

Factors Associated with Acute Malnutrition among Pregnant Women in Flood Affected Region

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ABSTRACT

Background: Adequate nutrition before and during pregnancy is necessary to maintain women's reproductive health and to ensure healthy foetal outcome. Pregnant women are at high risk of acute malnutrition specifically during humanitarian crisis leading to adverse effects in foetal outcomes and women's health. This study aimed to assess the factors associated with acute malnutrition among pregnant women visiting Antenatal Clinics in two hospitals and a Primary Health Care Centre of Siraha district in the south-eastern plains of Nepal immediately after 2017 flash flood.

Methods: A health-institution based cross-sectional study was conducted among 444 pregnant women of reproductive age (15-49 years) in second and third trimester in three health institutions. Data collection was done in the aftermath of 2017 flash floods through face to face interview. Multiple logistic regression analysis was used to identify the factors associated with acute malnutrition defined as Mid Upper Arm Circumference less than or equals to 21 centimetres.

Results: Out of 444 participants, 9.9% were found to be acutely malnourished. Participant's education (AOR[Adjusted Odds Ratio]: 3.09, 95% CI[Confidence Interval]: 1.43-6.70), occupation (AOR: 3.16, 95% CI: 1.08-9.22), husband's occupation (AOR: 6.61, 95% CI: 2.17-20.12), household food security (AOR: 3.39, 95% CI: 1.36-8.49) and participant's dietary diversity (AOR:10.06, 95% CI: 3.35-30.27) were found to be statistically significant factors associated with acute malnutrition among pregnant women.

Conclusions: Participants' illiteracy, unemployment, husband not employed for cash, household food insecurity and low dietary diversity were found to be statistically significant predictors of acute malnutrition among pregnant women during flash floods.

Keywords: Acute malnutrition; flash flood; malnutrition during pregnancy; MUAC

INTRODUCTION

Adequate nutrition before and during pregnancy is essential to maintain women's reproductive health and to ensure healthy foetal outcome.¹ Maternal undernutrition is an important modifiable risk factor intricately linked with foetal growth and adverse birth outcomes² resulting in elevated risk of stunting of linear growth and metabolic, endocrine and cardiovascular conditions in later life.³ Furthermore, intergenerational cycle of malnutrition has been well documented leading to serious consequences for the formation of human capital.⁴ Humanitarian emergencies aggravate the risk of acute malnutrition among vulnerable population including pregnant and lactating women through inadequate food production, disruption in harvesting

and storing mechanisms, limited access to food markets, reduced household income and breakdown of food distribution.⁵ This study assessed the factors associated with acute malnutrition among pregnant women visiting antenatal clinics of Siraha district in Nepal immediately after 2017 flash flood.

METHODS

A cross-sectional descriptive study design with a quantitative approach was used for the study. This study was conducted in Siraha district of Mahadesh Province in the southern plain of Nepal. Siraha district has a relatively low Human Development Index of 0.408 and it is located about 262 kilometres away from Kathmandu.⁶ Siraha district had a population of 637,328 and was

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predominantly inhabited by people of Madhesi ethnicity as of 2011 census of Nepal.^{6,7} Heavy monsoon rainfall during mid-August 2017 triggered severe flash floods in Tarai region including Siraha district of Nepal with intense humanitarian consequences in terms of damage to infrastructure, displacement, food insecurity, adverse health, reduced access to basic sanitation and loss in agricultural production.⁸ The study was conducted in the aftermath of 2017 monsoon floods. The current study was health-facility based and data collection was done in antenatal clinics of two hospitals and one PHCC of Siraha. According to Health Management Information System, a total of 2018 pregnant women visited the three health institutions for first ANC (antenatal check-up) from July 2017 to June 2018.⁹ All of the health institutions were located in urban municipalities of Siraha with convenient access from national highway and its subsidiary roads.

