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Original Article

Mid-upper arm circumference measurement for severe malnutrition screening in underfives

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Abstract

Background Severe malnutrition in Indonesia remains abundant. Severe malnutrition has been assessed by several methods, including mid-upper arm circumference (MUAC) and weight-for-height z-score (WHZ). As a screening method, MUAC is expected to be useful for identifying malnutrition in communities.

Objective To determine whether MUAC measurements can be used for screening severe malnutrition at the community level in Indonesia.

Method A cross-sectional study was conducted in 853 children aged 6-59 months who came to an integrated health service post (Posyandu) in Semarang, Central Java. Anthropometric measurements were performed by cadres and researchers and included MUAC and WHZ. Statistical analysis was done by McNemar test; results with P values >0.05 indicated no significant difference. Sensitivity and specificity were determined by 2 x 2 tables. The MUAC cut-off values were determined by receiver-operating characteristic (ROC) curve.

Results Eight hundred fifty-three out of 1,115 children met the inclusion criteria, consisting of 419 (49.1%) boys, with most over the age of 2 years (57.2%). Kappa test revealed good inter-rater reliability in measurements between the cadre and researchers (Kappa=0.726). There were significant differences between MUAC (by cadres) and below red line status as well as WHZ, between MUAC (by researchers) and WHZ, as well as MUAC (by cadre and researchers) with WHZ and height-for-age z-score/HAZ . Sensitivity, specificity, PPV, and NPV of MUAC (by cadre) were 12.5%, 99.9%, 75%, and 97.5%, respectively, while those by the researchers were 16.7%, 99.6%, 57%, and 97.6%, respectively. In this study, MUAC of 14 cm was the best cut-off for severe malnutrition.

Conclusion The MUAC measurement of 14 cm can be used for screening severe malnutrition in underfives at community. **[Paediatr Indones. 2020;60:42-52; doi: http://dx.doi.org/10.14238/pi60.1.2020.42-52**].

Keywords: *mid-upper arm circumference; WHZ; severe malnutrition; underfives*

In Indonesia, severe malnutrition is abundant and often accompanied by various complications.[1] These complications can either be short-term such as increased morbidity, mortality, and disability, or long-term such as decreased intellectual ability, economic productivity, reproductive function, short stature, and metabolic and cardiovascular diseases. The lack of an easy, inexpensive, and widely available screening tool for severe malnutrition contributes to its abundance.[2] Furthermore, the integrated health service posts (*pos pelayanan terpadu/posyandu*) have not optimally performed and promoted growth monitoring.[3]

Current practice in the *posyandu* is to assess only children who fall below the red line (*bawah garis merah* or BGM), which is categorized as malnourished. Such children should be reported to the community health centre (*pusat kesehatan masyarakat/puskesmas*). However, children with BGM might not be severely malnourished, and vice versa; children with severe

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acute malnutrition might not have yet reached BGM status.[3-5] Hence, the BGM designation can be misleading.

Screening for severe acute malnutrition in Indonesia has not been optimally carried out because the criteria for severe malnutrition issued by the Ministry of Health is based on the weight-for-age indicator. Weight-for-age represents only body weight related to age, without being able to depict a process of acute malnutrition, allowing for 'wasting' and 'stunting' to not be identified. Acute malnutrition can be most accurately assessed by how thin someone is, thus the anthropometrical indicators fitting for this purpose would be MUAC and WHZ.[4-7]

In Africa and south Asia, MUAC has been used as a screening method for under-fives in order to detect malnutrition cases early, for optimal intervention. The MUAC measurements can be done by field workers, such as posyandu cadres, since it is easy to perform and has high accuracy, reliability, sensitivity, and specificity.[8-10] We aimed to determine if MUAC can be useful for screening severe malnutrition in underfives at the community level.

