Assessing malnutrition in pregnant women using the Dietary Diversity Score and the Mid-Upper Arm Circumference: A cross-sectional study, Zambia

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Abstract

Background One of the easiest and effective ways of predicting under nutrition is to use the Dietary Diversity Score (DDS) and the mid-upper arm circumference (MUAC). The dietary diversity score is a qualitative measure of food consumption reflecting an individual's access to different food items and therefore is a proxy indicator of the nutritional status. The aim of the study was to assess whether the DDS and MUAC can be used to assess the nutritional status of pregnant women attending antenatal.

Methods A cross-sectional survey was conducted at Chilenje level I Hospital in a township located in Lusaka city, Lusaka province. The study employed quantitative methods to collect and analyse data on the dietary patterns and if this can be used to assess the nutritional status of individuals 24 hours preceding the survey. Health facilities were selected using random sampling method and systematic sampling method was used to select a sample of 299 pregnant women. An interview schedule was used to collect data. Logistic regression was used to establish associations between DDS and MUAC.

Results In this study, 44% of the women were in the lowest dietary diversity category, which indicates inadequate nutrient intake, 31% in the medium category and 24% in the high intake. Maternal weight was associated with a 0.08 cm increase in MUAC (95% CI; 0.74 – 0.93) and this was statistically significant. Marital status and age (95% CI; 0.83 – 0.93) were significantly associated with an increase in MUAC in the univariate analysis but when adjusted for other confounders this was not significant (95% CI; 0.81 – 1.00). Consumption of organ meat was associated with a 0.21cm increase in MUAC (95% CI; 0.04 - 0.97).

Conclusion The study results indicated that 44% of the women had inadequate nutrient intake, indicating that the dietary diversity score can be used to predict malnutrition in pregnant women. The mid upper was negatively correlated with the 24hour dietary diversity score implying that we might not rely on this measurement to assess the nutritional status. Key words Dietary Diversity Score, Malnutrition, Mid Upper Arm Circumference, Pregnant women, Antenatal.

Background

Nutritional status of a woman is important for positive pregnancy outcome [1, 2]. The nutritional status can be assessed using different parameters, one of them being the Mid-upper arm circumference (MUAC) [2–4], a simple measurement used to evaluate the nutritional status of an individual [5, 6] and serves as a surrogate of the body mass in pregnant women [7]. The MUAC is one of the most effective ways of determining short term change in the nutritional status of an identified population [8]. Biochemically nutritional status measurements in low-income countries are often too expensive to be used consistently thus there is need to use anthropometric measurements such as MUAC to determine the nutritional status of individuals [9]. The MUAC, on the other hand can be influenced by the Dietary Diversity Score (DDS).

Low intake of micronutrients caused by poor diet is one of the commonest causes of under nutrition [10]. One of the easiest and effective ways of predicting under nutrition is to use the DDS [11, 12]. The DDS is a qualitative measure of food consumption reflecting an individual's access to different food items and therefore is a proxy indicator of the nutritional status [13]. The 24-hour dietary recall is a subjective report method of collecting data [14] where the individual has to recall what they have consumed in the last 24 hours. There are different methods of conducting the survey, but the commonest one is a qualitative aspect where in-depth interviews are conducted by a trained interviewer or by self-reporting.

However, a single 24-hour dietary recall is not enough to make adequate conclusions about an individual's food intake and nutrient adequacy [15], because it is based on evaluating a day's intake. To evaluate the effect of nutrient intake, other than using the DDS, it is necessary to consider the MUAC, which is an important tool in the assessment of the nutritional status [16]. The MUAC is measured as the circumference of the right hand from the mid-point between the olecranon process (tip of the shoulder) and the acromion (tip of the elbow) [17]. Generally, a MUAC of between 22 and 23 cm indicates undernourishment [18] though this may vary from country to country [19].

The cut-off point for MUAC varies from one area to another. A study conducted in China considered a cut-off point of 22cm MUAC for the malnourished category of women, 7.3% of pregnant women were found to be malnourished but when the MUAC cut off was raised to 23 cm the number of malnourished women rose to 14.7% [20]. This indicates that the phenomenon of having women in the malnourished category is not limited to Zambia. In this study, the following MUAC cut-off points were considered; $\leq$ 26.3cm and below was considered to be malnutrition and $\geq$ 26.4 as normal [16].

