ORIGINAL ARTICLE

Mid-Upper Arm Circumference (MUAC): An Indicator to Identify, Wasting in Infants Less Than Six Months of Age

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ABSTRACT

Objective: Malnutrition under six months of age is one of the major challenging issues, in developing countries. The present study was conducted to determine the Mid-Upper Arm Circumference (MUAC) cutoff values, for identifying severe acute malnutrition in infants under six months of age, admitted to a tertiary care hospital.

Study Design: Cross-sectional study

Place and Duration of Study: The study was conducted at the Department of Pediatrics Dow University of Health Sciences & Dr. Ruth KM Pfau Civil Hospital Karachi from January to December 2021.

Material and Methods: A total of 249 infants of either gender, between the ages of two to six months, were included, in this study. The receiver operating characteristic curve was utilized to assess the diagnostic accuracy and identify optimal MUAC cut-off for screening, severe and moderate wasting.

Results: The MUAC cutoff value was determined for infants divided into two groups, two months to four months and infants four to six months of age, in males ranging from two to four months of age it was, 10.26cm. On the other hand, the cut-off for females in both age groups was the same, 9.25 cm. A combined MUAC cut-off value, between two months to four months of age, was calculated to be 10.25 cm whereas it was 9.25 cm, above four months of age

Conclusion: The MUAC cut-off values presented in this study will contribute to assessing the severity of malnutrition among infants up to six months of age.

Key Words: *Severe acute malnutrition, Wasting, Infants less than six months of age, MUAC cut-off*.

INTRODUCTION

Malnutrition is a major global health issue for infants and children. Approximately 8.5 million infants under six months old worldwide suffer from wasting.[1] An, earlier study showed that 3.8 million infants, less than 6 months of age were severely wasted (SAM) whereas 4.7 million had moderate malnutrition (MAM).[2] One of the research projects from Kenya reported that 9.7% of infants less than 6 months of age were wasted and 11% were stunted.[3] The COVID-19 pandemic has shown a devastating effect in South Asia, it is estimated that the majority, 1 in 22 children who have become wasted due to COVID-19 economic

losses belong to this region.[4] According to WHO, in Pakistan, 37 percent under five years of age are stunted,07 percent are moderately and severely wasted, whereas severe wasting is 02 percent.[5] Infants below six months of age are reported to be more vulnerable to nutritional compromise and approximately 17 to 21 %, are reported to be severely wasted.[6] There is a lack of comprehensive information on the prevalence of severe malnutrition, its associated risk factors, and treatment recommendations for infants in this age group. Reports highlight the prevalence of severe wasting among infants under six months old in South Asian countries, which ranges from 5.3% to 14.1%.[7] One of the earlier studies, from India, reported that wasting was higher in infants less than six months of age, 31% as compared to older children, and severe wasting was found in 13% of infants.[8] Whereas a recent study showed prevalence of, 14.8%, ranging from 3.5 to 21% across various states.[9] An increased risk of malnutrition in infants is attributed to many factors including low birth weight, prematurity, and feeding problems.[10] Undernutrition significantly increases infant mortality rates, especially in those under six months due to their physiological and immunological immaturity, leading to higher morbidity and mortality.[11] The anthropometric parameters mostly used to identify underweight, include weight for age, whereas, weight for length, and, mid-upper-arm circumference, are indicators for wasting in children between 6-59 months of age. However, in infants under six months of age, weight for length has been used to determine wasting. MUAC cutoff values to determine moderate and severe acute malnutrition are still under research. In this age group, studies have demonstrated that mid-upper arm circumference (MUAC) is a more reliable predictor of mortality than weight-for-length ratio.[12] The MUAC-Z-score tape has been used in the screening of malnutrition and management of severe wasting among children in the community.[13.]

We focused our research on the assessment of malnutrition under six months of age, excluding neonates because there was a scarcity of local studies conducted in Pakistan, on this issue. It is important to recognize the significance of early identification of moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) in infants for timely management and improvement of national nutrition policies. This approach can positively impact the reduction of morbidity and mortality. The study aimed to establish the mid-upper arm circumference (MUAC) cutoff values for identifying severe acute malnutrition in infants under six months of age who are admitted to a tertiary care hospital.

