Association of maternal dietary pattern and neural tube defects; a case-control study in Addis Ababa, Ethiopia

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ASSURANCE OF PRINCIPAL INVESTIGATOR

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the research publications office in effect at the time of grant is forwarded as the result of this application.

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Abbreviations

- **AOR –** Adjusted Odds Ratio
- **ANC –** Antenatal care
- **CDT –** Center for Innovative Drug Development and Therapeutic trial for Africa
- **CI –** Confidence Interval
- **COR –** Crude Odds Ratio
- **CVD -** Cardio Vascular Diseases
- **DM -** Diabetes Mellitus
- **FGR –** Fetal Growth Restriction
- **FFQ –** Food Frequency Questionnaire
- **IFA –** Iron Folic-acid Supplement
- **LMIC –** Low and Middle Income Countries
- **NTD –** Neural Tube Defect
- **SD –** Standard Deviation
- **KMO –** Kaiser–Meyer–Olkin

Summary

Background: Neural Tube Defects (NTDs) are significant public health problems with complex etiology. Maternal nutrition is one of the environmental factors to contribute to the etiology of NTDs. This study aims to assess the relationship of diet with NTDs among pregnant women who received antenatal care services in Zewditu Memorial Hospital.

Methods: We conducted a matched case-control study from January 1, 2020 to April 30, 2020 in Zewditu Memorial hospital, Addis Ababa. A total of 252 pregnant women (63 cases and 189 controls) were included in the study. Pregnant women were matched on age, gestational age and gravidity. We used a 70-item food frequency questionnaire to assess the dietary intake of pregnant women. Factor analysis was used to identify major dietary patterns. Cases and controls were confirmed by specialist gynecologists. Conditional logistic regression was used to assess the association between dietary patterns and neural tube defects.

Result: We identified seven major dietary patterns using factor analysis: prudent pattern, traditional pattern, western pattern, Mediterranean pattern, raw meat and alcohol pattern, refined cereal and vegetable pattern and sugar and caffeine pattern. In the adjusted model, the odds of having a fetus affected with NTDs was 83% lower among women who had high intake of prudent pattern compared to those who had low intake (high vs. low intake: AOR=0.17; CI: 0.05 - 0.52). Likewise, women with high intakes of Mediterranean pattern scores were less likely to have a fetus affected with NTD (high vs. low intake: AOR=0.20; CI: 0.06 - 0.59). The odds of having NTD-affected fetus was 3 times higher among women with high consumption of traditional pattern scores (high vs. low intake: AOR=3.37; CI: 1.23 - 9.19) compared to those who with low consumption. There was no statistically significant association between western pattern adherence before pregnancy and neural tube defect in the adjusted model (high vs. low intake: AOR=1.40; CI: 0.41 - 4.73)

Conclusion and recommendations: This study demonstrated that maternal adherence to high intake of prudent and Mediterranean diets a year before pregnancy have protective effects against NTDs. Conversely, pregnant women with high intake of traditional pattern one year prior to pregnancy are more likely to have a fetus affected with NTDs. Promoting healthy diet prior to pregnancy is one possible way to optimize reproductive outcomes. We suggest the application of

dietary patterns as an approach to communicate healthy dietary choices to the public and formulate dietary guidelines.

1. Introduction

1.1. Background

Neural tube defects (NTDs) are complex birth defects of the central nervous system that result from failure of neural tube closure (1). NTDs are multifactorial by nature having both genetic and environmental risk factors (1–3). Although several risk factors for NTDs were identified, each of them individually are not sufficient to disrupt neural tube closure (4) and more than half of the NTDs are caused by unknown factors (5). Hence, there is a need to identify other genetic and environmental risk factors to fully understand the etiology of NTDs.

Maternal nutrition was identified as one of the environmental factors to contribute to the complex etiology of NTDs. Among these nutritional risk factors are maternal deficiency of folate and vitamin B12 (6). Preconception use of iron folic-acid supplementation (IFA) have been shown to reduce the risk of having NTD affected pregnancies (7). Countries have also been implementing mandatory fortification of staple foods with folic-acid as a measure to decrease incidence of NTDs (8,9).

The complexity of human nutrition makes diet-disease relationship difficult to understand. It is important to focus on single nutrients as contributing factors for the development of NTDs. However, humans eat food that contain many nutrients, which interact with each other. Therefore, individual nutrient approach does not consider the biologic interaction of nutrients through different metabolic pathways (10). Studying dietary patterns that account for the interaction of nutrients could provide a more robust method to determine diet-disease associations (10).

Dietary pattern analysis could be used as a potentially valid tool to assess the relationship between diet and pregnancy outcomes and provide a complementary approach to deliver messages to the population (11,12). Studies suggested the association between maternal dietary patterns and pregnancy outcomes including NTDs (13,14), congenital heart defects (15,16), cleft lip and palate (17), fetal growth restriction (18) and preterm birth (19).

Ethiopia is a country with diverse population having variety of unique cuisines and culinary features. Studying dietary patterns of pregnant women in the country could help better understand

the relationship of diet with NTDs and provide a more tailored nutritional message to the population.

1.2. Statement of the problem

NTDs are significant public health problems with complex etiology. In 2015, 260,100 births were estimated to be affected by NTDs worldwide with prevalence of 18.6 per 10,000 live births. Majority (75%) of the NTD-affected live births led to under-5 deaths. The overall NTD birth prevalence in Sub-Saharan Africa (without folic acid fortification) was 15.27 per 10,000 live births. Moreover, 49,100 births in sub-Saharan Africa were affected by NTDs (20).

According to the March of Dimes Global Report ranking of countries by birth defects prevalence (from a low of 39.7 per 1000 live births (France) to a high of 82 per 1000 live births (Sudan)), Ethiopia had a birth defect prevalence of 54.4 per 1000 live births (21). A recent hospital based study indicated that the prevalence of neural tube defects in Addis Ababa and the Amhara regions, Ethiopia is 0.63% and 0.17% respectively (22). Similarly, studies reported that 63.4/10,000 births in Addis Ababa (23) and 131/10, 000 births in Tigray (Northern Ethiopia) (24) are affected with NTDs.

Healthy and high quality maternal diet is associated with reduced risk of birth defects including NTDs (13–15,25). Nevertheless, the overall consumption pattern among women aged 15-45 years based on a single 24-hour recall in Addis Ababa was 2.8% vitamin A rich fruits and vegetables, 63.9% cereals/grains, and 0.9% dairy products (26). Moreover, RBC folate deficiency among non-pregnant women of reproductive age groups (15-49 years) in Ethiopia is 32%, which is insufficient level for the prevention of neural tube defects (27)

In Ethiopia, 42% of pregnant women initiated their antenatal care visits after 4 months of pregnancy and 37.1% of them didn't have any ANC visits at all by the year 2016 (28). There is also no preconception folic acid supplementation and mandatory folic acid fortification programs in the country. These situations imply the need to focus on prevention of NTDs as part of preventive medicine in the country.

This study aims to assess the relationship of diet with NTDs among pregnant women who received antenatal care services in Zewditu Memorial hospital: Addis Ababa using dietary pattern analysis.

1.3. Significance of the study

Maternal intake of high quality diet has a protective effect against neural tube defects. This study will provide information on dietary pattern of women in Addis Ababa and will help us recognize the association of these patterns with NTDs. Studying dietary patterns associated with NTDs in Ethiopia could help generate nutrition message to women tailored to the cultural and culinary aspects of the country. It will also assist in strengthening promotion of healthy diet in national strategies and development of guidelines to prevent neural tube defects. This will help women of reproductive age group in Ethiopia to choose a healthy diet to prevent neural tube defects.

2. Literature review

2.1. Prevalence and associated factors of NTDs

There are considerable variations among literatures in estimating global and regional prevalence of NTDs based on the sources of data and methodology. A population-based surveillance system in which all pregnancy outcomes are included with clear case definitions and a defined area would provide the most complete estimate of NTDs (20,29). However, systems like this are not available in almost all countries (20). In addition, underlying risks due to variations in genetic of populations as well as access to health influenced the estimated prevalence of NTDs (20,29).