Dietary intake is an important indicator of pregnancy outcome [21, 22]. Research has shown that poor diet quality can be associated with a negative cognitive function of an individual [23, 24] thus stressing the need for dietary intake assessment methods. In most African countries, most of the women rely on starchy staples, vegetables and seasonal fruits for their diet and are plenty in rainy season [25, 26]. In Zambia, the staple food is nsima, a thick porridge made out of maize meal or cassava in some areas and it is eaten with meat, beans and green leafy vegetables.

The primary objective of this paper was to assess whether the DDS and MUAC can be used to assess the nutritional status in pregnant women attending the first antenatal visit. In Zambia, there is limited data on methods of nutritional assessment of women during antenatal care especially on the use of MUAC thus the reason why the investigator decided to embark on this study. Knowledge on the use of anthropometric measurements in pregnancy such as MUAC would enable adjustments on quality of care after diagnosing the nutritional status.

Methods

The study was conducted at Chilenje level I Hospital in a township located in Lusaka city, Lusaka province. Chilenje is a medium income residential area [27, 28]. However, the study area comprises a mixture of community members in the medium and low-income category. This has a bearing on the type of diet that the women were exposed to, that is, ranging from adequate to inadequate. The majority of the occupants were self-employed with a few in formal employment. Most of the people who were self-employed were engaged in small-scale businesses. Most of the families were able to meet their basic needs. Some people consumed a lot of alcohol and drug abuse was prevalent in the area. During the study period, there was relatively a good amount of food available as the rainy period in Zambia is usually accompanied by fresh fruits and vegetables. The study was undertaken between December 2017 and June 2018 when most of the food items were readily available and relatively affordable. The data on DDS were categorized in nine food groups [13], scored as 0 if not eaten and 1 if a specific food item was consumed, regardless of the number of times within 24 hours for instance, consuming all the 9 food stuffs resulted in a maximum score of 9. The following were the food items: (1) Starchy staples such as maize and cassava (2) Dark green leafy vegetables (3) Fruits and vegetables rich in vitamin A like pawpaw (4) Fruits and vegetables without vitamin A like guavas and cucumbers (5) organ meat (6) meat and fish (7) eggs (8) legumes, nuts and seeds and (9) milk and milk products [29]. A maximum score of “one” was allocated to the woman if they consumed that particular food item in the previous 24 regardless of the number of times an individual food item was consumed.

Study Design, Population and Sampling

The study design was cross-sectional and employed quantitative data collection and analysis methods to investigate dietary patterns of individual women in the previous 24 hours before the survey. The study population comprised pregnant women attending antenatal care for the first time in their current pregnancy. Random sampling method was employed to select the Health facility and a study sample of 269 respondents was systematically selected. Women aged between 15 and 49 years of age with singleton pregnancy were eligible for the study. Women who had multiple pregnancy, on medication such as Zinc and those who had a blood transfusion three (3) months before the study were not eligible for the study.

Data Collection and Analysis

Data were collected using an interview schedule and analyzed using the quantitative method. The data were collected from December 2017 to June 2018. The women were asked to mention the food items, which they consumed in the last 24 hours of the survey. In this study, MUAC tape recommended by the Food and Agricultural Commission was used (UNICEF Supply Division). Women who had a cut off ≤ 26.3cm and below were considered malnourished and those ≥ 26.4 as well nourished [16]. The median and interquartile range were used to compare the demographic characteristics and the women’s DDS where data was not normally distributed.

Each variable was tested for normality before determining the correlation test to use. Log transformation was used to normalize dependent variables which were continuous so as to meet the assumptions of linear regression. Spearman’s Correlation was used to determine the relationship between two continuous variables where data was not normally distributed and Pearson’s correlation where data was normally distributed. Simple linear regression was used to determine the relationship between MUAC and the independent variables. All variables with p values of 0.25 and below in the univariate analysis were considered in the adjusted regression. All statistical analyses were done using STATA version 13 (Stata Corp, College Station, Texas, USA). A p value of <0.05 was considered statistically significant for all statistical tests.

Ethical Approval

The University of Zambia Biomedical Research Ethics Committee approved the study (UNZABREC Ref: 007–11–17). The study was conducted in accordance with the Helsinki declaration. Participants signed an informed written consent and were free to withdraw from the study whenever they wished to do so. Written informed consent was obtained from guardians or parents of participants who were below 16 years of age.

Results

Demographic Characteristics of the Participants

Information on the demographic characteristics is shown in Table 1

A total of 296 participants were interviewed. The majority of the participants, 65% were in the age group between 25 to 50 years. The youngest participant was aged 13 and the oldest, 44 years [30]. The median age was 27 years. Most of the women, 80% booked in the second trimester whereas only 11% (30) booked in the first trimester.

