MALNUTRITION AMONG PREGNANT ADOLESCENTS IN RURAL MALAWI: A CROSS-SECTIONAL SURVEY

By

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RURAL MALAWI: A CROSS-SECTIONAL SURVEY

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Abstract:

The high rates of adolescent pregnancies in Malawi challenge the health and nutritional status for mothers and their babies. When an adolescent is pregnant, there is competition for nutrients and energy between her own developing body and the growing baby. If an adolescent is unable to meet her own nutritional needs, this may lead to a continued cycle of nutritional complications. In general, research focusing pregnant adolescent nutrition in Malawi is lacking. Therefore, the purpose of this study was to assess dietary diversity and the prevalence of malnutrition in pregnant adolescents in rural Malawi. The study included sixty-two pregnant adolescents between 15-19 years old. The mean (SD) age of the subjects was 17.7 (1.2) years old. The majority of the subjects were married (84%), not currently enrolled in school (98%), and not working outside of the home (92%). For 88% of the subjects, this was their first pregnancy. A questionnaire and standardized dietary diversity survey was used. Mid-upper arm circumference (MUAC), height, weight, and hemoglobin were measured. The mean (SD) MUAC was 25.89 cm (1.99) and 31% were classified as having low MUAC (<25 cm). The mean (SD) height-for-age z-score was -1.28 (0.82), 19% of the subjects were stunted and 21% were ≤150 cm tall. The mean hemoglobin was 10.37 g/dL and 66% of the subjects had anemia. The mean (SD) minimum diet diversity score (MDD-W) was 4.06 (1.18) and 69% did not meet the minimum dietary diversity-women (≥ 5 of the 10 recommended food groups). The majority of the subjects were not taking any antenatal supplements (63%) and only 37% were taking ferrous sulfate. Food restrictions during pregnancy were common (35%). Nearly half of the subjects had not received advice about what to eat during pregnancy and 92% had not received advice about infant and young child feeding practices. Consuming pulses, beans, and lentils predicted a 2.88 kg decrease in weight (p=0.0393). Consuming meat and poultry or dark leafy green vegetables predicted a 1.31 and 1.08 increase in hemoglobin levels, respectively. The likelihood of stunting increased as the number of individuals in the household increased [AOR=1.42 (1.05-1.90), p=0.0120]. As the number of antenatal visits increased, the likelihood of taking a supplement and receiving food advice increased [AOR=6.24 (2.03-19.18), p<0.0001), [OR=19.33(4.72-79.22), p<0.0001]. Interventions for pregnant adolescents should include nutrition education on dietary diversity, foods to increase hemoglobin, taking antenatal supplements and infant and young child feeding practices.

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CHAPTER I

INTRODUCTION

The World Health Organization (WHO) estimates nearly 16 million girls between 15-19 years old give birth every year (1). The country of Malawi, located in southeast Africa, is among the top 15 countries with the highest prevalence of pregnancy among girls younger than 18 years old. In 2017, the Malawi Demographic and Health Survey (MDHS) reported the fertility rate (live births/1,000 adolescents) among 15-19 year olds was 136, a slow decline from 152 reported in 2010. While the adolescent fertility rate has slightly decreased, the percentage of girls beginning childbearing in adolescence increased to 29% from 26%. Childbearing at a young age is more common in rural (31%) than urban areas (21%). Additionally, childbearing increases with age among adolescent females. At age 15, 5% of female adolescents either had a live birth or were pregnant with their first child, while 59% of 19 year olds have begun childbearing. Pregnancy during adolescence is most common in females with no education and in the lowest wealth quintile (2).

One of the preventable causes of death among female adolescents is complications from pregnancy and childbirth. Adolescent pregnancy is associated with higher morbidity and mortality for the mother and the baby. Deaths caused by early pregnancy contribute to a higher maternal mortality ratio (MMR) in Malawi. In 2010, the MDHS reported the pregnancy-related mortality ratio in Malawi was 675 deaths per 100,000 women (3). The United Nations

Millennium Development Goals (MDG), sought to be achieved by 2015, aimed to reduce the MMR in Malawi (4). In 2015, Malawi did not reach the goal to reduce the MMR by three-fourths (5). In the MDHS 2015-2016 report, 497 deaths per 100,000 women were estimated to be pregnancy related. The MDHS also reported that 14.5% of female adolescent deaths are considered maternal deaths (defined as death of a female while pregnant or within 42 days of termination of pregnancy, from any cause except violence or accidents.) In addition to a high percentage of maternal deaths related to pregnancy, Malawi has high perinatal, neonatal, infant, child, and under-5 mortality rates. These mortality rates are often influenced by the age of the mother. For example, neonatal and under-five mortality rates in Malawi are highest for children who are born to younger mothers (less than 20 years old).

The high rates of adolescent pregnancy in Malawi bring forth many health and nutrition implications for the mother and baby. Malnutrition is one of the significant contributing risk factors for complications during pregnancy and childbirth. Well-nourished adolescent mothers are less likely to experience complications. After the first 1,000 days of life, adolescence is the second most important time period of rapid growth and development (6). During adolescence a girl will gain approximately 50% of her adult body weight and 15% of her adult height. When an adolescent becomes pregnant, there is a competition for energy and nutrients between her own growth and that of the baby. If an adolescent is unable to meet her own nutritional needs and develops malnutrition, this can lead to a continued cycle of nutrition complications for herself and her baby. Research has shown correlations between maternal malnutrition, risk for anemia and hemorrhaging, and maternal mortality from complications during pregnancy and childbirth (6).

In addition to maternal health implications during adolescent pregnancy, there are also many health and nutrition risks for the baby. The central region of Malawi has the highest perinatal, neonatal, infant, child, and under-5 mortality rates compared to the northern and southern regions. In addition to mortality rates, the birth weight of newborns is also a public health concern. Young Malawian mothers have a higher proportion of low birth weight babies in the central region, in comparison to the northern and southern regions of Malawi (3).

Maternal malnutrition and poor pregnancy weight gain can lead to inadequate nutrition and a low birth weight infant. Maternal malnutrition can increase the risk for poor fetal growth and adverse birth outcomes which can lead to infant mortality. According to the United Nations System Standing Committee on Nutrition, the leading cause for low birth weight in adolescent pregnancy is that the mother has not yet reached her adult weight and nutritional status. They suggest working towards improving nutrition education and awareness during the pre-conception stage or as early in the pregnancy as possible (7).

However, many adolescents living in rural areas of developing countries like Malawi will receive medical attention very late in their pregnancy, if at all. The high MMR in Malawi, the health and nutrition implications of early pregnancy young mothers and their babies, and the lack of knowledge of the nutritional needs during adolescent pregnancy suggest the need for further research that would support the development of nutrition programs for pregnant adolescents.

Therefore, the purpose of this study was to investigate the nutritional status of pregnant adolescents in rural Malawi. The specific research aims of the study were to:

- Assess dietary diversity and the occurrence of malnutrition among a sample of pregnant adolescents
- Identify potential factors contributing to malnutrition among the sample of pregnant adolescents
- Provide research-based recommendations to improve nutritional status of pregnant adolescents living in rural Malawi

CHAPTER II

LITERATURE REVIEW

Importance of nutrition and dietary diversity during pregnancy

Maintaining a healthy nutritional status for females of childbearing age is vitally important. Pre-conception nutritional status plays a role in affecting pregnancy and birth outcomes. During pregnancy, there is an overall increase in energy needs. Additional nutrients and energy are needed for the development of the baby, as well as for the maternal tissue growth to support the growth of the baby. Compared to non-pregnant women, pregnant women require higher intakes of protein, folate, iodine, iron and many other vitamins and minerals in order to maintain good nutrition. To meet the demand for increased nutrients and energy, pregnant females rely on food and supplementation to ensure adequate nutrition. Recommendations for pregnant females include consuming a diverse diet to meet their varying nutrient needs (8).

The Dietary Reference Intakes published by the US Institute of Medicine provide specific nutrient recommendations for pregnant adult women. The specific energy needs for women during pregnancy depend on a variety of factors including: trimester, pre-pregnancy weight, weight gain, physical activity level and basal metabolic rate. However, young adolescents who are still growing and developing may have even higher energy requirements than adults to sustain adequate nutrition for themselves and their growing baby (8).

While energy needs are of great importance during pregnancy, protein also has a significant role. Protein has an important function in the development of the placenta, the growth of the baby, amniotic fluid production, increased maternal blood volume, and also for all the other maternal tissue growth needed to support the baby. Protein needs increase throughout the pregnancy and not meeting these needs creates a risk for having a low birth weight baby (8).

In addition to energy and protein, other vitamins and minerals play an important role for maintaining nutrition during pregnancy. Inadequate folate intake during pregnancy is related to megaloblastic anemia, spontaneous abortion, low birth weight and preterm babies. Obtaining folate from fortified foods and supplementation is recommended for pregnant women. Furthermore, a deficiency in iodine is linked to poor growth including cretinism and mental retardation. Lastly, anemia is the most common complication of pregnancy that is directly nutrition related. The majority of iron deficiencies during pregnancy occur from a poor intake of dietary iron. Iron deficiency anemia during pregnancy is associated with premature delivery, low birth weight, and risk of hemorrhaging during childbirth (8).

To ensure pregnant females can meet their increased nutrient needs, it is important that they have a diverse diet. Research has shown that dietary diversity is associated with adequate nutrient intake (9). Having a diverse diet has been linked to better pregnancy outcomes. A study in Ghana found that a pregnant female's dietary diversity score had a protective effect for low birth weight (COR=0.10, 0.04-0.13, $p<0.0001$) (10).

Health and nutrition implications of adolescent pregnancy

Pregnancy in adolescents is classified as a high-risk health condition because of the associations with increased rates of pre-eclampsia, premature deliveries, low birth weight babies, and neonatal mortality. Pregnant adolescents are considered to be at high nutritional risk because of their own increased nutrient and energy needs. If pregnancy energy needs are not met and optimal weight gain is not achieved in adolescents, the result can be inadequate weight gain leading to impaired intrauterine growth. While there are nutrient and energy recommendations for pregnant adult women, there are very limited data available to make appropriate nutrition recommendations for pregnant adolescents (8).

A retrospective study in the Niger Delta of Nigeria investigated differences in pregnancy outcomes for 83 adolescents among 263 mothers. The young mothers (<19 years old) had significantly increased complications during pregnancy and childbirth compared to adult mothers. Young mothers had significantly higher ($p<0.0001$) occurrence of iron deficiency anemia, pre-eclampsia, pre-term labor, and postpartum hemorrhage, compared to adult women. More than half of the young mothers had pre-term labor and nearly 35% experienced postpartum hemorrhage. For the infants, gestational age and birth weight were significantly lower in young mothers compared to adult mothers. The mean (SD) birth weight of infants born to young mothers was 1.2 kg ± 0.2 compared to infants born to adult women, 3.2 kg ± 0.08. The mean (SD) gestational age for young mothers was 31 weeks ± 1.8, compared to 37 weeks ± 1.2 for adult women (11).

In a study in Thailand, maternal and neonatal outcomes between 750 pregnant teens (<20 years old) and 750 pregnant adults (20-34 years old) were compared. A significantly ($p<0.001$) higher percentage of pregnant adults (97%) received antenatal care compared to pregnant teens (60%). Pregnant teens had a significantly higher occurrence of low birth weight babies and lower gestational age. Intrauterine growth restriction, premature delivery and maternal anemia occurred more frequently among pregnant teens compared to adult women, although rates were not statistically different (12).

