Nor. Afr. J. Food Nutr. Res. 2025; Vol. 9, No. 19, 163-173

DOI: 10.51745/najfnr.9.19.163-173

ORIGINAL ARTICLE

Public Health Nutrition Policy & Economics | Infant, Child, and Adolescent Nutrition

Concordance of caregivers and nutritionist MUAC measurements for acute malnutrition screening among children in rural Zimbabwe: A comparative study of the FL-MUAC Approach

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ABSTRACT

Background: Acute malnutrition in children represents a substantial public health concern, significantly elevating the risk of morbidity and impaired development. The Family-led Mid-Upper Arm Circumference (FL-MUAC) facilitates community-driven early diagnosis and treatment of acute malnutrition, thereby reducing morbidity, mortality, and program expenditures.

Aims: This investigation aimed to assess the ability of caregivers to accurately take MUAC measurements in children aged 6–59 months residing in rural Zimbabwean communities. Furthermore, this study aimed to elucidate the factors influencing the caregivers' ability to measure, focusing on their Knowledge, Attitudes, and Practices (KAPs) related to the FL-MUAC approach.

Subjects and Methods: A cross-sectional study utilizing a mixed-methods approach was conducted to collect both quantitative and qualitative data from Seke and Makoni rural districts in Zimbabwe. Multistage stratified random sampling was applied to select caregivers who participated in the study. Quantitative data were analyzed using SPSS version 20, incorporating Pearson's Chi-square test of association, Bland-Altman plot analysis, and binary logistic regression. Qualitative data were subjected to content analysis. Ethical clearance was obtained from the Medical Research Council of Zimbabwe (MRCZ/B/2223).

Results: A total of 96 caregivers were enrolled, yielding a response rate of 87.3%. Bland-Altman plot analysis demonstrated a mean difference close to zero (-0.024 ± 0.479 cm), indicating no statistically significant disparity between maternal and nutritionist-derived measurements. The capacity of caregivers to accurately measure MUAC was significantly associated with geographical proximity to health facilities (p = 0.001). Furthermore, maternal nutrition knowledge scores were identified as a significant determinant of MUAC measurement accuracy (p = 0.044) In 93.8% of cases, mothers demonstrated accurate MUAC measurement following adequate training.

Conclusions: This study establishes that, with appropriate exposure, maternal MUAC measurements exhibit a high degree of concordance with those obtained by nutritionists. Maternal nutrition knowledge scores significantly influence MUAC measurement accuracy. Therefore, the FL-MUAC approach demonstrates significant potential for enhancing community-based early diagnosis and management of acute malnutrition in this and comparable resource-constrained settings.

Keywords: Mid-Upper Arm Circumference, Severe acute malnutrition, Family-led MUAC, Malnutrition screening, Zimbabwe.

ARTICLE INFORMATION

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Received: September 18, 2024
Revised: February 23, 2025
Accepted: April 03, 2025
Published: April 15, 2025

Article edited by:
Prof. Khaled Méghit Boumédiène
Article reviewed by:
Dr. Loveness Nyanga
Dr. Meriem Bencharif

Cite this article as: Majiwa P., Chopera P., Matsungo M., T. (2025). The ability of caregivers to determine Mid Upper Arm Circumference (MUAC) in children aged 6 to 59 months from rural Zimbabwe: a comparative study. *The North African Journal of Food and Nutrition Research, 9* (19): 163 – 173. https://doi.org/10.51745/najfnr.9.19.163-173

1 INTRODUCTION

Malnutrition increases susceptibility and severity of infections hence is a risk factor for morbidity and mortality (Blössner *et al.*, 2005; Müller & Krawinkel, 2005). Factors such as poor diet, disease, environmental factors lead to malnutrition which in turn results in severe or repeated infections or death.

Malnutrition is implicated in approximately 50% of all child deaths (Blössner *et al.*, 2005; Lenters, Wazny, & Bhutta, 2016), representing a critical public health challenge. Severe wasting alone is attributable to one in ten deaths among children under five years of age in low- and middle-income countries, as children experiencing wasting exhibit an elevated risk of mortality from infectious diseases (Lenters, Wazny, & Bhutta, 2016). This is frequently attributed to inadequate dietary intake and the synergistic relationship between malnutrition and infectious disease, which perpetuates a detrimental cycle in developing nations (Müller & Krawinkel, 2005). It has been estimated that the combined effects of stunting, severe wasting, and intrauterine growth restriction were responsible for 2·2 million deaths and 21% of disability-adjusted life-years among children under five years of age (World Bank, Unicef, 2012).

