

Dietary Diversity, Body Mass Index and Haemoglobin Concentration of Health Students in a Public University in Ghana

Matilda Asante, Candy Ntiamoah, Samuel A. Sackar*, Eunice Nortey, Portia Nkumsah-Riverson, Freda D. Intiful
Department of Dietetics, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana
P.O. Box KB143, Accra-Ghana
*Corresponding author (sasackar@gmail.com)

There were no external funding sources for this study.

Abstract

Background: Tertiary students are known to have poor dietary habits and at risk of iron deficiency anaemia. The aim of this study was to assess the dietary diversity of Allied Health students and determine its relationship with haemoglobin (Hb) concentration and body mass index (BMI). **Methods:** A cross-sectional descriptive study was carried out among 96 health students in the University of Ghana. A stratified systematic sampling technique was used to select the participants and a structured questionnaire used to obtain demographic and socioeconomic information. Weight and height were measured, and BMI determined. Dietary diversity (DD) was assessed using the WHO/FAO guidelines. Haemoglobin concentration was measured using a portable hemocue 301^{+} analyser. Linear regression was used to determine the relationship between the DDS and Hb concentration, and BMI of the students. Level of significance was set at $p < 0.05$.**Results:** Mean age and BMI of the students were 21.8±1.7 years and 22.7±4.3kg/m^2 respectively. The mean DDS and Hb concentration were 4.68±1.40 and 12.6±1.3g/dl respectively. More than half (58%) of the students had moderate DD. Approximately forty percent (40.6%) of the students were anaemic. There was a strong positive correlation between BMI and DDS ($r= +0.810$, $p= 0.434$). **Conclusion:** These findings suggest a high prevalence of anaemia among the students, with half of them having a moderate DDS. There is a need for regular screening to identify and treat students with low haemoglobin concentrations. Although not significant there was a positive correlation between Hb concentration, BMI and Dietary Diversity score.

Keywords: dietary diversity, haemoglobin concentration, body mass index
DOI: 10.7176/JBAH/12-16-01
Publication date: August 31st 2022

Introduction

Dietary diversity describes the variety of foods within and across food groups capable of ensuring adequate intake of essential nutrients that can promote good health, physical and mental development (Mekuria, Wubneh and Tewabe, 2017). A diverse diet has been shown to reflect nutrient adequacy since no single food can meet the nutritional requirements of a person (Kiboi, Kimiywe and Chege, 2017). Mostly, monotonous staple diets lack essential nutrients leading to macronutrient and micronutrient deficiencies particularly in the most vulnerable groups (Worku, Hailemicael and Wondmu, 2017).

Optimal nutrition is critical during adolescence and young adult development. There have been indications that 50% of adult weight, height and skeletal muscle is attained during the adolescent period (Shahid *et al.*, 2010). However, about half of adolescent girls are found with sub-optimal dietary intake resulting in the development of varied micronutrient deficiencies such as vitamin A, iron, and iodine deficiencies (Delisle, 2005). Studies suggest that dietary diversity of adolescents are generally poor; with foods high in fat, salt, and sugar and low in fruits, vegetables, wholegrain and calcium-rich foods (Institute of Medicine, 2007; Tucker *et al.*, 2012). Poor dietary diversity increases the risk of developing several nutritional problems (Jayawardena *et al.*, 2013).

Some haematological changes associated with diversity in an individual's diet include, nutritional anaemia. Globally, nutritional anaemia affects 613 million women aged 15 to 49 years, corresponding to a prevalence of 32.8% (Development Initiatives, 2018). Of concern are tertiary students (mostly adolescents and young adults) who are vulnerable to iron deficiency anaemia because of increased iron requirements related to rapid growth and poor dietary habits evolving from poor dietary diversity (Benoist *et al.*, 2005). Menstruation also increases the risk of iron deficiency anaemia among female adolescents (Abdullah, Salem and Mohammed, 2018). Studies on the prevalence of nutritional anaemia with low haemoglobin concentration have been published but few have looked at its association with BMI (Manjeet *et al.*, 2015). Considering the increasing incidence of nutritional anaemia in adolescence and reports on the eating habits of university students, a study to determine the diet quality and haemoglobin concentration among such group of people is warranted.