Although prevalence estimates for NTDs and their related disabilities can vary based on the data source, type, and definition of conditions, we presented findings from some of the studies below.

A recent systematic review of global and regional prevalence of neural tube defects estimated 260,100 NTD-affected birth outcomes worldwide with prevalence of 18.6/10,000 live births. Approximately 50% of NTDs were elective terminations of pregnancy for fetal anomalies or stillbirths. Majority (75%) of NTD-affected live births resulted in under-5 deaths (20).

Another systematic review estimated the burden of neural tube defects in low– and middle–income countries (LMIC) using the median from studies based on livebirths to be 1.67/1000 for total NTD burden, 1.13/1000 for spinal bifida, 0.25/1000 for anencephaly and 0.15/1000 for encephalocele (29). Prevalence estimates based on all live births, stillbirths and terminations were 2.55/1000 for total NTD burden, 1.04/1000 for spinal bifida, 1.03/1000 for anencephaly and 0.21 for encephalocele. About 190, 000 neonates living in LMIC are born with NTD each year (29).

The March of Dimes' Global Report on Birth Defects (21) reported birth defects prevalence of countries from a low of 39.7 per 1000 live births (France) to a high of 82 per 1000 live births (Sudan). The report showed that Ethiopia had a birth defect prevalence of 54.4 per 1000 live births.

According to hospital based prevalence studies conducted in Ethiopia, prevalence of NTDs are 0.63% (Addis Ababa), 0.17% (Amhara), 1.31% (Tigray North West Ethiopia), (22,23,30). In these studies, lack of folic acid supplementation, presence of chronic disease, intake of drugs, low income and consumption of alcohol during pregnancy were significantly associated with birth defects. However, planned pregnancy, male sex of the child, normal to underweight body mass

index, and taking folic acid or multivitamins during first trimester were protective of NTDs (22,23,30).

2.2. Dietary factors

Evidence regarding the clear association between diet and neural tube defects is sparse. Among the existing evidence, the prompted ones demonstrated the protective effect of maternal intake of higher quality diet characterized by intake of fruits, vegetables grains and folic acids supplementations towards having NTD-affected child (13,15,25,31). Maternal intake of western diets characterized by meat, fat, fried potatoes, sweets and vegetarian lifestyles increases the risk of having NTD-affected birth (13,15,18,25,32–35). These studies recommend the importance of awareness creation regarding dietary diversity, folic acid and vitamin B12 (non-vegetarian diet) supplementations particularly for those consuming vegetarian diet in order to reduce the risk of NTDs and prevent morbidity and mortality.

2.2.1. Fruits, vegetables and grains

Evidences suggests that healthy maternal dietary patterns during the preconception period that are high in vegetables, fruits and grains; lower in red and processed meats; and low in sweets were associated with lower risk of developing of neural tube defects, particularly among women who do not take folic acid supplements (13,18,25,32).

Women who adhere to Mediterranean and prudent dietary patterns were found to be at a lower risk of having a child with NTDs (15,33–35). These dietary patterns are characterized by high intake of healthy foods such as fruits and vegetables, yogurt, reduced-fat milk, whole-wheat bread, fortified cereal, and fish (15,33–35). However, women with low consumption of fruits and vegetables and high consumption of meat and processed foods were found to be at higher risk of having a child affected with NTDs (15,33–35).

2.2.2. Meat, fried potato, restricted carbohydrate intake and vegetarian dietary habit

Women who follow western dietary pattern, characterized by high consumption of frankfurters, bacon, french fries, white bread, potato chips, and regular soda and low consumption of fruits and vegetables are at a higher risk of having NTD- affected child (13,15,25). Moreover, women who follow vegetarian dietary habit are at increased risk of having a child with NTD mostly because of

vitamin B-12 deficiency in the vegetarian diet (36, 39). It is also found that women with restricted carbohydrate intake were 30% more likely to have a child affected with birth defects particularly anencephaly or spinal bifida (36) .

2.3. Pre-conception folic acid supplementation

Systematic reviews and case control studies were consistent in demonstrating the association of pre-conception folic acid supplementation with reduced risk of having a child with birth defects such as neural tube defects, congenital heart defects, and cleft lip and palate (6,15,16,25,31,37)

2.4. Other factors

Maternal Age, Parity, and Obstetrical History

The risk of having a child with spinal bifida is found to be higher when maternal age exceeds 35; higher risk was reported for mothers under 20 years of age (16). Parity has also been found to be significantly related to the risk of neural tube defects (8). The previous pregnancy outcome of the mother also seems to be a risk factor for the occurrence of neural tube defects (3).

Socioeconomic Status

Several studies have investigated the relationship between the occurrence of neural tube defects and socioeconomic status (20-22). Relationships found have the same direction among different countries and for different ethnic groups: a progressive increase in the prevalence rate of neural tube defects from higher to lower socioeconomic class, as determined by the father's occupation. The biological significance of socioeconomic status is unknown. Factors such as housing conditions, frequency of infections, age at marriage, alcohol consumption, and smoking may be partly responsible for the association with neural tube defects. In addition, dietary factors such as the intake of vitamins and folic acid have been causally related to neural tube defects (23-25).

3. Objectives

3.1. General objective

- To assess the relationship of dietary patterns with NTDs among pregnant women who received antenatal care services in Zewditu Memorial Hospital in Addis Ababa, Ethiopia from January 1, 2020 to April 30, 2020.

3.2. Specific objectives

- To derive major dietary patterns consumed by pregnant women who received antenatal care services in Zewditu Memorial Hospital in Addis Ababa, Ethiopia from January 1, 2020 to April 30, 2020.
- To identify dietary patterns associated with NTDs among pregnant women who received antenatal care services in Zewditu Memorial Hospital in Addis Ababa, Ethiopia from January 1, 2020 to April 30, 2020.

4. Methods

4.1. Study area

This study was conducted in Addis Ababa, the capital city of Ethiopia, which has 25 hospitals and 97 Health Centers. In the year 2018 the city had 1,134,510 women aged 15-49 years, of which, 81,915 are expected to be pregnant by that year (38). According to the national food consumption survey 2013, consumption of cereals/grains, vitamin A rich fruits and vegetables, dairy products and flesh foods among women of reproductive age group in Addis Ababa was 63.9%, 2.8% and 0.9% respectively (26) .

4.2. Study design and period

We conducted a matched case-control study to address the study objective. Data was collected from January 1, 2020 to April 30, 2020 in Zewditu Memorial hospital located at the center of Addis Ababa. Pregnant women were matched on age (within 5 years age range), gestational age (within 2wks range) and gravidity (within 2 pregnancies range).

4.3. Study population

Study population were pregnant women who visited Zewditu Memorial hospital to receive antenatal care services during data collection period (January 1, 2020 to April 30, 2020).

Outcome (Status of the fetus in terms of NTD)

- **Outcome (Being a case):** Being a pregnant woman carrying a fetus affected with NTD confirmed by ultrasound at the time of data collection.
- **Outcome (Being a control):** Being a pregnant woman carrying a fetus not affected with NTD confirmed by ultrasound at the time of data collection, with in a 5 years age interval as compared to its matched case, having gestational age within (+/- 2wks interval of its matched case) and of gravidity having maxim of 2 pregnancies difference from its matched case.

4.4. Sample size

Sample size for the case control study was calculated using an online OpenEpi, Version 3, open source with the following assumptions:

- Percentage of pregnant women in the control arm who are exposed to having low intakes of Mediterranean diet is 36% (34) .
- The odds of pregnant women in the case group to have a child with NTD = 2.7 times higher as compared to the control group (34) .
- We want to have a power of 80% to detect the hypothesized difference between the two study arms
- We want to be 95% confident in our estimate of the effect size
- We took ratio of control: cases as: 3:1,
- 10% non-response rate.