Methods

This analytical cross-sectional study was done on 853 children aged 6-59 months who came to the posyandus in Semarang, Central Java, Indonesia. The inclusion criteria were 6-59 months of age and parental consent. The exclusion criteria were children who suffered from congenital or chronic diseases that are known to cause malnutrition, certain syndromes, edema, or organ enlargement (organomegaly). The cadres collected subjects' MUAC and body weight data. The results were documented and plotted to subjects' growth charts (*Kartu Menuju Sehat/KMS*). The MUAC, body weight, height or length, and the assessment of WHZ, WAZ, and HAZ were done by the researchers.

Body weight, body length/height, and MUAC measured by cadres and researchers; each measurement repeated 3 times and then we took the average. Body weight measured with *Onemed* digital weight scale. Body weight status was classified according to *WHO Child Growth Standard* (weight for age): severely underweight if < -3 standard deviations (SD) of the median, underweight if < –2 SD of the median, normal weight if > -2 SD and < 2 SD of the median, and overweight if > +2 SD of the median. Nutritional status was classified according to *WHO Child Growth Standard* (weight for length/height): severe malnutrition if < -3 SD of the median, malnutrition if < –2 SD of the median, well nourished if > -2 SD and < 2 SD of the median, overweight if > +2 SD of the median, and obesity if +3 SD of the median. Body length measured with *Onemed* infantometer while height measured with GEA stature meter. Stature was classified referring to *WHO Child Growth Standard* (length/height for age), as followed: very short stature if < –2 SD of the median, short stature if < –2 SD of the median, normal if > -2 SD and < 2 SD of the median, and tall if > 2 SD of the median. Measurement of MUAC used WHO MUAC tape, by measuring the middle part of the upper arm and the result was expressed in color: red if MUA ≤11.5 cm, not red if MUA > 11.5 cm.

Based on WHO 2013 recommendation, severe acute malnutrition in children aged 6-59 months is defined by MUAC ≤ 115 mm or WHZ ≤ -3 SD with HAZ > -2 SD, while severe chronic malnutrition is diagnosed for MUAC ≤ 115 mm or WHZ ≤ -3 SD with HAZ ≤ -2 SD. However, Ministry Health of Indonesia still used birth weight for age indicator to describe severe malnutrition that also called *bawah garis merah* (*BGM)*, as the body weight was under the red line of the grow charts (KMS). The reliability of MUAC measurement between cadres and researcher were examined by Kappa test. This MUAC measurement with cut off 11.5 cm was compared to WHZ by McNemar test for the identification of severe malnutrition cases. Sensitivity and specificity of MUAC were calculated using 2x2 tables. The optimal cut-off point for MUAC was obtained by ROC curve. This study was approved by the Medical Research Ethics Commission at Diponegoro University Medical School/Dr. Kariadi Hospital, Semarang.

Results

A cross-sectional study was conducted in Semarang in April 2018 in children aged 6-59 months who visited the *posyandus* that was selected for sampling. Semarang has 37 main *puskesmas* scattered in 16 sub-districts. In cluster sampling, 5 *puskesmas* were selected. Additional sampling was done to determine the selection of the *posyandu*, resulting in 30 *posyandus* fostered by said *puskesmas*. In total, 1,115 children visited the selected posyandu, but 98 children were less than 6 months of age and 64 children had incomplete data since they were uncooperative during the measurement, thus 853 children met the inclusion criteria (**Figure 1**). The characteristics of the study participants are shown in **Table 1**.

Table 1 shows that the subjects consisted of 419 boys (49.1%) and 434 girls (50.9%), with the majority of subjects older than 2 years of age (57.2%). The subjects' mean MUAC was 14.4 (SD 1.4) cm for children <1 year of age, 14.9 (SD 1.6) cm for children aged 1-2 years, and 16.4 (SD 2.2) cm in children aged >2 years. The subjects' mean WHZ was -0.47 (SD 1.25) for children <1 year of age, -0.48 (SD 1.36) for children aged 1-2 years, and -0.22 (SD 1.76) in children aged >2 years (**Table 2**).