Our aim was to assess the dietary diversity of Allied Health students in the University of Ghana and determine its relationship with haemoglobin concentration and body mass index. We hypothesised a significant relationship between dietary diversity score and haemoglobin concentration and a significant relationship between dietary diversity score and BMI among the students.

Materials and Methods

Study Population, Study Design and Sample Size

This cross-sectional study was conducted among 96 participants who were stratified according to course departments and year of study. Participants were second, third and fourth-year Allied Health students at the University of Ghana These students were resident on the university campus.

All second, third- and fourth-year students who consented to the study were included. Approval was obtained from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, University of Ghana.

Data Collection Procedures

A self-administered, semi-structured questionnaire adopted from the WHO STEPS questionnaire (World Health Organization, 2011), was used in this study. The questionnaire had five sections namely; socio-demographics, lifestyle behaviour, dietary intakes (24-hour recall) and the dietary diversity score. The questionnaire was pre-tested among 20 medical students to check for its validity and reliability.

Socio-demographic characteristics such as age, gender, educational level and other relevant information such as use of supplements and medications were obtained. Anthropometric measurements which included height, weight and BMI were measured following standard procedures. Height was measured to the nearest 0.1cm with a stadiometer (model HM200P Charder USA) on a firm, flat ground to ensure accuracy. Weight was measured with a UNICEF SECA floor scale (model 881 U, a maximum weighing capacity of 130kg), with participants in minimal clothing. Readings were taken to the nearest 0.1kg. All measurements were in duplicate and an average calculated. Body Mass Index was determined from the height and weight measurements and classified according to the WHO classification: underweight ($< 18.5 \mathrm{kg/m^2}$), normal weight (18.5 to 24.9$\mathrm{kg/m^2}$), overweight (25 to 29.9$\mathrm{kg/m^2}$) or obese ($> 30\mathrm{kg/m^2}$) (World Health Organization, 2005).

Determination of Haemoglobin Concentrations

Haemoglobin concentration was determined using a battery operated portable HemoCue 301^+ analyser and HemoCue 301^+ microcuvette according to the standard method described in HemoCueHb 301^+ manual (HemoCue, 2015). Blood samples were obtained from a drop of blood taken from the finger prick of each participant and collected into individual microcuvettes. Each microcuvette was placed into the cuvette holder and inserted into the measuring position. The Hb readings were then measured and recorded for each participant. All blood samples were handled appropriately following standard precautionary measures. The haemoglobin levels were categorized according to the WHO reference ;13.5 to 17.5g/dl for men and 12.0 to 15.5g/dl for women (World Health Organization, 2001).

Dietary Diversity

The 24-hour recall was used to obtain information on dietary intake. The students were asked to recall all foods and drinks they had taken in the past 24-hours. Household measures were used to aid with portion size estimation. Foods consumed were grouped according to the WHO/ FAO guidelines to obtain scores for dietary diversity. Dietary diversity was calculated using a simple count of food groups consumed over the period. The minimum 15g rule was used as indicative of food consumption from a group. This implies that food was deemed to have been consumed if an individual consumed at least 15g. A score of one was awarded when a food was consumed from a food group while zero was awarded when food was not consumed. The averages of the scores were computed. A scale of zero to nine was used to assess consumption from food groups. The dietary diversity (DD) score was categorized into three groups as: low dietary diversity (DD score 1 to 3), moderate dietary diversity (DD score of 4 to 5) and high dietary diversity (DD score of 6 to 10) (Food and Agricultural organization and World Health organization, 2016).

Statistical Analysis

The data was analysed using the Statistical Package for Social Sciences (SPSS) software, version 20.0. Descriptive data were summarized using figures, charts and tables of which sample characteristics were presented as mean and standard deviation for continuous variable, and frequencies and percentages for categorical variables. T-test was employed to determine differences between means for continuous variables while chi square test was used for categorical variables. Pearson correlation and linear regression were used to determine the relationships between the dietary diversity score and haemoglobin concentration as well as the dietary diversity score and BMI of the students. Level of significance was set at p-values <0.05.