With these assumptions, the required minimum sample size was **63 Cases** and **189 Controls.**

4.5. Sampling procedure

The study participants were recruited from the ANC clinic of Zewditu Memorial Hospital. Pregnant women who visit Zewditu Memorial Hospital routinely get ultrasound screening by gynecologists. In this study, pregnant women whose fetus were affected by NTD as confirmed by ultrasound were asked for consent and enrolled as cases. The next three consecutive pregnant women in the medical registry whose fetus were not affected by neural tube defects as confirmed by ultrasound and fulfill the matching criteria were recruited as controls after they consented for participation. This process continued until the required sample size was obtained.

4.6. Inclusion criteria

All pregnant women with gestational age of greater than 9 weeks visiting Zewditu Memorial hospital to receive antenatal care services at the time of data collection were eligible for the current study. Gestational age of greater than 9 weeks was taken as criteria because diagnosing NTDs at early gestational age is difficult especially in Ethiopia; making our case definition less reliable.

4.7. Exclusion criteria

Pregnant women who visited Zewditu Memorial hospital but live out of Addis Ababa were not eligible. We assumed that the dietary habit of people in the capital city and in other parts of Ethiopia is not the same. The dietary pattern tool was designed making primary focus on residents of Addis Ababa.

4.8. Data collection procedure and type of collected data

Four data collectors and one supervisor were trained and involved in field data collection.

Background data of pregnant women were collected using a structured questionnaire as exit interview. This data included age, marital status, educational status, occupational status, family monthly income, previous medical history (hypertension, diabetes, and IFA intake during pregnancy).

Dietary data were collected using a 70-item food frequency questionnaire (FFQ) adapted from a previous study conducted in Addis Ababa (39). The FFQ constituted 70 food types categorized in to 9 food groups. These include cereals, legumes, roots and tubers, fruits, vegetables, meat and fish, milk and milk products, sweets and beverages and fast foods. Pregnant women were asked to recall their intake of each food types in the year before they became pregnant.

4.9. Variables

4.9.1. Outcome variable

- Status of pregnant woman in terms of carrying a fetus with NTD confirmed by ultrasound (Cases/Controls).

4.9.2. Primary exposure variables

- Dietary patterns; factor loadings for variety of food items and drinks in maternal diet

4.9.3. Potential confounding variables

- Educational status and iron folic acid supplement intake of pregnant women

4.10. Data management and analysis

Data were codded and entered in Epidata version 4.2 software after checking the completeness of the collected data. We used Stata 14.0 statistical software for data cleaning and statistical analysis.

Background data: Descriptive statistics such as proportion, mean and standard deviation were used to describe sociodemographic, previous medical history and iron folic acid intake of pregnant women. Background data of cases and controls were compared using a Chi-squared test.

Dietary patterns based on the 70 food items were derived using factor analysis with orthogonal (varimax) rotation for better interpretation and identification of meaningful patterns. We excluded food items that were consumed by less than 5% or greater than 95% of women from factor analysis, as they do not vary much across study participants. We used Kaiser–Meyer–Olkin (KMO) test to evaluate the reliability of the factor analysis and sampling adequacy. All factors with Eigenvalues of more than 1 were retained and interpreted as major dietary patterns. Food items with factor loading greater than absolute 0.35 (|>0.35|) were considered to be highly related to the corresponding dietary patterns. Factor scores were calculated and assigned to each dietary pattern to indicate the extent to which maternal diet corresponded to that dietary pattern. Individuals with high factor scores were considered to have stronger adherence to the identified dietary pattern. Factor scores representing underlying dietary patterns were further divided in to three categories according to tertiles. Tertiles indicate degree of intake/consumption of each dietary pattern. Tertile 1 (T1) indicates low intake while Tertile 2 (T2) and Tertile 3 (T3) indicate moderate and high intakes of the dietary pattern respectively.

Association of dietary patterns with the odds of having a fetus affected with NTDs was modeled using conditional logistic regression models. Crude odds ratio was obtained as a measure of unadjusted association of each dietary pattern with the odds of having NTD-affected fetus using bi-variate conditional logistic regression. We obtained the adjusted effects from multivariable conditional logistic regression considering educational status and IFA supplement intake of pregnant women as confounding variables. For each dietary pattern, the effect was also adjusted for the other dietary patterns. Odds ratio was reported with its corresponding 95% CI.

4.11. Data quality management

Questionnaire used in this study was first prepared in English language and then translated to the local (Amharic) language. We trained all data collectors and supervisors for the purpose of this study. Questionnaires were pretested on pregnant women who were not included in this study. Data were checked for its completeness and coded before data entry. Entered data were cleaned using Stata software version 14.1.

4.12. Ethical considerations

Ethical clearance was obtained from Addis Ababa University, College of Health Sciences, CDT-Africa. Permission to conduct the study was also obtained from Zewditu Memorial Hospital Administration. Pregnant women involved in the current study provided written informed consent after receiving the necessary explanation about the purpose, benefits and risks of the study and their right on decision of participating in the study is provided to them. Confidentiality of the information was maintained throughout the study. Names and any other personal identifications were not linked to the collected data during data collection. It is the routine procedure of Zewditu Memorial Hospital to provide ultrasound screening for all pregnant women visiting antenatal care unit. Thus, neither pregnant women, nor the researchers were subjected to any cost relating to ultrasound or any other additional costs related to this research.

4.13. Dissemination of results

Findings of the study will be submitted and presented to Addis Ababa University College of Health Sciences, CDT-Africa, Zewditu Memorial Hospital and at different workshops. Publication of the findings on peer-reviewed journals will be considered.

5. Results

Background data: A total of 252 pregnant women (63 cases and 189 controls) were included in the current study with 100% response. Table 1 summarizes the background characteristics of study participants. Majority of the cases (71.43%) were spinal bifida followed by anencephaly (20.63%) and encephalocele (7.94%). Mean age (Standard deviation) of the study participants was 28 years (SD =5), mean (SD) gestational age was 34 weeks (SD =6) and majority (62.7%) were prim-gravidas. Among the cases, one pregnant woman had a history of having a child affected with spinal bifida and another one had a family history of anencephaly through her sister. None of the pregnant women stated that they took iron/folic acid supplementation before conception. Majority (96.3%) of pregnant women in the control group took IFA supplementation during pregnancy compared to 82.5% of pregnant women in the case group. More (38.6%) pregnant women in the control group had higher educational attainment (college and above) than those in case group (28.5%).

Table 1: Characteristics of pregnant women carrying NTD-affected fetus and controls

Characteristics	Case n(63)		Control n(189)		p-value
	N	%	N	%	
Religion					
Orthodox	36	57.1	136	71.9	
Muslim	15	23.8	25	13.2	0.09
Catholic	12	19.0	26	13.7	
Protestant	0	0.0	2	1.0	
Ethnicity					
Tigre	31	49.2	49	25.9	
Amhara	26	41.2	88	46.5	0.01
Gurage	4	6.3	30	15.8	
Oromo	1	1.5	12	6.3	
Silt'e	1	1.5	10	5.2	
Marital status					
Single	3	4.7	5	2.6	0.43
Divorced/separated	0	0.0	3	1.5	
Married/living together	60	95.2	181	95.7	
Educational status					
Can't read and write	11	17.46	13	6.88	
Can read and write	4	6.35	4	2.12	**0.01**
Finished primary school	20	31.75	28	14.81	
Finished secondary school	10	15.87	71	37.57	

College and above	18	28.57	73	38.62	
Occupational status					
Currently unemployed	43	68.25	103	54.50	
Labor worker	3	4.76	3	1.59	**0.03**
Civil servant	5	7.94	42	22.22	
Self employed	12	19.05	41	21.69	
Family monthly income (in birr)					
<2000	15	23.81	32	16.93	0.10
2000 – 4000	28	44.44	65	34.39	
4001 – 6000	11	17.46	41	21.69	
>6000	9	14.29	51	26.98	
History of hypertension	2	5.41	10	8.26	0.56
History of diabetes	0	0.00	4	2.12	0.24
Iron folic acid supplement use	52	82.54	182	96.30	**0.01**

Dietary pattern: We identified seven dietary patterns using exploratory factor analysis. One food item (a sauce made from peas and pepper) was excluded from the factor analysis because it was consumed by 98% of pregnant women. Thus, the factor analysis was conducted using 69 food items. The KMO value was 0.79. Table 2 shows factor loadings of major dietary patters identified through factor analysis.

