

# Predisposing and Reinforcing Factors of Undernutrition Among 0-to 59-Months-Old Children in Rural Communities of Central Malawi

**Maureen Chilanga**

Kamuzu college of Nursing, University of Malawi

**Emmanuel Chilanga** (✉ [echilanga@gmail.com](mailto:echilanga@gmail.com))

University of Livingstonia

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## Research Article

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# Abstract

## Background

Child undernutrition is a public health problem in Malawi. In 2015, about 23% of child mortality was linked to the phenomenon. Child undernutrition is more prevalent in rural areas and there is limited data to inform rural-specific programs. The aims of this study are to examine the prevalence and predisposing factors of undernutrition among 0–59 months-old children in rural central Malawi.

## Methods

A cross-sectional study design was used. A total of 538 child/mother dyads were systematically selected from postnatal clinics. Anthropometric assessment techniques and socio-demographic questionnaire was used to collect data. Child Z-scores for anthropometric data were calculated using Anthro v3.2.2. Logistic regressions were used to determine correlates of undernutrition.

## Results

The rates of stunting, underweight, and wasting were 42%, 11%, and 3%, respectively. In multivariable logistic regression models, limited access to safe water, and maternal exposure to intimate partner violence (IPV) were risk factors of child stunting ( $OR = 1.72$ ,  $CI: 1.13–2.61$ ) and ( $OR = 1.505$ ,  $CI: 1.001–2.261$ ) respectively. Child deworming, born at a low weight, and food insecurity were some of risk factors of child underweight ( $OR = 2.14$ ,  $CI: 1.18–3.89$ ), ( $OR = 2.41$ ,  $CI: 1.23–4.71$ ), and ( $OR = 1.89$ ,  $CI: 1.01–3.51$ ) respectively. Households that were near domestic water supply had low risk of registering wasted children ( $OR = 0.18$ ,  $CI: 0.41–0.79$ ).

## Conclusions

Only the prevalence of child stunting is greater in central Malawi compared to national level. This study suggests that child nutrition planners in Dowa district should pay attention to water access, food security, child deworming, childbirth weight, and IPV.

## Introduction

Child undernutrition is a pathological state mainly caused by an insufficient consumption of energy and nutrient-dense foods and frequent exposure to infectious diseases (1). The phenomenon compromises a child's growth and functioning and consequently reduces their human productivity in adulthood. Globally, undernutrition among children under five years old in the form of stunting, underweight, and wasting is a public health problem that underpins related development challenges in the Global South. In 2017, approximately 22.2% and 7.5% of children worldwide were stunted and wasted respectively (2). The

burden of child undernutrition is pervasive in Malawi despite the country adopting strategic plans such as a national nutrition policy and farm subsidies (3). Current statistics show that 37% of the under five-years-old children are too short for their age (stunting), 3% are too thin for their height (wasting), and 12% are too thin for their age (underweight) (4).

The Government of Malawi has renewed its commitment to avert child undernutrition by signing the United Nations' 2030 Development Agenda. Accordingly, therapeutic and preventative child nutritional programs have become available in clinical and community centers, including in rural areas (5). Children in rural areas of Malawi are at a higher risk of undernutrition compared to children in urban areas. In particular, the prevalence of stunted children is higher in the rural central region compared to the southern and northern regions (6). Therefore, continued surveillance of child nutritional status in rural central Malawi is crucial as it can provide evidence-based data for planning and evaluation of local nutritional programs. This study contributes to the literature on child undernutrition and nutritional program development by examining the prevalence and risk factors of child undernutrition in the rural agrarian communities of Dowa district in central Malawi. Furthermore, the findings can potentially inform the development of child nutrition sensitive policies and interventions in the study areas.

## **Conceptual framework**

My study is guided by the UN Children's Fund's (UNICEF) "care for nutrition" conceptual framework (7,8). The model suggests that child undernutrition in developing countries is caused by a nexus of biopsychosocial predisposing factors that operate at micro, mezzo, and macro levels. At microlevel, insufficient food intake and exposure to infectious diseases are core underlying factors of child undernutrition. At mezzo level, factors such as household food insecurity (HFI), low dietary diversity, unhygienic environments, inadequate access to basic health services, and poor care for children and women are predisposing factors of child undernutrition. Factors such as cultural and political ideologies, national resource control, and economic mismanagement are reinforcing factors of child undernutrition (7).