Pregnant women of reproductive age (15-49 years) visiting the antenatal clinic during the study period of three months were the participants of the study. Pregnant women in their second or third trimester were eligible to participate. Women suffering from diseases like hypertension, diabetes, tuberculosis, HIV/AIDS were not considered for this study.

The Cochran's formula $z^2p(1-p)/d^2$ was used to calculate the sample size. With estimated maximum prevalence of acute malnutrition (p) as 50%, confidence interval of 95% and margin of error (d) of 5%, the sample size was determined to be 384. With expected non-response rate of 10%, the minimum sample size was established as 422.

Three health institutions of Siraha district with the highest flow of pregnant women for ANC were selected purposively. Data collection was done from 150 pregnant women from primary health care centre and 151 pregnant women each from two hospitals on the first arrival basis. A total of 452 pregnant women participated in the study and 444 completed the survey.

Trained field researchers with educational background in Nutrition and Dietetics were stationed at each antenatal clinic collected the data. Every pregnant woman visiting the clinics for antenatal check-up were invited to participate in the study. After the written informed consent, participants were interviewed face to face with structured interview schedule in Nepali language.

Mid upper arm circumference (MUAC) was used to assess the nutritional status of participants. MUAC is a good indicator of the protein reserves of a body, and a thinner arm reflects wasted lean mass or acute malnutrition.¹⁰

Among different recommendations, this study used 21 cm as the cut-off for identifying pregnant women with acute malnutrition as a 21 cm cut-off was used for recruiting women for feeding programmes during humanitarian conditions.¹⁰⁻¹² The outcome variable was dichotomized as acutely malnourished (MUAC less than or equals to 21 cm) and not acutely malnourished (MUAC more than 21 cm).

Nutritional status of participants was assessed using a flexible, non-stretchable, non-elastic, standard adult MUAC tape. The measurement was taken at the mid-point of the upper arm identified and marked using a measuring tape, halfway between the tip of olecranon process and acromion process. MUAC of the arm was taken to nearest 0.1 cm with no clothing on the right arm to ensure consistency.¹³

Dietary Diversity was assessed using Women's Dietary Diversity Score (WDDS) calculated from 24-hour recall of all the foods and drinks consumed by the participants.¹⁴ Data collection was done for 16 food groups which were aggregated into nine food groups to create a WDDS during data analysis. The dietary diversity was categorized as adequate (WDDS>4) and inadequate (WDDS ≤4).¹⁵

Household Food Security was assessed using Household Food Insecurity Access Scale.¹⁶ Based on the guidelines, the households were categorized as food secure, mildly food insecure, moderately food insecure and severely food insecure. Mildly food insecure, moderately food insecure and severely food insecure were merged into a single category as food insecure.

Data was collected on socio-demographic variables like residence, age, number of children alive, gestational age, ethnicity, family type, education, occupation, husband's education, husband's occupation and annual family income.

Age of participant and gestational age were recorded in completed years and completed months, respectively. Age of participant was categorized into less than 20 years and more than or equals to 20 years based on the legal age of marriage in Nepal. Residence of participants was categorized into urban for those residing in municipality, sub-metropolitan city or metropolitan city and rural for those residing in rural municipality. Ethnicity was categorized into Madhesi and non-Madhesi. Madhesi are the indigenous inhabitants of the Southern Terai region of Nepal including the study district: Siraha. Participant's education and husband's education were categorized into illiterate and literate (some informal education or some level of school education). Participant's

occupation was categorized into employed for cash (daily wage, service, business, foreign employment) and housemaker or agriculture (unemployed, student, house maker, agriculture). Husband's occupation was categorized as employed for cash (daily wage, service, business, foreign employment) and employed not for cash (unemployed, student, house maker, agriculture).¹⁷ Family type was grouped into nuclear (husband and wife living together with their unmarried children) and joint or extended (husband and wife living together with their unmarried children along with older parents and/or relatives). Annual family income was categorized based on National Household Budget Survey and NRs30,121 was categorized as less than national average and more than NRs 30,121 as more than national average.¹⁸