With regards to marital status, 78% of the study participants were married. The majority of these women, 81%(241) had attained at least secondary or tertiary education. Less than half, 34%(100) of the women were in formal employment. At the time of the study (June 2018), 1 Zambian Kwacha (ZMW) was equivalent to USD 12. The lowest household income was USD 1.3 and most of the women 82%(131) had a household income of less than USD 1.90 per day. The lowest household income was USD 8.3 whereas the highest was USD 4,167 with the median income of USD 12.5.

Slightly below half, 44%(104) of these women had a low DDS of 0 to 3 with 203 (75%) having a mid-upper arm circumference between 26.4 and 50cm. Among all the women, only one smoked.

Table 1: Baseline characteristics of study participants (n = 296)

Variable	Category	Frequency (%)
Age (Years)	13 - 19	8
	20 – 24	27
	25 – 44	65
Educational level	Primary	19
	Secondary/tertiary	81
Income	Low	82
	Medium	6
	High	12
Employment status	Yes	34
	No	66
	Medium	6
	High	12
DDS	Low (0 - 3)	44
	Medium (4 - 5)	31
	High (6 - 9)	25
MUAC (cms)	0 – 26.3	25
	26.4 – 50	75
Trimester	First	11
	Second	80
	Third	10
Marital status	Married	78
	Single	22
Alcohol intake	Yes	20
	No	81
HIV status	Reactive	82.39
	Non- reactive	17.61

DDS = Dietary Diversity Score
MUAC = Mid-upper Arm Circumference

Regression co-efficient between MUAC and the independent variables (Table 2)

In this study, nutritional status was described by assessing the mid-upper arm circumference with the independent variables. For every unit increase in age, there was a 0.91 cm increase in the mid-upper arm circumference (95% CI; 0.81 – 1.00) although this was not statistically significant. Moving from low to medium income the mid-upper arm circumference increased by 2.09 units but not statistically significant (95% CI; 0.69 – 6.31). Moving from medium to high income the mid-upper arm circumference increased by 1.02 cms but not statistically significant (0.16 – 6.61). For education status, moving from primary to secondary level of education, MUAC 1.15 cms (95% CI; 0.38 – 3.48) and 1.27 cms moving from primary to tertiary education (95% CI; 0.26 – 6.23) but both were not statistically significant. Moving from being married to being single the MUAC increased by 1.54 cms (95% CI; 0.46 – 5.10) but not statistically significant. For every unit increase in the number of children MUAC increased by 1.21 cms (95% CI; 0.74 – 1.98) but not statistically significant. For every unit increase in weight MUAC there was a 0.88unit increase in MUAC (95% CI; 0.74 – 1.98) and this was statistically significant.

Table 2: Logistic regression between MUAC and the independent variables

	MUAC ≥ 26.4 (unadjusted)			MUAC ≥ 26.4 (adjusted)		
Variable	**OR**	**(95% CI)**	**p-value**	**aOR**	**(95% CI)**	**p-value**
Age (yrs)	0.88	0.83 – 0.93	<0.001	0.91	0.81 – 1.00	0.072
Income						
-Low	Ref.					
-Medium	0.76	0.34 – 1.71	0.513	2.09	0.69 – 6.31	0.190
-High	0.40	0.11 – 1.41	0.154	1.02	0.16 – 6.61	0.985
Employed						
No	Ref.					
Yes	0.47	0.25 – 0.90	0.022	0.97	0.35 – 2.74	0.804
Educational status						
1. Primary	Ref.					
- Secondary	1.26	0.62 – 2.59	0.526	1.15	0.38 – 3.48	0.804
- Tertiary	0.58	0.24 – 1.42	0.234	1.27	0.26 – 6.23	0.768
Married						
-Yes	Ref.					
-No	0.27	1.37 – 4.62	0.003	1.54	0.46 – 5.10	0.483
Pari ty	0.71	0.56 – 0.89	0.003	1.21	0.74 – 1.98	0.445
Weight	0.87	0.83 – 0.91	<0.001	0.88	0.74 – 0.93	<0.001

aOR adjusted odds ratio

OR odds ratio

CI confidence interval

DDS = Dietary Diversity Score

R^2 = 0.2955% on average, thus about 2% of the total variation in the MUAC can be explained by variations in the independent variables such as age, household income, occupation, and weight. Only body weight was statistically significant. The other variables did not have a significant influence on the MUAC.