Ethics

Ethical approval was obtained from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, University of Ghana. Permission from the various heads of departments was also sought. The protocol and purpose of the study was explained to the participants and written consent obtained before recruiting them in the study. The students were informed that participation was fully voluntary and that refusal to participate from the beginning or in the middle of the study would not affect them in any way. Students were assured of confidentiality of the information provided.

Results

Socio-Demographic Characteristics of Respondents

A total of ninety-six (96) students from different levels and departments participated in the study. Demographic characteristics of the students are shown in table 1. The mean age of the students was 21.8 ±1.7 years with no significant difference (p= 0.110) between gender. A significantly higher proportion (42.7% p=0.003) of the students were in their fourth year. Majority (64.6%) of the students were within the 21-23 years age group. About 40.6% of the students occupied hostel rooms alone while 59.4% had double occupancy.

Table 1: Socio-Demographic Characteristics of the Respondents

Variable	Male (n=46) N (%)	Female (n=50) N (%)	Total (n=96) N (%)	P-value
Age (Mean ± SD) years	22.1 ±1.6	21.6 ±1.7	21.8 ±1.7	0.110
Age range				
18-20	7 (7.3)	11 (11.5)	18 (18.8)	0.110
21-23	31 (32.3)	31 (32.3)	62 (64.6)	
24-26	8 (8.3)	8 (8.4)	16 (16.7)	
Department				
Medical Laboratory Sciences	15 (32.6)	13(26.0)	28(29.2)	
Physiotherapy	4 (8.7)	6 (12.0)	10(10.4)	
Dietetics	6 (13.0)	8 (16.0)	14(14.6)	
Radiography	11 (23.9)	11 (22.0)	22 (22.9)	
Occupational therapy	7 (15.2)	5 (10.0)	12 (12.5)	
Dental Laboratory Sciences	2 (4.3)	3 (6.0)	5 (5.2)	
Respiratory therapy	1 (2.2)	4 (8.0)	5 (5.2)	
Level				
Second year	14 (48.3)	15 (51.7)	29 (30.2)	0.033*
Third year	13 (50.0)	13 (50.0)	26 (27.1)	
Fourth year	19 (46.3)	22 (53.7)	41 (42.7)	
Room occupancy				
Single	19 (48.7)	20 (51.3)	39 (40.6)	0.897
Paired	27 (47.4)	30 (52.6)	57 (59.4)	

Means were compared using t-test; chi square test was used for categorical variables; p<0.05

Anthropometric characteristics of respondents

Table 2 shows the anthropometric indices of the participants. The mean weight was 65.2 ± 11.3kg and 61.4 ± 12.8 kg, for females and males respectively. Females were significantly heavier than males (p=0.002). There were no significant differences in height and BMI between the gender. More than half of the students had normal BMI.

Table 2: Anthropometric Characteristics of the Respondents

Variable	Male (n=46) (Mean ± SD)	Female (n=50) (Mean ± SD)	Total (N=96) (Mean ± SD)	p-value
Weight (kg)	61.4 ±12.8	65.2 ± 11.3	63.3 ±12.1	0.002*
Height (m)	1.6 ± 0.07	1.7 ± 0.09	1.7 ± 0.08	0.128
BMI (kg/ m^2)	22.6 ± 4.4	22.7 ± 4.2	22.7 ± 4.3	0.912
BMI Classification	**N (%)**	**N (%)**	**N (%)**	**P-value**
Underweight	6 (42.9)	8 (57.1)	14 (14.6)	
Normal weight	29 (48.3)	31 (51.7)	60 (62.5)	0.828
Overweight	7 (53.8)	6 (46.2)	13 (13.5)	
Obese	4 (44.4)	5 (55.6)	9 (9.4)	