Water purification in the house was categorized into no purification and some type of purification (boiling, filtration, cloth straining). Type of toilet was categorized into improved (non-shared toilet with flush or pour-flush toilets piped to sewer systems or septic tanks and pit latrines) and unimproved or no toilet.¹⁷

Data in the paper form was entered into EpiData v3.1 and exported to R v4.00 for data analysis. Descriptive analysis was done for all the outcome and explanatory variables. Pearson's chi-squared test was used to assess the association between every explanatory variable with acute malnutrition status. Multiple logistic regression was used to generate the effect of the explanatory variables on the odds of presence of acute malnutrition. Crude odds ratio (COR) and adjusted odds ratio (AOR) were obtained and two-sided P values below 0.05 were considered statistically significant. No multicollinearity was detected among the explanatory variables (Largest variance inflation factor = 2.22). Hosmer-Lemeshow chi-square test was performed to assess the goodness of fit of the model and it was found to be a good fit (p = 0.89).

Ethical approval for the study was taken from Nepal Health Research Council (Reference number: 2448). Participants were enrolled in the study voluntarily and were informed about the objectives of the study. Written consent was taken from each study participants and confidentiality of the information was ensured before the interview began.

RESULTS

Out of 444 pregnant women, 44 (9.9%) had acute malnutrition with MUAC less than or equal to 21cm. The mean MUAC of participants was found to be 23.28 (±1.79) cm. The mean MUAC in malnourished group was 20.04 (±0.62) cm and in non-malnourished group was

23.63 (±1.49) cm.

The average age of participants was 22.2 (±3.8) years and about half (51.4%) were in the third trimester of pregnancy. About nine out of 10 participants had three or more living children. Most (72.2%) of the participants were from urban area and majority (77.9%) were from joint or extended family. About three fourth (74.3%) of the participants were from Madhesi ethnicity. About seven out of ten participants were employed for cash or were engaged in agriculture. About nine out of 10 of the participants' husband were literate and 35.1% were employed for cash. The median annual household income was NPR 265,015. (Table 1)

Table 1. Socio-demographic characteristics of participants (n=444).

Characteristics	Number	%	Acute malnutrition (%)		P value
			No	Yes	
Age					
Less than 20 years	106	23.9	88.7	11.3	0.577
20 years or more	338	76.1	90.5	9.5	
Gestational age					
Second trimester	216	48.6	89.4	10.6	0.612
Third trimester	228	51.4	90.8	9.2	
Number of living children					
Two or less	48	10.8	93.8	6.2	0.607†
Three or more	396	89.2	89.6	10.4	
Residence					
Urban	321	72.3	88.5	11.5	0.066
Rural	123	27.7	94.3	5.7	
Family type					
Nuclear	98	22.1	92.9	7.1	0.299
Joint or extended	346	77.9	89.3	10.7	
Ethnicity					
Madhesi	330	74.3	88.8	8.3	0.118
Others	114	25.7	93.9	6.1	
Education					
Illiterate	135	30.4	82.2	17.8	0.000***
Literate	309	69.6	93.5	6.5	
Occupation					
Employed for cash or Agriculture	301	67.8	91.0	9.0	0.336

Unemployed/ housemaker	143	32.2	88.1	11.9	
Husband's education					
Illiterate	49	11.0	91.8	8.2	0.804 [†]
Literate	395	89.0	89.9	10.1	
Husband's occupation					
Employed for cash	156	35.1	93.6	6.4	0.069
Employed not for cash/ unemployed	288	64.9	88.2	11.8	
Annual household income					
Less than or equals to national average	45	10.1	95.6	4.4	0.291 [†]
More than national average	399	89.9	89.5	10.5	

*P values are generated from Pearson's chi-square test or Fischer's Exact test, *P<0.05, ***P<0.001, [†]P values from Fischer's Exact test*

Majority (83.8%) of the households were food secure. The mean dietary diversity score was 4.53±1.30 (SD). Out of all the participants, 49.1% had adequate dietary diversity. Household food security and dietary diversity were significantly associated with acute malnutrition among pregnant women (Table 2).

