USAID Nawiri

WHAT is the state of acute malnutrition in Marsabit and Isiolo Counties and WHO is at risk?

USAID Nawiri Longitudinal Study Learning Brief 1

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Parts of northern Kenya face persistently high rates of child acute malnutrition. This brief presents preliminary findings about its cause (drivers) and vulnerable groups in select sites in Isiolo and Marsabit Counties. The findings point to the role of community level drivers such as livelihoods, institutions, climate and the environment, in addition to individual and household, as being critical in influencing persistent levels acute malnutrition.

This brief is part of a series of learning briefs on the mixed-methods USAID Nawiri longitudinal research study, which took place in Marsabit and Isiolo Counties, Kenya, from September 2021 to September 2023. The research study is one component of the USAID Nawiri program, which is led by Catholic Relief Services. The mixed methods research study is a collaboration between Tufts and Kenyatta Universities, Catholic Relief Services, and Caritas.

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Key Messages

1. **Persistently high rates of acute malnutrition in selected sites.** In the context of Marsabit and Isiolo Counties, there exist areas that consistently, throughout the first year of the longitudinal study and across seasons, experienced above the emergency threshold (15%) of acute malnutrition in children under 5 years of age (CU5). The persistence of emergency levels of acute malnutrition occurred in the context of a prolonged drought and despite significant investment from national and international humanitarian and development actors.

2. **Child age and female caretaker nutritional status were associated with acute malnutrition across all sites.** Only two characteristics were significantly associated with acute malnutrition across *all* three sentinel sites. Older children, particularly those ages 36 to 59 months, and children with a female caretaker with lower mid-upper arm circumference (MUAC) were significantly more likely to be acutely malnourished. This has important implications for targeting both beyond the first 1,000 days for children and for supporting all members of the household, particularly the female caretaker.

3. **Few individual- and household-level variables were associated with acute malnutrition, pointing to the role of basic drivers on the community-level**. Only a handful of individual- and household-level variables are significantly associated with acute malnutrition in the two relatively rural sites, Laisamis and Garbatulla. In comparison, the largest number of variables consistently significantly correlated with acute malnutrition are in the peri-urban site, Ngaremara. The high prevalence of acute malnutrition paired with the limited number of significantly associated variables in the two rural sites points to the importance of considering more community-level basic drivers that would fall under what the Conceptual Framework of Acute Malnutrition in Africa's Drylands refers to as the systematic basic drivers: livelihood systems, institutions, and climate and environment.

Introduction

One of the ways we estimate or assess the severity of a humanitarian crisis is the rate of global acute malnutrition (GAM) in children under 5 years of age. When this rate surpasses 15%, it signifies a humanitarian emergency. However, around the globe[2] and—as described here—specifically in Isiolo and Marsabit Counties in the arid and semi-arid lands (ASALs) of Kenya, we find that emergency levels of GAM persist throughout the year despite ongoing international and national humanitarian and development support. The issue of persistent GAM and malnutrition hotspots[3] underscores that we are either not fully understanding and/or not adequately addressing the drivers of acute malnutrition in these contexts.

This learning brief explores the rate and drivers of acute malnutrition across three different sentinel sites, each representative of different livelihood sub-systems—primarily pastoral in Laisamis (Marsabit County), agropastoral in Garbatulla (Isiolo County), and peri-urban in Ngaremara (Isiolo County). While the overall prevalence of acute malnutrition in CU5 rarely dropped below 15% in any of the sites, significant differences were observed in what was associated with acute malnutrition in each site. Particularly, we find that except for child age and female caretaker[4] nutritional status, few individual- and household-level variables[5] were significantly

correlated with acute malnutrition in the two rural sites. The persistently high level of GAM in these two rural sites, along with the lack of significant association among most of our individual- and household-level variables, indicates a gap in our understanding of what the drivers of persistent GAM are. Pulling on the qualitative work (see "Mobility Matters" Learning Brief and "Vulnerability, Risk, and Resilience" Learning Brief)[6], we find that most likely the gap is in our understanding and ability to measure and address drivers that affect everyone in the community (or larger geographic/administrative area) similarly. To effectively address the problem of persistent GAM, it is crucial to understand how community-level factors related to livelihoods systems, institutions, and climate and environment influence GAM rates.

