**Concordance between weight-for-height z-score (WHZ) and mid-upper arm circumference (MUAC) for the detection of wasting among children in Bangladesh host communities**

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The authors would like to acknowledge the following individuals and agencies for their technical support and collaboration on this project including National Nutrition Services (NNS), Institute of Public Health Nutrition (IPHN), Ministry of Health and Family Welfare (MoHFW) Bangladesh, Bangladesh National Nutrition Council (BNNC), Action Against Hunger Bangladesh Mission (Jogie Abucejo Agbogan, Fitsum Tesfaye, Dr. Md Abul Hasan, Md. Saiful Islam Talukder and G.M. Mosharaf Hossain), Action Against Hunger France HQ (Clemence Malet and Benjamin Guesdon), Technical Rapid Response Team (Alexandra Humphreys) and Global SMART initiative and Action Against Hunger Canada (Jana Daher and Hassan Ali Ahmed).

**BANGLADESH**

What we know: There is poor concordance between children identified as wasted using weight-for-height z-score (WHZ) and mid-upper arm circumference (MUAC). MUAC only programming is recommended in Bangladesh community-based management guidelines.

What this article adds: A secondary data analysis explored the concordance between WHZ and MUAC to identify wasting in 12 districts of Bangladesh and the impact of different MUAC thresholds to capture low WHZ children. Analysis found poor and varied concordance between the two indicators with WHZ identifying the highest proportion of wasted children. Greater MUAC thresholds increased the proportions of severely and moderately wasted cases identified but also led to greater ‘false positives’ (children not meeting WHZ nor MUAC criteria). Expanded MUAC criteria ≥115 mm misclassified a proportion of severe acute malnutrition (SAM) cases (WHZ <-3) as eligible for moderate treatment. This has implications for the capacity and resources of existing programmes and reinforces questions regarding outcomes of low WHZ children excluded or under-treated by MUAC only programming.

**Context**

Both weight for height z-score (WHZ) and mid-upper arm circumference (MUAC) are recommended by the World Health Organization (WHO) as independent indicators of wasting in children (WHO 2009; WHO 2013). In practice, MUAC is increasingly used as a stand-alone anthropometric criterion, such as for community-based screenings, at remote clinics where height/length boards and weighing scales may not be available and as a temporary programming adaptation to COVID-19 where Infection Protection Control (IPC) measures cannot be assured (UNICEF, WHO 2020). MUAC and WHZ often identify different children, with the degree of overlap varying greatly by context (Grellety et al, 2016). While MUAC has long been considered as a better indicator of risk of death than WHZ (Briend et al, 2016), recent analyses suggest that children with low WHZ and low MUAC have a similar risk of dying (Schwinger et al, 2019; Grellety and Golden, 2018a and 2018b). Thus, there remain questions regarding the outcomes of low WHZ children that are not identified in MUAC only strategies, especially in contexts where concordance between WHZ and MUAC is poor and how to manage this, such as increasing the MUAC threshold to capture low WHZ children.

In Bangladesh, there are two national guidelines for the management of wasted children: i) facility-based management of children with severe acute malnutrition (SAM) and ii) community-based management of acute malnutrition (CMAM). The facility-based SAM guideline rec-
The national CMAM guideline, covering the management of uncomplicated SAM, moderate acute malnutrition (MAM) and acutely malnourished pregnant and lactating women, recommends admission and treatment using the MUAC only criterion (IPHN, MOHFW, 2017).

Given the above, Action Against Hunger (ACF) undertook an in-depth analysis of anthropometric data from multiple surveys across different regions of Bangladesh to investigate concordance between WHZ and MUAC in the detection of wasting to help decision-making with regards to CMAM programming in the Bangladesh national context.

**Research objectives**

After the recent publication of a similar analysis based on a large set of surveys across multiple countries, including Bangladesh (Guesdon et al., 2020), the main objective of this study was to explore the concordance of wasting between WHZ and MUAC in Bangladesh children to inform policy and programming. In addition, the analysis explored the effect of increasing MUAC referral and admission cut-offs on the concordance between low MUAC and low WHZ/LWLZ and the implications for the number of expected admissions to outpatient therapeutic feeding programmes (OTP) (severe wasting without medical complications) or to targeted supplementary feeding programmes (TSFP) (moderate wasting).