Table 2. Household food security and dietary diversity among participants(n=444).

Characteristics	Number	%	Acute malnutrition (%)		P-value
			No	Yes	
Household food security					
Food secure	372	83.8	83.3	16.7	0.036*
Food insecure	72	16.2	91.4	8.6	
Dietary diversity					
Adequate (>5 food groups)	218	49.1	98.2	1.8	0.000***
Inadequate (<= 4 food groups)	226	50.9	90.1	9.9	

*P values are generated from Pearson's chi-square test and Fischer's Exact test, *P<0.05, ***P<0.001*

About nine out of ten of the participants' households had an improved toilet. A majority (86.5%) of the participants did not utilize any water purification method. Kitchen garden was present in 56.8% of the households (Table 3).

Table 3. Description of environmental variables (n=444).

Characteristics	Number	%	Acute malnutrition (%)		P-value
			No	Yes	
Type of toilet					
Improved	398	89.6	89.7	10.3	0.603 [†]
Unimproved/ No toilet	46	10.4	93.5	6.5	
Water purification					
No purification	384	86.5	89.6	10.4	0.366
Some type of purification	60	13.5	93.3	6.7	
Kitchen garden in home					
Yes	253	56.8	90.9	9.1	0.527
No	192	43.2	89.1	10.9	

P values are generated from Pearson's chi-square test and Fischer's Exact test, [†]P values from Fischer's Exact test

Literacy, household food security and participant's dietary diversity were found to be statistically significant at 5% level of significance from Pearson's chi-square test (Table 1, Table 2).

From unadjusted logistic regression model literacy of participant, food security and dietary diversity were found to be statistically significant. Illiterate participants were about three times likely to be acutely malnourished than literate participants. Similarly, participants from food insecure households were about two times more likely to be acutely malnourished in comparison to those from food-secure households. Furthermore, participants with inadequate dietary diversity were 11.5 times more likely to be acutely malnourished than those with adequate dietary diversity.

In the adjusted model, however, participants' education, occupation, and their husbands' occupation were also found to be statistically significant. Participants with husbands employed not for cash or unemployed were six times(AOR[Adjusted Odds Ratio]:6.61, 95% CI[Confidence Interval]: 2.17-20.12) more likely to be acutely malnourished than with husbands employed for cash. Similarly, participants who were unemployed or housemaker were three times(AOR: 3.16, 95% CI: 1.08-9.22)more likely to be acutely malnourished than their counterparts. Furthermore, it was revealed that participants from food-insecure households were three times(AOR: 3.39, 95% CI: 1.36-8.49)more likely to be acutely malnourished than those from food-secure

households. Similarly, the odds ratio of dietary diversity on acute malnutrition slightly reduced from 11.5 in the unadjusted model to 10.063 (AOR:10.06, 95% CI: 3.35-30.27) in the adjusted model. The effect of literacy remained almost similar (AOR:3.09, 95% CI:1.43-6.70) in both adjusted and unadjusted models. (Table 4)

Table 4. Predictors of acute malnutrition among pregnant women in Siraha district.