Findings and Discussion

Across the six rounds of first year of data collection between September 2021 and September 2022, the prevalence of acute malnutrition for children 6–59 months only dropped below the emergency threshold of 15% twice and only in Ngaremara; even then, the confidence interval (CI) still clearly encompasses the emergency threshold (Table 1). More so, weight-for-height z-scores (WHZ) and weight-for-age z-scores (WAZ) significantly declined in Laisamis, WAZ declined in Garbatulla, and height-for-age z-score (HAZ) significantly declined in Ngaremara and Garbatulla. Thus, irrespective of season, livelihood sub-systems, or environment, we find that these sentinel sites are experiencing emergency levels of acute malnutrition, with some evidence of further decline. However, site-specific differences in child GAM rates do exist. Of the three sentinel sites, acute malnutrition is significantly higher in Laisamis, and there is no difference between Garbatulla and Ngaremara.

Table 1. Percent and 95% confidence interval (CI) for acute malnutrition (using WHZ < −2) in Isiolo, Ngaremara, and Garbatulla by month of survey round

	Laisamis			Ngaremara			Garbatulla		
	%	*95% CI*		*%*	*95% CI*		*%*	*95% CI*	
September, 2021	-	-	-	17%	12%	20%	17%	11%	20%
November, 2021	26%	19%	29%	18%	13%	21%	17%	11%	20%
January, 2022	24%	18%	27%	15%	10%	17%	16%	10%	18%
March, 2022	24%	18%	27%	15%	10%	18%	18%	13%	21%
June, 2022	22%	16%	25%	11%	7%	14%	15%	10%	18%
September, 2022	19%	13%	22%	14%	9%	16%	18%	12%	21%
average across all the rounds	**23%**	**20%**	**24%**	**15%**	**13%**	**16%**	**17%**	**15%**	**18%**

The three sentinel sites were intentionally chosen because a 2021 analysis, using ten years of secondary nutrition data (2010–2020), identified the selected sentinel sites as experiencing persistently high GAM compared to the surrounding areas, or put another way: they are acute malnutrition hotspots.[7] It is important to note that the data collection itself encompassed a period of consecutive seasons of drought, likely contributing to the persistence of GAM. However, the secondary data analysis also shows that the persistence of acute malnutrition does not correspond only to drought years but rather characterizes the region for the past decade (or more) of nutrition monitoring data.

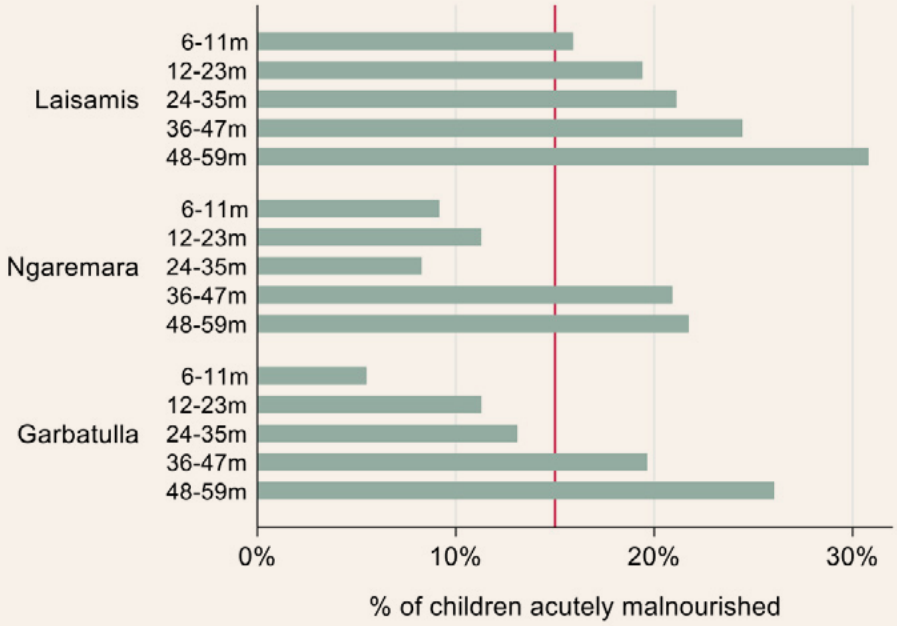
The findings from the first year of the longitudinal study concur with the earlier secondary data hotspot analysis. More so, the secondary data come from surveys done in one (or two) time period(s) a year, usually selected to be the period of highest food insecurity. Thus, in our longitudinal study, we expected to find high seasonal variation in the rates of acute malnutrition throughout the year, with only certain time periods surpassing the emergency threshold. However, other than a small (but not significant) dip below the 15% threshold in Ngaremara, we find that that these emergency levels of acute malnutrition persisted throughout the year, showing some, but only a little, variability. The drought conditions likely contributed to the attenuation of the seasonality of malnutrition. Yet, when it came to some of the other variables or hypothesized drivers of acute malnutrition (for example, animal milk consumption or food security more broadly), acute malnutrition remained extremely high and significant throughout the year, indicating that seasonality was still present, just less so for malnutrition.

