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Dietary Risk Factors of Preeclampsia among Women Attending Antenatal and Delivery Services in Governmental Hospitals of West Gojjam Zone, North West Ethiopia

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Abstract

Introduction: Preeclampsia is a major cause of fetal and maternal morbidity and mortality worldwide and affects 2–8% of all pregnancies. Dietary factors can be decisive in the progress of mechanisms for the development of preeclampsia. The issue has become controversial in light of recent reports.

Objective: This study aimed to assess dietary risk factors of preeclampsia among pregnant mothers attending antenatal care and delivery services in governmental hospitals of West Gojjam Zone, North West Ethiopia; by 2021.

Methods: An institutionally unmatched case-control study was carried out among 262(88 cases and 174 controls) between September and October 2021. A systematic random sampling technique was used, and data were entered into Epidata version 4.6 and exported to SPSS version 23 software for analysis. Variables with a p-value of less than 0.2 in bivariate logistic regression were entered into a multivariate logistic regression and a statistically significant association was declared at a 95% confidence interval p-value less than 0.05 in a multivariate logistic regression model.

Result: High consumption of fat related foods [AOR:3.7, 95%CI:(1.67,8.23)], anemia (AOR:3.3,95%CI: [1.62,6.78)], and didn't receiving nutritional counseling [AOR:2.18,95% (1.11,4.23)] were found to be risk factor for development of preeclampsia. On the other hand, frequent consumption of milk products (AOR:0.39, 95% CI 0.15,0.95), and fruits and vegetables rich in vitamin A [AOR: 0.12, 95% CI: (0.04,0.35)] were found to be preventive factors for preeclampsia.

Conclusion and recommendations: Diets that are characterized by a high intake of vitamin A-rich fruits and vegetables, milk products, and receiving nutritional counseling were significantly associated with a low risk of preeclampsia. On the other hand, high intake of fatty foods, anemia and obesity were associated with the development of preeclampsia. Therefore, encouraging and promoting healthy eating habits and dietary patterns during pregnancy, including vitamin A-rich fruits and vegetables and milk products, can effectively prevent the incidence of preeclampsia.

ACRONYMS

ANC: antenatal care BDU: Dar Dar University DHS: FFQ: food frequency questionnaires DBP: diastolic blood pressure DM: diabetes mellitus, PE: preeclampsia HDP: preterm hypertension Disorder PIH: preterm hypertension caused by pregnancy

INTRODUCTION

Preeclampsia is a pregnancy-related condition that manifests as hypertension, proteinuria, and edema, with or without multiple organ damage, after 20 weeks of gestation [1]. It is a major cause of fetal and maternal morbidity and mortality worldwide and affects 2–8% of all pregnancies [2,3]. Around 76 000 women and 500 000 babies die each year from preeclampsia and especially women in low-income countries are at a higher risk of developing preeclampsia (PE) compared with those in high-resource countries [4]. The estimation of WHO remarked that the incidence of preeclampsia is to be seven times higher

in low-income countries (2.8% of live births) than in high-income countries (0.4% of live births [5]. Furthermore, evidence has shown that preeclampsia alone is estimated to account for approximately 40% to 60% of maternal deaths in low-income countries [6].

In Ethiopia also, previous studies revealed that preeclampsia has shown an increasing trend with an estimated prevalence of 8.4% and ranks third among the top four causes of maternal mortality in the country [7]. Preeclampsia account for 19% of maternal deaths in Ethiopia. According to Ethiopian National Emergency Obstetric and Newborn Care (EMONC) evidence, 16% of direct maternal mortality and 10% of all maternal mortality (direct and indirect) was due to pre-eclampsia [8].

Today, the use of nutritional patterns and specifying their relationship with diseases is a relatively new topic in the field of epidemiology of nutrition. Nutritional habits can be considered as an important risk factor in the development of preeclampsia [9,11]. It is obvious that pregnant women need adequate and healthy nutrition not only for the health of pregnant women, but also for the health of the child [12,13]. There is much evidence supporting the link between poor dietary intake and adverse pregnancy outcomes including cardiovascular diseases [12]. Some studies have shown that excess energy intake (high carb and high fat diet) intake or insufficient nutrient intake may be associated with the increased risk of pre-eclampsia [14-16]. Studies estimated that nutritional status and diet pattern contributed nearly 66% to the development of preeclampsia, while other studies showed that the risk of preeclampsia can be reduced by nearly 53% by reducing the consumption of unhealthy diets [13,17-19]

Studies were done on the dietary factors associated with preeclampsia but these studies were done in high-income countries and these findings yielded diverse and often inconsistent results [13,20].

Maternal nutritional status during pregnancy has been investigated as a potential treatment target in the prevention of preeclampsia. Poor dietary quality in mid-pregnancy, including high energy intake has been implicated in increased risk for preeclampsia [21].

Micronutrients have been investigated to reduce the risk of developing preeclampsia. Micronutrients have clinical antioxidant and anti-inflammatory properties and are part of normal placentation [22].