Characteristics	COR	95% CI	AOR	95% CI
Age				
20 years or more Ref: Less than 20 years	0.82	0.42-1.71	1.12	0.49-2.55
Gestational age				
Third trimester Ref: Second trimester	0.85	0.45-1.58	0.86	0.41-1.78
Number of living children				
Two or less Ref: Three or more	1.73	0.6-7.36	1.86	0.44-7.87
Residence				
Rural Ref: Urban	0.46	0.09-0.18	0.56	0.22-1.42
Family type				
Joint or extended Ref: Nuclear	1.56	0.71-3.92	1.40	0.52-3.82
Ethnicity				
Others Ref: Madhesi	0.52	0.21-1.13	0.44	0.17-1.15
Education				
Illiterate Ref: Literate	3.12	1.66-5.93***	3.09	1.43-6.70**
Occupation				
Unemployed/ housemaker Ref: Employed for cash/ Agriculture	1.37	0.71-2.58	3.16	1.08-9.22*
Husband's education				
Literate Ref: Illiterate	1.27	0.48-4.36	2.19	0.63-7.62
Husband's occupation				
Employed not for cash/ unemployed Ref: Employed for cash	1.95	0.97-4.28	6.61	2.17-20.12**

Annual household income				
More than national average Ref: Less than or equals to national average	2.53	0.74-15.9	2.19	0.45-10.53
Household food security				
Food insecure Ref: Food secure	2.13	1.00-4.26*	3.39	1.36-8.49
Dietary diversity				
Inadequate (<= 4 food groups) Adequate (>5 food groups) (Ref)	11.50	4.53-38.85***	10.06	3.35-30.27***
Type of toilet				
Unimproved/No toilet Ref: Improved	0.61	0.14-1.76	0.49	0.121-1.95
Water purification				
Some type of purification Ref: No purification	0.61	0.18-1.6	0.81	0.25-2.71
Kitchen garden in home				
No Ref: Yes	1.22	0.65-2.29	0.97	0.48-1.99

Crude odds ratio (COR) and adjusted odds ratio (AOR), and corresponding confidence intervals (CI) generated from simple logistic regression and multiple logistic regression respectively, *P<0.05, **P<0.01, ***P<0.001, Ref: Reference level

DISCUSSION

To our best knowledge, this is the first study to examine the factors associated with acute malnutrition among pregnant women in the flood affected region in Nepal. We utilized MUAC to measure the muscle wasting of pregnant women in this health institutions-based study. Though body mass index (Low BMI) more accurately reflects the wasting of both body fat and lean tissue,¹³ MUAC has been recommended as an alternative to detect acute malnutrition in humanitarian conditions and low resource settings.¹⁰⁻¹² There is no universally agreed cut-off for MUAC to detect acute malnutrition among pregnant women and various studies have recommended or used different cut-off values of MUAC ranging from 21 cm-23.5cm.^{19,20} This study used a cut-off value of 21cm based on recommendations for admitting women into targeted supplementary feeding programmes. In this study, average MUAC was found to be 23.28 cm which is slightly more than 23.1 cm obtained from Policy and Science, Health, Agriculture and Nutrition (PoSHAN)

study done in community setting in a non-humanitarian situation among pregnant women of southern plains of Nepal.²¹

Participant's literacy, household food security, dietary diversity, participants' occupation and husband's occupation were found to be significantly associated with acute malnutrition among pregnant women after adjusting for confounders in the final model. It is plausible that the literacy of participants increases their exposure to nutrition education and nutrition-related messages thereby improving their nutrition-related behaviour. This is consistent with the findings from another study among women of early child-bearing age in Bangladesh.²² However, a large scale study in Nepal showed that the women of reproductive age with formal education were more likely to be malnourished than with informal education and warranted it to be verified with other large scale studies.²³ Similarly, women from food-insecure households were more likely to be acutely malnourished than those from food-secure households (AOR: 3.392, 95% CI:1.355-8.492). This finding is coherent with another study done in Nepal where 27% of women from food-insecure households were acutely malnourished (BMI<18.5 kg/m²) compared to 13% from food-secure households.²⁴ Another study in Ethiopia also concurred with this result.²⁵ Studies have shown that during the time of crisis women limit their food intake to satisfy the nutritional needs of other family members.²⁶ So, the problem of low food intake among pregnant women is likely to be even more among food insecure households. Similarly, women with inadequate dietary diversity were 10 times (AOR:10.064, 95% CI: 3.346-30.267) more likely to be acutely malnourished than their counterparts. This 95% CI for AOR is large because only four participants with adequate dietary diversity were acutely malnourished. This finding is cogent because the dietary diversity indicates the nutritional adequacy among adult population²⁷ and micro nutritional adequacy among pregnant women.²⁸ A study conducted in also Kenya showed that pregnant woman with higher DDS had a higher intake of micronutrients as well as macronutrients.²⁹ The finding also corroborates with other studies among pregnant women in Nepal³⁰ and Ethiopia.²⁵ The limited access to WASH facilities might be the reason for different finding in our study. The discrepancy also might be due to the different study setting and difference in sample sizes. More studies to confirm or reject the findings in humanitarian situations are required.