Table 2: Factor loadings of major dietary patterns identified using factor analysis

List of foods	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Flat white-teff bread (*injera*)	-	0.44	-	-	-	-	-
Shredded flat teff bread (*injera*) with spicy sauce	-	0.42	-	-	-	-	-
Pasta	-	-	-	-	-	0.33	-
Macaroni	-	-	-	-	-	0.56	-
Barely porridge	0.39	-	-	-	-	-	-
Boiled potato	0.41	-	-	-	-	-	-
Ethiopian Collard Greens	-	-	-	0.39	-	-	-
Raw tomato, onion, chili and oil	-	-	-	0.48	-	-	-
Tomato sauce	-	-	-	-	-	0.37	-
Green chili	-	-	-	0.37	-	-	-
Boiled black eyed peas	0.37	-	-	-	-	-	-
Yellow split peas sauce	-	0.43	-	-	-	-	-
Lentil sauce	-	0.44	-	-	-	-	-
Banana	-	-	-	0.55	-	-	-
Lemon	0.36	-	-	-	-	-	-

Meat stew	-	0.59	-	-	-	-	-
Stir-fried beef	-	0.35	-	-	-	-	-
Raw beef	-	-	-	-	0.36	-	-
Stir-fried sheep meat	-	-	0.36	-	-	-	-
Stir-fried goat meat	0.45	-	-	-	-	-	-
Tuna	-	-	0.40	-	-	-	-
Yogurt	0.41	-	-	-	-	-	-
Ethiopian cottage cheese	0.44	-	-	-	-	-	-
Boiled egg	0.60	-	-	-	-	-	-
Honey	0.47	-	-	-	-	-	-
Sugar	-	-	-	-	-	-	0.50
Tea	-	-	-	-	-	-	0.43
Coffee	-	-	-	-	-	-	0.41
Beer	-	-	-	-	0.62	-	-
Ethiopian traditional alcohol drink made from barely	-	-	-	-	0.59	-	-
Ethiopian traditional alcohol drink made from honey	-	-	-	-	0.52	-	-
Wine	-	-	0.40	-	0.58	-	-
Pizza	-	-	0.69	-	-	-	-
Burger	-	-	0.62	-	-	-	-

"-"indicates food items with factor loading of < |0.35|

The identified dietary patterns along with their food items, food groups of the food items and assigned labels are presented in table 3. We labeled the each factor based on the food items included in each particular factor guided by factor labels in literatures (14–16) . In dietary pattern analysis, labeling of the factors is arbitrary and is based on an investigator's interpretation of the factor so it is important to recognize what is behind the label to understand the dietary pattern (40).

- The first factor was characterized by high loadings on variety of food items such as barely porridge, boiled potato, boiled black eyed peas, lemon, fried goat meat, yogurt, Ethiopian cottage cheese, boiled egg and honey and was labeled as ***Prudent pattern***.
- The second factor had high loadings on various foods such as flat white-teff bread (injera), shredded flat teff bread with spicy sauce, yellow split peas sauce, lentil sauce, meat stew, fried beef and is labeled as ***Traditional pattern***.
- The third factor has high loadings on meat and fast foods including fried sheep meat, tuna, wine, pizza, and burger and was labeled as ***Western pattern***.

- The fourth pattern included high loadings of Ethiopian Collard Greens, raw tomato with onion, chili and oil, green chili, banana and was labeled as ***Mediterranean pattern***.
- The fifth factor was characterized by high loadings of raw beef and alcohol including raw beef, beer, Ethiopian traditional alcohol drink made from barely, Ethiopian traditional alcohol drink made from honey, and wine and it was labeled as ***Raw meat and alcohol***.
- The sixth factor was labeled as ***Refined cereals and vegetable*** which had high loadings on Pasta, macaroni, tomato sauce.
- The seventh factor was labeled as ***Sugar and Caffeine***, which had high loadings for Sugar, tea, coffee.

Table 3: Identified dietary patterns along with their high loading food items, food groups of the food items and assigned labels for the dietary patterns.

Factor	Food items	Food Groups	Label of dietary pattern
Factor 1	Barely porridge, boiled potato, boiled black eyed peas, lemon, stir-fried goat meat, yogurt, Ethiopian cottage cheese, boiled egg, honey	Cereals and grains, roots, legumes, fruits, meat, dairy, egg, honey	*Prudent pattern*
Factor 2	Flat white-teff bread *(injera)*, shredded flat teff bread with spicy sauce, yellow split peas sauce, lentil sauce, meat stew, stir-fried beef	Cereals, legumes, meat stew, fried beef	*Traditional pattern*
Factor 3	Stir-fried sheep meat, tuna, wine, pizza, burger	Meat, tuna, wine and fast foods	*Western pattern*
Factor 4	Ethiopian Collard Greens, raw tomato, onion, chili and oil, green chili, banana	Vegetables and fruit	*Mediterranean pattern*
Factor 5	Raw beef, beer, Ethiopian traditional alcohol drink made from barely, Ethiopian traditional alcohol drink made from honey, wine	Raw meat and alcohol	*Raw meat and alcohol*
Factor 6	Pasta, macaroni, tomato sauce	Refined cereals and vegetables	*Refined cereals and vegetable*
Factor 7	Sugar, tea, coffee	Sugar and Caffeine	*Sugar and Caffeine*

Consumption of major dietary patterns (categorized into tertiles) stratified by the outcome of interest (case/controls) is summarized in Table 4. Upon description of the distribution of consumption within each dietary pattern, majority of cases had relatively lower intake of the prudent and Mediterranean patterns and higher intake of western patterns than controls.

Table 4: Consumption of major dietary patterns among women a year before pregnancy stratified in tertiles from low intake (T1) to high intake (T3)

Dietary pattern		Case (n=63)		Control (n=189)	
		n	%	N	%
Prudent pattern					
	Low intake	30	47.6	54	28.5
	Moderate intake	18	28.5	66	34.9
	High intake	15	23.8	69	36.5
Traditional pattern					
	Low intake	18	28.5	66	34.9
	Moderate intake	20	31.7	64	33.8
	High intake	25	39.6	59	31.2
Western pattern					
	Low intake	15	23.8	69	36.5
	Moderate intake	18	28.5	66	34.9
	High intake	30	47.6	54	28.5
Mediterranean pattern					
	Low intake	27	42.8	57	30.16
	Moderate intake	23	36.5	61	32.28
	High intake	13	20.6	71	37.57
Raw meat and alcohol					
	Low intake	18	28.5	66	34.9
	Moderate intake	25	39.6	59	31.2
	High intake	20	31.7	64	33.8
Refined cereals and vegetable					
	Low intake	20	31.7	64	33.86
	Moderate intake	24	38.1	60	31.75
	High intake	19	30.1	65	34.39
Sugar and Caffeine					
	Low intake	24	38.1	60	31.7
	Moderate intake	16	25.4	68	35.9
	High intake	23	36.5	61	32.2

Dietary Patterns and the odds of having Neural Tube Defects: Measures of association between dietary patterns categorized in tertiles and the odds of having NTDs obtained from conditional logistic regression models are summarized in table 5. Before adjusting for potential confounding variables, women with moderate and high intakes of prudent pattern scores were less likely to have

a fetus affected by NTDs as compared to those with low intake (moderate vs. low intake: COR=0.48; CI: 0.24-0.97; high vs. low intake: COR=0.33; CI: 0.15 - 0.74). Similarly, the odds of having NTD-affected fetus was 63% lower among women who had high intake of Mediterranean pattern than women with low intake (high vs. low intake: COR=0.37; CI: 0.17-0.81). Conversely, women with high consumption of western pattern score (high vs. low intake: COR=2.77; CI: 1.29-5.92) were more likely to have NTD-affected fetus in comparison with women who had low consumption.