The WHO recommended food fortification of staple foods with calcium and nutritional counseling for all women considering pregnancy and promote adequate calcium intake through locally available, calcium-rich foods [23]. Taking into account the seriousness of the issue, Ethiopia has identified preeclampsia as one of the contributions to maternal death, and the government has been working on improving the quality of maternal health services and developing different intervention strategies [22-29]. Regardless of progress made, maternal mortality related to preeclampsia remains on the increase, unlike abortion and other direct obstetric causes of maternal mortality [30].

Regarding the inconsistent and inconclusive results about the effect of dietary patterns during pregnancy on the incidence of preeclampsia and its relationship with nutritional factors, suggesting a need to look at overall dietary patterns. Therefore, it needs a study that can fill such gaps in association of diet with preeclampsia. To fill these gaps, this study was conducted using probability sampling methods to select both cases and controls with incorporating wide range of dietary patterns and also by assessing nutritional status of mothers. Therefore, the main objective of this study was to evaluate the association between dietary patterns during pregnancy and preeclampsia, the study was tried to find preeclampsia dietary risk factors in government hospitals in the west Gojjam zone, northwest Ethiopia, which will be used to implement informative interventional programs to reduce risk factors and develop practical solutions to improve dietary habits among women at risk of preeclampsia.

METHODS AND MATERIALS

Study area and periods

This study was conducted in the West Gojjam zone, Amhara region from September -October, 2021. Its central town is Finoteselam, and it is located 176 kilometers from Bahir Dar. It is bounded on the south by the Abay River, which separates it from the Oromia and Benishangul-Gumuz regions, on the west by the Awi Zone, on the northwest by North Gondar, on the north by Lak Tana and the Abay River, which separates it from South Gondar, and on the east-by-East Gojjam [31]. The altitude and longitude coordinates for this zone are 10.9738°N 37.4681°E, with a height of 3535 meters above sea level. It has a surface area of 13,912 square kilometers and an elevation range of 1000 to 3535 meters above sea level [32].

There are 16 woredas and 5 municipal administrations in this zone According to the statistics abstract for the West Gojjam Zone (2018), the total population is 2,758,806 people (male 49.5 percent and women 50.5). The population of the west Gojjam zone is served by seven hospitals, 107 health centers, and 404 health posts. According to the Amhara region population projection formula, there are 89,484 pregnant women in the west Gojjam zone in 2021 who will receive service from seven hospitals. The hospitals included Adet primary hospital, Merawi primary hospital, Durbetie primary hospital, Burie primary hospital, Finoteselam primary hospital, Liben primary hospital and Feresebet primary hospital.

Teff, barley, wheat maize, and sorghum are the most widely available cereal crops, according to data from the 2020 CSA agricultural sample survey (2012C). Beans, peas, lentils, fenugreek, and lupine are the most regularly grown pulses. Lettuce, cabbage, tomatoes, peppers, carrots, onions, potatoes, and garlic are among the most widely grown vegetables and root crops, according to the CSA statistics. Fruits grown in the west Gojjam zone include avocado, banana, lemon, mangos, oranges, papayas, and pineapples [33].

Study design

A facility-based unmatched case-control study was conducted on mothers, attending antenatal care and delivery services in West Gojjam zone governmental hospitals, North West Ethiopia.

Case definition

The cases were mothers with a new onset of elevated diastolic

blood pressure of 90mmHg and/or systolic blood pressure of 140 mmHg in two consecutive records of four to six hours apart or highly elevated blood pressure (diastolic blood pressure <110 mmHg and / or systolic blood pressure ≥160mmHg) of a single occurrence, plus protein in urine estimated to be 300 mg per day or urine dipstick record of>1+ after 20 weeks of gestation [34].

Control definition

Controls were mothers who did not diagnose preeclampsia or mothers whose blood pressure is < 140/90 mmHg and proteinuria < 300mg/24 hours or < 1+ in the urine dipstick test after delivery during the study period in the same hospitals.

Source of population

The source population for cases: The source of the population for the cases were all mothers who have preeclampsia and who receive ANC and delivery services in government hospitals in the west Gojjam zone of northwest Ethiopia in 2021.

The source population for controls: The source of the control population were all mothers who do not have preeclampsia and who receive antenatal care and delivery services at governmental hospitals in the West Gojjam area in northwest Ethiopia 2021.

Study population

The study population for cases: Pregnant women with preeclampsia who attend antenatal care or delivery service during the study period,

The study population for controls: Mothers who do not have preeclampsia and who receive antenatal care and a skilled delivery service during the study period.

Eligibility criteria

Inclusion criteria:

Inclusion criteria for cases: Mothers who attended the ANC or delivery service and had blood pressure <140 / 90 mmHg and proteinuria <300mg / 24 hours or <1 + urine dipstick test after 20 weeks of gestation were included in the study.

Inclusion criteria for controls: Mothers who received the delivery service during the study period and had a blood pressure of < 140/90mmHg and proteinuria < 300 mg /24 hours or <1+ in the urine dipstick test within 24 hours after delivery were included in the study.

EXCLUSION CRITERIA

Exclusion criteria for cases: Pregnant women who have preeclampsia with known chronic hypertension and mentally ill were excluded.