Prior to the COVID-19 pandemic, an estimated 47 million children under the age of five years suffered from moderate or severe wasting, with the majority residing in sub-Saharan Africa and South Asia (Headey *et al.*, 2020). The economic, food, and health systems disruptions that occurred as a result of COVID-19 pandemic predictably compromised the health and nutrition status of young children, especially those in low- and middle-income countries, leading to a substantial increase in malnutrition across its various forms (Fore *et al.*, 2020). Public health emergencies such as the COVID 19 pandemic impeded routine growth monitoring activities at both community and healthcare facility levels. A study conducted in Zimbabwe indicated that only 19% of respondents reported continued accessibility of growth monitoring services, in contrast to 37.8% who reported otherwise (Matsungo & Chopera, 2020). Consequently, the imperative to empower families to monitor their own children's growth became apparent, as family-led methods facilitate the early detection of malnutrition. Family-led growth monitoring initiatives hold particular benefit for countries like Zimbabwe, which continue to grapple with high malnutrition prevalence and delayed presentation at healthcare facilities (Yaya, Odusina and Adjei, 2021).

Given the potentially lethal nature of childhood malnutrition, a prompt and comprehensive response in terms of nutritional intervention and medical support is warranted. Therefore, the early identification of affected children and the provision of necessary nutritional treatment and support are of paramount importance (Mogendi *et al.*, 2015). According to Marshall *et al.* (2009), Mid-Upper Arm Circumference (MUAC) offers an accurate diagnostic measure and facilitates the early identification of malnutrition in children, thereby contributing to a reduction in child-related morbidity and mortality. Their study further concluded that for Severe Acute Malnutrition (SAM), a higher MUAC cut-off point could improve case detection rates (Marshall *et al.*, 2009). A study by Mogendi *et al.*, (2015) also demonstrated the feasibility of utilizing MUAC for both admission and discharge assessments of children, citing advantages such as early identification leading to more straightforward and effective treatment. However, the authors noted that MUAC tends to identify younger children as malnourished more readily, given their increased likelihood of falling below the <12.5cm cut-off point. Another study highlighted the need to ascertain optimal MUAC thresholds for diverse geographical locations as well as consider age groups for categorization of acute malnutrition (Ariza *et al.*, 2023).

Research by Myatt *et al.* (2006) indicated that MUAC, in conjunction with the presence of bilateral pitting oedema, serves as an optimal indicator for community-based screening and case detection of malnutrition. To shift the burden from Village Health Workers (VHWs), an approach was developed to involve caregivers in the screening process, aiming for the earliest possible identification of malnutrition. The Family-led Mid-Upper Arm Circumference (FL-MUAC) initiative is an approach wherein caregivers receive training on how to use MUAC tapes to screen their children for acute malnutrition as well as to assess for oedema. The objectives of this approach were to optimize early diagnosis and treatment of malnutrition, thereby reducing mortality, morbidity, program costs and the proportion of children requiring resource-intensive in inpatient care. Developed by the Alliance of International Medical Action (ALIMA) in Niger, this approach has been adopted and implemented by various organizations in countries such as Mauritania, Nigeria, and Kenya (Action Against Hunger, 2017).

In several contexts, the FL-MUAC approach has been integrated with the Care Group approach, a peer-to-peer health promotion model wherein caregivers meet and transfer key health messages amongst themselves (Pieterse *et al.*, 2020; World Vision International, 2016). A lead mother who is the leader is responsible for transferring basic health information to a group of caregivers (Pieterse *et al.*, 2020). A study undertaken in Zimbabwe by Matsungo *et al.* (2023) revealed that the Care Group approach enhanced nutrition knowledge within communities, leading to positive changes in health-related behaviors.

Grant *et al.* (2018), provided empirical evidence indicating that mothers and caregivers can achieve sensitive and specific classifications of their child's nutritional status through the accurate application of MUAC. This finding was corroborated by Blackwell *et al.* (2015), whose study concluded that caregivers-led screening facilitates frequent monitoring, enabling early diagnosis and treatment, thereby positioning caregivers as central to the scaled-up community management of acute malnutrition. The FL-MUAC approach has enabled caregivers to develop a better comprehension of malnutrition, including its signs and symptoms, and to actively engage them in monitoring their children's nutrition status (UNICEF, 2020). Furthermore, research has demonstrated a high degree of agreement between MUAC measurements performed by caregivers and community health workers (Blackwell *et al.*, 2015). Given the relatively limited body of research on the Family-Led MUAC initiative, further investigation is warranted. Therefore, this study was designed to assess the capacity of caregivers to accurately perform MUAC measurements in children aged 6–59 months from the Seke and Makoni rural communities in Zimbabwe. Additionally, we explored the determinants of accurate MUAC measurement among caregivers. Subsequently, we assessed their Knowledge, Attitudes, and Practices (KAPs) related to child malnutrition, including the perceived barriers and facilitators for the implementation of the FL-MUAC approach.

2 METHODS

2.1 Study setting and population

This study was conducted in two rural districts in Zimbabwe, namely Seke and Makoni (Figure 1). These two districts were identified as having among the highest prevalence rates of stunting and wasting based on the 2018 National Nutrition Survey, with stunting rates exceeding the 30% threshold for the "very high" stunting category (FNC, 2018). Makoni and Seke were also the pilot districts for the implementation of the Family-Led MUAC approach. Data collected from these two districts is anticipated to provide valuable insights into the barriers and facilitators of the FL-MUAC approach within the Zimbabwean context.