Drawing upon UNICEF's "care for nutrition" framework, studies in Malawi suggest that notable risk factors for child undernutrition are child morbidity, child age, and low birth weight (9). Common maternal underlying factors of child undernutrition include low education, young age at conception, and low body weight (10). At the household level, underlying factors of child undernutrition include low expenditure on food, low household income, and poor market access. At the community level, being in matrilineal lineage societies and drinking unclean water increase the risk of child undernutrition (11). The studies suggest that risk factors of child undernutrition in Malawi vary across geographical location and there is a need for research in Malawi's various regions. To date, Dowa District in Central Malawi has received little attention from researchers despite known predisposing factors for child undernutrition (12,13). This article addresses the regional gap and contributes to the broader picture of the determinants of child undernutrition in rural agrarian areas of Malawi, with relevance to similar contexts elsewhere in sub-Saharan Africa.

# Methods

## Study location

The study was conducted in Malawi, a small landlocked country of about 118,484 km<sup>2</sup> in Sub Sahara Africa. Malawi is bordered by Mozambique to the South and East, Zambia to the West, and Tanzania to the North. The current population of Malawi is about 17,563,749 million and nearly 85% depend on agriculture for their livelihood (14). This research was conducted in six outreach clinics in rural communities that are within the radius of 5 to 10 kilometers away from Mvera Mission Hospital in Dowa district (Figure 1) during the months of May to September 2018.

## Figure 1. The research setting

>>>>>Insert figure 1 here<<<<<<

## Study sample

We employed a descriptive cross-sectional study design. A multi-stage cluster sampling technique was used to select representative research participants (15). Specifically, we randomly selected six out of eight outreach postnatal clinics that operate under Mvera Mission Hospital. The selected outreach clinics were Mkhalanjoka, Gogo, Mvera, Kalinyengo, Mphande, and Ching'amba. During the time of the study, Mvera hospital was serving a population of 27,719 people. Out of the total population, 4820 under-five year old child/mother dyads were clients of postnatal health services in the selected six-outreach clinics. A Raosoft online software program was used to calculate a sample size (16). The margin of error was set at 5%, with 95% confidence level, and a response distribution of 50%. The minimum sample size was found to be 356 under five-years-old child/mother dyads. A systematic sampling technique was used to select 538 out of 4,820 under-five child/mother dyads from postnatal registers by selecting every ninth pair starting with a randomly selected pair.

## Participant recruitment

We contacted the selected children and their mothers through their postnatal clinics when they were attending a regular monthly health assessment. Health workers asked the mothers if they would be interested in participating in the study following their health assessment in a private consultation room. Five mothers did not consent to take part in the study, and they were subsequently replaced by randomly selected child-mother dyads that were not chosen during the initial sampling stage. For those who consented, a research assistant who was also a health worker orally administered the questionnaire in the same consultation room, away from the other health workers and clients. Through this set-up, the research team was able to protect the confidentiality of children and their mothers.

## Measures

### Outcome variables

The primary outcome variable of this study was child undernutrition in the form of stunting, underweight, and wasting. Stunting refers to a chronic form of undernutrition that entails prolonged periods of insufficient nutrient intake and assimilation (17). In general, stunting is an indicator of overall community social-economic wellbeing, where there is enough accessible food for the child to consume (18). Wasting refers to an acute form of undernutrition and entails a deficit of body tissue and fat mass. The condition arises when a child fails to access adequate food nutrients within a short period of time (17). Underweight is a composite measure of child undernutrition that encompasses both stunting and wasting. SECA gmbh & co. Model 874 mother-infant weighing scale was used to measure and collect the weight of the children and mothers. All standard practices for weighing children were followed, which included children wearing minimal clothing and no shoes when they were weighed (19). For accuracy and consistency, a 2 kg weight was used to adjust the measuring scale to zero after weighing each mother-child pair. The results of child and maternal weight were calculated to the nearest 100 grams. Length measuring boards were used to take children's height and were recorded to the nearest 0.1cm (20). Children who were two or more years old were measured in a standing position while those that were less than two years old were measured in a recumbent position.