MATERIAL AND METHODS

This study was conducted after the ethical approval of the Department of Pediatrics Dow University of Health Sciences & Dr. Ruth KM Pfau Civil Hospital Karachi from January to December 2021. This study was a cross-sectional study, conducted over one year at the Pediatric Department of Dow University of Health Sciences & Civil Hospital Karachi. Informed consent was obtained from the parents or the guardian, before enrollment and collecting data for the research. A total of 249 infants of either gender between the ages of two to six months, regardless of their ethnicity were enrolled in the study. The sample size and its margin error of 4% were calculated using open EPI sample estimation software. Infants with any congenital anomalies of limbs, orthopedic problems like septic arthritis, fractures, dislocation of joints and limbs any neurodegenerative disorders with limb contractures or deformities due to which anthropometric measurements were either difficult or not possible to obtain were excluded from the study. Infants, who had serious illnesses like sepsis, meningitis, and bronchopneumonia requiring PICU care including ventilator support were also excluded from the study, infants with generalized edema due to any cardiac, or renal disease were also excluded from the study. The data was collected by medical officers and entered into a questionnaire. The questionnaire mainly consisted of anthropometric data including the participant's length, weight, MUAC, and birth weight, along with common demographic information such as age, ethnicity, and gender. The weight measurements, accurate to within 10g, were conducted while the infant was wearing lightweight clothing. This was done using a Salter electronic baby and toddler scale, which had been calibrated. In addition, MUAC measurements were taken using a non-stretch tape, accurate to within 1 mm, and the length was measured to the nearest 0.1 cm. The age was concluded to the

nearest days by asking the parents about the infant's age and date of birth or consulting medical records directly. In this study WHZ (weight-for-height Z scores) was calculated for all infants as recommended by WHO, child growth chart references, and classified as <-3 SD, severe wasting, and > -3 SD to < -2 SD, moderate wasting, respectively, as the standard.[14] To assess the diagnostic accuracy of MUAC with WLZ and identify optimal MUAC cut-offs for screening, severe and moderate wasting in infants from two to six months, the receiver operating characteristic curve was used. The ROC curve plots the true positive rate (sensitivity) versus the false-positive rate (1-specificity) along with the AUC, with its 95 % confidence interval, assessing the diagnostic accuracy of the tests used. The shape of the curve and the area under the curve determine the discriminatory power of the test, the test is more reliable if the area under the curve is large.[15] In the present study, the MUAC cutoff values, with the highest sensitivity in regards to a comparatively lower false-positive rate were selected. To ensure a lesser false-positive rate of MUAC cutoffs, the sample size, was divided into two groups according to the infant's age, 02 to 03 months plus 29 days, and 04 to 05 months plus 29 days respectively. These groups were further divided based on their gender, male, female, and combined. The data was entered into SPSS version 21 and analyzed.

RESULTS

The study recruited 249 infants aged between two to six months, and their average age was 3.9 ± 1.1 months. In this study, the number of female (51.8%) and male (48.2%) participants was nearly the same (table 1), with the measured weight, length, and MUAC for both genders combined being, 5.4 ± 1.1 kg, 59.8 ± 5.0 cm and 12.4 ± 1.4 cm, respectively. The majority of individuals were between four to six months of age (60.2%). The nutritional status identified by mid-upper arm circumference showed, (10.6%) severe wasted and the rest of the infants, 89.6%, were either normal or moderately malnourished. The ROC curve was used to identify a cut-off value of MUAC to distinguish severe malnutrition from moderate malnutrition and normal nutritional status in both genders together and individually in their respective age groups, (fig 1 - 6). The MUAC cutoff value found in males ranging from two to four months of age was, 10.26cm (AUC= 0.267). On the other hand, the cut-off for females in both age groups was the same 9.25 Cm (AUC= 0.257). A combined MUAC cut-off value, between two months to four months of age, was calculated to be 10.25 cm (AUC= 0.276) whereas it was 9.25 cm, (AUC= 0.247), above four months of age (table 2).