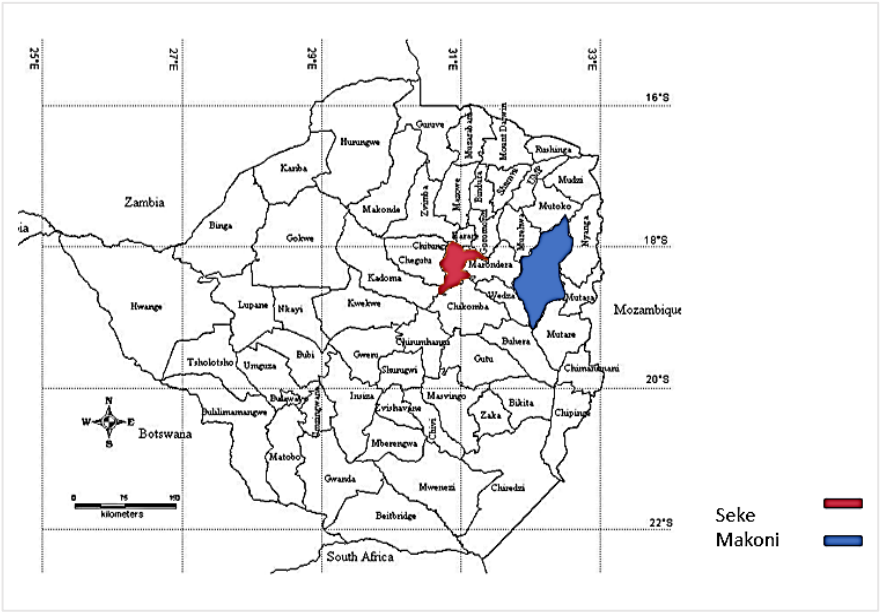

Figure 1. Map showing study setting. Map adopted from (Ministry of Health and Child Care, 2014)

2.2 Study design

A cross-sectional study design was employed, utilizing the mixed-methods approach. Quantitative data was collected through the administration of a structured and coded questionnaire. Qualitative data was gathered via Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) to facilitate triangulation and to obtain in-depth knowledge, which was used to formulate recommendations for the effective implementation of the FL-MUAC program.

2.3 Participants and sampling

The study population comprised caregivers of children aged 6 to 59 months, nutritionist, VHWs, and health workers (nurses and Environmental Health Technicians [EHTs]) who had received training on the FL-MUAC approach. FL-MUAC training started at the national and provincial levels, facilitated by the Ministry of Health and Child Care in coordination with United Nations agencies. These trainings were subsequently cascaded to selected districts. Health workers were trained at the district level, who, in turn, trained VHWs and lead mothers at facility level.

A multi-stage stratified random sampling was applied to select caregivers who participated in the study. Initially, a list of health facilities was obtained from the administrative offices of the two selected districts. Sequential numbers were assigned to all facilities within these two districts, and a random number generator was employed to select districts. Sequential numbers were assigned to all facilities within these districts, and a random number generator was used to select a sample of three health facilities from each district. Following the selection of the health facilities, a list of villages within the catchment area of each selected facility was obtained. Using the same random sampling method, two villages were selected from each catchment area. VHWs from each selected village were then contacted. Utilizing the VHW's register of all children under five years of age in their respective village, caregivers who met the inclusion criteria were enrolled in the study. The sample size was calculated using Cochran's formula, with an estimated prevalence of (p) of 0.037 (Nanjundeswaraswamy & Divakar, 2021).

The calculated sample size was 55 participants per district, yielding a total sample of 110 caregivers across the two districts.

Participants for the FGDs were obtained from the healthcare facilities selected in each district. These participants consisted of VHWs and lead mothers who had received training on the FL-MUAC approach at the selected facilities. They were informed of the date in advance, and the FGDs were conducted at the respective health facility.

Participants for the KIIs included all health cadres (nurses and EHTs) who had been trained on FL-MUAC and were stationed at the selected health facilities. Interviews were conducted with health cadres at every health facility visited during the study. A total of 24 KIIs were conducted with 2 (2 female) District Nutritionists, 2 (2 female) District Nutrition Assistants, 15 (11 female: 4 male) Primary Care Nurses, and 5 (2 female: 3 male) Environmental Health Technicians. A total of 46 (42 female: 4 male) VHWs and lead mothers participated in the Focus Group Discussions.

