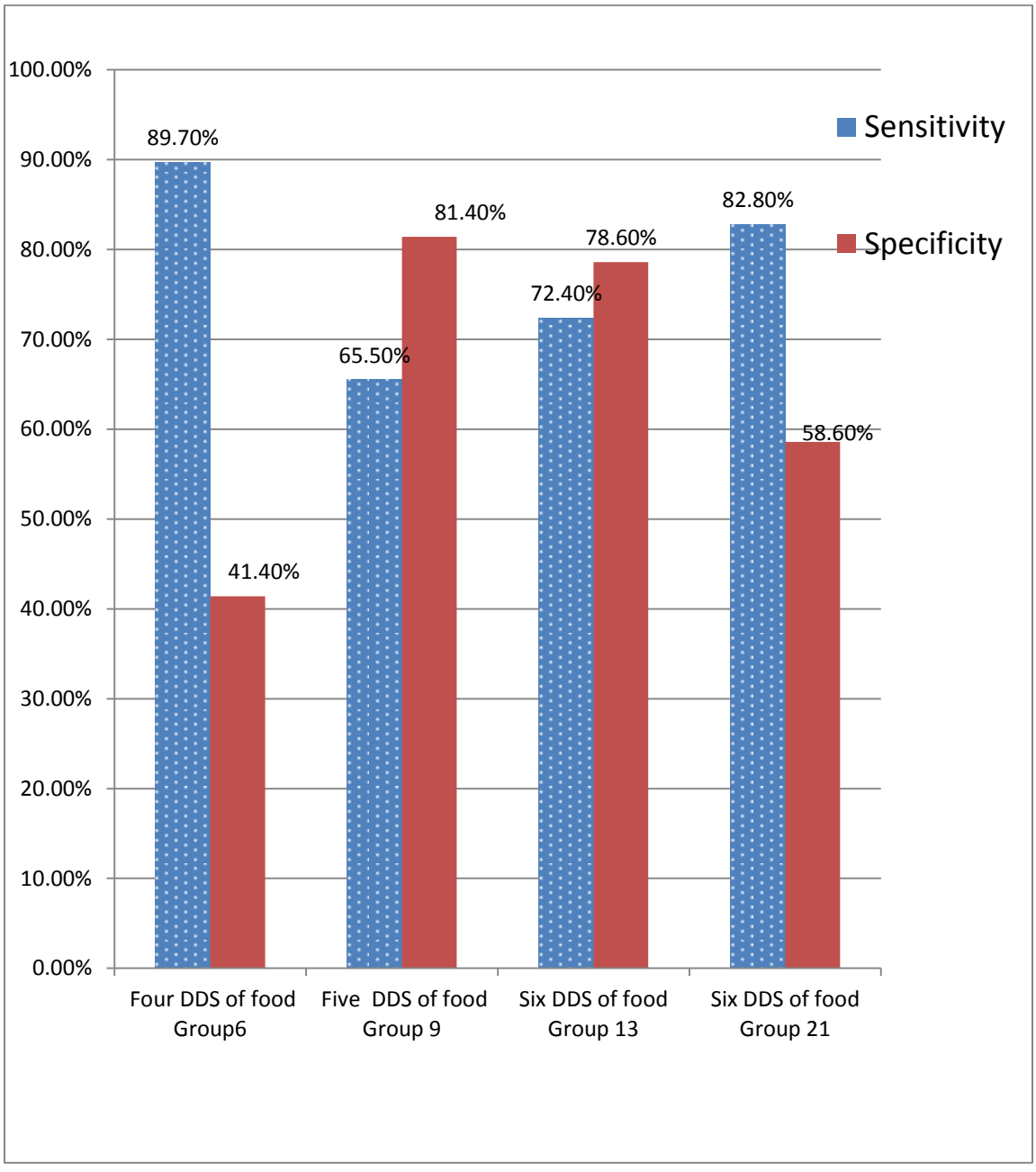

Figure 5 dietary diversity score cutoff point and their optimum sensitivity and specificity at ≥ 0.50 mean adequacy ratio (MAR) pregnant women Jimma town 2015 G.