BMI classified according to WHO reference values (2005). Underweight ($< 18.5kg/m^2$), normal weight (18.5-24.9kg/m^2), overweight (25-29.9kg/m^2) and obesity ($> 30kg/m^2$). T-test was used to determine differences between means while chi square test was used for categorical variables; p< 0.05

Dietary diversity of the participants

Figure1 shows the percentage of students that consumed foods from each food group. A higher proportion of the students consumed cereals (86%), followed by the meat and egg food group (69%) and fruits and vegetables (68%). A significantly higher proportion of females (p=0.041) compared to males consumed from the white root and tuber groups. The legumes, nuts and seeds food group recorded the lowest intake.

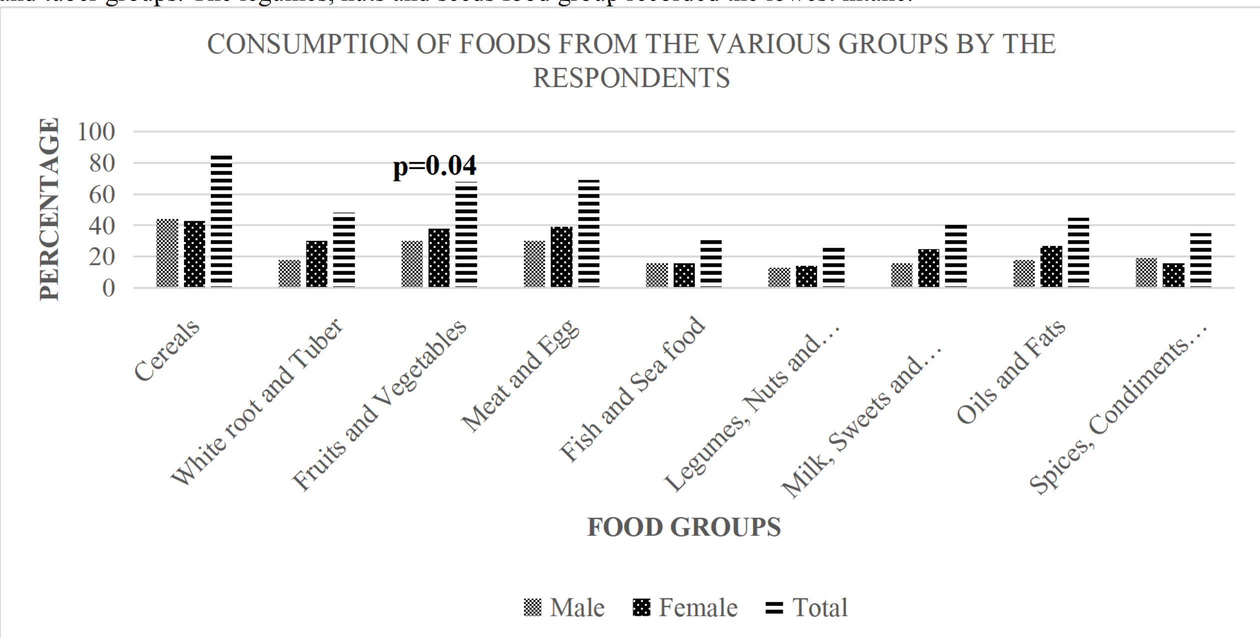

Figure 1: Food consumption patterns of foods from the various food groups

Haemoglobin Concentration of Respondents

Table 3 shows the haemoglobin concentration of the participants. The mean haemoglobin concentration was 12.6 ±1.3g/dl. There was no significant difference in haemoglobin concentration between gender. About 40.6% of the total population had low Hb levels. Low haemoglobin concentration was recorded among 51.3% males and 48.7% females.

Table 3: Haemoglobin Concentration of Participants

Variable	Males (n=46) n (%)	Females (n=50) n (%)	Total (N=96) n (%)	P-value
Haemoglobin (g/dl) (Mean ± SD)	12.8 ±1.4	12.4 ± 1.2	12.6 ±1.3	0.166
Hb Classification				
Low (Anaemic)	20 (51.3)	19 (48.7)	39 (40.6)	0.679
Normal	26 (45.6)	31 (54.4)	57 (59.4)	

Haemoglobin concentration reference range; for males (13.5-17.5g/dl) and females (12.0-155.5g/dl). (WHO, 2011).