TABLE 1: Demographic data (n=249)

Variables	Frequency (%)
Gender	
Male	120 (48.2)
Female	129 (51.8)
Age	
02 to 03 months + 29 days	99 (39.8)
04 to 05 months+29 days	150 (60.2)
MUAC Category (cm)	
Severe wasting	26 (10.4)
Normal and Moderate wasting	223 (89.6)

TABLE 2: Mid upper-arm circumference, Cutoff value (n=249)

Gender	MUAC cut off with age (cm)	
	02 to 03 months + 29 days	04 to 05 months+29 days
Male	10.26	9.6
Female	9.25	9.25
Both	10.25	9.25

ROC curve of infants
Test variable: MUAC
State variable : <-3SD classified as severe wasting

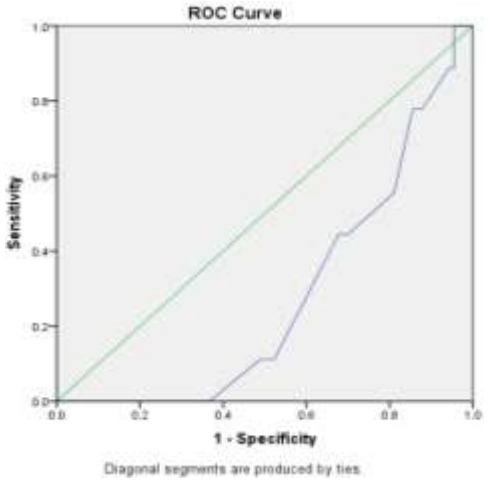

Fig 1: All infants (02 to 03 months + 29 days)

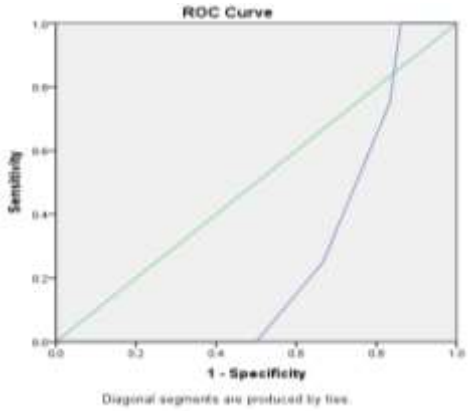

Fig 2: Male infants (02 to 03 months + 29 days)

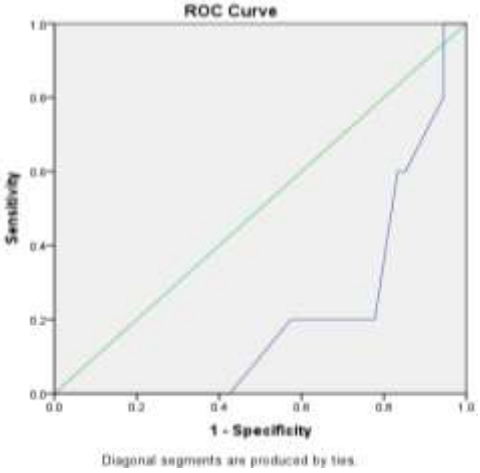

Fig 3: Female infants (02 to 03 months + 29 days)

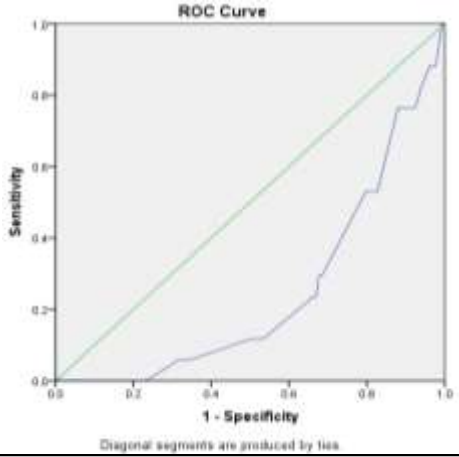

Fig 4: All infants (04 to 05 months + 29 days)

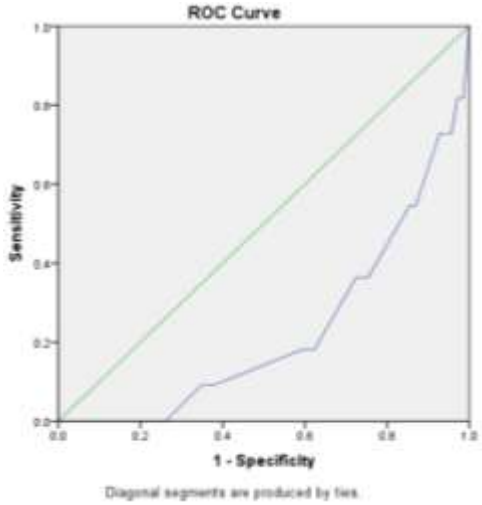

Fig 5: Male infants (04 to 06 months + 29 days)