2.4 Data collection and tools

Quantitative data was collected through the use of a structured and coded questionnaire. This questionnaire comprised sections on: (1) sociodemographic characteristics, (2) nutrition Knowledge, Attitudes, and Practices (KAP), (3) barriers and facilitators of FL-MUAC implementation, and (4) MUAC measurements. The questions were adapted from validated questionnaires designed for assessing KAP (Fautsch-Macías & Glasauer, 2014). In this study, KAP related to FL-MUAC were assessed using a total of 24 questions (Fautsch-Macías & Glasauer, 2014). The measurements and assessment of oedema performed by caregivers and nutritionists were recorded for comparison "*assess ability of caregivers to perform MUAC assessments*". Measurements were collected first by the caregiver and then by a nutritionist using a standardized MUAC tape (Figure 2).

Figure 2. Photograph of MUAC tape used for taking MUAC measurements

The qualitative data collection instruments were designed to elicit comprehensive information regarding the barriers and facilitators associated with the FL-MUAC approach. This included the acquisition of participants' perspectives on training efficacy, the inherent strengths and weaknesses of the FL-MUAC approach, its perceived impact, existing challenges, identified gaps, and elicited recommendations for program implementation enhancement. Both Key Informant Interviews and Focus Group Discussions were conducted to ensure data triangulation.

2.5 Statistical analysis

Data were entered and analyzed using SPSS software, version 23. Prior to analysis, the normality of the data distribution was assessed using Q-Q plots. Descriptive statistics, including frequencies, means and standard deviations, were computed to summarize the data. Pearson's Chi-square test (χ^2) of association was employed to examine statistically significant associations between categorical variables, with a significance threshold set at $p < 0.05$. The Bland-Altman plot was utilized to evaluate the agreement between the MUAC measurements obtained by nutritionists and caregivers. Binary logistic regression analysis explored the factors associated with caregivers' ability to accurately measure MUAC. Qualitative data, obtained from the KIIs and FGDs, were analyzed using thematic content analysis facilitated by Excel software. This process involved initial data sifting to identify recurring patterns and subsequently reducing the data into salient themes which best summarized the findings, focusing on common threads or trends in response patterns.

The attribution method was employed for calculating nutrition knowledge and attitudes scores, while a three-point Likert scale was used for scoring attitude responses (Fautsch-Macías & Glasauer, 2014). Attitude scores for each question were calculated by dividing the aggregate score of all participants who answered the question by the total number of respondents for that question. For practice scores, each question was scored based on the presence or absence of positive practices. Positive practices were assigned a score of one, whereas negative practices received a score of zero. The overall practice score was obtained by summing the scores for each question and dividing by the total possible points for that section, yielding an average raw score, which was then converted to a percentage.

Levels of KAPs were classified and assessed using modified Bloom's cut-off points, where 80%–100% indicated good KAP, 50%–79% indicated a medium level, and less than 50% indicated poor KAP. A higher score was indicative of superior KAPs among the participants. These modified Bloom cut-off points were adopted from a study by Tiyasa *et al.* (2023). The ability to measure MUAC accurately was defined as a measurement value of ± 5 mm from a trained health worker (Saeed *et al.*, 2015). Both the caregiver and the nutritionist independently took three separate MUAC measurements on each child, and an average was calculated for each. The nutritionist's measurements were considered the standard, and caregivers whose average measurement fell within a measurement range of ± 5 mm of the nutritionist's average were categorized as 'able to measure'. The internal

consistency of the final questionnaire segments evaluating knowledge, attitudes and practices among caregivers was measured by internal reliability, with a Cronbach's alpha coefficient of 0.745.

Table 1. Demographic characteristics of caregivers who participated in the survey assessing ability to use MUAC from the districts Seke and Makoni

Variables	Category	Frequency (n)	Percentage (%)
Gender of child	Female	48	50
	Male	48	50
Position in the family	First born	21	21.9
	Second born	17	17.7
	Third born	34	35.4
	Other	24	25.0
Gender of caregiver	Female	89	92.7
	Male	7	7.3
Relationship to the child	Parent	91	94.8
	Grandparent	5	5.2
Highest attained educational level	Primary	19	19.8
	Secondary	76	79.2
	Tertiary	1	1.0
Religion	Roman Catholic	10	10.4
	Protestant	3	3.1
	Pentecostal	28	29.2
	Apostolic Sect	31	32.3
	Zion	9	9.4
	Other Christian church	10	10.4
	Other religion	4	4.2
	No religion	1	1.0
Marriage status	Single	3	3.1
	Married	87	90.6
	Widowed	2	2.1
	Divorced or separated	4	4.2
Distance from health facility	< 5 km	50	52.1
	5–9 km	33	34.4
	> 10 km	12	12.5
	Don't know	1	1.0

2.6 Ethics and approvals

Ethical clearance for this study was obtained from the Medical Research Council of Zimbabwe (MRCZ/B/2223). Ethical principles of respect, justice, confidentiality, consistent with the Declaration of Helsinki, were upheld throughout the study. The study procedures were explained in detail to all participants, and written informed consent form was obtained from each participant prior to the completion of the questionnaire. The anonymity and confidentiality of participants were maintained throughout all stages of the research process.