Child age and female caretaker nutritional status were associated with acute malnutrition across all three sites.

Only two characteristics were consistently associated with acute malnutrition in children ages 6–59 months across all three sites: child age and female caretaker mid-upper arm circumference (MUAC) as a measure of the nutritional status of an adult female household member.

Within those under 5 years of age, older children were significantly more likely to be acutely malnourished. While 13% of children ages 6–23 months were acutely malnourished, 20% of children 24–59 months were acutely malnourished. This difference by age group translates into 76% greater odds of being acutely malnourished if the child is 2 to 5 years of age compared to being under 2 years. In the regression analysis, whether we controlled for other variables or not, we find the same relationship with age in each site: each additional month in age increases the odds that a child is acutely malnourished by approximately 5%. When breaking up the analysis by year of age, we find that the increase in acute malnutrition is most stark among children who are 3 to 5 years of age (36–59 months) (Figure 1).

Figure 1. Percent of children acutely malnourished in Laisamis, Ngaremara, and Garbatulla by age group (in months) with the red line representing the 15% emergency threshold.



The finding that children 3 to 5 years of age are more malnourished is unexpected and noteworthy as globally child wasting is greatest among children 0–2 years.[8] In Kenya, previous Kenya Demographic and Household Surveys (KDHS) also show that children under 24 months of age suffer higher GAM rates compared to the older cohort.[9] However, the most recent KDHS from 2022 similarly shows a reversal of the expected relationship between age and acute malnutrition for the whole of Kenya (though not as stark as in our sample), with 5.2% of children 24–59 months acutely malnourished compared to 4.3% of children 23 months and under.[10] The recent KDHS data further confirm the jump in acute malnutrition happens at around 3 years of age, thus primarily affecting children 36–59 years of age, just like in our longitudinal study.

Previous related research in Sudan has shown that in severe food insecurity or famine conditions, the proportional increase in acute malnutrition and mortality tends to be greater among children 2– years of age. The authors of these previous studies hypothesize that this might be because acute food crises usually have a community-wide effect, and that in famines the highest excess mortality is among children over the age of 2 years and adults. In contrast, morbidity and mortality rates (and thus disease-related drivers) are generally higher among infants and younger children compared to children who are no longer complimentary breastfeeding (2–5 years), which aligns with the more common or expected age distribution of child acute malnutrition, with younger children at a higher risk of being acutely malnourished compared to older children.[11]

We also observed some evidence in the longitudinal study of different drivers for children under versus over the age of 2 years. For children 2 years of age or older, individual consumption of animal milk or dairy products more broadly was significantly associated with lower odds of being acutely malnourished (though these children were less likely to consume animal milk or dairy products to begin with). At the same time, household food security and livestock ownership (camel and cattle) were significantly associated with lower odds of a child under the age of 2 being acutely malnourished. These associations were not always robust to different models, but they do indicate that not only is the prevalence of acute malnutrition different by age, but most likely so are the drivers.

