USAID FROM THE AMERICAN PEOPLE Nawiri

EXAMINING THE COMPLEX DYNAMICS INFLUENCING PERSISTENT ACUTE MALNUTRITION IN SAMBURU COUNTY – A LONGITUDINAL MIXED-METHODS STUDY TO SUPPORT COMMUNITY-DRIVEN ACTIVITY DESIGN

BASELINE REPORT FROM THE QUANTITATIVE SURVEY COMPONENT

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LIST OF ACRONYMS AND ABBREVIATIONS

AMREF-ESRC	AMREF Ethical and Scientific Review Committee
aOR	Adjusted Odds Ratio
APHRC	African Population and Health Research Center
ASAL	Arid and Semi-Arid Lands
ASRH	Adolescent Sexual and Reproductive Health
BCG	Bacille Calmette-Guerin (vaccine for tuberculosis)
BMI	Body Mass Index
CI	Confidence Interval
COVID-19	Coronavirus Disease 2019 (SARS-CoV-2)
CSI	Coping Strategy Index
DHS	Demographic and Health Survey
FO	Fecal–Oral
GAM	Global Acute Malnutrition
HAZ	Height-for-Age z-Score
HCD	Human-Centered Design
HWISE	Household Water Insecurity Experiences Scale
IMAM	Integrated Management of Acute Malnutrition
IYCF	Infant and Young Child Feeding
KAP	Knowledge, Attitudes, and Practices
KNBS	Kenya National Bureau of Statistics
MDD	Minimum Dietary Diversity
MDD-W	Minimum Dietary Diversity for Women
MIYCN	Maternal, Infant and Young Child Nutrition
MMF	Minimum Meal Frequency
MUAC	Mid-Upper Arm Circumference
NDMA	National Drought Management Authority
NGO	Nongovernmental Organization
PAM	Persistent Acute Malnutrition
PCA	Principal Component Analysis
PPI	Probability Poverty Index
REAP	Rural Entrepreneur Access Project
RTI	RTI International (registered trademark and trade name of Research Triangle Institute)

SBC	Social and Behavior Change
SD	Standard Deviation
SMART	Standardized Monitoring and Assessment of Relief and Transitions
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH	Water, Sanitation, and Hygiene
WAZ	Weight-for-Age z-Score
WHO	World Health Organization
WHZ	Weight-for-Height z-Score

EXECUTIVE SUMMARY

The goal of the United States Agency for International Development (USAID) Nawiri program is to sustainably reduce levels of persistent acute malnutrition in Kenya's arid and semi-arid lands. In Samburu County, USAID Nawiri is facilitated by a Mercy Corps-led consortium of partners that share a commitment to putting county governments and their citizens in the driver's seat of their own sustainability. In the first phase of Nawiri, the consortium is conducting learning and research activities, including a longitudinal study, to identify household and systemic factors associated with acute malnutrition. In the second phase, Nawiri is using the information collected to tailor and implement program activities to ensure they address the key factors associated with acute malnutrition.

Goal, objectives, and overarching research questions

This report summarizes the results from quantitative data collected during the baseline evaluation of a 24-month longitudinal, mixed-methods observational cohort study of children less than 3 years old, and their mothers or caregivers, in Samburu County, Kenya. The longitudinal study, part of Nawiri Phase 1 activities, aims to discern evidence-based insights for the development of overarching solutions as well as micro-solutions for sustainably reducing persistent acute malnutrition (PAM). It also will inform subsequent pilot studies and Phase 2 Nawiri activities in Samburu. Its two main objectives are to:

- Understand and map how a variety of immediate, underlying, and basic/systemic drivers interact to influence PAM over time, geography, and livelihood zones among infants and young children; and
- Identify and prioritize opportunities and barriers to achieve sustained reductions in PAM.

To address these objectives, the longitudinal study focuses on immediate and underlying factors associated with acute malnutrition, including (1) infant and young child feeding (IYCF) and morbidity and maternal diet; (2) livelihood dynamics and interactions with undernutrition; (3) access to and availability of water, household hygiene, and food safety; (4) health-seeking behavior; (5) gender, women's time poverty, decision-making, and control over resources; and (6) response to and experience with shocks. This study also gathers information that may be useful for improving nutrition surveillance.