The MUAC measurements were done by the cadres and the researchers. Inter-rater reliability was

Table 1. Basic characteristics of participants

Characteristics	N=853
Gender, n (%)	
Male	419 (49.1)
Female	434 (50.9)
Age, n (%)	
<1 year	108 (12.7)
1-2 years	257 (30.1)
>2 years	488 (57.2)
Body weight status, n (%)	
Severely underweight	27 (3.2)
Underweight	85 (10)
Normal	13 (83.6)
Overweight	28 (3.2)
Nutritional status, n (%)	
Severe malnutrition	24 (2.8)
Malnutrition	71 (8.3)
Well-nourished	730 (85.6)
Overweight	17 (2.0)
Obesity	11 (1.3)
Stature, n (%)	
Very short stature	27 (3.2)
Short stature	106 (12.4)
Normal	706 (82.8)
Tall	14 (1.6)

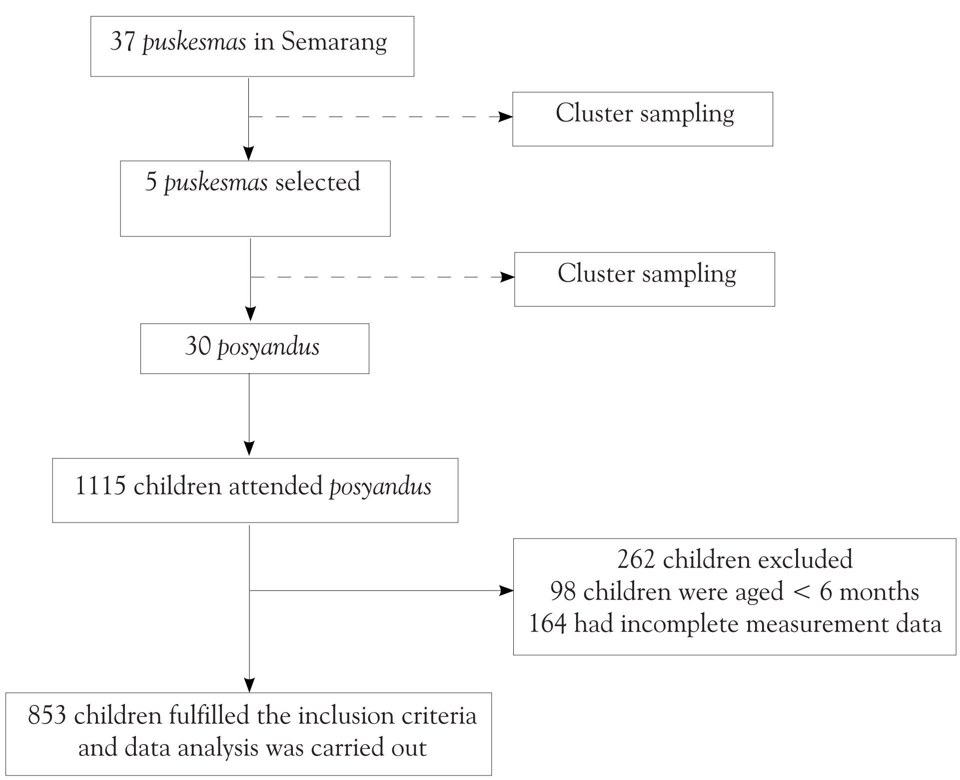

Figure 1. Study participant flow-

Table 2. Mean MUAC and WHZ based on age and sex

Age group	MUAC		WHZ (SD)	
	n	Mean (SD)	n	Mean (SD)
<1 year	108	14.4 (1.4)	108	-0.47 (1.25)
1-2 years	257	14.4 (1.6)	257	-0.48 (1.36)
>2 years	488	16.4 (2.2)	488	-0.02 (1.76)

analyzed by Kappa test, as shown in **Table 3**.