The overall performance of each indicator at ≥ 0.60 MAR cutoff point was summarized by the area under the curve (AUC) derived from ROC analysis. AUC of different DDS were (AUC= 0.733, AUC=0.790, AUC=0.769, AUC= 0.738) for food group indicators 6, 9, 13, 21 respectively. Overall, FGI-9 has the higher AUC (AUC=.790 and p-value<.00001)

Table 0-7 Area under curve of food group indicators at ≥0.60 mean adeuacy ratio (MAR) of pregnat women jimma town 2015

Food group indicators	Area	Std. Error[a]	p-value	95% Confidence Interval	
				Lower Bound	Upper Bound
Food group6	0.733	.058	.002	0.620	0.846
Food group 9	0.790	.056	.000	0.681	0.899
Food Group 13	0.769	.059	.000	0.653	0.884
Food Group 21	0.738	.058	.001	0.625	0.850

Null hypothesis: true area = 0.5

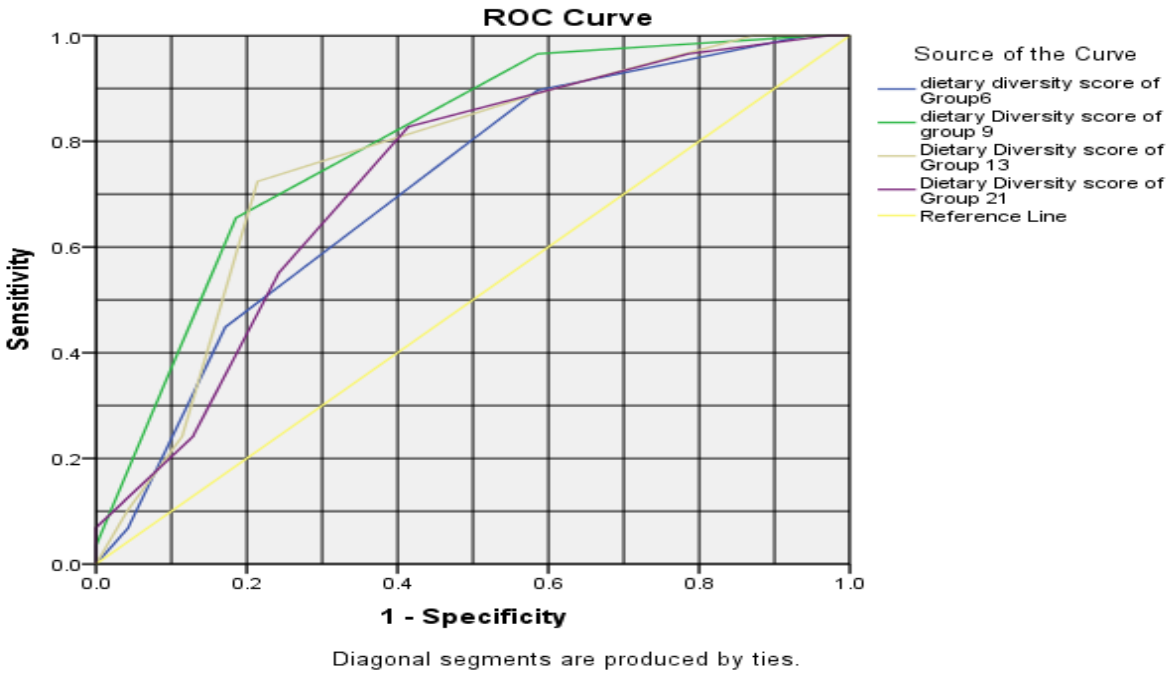

Figure 6 ROC of food group indicators at 0.60 mean adequacy ratio among pregnant women Jimma town 2015 G.C.

Result shown that from six foods group indicators five dietary diversity score cut off point was the best cut off point with 54.6% sensitivity, 81.2 % specificity at ≥ 60 % MARS cutoff point that was maximizing the balance between sensitivity and specificity. From nine-food group indicators five dietary diversity score were the best cutoff point with 73.7 % sensitivity, 77.5 % at ≥0. 60 MAR cut off point that was maximizing the balance between sensitivity and specificity. From thirteen-food group indicators six dietary diversity score was the best cutoff point with 78.9 % sensitivity, 73.8 % specificity at 60% MAR cut off point and six dietary diversity score was the best of 21 food group indicators with 84.2% sensitivity, 53.7 % specificity at 60% MAR cut off point that was maximized both sensitivity and specificity. From over all five dietary diversity, score of nine food group indicators or six-dietary diversity of 13-food group indicator was the best cut of point, which optimized sensitivity and specificity at≥0.60 of MAR (table 8 below).