This study had some limitations as well. As this was a health institution-based study among pregnant women

visiting for ANC in a post-disaster crisis, the results should be interpreted cautiously while applying to the population at community level. Furthermore, the study utilized MUAC as the measure of acute malnutrition and it was not corroborated by any other anthropometric measures. However, the study result is important to inform the national and local authorities about the development of acute malnutrition among pregnant women during the floods and similar natural disasters which occur every year during monsoon season in Nepal.

CONCLUSIONS

This study found out that pregnant women who are unemployed, illiterate, who have husbands not employed for cash, who are living in food insecure households, and have low dietary diversity are at high risk of acute malnutrition following natural disasters like flash floods. During natural disasters, nutritional interventions should focus on food security and dietary diversity of pregnant women; especially those who are illiterate and financially weak. Further studies assessing the relationship between Water, sanitation and hygiene and nutritional status of pregnant women during natural disasters are recommended.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* (London, England). 2008 Jan;371(9608):243–60. [\[Article\]](#)
2. Abu-Saad K, Fraser D. Maternal nutrition and birth outcomes. *Epidemiol Rev.* 2010;32:5–25. [\[Article\]](#)
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* (London, England). 2013 Aug;382(9890):427–51. [\[Article\]](#)
4. Martorell R, Zongrone A. Intergenerational influences on child growth and undernutrition. *Paediatr Perinat Epidemiol.* 2012 Jul;26 Suppl 1:302–14.
5. Bahwere P. Severe acute malnutrition during emergencies: burden management, and gaps. *Food Nutr Bull.* 2014 Jun;35(2 Suppl):S47-51. [\[Article\]](#)
6. Sharma P, Guha-Khasnobis B, Khanal DR. Nepal Human Development Report 2014 [Internet]. Kathmandu, Nepal; 2014. [\[Download PDF\]](#)