The case of Malawi

In collaboration with WHO, UNICEF, and the National AIDS Commission Malawi, the Ministry of Health developed National Nutrition Guidelines in 2007 that include advice regarding healthy nutrition during pregnancy. The importance of eating a diverse diet, taking antenatal supplements, and healthy weight gain during pregnancy are emphasized (13). However, few research studies have examined whether or not these guidelines are improving the nutritional status of pregnant females in Malawi, and mortality rates from pregnancy and childbirth complications remain a health concern.

According to the MDHS, in 2017 the number of pregnancy related deaths was 497 per 100,000 women. However, the MMR was not the only concerning statistic regarding pregnancy; high perinatal, neonatal, infant, child, and under-5 mortality rates remain a health concern. These rates were all highest in the central region of Malawi compared to the northern and southern regions. These rates varied depending upon the age of the mother. For example, neonatal and under-five mortality rates were highest for children who were born to younger mothers (less than 20 years old). Post-neonatal mortality and infant mortality were high among young mothers, only second to mothers between 40-49 years old (2). In addition to mortality rates, the birth weight of newborns is also a public health concern in Malawi. Young Malawian mothers had a higher proportion of low birth weight babies in the central region, in comparison to the northern and southern regions of Malawi (3). Despite these nutrition and health concerns, few research studies have investigated the relationship between adolescent pregnancy, malnutrition, and pregnancy outcomes. However, a few studies have examined nutritional status, dietary patterns, and pregnancy in adult women.

A recent study in Malawi (2016) by Hjertholm and colleagues investigated the relationship between maternal dietary intakes during pregnancy and infant birth size. For dietary information, they collected three repeated, nonconsecutive quantified 24-hour dietary recalls and four days of semi-quantified 24-hr dietary recalls to assess nutrient intakes. Assessment of dietary intake took place between 28-35 weeks of gestation and infant birth size was measured. Maternal diets that were high in energy from fat sources were associated with increased abdominal circumference and infant birth length. Vitamin C intake was positively associated with increased infant birth weight. Furthermore, maternal diets high in energy from carbohydrates were negatively associated with abdominal circumference and infant birth length. Maternal milk consumption (primarily cow's milk) was strongly associated with increased birth weight (14). Their findings indicate that maternal dietary intake plays an important role in affecting birth outcomes.

In 2015, a study conducted in Malawi among 577 pregnant women investigated the relationship between dietary patterns and mid-upper arm circumference (MUAC) and hemoglobin. Subjects were classified as having an animal-based, plant-based, or grain-based diet. Pregnant women with greater wealth were more likely to consume an animal-based diet which was associated with the higher hemoglobin levels. Pregnant women with the lowest wealth were more likely to rely on a grain-based diet for their nutrients. Women classified as having mainly a grain-based diet or plant-based diet had significantly lower hemoglobin concentrations (15). These results suggest the importance of consuming animal food sources in order to improve hemoglobin and reduce the risk of anemia during pregnancy.

An exploratory, descriptive qualitative study included 150 mothers in Malawi who were pregnant with their first child. The mean age of the mothers was 19 years old. Focus groups and individual interviews were used to collect information to investigate where the mothers received their health advice regarding pregnancy, childbirth, and labor. The mothers reported receiving cultural and traditional based pregnancy advice at home. However, some mothers did not receive any information about pregnancy, childbirth, and labor. Since the mean age of the participants was 19 years old, these results indicate a need for further health education and advice tailored to pregnant adolescents (16).

Overall, nutrition and dietary diversity play an important role during pregnancy. When an adolescent is pregnant, there are many health and nutrition implications for herself and her baby. Malawi has high adolescent pregnancy, malnutrition, and mortality rates. Despite these concerns, few research studies have focused on malnutrition and pregnant adolescents.

CHAPTER III

METHODS

Participants

This cross-sectional study was conducted in the rural catchment area of Child Legacy International (CLI) located in the central region of Malawi near Msundwe. Data collection took place at CLI Hospital, Nthondo Health Center, and Chileka Health Center. Subjects were invited to participate by word of mouth through the use of snowball sampling. Snowball sampling was chosen due to the sensitive nature of the inclusion criteria. Snowball sampling provided subjects the opportunity to be invited by their peers to participate in the study. Before agreeing to participate, each subject was informed of the purpose of the study and of the methods that would be used during data collection. The inclusion criteria for the study were adolescents between the ages of 12-19 with identifiable pregnancy of any trimester. Exclusion criteria included any pregnant individuals less than 12 or over 19 years old, as well as non-pregnant adolescents.

At the time of the study, over half of the females of childbearing age in the CLI catchment were pregnant. From health records collected at CLI, it was estimated that 35% of the pregnant females were adolescents (under the age of 19). In order to gain insight on adolescent pregnancy, our study included sixty-two female adolescents between 15-19 years old. Data collection occurred in 2016 during October and November. These periods are considered near the end of post-harvest season and the period a dry-hot season with little rainfall.

Each subject provided her informed consent through a signature on a consent form as well as verbal agreement to participate in the study. Incentives of 1,000 Malawi Kwacha (approximately $1.00 US) were given to each subject for their participation. This study was approved by Oklahoma State University's Institutional Review Board and the College of Medicine Research and Ethics Committee at the University of Malawi.

Data collection

Nutritional status was estimated using three anthropometric measurements including height, weight and mid-upper arm circumference (MUAC). A Charder digital scale with a measuring rod was used to measure height to the nearest 0.1 cm and weight to the nearest 0.1 kg. MUAC was recorded to the nearest 0.1 cm using a non-stretchable tape measure. MUAC was measured on the midpoint of the upper arm, halfway between the olecranon and the acromion. Hemoglobin was measured on a droplet of blood from the fingertip using a HemoCue instrument and recorded to the nearest 0.1 g/dL.

A questionnaire was developed in collaboration with Malawi health care professionals to ensure the questions were culturally appropriate and translatable. The questionnaire was pre-tested on individuals who were not included in the study. After pre-testing, adjustments to the questions were made prior to data collection. The questionnaire was used to collect information regarding demographic and social characteristics. Questions about age, marital status, household size, highest level of education, and employment status were included.

Additionally, information regarding health history and behaviors was collected. Subjects were asked about total number of pregnancies they had, how many antenatal visits they attended, whether or not they were taking antenatal supplements and if they received any advice about nutrition and pregnancy. Subjects were also asked if they had any previous diagnoses of goiter, night blindness, or malaria. See Appendix A for the complete questionnaire.

The dietary diversity questionnaire developed by the European Union (EU) and Food and Agriculture Organization of the United Nations (FAO) was used to collect information on food consumption. This food frequency questionnaire provided a cost-effective method to assess how diverse the subject's diets were and was used as a proxy for nutrient adequacy. Our subjects met the suggested criteria for using the questionnaire at the individual level which requires the respondent to be a female between 15-49 years old. To assess the typical diet at the individual level, it is recommended to use the dietary diversity questionnaire when food supplies are still adequate, within 4-5 months after the main harvest. Our data collection occurred during October and November which are considered post-harvest months in Malawi. For a more complete assessment of dietary diversity, the questionnaire should be administered during different seasons (17).

The dietary diversity questionnaire was reviewed by Malawi health care professionals prior to data collection to ensure the food groups were culturally appropriate. Subjects were asked what they ate during the previous day. All foods eaten by the subject inside and outside of the home were included. Data collectors recorded what each subject had eaten for breakfast, snack, lunch, snack, dinner, and snack. Based on the subject's report of food eaten during the previous day, each of the sixteen food groups was marked with a 1 for yes or a 0 for no. The sixteen food groups utilized during data collection were aggregated into the nine specified food groups to calculate the Women's Dietary Diversity Score (WDDS). The food groups were also aggregated into the ten specific food groups to calculate the newly released Minimum Dietary Diversity Score for Women (MDD-W) during the analysis phase of the study (18). See Appendix B for the food frequency questionnaire used to assess dietary diversity.

Variables

The variables that were measured during data collection were: height, weight, MUAC, and hemoglobin. From these measurements, the following variables were calculated and categorized: height-for-age z-score, stunting, BMI-for-age z-score, low MUAC and anemia. Height-for-age z-scores and BMI-for-age z-scores were calculated using WHO AnthroPlus Software, a software used to monitor the growth of 5-19 year olds (19). Categorical variables were created for stunting, anemia, and MUAC. Stunting was defined as a height-for-age z-score at least two standard deviations below the median height-for-age based on WHO standards (20).

Using the WHO hemoglobin standards to diagnose anemia at sea level for pregnant women (15 years and older), subjects with a hemoglobin level below 11.0 g/dL were classified as anemic. Subjects with anemia were further classified as mild, moderate, or severe. Mild anemia was classified as 10.0-10.9 g/dL, moderate anemia, 7.0-9.9 g/dL, and severe anemia, lower than 7.0 g/dL (21).

Currently, there is no standardized MUAC cutoff recommended to use to assess nutritional status in pregnant adolescents. A variety of cutoffs have been used for pregnant women, varying from 21.5-27.6 cm, when analyzing low MUAC in relation to poor birth outcomes (22). In a study conducted in Malawi in 2001, women with MUAC <23 were more likely to have a pre-term birth and intra-uterine growth retardation than women with MUAC ≥ 23. However, more recent research found that using a MUAC cutoff of 25 during pregnancy may be more appropriate. In a study recently conducted in Sudan, pregnant women with a MUAC ≥ 25 delivered babies who weighed more compared to those with lower MUAC. MUAC also was correlated with birth weight (r=0.437, p-value = 0.000) (23). For the purposes of this study, a MUAC cut-off value of 25 was chosen as an indicator of nutritional status. Therefore, subjects with a MUAC < 25 were classified as having low MUAC.

Statistical Analysis

The statistical software SAS 9.4 was used to compile descriptive data. The means (SD) of age, dietary diversity score, BMI-for-age z-score, MUAC, height-for-age z-score, and hemoglobin were calculated. The percentages of the sample size for the following variables were calculated: age, marital status, household size, highest level of completed education, number of pregnancies, employment, and food source. The percentages of subjects who received advice about what to eat during pregnancy and what to feed their newborn were calculated. The percentages of subjects avoiding foods during pregnancy, taking supplements, and attending antenatal visits, also were calculated.

Correlation and regression analyses were conducted using SAS 9.4 software to investigate the association between variables. For variables that followed a normal distribution, linear regression was used. These variables included: weight, hemoglobin, and BMI-for-age z-score. However, for those variables that did not follow a normal distribution and for categorical variables, logistic regression was used. These variables included: height, MUAC, stunting, anemia, and low MUAC.

Plausible explanatory variables were tested with weight, hemoglobin, and BMI-for-age z-score using multivariate linear regression. Bivariate and multivariate logistic regression was used for testing plausible explanatory variables with binary variables that were created for stunting, anemia, and low MUAC. Logistic regression was also performed to analyze associations with possible explanatory variables for WDDS and MDD-W. Each individual food group was tested as an explanatory variable in this analysis. The odds ratio of each variable that reached a $p < 0.05$ significance level was identified.