In the adjusted model, the odds of having a fetus affected with NTDs was 83% lower among women who had high intake of prudent pattern compared to those who had low intake (high vs. low intake: AOR=0.17; CI: 0.05 - 0.52). Likewise, women with high intakes of Mediterranean pattern scores were less likely to have a fetus affected with NTD (high vs. low intake: AOR=0.20; CI: 0.06 - 0.59). The odds of having NTD-affected fetus was 3 times higher among women with high consumption of traditional pattern scores (high vs. low intake: AOR=3.37; CI: 1.23 - 9.19) compared to those who with low consumption. There was no statistically significant association between western pattern adherence before pregnancy and neural tube defect in the adjusted model (high vs. low intake: AOR=1.40; CI: 0.41 - 4.73).

Table 5: Association between dietary patterns categorized in tertiles and neural tube defects using crude and adjusted conditional logistic regression models.

Dietary pattern		Crude model			Adjusted model		
		COR[1]	p-value	95% CI	AOR[2]	p-value	95% CI
Prudent pattern*							
	Low intake	1			1		
	Moderate intake	0.48	**0.04**	0.24 - 0.97	0.57	0.27	0.21 - 1.55
	High intake	0.33	**0.01**	0.15 - 0.74	0.17	**0.01**	0.05 - 0.52
Traditional pattern*							
	Low intake	1			1		
	Moderate intake	1.13	0.72	0.55 - 2.31	1.45	0.44	0.55 - 3.83
	High intake	1.60	0.19	0.78 - 3.28	3.37	**0.01**	1.23 - 9.19
Western pattern*							
	Low intake	1			1		
	Moderate intake	1.36	0.43	0.62 - 3.01	1.94	0.27	0.59 - 6.34
	High intake	2.77	**0.01**	1.29 - 5.92	1.40	0.58	0.41 - 4.73
Mediterranean pattern*							
	Low intake	1			1		
	Moderate intake	0.78	0.47	0.41 - 1.50	0.72	0.47	0.29 - 1.76
	High intake	0.37	**0.01**	0.17 - 0.81	0.20	**0.01**	0.06 - 0.59
Raw meat and alcohol*							
	Low intake	1			1		
	Moderate intake	1.59	0.20	0.77 - 3.26	1.81	0.23	0.68 - 4.83
	High intake	1.14	0.70	0.55 - 2.37	1.18	0.72	0.46 - 3.01
Refined cereals and vegetable*							
	Low intake	1			1		
	Moderate intake	1.29	0.47	0.63 - 2.63	1.12	0.79	0.44 - 2.85
	High intake	0.93	0.86	0.44 - 1.96	1.02	0.96	0.39 - 2.67
Sugar and Caffeine*							
	Low intake	1			1		
	Moderate intake	0.57	0.14	0.27 - 1.20	0.48	0.152	0.18 - 1.30
	High intakes	0.92	0.82	0.45 - 1.86	0.69	0.445	0.26 - 1.78

*Consumption of major dietary patterns among women a year before pregnancy stratified in tertiles from low intake (T1) to high intake (T3).

[1]COR – Crude matched odds ratio using bivariate conditional logistic regression.

[2]AOR – Adjusted matched odds ratio; adjusted for all dietary patterns, educational status and iron folic acid supplement intake during pregnancy using multivariate conditional logistic regression.

6. Discussion

The aim of this study was to assess the relationship between dietary patterns and neural tube defects. We identified seven major dietary patterns using factor analysis: prudent pattern, traditional pattern, western pattern, Mediterranean pattern, raw meat and alcohol pattern, refined cereal and vegetable pattern and sugar and caffeine pattern. Women who had high intake of prudent pattern characterized by high intakes of barely porridge, boiled potato, boiled black-eyed peas, lemon, stir-fried goat meat, yogurt, Ethiopian cottage cheese, boiled egg and honey in the year before pregnancy were less likely to have a fetus affected with NTDs. Similarly, high consumption of Mediterranean pattern, which represent high consumption of Ethiopian Collard Greens, raw tomato with onion, chili and oil, green chili, banana demonstrated a protective effect against having NTD-affected fetus in comparison with low consumption. On the contrary, women with high consumption of traditional pattern characterized by high intake of flat white-teff bread (injera), shredded flat teff bread with spicy sauce, yellow split peas sauce, lentil sauce, meat stew, and fried beef were more likely to have a fetus affected with NTDs. We didn't find significant association between western pattern, which represent high loadings of meat, tuna, wine and fast foods and the odds of having NTD-affected fetus after adjusting for potential confounders.

Our study demonstrated the protective effect of prudent pattern against having NTD-affected fetus. Components of the prudent dietary pattern in our study are comparable with other literatures (15,16,41). Studies supported the beneficial effect of prudent dietary pattern against the risk of birth defects including NTDs (15), congenital heart defect (CHD) (15,16) cleft lip or palate (13) and other chronic diseases such as cardio vascular diseases (CVD) and diabetes mellitus (DM) (41).

In the present study, women who adhered to pre-conception Mediterranean pattern were less likely to have a fetus affected with NTDs. Studies suggested that Mediterranean pattern mainly characterized by high intake of fruits, vegetables, whole grain cereals, legumes, fish and nuts; low-to-moderate consumption of dairy products and limited amounts of red meat and red wine is associated with the highest risk reduction in occurrence of NTDs (14,18). The Mediterranean pattern represents an important source of micronutrients including folate and vitamin B12 and essential cofactors that are necessary in several pathways of embryo development (42). Studies

reported positive associations of adherence to Mediterranean pattern during pre-conception with blood concentrations of folate and vitamin B12 and possible reduction of hyperhomocysteinaemia, which is considered as a biomarker for impaired reproductive function (14,31). Systematic reviews also reported the association between Mediterranean pattern and reduced risk of spinal bifida (13), fetal growth restriction and prematurity (18).

Our study revealed that women who had high intake of traditional pattern a year before pregnancy to be three times more likely to have a fetus affected with NTDs compared to those with low intake. One possible explanation for this result could be the cooking method of most Ethiopian foods, especially those high loading legumes under the traditional pattern in this study. Traditionally in Ethiopia, these food items are cooked for a long period and are mostly overcooked. Cooking methods alter the nutrient contents found in food (44). Prolonged cooking significantly decreases the micronutrient contents of vegetables and legumes including folate, which is important for a growing fetus (41,45).

The findings from our study confirmed the importance of healthy maternal diet in the year before pregnancy. Evidence also suggested the association of healthy maternal dietary pattern, which represents high intake of vegetables, fruits and grains and low intake of in meat and processed foods during preconception with reduced risk of having NTD-affected child, particularly among women who do not take folic acid supplements (32). Studies also revealed that high quality diet, as measured by diet quality scores, has a protective effect against neural tube defects and orofacial clefts (25,43).

Although the bi-variate analysis in our study suggested association between high intake of western pattern and increased odds of having a feus affected with NTDs, the association was not statistically significant after adjustment of confounders. Literatures reported an increased risk of cleft lip (13,17) and neural tube defects (15) among women with adherence to western dietary pattern.

7. Strength and limitations of the study

To our knowledge, this is the first study in Ethiopia to investigate the association of dietary patterns with neural tube defect using a case-control study design and dietary pattern analysis. Our study

provides more evidence on the benefits of maternal healthy diet in terms of reducing neural tube defects.

Response of our study participating pregnant women might be affected by recall bias, as it could be difficult to remember their consumption of the different food items a year before pregnancy. Future studies are likely to bring programmatically usable information if they are based on larger samples sizes and they use prospective study design, which is less exposed to recall bias. Thus, our findings should be interpreted carefully considering the above limitation.

8. Conclusion

This study demonstrated that maternal adherence to high intake of prudent and Mediterranean diets a year before pregnancy have protective effects against NTDs. Conversely, pregnant women with high intake of traditional pattern one year prior to pregnancy are more likely to have a fetus affected with NTDs.