Predictors of Mid-Upper arm circumference

Results for the predictors of MUAC are shown in Table 3. Consumption of green leafy vegetables resulted in a 0.58-unit increase in MUAC (95% CI; 0.31 – 1.07) but not statistically significant. Consumption of vitamin A rich fruits and vegetables resulted in a1.03 cm increase in MUAC (95% CI; 0.54 - 1.93) but not statistically significant. Consumption of organ meat resulted in a 0.21 cm increase in MUAC and was statistically significant (95% CI; 0.04 - 0.97). Consumption of fish and meat resulted in a 1.17cm (95% CI; 0.61 - 2.21) increase in MUAC but this was not statistically significant. Consumption of other fruits not rich in vitamin A was associated with a 0.61 cm increase in MUAC (95% CI; 0.19 - 1.91) but not statistically significant. Consumption of eggs was associated with a 0.80cm increase in MUAC (95% CI; 0.42 - 1.53) but this was not statistically significant. Consumption of milk was associated with a 1.77cm increase in MUAC (95% CI; 0.91 - 3.42) but this was not statistically significant.

Table 3: Logistic regression between Mid-Upper Arm Circumference and Dietary Diversity Score

Variables	MUAC ≥ 26.4 (unadjusted)	MUAC ≥ 26.4
	OR (95% CI) p value	aOR (95% CI) p value
Starchy staples	-	-
Dark green leafy vegetables	0.06 (0.32 – 0.98) 0.04	0.58 (0.31 – 1.07) 0.08
Vitamin A fruits and vegetables	0.89 (0.51 – 1.55) 0.67	1.03 (0.54 - 1.93) 0.92
Organ meat	0.18 (0.04 – 0.81) 0.02	0.21 (0.04 - 0.97) 0.04
Meat and fish	- - -	1.17 (0.61 - 2.21) 0.63
Other fruits	0.57 (0.19 – 1.75) 0.33	0.61 (0.19 - 1.91) 0.39
Eggs	0.74 (0.42 – 0.34) 0.33	0.80 (0.42 - 1.53) 0.50
Legumes and nuts	0.97 (0.56 – 1.71) 0.94	- - -
Milk	1.39 (0.77 - 2.53) 0.27	1.77 (0.91 - 3.42) 0.09

aOR adjusted odds ratio
OR odds ratio
CI confidence interval

Discussion

Our study attempted to use 24 hours DDS which is a proxy measure of nutrition and whether it can correlate with MUAC in pregnant women attending the first antenatal visit among women. The majority of the women booking in the second trimester is similar to a study conducted by Nsibu and others in the Democratic Republic of Congo where the majority of antenatal women reported to the clinic after the first trimester [31]. Reporting to the antenatal clinic in the first trimester is important as ailments can be detected in good time and treated before affecting the foetus [32]. Women in this study might have shunned early antenatal booking as most of them feel that pregnancy is a natural phenomenon and does not require much intervention by the hospital authorities [33].

The number of women who had a low DDS in this study suggests undernutrition though this is higher than the magnitude of the problem reported in Ethiopia and Kenya respectively [34, 35] (28.6% and 31.7%). It is possible that the observed differences with the two studies could be due to different MUAC cut-off points that were used or Body mass index (BMI) difference among regions. However, in our study, we did not calculate the BMI of the women. This is because it is difficult to calculate the BMI in pregnancy unless the woman knows the pre-pregnancy weight.

In our study, the DDS was negatively correlated with the MUAC. Similarly, Ghosh and his colleagues in their study, found that having a high DDS did not have a positive increase on the MUAC [36]. In this study, the DDS could have been negatively correlated with MUAC as the 24-hour dietary recall may not give a true reflection of the daily food intake of the participants. The positive correlation between age and MUAC is in keeping with a study among pregnant women conducted by Fakier et al., in the Metro West area of Cape Town [37]. A cross-sectional study in Bangladesh in both male and female adults showed that there was a positive linear correlation between MUAC and the Body Mass Index (BMI) [38] which justifies the use of anthropometric measurements in nutritional assessment. The BMI is difficult to calculate in pregnancy as it requires calculation of the pre-pregnancy weight which very few women can remember [39].

Being single and poor were independently associated with lower MUAC at first antenatal visit. Other studies have shown that being poor, single and parity of more than three are associated with lower MUAC [40] in keeping with this study. However, one of the differences between the two studies was that we did not find associations between MUAC and lower education but in the other studies associations were reported. On the other hand, the United States Agency for International Development (USAID) reported that high fertility and unwanted pregnancy contributed to decreased nutritional status in women [35].