CHAPTER IV

ASSESSMENT OF DIETARY DIVERSITY AND NUTRITIONAL STATUS OF PREGNANT ADOLESCENTS IN RURAL MALAWI: A CROSS-SECTIONAL SURVEY

Abstract

The high rates of adolescent pregnancies in Malawi challenge the health and nutritional status for mothers and their babies. When an adolescent is pregnant, there is competition for nutrients and energy between her own developing body and the growing baby. If an adolescent is unable to meet her own nutritional needs, this may lead to a continued cycle of nutritional complications. In general, research focusing on pregnant adolescent nutrition in Malawi is lacking. Therefore, the purpose of this study was to assess dietary diversity and to investigate the prevalence of malnutrition in pregnant adolescents in rural Malawi. The study included sixty-two pregnant adolescents between 15-19 years old. The mean (SD) age of the subjects was 17.7 (1.2) years. The majority of the subjects were married (84%), not currently enrolled in school (98%), and not working outside of the home (92%). For 88% of the subjects, this was their first pregnancy. A pre-tested questionnaire and dietary diversity survey were used. Mid-upper arm circumference (MUAC), height, weight, and hemoglobin were measured.

The mean (SD) MUAC was 25.9 (2.0) cm and 31% were classified as having low MUAC (<25 cm). The mean (SD) height-for-age z-score was -1.28 (0.82), 19% of the subjects were stunted and 21% were ≤150 cm tall. The mean hemoglobin was 10.37 g/dL and 66% of the subjects were anemic. The mean (SD) minimum diet diversity score (MDD-W) was 4.06 (1.18)

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Food restrictions during pregnancy were common (35%). Nearly half of the subjects did not receive advice about what to eat during pregnancy and 92% did not receive advice about infant and young child feeding practices. Consuming pulses, beans, and lentils predicted a 2.88 kg decrease in weight (p=0.0393). Consuming meat and poultry or dark leafy green vegetables predicted a 1.31 and 1.08 increase in hemoglobin levels, respectively. The likelihood of stunting increased as the number of individuals in the household increased [AOR=1.42 (1.05-1.90), p=0.0120]. As the number of antenatal visits increased, the likelihood of taking a supplement and receiving food advice increased [AOR=6.24(2.03-19.18), p<0.0001), [OR=19.33(4.72-79.22), p<0.0001]. Interventions for pregnant adolescents should include nutrition education on dietary diversity, foods to increase hemoglobin, taking antenatal supplements and infant and young child feeding practices.

INTRODUCTION

The World Health Organization (WHO) estimates nearly 16 million girls between 15-19 years old give birth every year (1). The country of Malawi, located in southeast Africa, is among the top 15 countries with the highest prevalence of pregnancy among girls younger than 18 years old. In 2017, the Malawi Demographic and Health Survey (MDHS) reported the fertility rate (live births/1,000 adolescents) among 15-19 year olds was 136, a slow decline from 152 reported in 2010. While the adolescent fertility rate has slightly decreased, the percentage of girls beginning childbearing in adolescence increased to 29% from 26%. Childbearing at a young age is more common in rural (31%) than urban areas (21%). Additionally, childbearing increases with age among adolescent females. At age 15, 5% of female adolescents either had a live birth or were pregnant with their first child, while 59% of 19 year olds had begun childbearing. Pregnancy during adolescence was most common in females with no education and in the lowest wealth quintile (2).

One of the preventable causes of death among female adolescents is complications from pregnancy and childbirth. Adolescent pregnancy is associated with higher morbidity and mortality for the mother and the baby. Deaths caused by early pregnancy contribute to a high maternal mortality ratio (MMR) in Malawi. In 2010, the MDHS reported the pregnancy-related mortality ratio in Malawi was 675 deaths per 100,000 women (3). The United Nations Millennium Development Goals (MDG), sought to be achieved by 2015, aimed to reduce the MMR in Malawi (4). In 2015, Malawi did not reach the goal to reduce the MMR by three-fourths (5). In the MDHS 2015-2016 report, 497 deaths per 100,000 women were estimated to be pregnancy related. The MDHS also reported that 14.5% of female adolescent deaths are considered maternal deaths (defined as death of a female while pregnant or within 42 days of termination of pregnancy, from any cause except violence or accidents.) In addition to a high percentage of maternal deaths related to pregnancy, Malawi has high perinatal, neonatal, infant, child, and under-5 mortality rates. These mortality rates are often influenced by the age of the mother. For example, neonatal and under-five mortality rates in Malawi were highest for children who are born to younger mothers (less than 20 years old).

The high rates of adolescent pregnancy in Malawi bring forth many health and nutrition implications for the mother and baby. Malnutrition is one of the significant contributing risk factors for complications during pregnancy and childbirth. Well-nourished adolescent mothers are less likely to experience complications, despite being young. After the first 1,000 days of life, adolescence is the second most important time period of rapid growth and development (6).

During adolescence a girl will gain approximately 50% of her adult body weight and 15% of her adult height. When an adolescent becomes pregnant, there is a competition for energy and nutrients between her own growth and that of the baby. If an adolescent is unable to meet her own nutritional needs and develops malnutrition, this can lead to a continued cycle of nutrition complications for herself and her baby. Research has shown correlations between maternal malnutrition, risk for anemia and risk for hemorrhage, and maternal mortality from complications during pregnancy and childbirth (6).

In addition to maternal health implications during adolescent pregnancy, there are also many health and nutrition risks for the baby. The central region of Malawi had the highest perinatal, neonatal, infant, child, and under-5 mortality rates compared to the northern and southern regions. In addition to mortality rates, the birth weight of newborns is also a public health concern. Young Malawian mothers have a higher proportion of low birth weight babies, in the central region in comparison to the northern and southern regions of Malawi (3).

Maternal malnutrition and poor pregnancy weight gain can lead to inadequate nutrition and a low birth weight infant. Maternal malnutrition can increase the risk for poor fetal growth and adverse birth outcomes which can lead to infant mortality. According to the United Nations System Standing Committee on Nutrition, the leading cause for low birth weight in adolescent pregnancy is that the mother has not yet reached her adult weight and nutritional status. They suggest working towards improving nutrition education and awareness during the pre-conception stage or as early in the pregnancy as possible (7).

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METHODS

Participants

This cross-sectional study was conducted in the rural catchment area of Child Legacy International (CLI) located in the central region of Malawi near Msundwe. Data collection took place at CLI Hospital, Nthondo Health Center, and Chileka Health Center. Subjects were invited to participate by word of mouth through the use of snowball sampling. Snowball sampling was chosen due to the sensitive nature of the inclusion criteria. Snowball sampling provided subjects the opportunity to be invited by their peers to participate in the study. Before agreeing to participate, each subject was informed of the purpose of the study and of the methods that would be used during data collection. The inclusion criteria for the study were adolescents between 12-19 years old with identifiable pregnancy of any trimester. Exclusion criteria included any pregnant individuals less than 12 or over 19 years old, as well as non-pregnant adolescents.

At the time of the study, over half of the females of childbearing age in the CLI catchment were pregnant. From health records collected at CLI, it was estimated that 35% of the pregnant females were adolescents (under 19 years old). In order to gain insight on adolescent pregnancy, our study included sixty-two female adolescents between 15-19 years old. Data collection occurred during October and November which are considered at the near end of post-harvest season approximately 5 months after the start of harvest season and is a dry-hot season is little rainfall.

Each subject provided her informed consent through a signature on a consent form as well as verbal agreement participate in the study. Incentives of 1,000 Malawi Kwacha (approximately $1.00 US) were given to each subject for their participation. This study was approved by Oklahoma State University's Institutional Review Board and the College of Medicine Research and Ethics Committee at the University of Malawi.

Data collection

Nutritional status was estimated using three anthropometric measurements including height, weight and mid-upper arm circumference (MUAC). A Charder digital scale with a measuring rod was used to measure height to the nearest 0.1 cm and weight to the nearest 0.1 kg. MUAC was recorded to the nearest 0.1 cm using a non-stretchable tape measure. MUAC was measured on the midpoint of the upper arm, halfway between the olecranon and the acromion. Hemoglobin was measured on a droplet of blood from the fingertip using a HemoCue instrument and recorded to the nearest 0.1 g/dL.

A questionnaire was developed in collaboration with Malawi health care professionals to ensure the questions were culturally appropriate and translatable. The questionnaire was pre-tested on individuals who were not included in the study. After pre-testing, adjustments to the questions were made prior to data collection. The questionnaire was used to collect information regarding demographic, and social characteristics. Questions about age, marital status, household size, highest level of education, and employment status were included.

Additionally, information regarding health history and behaviors was collected. Subjects were asked about prior pregnancies, how many antenatal visits they attended, whether or not they were taking antenatal supplements and if they received any advice about nutrition and pregnancy. Subjects were also asked if they had any previous diagnoses of goiter, night blindness, or malaria.

The dietary diversity questionnaire developed by the European Union (EU) and Food and Agriculture Organization of the United Nations (FAO) was used to collect information on food consumption. This food frequency questionnaire provided a cost-effective method to assess how diverse the subject's diets were and was used as a proxy for nutrient adequacy. Our subjects met the suggested criteria for using the questionnaire at the individual level which requires the respondent to be a female between 15-49 years old. To assess the typical diet at the individual level, it is recommended to use the dietary diversity questionnaire when food supplies are still adequate, within 4-5 months after the main harvest. Our data collection occurred during October and November which are considered post-harvest months in Malawi. For a more complete assessment of dietary diversity, the questionnaire should be administered during different seasons (17).

The dietary diversity questionnaire was reviewed by Malawi health care professionals prior to data collection to ensure the food groups were culturally appropriate. Subjects were asked what they ate during the previous day. All foods eaten by the subject inside and outside of the home were included. Data collectors recorded what each subject had eaten for breakfast, snack, lunch, snack, dinner, and snack. Based on the subject's report of food eaten during the previous day, each of the sixteen food groups was marked with a 1 for yes or a 0 for no. The sixteen food groups utilized during data collection were aggregated into the nine specified food groups to calculate the Women Dietary Diversity Score (WDDS). The food groups were also aggregated into ten specific food groups to calculate the newly released Minimum Dietary Diversity Score for Women (MDD-W) during the analysis phase of the study (18).

Variables

The variables that were measured during data collection were: height, weight, MUAC, and hemoglobin. From these measurements, the following variables were calculated and categorized: height-for-age z-score, stunting, BMI-for-age z-score, low MUAC and anemia. Height-for-age z-scores and BMI-for-age z-scores were calculated using WHO AnthroPlus Software, a software used to monitor the growth of 5-19 year olds (19). Categorical variables were created for stunting, anemia, and MUAC. Stunting was defined as a height-for-age z-score at least two standard deviations below the median height-for-age based on WHO standards (20).

Using the WHO hemoglobin standards to diagnose anemia at sea level for pregnant women (15 years and older), subjects with a hemoglobin level below 11.0 g/dL were classified as being anemic. Subjects with anemia were further classified as mild, moderate, or severe. Mild anemia was classified as 10.0-10.9 g/dL, moderate anemia, 7.0-9.9 g/dL, and severe anemia, lower than 7.0 g/dL (21).