9. Recommendations

Our findings imply the importance of having a healthy dietary choice. Promoting healthy diet prior to pregnancy is one possible way to optimize reproductive outcomes. We suggest the application of dietary patterns as an approach to communicate healthy dietary choices to the public and formulate dietary guidelines. Further, we suggest initiation of pre-conception folic acid supplementation, possibly through government programs in addition to the existing pregnancy iron folic acid supplementation program to prevent neural tube defects.

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Annexes

Annex 1. English Information sheet and Informed consent

Dear Participants

My name is …….. I am here on the behalf of Afrah Mohammedsanni who is a master's student in Addis Ababa university school medicine CDT-Africa. She is working her thesis on dietary pattern and neural tube defects and she received permission from Addis Ababa University and this hospital.

This letter is to ask consent from you to participate in this research. The purpose of this research is to identify the dietary patterns of women and its association with NTDs. This study will be helpful to know which dietary habit can cause NTDs and will help us to avoid such food types and to follow healthy diet. It will help to deliver some information to researchers.

Your participation in this research is completely with volunteer. If you decide not to participate, you can say so and there will be no consequences for you. If you participate in our study there will be no direct benefits for you. However, your participation on this study is very important for achievement of the objective of the study. There will not be greater risk that will befall you because of your participation. All of your responses and results obtained will be kept confidential using coding system whereby no one will have access your response or personal information. You are not expected to give your name to the data collectors.

We will not disclose any information to a third person without permission from you. You have full right to refuse and withdraw from the participation at any time during data collection. We will appreciate your participation. To describe your willingness to participate, please sign the agreement form.

Address: Cell phone Afrah Mohammedsanni +251944 25 77 32, IRB contact: +2519

Questionnaire number (ID)_____

Informed Consent Form

Based on the understanding of the information, are you willing to participate in this study?

A) Yes

B) No

(1) If yes, I will continue

2) if no I will skip to next participant

Respondent

I have understood the information provided to me and I agreed to participate in this study.

Signature _____Date_____

Interviewer

Name_____ Signature_____

Questionnaires number_____

Date of interview_____ Starting time_____ Completed_____

Result of interview A) Completed

B) Not completed

C) Partially completed

D) Refused

Supervisor: Name _____Signature_____

Address: Cell phone +251944 25 77 32

Annex 2. English questionnaire

Background information

1.	**Sociodemographic characteristics**		
101	Card No.	_____ _____	
103	Status	1. Case 2. Control	
104	If case, What is the type?	1. Anecephale 2. Encephalocele 3. Spinal Bifida 4. Other Specify _____	
105	Age (in completed years)	_____	
106	What is your religion?	Orthodox ……...1 Muslim ….…….2 Protestant...…….... 3 Catholic …….4 Others (specify) _____	
107	To which ethnic group do you belong to?	Amhara ……..….1 Tigre ……..……...….2 Oromo ……..……...3 Gurage ……...4 Silte ……5 Other (specify) _____	
108	What is the highest level of school you attended?	Can't read and write……1 Can read and write ……2 Primary school ……...3 Secondary school ……...4 College and above ……..5	
109	What is your occupational status? **(*please state main source of income*)**	Unemployed ……...1 Daily laborer. ….. ……...2 Merchant...……...3 Civil servant...…...……...4 Self-employed...……....5 Other (specify) _____	
110	What is your marital status?	Single.…….…1 Divorced/separated.....……2 Widowed…….……3 Married/living together.……4	Circle and Skip to Q212
111	Family monthly income in birr		
112	Known hypertensive patient	1. Yes 2. No	
113	Known diabetic patient	1. yes	

		2. no	
114	Took IFA during pregnancy	1. yes 2. no	
115	Took IFA before pregnancy	1. yes 2. no	

Food frequency questionnaire

Dear respondent please take few moment to memorize the foods and drinks you ate in the year before you were pregnant and you will tell me if you consume the food type or not.

No.	**Food types** **N.B–*the respondents must be asked if they ate each food type listed***	**Did you eat ------in the year before you were pregnant**
Cereals		
1	Teff keyinjera	1.Yes 2. No
2	Teff nechinjera	1.Yes 2. No
3	Enjerafirfir	1.Yes 2. No
4	Gebs dabo	1.Yes 2. No
5	Ammbasha	1.Yes 2. No
6	Sindedabo	1.Yes 2. No
7	Yeajaatmit	1.Yes 2. No
8	Pasta	1.Yes 2. No
9	Macarooni	1.Yes 2. No
10	Rice	1.Yes 2. No
11	Chechebsa	1.Yes 2. No
12	Gebis genfo	1.Yes 2. No
13	Chiku	1.Yes 2. No
14	Yegebskolo	1.Yes 2. No
15	Yeajakinche	1.Yes 2. No
Roots		
16	Yedinichtibs	1.Yes 2. No

17	yedinichkikil	1.Yes 2. No
18	yedinichwot	1.Yes 2. No
19	Carrott	1.Yes 2. No
20	Keyser	1.Yes 2. No
21	Kochow	1.Yes 2. No
Vegetables		
22	Tiklil gomen	1.Yes 2. No
23	Ttikur yehabesha gomen	1.Yes 2. No
24	Sellata	1.Yes 2. No
25	Kusta	1.Yes 2. No
26	Timatim kurt tere	1.Yes 2. No
27	Timatim sils yebesele	1.Yes 2. No
28	Fossoliya	1.Yes 2. No
29	Duba	1.Yes 2. No
30	Karia	1.Yes 2. No
Legumes		
31	Mitin Shirowot	1.Yes 2. No
32	BakelaAshuke	1.Yes 2. No
33	Aterkek wot	1.Yes 2. No
34	Misirkek wot	1.Yes 2. No
Fruits		
35	Avocado	1.Yes 2. No
36	Banana	1.Yes 2. No
37	Mango	1.Yes 2. No
38	Orange	1.Yes 2. No
39	Pineapple	1.Yes 2. No

40	Papaya	1.Yes 2. No
41	Lemon	1.Yes 2. No
Meat		
41	Ketfo	1.Yes 2. No
43	Sega wet	1.Yes 2. No
44	Yebere tebs	1.Yes 2. No
45	Tere sega	1.Yes 2. No
46	Yebeg tebs	1.Yes 2. No
47	Ye feyel tebs	1.Yes 2. No
48	Tuna	1.Yes 2. No
49	Yetetebese asa	1.Yes 2. No
Dairy, fats and egg		
50	Yelam wotet	1.Yes 2. No
51	Ergo	1.Yes 2. No
52	Ayeb	1.Yes 2. No
53	Yetekekele enkilal	1.Yes 2. No
54	Yetetebese enkilal	1.Yes 2. No
55	Kibe	1.Yes 2. No
Sweets		
56	Mar	1.Yes 2. No
57	Sekuar	1.Yes 2. No
58	Marmalata	1.Yes 2. No
Beverage and Fast foods		
59	Mirinda	1.Yes 2. No
60	Cocacola	1.Yes 2. No
61	Sprite	1.Yes 2. No
62	Shay	1.Yes 2. No

63	Bunna	1.Yes 2. No
64	Machiato	1.Yes 2. No
65	Bira	1.Yes 2. No
66	Tella	1.Yes 2. No
67	Tej	1.Yes 2. No
68	Weyn	1.Yes 2. No
69	Pizza	1.Yes 2. No
70	Burger	1.Yes 2. No

Annex 3. Amharic Information sheet and Informed-consent

□ት□□ቂ□ /መላሾች □መረ□ ቅን

እን□ምን አ□ሩ/□ሉ፡- ስሜ- ---------- □ባላል፡፡ እ□ህ የመጣሁት የአ□ስ አበባ ዩንቨርስቲ□ኬና ሳ□ንስ ሁለተኛ □ፅሪ ተማሪ□ሆነችን አፍራህ መሃመድሳኒን □□ቱ ነ□፡ የሁለተኛ □ፅሪ የመመረቂያ ጽሁፏን በአ□ስ አበባ ከተማበሚ□ኙ □መንፅስት ሆስፒታሎች ላ□ የህጻናት የነርቭ ቱቦ ጉድለትና □እናቶችአመ□□በ ሁኔታን ፅንኙነት በሚመለከት ለማዓናት ከአ□ስ አበባ ዩኒቨርሲቲእናከሆስፒታሎች □ቃት አግኝታ በመስፈት ላይ ትገኛለች ፡፡