**Methodology**

Data were drawn from population representative SMART surveys on the nutritional status of Bangladeshi children aged 6-59 months conducted by Action Against Hunger (ACF) Bangladesh between 2009 and 2020. A total of 34 SMART surveys across 12 districts of Bangladesh (Figure 1) rated either “excellent” or “good” quality and with an acceptable standard deviation for WHZ (standard deviation between 0.80 and 1.20) were retained for analysis. Two SMART surveys with the Emergency Nutrition Assessment (ENA) plausibility score “acceptable” were excluded. Individual child observations missing MUAC, WHZ, or oedema data (n=342), children with WHZ with outliers based on World Health Organization (WHO) flags (±5 SD, n=10), extreme MUAC (n=3) and children with bilateral pitting oedema (n=1) were excluded from the analysis. In total, the pooled sample for analysis consisted of 16,519 children 6-59 months.

A limitation of the study was that data was drawn from a limited number of districts, surveys were often small-scale and infrequently representative of the entire district and were conducted during different seasons of the year. Furthermore, the final sample was not weighted, so larger samples had a stronger influence on the pooled results.

**Results**

The final analyses included 16,519 children aged 6 to 59 months of which 2,349 cases of wasting (1,996 MAM and 353 SAM) were identified by WHZ and/or MUAC. Table 1 shows the concordance of wasting prevalence by WHZ only, MUAC only and both WHZ and MUAC.

A limitation of the study was that data was drawn from a limited number of districts, surveys were often small-scale and infrequently representative of the entire district and were conducted during different seasons of the year. Furthermore, the final sample was not weighted, so larger samples had a stronger influence on the pooled results.
According to the all-district pooled analysis (Figures 2 and 3), it was estimated that overall 63.5% of GAM and 65.4% of SAM cases were identified by WHZ only; 15.1% of GAM and 19.3% of SAM cases were identified by MUAC only and 21.4% of GAM and 15.3% of SAM cases were identified by both WHZ and MUAC.

Among all surveyed districts (Table 1), the highest concordance for GAM was observed in Habiganj (27.9%) and Cox’s Bazar (25.6%). The lowest concordance for GAM was observed in Sirajganj (6.7%) and Satkhira (8.4%) districts. The highest concordance for SAM was observed in Sunamganj (20.0%) and Cox’s Bazar (19.8%). In three district samples, all SAM cases were identified by either WHZ or MUAC (no cases identified by both). In three district samples, all SAM cases were identified by WHZ alone. These findings indicate poor and varied concordance between the two indicators with WHZ identifying the highest proportion of wasted children.

Data was further analysed to project different scenarios of SAM and MAM case detection (Figures 4 and 5) and admission eligibility (Figure 6) for OTP and TSFP programmes based on different MUAC cut-offs. Figure 4 shows that, based on the global reference criteria for SAM (WHZ < -3 SD and/or MUAC < 115 mm) and MAM (-3 SD ≤ WHZ < -2 SD and/or MUAC ≤ 115 mm), a standalone MUAC only referral cut-off of <115 mm would be able to detect 34.6% of total SAM (by both MUAC and WHZ). A standalone MUAC only referral cut-off of <125 mm would be able to identify only 32.1% of total MAM (by both MUAC and WHZ) and/or MUAC (115 mm ≤ MUAC < 125 mm) and not SAM by any indicator. "SAM ALL undetected" refers to those children who are not SAM (WHZ < -3 SD) and/or MUAC <115 mm) and MAM (-3 SD ≤ WHZ < -2 SD) by WHZ with a MUAC above the cut-off used for screening.

As the aim of the expanded thresholds is to try to capture children with low WHZ not detected using standard MUAC cut-offs, we defined cases that met the increased MUAC cut-off criteria but did not meet the WHZ criteria as ‘false positives’. There are practical consequences of false positive cases. Children may be referred from the community based on MUAC screening but considered nourished in a nutrition facility if re-assessed using WHZ and returned home. This may undermine the screening strategy. In the absence of WHZ verification at facility-level, the nutrition status of SAM referred children would not be verified and hence admitted for treatment. This has wide implications for programme capacity and resources.