We calculated height-for-age, weight-for-height, and weight-for-age Z-score values from measured children's heights, weights, age in months and reported child sex. A WHO Anthro software version 3.2.2, January, 2011 (21) was used to calculate the Z-scores with reference to the WHO child growth standards (22). Child stunting, underweight, and wasting were denoted as those that were less than or equal to 2 standard deviations of height-for-age, weight-for age, and weight-for-height Z-scores (20).

### Independent variables

Based on UNICEF's "care for nutrition" conceptual framework, we included numerous explanatory variables that have been linked to child undernutrition in developing countries (23). The following immediate child risk factors were considered as potential explanatory variables. Normal childbirth weight ( $\geq 2.5$  kg) was coded zero, and low birth weight ( $< 2.5$  kg) was recorded = one. Common child morbidities in the study areas were diarrhea, malaria, and acute respiratory infection (ARI). Mothers were asked to report the common sicknesses that the child suffered from in the two weeks prior to the research. Mothers' reported child morbidity was ascertained in the child health passport book as examined by medical personnel on the day that corresponded with the survey. I coded 1= diagnosed/reported sicknesses and 0 = no sickness in the past two weeks. Child gender was coded as 0 = female, and 1= male. Children who were treated with deworming drugs such as albendazole within the past year were coded = 1 and those who did not receive the treatment were coded = 0. Age of children were categorized as 1= 1-5 months, 2= 6-11 months, 3 = 12-23 months, and 4 = 24-59 months old.

The first underlying risk factors of child undernutrition were maternal demographic characteristics. They included age which was coded as 1=16-24 years old, 2 = 25-34, and 3=35-49. Maternal education was categorized as 0 = no education, 1= primary school, and 2 = secondary school. Maternal faith was categorized as 1= Church of Central African Presbyterian (CCAP), 2=Catholic, and 3=Pentecostal. The

number of children that a mother gave birth to were coded as 1 = one, 2 = two, 3 = three, 4 = four, and 5 = five and more. We also considered whether the pregnancy for the child participant was planned or unplanned. We coded 0 = planned, and 1 = unplanned. Mothers' nutritional status was categorized as 1 = underweight (BMI <18.5 kg/m<sup>2</sup>), 2 = normal (BMI 18.5–24.9 kg/m<sup>2</sup>), 3 = overweight (25.0–29.9 kg/m<sup>2</sup>), and 4 = obesity ( $\geq 30.0$  kg/m<sup>2</sup>) (20). Mothers who received nutritional counselling during pregnancy were coded 1 = yes and 0 = no. We also assessed whether a mother was exposed to IPV which was coded as 1 = yes and 0 = no. IPV was assessed by using a WHO Multi-country study questionnaire on women's health and life experiences that was previously validated and administered in Malawi (24,25).

The second underlying risk factors of child undernutrition were attributed to the father. Amongst them was education which was coded 0 = no formal education, 1 = primary, and 2 = secondary and tertiary education. Age was coded as 1 = 15-24 years old, 2 = 25-34, and 3 = 35-49. We included fathers' risky health behaviours such as alcohol consumption, smoking, whether he was involved in polygamous family, infidelity, and/or divorced. Each risk behavior was coded as 0 = no and 1 = yes.

Poverty threshold as a household level underlying risk factor for child undernutrition was defined based on the international poverty headcount ratio of USD 1.90 a day (26). Household food security was measured by a Household Food Insecurity Access Scale (HFIAS), which is calculated based on responses to questions about the frequency of occurrence of nine experiences characteristic of food security in the past month (27). Whereas the HFIAS yields four categories of food security, we coalesced the four HFIAS categories into food secure (food secure and mildly food insecure) and food insecure (moderately and severely food insecure) households to produce a binary set of categories (0 = food secure and 1 = food insecure household). The nutritional quality of diets was measured by Household Dietary Diversity Scale (HDDS) (20,28). We coded households as 1 = inadequate household dietary diversity when the mother reported that they consumed four or less food groups in the past 24 hours. We coded 2 = adequate household dietary diversity when a mother reported that they consumed five or more food groups in the past 24 hours (20,29). I also inquired about household domestic water source. We coded 1 = borehole (potable water) and 0 = river/wells (unsafe water). I also considered time that the mother took to fetch a pail of water. This was coded as 0 =  $\leq 30$  minutes, and 1 =  $\geq 30$  minutes. We considered child delivery place as hospital = 1, and home or traditional birth attendant = 0. We did not include toilet facility and household type because almost 99% and 98% of participants reported having an open pit latrine and grass thatched houses respectively.