Table 4 shows the analyses of MUAC measurements performed by the cadres compared to (A.) WHZ, (B.) BGM, and (C.) Z-score (WHZ and HAZ). Severe acute malnutrition screening was defined as WHZ ≤ -3 SD and HAZ > -2 SD, and severe chronic malnutrition was defined as WHZ ≤ -3 SD and HAZ ≤ -2 SD. McNemar analysis revealed significant differences between MUAC and WHZ, MUAC and BGM, and MUAC and WHZ/HAZ for both acute and chronic severe malnutrition screening.

Table 5 shows the analysis of MUAC performed by researcher compared to (A.) WHZ, (B.) Z-score to evaluate if MUAC measurement could be utilized for severe acute malnutrition screening (WHZ ≤ -3 SD, HAZ > -2 SD), and severe chronic malnutrition (WHZ ≤ -3 SD, HAZ ≤ -2 SD). McNemar test revealed that MUAC measurement (by researcher)

Table 3. Inter-rater reliability of MUAC measurements by cadres and researchers (Kappa test)

		MUAC (researchers)		Total	Kappa value	P value
		≤11.5 cm	>11.5 cm			
MUAC (cadres)	≤11.5 cm	4	0	4	0.726	0.000
	>11.5 cm	3	846	849		
Total		7	846	853		

Table 4. Comparison of MUAC (by the cadres) and:
A. WHZ

		MUAC (cadres)		Total	P value
		≤11.5 cm	>11.5 cm		
WHZ	≤-3 SD	3	21	24	0.000
	> -3 SD	1	828	829	
Total		4	849	853	

McNemar test

B. *BGM*

		MUAC (cadres)		Total	P value
		≤11.5 cm	>11.5 cm		
BGM status	*BGM*	1	15	16	0.008
	Non-*BGM*	3	834	837	
Total		4	849	853	

McNemar test

C. WHZ and HAZ

		MUAC (cadres)		Total	P value
		≤11.5 cm	>11.5 cm		
MUAC (cadres)	≤11.5 cm	3	0	3	0.000
	> 11.5 cm	20	1	21	
Total		23	1	24	

McNemar test

Table 5. Comparison of MUAC (by researchers) and:

A. WHZ

		MUAC (researchers)		Total	P value
		≤11.5 cm	>11.5 cm		
WHZ	≤-3 SD	4	20	24	0.000
	> -3 SD	3	826	829	
Total		7	846	853	

McNemar test

B. WHZ and HAZ

		Severe malnutrition		Total	P value
		Acute	Chronic		
MUAC (cadres)	≤11.5 cm	4	0	4	0.000
	> 11.5 cm	19	1	20	
Total		23	1	24	

McNemar test

Table 6. Sensitivity, specificity, positive predictive value, negative predictive value for MUAC compared to WHZ

A. MUAC cut-off of 11.5 cm

		WHZ		Total
		≤-3 SD	>-3 SD	
MUAC (cadres)	≤11.5 cm	3	1	4
	> 11.5 cm	21	828	849
Total		24	829	853

		WHZ		Total
		≤-3 SD	>-3 SD	
MUAC (researchers)	≤11.5 cm	4	3	7
	> 11.5 cm	20	826	846
Total		24	829	853

Variables	MUAC (cadres)	MUAC (researchers)
Sensitivity (%)	12.5	16.7
Specificity (%)	99.9	99.6
Positive predictive value (%)	75.0	57.1
Negative predictive value (%)	97.5	97.6

B. MUAC cut-off of 13.8 cm

		WHZ		Total
		≤-3 SD	>-3 SD	
MUAC (researchers)	≤13.8 cm	22	107	129
	> 13.8 cm	2	722	724
Total		24	829	853

Variables	MUAC (researchers)
Sensitivity (%)	91.7
Specificity (%)	87.1
Positive predictive value (%)	17.1
Negative predictive value (%)	99.7

C. MUAC cut-off of 14 cm

		WHZ		Total
		≤-3 SD	>-3 SD	
MUAC (researchers)	≤14 cm	23	163	186
	> 14 cm	1	666	667
Total		24	829	853