Table 0-8 sensitivity and specificity of dietary diversity score cut off point at 60% mean adequacy ratio (MAR) among pregnant women Jimma town 2015 G

Type of food group	DDS cutoff point	Sensitivity	Specificity
Food Group6	≥2.00	100%	00
	≥3.00	100%	5%
	≥4.00	94.7%	38.7%
	≥5.00	52.6%	81.2%
	≥6.00	5.3%	95%
Food Group 9	≥2.00	100%	000
	≥3.00	100%	3.7%
	≥4.00	94.7%	36.2%
	≥5.00	73.7%	77.5%
	≥6.00	31.6%	91.2%
	≥7.00	5.3%	100%
	≥8.00	.000	100%
Food Group 13	≥2.00	100%	000
	≥3.00	100%	00%
	≥4.00	100%	11.2%
	≥5.00	89.5%	36.2%
	≥6.00	78.9%	73.8%
	≥7.00	31.6%	88.7%
	≥8.00	15.8%	96.3%
	≥9.00	5.3%	98.8%
	≥10.0	.000	100%
Food Group 21	≥2.00	100%	00
	≥3.00	100%	000
	≥4.00	100%	2.5%
	≥5.00	100%	20%
	≥6.00	84.2%	53.7%
	≥7.00	58%	72.5%
	≥8.00	31.6%	87.5%
	≥9.00	10.5%	100%
	≥11.00	.000	100%

Different dietary diversity score cut of point that maximized sensitivity and specificity. Five DDS of nine food group or six dietary diversity score cut off point of thirteen-food group was the best from over all food groups with sensitivity and specificity as shown (figure 7 below).