Exclusion criteria for controls: Women who cannot answer questions due to mental and severe illness were excluded from the study, as it can be difficult to obtain information on their nutritional history.

Definitions of terms and operational definitions

Household wealth index: A proxy measure of living standards derived from information on ownership available assets and household characteristics was created and the household classified into five categories and the wealth score was created to categorize households as the poorest, poor, medium, rich, and richest [35].

Consumer of specific food items; Consumers of a food item were defined as when respondents consume a specific food item at least once a week [36,37].

Anemia: Maternal anemia was defined when hematocrit was less than 33 %(hgb<11g/dl) and was classified as moderate HCT level 21-33%(hgb 7-11g/dl) or severe hematocrit level< 21% or hemoglobin less than 11g/dl [38,39].

Coffee Consumption: Mothers were asked to respond to a closed question on whether they drink coffee or not. If mothers answered less than 5 cup of coffee per day was considered as moderately coffee consumption. If mothers answered >=5 cup of coffee per day was considered as excessive coffee consumption [40,41].

Khat chewing assessment: Mothers were asked to respond to close-ended questions on khat chewing. When the mother chewing chat at least once a week she was classified as habitual user while the mother chewing khat less than once in a week is classified as occasional khat user [42].

Alcohol consumption: Consumption of at least one unit (one unit is 1 shot (25 ml) of spirits (areqe, gin), or 1 small glass (125 ml) of wine/tej or 1 can / bottle (330 ml) of beer/tela) of alcohol from any source. If a woman reported as consuming at least one unit of alcohol from any sources (Tella, Teje, Areqe, Beer and Wine) during the current pregnancy, she was labeled as alcohol consumer. If she consumed five or more alcohol drinks in one session (one sit) during the current pregnancy, she was labeled a binge alcohol consumer [43].

Nutrition counseling: If a pregnant woman was advised or assisted in having the appropriate nutritional intake by integrating information from the nutrition assessment with information on the consumption of healthy food choices and the frequency of feeding during pregnancy by a health professional, the mother was considered to receive nutritional counseling [44].

SAMPLE SIZE DETERMINATION AND SAMPLING PROCEDURE

The sample size was determined by using epi-Info version 7.2 to compute the estimated sample size using double population proportion formula by assuming coffee consumption as a factor with lowest odds ratio of 2.14 and the proportion of exposed group in controls was (38.8%) from previously published research study [11]. In addition, 95% confidence interval, 5% marginal error and 80% power were considered. The calculated sample size was 249 and after adding 5% for possible non-responses, the final sample size was estimated as 262(88 cases and 174 controls). To obtain an adequate sample size, the study included all seven governmental hospitals in the West Gojjam Zone. The calculated sample size (both for cases and for controls) was distributed proportionally to each institution's antenatal and delivery caseload (data obtained from the 9-month report

of the West Gojjam zone Health Department of 2013 EFY). Cases and controls were chosen using a systematic random sampling procedure from the ANC service and delivery service by using the delivery and ANC register. The selection of cases was carried out after the physician (general practitioner (GP) or gynecologist) had the diagnosis preeclampsia. The first samples for the cases and controls were selected by lottery method from their order of registration.

DATA COLLECTION

Types and sources of data

The data were collected from primary and secondary data sources through record review, measurement and a face-to-face interview of mothers using a pretested questionnaire that contains sociodemographic and economic, dietary habit, lifestyle and health related and obstetrics questions. The measurement was included MUAC of the women and the recent record of hematocrit was taken from mother's medical record chart. They were interviewed about their sociodemographic and economical characteristics, medical history, obstetric factors, dietary practice, and behavioral factors by trained 8 midwives (data collectors) and 2 health officers (supervisors). A questionnaire was prepared by reviewing different works of literature, including WHO, DHS, FFQ, NHANES, and other documents related to preeclampsia and the dietary practice of pregnant women [45-48].

Data collection tools and procedures

The questionnaires used for data collection were adapted from different previous works of literature; then were modified into our context. To verify its consistency, the questionnaires were first translated from English to Amharic and then translated back into English.

Measurements

Using a mercury sphygmomanometer and covering the upper two thirds of the arm, blood pressure was measured in accordance with recommendations made by the American Heart Association. The women were sitting in an upright position at the prenatal clinic and PNC unit when the blood pressure readings were taken. A rate of 2-3 mmHg per second was used to inflate the cuff throughout the process. The first Korotkoff sound was marked as the systolic blood pressure (SBP), and the fourth Korotkoff sound was recorded as the diastolic blood pressure (DBP) [91]. Maternity charts were used to retrieve information on proteinuria, hematocrit, and other pertinent data. For mothers who had more than one records of HCT and other pertinent studies, the most recent recorded data was taken. Data collectors measured the participant's MUAC to the nearest 1 mm by wrapping a non-stretchable MUAC tape around the participant's left arm bent at the midpoint between the olecranon and the acromion.