In this study, the median age was 27 years which is higher than what is reported in other studies [41]. In our study we did not get information about age at first marriage but other studies have shown that women who were married or cohabiting were less likely to be under nourished [42]. Although in our study there was no association between alcohol and lower MUAC, some studies have reported that alcohol consumption is associated with under nutrition and lower MUAC [43]. This was probably due to the lower number of women who reported that they consumed alcohol (20%) compared to other studies where there is almost equal number of women who consume alcohol to those who do not [44, 45]. We did not determine the association between MUAC and smoking because of the insufficient numbers (1%) of participants that smoked in this study. However others have reported that women who smoke during pregnancy were more likely to have lower MUAC and lower baby birth weight compared to non-smokers [46].

Other studies have reported that HIV positive status was independently associated with lower MUAC [47]. One would speculate that it could be due to the independent effect of HIV on the immune system which is likely to be observed especially in immune compromised states. Surprisingly, in this study there was no association between HIV and lower MUAC suggesting that maybe it was not an immune compromised group although we did not check for CD4 or viral load to confirm our claims.

In our study, the majority of the women consumed starchy staples as part of their diet. This could be due to the fact that Zambia's main staple food is maize [48]. This is confirmed by the Science Brief on Bio fortification which explains that most of the African countries rely on maize as a staple food [49]. Eating of dark green leafy vegetables was significant in the univariate analysis but not in the multivariate one. These findings have some similarities with the National Food and Nutrition Commission where it was discovered that most of the pregnant women took green leafy vegetables as part of their diet most of the time [50]. Consumption of the vegetables in the Zambian diet is very common as they are cheap and most of the people cannot afford a varied diet. Eating vegetables however is an advantage as one is protected from cancer [51, 52]. On the contrary, a study conducted in northern Ghana revealed that pregnant women who were of a low socio-economic status ate less vegetables compared to those who were of a higher socio-economic status. In the same study, there was a strong negative association between the consumption of animal products in the previous 24 hours and socio-economic status [53].

A cross-sectional descriptive study aimed at evaluating dietary habits among pregnant women in Turkey revealed that most of the foods consumed were fruits and vegetables with a decrease in the consumption of tea and red meat (22). Pregnant women from a low socio-economic class were two times more likely to be undernourished compared to pregnant women from food secure households [54]. In the same study, pregnant women and their husbands who had low levels of education were more likely to be undernourished compared to those who had higher levels of education showing that the educational status can have a bearing on the nutritional status of individuals.

A study aimed at assessing the consumption pattern and dietary practices of women in Nigeria revealed high consumption of cereals and grains, in particular rice, the mostly consumed fruits were oranges and green leafy vegetables, whereas fish, meat and eggs were eaten on a daily basis [55]. The study limitations include the fact that most of the participants were from a middle income background, however, non-adjusted and adjusted analysis was performed to factor in for the confounders. Additionally, it is possible that there was recall bias on the type of food consumed the previous day but women were given time to think about the activities that took place.

Conclusion

In this study, it was discovered that 44% of the women were in the lowest DDS category, which indicates inadequate nutrient intake, 31% in the medium category and 24% in the high intake. This implies that most of the women are unable to take adequate nutrients. These results might be attributed to the fact that most of the women (40%) were in the lower income category as the income may have a bearing on the quality and quantity of food (56, 57). In this study, the DDS was negatively correlated with MUAC which is unusual as we expect the MUAC to be higher under normal circumstances. This suggests that the food consumed in the previous 24 hours before the study did not have an impact on the MUAC. Despite most of the women being in the lower DDS category, most of them (75%) were in the higher MUAC category meaning that their nutritional status was good. However, the study findings might not be generalized to the rural areas of Zambia where dietary patterns differ from the urban population.

List Of Abbreviations

DDS: Dietary Diversity Score; MUAC: Mid-Upper arm circumference; UNICEF: United Nations Children's Fund; UNZABREC: University of Zambia Biomedical Research Ethics Committee; ZMW: Zambian Kwacha; USD: United States Dollar; IQR: Interquartile Range: HIV: Human Immunodeficiency virus; OR: Odds Ratio; aOR: Adjusted Odds ratio; CI: Confidence Interval; BMI: Body Mass Index; USAID: United States Agency for International Development; CD4: Cluster of Differentiation 4; NORHED: Norwegian Programme for Capacity Development in Higher Education and Research for Development; TROPGAN: Tropical Gastroenterology and Nutritional Group; SACORE: Southern African Consortium for Research Excellence.