7. Central Bureau of Statistics. National Population and Housing Censeus 2011 [Internet]. Kathmandu, Nepal; 2012. [\[Link\]](#)
8. GON, UKAID, WFP, NeKSAP. A Report on Food Security Impact of 2017 Flood in Terai [Internet]. 2017. [\[Download PDF\]](#)
9. Ministry of Health and Population. Health Management Information System Nepal. 2018.
10. Ververs M-T, Antierens A, Sackl A, Staderini N, Captier V. Which anthropometric indicators identify a pregnant woman as acutely malnourished and predict adverse birth outcomes in the humanitarian context? PLoS Curr [Internet]. 2013 Jun 7;5:eurrents.dis.54a8b618c1bc031ea140e3f2934599e8. [\[PubMed\]](#)
11. UNHCR, WFP. Guidelines for selective feeding: The management of malnutrition in emergencies. 2011.
12. Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response [Internet]. Geneva; 2018. Available from: www.spherestandards.org/handbook
13. WHO. Physical status: The use and interpretation of anthropometry. Geneva; 1995.
14. FAO. Guidelines for measuring household and individual dietary diversity [Internet]. 2010. [\[Download PDF\]](#)
15. Zerfu TA, Umata M, Baye K. Dietary diversity during pregnancy is associated with reduced risk of maternal anemia, preterm delivery, and low birth weight in a prospective cohort study in rural Ethiopia. Am J Clin Nutr [Internet]. 2016 May 11;103(6):1482–8. [\[Article\]](#)
16. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide (v.3). Washington, D.C.; 2007. <https://psycnet.apa.org/buy/PE>
17. ICF. Nepal Demographic and Health Survey 2016 [Internet]. Kathmandu, Nepal : MOH/Nepal, New ERA, and ICF ; 2017. [\[Download PDF\]](#)
18. Nepal Rastra Bank. Fifth Household Budget Survey 2014/15. Kathmandu, Nepal; 2016.
19. Demilew YM, Alene GD, Belachew T. Dietary practices and associated factors among pregnant women in West Gojjam Zone, Northwest Ethiopia. BMC Pregnancy Childbirth [Internet]. 2020;20(1):18. [\[Article\]](#)
20. Vasundhara D, Hemalatha R, Sharma S, Ramalaxmi BA, Bhaskar V, Babu J, et al. Maternal MUAC and fetal outcome in an Indian tertiary care hospital: A prospective observational study. Matern Child Nutr [Internet]. 2019/12/12. 2020 Apr;16(2):e12902–e12902. [\[PubMed\]](#)
21. Manohar S, Klemm R, Rajbhandary R, Adhikari R, Gauchan D, Shrestha K, et al. PoSHAN Community Studies Baseline Report [Internet]. Baltimore, MD; 2014. Available from: <http://hdl.handle.net/10427/008897>
22. Islam A, Islam N, Bharati P, Aik S, Hossain G. Socio-economic and demographic factors influencing nutritional status among early childbearing young mothers in Bangladesh. BMC Womens Health. 2016 Aug;16(1):58. [\[Article\]](#)
23. Bhandari S, Sayami JT, Thapa P, Sayami M, Kandel BP, Banjara MR. Dietary intake patterns and nutritional status of women of reproductive age in Nepal: findings from a health survey. Arch Public Heal [Internet]. 2016;74(1):2. [\[Article\]](#)
24. Singh A, Singh A, Ram F. Household food insecurity and nutritional status of children and women in Nepal. Food Nutr Bull. 2014 Mar;35(1):3–11. [\[Article\]](#)
25. Nigatu M, Gebrehiwot TT, Gemedo DH. Household Food Insecurity, Low Dietary Diversity, and Early Marriage Were Predictors for Undernutrition among Pregnant Women Residing in Gambella, Ethiopia. Prineas RJ, editor. Adv Public Heal [Internet]. 2018;2018:1350195. [\[Article\]](#)
26. USAID. Maternal dietary diversity and the implications for children 's diets in the context of food security. Infant young child Nutr Proj [Internet]. 2012;(January):1–6. [\[Download PDF\]](#)
27. Foote JA, Murphy SP, Wilkens LR, Basiotis PP, Carlson A. Dietary Variety Increases the Probability of Nutrient Adequacy among Adults. J Nutr [Internet]. 2004 Jul 1;134(7):1779–85. [\[Article\]](#)
28. Nguyen PH, Huybregts L, Sanghvi TG, Tran LM, Frongillo EA, Menon P, et al. Dietary Diversity Predicts the Adequacy of Micronutrient Intake in Pregnant Adolescent Girls and Women in Bangladesh, but Use of the 5-Group Cutoff Poorly Identifies Individuals with Inadequate Intake. J Nutr [Internet]. 2018 May 2;148(5):790–7. [\[Article\]](#)
29. Kemunto ML. Dietary Diversity and Nutritional Status of Pregnant Women Aged 15-49 Years Attending Kapenguria District Hospital West Pokot County, Kenya [Internet]. 2013. [\[Download PDF\]](#)
30. Lama N, Lamichhane R, KCSBGP, Wagle RR. Determinants of nutritional status of pregnant women attending antenatal care in Western Regional Hospital, Nepal. Int J Community Med Public Heal. 2018;5(12):5045–51.