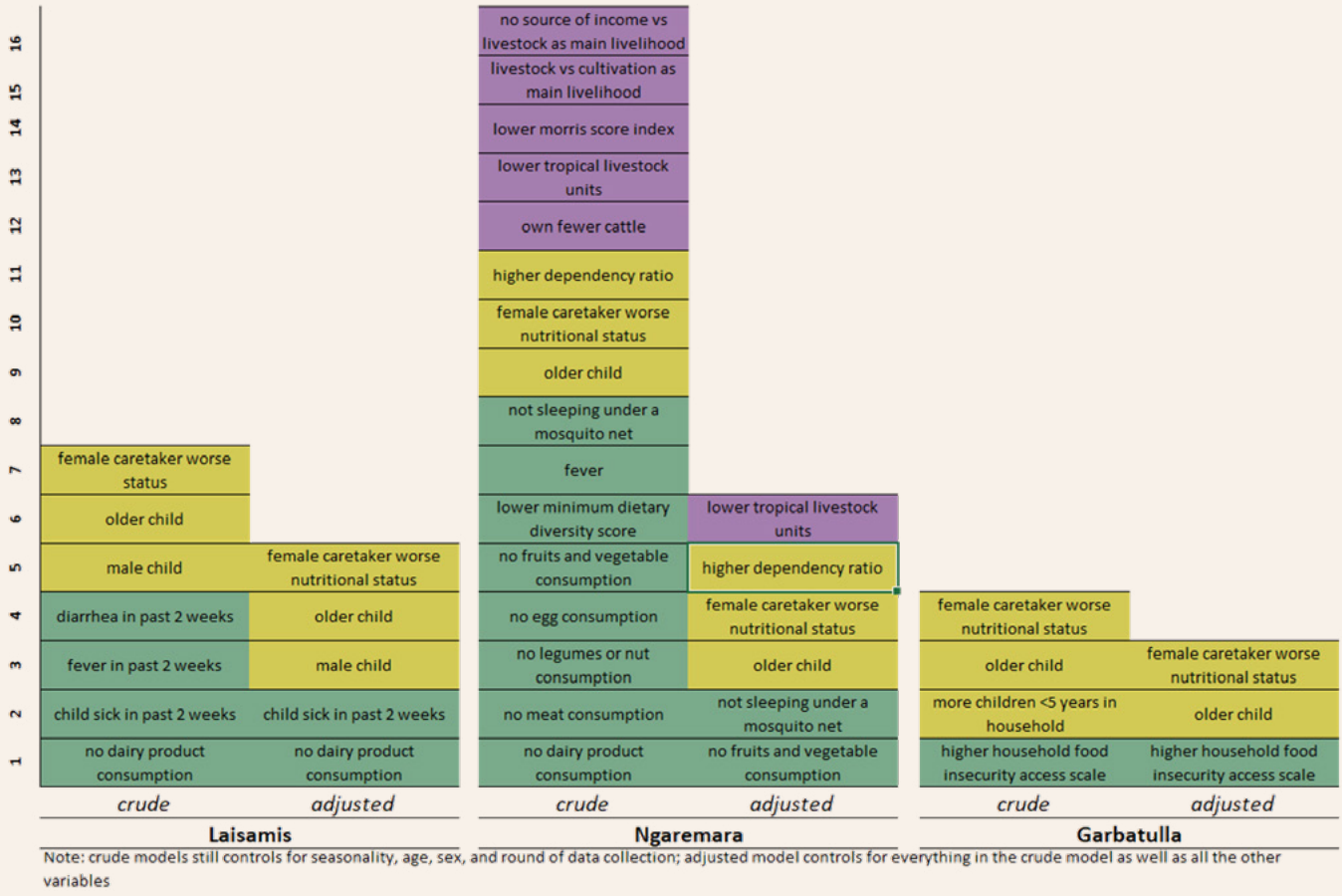
The other variable that was consistently correlated with child acute malnutrition irrespective of regression model used or site analyzed was female caretaker MUAC. This correlation indicates that better nutritional status of female caretakers was associated with a lower likelihood of a child being acutely malnourished. Every additional centimeter in female caretaker MUAC was associated with a 10% *decrease* in the odds that a child is acutely malnourished. Put another way, when the female caretaker was less malnourished, the child was also more likely to be less malnourished. The relationship with female caretaker MUAC holds for both children 6–23 months and those 24–59 months, as well as for boys and girls. Thus, we find that the nutritional status of the female adult in the household follows the same trajectory as that of children under the age of 5, irrespective of the child's age group, sex, or the characteristics of the context.

Few individual- and household-level variables were associated with acute malnutrition, pointing to the role of basic drivers.

Besides child age and female caretaker MUAC, no other variables were consistently associated with acute malnutrition across all three sites. More so, there was a large difference in the number of significant immediate and underlying drivers associated with acute malnutrition across the three sites. The variability in the number of variables associated with acute malnutrition by site is a direct reflection of the variability in acute malnutrition found in the villages that make up each of the three sentinel sites, with the greatest variability found between villages in Ngaremara and the lowest in Laisamis.

In Ngaremara, there were more individual- and household-level factors significantly associated with acute malnutrition compared to the other two sentinel sites. These factors included measures of household wealth, household composition, disease, and diet (Figure 2). Differences in measures of wealth, such as livestock ownership and productive asset ownership, were particularly important in Ngaremara. This could be because Ngaremara is a peri-urban area. In contrast, in the relatively rural sites of Garbatulla and Laisamis, the significant factors were mainly related to disease and diet/food insecurity. Thus, we need to look more closely at drivers that affect every household and child in the community similarly in the latter two sites.

Figure 2. Variables significantly associated with *higher* odds of a child being acutely malnourished in Isiolo, Ngaremara, and Garbatulla by category using both a crude and adjusted regression model.