Currently, there is no standardized MUAC cutoff to be used for pregnant adolescents. A variety of cutoffs have been used for pregnant women, varying from 21.5-27.6 cm, when analyzing low MUAC in relation to poor birth outcomes (22). In a study conducted in Malawi in 2001, women with MUAC <23 cm were more likely to have a pre-term birth and intra-uterine growth retardation than women with MUAC ≥ 23 cm. However, more recent research found that using a MUAC cutoff of 25 cm during pregnancy may be more appropriate. In a study recently conducted in Sudan, pregnant women with a MUAC ≥ 25 cm delivered babies who weighed more compared to those with lower MUAC. MUAC also was correlated with birth weight (r=0.437, p-value = 0.000) (23). For the purposes of this study, a MUAC cut-off value of 25 cm chosen as an indicator of adequate nutritional status Therefore, subjects with a MUAC < 25 cm were classified as having low MUAC.

Independent variables

Table 1: Independent variables used in statistical analysis

Demographic and social	**Health**	**Nutrition**
Age	Number of pregnancies	Received dietary advice
Marital status	Number of births	Received Infant and Young Child Feeding (IYCF) advice
Number living in household	Number of living children	Food sources
Living father and/or mother	Past breastfeeding choices	Food restrictions
Highest level of education	Number of antenatal visits with past pregnancy	Goiter
Current enrollment in school	Number of antenatal visits with current pregnancy	Night blindness
Working outside of the home	Malaria	Supplement intake and type

Table 2: Food groups used as independent variables used in dietary diversity analysis

WDDS	**MDD-W**
Starchy staples	Grains, white roots, tubers, and plantains
Dark green leafy vegetables	Dark green leafy vegetables
Legumes, nuts, and seeds	Nuts and seeds
	Pulses: beans, peas, and lentils
Milk and milk products	Dairy
Meat and fish	Meat, poultry, and fish
Organ meat	
Eggs	Eggs
Other vitamin A rich fruits and vegetables	Other vitamin A rich fruits and vegetables
Other vegetables and fruits	Other vegetables
	Other fruits

Statistical Analysis

The statistical software SAS 9.4 was used to compile descriptive data. The means (SD) of age, dietary diversity score, BMI-for-age z-score, MUAC, height-for-age z-score, and hemoglobin were tabulated. The percentage of the sample for the following variables were calculated: age, marital status, household size, highest level of completed education, number of pregnancies, employment, and food source. Percentage of subjects who received advice about what to eat during pregnancy and what to feed their newborn was calculated. The percent of subjects avoiding foods during pregnancy, taking supplements, and attending antenatal visits was calculated.

Correlation and regression analyses were also conducted using SAS 9.4 software to investigate the association between variables. For variables that followed a normal distribution, linear regression was used. These variables included: weight, hemoglobin, and BMI-for-age z-score. However, for those variables that did not follow a normal distribution and for categorical variables, logistic regression was used. These variables included: height, MUAC, stunting, anemia, and low MUAC.

Plausible explanatory variables were tested with weight, hemoglobin, and BMI-for-age z-score using multivariate linear regression. Logistic regression was used for testing plausible explanatory variables with binary variables that were created for stunting, anemia, and low MUAC. Logistic regression was also performed to analyze associations with possible explanatory variables for WDDS and MDD-W. Each individual food group was tested as an explanatory variable in this analysis. The odds ratio of the variables that reached a $p < 0.05$ significance level was identified.

RESULTS

Sociodemographic and health characteristics

The mean (SD) age of the subjects was 17.7 (1.2) years; ages ranged from 15-19 years, with 33% under the age of 18 (Table 3). Over 80% of the pregnant adolescents were married and the mean number of individuals living in the household was three. The majority of the subjects had finished primary school (72%) and only 10% had completed secondary school. At the time of the study, only one subject reported to be currently enrolled in school and five subjects considered themselves to be working outside of the home. While the majority of the subjects had both parents living, 11% had lost at least one parent.

For the majority of the subjects, this was their first pregnancy (87%). For six of the subjects, it was their second pregnancy and for one subject it was her third pregnancy. Six of the seven girls who reported being pregnant before had given birth and only four of them reported having one living child. Six of the seven subjects who had prior pregnancies reported attending antenatal visits for that pregnancy.

All of the subjects had attended at least one antenatal visit at the time of the study. Less than half the subjects had only attended one antenatal visit and 30% attended at least two visits (Figure 1). Despite all subjects attending at least one antenatal visit, only 48% of them reported receiving any advice about what to eat during pregnancy and only 8% received advice about what to feed their newborn. Among those who received advice, the majority (80%) reported the advice was given by health care workers. However, advice was also reportedly given by a teacher, a mother, and a church. Less than half of the girls (37%) were taking any vitamin or mineral supplement, and the only supplement being taken was ferrous sulfate.

Food restrictions during pregnancy were common among this sample of young girls with 22 (35%) subjects avoiding certain foods. A variety of foods were restricted with the most common being eggs and leftovers (Table 4). Some of the reasons for avoiding eggs included preventing the baby from being born bald or blind. Additionally, leftovers were avoided for reducing childbirth complications. However, seven of the nine subjects reported restricting leftovers but did not explain the reason because they did not know why they were advised to avoid leftovers. A high percentage of subjects reported buying food from the market as their primary food source (64%) and approximately 25% reported relying on their farm for the food.

Nutritional Status

Low MUAC was found among 31% of the subjects with a mean (SD) MUAC of 25.8 (2.0) (Table 5). Stunting occurred among 19% of the subjects in the sample and 21% were ≤ 150 cm tall. The majority of the subjects had a BMI-for-age z-score that was indicative of a healthy body weight for non-pregnant adolescents (80%). The prevalence of anemia was 66% with the majority of the subjects being classified as having moderate anemia (Table 3).

Dietary Diversity

Using the new MDD-W, the mean dietary diversity score was 4.0 (1.2). However, using the WDDS, the mean dietary diversity score was 3.9 (1.0). The score range for MDD-W is 0-10 and WDDS is 0-9. The majority of the subjects (69%) did not meet the minimum dietary diversity (≥ 5 of the 10 recommended food groups). None of the sixty-one subjects reported consuming any dairy products (Figures 2 and 3). Consumption of eggs was low with only 7% of the subjects eating eggs on the day before the interview. All of the subjects ate from the starchy staples group which included grains, white roots, tubers, and plantains. The subjects consumed high amounts of dark green leafy vegetables (62%), other vitamin A rich fruits and vegetables (61%), and other vegetables (77%). Less than half reported consuming meat, poultry, and fish (39%).

Correlation

MUAC was highly correlated with weight (r = 0.65, $p<0.0001$) and with BMI-for-age z-score (r = 0.77, $p<0.0001$).

Linear Regression

Using multivariate linear regression, four variables were predictors of weight: height; MUAC; consumption of white roots, tubers, and plantains; consumption of pulses (beans, peas, lentils). For every 1 cm increase in height, weight was predicted to increase 0.22 kg (p-value 0.0296). For every 1 cm increase in MUAC, weight was predicted to increase by 1.94 kg (*p*-value <0.0001). Two food groups from the MDD-W were also found to be predictors of weight. Consuming pulses such as beans, peas, and lentils predicted a 2.88 kg decrease in weight ($p=0.0393$). Although not significant at $p<0.05$ in multivariate regression, consuming white roots, tubers, and plantains showed a trending decrease in weight of 2.69 kg ($p=0.0542$) (Table 6).

Three independent variables were predictors of hemoglobin. For every unit increase of BMI-for-age Z-score, hemoglobin was predicted to decrease by 0.67 g/dL. Two food groups from the MDD-W were found to be predictors of hemoglobin. Consumption of meat and poultry and consumption of dark leafy green vegetables predicted a 1.31 and 1.08 increase in hemoglobin, respectively (Table 9).

Logistic Regression

As the number of individuals in the household increased, subjects were more likely to be stunted [AOR=1.42 (1.05-1.90), $p=0.0120$]. Consuming white roots and tubers increased the likelihood of stunting [OR=4.17 (1.02-17.05), $p=0.0471$], however this was not significant when analyzed using multivariate logistic regression (Table 10). As BMI-for-age- z-score increased, subjects were less likely to have low MUAC (<25 cm) [AOR=0.20 (0.07-0.59), $p=0.0014$) (Table 11). Also, as BMI-for-age z-score increased, subjects were more likely to have anemia [OR=2.90

(1.19-7.10), *p* = 0.0197] (Table 14). Consuming condiments and seasonings increased the likelihood of having low MUAC [OR=3.26 (1.04-10.20), *p*=0.0429], however this was not significant when analyzed in multivariate regression.

In addition to analyzing the relationships in assessing nutritional status, variables were also tested for their prediction for taking an antenatal supplement. The subjects who received food advice were more likely to report taking a supplement [AOR=11.63 (1.73-78.26), *p*=0.0053] than those who reported not receiving any advice. As the number of antenatal care visits increased, subjects were more likely to have taken a supplement [AOR=6.24 (2.03-19.18) *p*=<0.0001]. Additionally, as the number of individuals in the household increased, subjects were less likely to be taking a supplement [OR=0.69 (0.49-0.970, *p*=0.0344], but this was not significant in multivariate regression (Table 12). The number of antenatal visits was also related to whether or not the subjects reported receiving food advice. As the number of antenatal visits increased, the subjects were more likely to have received food advice [OR=19.33 (4.72-79.22) *p*<0.0001] (Table 13).

DISCUSSION

Sociodemographic

According to the MDHS, among a survey of females between 15-19 years old, 73.2% never married, 21.5% married, and 1.0% were divorced (2). However, these numbers were very different from the adolescents in our study. The majority of the subjects were married (84%) compared to the MDHS report (21.5%). The age of marriage appears to be younger in the rural areas of the central region, thus increasing the likelihood of pregnancy during adolescence. According to the WHO, the frequency of sexual activity is high in adolescents who are in stable relationships such as marriage compared to those who are not married (24).

At the time of the study, only one adolescent was currently enrolled in school. The majority completed primary school as their highest level of education (72%) and 10% completed secondary school. The MDHS surveyed 5,263 adolescents and the majority (64.1%) completed only some level of primary education (2). Primary school dropout rates are higher in rural compared to urban areas. In the central region of Malawi, the dropout rates were higher compared to the southern and northern regions (3). Additionally, the central region had the lowest percentages of girls between 15-19 years old completing secondary school or higher compared to the northern and southern regions (3). Maternal education plays an important factor in nutrition. Research has found that undernutrition is strongly associated with shorter adult height (lower height-for-age z-scores), less schooling and education, and lower infant birth weight (25).

Antenatal Care

At the time of the study, all of the adolescents had attended at least one antenatal visit. However, this could have been skewed because data collection took place at three health care facilities and may not be reflective of all pregnant adolescents in the central region. According to the MDHS, approximately 94.4% of mothers less than 20 years old received at least one visit by a skilled health professional. The MDHS found 50% of pregnant women in Malawi received at least four antenatal visits, whereas only 8% of the subjects in this study had received at least 4 antenatal visits at the time of the study (2). In our study, only 51% of the adolescents attended more than one antenatal visit at the time of the survey. However, the adolescents in the study were in various trimesters of pregnancy. If she was in an early stage of her pregnancy at the time of the study, she may have the opportunity to attend more antenatal visits compared to an adolescent in a later trimester. In 2016, the WHO released new recommendations regarding antenatal care for a positive pregnancy experience (26). One of the recommendations included increasing the number of antenatal visits from four to eight in order to reduce perinatal mortality, increase overall quality of antenatal care and improve maternal satisfaction.