The survey was administered on Android tablets. The Open Data Kit (ODK) was used to upload the digital version of the questionnaire into the tablets. An ODK is an Android application that can administer surveys, collect, and organize the survey data (30). This application allows for immediate data validation in the field. My team (the research trainers) included a clinical officer, a medical doctor, and a PhD social work candidate. Nine married female health surveillance assistants (research assistants) that were trained using the WHO protocol for conducting studies of IPV were responsible for data collection (31,32). It took five days to train the research assistants and to pretest the survey questionnaire. The research assistants and trainers all had professional training in child and maternal health. The researcher

stakeholders also had vast experience in measuring child weight and height and diagnosing common child illnesses in Malawi. Since we examined a sensitive topic relating to IPV, stakeholders decided that the questionnaire should be administered in the clinic's consultation room (33,34). The procedure for recruitment was as follows: when a mother and her child completed their monthly postnatal primary healthcare check-up, a health worker on-duty informed the mother about my nutritional study. If the mother was interested to take part in the research, the health worker invited the survey enumerator to administer the questionnaire. The arrangement was agreed upon by the survey team in consultation with hospital officials to maximize confidentiality of the research participants. Research assistants explained the objectives of the research and when the mother agreed to participate, she was requested to affirm her consent verbally.

### Research Ethics Review

We obtained ethics approval to conduct this study from McGill University's Research Ethics Board in Canada protocol number (REB File #: 503-0518), and University of Livingstonia research committee in Malawi protocol number (UNILIA-REC-4/18). We also obtained written permission from the authorities at the Dowa district Commissioner's office, the Dowa District Health Office, and Mvera Mission Hospital. Oral consent was also obtained from local health leaders.

### Data analysis

All 538 selected child-mother pairs were assessed for nutritional status. Cronbach's  $\alpha$  analysis was conducted to calculate the internal reliability of the questionnaire items that were used to determine HFS, dietary diversity, and IPV (35). The HFIAS' 9 items ranged in severity from worrying about household access to food to going the whole day and night without consuming any food due to lack of resources (36,37). The HDDS had 12 food categories which were used to probe the type of food that household members consumed in the past 24 hours. The scales on IPV controlling behavior had five items, psychological abuse had four items, physical abuse had six items, and sexual abuse had three items. We considered an  $\alpha$  level of 0.70 or higher as satisfactory (35). The calculated Cronbach's  $\alpha$  for the HFIAS was 0.87, 0.83 for the HDDS, while the Cronbach's  $\alpha$  for the controlling behavior items was 0.81, psychological violence was 0.75, physical violence was 0.83, and sexual violence was 0.87.

We used the Kolmogorov-Smirnov test to determine the normality of the distribution of numerical variables that included age, number of children, and HFIAS. It was found that my data was not normally distributed and opted to construct numerical variables into categories according to standard procedures (38). We calculated the determinants of stunting, wasting, and underweight based on socio-demographic characteristics of children, mothers, fathers, and household factors. A chi-square test was used to examine the association between indicators of each form of child undernutrition and given explanatory variables. Univariate logistic regressions were also performed to determine significant risk factors of child undernutrition from the selected independent variables. Three separate multivariable logistic regression analyses were performed to explore predictors of child stunting, underweight, and



The study showed that 224 (41.7%) of the children were stunted, 61 (11.3%) were underweight, and 17 (3.2%) were wasted. The results of chi-square tests highlighted a significant association between child stunting and maternal education ( $\chi^2 = 7.47$ ,  $df = 2$ ,  $p = .024$ ), child sex ( $\chi^2 = 5.57$ ,  $df = 1$ ,  $p = .018$ ), unplanned pregnancy ( $\chi^2 = 4.02$ ,  $df = 1$ ,  $p = .045$ ), household dietary diversity ( $\chi^2 = 7.07$ ,  $df = 1$ ,  $p = .008$ ), and maternal exposure to IPV ( $\chi^2 = 4.61$ ,  $df = 1$ ,  $p = .032$ ). In addition, child stunting was significantly correlated with domestic water source ( $\chi^2 = 4.18$ ,  $df = 1$ ,  $p = .048$ ), father who has divorced a wife ( $\chi^2 = 4.00$ ,  $df = 1$ ,  $p = .046$ ), and household farmland size ( $\chi^2 = 8.58$ ,  $df = 2$ ,  $p = .014$ ). Child underweight was significantly associated with water source ( $\chi^2 = 4.48$ ,  $df = 1$ ,  $p = .034$ ), child access to deworming treatment ( $\chi^2 = 4.14$ ,  $df = 1$ ,  $p = .042$ ), HFS ( $\chi^2 = 4.50$ ,  $df = 1$ ,  $p = .034$ ), and father who has divorced a wife ( $\chi^2 = 4.67$ ,  $df = 1$ ,  $p = .031$ ). Child wasting was significantly associated with maternal BMI ( $\chi^2 = 15.97$ ,  $df = 3$ ,  $p = .001$ ), and time a mother took to fetch water ( $\chi^2 = 6.45$ ,  $df = 1$ ,  $p = .011$ ).