Evaluation of dietary data

The FFQs that made up different food types were divided into different food groups, including grains, white roots and tubers and plantains, pulses (beans, peas and lentils), nuts and seeds, dairy, meat, poultry and fish, eggs, dark green leafy vegetables, vitamin A rich fruits and vegetables, other vegetables, other fruits, sweets and beverages, and fast foods. Each food group contained different numbers of food items. Cases and controls were asked to recall their usual intake frequency for the last month. The frequency of food intake was assessed monthly, weekly, and daily. Items of food were listed in this FFQ and were divided into similar food groups. The respondents had to answer only once for the frequency of intake of these foods. The food intake pattern was then estimated using the method adapted and modified from Nicolas et al 2013[49,50]. The values used for each frequency option were the following: Never = 0; one time a month=1/30; two to three times a month = 2.5/30; one times a week = 1/7; two to four times a week = 3/7; five to six times a week = 5.5/7; one time a day = 1; 2 times a day =2 and. 3 times or more a day =3.5'. Consumers of a food item were defined as when the respondents consumed a specific food item at least once a week [36,37]. The number of food items that the women ate at least once a week was counted to analyze logistic regression for each food group. The food-intake scores for each food group were divided into three parts (tirtiles): mostly consumed foods; moderately consumed foods and rarely consumed foods.

Data Management and Analysis

The data was entered using the epi-data manager, checked manually for accuracy and cleanliness, and then exported, cleaned, and analyzed using the statistical package for social science (SPSS) version 23. Data correctness and missing values were systematically examined for each variable. The primary findings were presented using graphs, tables, charts, and other visual aids. In bivariate regression analysis, relevant factors were measured using the crude odds ratio (COR) with 95% confidence intervals, and variables that had a p value of less than 0.2 were taken into consideration when building the final multivariate regression analysis model. Using Hosmer-Lemeshow goodness-of-fit test results, the model's predictive power was determined to be 0.766. As a result, the Hosmer and Lemeshow chi-square p-value was higher than 0.05, indicating that the model was fit. Texts and tables were used to present the overall findings. To determine the strength of the link between the outcome and explanatory factors, adjusted odds ratios (AOR) and the related 95% confidence intervals were computed in multivariable regression analysis. Finally, independent variables were considered to be statistically significant potential risk factors if their p-value was less than 0.05. Texts and tables were used to present the overall findings. To determine the strength of the link between the outcome and explanatory factors, adjusted odds ratios (AOR) and the corresponding 95% confidence intervals were computed in multivariable regression analysis. Finally, independent variables were deemed to be statistically significant potential risk factors if their p-value was less than 0.05.

Wealth index data analysis

In order to provide a common factor score for each household, the wealth index was built utilizing several factors for urban and rural respondents connected to ownership of a chosen household, including ownership of a latrine, water supply, household assets, livestock, and agricultural land. Due to the obvious differences in the study population's living conditions between urban and rural locations, distinct wealth indices for rural and urban households were created.

A wealth index was created using principal component analysis and data from households. A weight or factor score produced by principal component analysis was given to each household asset for which data was gathered. The obtained asset scores were normalized using a normal distribution with a mean of zero and a standard deviation of one. For both urban and rural areas, the Kesie-Myer Oklin test (KMO test) result was greater than 0.5, and it was used to assess the applicability of factor analysis and sampling adequacy. In order to create factor scores, PCA analysis was performed on variables with commonality values more than 0.5 in the communality output and greater than 0.5 in the anti-image output.

Frequency analysis was used to eliminate variables and assets from the analysis that were owned by more than 95% of the sample or less than 5% of the sample. When a variable had many alternatives, it was recoded into a meaningful variable with a separate scoring system in accordance with its value. Variables were initially binary, with scores of 1 for having them and 0 for not having them. Assigning the household score, ranking, and dividing into 5 equal parts produced the first component wealth quintiles (from lower to higher). To categorize households into the lowest, poorest, medium, rich, and richest groups, quintiles of the wealth score were developed.

Data Quality Control

The principal investigator prepared training on data collection techniques and was initially given to data collectors, prior to actual data collection. A pretest was conducted at the Dangila Primary Hospital to verify the functionality and reliability of the data collection tools and the performance of the data collectors. Some modifications were made to the clarity of the questions and the layout of the questionnaire. At the end of each data collection day, the data consistency, completeness, and cleanliness were done with the close supervision of the principal investigator.

Ethical Considerations

This study was conducted in accordance to the relevant guidelines and regulations or in accordance to the Declaration of Helsinki. Ethical clearance was obtained from the ethical review board of BDU, college of medicine and health science. Then officials at different levels in the study area were communicated through letters from BDU, college of medicine and health science. Letters of permission was presented to the West Gojjam zone health department and another official support letter was obtained from west Gojjam zone health department to all hospitals found in west Gojjam zone. After explaining the purpose of the study to the different hospital level managers, verbal informed consent was obtained from each study subject prior to interview. Confidentiality and privacy of the respondent's response was maintained during data collection, analysis and reporting of the findings.