Figure 6 shows the proportion of children eligible for SAM and MAM programmes including false positives based on different referral cut-offs. Among all referred cases with an expanded MUAC cut-off of <120 mm, 55% children met admission eligibility for the SAM programme and 45% for the MAM programme as per the global thresholds for MUAC and WHZ. However, the analysis estimates that increasing MUAC referral cut-offs from <125 mm to <130 mm, for example, would lead to 36% false positives (those with a MUAC ≥ 125 mm and WHZ ≥ -2 SD) who would not meet admission eligibility for the SAM and MAM programmes. The percentage of false positives would increase to 70% with a raised MUAC referral cut-off of <140 mm (Figure 6).

The expanded MUAC only admission criteria were also applied to different scenarios to understand the programmatic implications (Figures 7 and 8). The implication of the expanded MUAC only programming is the misclassification of a number of MAM cases as eligible for OTP admission. Scenario 2 in Figure 7 shows that an expanded MUAC only admission criteria with a raised cut-off of <120 mm will lead to the admission of 45% of MAM children to OTP (115 mm ≤ MUAC < 120 mm and/or -3 SD ≤ WHZ < -2 SD). A raised MUAC cut-off of <120 mm for OTP admission will lead to the OTP caseload consisting of 75% MAM children (those with 115 mm ≤ MUAC < 125 mm and/or -3 SD ≤ WHZ < -2 SD).

For TSFP, the expanded MUAC only admission also has programmatic implications with the misclassification of a number of SAM cases as eligible for TSFP (those with a WHZ<-3SD and a MUAC≥115 mm), and with a large proportion of false positives included when the admission cut-off exceeds 125 mm (Figure 8). This will further inflate the caseload, as many well-nourished children will be enrolled into the TSFP programme due to the expanded MUAC admission criteria.

**Discussion and Conclusion**

Discordance between wasting prevalence as identified by WHZ and MUAC among children 6-59 months is well documented in the literature.
(Grellety, 2016 and Bilukha, 2018). This is confirmed by the present analysis in 12 districts of Bangladesh where the majority of children were wasted by WHZ only compared to MUAC only or by both criteria. Using only one indicator of wasting (MUAC only or WHZ only) for the diagnosis and treatment of wasting will result in a significant proportion of malnourished children being undetected and excluded from treatment. For Bangladesh, this analysis indicates that more than 60% of wasted cases (wasted by WHZ only: GAM 63.5%; SAM 65.4%) would not be detected using MUAC-only diagnostic criterion in CMAM programme. In other words, more than three of every five cases of wasting were excluded when WHZ was not considered as a diagnostic criterion.

In countries where screening and admission is conducted exclusively using MUAC and the concordance of wasting between WHZ and MUAC is poor, the overall cut-off for referral has sometimes been raised in an effort to capture more GAM by WHZ cases. This study demonstrates that the higher a MUAC cut-off is raised, the greater the number of wasting cases by WHZ will be detected. However, this has side effects of including non-wasted children and MAM children in SAM treatment programmes. These increased referrals have the potential to overload treatment centre capacity and accelerate opportunity cost in terms of availability of resources due to providing SAM treatment to MAM children.

The present study explored different scenarios to understand the allocation of SAM and MAM cases into OTP and TSFP programmes based on different expanded MUAC only programming where WHZ is not measured (due to national protocol) or not possible (as in COVID-19 in some contexts where Infection Protection Control (IPC) standards cannot be met). If an expanded MUAC threshold for screening is applied, the threshold must be carefully selected considering the proportion of misclassification and false positive cases introduced by expanded MUAC only cut-offs. This requires a thorough in-country consultation, capacity gap assessment and informed decision-making that takes into account the capacity of health and nutrition service centres (staff, supplies and other resources) to ensure that they are not overburdened. The absence of WHZ as a detection and verification method excludes a large proportion of wasted children from treatment or risks overloading treatment capacity with a high proportion of false positive cases if higher MUAC cut-offs are used. This reinforces questions regarding outcomes of low WHZ children excluded by MUAC only programming.

In Bangladesh, the national CMAM guideline recommends use of MUAC as the sole anthropometric criterion to identify SAM for admission to outpatient sites across the country. This may reflect that MUAC has practical advantages in terms of community screening and a lack of data on discordance between WHZ and MUAC when the national CMAM guideline was developed in 2017. Given this, we hope this analysis can help to provide updated information and understanding around the technical issues around the poor concordance between WHZ and MUAC in Bangladesh specifically.

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