Dietary Diversity Score of Respondents

Table 4 shows the dietary diversity score of the participants and their corresponding percentages. The mean dietary diversity score for males and females were 4.39 ±1.33 and 4.96 ±1.47 respectively. None of the male students had a dietary diversity score of 8.

Table 4: Dietary Diversity Score of the Students (N= 96)

Variable	Male N (%)	Female N (%)	Total N (%)
Mean DDS (Mean ± SD)	4.39 ±1.33	4.96 ± 1.47	4.68 ±1.40
DD SCORE			
2	3 (75.0)	1 (25.0)	4 (4.2)
3	10 (55.6)	8 (44.8)	18 (18.8)
4	10 (47.6)	11 (52.4)	21 (21.9)
5	16 (57.1)	12 (42.9)	28 (29.2)
6	3 (21.4)	11 (78.6)	14 (14.6)
7	4 (50.0)	4 (50.0)	8 (8.3)
8	0 (0.0)	3 (100)	3 (3.1)

Classification of Dietary Diversity Among the Students

Figure 2 shows the classification of dietary diversity of the students. More than half (58%) of the student population had moderate dietary diversity. Twenty-eight percent (28%) of the students fell into the high DD category.

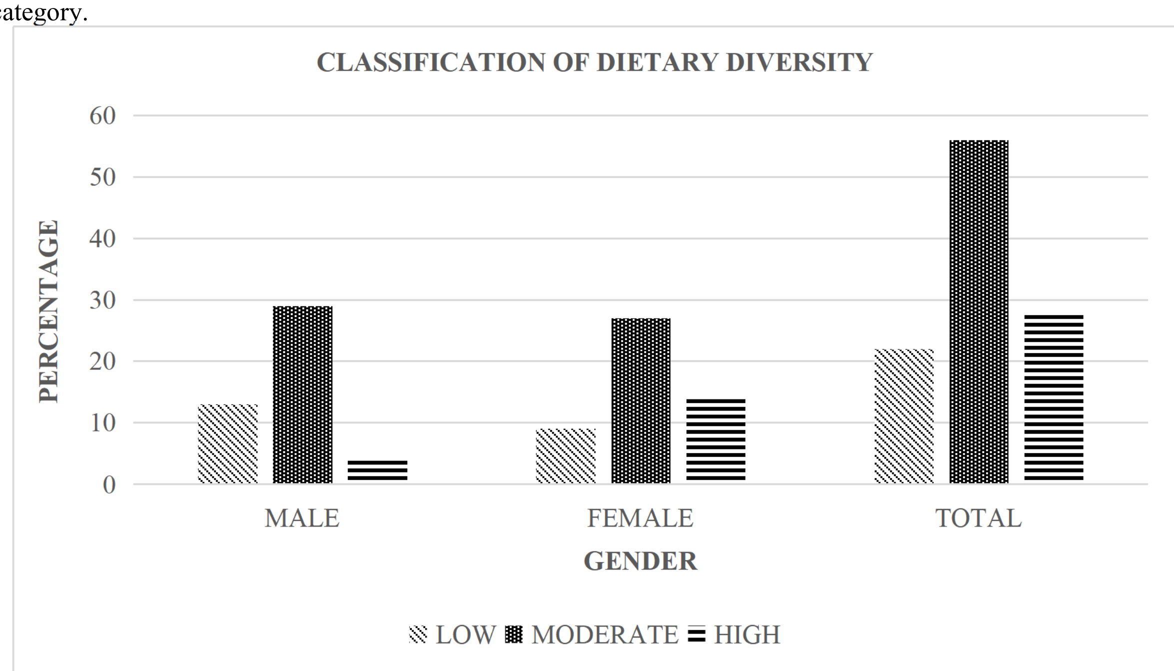

Figure 2: Classification of Dietary Diversity by gender

Correlation Between Dietary Diversity, BMI, and Haemoglobin Concentration

Table **5** shows the linear correlation between dietary diversity, haemoglobin concentration and among the respondents. There was no significant relationship between BMI and Hb concentration, DDS and Hb concentration, BMI and DDS, DDS and Hb classification and DDS and BMI classification. However, a positive correlation existed between, DDS and Hb concentration, BMI and DDS, DDS and Hb classification and DDS and BMI classification and a negative correlation between BMI and Hb concentration.