### Significant risk factors of child undernutrition

The findings of unadjusted logistic regressions (Table 2, crude models 1, 2, and 3) show that being a male child, accessing unsafe water, mother's exposure to IPV, low household dietary diversity, mothers' lack of access to nutritional counseling, children who reside in families where fathers divorced a wife, and unplanned pregnancy were risk factors of child stunting. Household limited access to safe water, low child birthweight, HFS, and child-limited access to deworming drugs were risk factors of child underweight. Finally, only children whose mothers took more than thirty minutes to access water were at high risk of wasting than children whose mothers took less than 30 minutes.

In multivariable regression analyses, we adjusted for all variables that were significant predictors of child undernutrition in the prior models. The results of multivariable logistic regression of child stunting (Table 2, Model 1) show that boys were at an increased risk of stunting (*AOR*: 1.54, 95% *CI*: 1.06-2.23,  $P < 0.023$ ) compared to girls. Furthermore, children from households that use unsafe water had an increased risk of stunting (*AOR*: 1.72, 95% *CI*: 1.13-2.61,  $P < 0.011$ ) than children from households that used potable water. Children born from mothers who received nutritional education during gestational period had low risk of stunting (*AOR*: 0.29, 95% *CI*: 0.14-0.59,  $P < 0.001$ ) than children born from mothers who did not receive nutritional education when they were pregnant. Children who were residing in households that mothers experienced IPV were at an increased risk of stunting (*AOR*: 1.69, 95% *CI*: 1.14-2.49,  $P < 0.009$ ) compared to children whose mothers did not experience IPV.

The results of multivariable logistic regression analyses of underweight children (Table 2, Model 2) shows that children whose fathers have divorced were more likely to be underweight (*AOR*: 1.88, 95% *CI*: 1.02-3.48,  $P < 0.044$ ) than children whose fathers never divorced a wife. Children from families that used potable water were less likely to be underweight (*AOR*: 0.50, 95% *CI*: 0.28-0.90,  $P < 0.021$ ) than children from families that used unsafe water. Children whose mothers spent less than 30 minutes to access water were less likely to be underweight (*AOR*: 0.44, 95% *CI*: 0.23-0.83,  $P < 0.011$ ) than children whose mothers spent 30 minutes or more. It was also observed that children from food insecure households had higher chances of being underweight (*AOR*: 1.89, 95% *CI*: 1.01-3.53,  $P < 0.047$ ) than children from food



Furthermore, the study found that children from households that had easy access to potable water were less likely to be stunted and underweight compared to children from household with constrained safe water access. This finding is unsurprising given studies in Malawi that suggest that water from many boreholes is safe because are within WHO and Malawi Bureau of Standards quality limits. Furthermore, the studies maintain that approximately 80% of well water in Malawi is unfit for human consumption. Specially, fecal coliforms that cause typhoid, diarrhea, and cholera are prevalent forms of pathogens in these open water sources (45, 46). Therefore, the observed stunting in children who used unsafe water from rivers or wells can be partially attributed to recurrent illness from waterborne diseases such as diarrhea (47).