According to the MDHS, nearly 90.2% of 2,587 young mothers under 20 years old received information about foods to eat during pregnancy (2). Less than 50% of the girls received any advice about what to eat during pregnancy, despite all of the subjects having at least one antenatal visit at the time of the study. Among those who received advice, the majority (80%) reported the advice was given by health care workers. However, the adolescents also received advice from school teachers, mothers, and churches. Only 8% of the adolescents received advice about what to feed their newborn. This reveals a staggering nutrition education deficit in the area where the subjects are living and indicates the need for education regarding healthy food choices and dietary diversity to be included during antenatal care.

The number of antenatal visits played an important role in determining whether or not a subject was taking a supplement and received advice about what to eat during pregnancy. As the number of antenatal visits increased, the subjects were more likely to receive food advice [COR=19.33 (4.72-79.22) $p<0.0001$] and more likely to be taking an antenatal supplement [AOR=6.24 (2.03-19.18) $p<0.0001$]. These results emphasize the relevance and importance of antenatal care. Because fewer than 50% were receiving food advice and only 35% were taking an antenatal supplement, nutrition advice and antenatal supplementation need to be emphasized very early and repeatedly in antenatal care.

Antenatal supplementation

Approximately 63% of subjects in the study were not taking any iron supplementation. According to the MDHS, only 10% of 15-19 year olds were not taking iron supplementation during pregnancy (2). These results indicate a need for awareness, education, and implementation regarding the importance of iron supplementation during pregnancy in the catchment area. A few factors played an important role in determining whether or not subjects were likely to take a supplement during pregnancy. First, subjects who received food advice were more likely to report taking a supplement [OR=4.19 (1.82-9.68), $p=0.0008$] than those who reported not receiving any advice. This could be related to the fact that the majority of subjects received advice about food during antenatal visits and were likely encouraged to take an antenatal supplement. Secondly, as the number of antenatal care visits increased, the more likely the subjects reported taking a supplement [OR=11.88 (3.40-41.49) *p*=0.001]. This could be related to the increased exposure to a health care worker encouraging taking an antenatal supplement. However, there was a factor that indicated subjects would be less likely to take a supplement. As the number of individuals in the household increased, subjects were less like to be taking a supplement [OR=0.69 (0.49-0.970, *p*=0.0344]. One potential reason could be that as the size of the household is increased, resources are divided amongst more individuals. A study in Bangladesh found that larger households had an increased risk of food insecurity (adjusted RR 1.47 (1.02, 2.09) (27). Larger households potentially face a greater challenge in allocating resources amongst individuals.

Anemia and Hemoglobin

The occurrence of anemia in the study was very high with 66% of the adolescents having mild, moderate, or severe anemia. Furthermore, a high percentage of the subjects were facing moderate anemia (77%) compared to mild (20%) or severe (3%). According to the MDHS, 35.3% of 1,715 females between 15-19 years old were anemic; moderate (6.4%), mild (28.6%), and severe (0.4%) (2). While it cannot be determined if anemia was directly caused by iron deficiency, chronic disease, malaria, or other conditions, hemoglobin concentrations have been associated with maternal mortality regardless of the cause of anemia.

Studies have shown that increasing the mean hemoglobin concentration 1.0 g/L is associated with a 25% decrease in the risk of maternal death (8). Increasing the hemoglobin concentration of the subjects is important to promote healthy pregnancy and childbirth. Two food groups from the MDD-W were found to be predictors of higher hemoglobin. Consumption of meat and poultry and of dark leafy green vegetables predicted a 1.31 and 1.08 g/dL increase in hemoglobin, respectively. Both dark leafy green vegetables and animal protein are sources of iron. During antenatal care, encouraging the taking of antenatal mineral supplementation of ferrous sulfate and increasing the consumption of iron-rich food would likely promote an increase in hemoglobin.

Weight

Two food groups from the MDD-W were found to be predictors of weight. Consuming pulses such as beans, peas, and lentils predicted a 2.88 kg decrease in weight (p=0.0393). One potential reason could be that beans, peas, and lentil are typically consumed more regularly by lower income households. They do not provide a large amount of calories and are often used in place of animal foods. Although not significant at $p<0.05$, consuming white roots, tubers, and plantains showed a trending decrease in weight of 2.69 kg (0.0542). Consuming food such as cassava in place of maize with animal food is sometimes more by circumstance of poverty than by preferential food choice.

As expected, for every 1 cm increase in height, weight was predicted to increase 0.22 kg (p= 0.0296). For increasing height, a subject would have more body mass and thus would be more likely to have a higher weight. MUAC appears to be a good indicator of weight status as for every 1 cm increase in MUAC, weight was predicted to increase 1.94 kg (p-value <0.0001).

Height and Stunting

The occurrence of low height-for-age z-score among the adolescents was 19% and 21% had a height ≤150 cm. Low maternal height brings about health and nutrition implications for the baby. Stunting and short height has been associated with restriction of uterine blood flow and lower growth of the uterus and placenta, and ultimately is a strong predictor for infant birth weight (28). Additionally, maternal stunting has been associated with intrauterine growth restriction and perinatal mortality. Early interventions that combat stunting are a key point for improving reproductive health and birth outcomes in Malawi.

As the number of individuals in the household increased, the risk of being stunted increased [AOR=1.42 (1.05-1.90), p=0.0120]. Similar to the potential reason why subjects in households that are larger in size were not taking an antenatal supplement, food insecurity has been shown to occur more often in larger households (27).

Those who reported eating white roots and tubers were more likely to be stunted than those who did not report eating white roots and tubers [OR=4.17 (1.02-17.05), p=0.0471], however this was not significant in multivariate logistic regression. Those who reported eating from this food group were consuming cassava and did not eat grains. Cassava is lower in protein content compared to other typically consumed staple foods (29). In a study in Nigeria and Kenya, children who relied on cassava as a staple food had in inadequate protein intakes and a high occurrence of stunting (30).

MUAC

Low MUAC occurred among 31% of the subjects with a mean (SD) MUAC of 25.8 (2.0) cm. MUAC was highly correlated with weight (r = 0.65, p<0.0001) and with BMI-for-age z-score (r = 0.77, p<0.0001). The categorical variable created for the MUAC cut-off (<25) was also a predictor of weight (R^2 = 0.16, p=0.0011). These results indicate verify the use of MUAC is an appropriate indicator for nutritional status based on weight. In a study in Nepal of 22,000 pregnant women, for every 1 cm increase in MUAC during the first trimester, the risk of maternal death decreased 24% (AOR=0.76, CI 0.67-0.87) (8).

Food Restrictions

It is not uncommon for pregnant females living in rural areas in developing countries to follow cultural and traditional advice regarding food during pregnancy. Traditionally, cultural food practices may serve as a way of protecting both the mother and child during pregnancy. For example, in a qualitative study by Maliwichi-Nyirenda and Maliwichi (2016) in Malawi, some pregnant women avoided cooked food sold in the market and food prepared by unknown people

(31). These food avoidances could protect a pregnant female from contracting unwanted foodborne illnesses. Furthermore, eating fish and salt during pregnancy was considered a food taboo. Avoiding fish could be a protective mechanism against consuming too much mercury and restricting salt could reduce the risk of hypertension.

However, some cultural and traditional food restrictions lack scientific evidence and can be nutritionally harmful (8). Thirty-five percent of the girls in the study were restricting foods for various reasons. The foods that were reported to be restricted were: eggs, leftovers, Coca-Cola, cabbage, okra, pork, catfish, mice, attached bananas, red chili, sugarcane and groundnuts. The subjects provided reasons for most of the avoided food items that all related to harmful effects either on mother, baby, or the childbirth process (Table 4).

Other studies have also shown that food restrictions for cultural and traditional reasons are not uncommon among the Malawian people. A qualitative study conducted among 110 women in Malawi found 46 food taboos that were being observed during pregnancy to avoid potentially harmful consequences for themselves or their babies. Similar to our findings, some pregnant women were avoiding eggs, red chili, and sugarcane (31). While not all food restrictions have risks of leading to nutritional deficiencies, some of the foods being restricted such as eggs and bananas are very nutritious. Avoiding these nutritious foods during pregnancy may increase the likelihood of a pregnant adolescent not meeting her nutritional needs.

Dietary Diversity

Consuming a diverse diet during pregnancy is important for achieving healthy nutritional status, especially among growing adolescents. The majority of the subjects (69%) were not meeting the minimum dietary diversity for women (MDD-W) (≥ 5 of the 10 recommended food groups). While some of the subjects reported receiving education about dietary diversity during their antenatal care, it’s imperative for all pregnant adolescents to receive advice about consuming a diverse diet especially during pregnancy. Including education about the importance of diet diversity in antenatal care may help improve the subjects' nutritional status during pregnancy.

All of the subjects ate carbohydrates primarily in the form of *nsima*, a thick porridge made from maize, the staple crop in Malawi. As the staple food, maize is typically consumed on almost all days of the week by Malawians. A recent cross-sectional study in Malawi by Hjertholm and colleagues (2017) found similar results among 203 pregnant women who all ate maize, wheat, rice, or sorghum every day of the week over a seven day period (14).

Many of the subjects ate dark green leafy vegetables (62%), other vitamin A rich fruits and vegetables (61%), or other vegetables (71%), yet very few consumed other fruits (7%). Hjertholm and colleagues also found pregnant women in Malawi were eating dark green leafy vegetables (90%), Vitamin A-rich vegetables and tubers (8.4%), Vitamin A-rich fruits (80.3%), other vegetables (100%), and other fruits (92.6%) on several days over a seven day period during the post-harvest season (14). While the findings are similar, the subjects in our study had extremely lower intake of other fruit.

The percentage of adolescents consuming animal protein foods such as meat, poultry, or fish, eggs or dairy were low (39%, 7%, and 0%, respectively). One reason for low egg consumption could be related to the fact that eggs were one of the common foods avoided during pregnancy. However, milk and other dairy products were not among the foods restricted during pregnancy and are not a common taboo in Malawi (32). In the study by Hjertholm and colleagues, consumption of animal protein foods was higher compared to the consumption in our study (flesh meat (37.9%), eggs (29.1%), fish (92.6%), and milk (19.7%). One of the most interesting findings in their study was that the frequency of milk intake by the mother was positively associated with birth weight (β: 75.3, 95% CI: 13.6, 137.0 grams/day) (14). Milk is a source of protein and fat that are two essential macronutrients to maintain good nutrition during pregnancy.

While the dietary diversity provides a cost-effective way to assess the diet, it also has some limitations. In this study, WDDS and MDD-W were not found to be predictors of nutritional status, as measured by MUAC, anemia, and stunting.

BMI-for-age Z-score

Most of the subjects (80%) had a BMI-for-age z-score that was indicative of a healthy body weight for non-pregnant adolescents. However, BMI-for-age z-score is not a recommended indicator of nutritional status during pregnancy, especially among growing adolescents. Pre-pregnancy BMI and weight gain during pregnancy are good indicators of nutritional status for healthy pregnancy outcomes (33). Weight standards are not currently available for pregnant adolescents and therefore it makes recommendations difficult for this age group.

Limitations

Limitations of the study were that dietary intake was self-reported and only measured what was consumed the day prior to data collection. Therefore, the data may not represent typical dietary intake. Additionally, the dietary diversity is more thoroughly assessed for more days and in multiple seasons.