Declarations

Ethics declaration

The University of Zambia Biomedical Research Ethics Committee approved the study (UNZABREC Ref: 007-11-17). The study was conducted in accordance with the Helsinki declaration. Participants signed an informed consent and were free to withdraw from the study whenever they wished to do so. Written consent was obtained from the parents or guardians of participants who were aged below 16 years of age.

Consent for publication

Not applicable

Availability of data and materials

The datasets used for analysis can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

CMH, PK[5] and CK provided the survey materials, SM drafted the manuscript BP, EC and CM revised the manuscript and PK[6]conducted the statistical analysis. All authors read and approved the final manuscript.

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References

1. Lim Z, Wong J, Lim P, Soon LJIJoPH, Sciences C. Knowledge of nutrition during pregnancy and associated factors among antenatal mothers. 2018;5(1):117-28.

2. Oliver E, Grimshaw K, Schoemaker A, Keil T, McBride D, Sprikkelman A, et al. Dietary habits and supplement use in relation to national pregnancy recommendations: data from the EuroPrevall birth cohort. 2014;18(10):2408-25.
3. Bhattacharya A, Pal B, Mukherjee S, Roy SKJBPH. Assessment of nutritional status using anthropometric variables by multivariate analysis. 2019;19(1):1045.
4. Van Tonder E, Mace L, Steenkamp L, Tydeman-Edwards R, Gerber K, Friskin D. Mid-upper arm circumference (MUAC) as a feasible tool in detecting adult malnutrition. South African Journal of Clinical Nutrition. 2019;32(4):93-8.
5. Benítez Brito N, Suárez Llanos JP, Fuentes Ferrer M, Oliva García JG, Delgado Brito I, Pereyra-García Castro F, et al. Relationship between Mid-Upper Arm Circumference and Body Mass Index in Inpatients. PLOS ONE. 2016;11(8):e0160480.
6. Debnath S, Mondal N, Sen J. Use of upper arm anthropometry, upper arm muscle area-by-height (UAMAH) and midupper-arm-circumference (MUAC)-for-height as indicators of body composition and nutritional status among children. Anthropological Review. 2017;80(1):85-102.
7. Fakier A, Petro G, Fawcus S. Mid-upper arm circumference: A surrogate for body mass index in pregnant women. South African Medical Journal. 2017;107(7):606-10.
8. Frison S. Middle-upper arm circumference for nutritional surveillance in crisis-affected populations: Development of a method: London School of Hygiene & Tropical Medicine; 2017.
9. Kulathinal S, Freese R, Korkalo L, Ismael C, Mutanen M. Mid-upper arm circumference is associated with biochemically determined nutritional status indicators among adolescent girls in Central Mozambique. Nutrition Research. 2016;36(8):835-44.
10. Ngala S. Evaluation of dietary diversity scores to assess nutrient adequacy among rural Kenyan women: Wageningen University; 2015.
11. Zhao W, Yu K, Tan S, Zheng Y, Zhao A, Wang P, et al. Dietary diversity scores: an indicator of micronutrient inadequacy instead of obesity for Chinese children. BMC Public Health. 2017;17:440.
12. Caswell BL, Talegawkar SA, Siamusantu W, West JKP, Palmer AC. A 10-Food Group Dietary Diversity Score Outperforms a 7-Food Group Score in Characterizing Seasonal Variability and Micronutrient Adequacy in Rural Zambian Children. The Journal of Nutrition. 2018;148(1):131-9.
13. Kennedy GB, T. Dop, MC,. Guidelines for Measuring Household and Individual Dietary Diversity. Rome: Food and Agriculture Organization; 2013.
14. Shim J-S, Oh K, Kim HC. Dietary assessment methods in epidemiologic studies. Epidemiology and health. 2014;36:e2014009-e.
15. FAO. Dietary Assessment. Rome: Food and Agriculture Organisation of the United Nations; 2018 2018. Contract No.: ISBN 978-92-5-130635-2.
16. Tang AM, Chung M, Dong K, Terrin N, Edmonds A, Assefa N, et al. Determining a Global Mid-Upper Arm Circumference Cutoff to Assess Malnutrition in Pregnant Women. FHI; 2016.
17. Yallamraju SR, Mehrotra R, Sinha A, Gattumeedhi SR, Gupta A, Khadse SV. Use of mid upper arm circumference for evaluation of nutritional status of OSMF patients. Journal of International Society of Preventive & Community Dentistry. 2014;4(Suppl 2):S122-S5.
18. 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 Currents. 2013;5:ecurrents.dis.54a8b618c1bc031ea140e3f2934599c8.
19. Alvarez JL, Dent N, Browne L, Myatt M, Briend A. Mid-Upper Arm Circumference (MUAC) shows strong geographical variations in children with edema: results from 2277 surveys in 55 countries. Archives of Public Health. 2018;76(1):58.
20. Gao H, Stiller CK, Scherbaum V, Biesalski HK, Wang Q, Hormann E, et al. Dietary Intake and Food Habits of Pregnant Women Residing in Urban and Rural Areas of Deyang City, Sichuan Province, China. Nutrients. 2013;5(8):2933-54.
21. Ramlal RT, Tembo M, King CC, Ellington S, Soko A, Chigwenembe M, et al. Dietary patterns and maternal anthropometry in HIV-infected, pregnant Malawian women. Nutrients. 2015;7(1):584-94.
22. Şenol Eren N, Şencan İ, Aksoy H, Koç EM, Kasım İ, Kahveci R, et al. Evaluation of dietary habits during pregnancy. Turkish Journal of Obstetrics and Gynecology. 2015;12(2):89-95.
23. Wright RS, Waldstein SR, Kuczmarski MF, Pohlig RT, Gerassimakis CS, Gaynor B, et al. Diet quality and cognitive function in an urban sample: findings from the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. Public Health Nutrition. 2016;20(1):92-101.
24. Wright RS, Waldstein SR, Kuczmarski MF, Pohlig RT, Gerassimakis CS, Gaynor B, et al. Diet quality and cognitive function in an urban sample: findings from the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. Public health nutrition. 2017;20(1):92-101.
25. Kiboi W. Dietary diversity, nutrient intake and nutritional status among pregnant women in Laikipia county, Kenya. 2016.
26. Kinyua LW. Association of Nutrition Knowledge and Attitude with Dietary Practices and Nutritional Status of Female Undergraduate Students Attending University Colleges within Nairobi Metropolis (Unpublished Doctoral Dissertation). The University of Nairobi, Kenya.