Table 5: Correlation between Body Mass Index (BMI), Haemoglobin (Hb) concentration, and dietary diversity score (DDS) (N=96)

Variable	Pearson Correlation (+1 to -1)	p-value
BMI and Hb	**-0.006**	0.954
BMI and DDS	**+0.810**	0.434
DDS and Hb	**+0.131**	0.205
DDS and Hb classification	**+0.147**	0.153
DDS and BMI classification	**+0.031**	0.766

Discussion

This study examined the dietary diversity of Allied Health students in the University of Ghana and determined its relationship with their haemoglobin concentration and body mass index. The findings indicated that more than half of the students had a moderately diverse diet with about a fifth of them having low dietary diversity. Almost all of the students consumed cereal products. This is consistent with findings in a study by Habte and colleagues where cereals were found to be the major component of most African meals (Habte and Krawinkel, 2016). Also, a study by Asante et al, (2015), on the food consumption pattern of Ghanaians living in London and Accra found that rice was a frequently consumed staple. This could be due to the relatively cheaper cost of rice dishes in Ghana whether prepared at home or bought from a food vendor. Anecdotal evidence also indicates that many university students frequently consumed rice dishes because of the ease of preparation and its availability on campus. This may also explain why a significantly higher proportion of females, than males, frequently consumed foods from the white root and tuber group.

More than half of the students had a normal BMI with less than a tenth being obese. The proportion of students who were obese is similar to that reported in a student population in South Africa (9.5%). However, the prevalence of overweight recorded in this present study was lower when compared to the South African students (20%) (Chukwudi, 2016). No significant difference was observed in the BMI between the males and females. Several studies, however, have reported a significant difference in BMI with that of females being higher compared to males (Ofori-Asenso *et al.*, 2016; World Health Organization, 2019).

A little over half of the students had normal Hb levels, and about 40% had low haemoglobin levels and thus, were classified as anaemic. Having 40% of the students being anaemic calls for urgent intervention among the students. Interestingly, more males than females in this study were anaemic even though the mean haemoglobin concentration was not significantly different between gender. This contradicts findings from some similar studies among university students. A study conducted in Bangladesh reported that, more than half (53.5%) of university students were anaemic out of which females formed about 60% (Kumar, B. *et al.*, 2014). Another study in Yemen reported that most university students, especially females, had iron-deficiency anaemia (Abdullah, Salem and Mohammed, 2018). Our results were contrary to these findings and this could be attributed to then of frequent consumption of iron-rich foods such as meat, eggs, in addition to vitamin C rich fruits and vegetables by females compared to their male counterparts. This may possibly explain the differences in Hb levels. There were no significant associations between BMI, Hb level and dietary diversity. However, a positive correlation was observed between BMI and dietary diversity, indicating that the BMI of students increases when dietary diversity increases. There also existed a positive linear correlation between haemoglobin concentration and Dietary Diversity score, agreeing with results by Manjeet and colleagues, among Indian students (Manjeet *et al.*, 2015).

Conclusion

Majority of the students had normal BMI and approximately forty percent were anaemic. More than half of the Allied Health students had a moderate dietary diversity score. Majority of the students consumed cereals, meat, egg, fruit and vegetables. There was a positive correlation between Hb concentration, BMI and Dietary Diversity score, although not significant. Although, this is a cross sectional study and hence does not give any causative inferences, the findings from this study are highly informative and warrants further studies. The high prevalence of anaemia among the students requires an action to possibly screen all students and treat those with or at risk of anaemia.