እርስ- □ተመረጡት በ□ህ ሆስፒታል የእርግዝና ክትትል በማትረፅ- ነ□፡፡ □□ህ ዓናት አላማም የአመጋገብ ሁኔታንና የህጻናት የነርቭ ቱቦ ጉድለት ፅንኙነት ለማወቅ ነ□፡፡ □ህም ጥናት የትኛ□ አ□ነት አመ□□በ ለህጻናት የነርቭ ቱቦ ጉድለት አን□ሚ□□ልዓ ለማ□ቅና ለወደፊትም ቅትመ ዓንቃቂ ለማትረፅ □ረ□ናል፡፡ ከ□ህም በተፊ ማሪ ለሌሎች በተመሳሳ□ ነ□ር ላይ ጥናት ማድረግ ለሚፈልጉ አጥኒዎች መረጃ ለመስጠት ያገለግላል፡፡

□እርስ- ተሳትፎ ሙሉበሙለ በእርስ- ፈቃደኝነት ላይ የተመሰረተነው፡፡ በዓናቱ መሳተአና ያለመሳተፍ መብት አለዎት፡፡ ለመሳተፍ□ቃ□ኛ ከሆኑ በኋላ በሚፈልጉት□□ ማቋረዓ □□ም ማቆም ይችላሉ፡፡ በጥናቱ ባለመሳተፍ- □ሚ□ርስብዎት ምንም አ□ነትችፅር አ□ኖርም፡፡ በዓናቱ ለመሳተፍ ከተስማሙ ስለ አመጋገብ- ስከ 35 □ቂቃ ሊ□ሰት □ሚችሉ□ዙ□ሰኑ ዓ□ቄ- ችን እን□□ቆታን፡፡

ለማንኛውም አይነት ጥያቄ ዋና አጥኝውን እና የሥነ ምግባር ኮሚቴ ሃላፊውንሚከተሉት አድራሻ ማነ□□ር □ችላሉ፡፡

ዋናአጥኝወ □ምባ□ል ቁዓር፥ 0944 25 77 32

የሥነ ምግባር ኮሚቴሃላፊው □ምባ□ል ቁር፥ 09

የስምምነት መጠየቂያ/ማረጋገጫ ቅፅ

ከላይ በሠጠዎት መረጃ መሰረትበ□ህ ዓ ናት ላይ ለመሳተአ □ቃ□ኛ ነዎት?

የተሰጠውን መረጃ ተረድቼ በጥናቱ ለመሳተፍተስማምቻለሁ።

1. **አዎ** ☐ **2. አይደለሁም** ☐

2. ኝርማ ---------- ቀን----------

የመ□ደቅቁዓ ር	
መ□ደቅ □ተካሂድትቀን	
□የስ□ሉ ስም	
የተጀመረበት ሰዓት	
የተጠናቀቀበት ሰዓት	

□□ቂ ስም ---------- ኝርማ ----------

ቀን----------

ተቆ□□ሪስም ---------- ኝርማ ----------

ቀን----------

የቃለመጥይቅ ውጤት

1. **ሙሉ በሙሉ □ተሞላ** ☐
2. **በከፊል የተሞላ** ☐
3. **ምንም ያልተሞላ** ☐

Annex 4. Amharic questionnaire

ክፍል 1-ማህበረሰባዊ ጥያቄዎች

ከዚህ በመቀጠል ስለራስዎና ቤተሰብዎ ባህሪዎች አስመልክቶ የተወሰኑጥያቄዎችን እጠይቀወታለሁ::

መረጃ ሰብሳቢ _____		ቀን፥_____	
1. መረጃዎች			
ተ.ቁ	**ጥያቄዎች**	**ምርጫዎች**	**እለፍ**
101	**ክፍለ ከተማ**	_____	
2. ተሳተፊን የተመለከቱ መረጃዎች			
202	**ካርድ ቁጥር**	_____	
204	Status	3. Case 4. Control →	If control skip to
205	If case, What is the type?	5. Anecephale 6. Encephalocele 7. Spinal Bifida 8. Other Specify _____	
206	**ዕድሜዎት**	_____**ዓመት**	
207	**ሐይማኖትዎት**	**ኦርቶዶክስ**_____1 **ሙስሊም**_____2 **ፕሮቴስታንት**_____3 **ካቶሊክ** _____4 **ሌላ(ይግለፁ)**_____	
208	**ብሔርዎት**	**አማራ**_____1 **ትግሬ**_____2 **ኦሮሞ**_____3 **ጉራጌ**_____4 **ስልጤ**_____5 **ሌላ(ይግለፁ)**_____	
209	**የትምህርት ደረጃዎት**	**ማንበብና መፃፍ የማይችሉ**_____1 **ማንበብና መፃፍ የሚችሉ**_____2 **የመጀመሪያ ደረጃ** _____3 **ሁለተኛ ደረጃ**_____4 **ኮሌጅ /ዩኒቨርሲቲ**_____5	
210	**ስራዎት**	**ስራ የሌላት** _____1 **የቀን ሰራተኛ** _____2 **ነጋዴ** _____3 **ተቀጥራ የምትሰራ** _____4 **የግል ስራ** _____5 **ሌላ (ይግለፁ)**_____	
211	**የጋብቻ ሁኔታዎት**	**ያላገቡ** _____1 **የተፋቱ/የተለያዩ**_____2 **ባለቤታቸው የሞቱባቸው**_____3 **ያገቡ /አብረው የሚኖሩ** _____4	**ወደ 212 ይለፉ**
212	**የቤተሰብ ወርሃዊ ገቢዎ**	_____**ብር**	

3. አሁን ስለ በፊት እርግዝናዎ እጠይቅዎታለሁ

ተ.ቁ	ጥያቄዎች	ምርጫዎች	እለፍ
301	ያሁኑን እርግዝና ሳይጨምር እስካሁን ስንት ጊዜ አርግዘዋል?	_____ ጊዜ መልሱ "ምንም/ 0" ከሆነ ወደ 501 እለፍ	
316	የደም ግፊት አለብዎት ተብለው ያውቃሉ?	አዎ _____1 አይ _____2	
317	በባለፈው እርግዝናዎ የነርቭ ቱቦ ጉድለት አጋጥሞዎት ነበር?	አዎ _____1 አይ _____2	
318	ምን አይነት የነርቭ ቱቦ ጉድለት ነበር?	_____	
319	መልስዎ አዎ ከሆነ ስንት ጊዜ?	_____ጊዜ	
	4. አሁን ደግሞ ስለ አሁኑ እርግዝናዎ እጠይቅዎታለሁ፡፡		
401	የአሁን እርግዝናዎ ስንት ሣምንቱ ነው?	_____ ሣምንት	
402	በአሁን እርግዝናዎ ወቅት የአይረን ፍሌት/ የብረት ክኒኖችን ወስደዋል?	አዎ _____1 አይ _____2 →	ወደ እለፍ
403	ከእርግዝናዎ በፊት የአይረን ፍሌት/ የብረት ክኒኖችን ወስደዋል?	አዎ _____1 አይ _____2 →	ወደ እለፍ
404	የስኳር በሽታ አለብዎት ተብለው ያውቃሉ?	አዎ _____1 አይ _____2	
405	ከቤተሰብዎ በነርቭ ቱቦ ጉድለት የተጠቃ ሰው አለ?	አዎ _____1 አይ _____2 →	ወደ 501 እለፍ
406	መልስዎ አዎ ከሆነ ማን? ***የቤተሰቡን አባል ይግለፁ***	_____	
407	ምን አይነት የነርቭ ቱቦ ጉድለት ነበር?	_____	