RESULTS

Sociodemographic and economic characteristics

A total of 261(88 cases and 173controls) verbally consented pregnant women who came for antenatal follow-up or skilled delivery service were enrolled in this study with a response rate of 99.6%. The mean age of case and controls was 29 years (±5.9 SD) and 27 years (±6.1 SD) respectively. Majority of the participants 250(95.8) were Orthodox Christian followers of whom 81(92%) were cases and 169(98%) were controls. About 171(98.8%) controls and 85(96.6%) of cases were Amhara in ethnicity and majority of cases 85(96.6%) and 165(95.4%) controls were married. Almost half of cases 43(48.9%) and 79(45.7%) controls were housewives. Regarding educational status, about 26(29.5%) of the cases and 49 (23.8%) of the controls were unable to read and write. For all respondents the mean family size was 4.13 (±1.8 SD) and from all respondents 60(68.2%) cases and 108(62.4%) controls had less than five family members. Similarly, 59(67.0%) cases and 111(64.2%) controls were urban residents (Table 1).

Health-related, obstetrics, and behavioral factors of preeclampsia

In this study about 39(44.3%) of cases and 66 (38.2%) of controls ever drunk alcohol. Among the different types' alcohol Tella was more frequently drunk followed by Arekie. Similarly, among the study participants who were ever drunk coffee 56(63.6%) were cases and 104(60.1%) were controls (Table 2).

Table 1: Sociodemographic characteristics of women who attended ANC and delivery services in government hospitals in the West Gojjam Zone, north-west Ethiopia, 2021(n1= 88, n2 = 173).

Sociodemographic characteristic	Cases (88) N (%)	Control (173) N (%)
Religion Orthodox Muslim	81(92.0)	169(97.7)
	7(8.0)	4(2.3)
Ethnicity		
Amhara	85(96.6)	171(98.8)
Agew	2(2.3)	2(1.2)
Tigray	1(1.1)	
Marital status Married	86(97.7)	165(95.4)
Unmarried	2(2.3)	8(4.6)
Mothers' occupation		
housewives'	43(48.9)	79(45.7)
Farmer	16(18.2)	38(22)
Merchant	10(11.4)	29(16.8)
Government employee	14(15.9)	23(13.3)
private employee	5(5.7)	4(2.3)
Educational status Cannot read		
and write	26(29.5)	49(28.3)
Can read and write only	16(18.2)	41(23.7)
Primary school (1-8)	20(22.7)	30(17.3)
Secondary school (9-12)	12(13.6)	21(12.1)
Diploma and above	14(15.9)	32(18.5)
Family numbers family not less	108(62.4)	60(68.2)
than 5	65(37.6)	28(31.8)
family no 5 or more		
Residence of the mother urban	59(67.0)	111(64.2)
Rural	29(33.0)	62(35.8)
Wealth index poorest Poorest	17(19.3)	32(18.5)
medium	18(20.5)	36(20.8)
rich.	27(30.7)	45(26.0)
richest	18(20.5)	25(14.5)
	8(9.1)	35(20.2)

Table 2: Health related, obstetrics, and behavioral characteristics of women attending ANC and delivery services in governmental hospitals of West Gojjam Zone, north west Ethiopia, 2021(n1= 88, n2 = 173).

Health related, obstetrics, and behavioral characteristic		Cases (88) N (%)	Control (173) N (%)
ANC service	ANC service less than 4 times	48 (54.5)	83(48.0)
	getting ANC serve >=4 times	40(45.5)	90(52.0)
getting counselling about diet	Yes.	50(56.8)	127(73.4)
	No.	38(43.2)	46(26.6)
Family history of hypertension	Yes.	5(5.7)	8(4.6)
	No.	83(94.3)	165(95.4)
History of previous preeclamsia	Yes.	10(11.4)	11(6.4)
	No.	78(88.6)	162(93.6)
number of gravidities	Less than 5 times pregnancy	70(79.5)	135(78.0)
	>=5 pregnancy	18(20.5)	38(22.0)
Number of parities	less than 5 life birth	79(89.8)	155(89.6)
	more than 5 live births	9(10.2)	18(10.4)
Drinking alcohol	Yes.	39(44.3)	66(38.2)
	No.	49(55.7)	107(61.8)
drinking coffee	Yes.	56(63.6)	104(60.1)
	No.	32(36.4)	69(39.9)
Ever chawed khat	Yes.	3(3.4)	1(0.6)
	No.	85(96.6)	172(99.4)

Among all respondents, only 4(1.5%) of mothers were chawed chat and 3(3.4%) were cases, and there were no respondents who had a history of smoking throughout their life. Of 261 study participants, 9 (10.2%) cases and 18(10.4%) controls had <5 live births, while 18(20.5%) cases and 38(22%) controls were multigravida mothers. Of all participants, almost half of cases 48 (54.4%) and almost half of controls 83(48.0%) had 4 ANC visits during the current pregnancy and more than half 50 (56.2%) cases and 127(73.4%) controls received counseling about their dietary habits from health professionals during their follow-up with ANC follow-up (Table 2).

Regarding medical history, a family history of hypertension was reported as 5(5.7%) cases and 8(4.6%) in controls. Regarding to their previous personal preeclampsia history 10(11.4%) cases and 11(6.4%) controls reported history of preeclampsia during their previous pregnancy. Similarly, two percent of cases and 1.7% of controls had a personal history of diabetes millets.