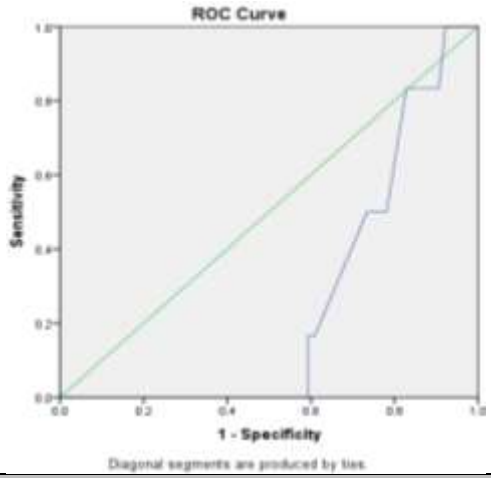

Fig 6: Female infants (04 to 06 months + 29 days)

DISCUSSION

Malnutrition in infants below six months of age is being considered a sweltering issue globally, especially in developing countries like Pakistan. Infants aged under six months are small and nutritionally at-risk, with different forms of anthropometric deficits, including wasting, underweight, stunting, or low birth weight.[16] These deficiencies result in various health problems, leading to subsequent malnutrition, impaired development, and higher mortality rates.[17] Mid-upper arm circumference (MUAC) has been regarded as the most efficient and cost-effective

tool for the assessment of nutritional status and severe acute malnutrition among pediatric age groups less than six months of age with minimum risks. However, the optimal cutoff values are still required to be determined.[18,19] In this study, MUAC cut-off was estimated to be higher, 10.25cm, in young infants, from two up to four months of age, as compared to MUAC cut-off, 9.25 cm, in infants with age four to six months. During infancy, malnourishment due to socio-demographical and environmental influences also leads to developmental delays later in childhood.[20] Research conducted in Kenya has established a link between infant mortality rate and MUAC and weight-for-age, declaring MUAC a critical indicator of mortality. Another study in Burkina Faso found that around 17% of infants are at risk of mortality, as they had MUAC less than 11.5cm.[22] Similarly, a study done in Ethiopia has that a MUAC cutoff of ≤112 mm is vital in detecting severe wasting among infants below six months of age.[23] Nonetheless, the present study suggests that the most effective MUAC cutoffs to identify wasting are 10.25 cm and 9.25 cm. The MUAC cutoff is higher in male infants than in females, according to the research findings. This may be due to the usual physical characteristics of girls, who are typically slimmer and shorter than boys. It has been practically feasible to use MUAC as an indicator of malnutrition in the community, and mothers can keep track of their infants' growth by using the MUAC tape. The use of the MUAC tape has been proven to be effective in monitoring malnutrition.[24] The present study comprises participants recruited from Civil Hospital, Karachi, Pakistan, as a result, the MUAC cutoffs identified in the study are better suited to the moderate-low socioeconomic tier which constitutes a big section of the Sindh population. It is crucial to consider practical limitations when determining the most suitable anthropometric criteria. This study was conducted in a hospital setting among sick infants with medical illnesses. As a result, the findings may not be representative of infants in the community, where MUAC is the preferred screening method. However, because the study took place in a large public hospital, the result may apply to a diverse range of infants and can be generalized for inpatient care. It is important to validate these results by conducting a study involving multiple centers and a larger sample size.

CONCLUSION

To conclude this study predicts MUAC cutoffs for screening malnutrition, by gender and age groups for infants between two to six months of age. The MUAC cutoff value for infants in the age group, two months up to four months was identified to be 10.25 in both genders, whereas in females it was 9.25 and in males 10.26. On the other hand, combined average cutoff values in children, four months up to six months of age were found to be 9.25, for females in this group it was 9.25 and for males 9.6. The MUAC cut-off values reported in this study will help to assess the severity of malnutrition among infants up to six months. Adding mid-upper arm circumference (MUAC) measurement to the evaluation of nutritional status in infants younger than six months could increase coverage. Additionally, the national nutritional management strategy should include the guidelines suggested by the MAMI (Management of Small and Nutritionally At-risk Mothers and Infants) Care Pathway. It is important to have more studies that, cater to moderate-low socioeconomic classes at the community level and will provide a standardized international reference of the MUAC cutoffs for the screening of severe and moderate acute malnutrition

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