ክፍል 5 - የዘወትር የአመጋገብ ሁኔታና የምግብ መጠንን የሚያሣይ መጠይቅ

ከዚህ በመቀጠል በሚገኘው የምግብ ዝርዝር የያዘው ሠንጠረዥ ውስጥ እርጉዝ ከመሆንዎ በፊት ባለው 1 አመት ውስጥ የተመገቡትን የምግብ አይነት ለትንሽ ደቂቃ አስበው ይገልፁልኛል፡፡

ተ.ቁ	የምግብ አይነቶች *ከዚህ በታች የተዘረዘሩትን ምግቦች እርጉዝ ከመሆናቸው በፊት ባለው 1 አመት ውስጥ መመገባቸውን ይጠይቁ*	እርጉዝ ከመሆንዎ በፊት ባለው 1 አመት ውስጥ ተመግበው ያውቃሉ? 1.አዎ 2.አልተመገብኩም
የእህል ዘሮች		
1	ቀይ ጤፍ እንጀራ	1.አዎ 2.አልተመገብኩም
2	ነጭ ጤፍ እንጀራ	1.አዎ 2.አልተመገብኩም
3	እንጀራ ፍርፍር	1.አዎ 2.አልተመገብኩም
4	የአጃ ቅንጬ	1.አዎ 2.አልተመገብኩም
5	አምባሻ	1.አዎ 2.አልተመገብኩም
6	ነጭ የስንዴ ዳቦ	1.አዎ 2.አልተመገብኩም
7	የአጃአጥሚት	1.አዎ 2.አልተመገብኩም
8	ፓስታ	1.አዎ 2.አልተመገብኩም
9	ማካሮኒ	1.አዎ 2.አልተመገብኩም
10	ሩዝ	1.አዎ 2.አልተመገብኩም
11	ጨጨብሳ	1.አዎ 2.አልተመገብኩም
12	ነጭ ገብስ ገንፎ	1.አዎ 2.አልተመገብኩም
13	ጭኮ	1.አዎ 2.አልተመገብኩም
14	የገብስ ቆሎ	1.አዎ 2.አልተመገብኩም
15	የገብስ ዳቦ	1.አዎ 2.አልተመገብኩም
16	ብስኩት	1.አዎ 2.አልተመገብኩም
ተ.ቁ	**የምግብ አይነቶች**	**እርጉዝ ከመሆንዎ በፊት ባለው 1 አመት ውስጥ ተመግበው ያውቃሉ?**

	ከዚህ በታች የተዘረዘሩትን ምግቦች እርጉዝ ከመሆናቸው በፊት ባለው 1 አመት ውስጥ መመገባቸውን ይጠይቁ	**1.አዎ** **2.አልተመገብኩም**
ስራስር ምግቦች		
17	የተጠበሰ ድንች	1.አዎ 2.አልተመገብኩም
18	የተቀቀለ ድንች	1.አዎ 2.አልተመገብኩም
19	ድንች ወጥ	1.አዎ 2.አልተመገብኩም
20	ካሮት	1.አዎ 2.አልተመገብኩም
21	ቀይስር	1.አዎ 2.አልተመገብኩም
22	ቆጮ	1.አዎ 2.አልተመገብኩም
ቅጠላ ቅጠሎች		
23	ጥቅል ጐመን	1.አዎ 2.አልተመገብኩም
24	ጥቁር ጐመን	1.አዎ 2.አልተመገብኩም
25	ሰላጣ	1.አዎ 2.አልተመገብኩም
26	ቆስጣ	1.አዎ 2.አልተመገብኩም
27	ቲማቲም ቁርጥ	1.አዎ 2.አልተመገብኩም
28	ቲማቲም ስልስ	1.አዎ 2.አልተመገብኩም
29	ዱባ	1.አዎ 2.አልተመገብኩም
30	ፎሶሊያ	1.አዎ 2.አልተመገብኩም
31	ቃሪያ	1.አዎ 2.አልተመገብኩም
ጥራጥሬዎች		
32	ሽሮ ወጥ	1.አዎ 2.አልተመገብኩም
33	ባቄላ አሹቅ	1.አዎ 2.አልተመገብኩም
34	አተር ክክ ወጥ	1.አዎ 2.አልተመገብኩም
35	ምስር ክክ ወጥ	1.አዎ 2.አልተመገብኩም

	የምግብ አይነቶች ***ከዚህ በታች የተዘረዘሩትን ምግቦች እርጉዝ ከመሆናቸው በፊት ባለው 1 አመት ውስጥ መመገባቸውን ይጠይቁ***	**እርጉዝ ከመሆንዎ በፊት ባለው 1 አመት ውስጥ ተመግበው ያውቃሉ?**
ፍራፍሬዎች		
37	አቮካዶ	1.**አዎ** 2.**አልተመገብኩም**
38	ሙዝ	1.**አዎ** 2.**አልተመገብኩም**
39	ማንጎ	1.**አዎ** 2.**አልተመገብኩም**
40	ብርትኳን	1.**አዎ** 2.**አልተመገብኩም**
41	አናናስ	1.**አዎ** 2.**አልተመገብኩም**
42	ሎሚ	1.**አዎ** 2.**አልተመገብኩም**
43	ፓፓያ	1.**አዎ** 2.**አልተመገብኩም**
ስጋ እና አሳ		
44	ክትፎ	1.**አዎ** 2.**አልተመገብኩም**
45	ስጋ ወጥ	1.**አዎ** 2.**አልተመገብኩም**
46	የበሬ ስጋ ጥብስ	1.**አዎ** 2.**አልተመገብኩም**
47	የበሬ ቁርጥ	1.**አዎ** 2.**አልተመገብኩም**
48	የበግ ጥብስ	1.**አዎ** 2.**አልተመገብኩም**
49	የፍየል ጥብስ	1.**አዎ** 2.**አልተመገብኩም**
50	ቱና	1.**አዎ** 2.**አልተመገብኩም**
51	የአሳ ጥብስ	1.**አዎ** 2.**አልተመገብኩም**
የወተት ተዋጽኦዎች		
51	የላም ወተት	1.**አዎ** 2.**አልተመገብኩም**
52	እርጎ	1.**አዎ** 2.**አልተመገብኩም**
53	አይብ	1.**አዎ** 2.**አልተመገብኩም**
54	የተቀቀለ እንቁላል	1.**አዎ** 2.**አልተመገብኩም**

55	የተጠበሰ እንቁላል	1.አዎ 2.አልተመገብኩም
ተ.ቁ	**የምግብ አይነቶች** ***ከዚህ በታች የተዘረዘሩትን ምግቦች እርጉዝ ከመሆናቸው በፊት ባለው 1 አመት ውስጥ መመገባቸውን ይጠይቁ***	**እርጉዝ ከመሆንዎ በፊት ባለው 1 አመት ውስጥ ተመግበው ያውቃሉ?**
ጣፋጭ ምግቦች		
56	ማር	1.አዎ 2.አልተመገብኩም
57	ስኳር	1.አዎ 2.አልተመገብኩም
58	ማርማላት	1.አዎ 2.አልተመገብኩም
መጠጦችና ፈጣን ምግቦች		
59	ሚሪንዳ	1.አዎ 2.አልተመገብኩም
60	ኮካ ኮላ	1.አዎ 2.አልተመገብኩም
61	ስፕራይት	1.አዎ 2.አልተመገብኩም
62	ሻይ	1.አዎ 2.አልተመገብኩም
63	ቡና	1.አዎ 2.አልተመገብኩም
64	ማኪያቶ	1.አዎ 2.አልተመገብኩም
65	ቢራ	1.አዎ 2.አልተመገብኩም
66	ጠላ	1.አዎ 2.አልተመገብኩም
67	ጠጅ	1.አዎ 2.አልተመገብኩም
68	ወይን	1.አዎ 2.አልተመገብኩም
69	ፒዛ	1.አዎ 2.አልተመገብኩም
70	በርገር	1.አዎ 2.አልተመገብኩም