2013.

27. Owino V, Amadi B, Sinkala M, Filteau S, Tomkins AJAJoF, Agriculture, Nutrition, Development. Complementary feeding practices and nutrient intake from habitual complementary foods of infants and children aged 6-18 months old in Lusaka, Zambia. 2008;8(1):28-47.
28. Simatele M, Binns J, Simatele M. Sustaining livelihoods under a changing climate: The case of urban agriculture in Lusaka, Zambia. Journal of Environmental Planning and Management - J ENVIRON PLAN MANAG. 2012;55:1-17.
29. Kennedy G, Dop MJN, Division CP. Guidelines for measuring household and individual dietary diversity. Rome Italy: FAO. 2013.
30. Central Statistical Office (CSO) [Zambia], Ministry of Health (MOH) [Zambia], International I. Zambia Demographic and Health Survey 2013-14. Central Statistical Office, Ministry of Health, and ICF International; 2014.
31. Nsibu CN, Manianga C, Kapanga S, Mona E, Pululu P, Aloni MNJO, et al. Determinants of antenatal care attendance among pregnant women living in endemic malaria settings: experience from the Democratic Republic of Congo. 2016;2016.
32. Qin J-B, Feng T-J, Yang T-B, Hong F-C, Lan L-N, Zhang C-L, et al. Risk factors for congenital syphilis and adverse pregnancy outcomes in offspring of women with syphilis in Shenzhen, China: a prospective nested case-control study. 2014;41(1):13-23.
33. Qureshi RN, Sheikh S, Khowaja AR, Hoodbhoy Z, Zaidi S, Sawchuck D, et al. Health care seeking behaviours in pregnancy in rural Sindh, Pakistan: a qualitative study. 2016;13(1):34.
34. Nigatu M, Gebrehiwot TT, Gemeda DH. Household Food Insecurity, Low Dietary Diversity, and Early Marriage Were Predictors for Undernutrition among Pregnant Women Residing in Gambella, Ethiopia. Advances in Public Health. 2018;2018.
35. Rana MJ, Goli S. Family Planning and Its Association with Nutritional Status of Women: Investigation in Select South Asian Countries. Indian Journal of Human Development. 2017;11(1):56-75.
36. Ghosh S, Spielman K, Kershaw M, Ayele K, Kidane Y, Zillmer K, et al. Nutrition-specific and nutrition-sensitive factors associated with mid-upper arm circumference as a measure of nutritional status in pregnant Ethiopian women: Implications for programming in the first 1000 days. PLOS ONE. 2019;14(3):e0214358.
37. Grellety E, Golden MHJBn. Weight-for-height and mid-upper-arm circumference should be used independently to diagnose acute malnutrition: policy implications. 2016;2(1):10.
38. Sultana T, Karim MN, Ahmed T, Hossain MI. Assessment of under nutrition of Bangladeshi adults using anthropometry: can body mass index be replaced by mid-upper-arm-circumference? PloS one. 2015;10(4):e0121456.
39. Russell A, Gillespie S, Satya S, Gaudet LM. Assessing the Accuracy of Pregnant Women in Recalling Pre-Pregnancy Weight and Gestational Weight Gain. Journal of Obstetrics and Gynaecology Canada. 2013;35(9):802-9.
40. Mtumwa AH, Paul E, Vuai SA. Determinants of undernutrition among women of reproductive age in Tanzania mainland. South African Journal of Clinical Nutrition. 2016;29(2):75-81.