Variables	MUAC (researchers)
Sensitivity (%)	95.8
Specificity (%)	80.3
Positive predictive value (%)	12.4
Negative predictive value (%)	99.9

D. MUAC cut-off of 15.8 cm

		WHZ		Total
		≤-3 SD	>-3 SD	
MUAC (researchers)	≤15.8 cm	24	495	519
	> 15.8 cm	0	334	334
Total		24	829	853

Variables	MUAC (researchers)
Sensitivity (%)	100
Specificity (%)	40.3
Positive predictive value (%)	4.6
Negative predictive value (%)	100

was significantly different from WHZ in severe malnutrition screening. In addition, MUAC was significantly different from WHZ and HAZ for both acute and chronic severe malnutrition screening.

In 2013, the WHO recommended using WHZ ≤ -3 SD to diagnose severe malnutrition. As such, we compared MUAC to WHZ as the gold standard, to determine sensitivity, specificity, positive predictive value, and negative predictive value of various MUAC cut-off points [(A.) 11.5 cm, by cadres and researchers; (B.) 13.8 cm by researchers; (C). 14 cm by researchers; and (D.) 15.8 cm by researchers]. From the ROC curve, WHZ ≤ -3 SD area under curve value was 0.926 (between 0.878 and 0.974), fitting the MUAC measurements of 13.8 cm, 14 cm, and 15.8 cm. Using a 2x2 table, we determined sensitivity, specificity, positive predictive value, and negative predictive value from several MUAC points (**Table 6**).

In our study, the ROC curve showed that MUAC sensitivity and specificity for severe malnutrition screening could be optimized if the cut-off point was increased. The cut-off point of 14 cm was selected because it had 95.8% sensitivity, 80.3% specificity, 12.4% positive predictive value, and 99.9% negative predictive value, thus, it could yield better results if used for severe malnutrition screening in the community (**Figure 2**).

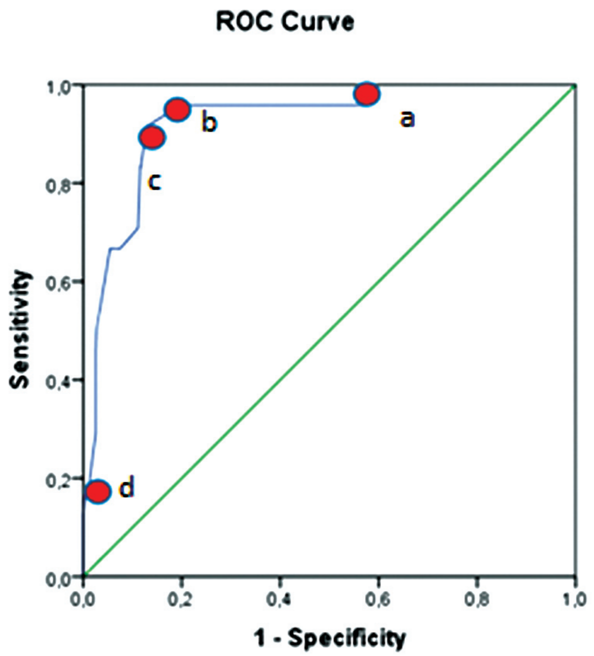

Figure 2. The ROC curve for sensitivity and specificity for MUAC compared to WHZ ≤-3 SD in severe malnutrition screening (red dots=sensitivity and specificity from several MUA cut off points: a. 15.8 cm, b. 14 cm, c. 13.8 cm, d. 11.5 cm)

Discussion

Mid-upper arm circumference (MUAC) and WHZ anthropometry indexes are used to describe a child's level of emaciation. The emaciation level indicating a severe process of weight loss, where this condition is associated with acute malnutrition condition.[11] Our study examined the appropriateness of MUAC measurements for screening severe malnutrition in the community.