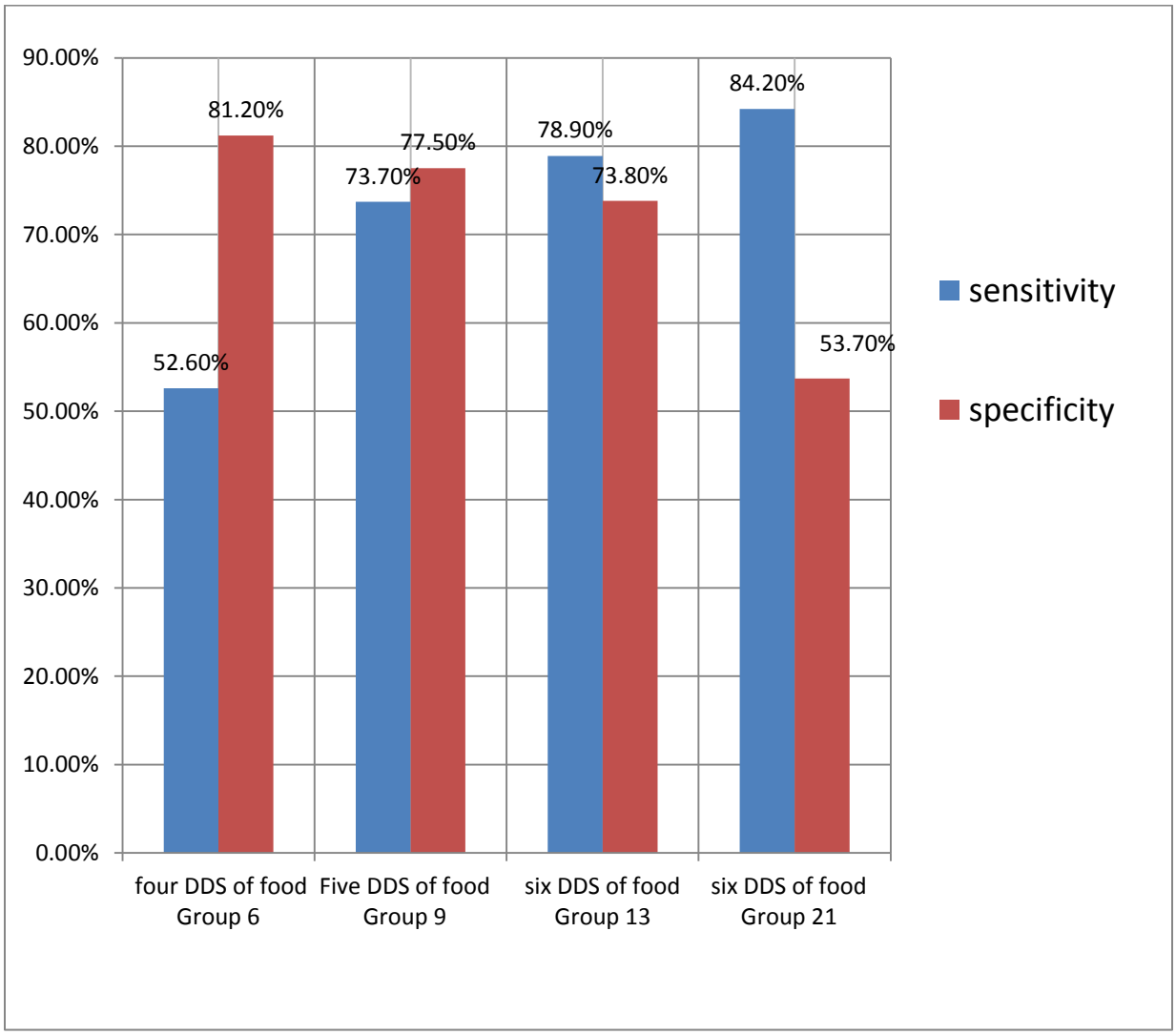

Figure 7 dietary diversity score with optimum sensitivity and specificity at ≥ 0.60 mean adequacy ratio (MAR) among pregnant women of Jimma town 2015 G.C

Chapter six

Discussion

From this study all 100%(N=99) of pregnant women had consumed some kind starch staple food group of cereal/roots/tubers which similar the study done in adolescents' grill of Iran 100%((23)), study on pregnant women in Kenya(54) and study of elderly in Sri-Lanka with 100% cereal . (100%) study participants were consumed from food group of other vegetables and fruit which was higher than study done in Kenya(20 %) and higher study done in Iran(50 %) (23). Highest consumption of other vegetables and fruit is not fruit consumption but due to consumption of vegetables like (onion, tomatoes, garlic and green pepper) was increase the percentage of others vegetables and fruits. Nearly 70 percent of pregnant women also consumed legume which was higher than other study done in Ethiopia SNNP Sidama zone where (52.7%) use legumes(47). In this study of the rest of food group were consumed <50% and eggs (13%) consumed, and only 4% consumed organ meat from this study this was low as compared Study done in South Africa with 50% eggs consumption(6).

The mean from six dietary diversity was (3.9±0.92) with ranging 2-6, mean of nine dietary diversity was (4.13±1.07) with range 2-7, from thirteen dietary diversity was (5.19±1.35) with ranging 3-19 and mean of twenty-one dietary diversity was (5.89±1.46) with ranging 3-10. The mean of dietary diversity were lower that the FAO/WHO dietary diversity recommendation (55) The mean of dietary diversity of this study was higher as compared the dietary diversity of study of SNNP Sidama zone Women (mean of dietary diversity 1.94 range from (95% CI 1.17-3.19) (48). The mean of dietary diversity in this study were lower as compared with study done on women in Alexandra South Africa mean food group consumption were 6.70 (± 2.22) from nine dietary diversity score , lower than study done in Islamabad Pakistan (6.17+0.99). The mean dietary diversity of this study was almost similar with of study done in Sri-Lanka (4.4 ±0.9)(43) and lower than the result of study done in Mali with (mean DDS =7.8 and DDS ranged from 4 to 10 different food groups)(22)

Mean adequacy ratio (MAR) of eight micronutrients of the study population was (55%±12) with ranging from (29%- 84%) was higher than MPA of NPNL women ranged from (34%–35%) of Bangladesh, Philippines and almost the same with result of NPNL women Mozambique sites (54%). Result of study also higher than the result of study done for lactating women in Bangladesh, Philippines with MPA range (24%–25%) and study in Mozambique with, MPA (34%) (35). The reason of increase MAR in this study was due to high consumptions of teff, which is high in iron and calcium as compared with others cereal and study season and area where the availability of fruits was high. The mean of MAR of this study (55%±12) was lower as compared other study of Mali (mean of MAR =87%) (22). The mean of MAR of this study was higher as compared with study conducted in Burkina Faso on women of reproductive age group MPA across the 11 micronutrients was (0.38). The mean MAR of this study was slightly higher (0.55) than the mean MPA in the Mali data was (0.47) (41).