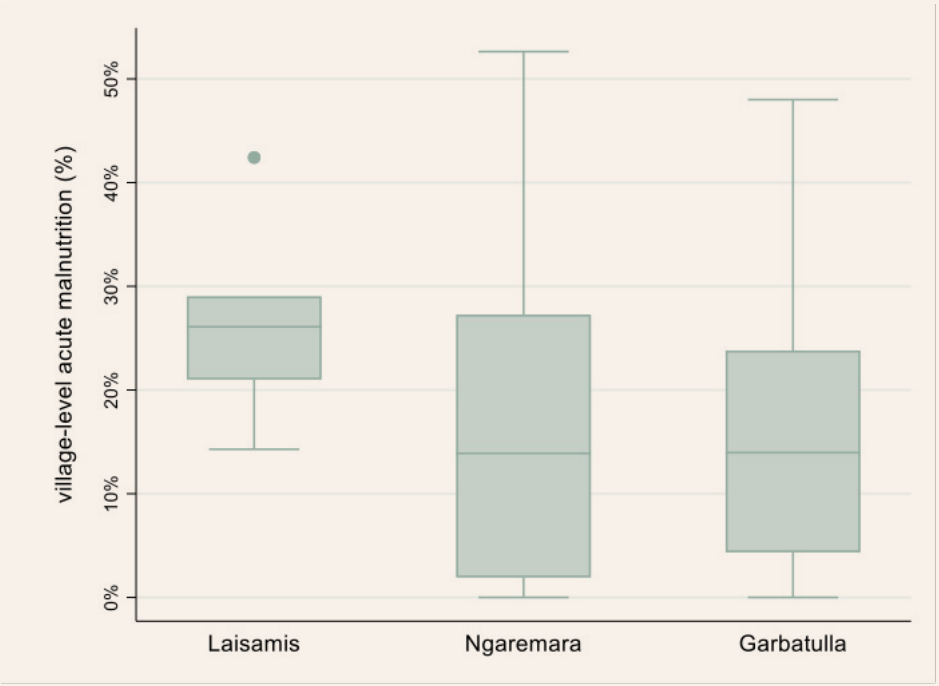


Note: crude models still controls for seasonality, age, sex, and round of data collection; adjusted model controls for everything in the crude model as well as all the other variables

We also see that boys are significantly more likely to be acutely malnourished compared to girls in Laisamis. The same relationship exists in the other two sites but the difference between boys and girls is not significant in Ngaremara and Garbatulla. A recent narrative review of sex differences in undernutrition found that sex differences tended to be much higher in more food-insecure contexts.[12] The association between sex differences and food insecurity corresponds to the differences observed across the three sites in our study in regard to dietary diversity, with Laisamis reporting the lowest dietary diversity and also the highest differences in acute malnutrition by sex for children under 5 years of age.[13]

Nutrition outcomes also show greater variability in Ngaremara than in either Garbatulla or Laisamis. The greater variability is in line with our analysis of the number of drivers significantly associated with acute malnutrition. The greater the difference in nutrition outcomes between children, the more individual- or household-level variables are significantly associated with either lower or higher odds of a child being malnourished. Using a standardized measure of variability called the coefficient of variation, we see that the greatest child-level variability in weight-for-height z-scores (WHZ) is in Ngaremara, followed by Laisamis, and Garbatulla. We also find greater variability in the prevalence of acute malnutrition between villages in Ngaremara compared to between villages in Laisamis and Garbatulla (Figure 3). For example, in Laisamis 50% of all villages in the middle of the distribution of acute malnutrition have a prevalence of acute malnutrition between 21–29%, compared to a range of 2–24% in Ngaremara and 5–24% in Garbatulla. The analysis of variability indicates overall greater homogeneity in nutrition outcomes in Laisamis and Garbatulla as compared to Ngaremara, with Laisamis also showing greater homogeneity across villages compared to Garbatulla.

Figure 3. Distribution (minimum value, 25th, 50th, and 75th% percentile, maximum value, and outliers) of village-level prevalence of acute malnutrition across Laisamis, Ngaremara, and Garbatulla.



The significance of a limited number of individual- and household-level drivers in Laisamis and Garbatulla with respect to acute malnutrition, greater homogeneity or similarity of nutrition outcomes on the child and village level in the two sites, coupled with persistent emergency levels of GAM, indicates the likely role of more community-level basic drivers of acute malnutrition.

Implications

The persistence of acute malnutrition over many years and seasons means the status quo of acute malnutrition *prevention* and *response* is not working in these areas.

The first year of the USAID Nawiri longitudinal study (September 2021–2022) coincided with a second year of drought in the Kenya ASALs. The effects of drought, and particularly the consecutive nature of the failed rains, have had a direct and negative impact on livelihood systems that depend on access to natural resources, health of livestock, and mobility patterns, which all in turn impact child nutrition (see "Mobility Matters" Learning Brief and "Vulnerability, Risk, and Resilience" Learning Brief). During that time, the longitudinal study indicated a decline in nutritional status (using WAZ, WHZ, and HAZ; though with some differences by sentinel site) and an almost consistent emergency level of acute malnutrition, despite international and national support. And while these poor nutritional findings, and their drivers, are heavily driven by the drought, it is worth nothing that in the ten-year secondary analysis, the selected sites experienced persistently high levels of acute malnutrition even in nondrought years. These findings indicate that the appropriateness, coverage, and efficacy of typical programs aimed to prevent acute malnutrition and the emergency response need to be further reviewed.