In this study, we have found that children from families who obtained water in less than 30 minutes were less likely to be underweight and wasted compared to children from families that took 30 minutes or more to access water. There are two possible explanations for this result. Firstly, studies suggest that the longer mothers take to collect water, the less time they have to care for their children (48), including providing regular breastmilk and frequent meals (49, 50). The second reason for the child nutritional outcome is related to household hygiene. Studies suggest that good hygienic practices are inversely related to distance from the water source. This means that households that are far away from the water source are more likely to be engaged in unhygienic childcare practices such as reduced laundry and unhygienic food preparation practices. These basic sanitary practices directly exacerbate poor child nutrition and health outcomes (51–53).

Our study support current findings in Malawi that low birthweight is a risk factor of child undernutrition (54). As observed in this study, children born with low birth weight were 2.6 times more likely to be underweight than children who were born within the normal weight range. The explanation of the finding can be drawn from the literature which suggests that children who suffered intrauterine growth retardation as fetuses are more likely to be undernourished compared to children without such a condition (55, 56). Furthermore, the phenomenon is intergenerational as maternal undernutrition, maternal underweight, and low stature exacerbate a low child birthweight. Therefore, the issue of underweight children can be addressed through programs that specifically ensure that girls, women, and pregnant mothers are adequately nourished, while also focusing on the first 1000 days of children's lives (57, 58).

This study has also found that children who did not receive intestinal deworming drugs such as albendazole in the year prior to the study were 1.8 times more likely to be underweight than children that were dewormed. This finding supports the importance of child deworming programs that are underway in Malawi and other developing countries (59). There is no study that has been done in the study areas on the nutritional benefits of child deworming, but a randomized study in Southern Malawi did not find any significant benefits of the treatment (60). These two conflicting studies from Malawi confirm the global literature that shows inconclusive benefits of child deworming (61–63). For instance, a study in India reported that under five-years-old children who received albendazole significantly gained an average weight of 3.04 kg than untreated children (64). However, a recent literature review suggests that child

deworming has little or no impact on child weight in many low and middle income countries (65). Therefore, more research is needed in my study area to validate this finding.

The study has also found that children from food insecure families were 1.9 times more likely to be underweight than children from food secure households. The finding supports the available literature in developing countries that link HFI and child undernutrition. For instance, studies in Kenya and India found that household food insecurity was a risk factor for child stunting, wasting, and underweight (66, 67). Similarly, a study that was conducted in Nicaragua found that even mild household food insecurity was detrimental not only to child nutrition but general child wellbeing (68).

Finally, this study has found that sex of children predicted child stunting but not wasting and underweight. Specifically, girls were 0.65 less likely to be stunted than boys. The result agrees with the current findings of the national study in Malawi where 39% of the boys and 35% of girls under five years old were stunted (4). Likewise, studies suggest that young boys in SSA countries are at an increased risk of stunting (*OR* 1.16) than young girls (69, 70). The sex-related difference in child stunting requires further study in the study areas. Specifically, it is inconclusive whether behavioral factors such as a gender bias, in terms of preferential treatment of girls over boys, can explain the difference (71, 72). In biology, the evolution theory speculates that natural selection favors a 1.0 sex ratio (73). In our study area, there were more boys (51%) than girls (49%). Therefore, based on evolution concepts, girls are more likely to survive in this area than boys despite being exposed to the same environmental stressors (74).

## Conclusion And Recommendations

The study has found that the prevalence of stunted children is higher in the study areas as compared to national prevalence. The prevalence of underweight and wasting are within the range of the national rate. The notable risk factors for child stunting include being a male child, access to open water sources, mothers' exposure to IPV controlling behavior, and lack of nutritional counselling during the gestational period. The study also suggests that limited access to portable water, low child birthweight, household food insecurity, and non-dewormed children were associated with child underweight. Finally, the study found that longer time that mothers took to fetch water increased the risk of child wasting.

This study suggests that on top of already existing child nutrition promotion programs in the study areas, there is also a need to consider improving household water access. Such programs can free up childcare givers who are mostly mothers to have ample time to dedicate to their childcare activities. We also recommend that a holistic approach should be taken to address child undernutrition in the study areas. Programs that improve household food security, low child birthweight, access to nutritional education, and increased child deworming can have positive impact on child nutrition. Furthermore, child undernutrition in Malawi should be perceived as a problem that can be addressed by all policy stakeholders. Specifically, the Ministry of Health, Agriculture, Economics, Education, and Water among others should collaborate to address these issues at hand.