41. Feyissa TR, Genemo GA. Determinants of institutional delivery among childbearing age women in Western Ethiopia, 2013: unmatched case control study. PloS one. 2014;9(5):e97194-e.
42. Mtumwa AH, Paul E, Vuai SAH. Determinants of undernutrition among women of reproductive age in Tanzania mainland. South African Journal of Clinical Nutrition. 2016;29(2):75-81.
43. Nunes G, Santos CA, Barosa R, Fonseca C, Barata AT, Fonseca J. Outcome and Nutritional Assessment of Chronic Liver Disease Patients Using Anthropometry and Subjective Global Assessment. Arquivos de gastroenterologia. 2017;54(3):225-31.
44. Watts R, Linke S, Murray E, Barker C. Calling the shots: Young professional women's relationship with alcohol. Feminism & Psychology. 2015;25(2):219-34.
45. Colell E, Sánchez-Niubò A, Domingo-Salvany A. Sex differences in the cumulative incidence of substance use by birth cohort. International Journal of Drug Policy. 2013;24(4):319-25.
46. Zheng W, Suzuki K, Tanaka T, Kohama M, Yamagata Z, Okinawa Child Health Study G. Association between Maternal Smoking during Pregnancy and Low Birthweight: Effects by Maternal Age. PLoS One. 2016;11(1):e0146241.
47. Wilkinson AL, Pedersen SH, Urassa M, Michael D, Todd J, Kinung'hi S, et al. Associations between gestational anthropometry, maternal HIV, and fetal and early infancy growth in a prospective rural/semi-rural Tanzanian cohort, 2012-13. BMC Pregnancy and Childbirth. 2015;15(1):277.
48. Faostat F. Disponível em:< http://faostat. fao. org>. Acesso em. 2012;14.
49. Menkir A, Palacios-Rojas, Alamu N. Vitamin A-Biofortified Maize: Exploiting Native Genetic Variation for Nutrient Enrichment Cimmyt,lita, Embrapa, HarvestPlus, and Crop Trust Bonn, Germany; 2018.
50. Zambia TNFaNCo. Qualitative Assessment of Maternal Nutrition Practices in Zambia. Lusaka: National Food and Nutrition Commission; 2010.
51. Norat T, Scoccianti C, Boutron-Ruault MC, Anderson A, Berrino F, Cecchini M, et al. European Code against Cancer 4th Edition: Diet and cancer. Cancer epidemiology. 2015;39 Suppl 1:S56-66.

52. Schwingshackl L, Schwedhelm C, Galbete C, Hoffmann G. Adherence to Mediterranean Diet and Risk of Cancer: An Updated Systematic Review and Meta-Analysis. Nutrients. 2017;9(10).
53. Saaka M, Oladele J, Larbi A, Hoeschle-Zeledon I. Household food insecurity, coping strategies, and nutritional status of pregnant women in rural areas of Northern Ghana. Food Science & Nutrition. 2017;5(6):1154-62.
54. Nigatu M, Gebrehiwot TT, Gemeda DH. Household Food Insecurity, Low Dietary Diversity, and Early Marriage Were Predictors for Undernutrition among Pregnant Women Residing in Gambella, Ethiopia. Advances in Public Health. 2018;2018:10.
55. Ademuyiwa M, Sanni S. Consumption pattern and dietary practices of pregnant women in Odeda local government area of Ogun state. Int J Biol Vet Agric Food Eng. 2013;7:11-5.
56. Corfe SJSMF. What are the barriers to eating healthily in the UK. 2018.
57. Anderson PM, Butcher KFJCoB, June PPP. The relationships among SNAP benefits, grocery spending, diet quality, and the adequacy of low-income families' resources. 2016;14.

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