Pearson correlations between dietary diversity indicators and mean adequacy ratio (MAR) shown that positive and significantly association with correlation coefficients range (r=0.307-0.426), ($p<.0001$). The correlation between dietary diversity indicators and mean adequacy ratio(MAR) of this study was similar with study done in Bangladesh with correlation range from, (r= 0.39-0.52) for NPNL and range from (r= 0.28-0.41), for lactating women (42),and study of Sri Lanka on elderly (r=0.48) (43). results also consistent with study from five resource-poor Settings countries' with the correlations ranged from (r=0.21 to 0.53) for non- pregnant non- lactate (NPNL)(35). The correlation this study was also almost same line with results of study done in Philippines among NPNL women with correlations ranged from (r= 0.21 - 0.45) (41) ,but lower than study done in south African women (r 0.43 to 0.88)(6) . Correlation of this study was higher than study done in Mozambique on non-pregnant non-lactated women ranging from (0.10 to 0.35) (8) because the numbers of micro nutrient included in the study was different

Micronutrient adequacy was poor for the pregnant women in this study. Only 6% women had an MAR > 0.70 therefore, at MAR cutoff points of ≥ 0.50 and 0.60 for all pregnant women were evaluated to define adequate diets. The AUC were above 0.70, predictive power and significant (p-value ≤001) for all dietary diversity indicators. AUC of this study was higher than the result of study done in Bamako Mali with AUC of 50% MPA cutoff point and the AUC of 60 % cut off point (38). The area under curve (AUC) of this study was also higher than study done in Bangladesh with AUC for 50% cutoff point were range ,(AUC =0.68-0.74) and AUC 60% cutoff point MPA (0.66 - 0.764) (42) and study done in Philippines(AUC=0.63-0.71) (44). The reason may due to variation in type food group they use and type of mean adequacy ratio. The Area under curve of in this study was in same line with study done in Burkina Faso and Mozambique (7).

ROC analysis was done, using two cut-off points for MAR, 0.50 and 0.60 the best cut-off point of dietary diversity that optimizing sensitivity and specificity for six foods group indicators was four and above dietary diversity score, from nine food group indicators five and above dietary diversity score . Six and above dietary diversity score was the best cutoff point from thirteen-food group indicators and six dietary diversity score and above was the best of 21 food group indicators. Dietary diversity score cut of point that optimizes sensitivity and specificity of this study was different in all food groups in study done in Mali(38). It also different for food group 9,13 and 21 Mozambique Site(8) , in Burkina Faso within six food group ,thirteen food group and 21 food group and for six food group and 21 food group in study done in Bangladesh (45) . The result of this study was consistent for nine food group and thirteen-food group of study done in Bangladesh, for six-food group of Mozambique Site and nine-food group of Burkina Faso site.

Final from over all five and above dietary diversity score of nine food group indicators or six and above dietary diversity score of 13-food group indicators were the best cutoff to maximized sensitivity and specificity to measure micronutrient adequacy of pregnant women.

Limitation

Recall bias, socially desirability bias

Seasonal variation can affected food consumption

Small sample size due to resource constraint

Under or over report of certain food item may be occur

Not laboratory based to determine micronutrient contains of food

Strength

New study conducted in this country and Validation study

Challenge

Ethiopian food composition table incomplete micronutrient values and not included all recent type of food consumed in the country.

Chapter seven

Conclusion

DDS is Positive and significant correlation with MAR.

All food group indicators have power and significant to predict micronutrient adequacy. The findings of this study confirm that dietary diversity scores have ability to predict micronutrient adequacy in pregnant women.

Five dietary diversity score and above of nine food group or six dietary diversity score and above of food group 13 indicators was good for assessing the micronutrient adequacy of the diet . The findings of this study confirm that simple count of food groups can be used to predict mean adequacy ratio (MAR) of micronutrient among pregnant women

Chapter eight

Recommendation

This study showed that DDS are useful proxies of micronutrient adequacy of foods consumed by pregnant women so Ministry of health, NGO and donor can use dietary diversity score to evaluate, monitor and intervention micronutrient adequacy.

Addition validation of dietary diversity as an indicator of micronutrient adequacy important in different season in different place with large sample size is important because dietary diversity score is convenient, simple and cost efficient indicators that can measure micronutrient adequacy of diet.