Due to the nature of cross-sectional studies, the data collected only reflect nutritional status at one point during the pregnancy. To understand the nutritional status of pregnant adolescents, collecting data throughout the entire pregnancy would be ideal. Gestational age and trimester were also not available.

CONCLUSION

The nutritional status of pregnant adolescents living in this rural areas of the central region of Malawi is compromised and needs to be addressed. Our results revealed occurrence of anemia (66%), of low MUAC (31%), and of stunting (19%). The majority of the pregnant adolescents were not meeting the minimum dietary diversity (69%). Less than half the adolescents received advice about what to eat during pregnancy and less than 10% received advice about what to feed their newborns. The majority were not taking any antenatal supplements and the only supplement taken was ferrous sulfate.

The results from this research revealed the need for a comprehensive nutrition education program to be implemented during antenatal care. The program would focus on improving dietary diversity by eating from a variety of food groups each day. Increasing the dietary diversity among pregnant adolescents, would help to ensure they are meeting their vitamin and mineral needs during pregnancy. Furthermore, increasing the consumption of iron-rich foods would improve hemoglobin levels and decrease the occurrence of anemia. Education would include information about dietary diversity, antenatal supplementation and also about the importance of not restricting nutritious foods during pregnancy.

While the MMR in Malawi is slowly declining, the percentage of young girls beginning childbearing has increased. As the United Nations System Standing Committee on Nutrition stated, improving nutrition education and awareness during the pre-conception stage or as early in the pregnancy as possible will be essential to promoting healthy nutrition for pregnant adolescents (7).

Table 3: Demographic, social, and health characteristics of a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=62)

Characteristic	n	%
Age (years)		
15	3	5
16	10	16
17	7	12
18	22	36
19	19	31
Marital Status		
Married	52	83
Single	9	15
Divorced	1	2
Household		
Has lost one or both parents	7	11
Has both living parents	56	89
Education (highest level completed)		
Less than primary	1	2
Some primary	10	16
Primary	45	72
Secondary	6	10
Currently enrolled in school	1	2
Health		
First pregnancy	55	87
Received advice about food to eat during pregnancy	30	48
Received advice about food to feed baby	5	8
Restricts some food during pregnancy	22	35
Has been told she has a goiter	3	5
Has trouble seeing at night time	1	2
Takes ferrous sulfate vitamin supplement	23	37
Has had malaria at least once during pregnancy	2	3

Figure 1: Number of antenatal visits attended by a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=60)

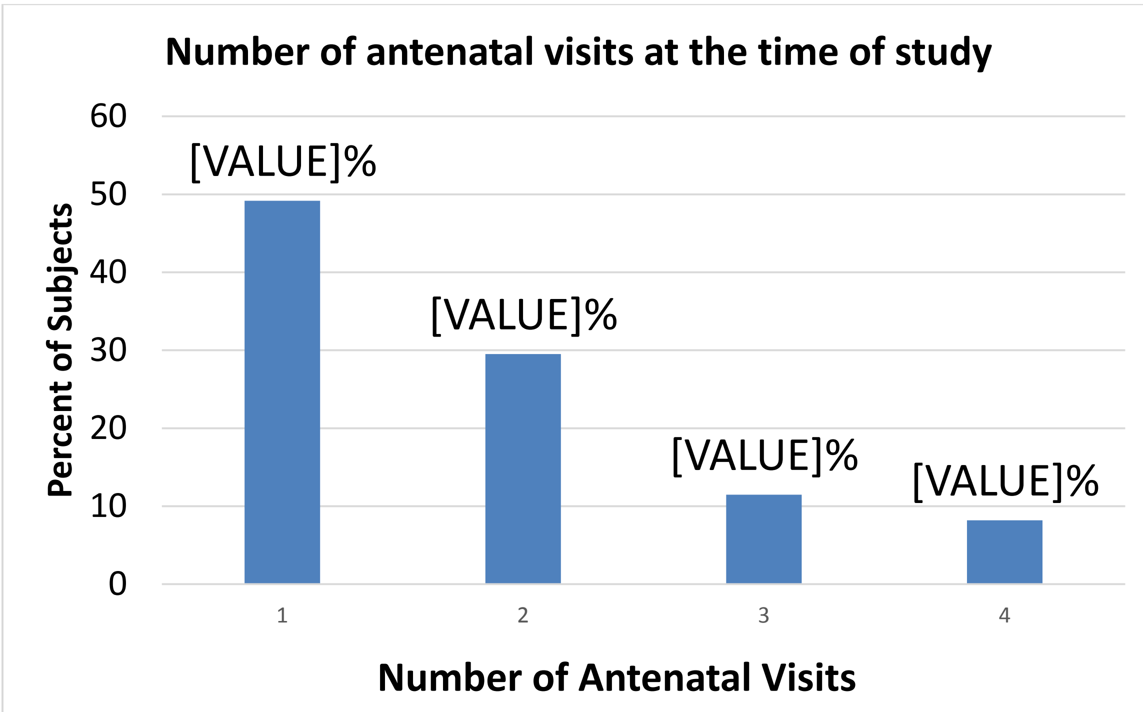


Table 4: Food avoidance practices followed during pregnancy among a sample of adolescents living in rural areas in the central region of Malawi (N=62)

Food avoided	# of subjects	Reason for avoidance
Eggs	7 1	Baby can be born bald Baby can be born blind
Leftovers Leftover Nsima	1 4 1 3	Cause defecation in labor Reason not explained Can cause labor problems Reason not explained
Pork	2	Reason not explained
Catfish	1	Reason not explained
Okra	1 1	It's dirty for the stomach Reason not explained
Coca-Cola	1	Burns the stomach
Mice	1	Reason not explained
Nkute	1	Can defecate during childbirth
Cabbage	1	Can cause abdominal cramps
Tea with milk	1	Reason not explained
Banana Attached banana	1 1 1	Baby can be born blind Can have asphyxiated baby Fear to have twins
Sugarcane	1 1	Baby can be born blind Baby can be born with fungus on head
Red chili	1	Baby can be born blind
Bambara nuts	1	Baby can be born bald

Indicator	Mean (+/-SD)	Number (Percentage)
BMI-for-Age Z-Score	0.43 (0.71)	
Thinness[1]		0 (0%)
Normal weight		49 (80%)
Overweight[2]		11 (18%)
Obesity[3]		1 (2%)
MUAC (cm)	25.8 (2.00)	
Low MUAC[4]		19 (31%)
Height-for-Age Z-Score	-1.28 (0.82)	
Stunted[5]		11 (19%)
Hemoglobin (g/dL)	10.37 (1.93)	
Anemia		40 (66%)

Table 5: Nutritional status of a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=62)

Mild[6]	8 (20%)
Moderate[7]	31 (77%)
Severe[8]	1 (3%)

1. BMI-for-Age Z-Score <-2SD
2. BMI-for-Age Z-Score >+1SD
3. BMI-for-Age Z-Score >+2SD
4. MUAC ≤ 25.0 cm
5. Height-for-Age Z-Score <-2SD
6. Hemoglobin 10.0-10.9 g/dL
7. Hemoglobin 7.0-9.9 g/dL
8. Hemoglobin < 7.0 g/dL

Figure 2: The consumption from the Minimum Dietary Diversity-Women Food Groups among a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=61)

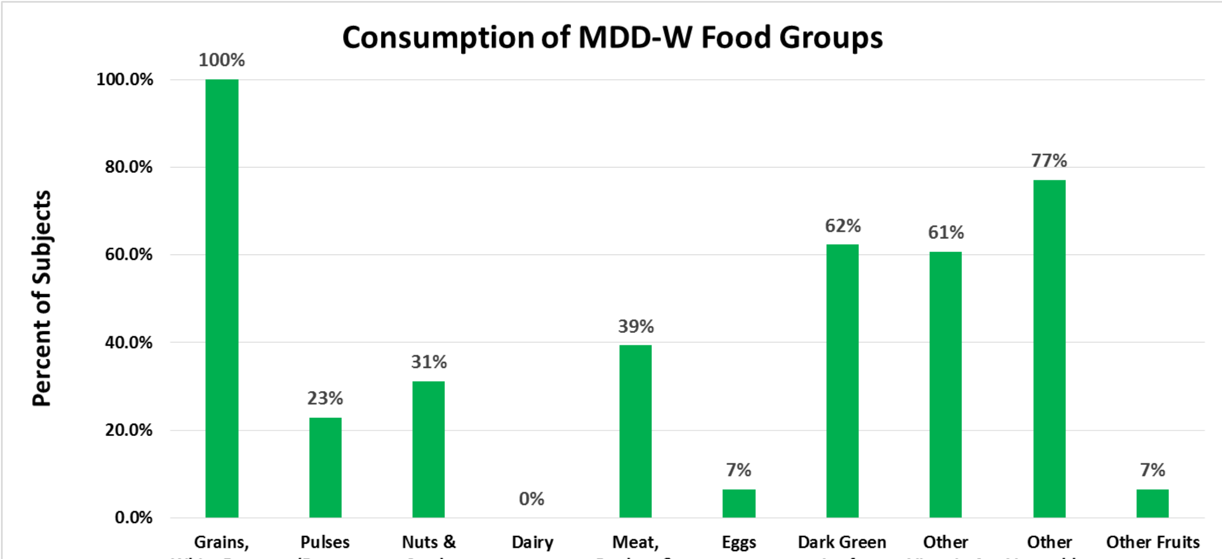


Table 6: Number of pregnant adolescents among a sample living in rural areas in the central region of Malawi consuming from the MDD-W food groups

Food Group	**n**
Grains, white roots, tubers, plantains	61
Other vegetables	47
Dark green leafy vegetables	38
Other vitamin A-rich fruits and vegetables	37
Meat, poultry, fish	24
Nuts and seeds	19
Pulses: beans, peas, lentils	14
Eggs	4
Other fruits	4
Dairy	0

Figure 3: The consumption from the Women's Dietary Diversity (WDD) Food Groups among a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=61)

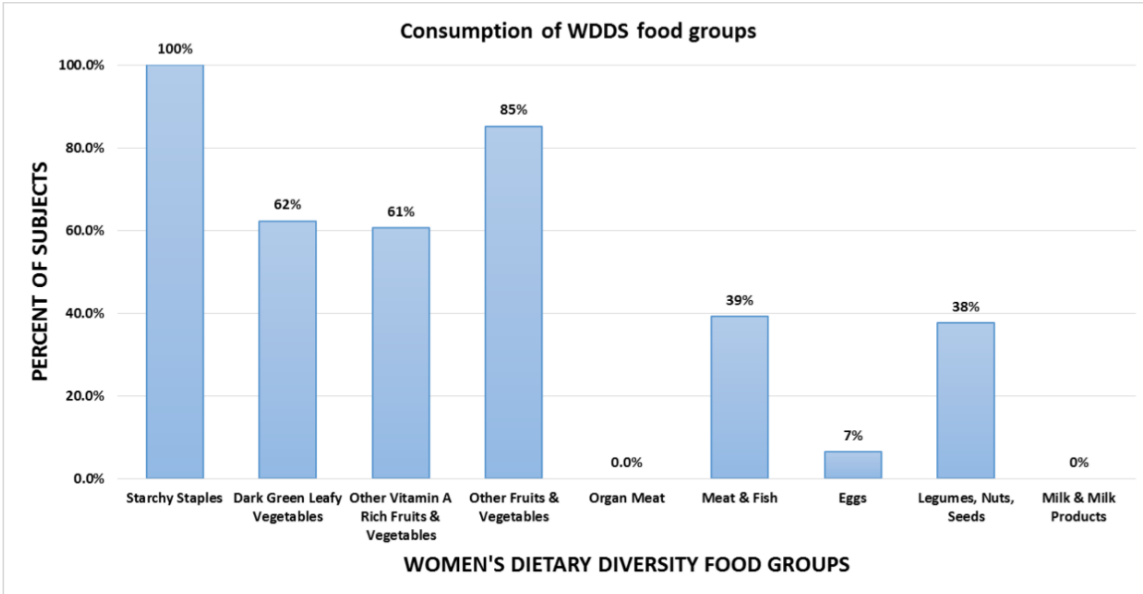


Table 7: Number of pregnant adolescents among a sample living in rural areas in the central region of Malawi consuming from the WDD food groups (n=61)