We also suggest that IPV against mothers of children under five years old should also be considered as one of the risk factors of child undernutrition. Fathers' controlling behavior towards mothers should be addressed as it may potentially minimize maternal access to social networks that can be used to support the child. As such, counselling should be given to couples to reduce incidences of divorce that seems to have an impact on child nutrition, in addition to dealing with IPV.

## **Strengths and Limitations**

This study used the WHO reference group to measure the prevalence of child undernutrition in rural areas of central Malawi. Therefore, the results are comparable to national and global studies. Nevertheless, this study had some limitations. Since this is a cross-sectional study, I do not claim that the identified risk factors cause child undernutrition. In addition, some of the socio-demographic factors that were controlled were obtained retrospectively. Therefore, it is possible that a recall bias resulted in over or under reporting of some variables. Finally, I did not had control over social desirability bias that could emanate from the responses of the research participants (75). Some of the questions such as exclusive breastfeeding, child complementary feeding, and sleeping under mosquito nets were asked. It could be possible that a section of mothers accepted these childcare practices to appease the health workers who were my research assistants.

## **Abbreviations**

AOR

Adjusted odds ratios

COR

Crude odds ratios

CCAP

Presbyterianism

CI

Confidence interval

HDDS

Household Dietary Diversity Scale

HFI

Household food insecurity

HFIAS

Household Food Insecurity Access Scale

IPV

Intimate partner violence

NSO

National Statistics Office

SRQ

Self reporting questionnaire

SSA  
Sub-Sahara Africa  
US\$  
United States dollar  
WHO  
World Health Organization

## **Declarations**

### **Ethics approval and consent to participate**

All authors confirm that all methods were carried out in accordance with relevant research guidelines and regulations. The authors received research ethics approval from the Non-Medical Research Ethics Board at University of Livingstonia in Malawi (UNILIA-REC-4/18), and at McGill University, Canada (REB File #: 503-0518). The study also received written consent from Dowa district health office. Informed oral consents were obtained from all participants before each interview. The study did not involve experiments on human subjects.

### **Consent for publication**

The authors informed the participants that the study will be published to partially fulfill the requirement for the PhD. With full understanding of the research and its intended purpose, all participants gave full informed oral consent for authors to disseminate the results through publication. The gatekeepers provided a written informed consent for the research team to publish disseminate the study findings through various channels.

### **Availability of data and materials**

The study involved capturing of sensitive data according to WHO standards. I documented mothers' disclosure of violence by their current husbands. Due to the sensitivity of the study the two ethics boards did not recommend sharing the raw data publicly. For data accessibility, contact the corresponding author.

### **Competing interests**

We declare no competing interests

### **Funding**

The study did not have any external funding.

### **Authors' contributions**

E.C, designed the study, collected, and analyzed the data and wrote the sections of the first draft manuscript. E.C, and M.C revised the first manuscript. All authors read and approved the final manuscript.

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## Tables

**Table 1:** Socio-demographic characteristics of study sample

|                                   |                                    |        |      |
|-----------------------------------|------------------------------------|--------|------|
| <i>Mothers' characteristics</i>   | Age (years)                        | N= 538 | %    |
|                                   | 15-24                              | 224    | 41.6 |
|                                   | 25-34                              | 209    | 38.8 |
|                                   | 35-49                              | 105    | 19.5 |
|                                   | Education                          |        |      |
|                                   | No education                       | 81     | 15.1 |
|                                   | Primary                            | 370    | 68.8 |
|                                   | Secondary                          | 87     | 16.2 |
|                                   | BMI                                |        |      |
|                                   | Underweight                        | 27     | 5.0  |
| Normal                            | 323                                | 60.0   |      |
| Overweight                        | 150                                | 27.9   |      |
| <i>Children's characteristics</i> | Sex                                |        |      |
|                                   | Female                             | 263    | 48.9 |
|                                   | Male                               | 275    | 51.1 |
|                                   | Age range                          |        |      |
|                                   | 1-5                                | 72     | 13.4 |
|                                   | 6-11                               | 90     | 16.7 |
|                                   | 12-23                              | 156    | 29   |
|                                   | 24-59                              | 220    | 40.9 |
|                                   | Diarrhea episode                   | 163    | 30.3 |
|                                   | ARI episode                        | 216    | 40.1 |
| <i>Fathers' characteristics</i>   | Age category                       |        |      |
|                                   | 15-24                              | 87     | 16.2 |
|                                   | 25-34                              | 245    | 45.5 |
|                                   | 35-49                              | 206    | 38.3 |
|                                   | Current smoker                     | 138    | 26.0 |
|                                   | Ever divorced a wife               | 127    | 23.6 |
|                                   | Below poverty line (US\$ 1.90/day) | 515    | 95.7 |
|                                   | Food insecure                      | 320    | 59.5 |
|                                   | Inadequate HDD                     | 355    | 66.0 |
|                                   | Domestic water source              |        |      |
|                                   | Borehole                           | 380    | 70.6 |
|                                   | River/open well                    | 158    | 29.4 |
|                                   | Time taken to drew water           |        |      |
|                                   | ≤30 minutes                        | 314    | 58   |
|                                   | ≥ 30 minutes                       | 224    | 42   |
|                                   | Number of children                 |        |      |
|                                   | one                                | 168    | 31.2 |
|                                   | two                                | 121    | 22.5 |
|                                   | three                              | 106    | 19.8 |
|                                   | Four                               | 61     | 11.3 |
| Five or more                      | 79                                 | 14.7   |      |