3 Results

3.1 Characteristics of the study participants

A total of 96 caregivers were interviewed and involved in this study, yielding a response rate of 87.3%. The age of respondents ranged from 17 to 62 years, with a modal age of 35 years and a mean age of 32 years. Household sizes varied from 2 to 10 individuals, with an average household size of 5. The majority of households reported having at least one child under the age of five years, with a mean number of two such children per respondent. The average age of children for whom MUAC measurements were taken was 29 months, with a range from 6 to 59 months. The most frequently observed age among these children was 48 months. The distribution of children by their position in the family is presented in Table 1, with the most frequent position reported as third-born.

3.2 Nutrition and FL-MUAC related knowledge, attitudes, and practices of participants

Nutrition Knowledge Score (NKS)

The prevalence of adequate Nutrition Knowledge Scores (NKS) was 97.9%, while 2.1% of participants demonstrated deficient NKS. No statistically significant sex differences were observed in NKS. The knowledge assessment encompassed areas such as basic nutrition principles, accurate identification of malnutrition signs, the purpose of MUAC measurements, and the etiology of malnutrition. The high prevalence of adequate nutrition knowledge observed in the quantitative data correlated with responses provided during KIIs and FGDs, where participants indicated that the FL-MUAC initiative had increased caregiver's understanding of malnutrition. For instance, one key informant stated:

"*Most caregivers are now very knowledgeable about nutrition, especially regarding the definition of malnutrition, its causes, and its symptoms. The initial trainings sessions and subsequent regular refresher trainings with VHWs have had a significant impact on nutrition knowledge as well as fostering positive behavior change among caregivers. Although some remain resistant, a substantial number of caregivers have shown improvement, even in their health-seeking behavior.*"

Based on our survey results, the majority of caregivers (77.1%) identified VHWs and the FL-MUAC training as their primary sources of nutrition knowledge. The remaining 21.9% attributed their knowledge to health workers, and a further 1% cited lead mothers within care groups. The NKS, attitude score, and practice score did not exhibit a

statistically significant association with the ability of caregivers to accurately measure MUAC (Table 2).

Attitudes on FL-MUAC

An overwhelming majority of caregivers (94.8%) expressed a positive attitude towards the FL-MUAC approach. During FGDs, one lead mother, who was also a caregiver, conveyed satisfaction with her ability to measure her child's MUAC to monitor their nutritional status:

"*Measuring my child's MUAC is beneficial as their health status can be assessed, allowing to be aware of the child's condition before they become ill or malnourished."*

However, a proportion of caregivers (68.8%) held the belief that measuring a child's MUAC was not essential, as nurses or VHW would routinely perform this task.

FL-MUAC Practices

In this study, it was noticed that 60.4% of caregivers reported visiting the clinic only when their child became ill, while only 37.5% of caregivers adhered to the recommended monthly clinic visits for immunizations or growth monitoring, in accordance with Ministry of Health Primary Health Care guidelines. A significant majority (83.3%) of caregivers reported that their child's weight had been measured at least once in the preceding month. Furthermore, a larger proportion of these children (69.8%) were weighed at the village level by VHWs, while 14.6% were weighed at the health facility level, and 15.6% during outreach programs. Concerning length or height measurements, only 43.8% of the children had their height measured at least once in the previous month, with 84.4% of these height measurements being conducted at the health facility level. More than half (76%) of the caregivers confirmed that height measurements were recorded. For child MUAC measurements, 83.3% reported that a measurement was taken in the previous month. The majority of the measurements (68.8%) were performed at the village level, with 16.7% at the facility level and 14.6 % at outreach points.

During the KIIs, health workers identified key challenges associated with the FL-MUAC approach, notably the insufficient supply of MUAC tapes and child health record cards, as well as a lack of incentives and provision of cooking ingredients. The initial success of the FL-MUAC initiative was partly attributed to its integration with the Care Group approach, which provided incentives to lead mothers and facilitated the provision of some of cooking ingredients. Following the cessation of funding for the Care Group approach, program continuity was compromised in several areas, consequently impacting FL-MUAC due to the discontinuation of regular refresher trainings that were conducted during care group meetings.

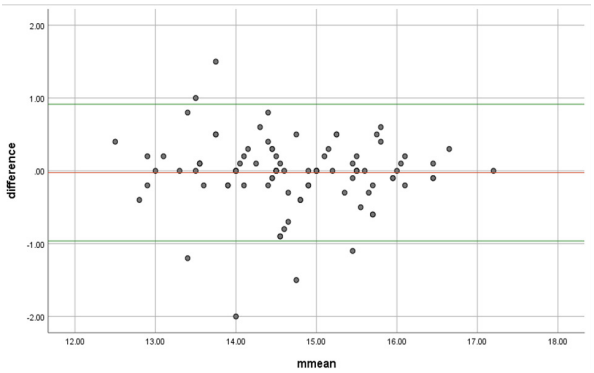

Figure 3. Bland-Altman scatter plot for the caregiver and nutritionist MUAC measurements

Key Informant 1 stated:

"*After the project was initiated, there has been no replenishment of MUAC tapes. This impedes project implementation as newly trained caregivers are unable to apply their knowledge at home. Torn, lost, or damaged MUAC tapes are not being replaced, resulting in a scarcity of these tools among caregivers, with some even resorting to sharing tapes, which is unhygienic and poses a risk of transmitting conditions such as skin infections among infants.*"

Table 2. Nutrition and FL-MUAC related knowledge, attitudes and practices of caregivers

Variables	Category	Total n (%)	Ability to measure MUAC Yes n (%)	Ability to measure MUAC No n (%)	*p*-value[1]
NKS	Adequate	88 (91.7%)	6 (6.3)	94 (97.9)	0712
	Deficient	2 (2.1%)	0 (0)	2 (2.1)	
Attitudes	Positive	86 (89.6%)	6 (6.3)	92 (95.8)	0.598
	Negative	4 (4.2%)	0 (0.0)	4 (4.2)	
Practices	Positive	86 (89.6%)	81 (84.4)	5 (5.2)	0.605
	Negative	10 (10.4%)	9 (9.4)	1 (1.0)	

Notes: NKS = Nutrition Knowledge Score, [1] *p*-value from Pearson's Chi-square test or Fisher's Exact test in cases where cell counts were below 5. * *p*-value significant at $p < 0.05$.

Key Informant 2 noted:

"*Cooking demonstrations were a central activity that effectively engaged caregivers in the program. However, due to funding constraints, these demonstrations have become infrequent, leading to challenges in maintaining the engagement of in Care Group meetings. Consequently, some care groups have become non-functional.*"

Key Informant 3 recommended:

"*One recommendation for the FL-MUAC approach is to enhance male involvement, as the initial phase of the project primarily focused on caregivers. Increased male participation would ensure that children are measured even in the absence of the primary caregivers.*"

A substantial majority (80%) of participants stated that FL-MUAC data were utilized for monitoring malnutrition prevalence within communities, planning community-based programs, and verifying statistics related to active screening efforts. A similar proportion (75%) highlighted that despite their data reporting, feedback meetings on the reported statistics have not been conducted. While children have been identified and referred through the FL-MUAC approach, the data appears to be lost at the health facility level due to the absence of a specific indicator for the number of children identified with malnutrition via this approach.

Assessing agreement between MUAC measurements

The Bland-Altman plot (Figure 3) was employed to assess the agreement between MUAC measurements performed by caregivers and nutritionists. The distribution of points above and below zero on the plot indicated the absence of consistent bias in the measurements. The Bland-Altman plot revealed a mean difference ± standard deviation close to zero (-0.024 ± 0.479 cm), implying a high degree of agreement between MUAC measurements taken by caregivers and nutritionists – indicative of 'caregivers' successful measurement of MUAC'.

Ability of caregivers to measure MUAC accurately

In this study, 93.8% of the caregivers were classified as possessing the ability to measure MUAC accurately. The average MUAC measurement recorded by caregivers was 14.72 ± 1.01 cm, while the average measurement by nutritionists was 14.95 ± 0.98 cm. The MUAC averages recorded by nutritionists were slightly higher than those recorded by caregivers, with disparities fluctuating between -2.00 cm to 1.50 cm. The average difference between the two sets of measurements was -0.024 ± 0.479 cm, indicating no statistically significant difference between caregivers' and nutritionists' measurements.

The approximate distance from a caregiver's residence to the nearest clinic (p = 0.001) exhibited a statistically significant association with their ability to measure MUAC accurately (Table 3). Specifically, closer proximity to a clinic correlated with a greater ability to accurately measure MUAC. Caregivers who reported taking MUAC measurements demonstrated a significant ability to measure accurately compared to those who did not report taking measurements (p = 0.028). Exploratory analyses were performed to ascertain the relationship between frequency of MUAC measurements and variables in the study. The results indicated that caregivers who received FL-MUAC training and were instructed or prompted to measure MUAC during clinic or outreach visits were significantly more likely to measure their child's MUAC frequently (p < 0.001). Furthermore, the type of personnel who provided the training was also significantly associated with the frequency of measurements (p = 0.001). Caregivers trained by VHWs were observed to measure their child's MUAC more frequently compared to those trained by nurses and lead mothers.

The frequency of clinic visits and the availability of child health record cards were associated with MUAC tape usage (p < 0.001). This implies that caregivers with more positive health-seeking behaviors were more likely to measure their child's MUAC compared to those with less frequent clinic attendance. Both the recording (p < 0.001) and reporting (p = 0.001) of MUAC measurements were significantly associated with MUAC usage. Caregivers who had attended a community-based session on child health and nutrition within the preceding three months were also significantly more likely to participate in the FL-MUAC approach (p = 0.010).

Determinants of ability to measure MUAC

Binary logistic regression analysis (Table 4) was performed to determine the relationship between selected variables and caregivers' ability to measure MUAC accurately. The results revealed that NKS was significantly associated with the ability of caregivers to measure MUAC (p = 0.044).