Nutritional status

Regarding the nutritional status of the mothers, the mean (±) SD () of MUAC were 24.5cm ± (2.73) and 23.1cm± (2.24) for cases and controls, respectively.

The mean (±) SD of hematocrit concentration among the study participants was 35.8± (5.17) among these 38(43.2%) case 29(16.8%) controls had anemia. From 261 study participants only 1 woman from control groups had severe anemia which is HCT level below 21%. From all respondents almost half of the cases 41(46.6%) and 99(57.2%) of controls take iron for 3 months.

Results of the bivariate and multivariate logistic regression of the study

In the bivariate analysis, old age, personal history of preeclampsia, low economic status did not receive diet counseling during pregnancy, higher MUAC, anemia (HCT less than 33%), higher consumption of fat-related foods and fast foods, lower consumption of dairy products and infrequent use of dark green leafy vegetables and other fruits and vegetables rich in vitamin A were significantly associated with preeclampsia (Table 3).

In the multivariate logistic regression analysis, seven variables are identified as determinants of preeclampsia among women attending ANC and delivery services at a level of significance of 5%. Having preeclampsia in previous pregnancy, lowest wealth index (poorest) and infrequent consumption of dark green leafy vegetables were significantly associated with preeclampsia in bivariate analysis but it remains insignificant in the multivariable analysis. Multivariate analysis revealed that high consumption of foods related to fat was associated with the development of preeclampsia. Women who had high consumption of foods related to fat were 3.7 times more likely to develop preeclampsia compared to mothers who did not eat or rarely ate (AOR: 3.7 at 95% CI: 3.7(1.67,8.23)). This study showed that consumption of vitamin A-rich fruits and vegetables during pregnancy were associated with reduction of the risk of developing preeclampsia. Pregnant women who had high consumption of vitamin A-rich fruits and vegetables 88% lower risk of developing preeclampsia compared to pregnant women who rarely had low preferences for vitamin A-rich fruits and vegetables (AOR: 0.12 at 95% CI: 0.04,0.35) (Table 3). Milk product intake during pregnancy was

Table 3: Crude odds ratio output of binary logistic regression of women attending ANC and delivery services in governmental hospitals in the West Gojjam zone, northwest Ethiopia, 2021(n1= 88, n2 = 173).

Variables	Categories	Health status		COR (95%:CI)	AOR (95%:CI)
		Cases N (%)	Controls N (%)		
Wealth index	Poorest	17(19.3%)	32(18.5)	1	
	Poor	36(20.8)	36(20.8)	0.9(0.4,2.1)	
	Medium	27(30.7)	45(26.0)	1.12(0.5,2.40)	
	Rich	25(14.5)	18(20.5)	1.3(0.5,3.1)	
	Richest	8(9.1)	35(20.2)	0.4(0.2,1.1	
History of preeclamsia	Yes.	10 (11.4)	11(6.4)	1	1
	No.	78(88.6)	162(93.6)	0.5(0.2,1.3)	0.83(0.23,2.96)
Receiving about Counselling	Yes.	50(56.8)	127(73.4)	1	1
	No.	38(43.2)	46(26.6)	2.1(1.2,3.6)	2.18(1.11,4.29) *
Hematocrit level	Normal HCT level	50(56.8)	144(83.2)	1	1
	Anemic	38(43.2)	29(16.8)	3.8(2.1,6.7)	3.31(1.62,6.78) **
Dairy Products	Rarely Consumed	37(42.0)	47(27.2)	1	1
	Moderately	39(44.3)	55(31.8)	0.9(0.5,1.6)	1.36(0.63,2.93)
	Highly Consumed	12(13.6)	71(41.0)	0.2(0.1,0.5)	0.39(.15,0.95) *
Egg	Rarely Consumed	25(28.4)	68(39.3)	1	
	Moderately	52(59.1)	84(48.6)	1.6(0.9,2.9)	
	Highly Consumed	11 (12.5)	21(12.1)	1.4(0.6,3.4)	
Dark green leafy vegetables	Rarely Consumed	31(35.2)	39(22.5)	1	
	Moderately	27(30.7)	61(35.3)	0.6(0.3,1.1)	
	Highly Consumed	30(34.1)	73(42.2)	0.5(0.3,0.9)	
Other vitamin A-rich fruits and vegetables	Rarely Consumed	35(39.8)	29(16.8)	1	1
	Moderately	46(52.3)	79(45.7)	0.5(0.3,0.9)	0.55(0.26,1.16)
	Highly Consumed	7(8.0)	65(37.6)	0.08(0.03,0.22)	0.12(.04.35) **
fat-related foods	Rarely Consumed	20(22.7)	74(42.8)	1	1
	Moderately	33(37.5)	54(31.2)	2.3(1.2,4.3)	2.07(0.93,4.61)
	Highly Consumed	35(39.8)	45(26.0)	2.9(1.5,5.6)	3.70(1.67,8.23) **
Fast food	Rarely Consumed	37(42.0)	78(45.1)	1	
	Moderately	41(46.6)	79(45.7)	1.2(0.6,1.9)	
	Highly Consumed	10(11.4)	16(9.2)	1.3(0.5,3.2)	