**Table 2:** Crude and adjusted odds ratios (95% CI) for factors associated with child undernutrition in Dowa

| Variables                         | Model 1<br>Stunting |         | Model 2<br>Underweight |         | Model 3<br>Wasting |       |       |
|-----------------------------------|---------------------|---------|------------------------|---------|--------------------|-------|-------|
|                                   | Crude OR            | AOR     | Crude OR               | AOR     | Crude OR           | AOR   |       |
| <i>Child sex</i>                  |                     |         |                        |         |                    |       |       |
|                                   | Male                | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Female              | 0.66*** | 0.65*                  | 0.92    | 0.94               | 0.93  | 0.76  |
| <i>Water source</i>               |                     |         |                        |         |                    |       |       |
|                                   | River               | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Borehole            | 0.67*   | 0.58**                 | 0.56*   | 0.47**             | 0.73  | 0.80  |
| <i>Exposed to IPV</i>             |                     |         |                        |         |                    |       |       |
|                                   | Yes                 | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | No                  | 0.68*   | 0.59***                | 0.86    | 0.93               | 0.57  | 0.62  |
| <i>Dietary Diversity</i>          |                     |         |                        |         |                    |       |       |
|                                   | Average             | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Low                 | 1.64*** | 1.34                   | 1.87    | 1.84               | 2.23  | 1.99  |
| <i>Nutrition information</i>      |                     |         |                        |         |                    |       |       |
|                                   | Yes                 | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | No                  | 3.22*** | 3.50***                | 1.00    | 1.02               | 2.12  | 2.08  |
| <i>Husband divorced</i>           |                     |         |                        |         |                    |       |       |
|                                   | No                  | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Yes                 | 1.51*   | 1.66                   | 1.87*   | 1.72               | 2.26  | 2.00  |
| <i>Unplanned pregnancy</i>        |                     |         |                        |         |                    |       |       |
|                                   | Yes                 | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | No                  | 0.69*   | 0.69                   | 0.64    | 0.78               | 0.66  | 0.88  |
| <i>Time taken to fetch water</i>  |                     |         |                        |         |                    |       |       |
|                                   | ≥30 Minutes         | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | ≤30 minutes         | 0.98    | 0.87                   | 0.42*** | 0.50*              | 0.18* | 0.25* |
| <i>Childbirth weight</i>          |                     |         |                        |         |                    |       |       |
|                                   | Normal              | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Low                 | 1.32    | 1.39                   | 2.47*** | 2.55***            | 2.64  | 2.93  |
| <i>Household food security</i>    |                     |         |                        |         |                    |       |       |
|                                   | Secure              | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | Insecure            | 1.09    | 1.16                   | 1.88*   | 1.92*              | 1.25  | 2.05  |
| <i>Child received Albendazole</i> |                     |         |                        |         |                    |       |       |
|                                   | Yes                 | 1       | 1                      | 1       | 1                  | 1     |       |
|                                   | No                  | 1.13    | 1.02                   | 1.74*   | 1.82*              | 1.08  | 1.25  |

\* $p \leq .05$ ; \*\* $p \leq .01$ ; \*\*\* $p \leq .0001$ .

## Figures

Figure 1

The research setting