The baseline data collection step was designed to produce data to compare to future survey waves. It also collected qualitative information through various methods that will be included in a companion report. The two reports are intended to inform stakeholders on gaps in knowledge, facilitators, and barriers to behaviors that can feed into the initial design of implementation activities and pilots. Further information on seasonal influences will be available after the third wave of data collection. The post-baseline waves are designed to allow comparisons over time, relevant for specific thematic areas, such as when, where, why, and how households engage with the health care system and different actors within the system and how water, sanitation, and hygiene practices change. The first analysis of yearly changes with respect to climatic patterns

and how households respond to lean versus non-lean seasons and other shocks will be generated from the third wave of data collection.

Study design and timing of data collection

The study sample was population-based, with stratification by sub-counties grouped into three survey zones (Central, North, and East) reflecting administrative sub-counties used in the Samburu Standardized Monitoring and Assessment of Relief and Transitions (SMART) Surveys. Stratification by livelihood zones was done through post-stratification analysis. We analyzed the data by livelihood zone because it was hypothesized that undernutrition might be more related to a household's livelihood than to its physical location.

As noted, the study used mixed-method techniques with quantitative and qualitative data collection. The quantitative component included a household survey and a caregiver survey and covered 699 households. The qualitative data collection activities yielded rich and in-depth insights that will be triangulated with the quantitative survey findings in a companion report. Therefore, this report focuses only on findings from the quantitative survey component. Results are reported for global acute malnutrition (GAM), stunting, and underweight. However, the discussion focuses only on GAM because the purpose of the Nawiri program is to reduce persistent acute malnutrition.

The baseline data collection was carried out in June and July 2021 following a full household listing operation in the county to establish the sampling frame of households with children under 3 years. Subsequent data collection waves are planned for November–December 2021 (Wave 2), March–April 2022 (Wave 3), September–October 2022 (Wave 4), March–April 2023 (Wave 5), and August–September 2023 (Wave 6).

Baseline findings

Mapping GAM among children and underweight among caregivers/mothers

The overall prevalence of GAM when assessed by weight-for-height z-score (WHZ) was greater than when assessed by mid-upper arm circumference (MUAC) (19% versus 8%). Analysis by survey zone and livelihood zone showed that prevalence of GAM using WHZ or MUAC was the highest in the North (WHZ 21% and MUAC 10%), followed by Central (WHZ 12% and MUAC 7%), and East (WHZ 11% and MUAC 3%). When examined by livelihood zone, the prevalence of GAM was significantly higher among pastoralists (22%) compared to agro-pastoralists (8%) and urban/peri-urban dwellers (5%). Consistent with the literature, our findings show that the prevalence of GAM when assessed by WHZ is generally greater then when assessed by MUAC.

GAM prevalence was higher for boys (25%) than girls (14%) when assessed by WHZ. However, when assessed by MUAC, girls were more likely to be acutely malnourished (11%) compared to boys (6%), though this difference is not statistically significant. When assessed by WHZ, the prevalence of GAM was similar across all child age groups. However, when assessed by MUAC, children 6–11 months had the highest rates (11%) compared to children in the other age categories. The bi-variate and regression analysis using WHZ showed no statistically significant difference by child age.

The highest prevalence of GAM (29%) was found among children of mothers or caregivers aged 30–34 years when WHZ was used as the indicator compared to 18% among children of caregivers younger than 25 and 15% among caregivers aged 25–29 years. When MUAC was used as the indicator, the prevalence of GAM among mothers or caregivers 30–34 years dropped to 9% and was the highest for those under 25 years (13%). The bi-variate and regression analysis using WHZ showed no significant difference by caregiver age.

More than half (51%) of non-pregnant mothers or caregivers were underweight. Results by survey zone showed that 52% of caregivers in the North were underweight, followed by 47% in the East, and 46% in the Central zone. Results by livelihood zone showed that 62% of caregivers in agro-pastoral communities were underweight, followed by 51% in pastoral communities, and 43% in urban/peri-urban communities. Underweight was highest among caregivers less than 25 years (58%), and lowest among caregivers 30–34 years (42%). Underweight among pregnant mothers or caregivers, assessed by MUAC, was 37%.