This study was conducted on 853 subjects aged 6-59 months, with more females (50.9%) than males (49.1%). Most subjects were aged> 2 years (57.2%), and most subjects had well-nourished (85.6%) nutritional status. Of the 853 subjects, MUAC ≤ 11.5 cm was found in 4 children (0.5%) based on measurements by the cadres, and 7 children (0.8%) based on measurements by researchers. Although different percentages were obtained between the cadres and researchers, Kappa test revealed good inter-rater reliability coefficient values of 0.726 and P=0.000.

We also conducted a comparison test between MUAC and bawah garis merah (*BGM*/ below the red line), weight/age ≤ -3 SD) because the interpretation of the measurement results is mainly based on the *BGM* at the *posyandu*. Children with *BGM* status are considered to have malnutrition and referred to the *puskesmas*. However, reporting to the *puskesmas* does not necessarily mean that the children will be directly followed up unless they already have complications, because the *puskesmas* does not have confirmation of the child's nutritional status, including weight/ height (WHZ). In fact, children with *BGM* may not necessarily even have severe acute malnutrition and vice versa, while children with severe acute malnutrition may not have *BGM* status.[3-5]

There was a significant difference between MUAC and *BGM* for diagnosing severe malnutrition. This finding was in agreement with a previous study that the weight/age indicator only reflects body mass for age, so it cannot be used as a diagnostic criteria for acute malnutrition, which requires prompt management.[12] Cases of severe acute malnutrition in Indonesia cannot be optimally treated, because screening with BGM criteria identifies children with chronic malnutrition, not acute malnutrition.[4,7]

In our study, we also compared MUAC to Z score (WHZ $\leq$ -3 SD) for the diagnosis of severe malnutrition. McNemar test revealed a significant difference between MUAC measurement and WHZ $\leq$ -3 SD (by both cadres and researchers). In addition, MUAC measurement and WHZ/HAZ to assess acute vs. chronic severe malnutrition was also significantly different. Hence, we can conclude that MUAC <11.5cm cannot be used as a single anthropometric indicator for diagnosing severe malnutrition, either acute or chronic, due to the incompatibility between MUAC and WHZ $\leq$ -3 SD, which is the gold standard for diagnosing severe malnutrition anthropometrically. We obtained different numbers of malnutrition cases using the two methods, MUAC <11.5cm and WHZ $\leq$ -3 SD.

In previous studies, there were indeed differing results. One mentioned that MUAC was suitable for the diagnosis of severe acute malnutrition.[13] However, others stated that several cases of severe acute malnutrition were not diagnosed if MUAC was used singly as an anthropometric indicator for screening for acute malnutrition.[14]

In several studies there appeared to be discrepancies between malnourished children using WHZ or MUAC criteria. A previous study mentioned that MUAC and WHZ identified different groups of severe acute malnutrition. Also, the use of WHZ resulted in finding a higher prevalence of severe acute malnutrition compared to MUAC, as >90% of children with WHZ <-3 SD were not identified by MUAC <115 mm, while 80% of children with MUAC <115 mm were not detected by WHZ <-3 SD.[15] In addition, Fernandez et al. reported that among 34,937 children between the ages of 6 and 59 months obtained from 39 nutritional surveys, 75% of children with WHZ <-3 SD were not identified by MUAC <115 mm.[16]

When an individual loses weight, major losses of fat and muscle mass occur, so the MUAC and overall body mass would be affected. This raises the question as to why there is such a marked difference in diagnosing severe malnutrition by the two indicators, WHZ and MUAC.[17]