Food Group	**n**
Starchy staples	61
Other vegetables	47
Dark green leafy vegetables	38
Other vitamin A-rich fruits and vegetables	37
Meat and fish	24
Legumes, nuts, seeds	23
Eggs	4
Organ meat	0
Milk and milk products	0

Table 8: Predictors of weight in a sample of pregnant adolescents living in the rural areas in

the central region of Malawi (N=62)

Adjusted-R^2=0.51	WEIGHT	
Variable	**β**	***p*-value**
Constant	-28.33	
Height	0.22	0.0296
MUAC	1.94	<0.0001
White roots, tubers, plantains	-2.69	0.0542
Pulses: beans, peas, lentils	-2.88	0.0393

Table 9: Predictors of hemoglobin in a sample of pregnant adolescents living in in rural areas in the central region of Malawi (N=61)

Adjusted-R^2=0.15	HEMOGLOBIN	
Variable	**β**	***p*-value**
Constant	9.74	
BMI-for-age Z-score	-0.67	0.0454
Meat and poultry	1.31	0.0306
Dark leafy green vegetables	1.07	0.0331

Table 10: Predictors for height-for-age z-score <-2SD in a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=61)

STUNTING				
	OR	***p*-value**	**AOR**	***p*-value**
Variables				
White roots and tubers - Did consume - Did not consume	 4.17 (1.02-17.05) 1	0.0471	NS	NS
Number of individuals in household	1.41 (1.05-1.89)	0.0211	1.42 (1.05-1.90)	0.0120

Table 11: Predictors for MUAC <25cm in a sample of pregnant adolescents living in rural

areas in the central region of Malawi (N=62)

LOW MUAC				
	OR	***p*-value**	**AOR**	***p*-value**
Variables				
Weight	0.83 (0.73-0.94)	0.0035	NS	NS
MDDS15 (Condiments/Seasonings) - Did consume - Did not consume	3.26 (1.04-10.20) 1	0.0429	NS	NS
BMI-for-Age Z-Score	0.20 (0.07-0.59)	0.0032	0.203(0.07-0.59)	0.0014

Table 12: Prediction for supplement intake in a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=62)

SUPPLEMENTATION				
	OR	***p*-value**	**AOR**	***p*-value**
Variables				
Food advice - Received food advice - Did not receive food advice	4.19 (1.82-9.68) 1	0.0008	11.63 (1.73-78.26)	0.0053
Number of Individuals in household	0.69 (0.49-0.97)	0.0344	NS	NS
Number of antenatal care visits	11.88 (3.40-41.49)	0.0001	6.24 (2.03-19.18)	<0.0001

Table 13: Prediction for receiving food advice among a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=62)

	Food Advice	***p*-value**
Variables	**OR**	
Number of antenatal visits	19.33 (4.72-79.22)	<0.0001

Table 14: Prediction for anemia among a sample of pregnant adolescents living in rural areas in the central region of Malawi (N=61)

	Anemia	***p*-value**
Variables	**OR**	
BMI-for-Age Z-Score	2.90 (1.19-7.10)	0.0197

REFERENCES

1. World Health Organization. Adolescent pregnancy 2014 [updated November 20th, 2016]. Available from: http://www.who.int/mediacentre/factsheets/fs364/en/.

2. NSO, ICF Macro. Malawi Demographic and Health Survey 2015-2016. 2017.

3. NSO, ICF Macro. Malawi Demographic and Health Survey 2010. 2011.

4. United Nations Development Programme. Improve maternal health: Where do we stand? 2016.

5. WHO, UNICEF, UNFPA, World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015. 2015.

6. Thurnham DI. Nutrition of adolescent girls in low and middle income countries. Sight and Life. 2013;27(3):26-37.

7. United Nations System Standing Committee on Nutrition. Maternal nutrition and the intergenerational cycle of growth failure. 2012.

8. Lammi-Keefe CJ, Couch SC, Philipson EH. Handbook of Nutrition and Pregnancy: Humana Press; 2008.

9. Ruel MT. Operationalizing dietary diversity: a review of measurement issues and research priorities. The Journal of Nutrition. 2003;133(11 Suppl 2):3911s-26s.

10. Saaka M. Maternal dietary diversity and infant outcome of pregnant women in Northern Ghana. International Journal of Child Health and Nutrition. 2013;1(2):148-56.

11. Ayuba II, Gani O. Outcome of teenage pregnancy in the Niger Delta of Nigeria. Ethiopian Journal of Health Sciences. 2012;22(1):45-50.

12. Watcharaseranee N, Pinchantra P, Piyaman S. The incidence and complications of teenage pregnancy at Chonburi Hospital. J Med Assoc Thai. 2006;89(Suppl 4):S118-23.

13. WHO, UNICEF, Ministry of Health, NAC. National Nutrition Guidelines for Malawi. Malawi: 2007.

14. Hjertholm KG, Iversen PO, Holmboe-Ottesen G, Mdala I, Munthali A, Maleta K, Shi Z, Ferguson E, Kamudoni P. Maternal dietary intake during pregnancy and its association to birth size in rural Malawi: A cross-sectional study. Maternal & Child Nutrition. 2017.

15. Ramlal RT, Tembo M, King CC, Ellington S, Soko A, Chigwenembe M, Chasela C, Jamieson DJ, Van der Host C, Bentley M. Dietary patterns and maternal anthropometry in HIV-infected, pregnant Malawian women. Nutrients. 2015;7(1):584-94.

16. Malata A, Chirwa E. Childbirth information feeds for first time Malawian mothers who attended antenatal clinics. Malawi Medical Journal. 2011;23(2):42-6.

17. Kennedy G, Ballard T, Dop MC. Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization of the United Nations, 2011.

18. FAO, FHI. Minimum dietary diversity for women: a guide to measurement. 2016.

19. WHO. Application Tools: WHO AnthroPlus software. WHO, 2007.

20. WHO. Who child growth standards: length/height-for-age, weight-for-age, weight-forlength,weight-for- height and body mass index-for-age : methods and development. WHO, 2006.

21. WHO. Haemoglobin concentration for the diagnosis of anaemia and assessment of severity. Geneva: Vitamin and Mineral Nutrition Information System, 2011.

22. Tang AM, Dong K, Deitchler M, Chung M, Maalouf-Manasseh Z, Tumilowicz A, Wanke C. Use of cutoffs for mid-upper arm circumference (MUAC) as an indicator or predictor of nutritional and health-related outcomes in adolescents and adults: A systematic review. 2013.

23. Gritly SMO, Bahafizalla DNA. Assessment of nutritional status using anthropometric measurements in relation to pregnancy outcome among southern sudanese pregnant mothers in Juba City. International Journal of Science and Research. 2014.

24. WHO. Early marriages, adolescent and young pregnancies World Health Organization 2011.

25. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, Sachdev HS. Maternal and child undernutrition: consequences for adult health and human capital. The Lancet. 2008;371(9609):340-57.

26. Tunçalp Ö, Pena-Rosas JP, Lawrie T, Bucagu M, Oladapo OT, Portela A, Metin AG. WHO recommendations on antenatal care for a positive pregnancy experience—going beyond survival. BJOG: An International Journal of Obstetrics & Gynaecology. 2017.

27. Harris-Fry H, Azad K, Kuddus A, Shaha S, Nahar B, Hossen M, Younes L, Costello A, Fottrell E. Socio-economic determinants of household food security and women's dietary diversity in rural Bangladesh: a cross-sectional study. Journal of Health, Population and Nutrition. 2015;33(1):2.

28. Dewey KG, Begum K. Long-term consequences of stunting in early life. Maternal & Child Nutrition. 2011;7(s3):5-18.

29. Morgan NK, Choct M. Cassava: Nutrient composition and nutritive value in poultry diets. Animal Nutrition. 2016;2(4):253-61.

30. Stephenson K, Amthor R, Mallowa S, Nungo R, Maziya-Dixon B, Gichuki S, Mbanaso A, Manary M. Consuming cassava as a staple food places children 2-5 years old at risk for inadequate protein intake, an observational study in Kenya and Nigeria. Nutrition Journal. 2010;9(1):9.

31. Maliwichi-Nyirendat CP, Maliwichi LL. Food Related Taboos Observed During Pregnancy in Malawi. Studies on Ethno Medicine. 2016;10(2):263-8.

32. Banda J. Acceptability of goat's, sheep's and cow's milk in Malawi. International Journal of Consumer Studies. 1992;16(2):129-38.

33. Doherty DA, Magann EF, Francis J, Morrison JC, Newnham JP. Pre-pregnancy body mass index and pregnancy outcomes. International Journal of Gynecology & Obstetrics. 2006;95(3):242-7.

APPENDICES

APPENDIX A: SOCIODEMOGRAPHIC AND HEALTH CHARACTERISTICS SURVEY

Subject's Code: _____________

Name/Dzina____

✂
- -

Cross Sectional Survey of Pregnant Adolescent Malnutrition in Rural Malawi

Kafukufuku okhuza kunyetchera pakati pa atsungwa omwe alin ndi mimba

Questionnaire

Question	**Questions**	**Responses**
1.	What is your age? Muli ndi zaka zingati?	1. 12 2. 13 3. 14 4. 15 5. 16 6. 17 7. 18 8. 19 9. Unknown
2.	What is your marital status? Kodi muli pa banja?	1. Married Okwatiwa 2. Single Osakwatiwa 3. Divorced Banja linatha 4. Widowed Namfedwa
3.	How many people do you live with? Mnyumba mwanu mumakhalmo anthu angati?	
4.	Is your mother living? Kodi amayi anu ali moyo?	1. Yes Inde 2. No

		Ayi 3. Unknown Sindikudziwa
5.	Is your father living? Kodi bamboo anu ali moyo?	1. Yes 2. No 3. Unknown
6.	What is your highest level of education completion? Maphunziro anu munasiyira pati?	1. Junior Primary 2. Senior Primary 3. Secondary 4. None 5. Other_____
7.	Are you in school now? (If no, skip to 9) Kodi muli pa sukulu pakadali pano?	1. Yes Inde 2. No Ayi
8.	How far do you walk to school? Kodi kupita sukulu kwanu mumayenda mtunda wautali bwanji?	
9.	Are you working? (If no, skip to 11) Kodi muli pa ntchito?	1. Yes Inde 2. No Ayi
10.	What kind of work do you do? Mumagwira ntchito yanji?	
11.	How many pregnancies have you had including this one? (If only one, skip questions 18 and 19) Mwakhalapo ndi oyembekezera kangati kuphatikizirapo mimba imene muli nayo pano?	1. None 2. One 3. Two 4. Three 5. Four 6. Five
12.	How many children have you given birth to? Mwaberekapo kangati?	
13.	How many of your children are living? Muli ndi ana a moyo angati?	
14.	What are the ages of your living children? Kodi ndi a zaka zingati?	
15.	Have you breastfeed in the past? Kodi munayamba mwayamwitsapo mwana mbuyomu?	1. Yes Inde 2. No Ayi
16.	Did you exclusively breastfeed in the past? (If yes, skip to 18) Kodi muyamba mwayamwitsapo mwakathithi mbuyomu?	1. Yes Inde 2. No Ayi