References

Abdullah, A., Salem, B. and Mohammed, A. (2018) ‘Prevalence of Iron Deficiency Anaemia among University Students in Hodeida Province, Yemen’, *Anemia*, 6(7).

Benoist, B. *et al.* (2005) ‘Worldwide Prevalence of Anaemia, WHO Vitamin and Mineral Nutrtion Information System. Depaartment of Nutrition and Physical Activity, WHO’, *Public Health Nutrition*.

Chukwudi, A. G. (2016) 'The determinants of Obesity among students of the University of Verda, Limpopo Province of South Africa', *Journal of obesity and weight loss therapy*.

Delisle, H. (2005) 'Organization of World Health Nutrition in Adolescents: Issues and changes for the health sector: Issues in adolescent health and development.', *Italian Journal of pediatrics*.

Development Initiatives (2018) *Global Nutrition Report, 2018: Shining a light to spur action on nutrition*. Bristol, UK.

Food and Agricultural organization and World Health organization (2016) *Technical consultation on national food-based dietary guidelines*.

Habte, T. Y. and Krawinkel, M. (2016) 'Dietary Diversity Score: A Measure of Nutritional Adequacy or an Indicator of Healthy Diet?', *J Nutr Health Sci*.

Institute of Medicine (2007) *Dietary Reference Intakes Research Synthesis: Workshop Summary*. Washington, DC. Available at: https://doi.org/10.17226/11767.

Jayawardena, R. *et al.* (2013) 'High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores', *BMC Public Health*.

Kiboi, W., Kimiywe, J. and Chege, P. (2017) 'Determinants of dietary diversity among pregnant women in Laikipia County , Kenya : a cross-sectional study'. BMC Nutrition, pp. 1–8. doi: 10.1186/s40795-017-0126-6.

Kumar, B., S. *et al.* (2014) 'Prevalence of Iron-Deficiency Anaemia among University students in Noakhali Region, Bangladesh', *Journal of Health and Population Nutrition*.

Manjeet, K. *et al.* (2015) 'Nutritional Status and anemia in medical students of Sgrdimsar, Amrisar', *National. Journal of Physiology, Pharmacy and Pharmacology*.

Mekuria, G., Wubneh, Y. and Tewabe, T. (2017) 'Household dietary diversity and associated factors among residents of finote selam town, north west Ethiopia : a cross sectional study'. BMC Nutrition, pp. 3–8. doi: 10.1186/s40795-017-0148-0.

Ofori-Asenso, R. *et al.* (2016) 'Overweight and obesity epidemic in Ghana - A systematic review and meta-analysis', *BMC Public Health*. BMC Public Health, 16(1). doi: 10.1186/s12889-016-3901-4.

Shahid, A. *et al.* (2010) 'Assessment of nutritional status of adolescent college girls at Rawalpindi', *Annals of King Edward Medical University journal*.

Tucker, P. *et al.* (2012) 'The Influence of Local Food Environments on Adolescents Food Purchasing Behavior.', *International Journal of Environmental Research and Public Health*.

Worku, M., Hailemicael, G. and Wondmu, A. (2017) 'Dietary diversity score and associated factors among high school adolescent girls in Gurage zone, Southwest Ethiopia', *World journal of clinical Nutrition Health*.

World Health Organization (2001) *Iron deficiency anaemia: assessment, prevention, and control. A guide for programme managers*. Geneva.

World Health Organization (2005) *The world health report: reducing risks, promoting healthy life. Geneva: World Health Organization; 20th World Health Organization conference. Worldwide prevalence of anemia 1993–2005. WHO Global Database on Anemia*. Geneva.

World Health Organization (2011) *Hemoglobin concentrations for the diagnosis of anemia and assessment of severity. Vitamin and mineral nutrition information system*. Geneva.

World Health Organization (2019) *Global Health Observatory Data. Global Statistics and Incidence of Anaemia in Young adults. World Health Organization Global Database in Anaemia*. Geneva.