4 Discussion

The study investigated the ability of caregivers to accurately measure MUAC for the screening of acute malnutrition in children aged 6–59 months from selected rural communities in Zimbabwe. Our findings revealed that the majority of the caregivers (93.8%) demonstrated the ability to measure MUAC accurately, with no statistically significant difference compared to measurements taken by a trained Nutritionist (p > 0.05). Previous studies have reported similar results, supporting the capacity of caregivers to accurately classify their child's nutritional status using MUAC (Blackwell *et al.*, 2015; Alé *et al.*, 2016; Bliss *et al.*, 2018; Buttarelli, Woodhead and Rio, 2021).

Table 3. Test for association between ability of caregivers to take accurate MUAC measurements and sociodemographic characteristics

Variables	Category	Total n (%)	Ability to measure MUAC accurately		*p*-value[1]
			Yes n (%)	No n (%)	
Position of child in the family	Firstborn	21 (21.9)	18 (18.8)	3 (3.1)	0.235
	Second born	17 (17.7)	17 (17.7)	0 (0.0)	
	Third born	34 (35.4)	33 (34.4)	1 (1.0)	
	Other	24 (25.0)	22 (22.9)	2 (2.1)	
Gender of caregiver	Female	89 (92.7)	83 (86.5)	6 (6.7)	0.478
	Male	7 (7.3)	7 (7.3)	0 (0.0)	
Relationship to the child	Parent	91 (94.8)	85 (88.5)	6 (6.7)	0.553
	Grandparent	5 (5.2)	5 (5.2)	0 (0.0)	
Highest attained educational level	Primary	19 (19.8)	17 (17.7)	2 (2.1)	0.675
	Secondary	19 (19.8)	72 (75.0)	4 (4.2)	
	Tertiary	1 (1.0)	1 (1.0)	0 (0)	
Religion	Roman Catholic	10 (10.4)	8 (8.3)	2 (2.1)	0.282
	Protestant	3 (3.1)	3 (3.1)	0 (0)	
	Pentecostal	28 (29.2)	28 (29.2)	0 (0)	
	Apostolic Sect	31 (32.3)	29 (30.2)	2 (2.1)	
	Zion	9 (9.4)	9 (9.4)	0 (0)	
	Other Christian church	10 (10.4)	9 (9.4)	1 (1.0)	
	Other religion	4 (4.2)	3 (3.1)	1 (1.0)	
	No religion	1 (1.0)	1 (1.0)	0 (0)	
Marriage status	Single	3 (3.1)	3 (3.1)	0 (0)	0.428
	Married	87 (90.6)	82 (85.4)	5 (5.2)	
	Widowed	2 (2.1)	2 (2.1)	0 (0)	
	Divorced or separated	4 (4.2)	3 (3.1)	1 (1.0)	
Distance from health facility (km)	<5 km	50 (52.1)	48 (50.0)	2 (2.1)	0.001*
	5-9 km	33 (34.4)	30 (31.3)	3 (3.1)	
	>10 km	12 (12.5)	12 (12.5)	0 (0)	
	Don't know	1 (1.0)	0 (0)	1 (1.0)	
Did you ever report any MUAC measurements to your VHW	Yes	57 (59.4)	56 (58.3)	1 (1.0)	0.028*
	No	39 (40.6)	34 (5.4)	5 (5.2)	
What is source of knowledge of FL-MUAC	Health workers	21 (21.9)	18 (18.8)	3 (3.1)	0.224
	VHW	74 (77.1)	71 (74.0)	3 (3.1)	
	Lead mothers	1 (1.0)	1 (1.0)	0 (0.0)	
During the past three months have you attended a community-based session on child health and nutrition	Yes	75 (78.1)	71 (74.0)	4 (4.2)	0.483
	No	21 (21.9)	19 (19.8)	2 (2.1)	
Are you part of a care group	Yes	74 (77.1)	69 (71.9)	5 (5.2)	0.707
	No	22 (22.9)	21 (21.9)	1 (1.0)	

Notes: [1] *p*-value from Pearson's Chi-square test or Fischer's Exact test in cases where cell counts were below 5. * *p*-value significant at $p < 0.05$.

Table 4. Determinants of caregivers' ability to measure MUAC accurately

Variables	B	S.E.	Wald	*p*-value	Odds Ratio (OR)	95% C.I. for OR	
						Lower	Upper
NKS	-0.89	0.441	4.043	0.044*	0.412	0.173	0.978
Caregiver age (years)	-0.09	0.055	2.413	0.120	0.918	0.824	1.023
Practices score	-0.51	0.332	2.360	0.125	0.601	0.313	1.151
Constant	4.98	3.373	2.176	0.140	144.82		

Notes: Hosmer and Lemeshow Test ($p = 0.816$), Cox & Snell $R^2 = 0.058$, Nagelkerke $R^2 = 0.156$. The reverse conditional elimination method was used. *p-value significant at $p < 0.05$. NKS = Nutrition Knowledge Score

We posit that the high level of accuracy observed among caregivers in our study could be attributed to the comprehensive training provided within the FL-MUAC community program, and potentially influenced by the relatively high literacy levels among the sampled caregivers, with 79.2% having completed secondary school education.