A possible explanation of this problem is that first, in contrast to WHZ, the diagnosis of acute malnutrition based on MUAC depends on one absolute cut-off point that is independent of age, height, and sex. As the child grows taller, weight and MUAC also increase, although to a different degree; children with the same WHZ tend to be below the absolute cut-off point of MUAC if they are shorter or younger. Thus, those who are diagnosed with malnutrition by MUAC tend to be younger than those who are diagnosed with malnutrition by WHZ.[13,14,18] Second, more children with shorter stature will not be diagnosed with severe malnutrition using MUAC, because the child is still in the stunting process. If nutritional management is done with an adequate intake of energy, then the rate of weight loss will stop/improve, but the rate of decrease in body length remains constant, so many children with normal MUAC are found and WHZ is improved. This is consistent with the WHZ, WAZ, and HAZ patterns presented in the previous study.[19] However, if inadequate nutrition affects longitudinal growth, then a positive relationship between nutritional status and stature should be found.[20] Third, racial differences impact the distribution of fat throughout the body in populations that normally live in the same environment. In groups where fat is more dominant in the limbs than the trunk, the value of MUAC increases relative to WHZ, whereas, if most of the fat is in the trunk, then the WHZ can be disproportionately increased. Although MUAC is a relatively good indicator of total body fat in children, MUAC is a poor indicator for describing fat-free tissue, especially muscle. Thus, muscle and fat loss can affect MUAC and WHZ differently.[21-23] Fourth, out of 853 under-fives with complete data in our study, short stature was noted in only 15.6%, far fewer compared to under-fives with normal stature (82.8%). The number of short (12.4%) and very short stature (3.2%) under-fives was also lower than the results of the *Indonesian Basic Health Research Report 2013* (*Riskesdas 2013*), which were 18.1% and 19.2%, respectively.[1] In addition, only 8.3% of under-fives had undernutrition and 2.8% had malnutrition in our study compared to the *Indonesian Basic Health Research Report 2013*, with percentages of thin under-fives of

6.8% and very thin under-fives of 5.3%.[1] There were also far fewer under-fives with undernutrition and malnutrition in our study (11.1%) than well-nourished under-fives (85.6%). We also noted that only 1.9% of our under-fives had weight/age ≤ -3 SD (*BGM*) in our study, compared to 5.7% in the *Indonesian Basic Health Research Report 2013*.[1] Thus, the under-fives who came to the posyandus mostly had normal weight, normal stature, and well-nourished status.[1]

The relationship between MUAC and WHZ is far more complicated than it appears. Although absolute MUAC values can identify malnutrition in younger and shorter children, further analysis must be done as to whether MUAC or WHZ can be used as criteria to assess increased risk of death and complications of malnutrition in older children.[13,24]

Previous study on the use of MUAC and WHZ in malnutrition screening was mostly carried out in countries with higher malnutrition rates and lower socioeconomic levels of society, such as some countries in the African continent that are categorized as poor. The high number of infections and the lack of guaranteed food availability are factors that cause high rates of malnutrition, both moderate and severe. A study mentioned that age had an important role in MUAC and WHZ differences in identifying children with malnutrition, which is related to food insecurity.[25] In younger children, the incidence of malnutrition is an indication of a disease accompanied by an inadequate intake process, whereas in older children malnutrition is more likely to occur due to certain periods of a lack of food availability in these countries. During periods of food shortages, older children tend to experience greater increases in acute malnutrition than younger children. The use of a single anthropometric indicator can mask the actual amount of malnutrition. Therefore, it is recommended to use both anthropometric indicators, MUAC and WHZ, to be able to correctly identify malnutrition for all age groups.[26]

Another study noted that the two indicators (MUAC and WHZ) complement each other in identifying children with increased risk of death from malnutrition. This finding was supported by the observation that children with deficits in both MUAC and WHZ have a worse prognosis than those who only have a single anthropometric deficit.[27]

Diagnostic testing is a technique for assessing the accuracy of new diagnostic modalities compared to standard diagnostic modalities, which are referred to as gold standards. New diagnostic tests must promise benefits, for example, less expensive, easier, faster, and less invasive compared to the gold standard, even though the sensitivity and specificity are (slightly) lower. The development of diagnostic tests can have several objectives, including to establish the diagnosis, as well as to fulfill the need for screening, treatment, and epidemiological studies.[28]

The results obtained from the comparison of standard and new diagnostic tests are sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios. The purpose of a diagnostic test should be determined. For screening purposes, diagnostic tests with high sensitivity are required. The sensitivity of a new diagnostic test shows the ability of the diagnostic tool to correctly detect a disease, while the specificity indicates the ability to determine that the subject does not have the condition.[29]