Annex I

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ANNEX II

Annex consent form

JIMMA UNIVERSITY COLLEGE OF PUBLIC HEALTH AND MEDICAL SCIENCES DEPARTMENT OF POPULATION AND FAMILY HEALTH POST-GRADUATE IN MASTER OF HUMAN NUTRITION (MSC) 2015

Study Title: dietary diversity as an indicator of micronutrient adequacy of diet of pregnant women of Jimma town south west Ethiopia.

Read for the study participants Purpose of the study

Dear Mother:

Consent Form

My name is _____ and I am Master Degree student in Jimma University. As part of my academic requirements, I am conduct study on dietary diversity and micro nutrient adequacy of diet of pregnant women in Jimma town .The objective of this study is to validate dietary diversity as an indicator of micronutrient adequacy of the diet of pregnant women. The information that I is obtained from you are very use full for my study and important for future health policy , pregnant women and future generation including you. I am assuring you that the information will be kept confidentially. There is no any harm to you by giving this information except the time you will expend for the interview. The interview will take 30-40 minute and you have full right to participate or refuse or to withdraw in the meantime. Are you willing to continue with the interview? Yes_____ No_____

Interviewer name_____ Sign. _____

Thank you for your cooperation!!!

Questionnaires

Part I: General Information and Socio demographic information of the respondent

1. Date of interview_____
2. House number_____
3. House hold code_____
4. Age----------Weight ----------kg height ----------in cm
5. Ethnic group: A) Oromo B) Amhara C) Gurage D)Yem
   E) Dawuro F) Tigre G) Other specify_____
6. Religion A) Muslim B) Protestant C) Orthodox D) Catholics
   E) waqeffata F) Other (specify)_____
7. Respondent's marital status
   A) Single B) Married C) Divorced D) Widowed
8. Pregnancy trimesters /week A) first trimester B) second trimester C) third Tr
9. What is your Occupation?
   A) House wife
   B) GOV/Employed
   C) Merchant
   D) Farmer
   E) Daily laborer
   F) Other specify_____
10. What is the respondent's education status?
    A) Illiterate
    B) Only Read & Write
    C) Elementary School (1-8)
    D) Secondary School (9-12)
    E) Above 12 grade
11. Average Monthly Family Income _____ (birr

24-Hour Diet Recall

Please be as specific as possible. Include all description of Food or Drink and Leftovers and portion sizes.

Time	Meal	Food/ drink Item	Details/Ingredients/Preparation	Amount Eaten	Amount of eaten in grams (g)	place

Dietary diversity for women			
	Food group	Examples	YES=1 NO=0
1	Cereals	Tef,maize(boqollo),sorghum(mashilla),Barley(Gabsi), wheat (sinde), Rice, Emmer wheat(Ajja), Millet (dagussa),	
2	white roots and tubers	False banana (Enset), anchoottee, Sweet potato (metatish,Sikkwardinnich),Potato Oromo(dinichaoromo), potatoIrish (yeAbash adinich) ,Taro(Goderyi), Tuber/Bury	
3	All legumes and nuts	Broad beans (baqala), Chickpeas (shimbura), Lentils (misir), Kidney beans (Adengwarrye),Peas(Ater) ,Fenugreek (Abish),Vetch(gwayya), foods made from these (Eg. shiro wet, kik wet, misir wet, shimbra kolo, bakela ashuk, adenguare, boloke……)	
4	Milk & milk products exception of butter	Milk, cheese, yogurt or other milk products like (watat Ayib,Yeragawatat, arera	
5	Organ meat	Liver, kidney, heart or other organ meats or blood-based foods	
6	All other flesh foods and various small animal protein	Beef, goat, lamb, or domesticated mammals, Chicken, duck, turkey, pigeon, guinea hen.	
7	Fish and seafood	fresh or dried fish or shellfish	
8	Eggs	Chicken eggs, Duck eggs	
9	Vitamin A rich vegetables and tubers	Pumpkin, carrots, squash, or sweet potatoes that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper).	
10	dark green leafy vegetables	dark green/leafy vegetables, including wild ones + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach etc.	
11	other vegetables	other vegetables (e.g. tomato, onion, eggplant) , including wild vegetables	
12	vitamin A rich fruits	ripe mangoes, cantaloupe, apricots (fresh or dried), ripe papaya, dried peaches + other locally available vitamin A rich fruits	
13	other fruits	other fruits, including wild fruits	