The persistence of emergency levels of acute malnutrition in these communities calls for new programming and policy approaches, but it also calls for identifying areas that are hotspots of acute malnutrition and/or areas experiencing persistent GAM and analyzing what drivers are associated with this phenomenon, the rationale for USAID Nawiri's Acute Malnutrition Hotspot Mapping in Phase 1. Hotspot analysis is generally gaining more popularity in both research[14] and for improved targeting by World Health Organization (WHO) and World Food Program (WFP).[15] However, much of this work is still done on a regional level, ignoring the heterogeneity and climatic variability found over shorter spatial distances, particularly in the Kenyan ASALs.[16] Nutrition monitoring data (be it Standardized Monitoring and Assessment of Relief and Transitions (SMART), KDHS, Nutrition Drought Management Authority (NDMA) or other types of data) need to be used for hotspot analysis on the ward level, to better understand where the hotspots are and whether and how we are making progress in addressing malnutrition in these areas. Addressing acute malnutrition hotspots and persistent GAM requires a constantly evolving evidence-based understanding of which communities are affected and what the context-specific drivers are, including basic drivers as well as immediate and underlying ones.

Targeting of programs needs to go beyond the first 1,000 days as well as provide support to the entire household, not just individual children.

The findings around the significant correlation between the age of the child and acute malnutrition are not only consistent across *all* of our sites (and robust to different model specifications) but are also observed for Kenya as a whole. While more analysis is required to understand this trend, some initial explanations coming out of the qualitative analysis point to the interaction across multiple different underlying drivers, which are affected by basic drivers. For example, the drought has added extra pressure and time constraints on the household, leading to households relying on secondary carers (siblings, neighbors, grandparents, etc.) for older children. This care is likely of lower quality than what the primary caretaker would have provided if available. Similarly, pressures on livelihoods could contribute to greater migration, with older children being left in the community and younger children taken to the fora (rangeland area for animal grazing). One thing we do note from the quantitative analysis is that what is associated with malnutrition in the two age groups (2 years

and older versus under 2 years) also varies, and hence might require a different programming focus. However, what is clearer are the implications for targeting. Nutrition interventions need to go beyond the first 1,000 days to make sure we are not missing children ages 24 to 59 months who, contrary to population assumptions, may be worse off than their younger counterparts.

Similarly, the consistency of the correlation between the nutritional status of the female caretaker and the child in the household means that treatment of malnutrition needs to consider the needs of the female caretaker as well as of the child. Given the emergency context, a priority would be for emergency food assistance to provide a *household* family ration for mothers with malnourished children, as opposed to just targeting *children*.

In addition, given the unexpected differences in nutritional outcomes by age, it is imperative that all nutritional data need to be disaggregated by age group (over and under 2 years of age). While this is common practice in the KDHS, it is not always presented in the SMART reports or NDMA data. Additional analysis that would be worth exploring would be to look at the functional outcomes of child acute malnutrition. For example, does the association between acute malnutrition and mortality differ by age group?

Programming and policy need to further explore and better address community-level drivers of acute malnutrition.

All three of the sentinel sites represent a diversity in climate and environment,[17] predominant livelihood sub-systems, and the formal and informal institutions that govern them (see "Vulnerability, Risk, and Resilience" Learning Brief and "Mobility Matters" Learning Brief). It is thus not surprising that, even though all the sites are part of the Kenyan ASALs, we identified not only different drivers significantly associated with acute malnutrition in each site but also a very different number of drivers that were significant by site. In Laisamis and especially Garbatulla, where few individual- and household-level drivers are associated with acute malnutrition, the qualitative data point to the role of basic drivers that play out on the community level. For example, as the "Mobility Matters" brief highlights, programs need to consider that a large portion of the livelihood system in the ASALs depends on strategic mobility, and thus fixed-place delivery of services and programs in predominately pastoral areas can lead to the exclusion of certain groups and result in negative externalities for livelihood systems. The institutions that govern household mobility and access to natural resources must be considered to make sure households continue to be able to take advantage of the benefits of mobility. This approach does not eliminate the need for more traditional interventions, such as food aid and cash distribution in response to a drought, but when it comes to *prevention* of acute malnutrition, more community and regional level drivers need to be addressed.