Notwithstanding this, the utilization of color-coded MUAC tapes facilitates caregivers' determination of their child's nutritional status based on color classification alone, enabling women with limited literacy and/or numeracy skills to perform this screening test accurately (Blackwell *et al.*, 2015). Our findings demonstrated a statistically significant association between the NKS and the caregiver's ability to measure MUAC. Consequently, future research is required to explore the impact of nutrition knowledge on ability to measure MUAC and related practices among caregivers in comparable low-income settings. This significant association, which was not evident in the initial Chi-square test, may be attributable to the limitations of the Chi-square test in controlling for confounding variables. Logistic regression, by adjusting for other variables, can reveal significant effects of exposure on the outcome that may otherwise be obscured. However, further studies with larger sample sizes are necessary to elucidate the precise relationship between knowledge scores and the ability to measure MUAC.

The prevalence of adequate NKS was high (97.9%) and an overwhelming majority of caregivers (94.8%) exhibited a positive attitude towards the FL-MUAC approach. Consistent with the findings of Blackwell (2015) and other programmatic documents, FL-MUAC implementation is associated with increased nutrition knowledge among mothers (UNICEF, 2020; World Vision, 2017). Adequate knowledge constitutes a fundamental cornerstone of all behavior change programs. While Blackwell *et al.* (2015) postulated a potential decline in caregivers' measurement ability over time, our study revealed that caregivers retained the capacity to assess accurately even after several years of initial training. This sustained ability could be attributed to the continuous practice, as caregivers are encouraged to measure their children during outreach activities and facility visits.

Limitations

This study was conducted in pilot districts that received initial intensive training during the early implementation phase of the FL-MUAC approach. The intensity and scale of training in these districts may have differed from other districts where different implementing partners coordinated the program. Furthermore, while our target sample size was 110 caregivers (55 per district) we were able to recruit only 96 caregivers due to unavailability of some sampled participants. Seke, being a peri-urban district with a significant proportion of women engaged in market produce sales, most were unavailable at their homesteads during the survey period. Peri-urban populations also exhibit high mobility, which further contributed to participant unavailability. Limited funding excluded extensive monitoring and follow-up efforts for non-responses. Further research should be conducted in other rural settings within Zimbabwe to enhance the generalizability of the findings. However, a key strength of the study is the utilization of a mixed methods data collection approach, which allowed for the triangulation of findings.

5 CONCLUSIONS

This study was designed to assess the ability of caregivers to accurately perform MUAC measurements in children aged 6–59 months from the Seke and Makoni rural communities in Zimbabwe. Furthermore, we explored determinants of accurate MUAC measurement in children, and subsequently assessed caregivers' Knowledge, Attitudes, and Practices (KAPs), including the perceived barriers and facilitators for the implementation of the FL-MUAC approach.

This study demonstrated the ability of caregivers (93.8%) to effectively utilize the color-coded MUAC tape for the detection of SAM among children. However, regular refresher training sessions were found to be important in maintaining caregivers' adherence to the MUAC measurement protocol. Furthermore, the NKS was identified as a significant factor positively associated with the caregiver's ability to measure MUAC accurately. Therefore, the FL-MUAC approach holds significant potential for enhancing community-led early diagnosis and treatment of acute malnutrition, thereby serving as a crucial component in scaling up community-based management of acute malnutrition in low-income settings. Based on the findings of the current study, we propose the following recommendations:

- While the FL-MUAC approach can improve the coverage of acute malnutrition screening at a community level, there is a need to actively involve and train male family members in the approach to ensure that children are assessed even in the absence of the primary caregiver.
- In addition, there is a need for a consistent supply of MUAC tapes to communities, as well as the revitalization and mainstreaming of the approach via mother-support "care" groups to increase adoption and ensure program sustainability.
- To ensure the long-term sustainability of FL-MUAC, it should be integrated into the routine healthcare system to ensure continuous training, monitoring, and scaling up efforts.

Acknowledgment: Special thanks to all the mothers and/or caregivers and health workers who participated in the study. We thank the Ministry of Health and Child Care (MoHCC) authorities for approving the study.

Source of funding: There was no support funding obtained for this study.

Previous submissions: No presentations have been done on the manuscript.

Authors' Contribution: Promise Majiwa: Conceptualization, methodology, data curation, statistical analysis, writing first draft. **Prosper Chopera and Tonderayi Mathew Matsungo**: Conceptualization, supervision, validation, writing - review & editing, data analysis.

Conflicts of Interest: There are no conflicts of interest pertaining this manuscript.

Preprint deposit: Authors did not share this manuscript as a preprint deposit.

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