NB: * P< 0.05, ** P< 0.01 in multivariate model, 1 = reference, COR=crude odds ratio, AOR=adjusted odds ratio

a protective factor for preeclampsia independently. Compared to women who did not eat milk products, women who ate milk products more frequently had 61% less risk of developing preeclampsia (AOR:0.39, 95% CI (0.15,0.95). The result of this study also revealed that women who had receiving nutritional counseling during antenatal care follow up was found that protective for preeclampsia compared to who hadn't receiving nutritional counseling during pregnancy (Table 3). In the multivariable analysis, mothers who hadn't receive nutritional counselling were 2.18 more likely to develop preeclampsia than those who had receive counselling (AOR: 2.18, 95% CI (1.11, 4.29)).

This study revealed that the risk of developing preeclampsia increases with age (AOR: 1.21 at 95% CI: (1.15, 1.28)). There was a significant relationship between the MUAC status of mothers and the development of preeclampsia. By keeping other variables constant, for each 1-cm increase in MUAC, there was an 18% increase in the risk of developing preeclampsia (AOR: 1.18 at 95% CI: (1.04, 1.34)). Anemia showed a significant association with preeclampsia among pregnant women than among those who did not have anemia. Those mothers who had anemia were 3.31 times more related to developing preeclampsia compared to who had no anemia(AOR: 3.31 at 95% CI: (1.62,6.78) (Table 3).

DISCUSSION

The aim of this study was to evaluate the dietary risk factors for preeclampsia and in this study the consumption of vitamin A rich fruits and vegetables, milk products and the nutritional counseling during pregnancy, anemia, increased MUAC, high fatty foods consumption, and advanced age were found to be significant predictors of the development of PE.

The finding of this study revealed that women who reported

a high intake of fatty foods had a higher risk of developing preeclampsia than women who reported consuming fatty foods rarely. These findings are supported by other studies conducted in Jordan, Norway, and Denmark [51-53]. Although the cause of preeclampsia is unknown, there are a number of molecular theories for how fatty meals affect preeclampsia incidence. It was hypothesized that extra fat would elevate the level of free radicals in the blood and change the physiological state of the tissues to one that was more pro-inflammatory state [54-56]. Additionally, there is evidence that preeclampsia progresses in development as a result of increased plasma concentrations of free radical oxidation products [57]. Since free radicals and lipid peroxides damage endothelial cells [51] and reduce endothelial production of prostaglandin (prostacyclin), a potent vasodilator and inhibitor of platelet aggregation, there is deductive evidence that an imbalance between antioxidant activity and oxidants may play a significant role in the pathogenesis of preeclampsia. Injury to endothelial cells can cause the release of platelet-derived thromboxane, a potent vasoconstrictor and activator of platelet aggregation that increases the likelihood of preeclampsia developing. It also exposes subendothelial collagen and may cause platelet aggregation, activation, and release [52].

This study revealed that mothers who had a high consumption of dairy products had a 61% lower risk of developing preeclampsia compared to those who had only consumed milk products rarely. This finding is consistent with the study conducted in Norway, Netherlands and Iran which revealed a reduced risk of preeclampsia with high milk consumption [20,58,59]. This could be due to the fact that milk products are the main source of calcium. It is hypothesized that calcium reduced parathyroid hormone (PTH) concentration, which in turn lowers the intracellular free calcium level, ultimately resulting in smooth muscle relaxation, and calcium also reduces vascular sensitivity to vasopressor agents that increase blood pressure [60,61].

In the current study, consuming fruits and vegetables frequently that are high in vitamin A reduced the risk of developing preeclampsia. When compared to individuals who ate infrequently, those who consumed a lot of vitamin A-rich fruits and vegetables everyday had an 88% lower risk of having preeclampsia. Studies conducted in Ethiopia, Norway, Jordan, and Sira leon were congruent with these findings [13,51,62,63]. Conversely, a research conducted in India found no association between eating fruits and vegetables and developing preeclampsia [64]. This difference could be due to different sample size was used in the previous study, and cultural difference between study populations. Due to their antioxidant properties, these vitamins can stop preeclampsia from developing. Hypoperfusion is avoided by the plasma's and placenta's high antioxidant content. Because of this, the endothelium cell may function normally when these antioxidants are present at the required quantity [13,65,66].

According to this study, women who received nutritional advice during their antenatal care visits were found to be more protective against preeclampsia than those who did not. Studies conducted in Ethiopia had comparable findings to those of this study [13]. A wide range of nutritional values are covered during advice on eating well. Preeclampsia can be prevented by following dietary recommendations that emphasize the benefits of eating fruit and vegetables. Most women are quite motivated to get nutrition advice throughout pregnancy. Because dietary modifications could be beneficial to their children, too [65,67].