While we are still exploring some of the reasons for the differences in significant drivers by sentinel site, one possible hypothesis is that the more peri-urban nature of Ngaremara means that household-level differences in things such as wealth and household demographics (disability and proportion of dependents in the household) are more relevant for distinguishing what household will have a malnourished child. In Laisamis and Garbatulla, on the other hand, greater similarity of livelihood activities coupled with community-level support and strong social networks make household-level differences less relevant. Put another way, the community-level practices and structures likely mitigate some of the impact of household-level differences. For example, if there is a culture of sharing animal milk with households that do not have animals (i.e., households with a low Tropical Livestock Unit (TLU) score) during difficult periods, then we would not observe an association between acute malnutrition and wealth measured by TLU. Thus, depending on the community, different tar-

geting schemes need to be considered, with wealth ranking and household-level vulnerability analysis more relevant in some communities, and community blanket interventions more relevant in others.

While we can make assumptions about the influence of community-level drivers of persistent GAM given the lack of significance of many household-level factors in two of our three sentinel sites, we are unable to quantitatively measure and test these assumptions in our current quantitative data collection study design. This is because most quantitative surveys are designed to identify individual- and household-level drivers of acute malnutrition only, leaving out the impact of more community-level or basic drivers that are important in preventing acute malnutrition. To address this limitation, future studies should consider the biases imposed by the research design when identifying the drivers of child acute malnutrition. We cannot say something is not associated with acute malnutrition if we do not measure it correctly. Thus, it is crucial to adopt mixed methods approaches and analyze secondary data, where the community can be studied as the primary unit of analysis. This methodological approach is essential to understand the variability of drivers and the role of community-level factors in relation to the nutritional status of children (see "Vulnerability, Risk, and Resilience" Learning Brief).

In Conclusion

The findings from the USAID Nawiri longitudinal study in Marsabit and Isiolo Counties highlight the persistent and alarming rates of acute malnutrition in the selected sentinel sites. Despite significant investments from national and international actors, emergency levels of acute malnutrition have been consistently observed throughout the year, surpassing the 15% threshold. And while we recognize that the data collection was done during the second year of a severe drought, not only does secondary data from the past 10 years confirm that emergency levels of GAM are present irrespective of drought, but also, we did not observe any large seasonal improvement in GAM during the data collection. The consistency of the problem, coupled with the limited number of significantly associated individual- and household-level variables with acute malnutrition, and the findings from the qualitative work, suggests that the drivers of this crisis are rooted in more basic systemic causes that function on the community level, such as livelihoods, institutions, and climate and environment. To effectively address persistent GAM, it is crucial to explore and better understand these community-level drivers and develop comprehensive data collection, programming, and policy approaches that go beyond the focus on individuals or households. By shifting the focus to these basic drivers, we can make significant strides in tackling the persistent crisis of acute malnutrition in Marsabit and Isiolo Counties as well as other dryland contexts.

[1] H. Young, "Nutrition in Africa's Drylands: A Conceptual Framework for Addressing Acute Malnutrition" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2020). The adapted UNICEF framework shows that the immediate and underlying causes of child malnutrition (which are related to food, health, and care at the individual, household, and local level) are affected by the broader systemic and basic drivers of malnutrition that operate on the community, regional, national, and international levels.

[2] H. Young and A. Marshak, "Persistent Global Acute Malnutrition: A Discussion Paper on the Scope of the Problem, Its Drivers, Its Strategies for Moving Forward with Policy, Practice, and Research" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, January 2018). Accessed July 4, 2023, https://fic.tufts.edu/publication-item/persistent-global-acute-malnutrition-discussion-paper/.

[3] S. Ochola, "Malnutrition Hotspot Analysis and Mapping for the Nawiri Project in Marsabit and Isiolo County" (Catholic Relief Services, United States Agency for International Development (USAID) Nawiri, 2021).

[4] We refer to the "female caretaker" instead of the mother because for some of the children measured in the study, it was an older sibling, grandparent, or other female adult in the household who either fully cares for the child or on the day of the data collection was taking care of the child.

[5] We tested for the standard list of individual child-level variables (have a morbidity, type of morbidity, health-seeking behavior, sleeping under a mosquito net, child sex, child age, consumption of individual food groups, minimum dietary diversity score, exclusive breastfeeding, complimentary breastfeeding), individual female adult-level variables (lactating, pregnant, nutritional status), and household-level variables (number of children, number of household members, number of household members experiencing disability, household dependency ratio, main livelihood of the female respondent, main livelihood of the male household head, different indexes of household food insecurity, access to potable water, distance to water source, access to a latrine, animal ownership and wealth, distance of animals from the village, animal water source, asset wealth). See full quantitative report for more details on the variables and regression models run.