Previous studies have also assessed MUAC as a method of determining nutritional status in the community. These studies compared anthropometric measurements with the results of clinical evaluations or other methods besides anthropometry. In other studies, the sensitivity and specificity of MUAC compared to other anthropometric indicators were also evaluated.[16,30-32]

In our study, a diagnostic test for severe malnutrition screening was done to compare MUAC ≤11.5 cm to the gold standard WHZ ≤ -3 SD. The MUAC sensitivity obtained by the cadre was 12.5% and by researchers was 16.7, while the specificity of MUAC measurement by the cadre was 99.9% and by researchers was 99.6%, for MUAC cut off 11.5 cm. These results indicate that MUAC ≤ 11.5 cm cannot be used for screening severe malnutrition because it is not sensitive, even though its specificity is good. The MUAC sensitivity of 12.5% and 17% shows that a MUAC cut-off of 11.5cm can only detect 12.5-17% of children with severe malnutrition, while the other 83-87.5% who actually experience severe malnutrition are not detected, leading to a high number of false negatives despite the low number of false positives due to its high specificity of almost 100%. Such high MUAC specificity of the 11.5 cm cut-off indicates that children with MUAC> 11.5 cm do not really suffer from severe malnutrition.

Our results are in agreement with a study that compared MUAC to WHZ in 5,751 children aged less than 5 years in Senegal. The sensitivity was 5.9% and specificity was 99%, when using a combination of diagnostic criteria for severe malnutrition WHZ <-3 SD and MUAC <115 mm. However, if they used only MUAC <115 mm as the diagnostic criteria, the sensitivity was 13.2% and specificity was 96.9%. In this study they also tested the sensitivity and specificity of various MUAC cut-off values. When using a MUAC cut-off of 112 mm, the sensitivity to diagnose acute malnutrition was 6% and specificity 99.1%. A MUAC cut-off of 119 mm, had 14.9% sensitivity and 96.9% specificity. Therefore, MUAC has better ability to diagnose severe acute malnutrition with a higher risk of complication than WHZ. In addition, there was no benefit to using a combination of WHZ and MUAC criteria to screen for children with severe acute malnutrition.[31]

Since the 11.5 cm MUAC cut-off showed a low sensitivity value, a ROC curve was used to determine the best MUAC cut-off value for screening, which was expected to have high sensitivity and specificity. The ROC curve showed an optimal MUAC cut-off of 14 cm with a 95.8% sensitivity, 80.3% specificity, 12.4% positive predictive value, and 99.9% negative predictive value. This is in accordance with a previous study in West Nigeria that assessed sensitivity, specificity, positive predictive value, and negative predictive value of MUAC in children aged 12-59 months, compared to WHZ as the gold standard. A 13.5 cm MUAC cut-off had 20% sensitivity and 95.3%specificity. Their ROC curve showed an optimal MUAC cut-off value of 15.5 cm, with 80% sensitivity and 53.5% specificity. Therefore, they recommended to increase the MUAC cut-off value for screening severe malnutrition patients under 5 years old.[32]

A limitation of our study was the small number of severe malnutrition cases of only 2.8%. Hence, our sample cannot reliably be used to determine MUAC cut-off point to screen for severe malnutrition. In addition, subjects from only one city were included, so they did not represent the actual number of cases of severe malnutrition in the country. Despite these limitations, MUAC can still be used as an indicator examination that is quite simple and easy for the cadres to use in order to find cases of malnutrition that need to be referred immediately to get appropriate treatment.

In conclusion, MUAC measurement with an 11.5 cm cut-off cannot be used for screening severe malnutrition cases in Posyandu because it lacks sensitivity, despite its good specificity. In this study, 14 cm is the best MUAC cut-off value for screening underfives with severe malnutrition.

Conflict of Interest

None declared.

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