Because women in poor nations' mid-upper arm circumferences (MUAC) are thought to remain comparatively stable during pregnancy [68] and MUAC was used to assess nutritional status of women. According to this study, preeclampsia was more likely to occur in women who had greater MUAC levels. This finding is in line with research carried out in Ethiopia, Zimbabwe, and the United Kingdom [62,69,70]. The 2019 study carried out in Indonesia, however, found no connection between nutritional status (MUAC) and the development of preeclampsia. [19]. Such difference could be due to the variation of study design (the previous study used cross-sectional study design) and study settings.

It is suggested that obesity is a key component of the "metabolic syndrome" [71]. The actual mechanism by which obesity poses this risk, however, is less well understood. Before becoming pregnant, obese women may have chronic hypertension, insulin resistance, and/or hypertriglyceridemia. Preeclampsia risk factors include insulin resistance and hypertriglyceridemia [72,73], and are also important cofactors in the development of endothelial dysfunction [56]. Since endothelial dysfunction is thought to be a major factor in the development of preeclampsia [55], it is hypothesized that the high incidence of preeclampsia in obese pregnant women may be biologically linked to the presence of endothelial dysfunction prior to pregnancy brought on by insulin resistance and/or hypertriglyceridemia [74]. Obese women have lower blood concentrations of antioxidants [75]. This might be because people consume fewer antioxidants in their diets, but it's also plausible that reactive oxygen species are consuming more. Leukocyte free radical production is boosted when substantial amounts of lipids or carbs are consumed [76]. It's interesting that this dietary pattern is more common in obese people and pregnant women who get preeclampsia [77].

In the present study, preeclampsia rates among women with anemia were 3.3 times greater than those among women without anemia. This result is consistent with earlier research conducted in Ethiopia, Iran, Bangladesh, and Sudan. [39,78,79]. A lack in micronutrients and antioxidants may contribute to preeclampsia in women with severe anemia. According to recent findings, preeclampsia may occur as a result of decreased serum levels of calcium, magnesium, and zinc during pregnancy [80]. According to several studies, anemia, elevated ferritin levels, and decreased transferrin levels are associated with preeclampsia in women [81]. Hemolysis, a characteristic of preeclampsia, is recognized to be represented by increased free iron. Anemia is a sign of numerous nutritional deficiencies. Similar to how reduced transferrin causes inflammatory reactions and may have contributed to an increase in preeclampsia, increased ferritin is not just a measure of diminished iron reserves but also an inflammatory marker [82-84].

The results of this research showed that preeclampsia's emergence is related to the mother's advancing age. Other research from Iran, India, and Ethiopia that demonstrated that age is a risk factor for preeclampsia also supports this conclusion [79,85-87]. This may be caused by the uterine blood arteries

aging, which results in increasing arterial stiffness and a gradual loss of cardiovascular vessels' compliance, which in turn causes endothelial dysfunction (a characteristic of preeclampsia). Additionally, this could be explained by the fact that as people age, their arteries become clogged, increasing their risk for heart attacks or strokes, as well as poor diet, inactivity, and the body's inability to process salt from food. These factors together cause the blood vessels to become less elastic, which leads to preeclampsia in the pregnant women [67,88-90].

CONCLUSIONS

In conclusion, this study identified the role of dietary factors in the prevention of preeclampsia, revealing that diets characterized by high intake of vitamin A rich fruits and vegetables, and milk products were significantly associated with a low risk of preeclampsia. High consumption of milk products has protective association with of preeclampsia. At the same time, receiving nutritional counseling from health professionals was a protective factor for preeclampsia. However, a high intake of fatty foods was associated with the development of pre-eclampsia. Being obese or increasing MUAC and anemia also has a significant risk association with preeclampsia. Health professionals, particularly those who work in maternity rooms or gynecological and obstetric wards, it is better to provide counseling for women to choose a healthy dietary pattern (increasing intake of milk products, fruits and vegetables, and by reducing high fatty foods) before or during the follow-up of ANC. It is better to recommend overweight mothers to lifestyle modifications, including weight control, before, during, and after pregnancy, because overweight mothers are at high risk of developing preeclampsia. Researchers should focus on this maternal complication to find other possible causes of preeclampsia by using a more strong study design, such as cohort/longitudinal and experimental designs.

DECLARATION

Ethics approval and consent to participate

The study was approved by IRB of College of Medicine and Health Sciences, Bahir Dar University reference no/3060/2.4. Permission was obtained after formal support letter submitted to the Amhara Regional Health Bureau, Zonal and Districts Health oces. Information related ethical issue was given for mothers by reading its content attached together in the first part of the questionnaire. Each study participant was briefed on the objective of the study, and informed about the right to refuse to participate in the study or to discontinue at any time. Participants were also informed that all data was condential and personal identiers were not registered. Interview was conducted after the participants provided informed consent to participate in the study.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analysed during this study are included in this published article.

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AUTHORS' CONTRIBUTIONS

MNA: conceived and designed the study, conducted statistical analysis and result interpretation, prepared manuscript. YM and HA: conceived and designed the study, conducted statistical analysis and result interpretation. WM: conducted statistical analysis and result interpretation. The authors read and approved the manuscript.

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