17.	What do you feed your infants?	
18.	Have you received antenatal care for previous pregnancies? Kodi munalandirapo chithandizo cha kusikelo ya amayi oyembekezera mbuyomu?	1. Yes Inde 2. No Ayi
19.	How many times have you received antenatal care for previous pregnancies? Mwalandirapo thandizo la ku sikelo ya amayi oyembekezera mbuyomu kangati?	1. Once Kamodzi 2. Twice Kawiri 3. None Katatu
20.	How many times have you received antenatal care for this pregnancy? Mwapitapo ku sikelo kangati pa mimba imene muli nayo pano?	1. Once Kamodzi 2. Twice Kawiri 3. None Palibe 4. Other: ______________ __________
21.	Have you received advice about foods to eat during pregnancy? (If no, skip to _22) Munalandirapo malangizo okhudza zakudya zoyenera kudya pamene mayi ali oyembekezera?	1. Yes Inde 2. No Ayi
22.	What advice have you received and from who?	
23.	Have you received advice about foods to feed infants? (If no, skip to 25) Mulandirapo malangizo a zakudya zoyenera kudyetsa ana ang'ono?	1. Yes Inde 2. No Ayi
24.	What advice have you received and from who? Munalandira malangizo otani ndipo kuchokera kwa ndani?	
25.	Where do you obtain your food? Chakudya mumachipeza bwanji?	
26.	Do you restrict any foods during pregnancy? (If no, skip 27) Pali zokudya zimene mumasala chifukwa choti muli ndi mimba?	1. Yes Inde 2. No Ayi
27.	What foods you restrict and why? Mumasala zakudya ziti nanga chifukwa chiyani?	______________________
28.	Have you ever been told you have a goiter? Munayamba mwauzidwapo kuti muli chotupa pa khosi?	1. Yes Inde 2. No Ayi

29.	Do you ever have trouble seeing at night? Kodi mumakhala ndi mavuto kuona usiku?	1. Yes Inde 2. No Ayi
30	Do you take any vitamins? (If no skip to question 32) Kodi mumamwa mankhwala onjezera ma vitamin mthupi	1. Yes Inde 2. No Ayi 3. I don't know Sindkudziwa
31	What vitamins do you take? Kodi mumamwa ma vitamin	______________________ __________
32	Have you had malaria during this pregnancy? (If NO , - skip questions 34 & 35) Munadwalapo malungo muli ndi mimba?	1. Yes Inde 2. No Ayi 3. I don't know Sindikudziwa
33	Did you receive care when you had malaria? Munalandira thandizo pa nthawi imene mumadwala malungo?	1. Yes Inde 2. No Ayi
34	Were you taking iron supplement while you had malaria? Kodi munalandira mankhwala onjezera magazi pa nthawi imene mumadwala malungo?	1. Yes Inde 2. No Ayi 3. I don't know Sindikudziwa

APPENDIX B: DIETARY DIVERSITY QUESTIONNAIRE ADAPTED FROM THE FANTA HOUSEHOLD DIETARY DIVERSITY SCORE INDICATOR GUIDE

Name/Dzina____

✂

Dietary Diversity Questionnaire

Adapted from the FANTA Household Dietary Diversity Score Indicator Guide

Subject's Code: ____________

Please describe anything that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

BREAKFAST	SNACK	LUNCH	SNACK	DINNER	SNACK	OTHER

When the participant has finished, fill in the food groups based on the information recorded above. For any good groups not mentioned, ask the participant if a food item from this group was consumed.

Question Number	Food Group	Examples	Yes =1 No = 0
1	Cereals	Nsima, porridge, rice	
2	White roots and tubers	White potatoes, yams, cassava	
3	Vitamin A rich vegetables	Pumpkin, carrot, orange sweet potatoes, red pepper	
4	Dark green leafy vegetables	Any leaves: Cassava, pumpkin, spinach, sweet potato	
5	Other vegetables	Tomato, onion, eggplant, peppers	
6	Vitamin A rich fruits	Mango, papaya, guava	
7	Other fruits	Tangerines, banana, wild fruits, fruit juices	
8	Organ meats	Liver, kidney, heart	
9	Flesh meats	Beef, pork, lamb, goat, rabbit, chicken	
10	Eggs	Any eggs	
11	Fish and seafood	Fresh or dried fish	
12	Legumes, nuts, and seeds	Dried beans, peas, soya, groundnuts	
13	Milk and milk products	Milk, cheese, yogurt, other milk	
14	Oils and fats	Oils, fats, butter	
15	Sweets	Sugar cane, honey, soda, cookies, cakes	
16	Spices, condiments, beverages	Salt, pepper, coffee, tea, alcohol	

APPENDIX C: Oklahoma State University Institutional Review Board Approval

Oklahoma State University Institutional Review Board

Date:	Tuesday, June 28, 2016
IRB Application No	HE1612
Proposal Title:	Cross sectional survey of pregnant adolescent malnutrition in rural Malawi
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved Protocol Expires: 6/27/2017

Principal Investigator(s):

Christine Patella
Stillwater, OK 74078

Barbara Stoecker
421 HS
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

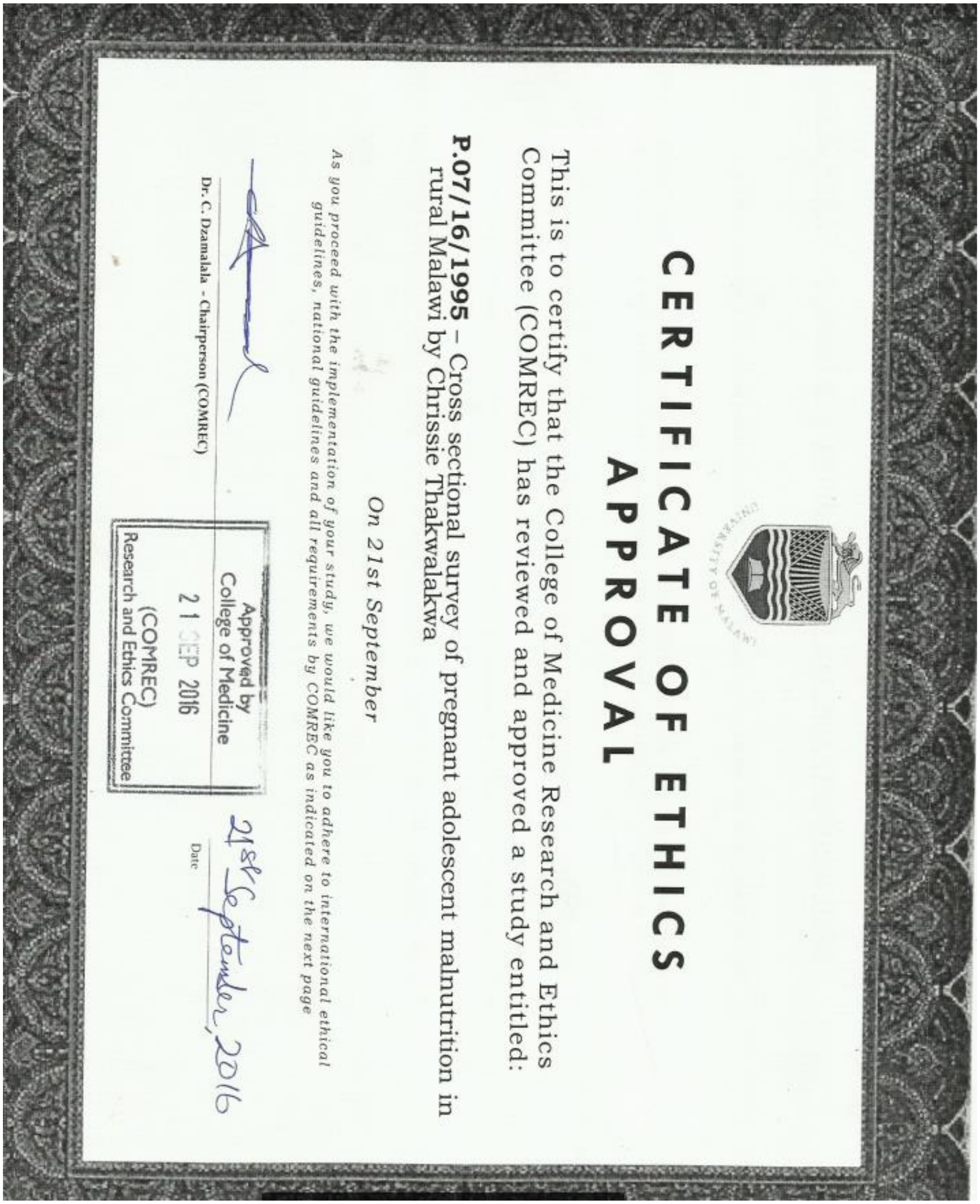
1.Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2.Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3.Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4.Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Scott Hall (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Hugh Crethar, Chair
Institutional Review Board

APPENDIX D: College of Medicine Research and Ethics Committee Approval



UNIVERSITY OF MALAWI

CERTIFICATE OF ETHICS APPROVAL

This is to certify that the College of Medicine Research and Ethics Committee (COMREC) has reviewed and approved a study entitled:

P.07/16/1995 – Cross sectional survey of pregnant adolescent malnutrition in rural Malawi by Chrissie Thakwalakwa

On 21st September

As you proceed with the implementation of your study, we would like you to adhere to international ethical guidelines, national guidelines and all requirements by COMREC as indicated on the next page

Dr. C. Dzamalala - Chairperson (COMREC)

Approved by College of Medicine
21 SEP 2016
(COMREC)
Research and Ethics Committee

21st September, 2016
Date

VITA

Christine Nicole Patella

Candidate for the Degree of

Master of Science

Thesis: PREGNANT ADOLESCENT MALNUTRITION IN RURAL MALAWI: A CROSS SECITONAL SURVEY

Major Field: Nutritional Sciences

Biographical:
Place of Birth: Mayfield Heights, Ohio
Hometown: Concord Township, Ohio

Education:

Completed the requirements for the Master of Science in Nutritional Sciences at Oklahoma State University, Stillwater, Oklahoma in May, 2017.

Completed the requirements for the Bachelor of Science in Medical Dietetics at The Ohio State University, Columbus, Ohio/USA in 2013.

Experience:

Graduate Teaching Associate: 2015-present
Registered Dietitian/Nutritionist: 2013-present
Licensed Dietitian: 2013-present

Professional Memberships:

Academy of Nutrition and Dietetics: Student Member, 2011-present
American Overseas Dietetic Association: Student Member, 2014-present
American Society for Nutrition: Student Member, 2016-present