[6] E. Stites, A. Gargule, P. Iyer, and H. Young, "Mobility Matters. The Benefits of Pastoralist Mobility for Nutrition in Marsabit and Isiolo Counties, Kenya," USAID Nawiri Longitudinal Study Learning Brief No. 2 (USAID Nawiri program, Catholic Relief Services, Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2023); H. Young, A. Gargule, E. Stites, A. Marshak, E. Odundo, J. Munga, and S. Ochola, "Vulnerability, Risk and Resilience: The Implications for Nutrition in Isiolo and Marsabit Counties, Kenya," USAID Nawiri Longitudinal Study Learning Brief Number 3 (USAID Nawiri program, Catholic Relief Services, Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2023).

[7] Ochola, "Malnutrition Hotspot Analysis."

[8] O. Karlsson, R. Kim, S. Guerrero, A. Hasman, and S. V. Subramanian, "Child Wasting Before and After Age Two Years: A Cross-Sectional Study of 94 Countries," *The Lancet* 46 (2022): 101353.

[9] A. Marshak, "Nawiri Desk Study: Drivers of Acute Malnutrition in the Kenyan Arid and Semi-Arid Lands" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2021).

[10] Kenya Demographic and Household Surveys (KDHS), Demography and Health Survey, "Key Indicator Report 2022" (2023).

[11] H. Young and S. Jaspers, "Nutrition, Disease, and Death in Times of Famine," *Disasters* 19, no. 2 (1995): 94–109; H. Young and S. Jaspars, "The Meaning and Measurement of Acute Malnutrition: A Primer for Decision-Makers," Humanitarian Practice Network Paper No. 56 (Humanitarian Practice Network, Overseas Development Institute, London, 2006).

[12] S. Thurstans, C. Opondo, A. Seal, J. C. Wells, T. Khara, C. Dolan, A. Briend, M. Myatt, M. Garenne, A. Mertens, R. Sear, and M. Kerac, "Understanding Sex Differences in Childhood Undernutrition: A Narrative Review," *Nutrients* 14, no. 5 (February 2022): 948. doi: 10.3390/nu14050948.

[13] We also looked at measures of sanitation and hygiene such as distance to water, access to formal water source, and open defecation. While differences were observed across the sentinel sites in these variables, none of them were significantly associated with acute malnutrition.

[14] B. T. Seboka, T. D. Alene, H. S. Ngusie, S. Hailegebreal, D. E. Yehualashet, G. Gilano, M. H. Ahmed, R. H. Kabthymer, G. G. Kanno, and G. A. Tesfa, "Spatial Variations and Determinants of Acute Malnutrition Among Under-Five Children in Ethiopia: Evidence from 2019 Ethiopian Demographic Health Survey," *Annals of Global Health* 87, no. 1 (November 2021): 114. doi: 10.5334/aogh.3500; H. B. Fikrewold, C. S. Sparks, S. H. Nyarko, and L. Apgar, "Spatiotemporal Variations and Determinants of Under-Five Stunting in Ethiopia," *Food and Nutrition Bulletin* 44, no. 1 (March 2023): 27–38.

[15] S. Kureishy, S. Magagi, A.-C. Delinger, O. Sib, and K. Ghoos, "The Nutrition Hotspot Analysis: Prioritising Intervention Areas in the Sahel Countries," *Field Exchange* 67 (April 2022): 33, www.ennonline.net/fex/67/wcahotspotanalysis.

[16] A. Marshak and A. Venkat, "Nawiri Desk Study: Climatic Variability and Disasters in Kenya's Arid and Semi-Arid Lands" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2021).

[17] A. Marshak, A. Ezaki, E. Odundo, J. Munga, A. Garbule, E. Stites, S. Ochola, and H. Young, "Nawiri Quantitative Longitudinal Study Report (Year 1). Part 2: Factors Associated with Child Acute Malnutrition and Seasonality Analysis" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, May 25, 2023).

About the USAID Nawiri Longitudinal Study

The USAID Nawiri longitudinal study is a mixed methods research study titled "The Seasonality of Child Acute Malnutrition and its Drivers in Marsabit & Isiolo." This collaborative study took place in Ngaremara and Garbatulla wards in Isiolo County and Laisamis, and Loiyangalani wards in Marsabit County between September 2021 and September 2023. The quantitative component entailed twelve rounds of data collection (including anthropometric measurements) with a cohort of households with children under five years of age and two annual surveys. The qualitative component consisted of iterative rounds of data collection using participatory approaches in all study sites. The goal of the study was to increase the understanding of the causes of persistent acute malnutrition in the counties through a collaborative learning and research process which involved local actors, including communities, county institutions, civil society, and the private sector. More details on the research study can be found at https://fic.tufts.edu/research-item/research-and-capacity-building-support-to-the-nawiri-project/

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