Infant and young child feeding, maternal diet, and child morbidity

Most participating newborns were breastfed within the first hour of life (86%) and most newborns received colostrum (96%). However, only 58% of infants less than 6 months old were exclusively breastfed and only two-thirds of infants 6–8 months old had been fed a solid or semi-solid food the previous day. Continued breastfeeding at 1 year was common (95%). One-quarter of children 6–23 months had received something in a bottle the previous day.

Overall, among children 6–23 months old, only 8% met the threshold for minimum dietary diversity (MDD), increasing to 15% in children in urban/peri-urban areas. In addition to being fed a diet lacking in diversity, children were fed infrequently; only one-third of children met the threshold for minimum meal frequency. Dairy foods were the most consumed (79%), followed by grains, roots, and tubers (71%). Vitamin A rich fruits and vegetables and legumes and nuts were consumed by about 12% of children. Only 6% of children consumed flesh foods (16% in urban/peri-urban children), and eggs were consumed by less than 3%.

None of the IYCF indicators included in a regression analysis were associated with any of the three indicators of undernutrition (GAM, stunting, and underweight), which may be because of the extremely poor complementary feeding diet among all children, including among those with adequate anthropometric measurements, but also because the indicators of IYCF practices were not designed for this purpose. Other studies have shown that the feeding indicators are not significantly associated with anthropometry.

Maternal diet was poor, with only 6% of caregivers reaching the threshold for minimum dietary diversity for women (MDD-W). Most consumed were grains, white roots and tubers, and plantains (98%), followed by dairy (59%) and pulses (41%). Consumption of meat, poultry, and fish was higher among agro-pastoralists (36%) and urban/peri-urban dwellers (23%) compared to pastoralists (12%). As it was among children, consumption of eggs was extremely low. The finding that mother or caregiver consumption of pulses and foods in other highly nutritious food groups was greater than that of children suggests household do have access to such foods and that they could potentially be promoted for child feeding.

In the 2 weeks preceding the survey, two-thirds of children aged 3 years and younger were reported to have been ill; 41% of children had had a cough with difficult breathing, 29% had a fever, and 31% had diarrhea. Reported illness did not differ by livelihood zone, child gender, mother or caregiver age or education, or wealth quintile. However, children 6–11 months were more likely to have been ill compared to children in other age groups. Care-seeking behavior for child illness was high (78%) and did not vary by livelihood zone, child age, child sex, or other background characteristics of the mother/caregiver or household.

Livelihood dynamics and interactions with undernutrition

Overall, 85% of the households were headed by men while the remaining households were headed by women, though this varied by livelihood zone. In the urban/peri-urban livelihood zone, 51% of households were headed by women. There was no significant difference in GAM rates among children based on the gender of the household head.

The main occupation for household heads aligned with their livelihood zone. Livestock herding was the most common occupation at 74% in the pastoral livelihood zone, whereas employed, wage labor, or petty trading were the most common occupations in the agro-pastoral and urban/peri-urban zones. The highest percentage of households reporting no income was in the agro-pastoral livelihood zone (32%). In terms of productive assets, 95% of pastoralists had livestock or poultry, compared to only 39% of urban/peri-urban dwellers. Nearly three-quarters (70%) of agro-pastoral households had access to agricultural/grazing.

The regular cash saving rate was low, with the pastoralists recording the highest rate (37%) and urban/peri-urban dwellers the lowest (23%). Use of credit was relatively high, and loans were mostly taken from friends or relatives (over 80% across livelihood zones). Credit was used primarily for purchasing food (80%), followed by health expenses (18%). Only 3% of households reported receiving any financial support in the past 4 months, with 52% coming from government programs, 11% from non-governmental organizations, and 39% as unspecified gifts.

Severe food insecurity in the last 12 months as measured by the Household Food Insecurity Experience Scale was reported by 93% households in the pastoral livelihood zone, followed by urban/peri-urban (87%), and agro-pastoral (81%). Severe food insecurity was significantly less prevalent in households where the mother/caregiver had a secondary or higher level of education. Households in most pastoral and urban/peri-urban zones had similar coping strategy index (CSI) scores (20 and 22, respectively). The agro-pastoral communities had the lowest CSI score (17). Bi-variate and regression analysis using WHZ as the indicator showed no significant associations between household food security and GAM rates, possibly because almost all households were food insecure.

Access to and availability of water, household hygiene, and food safety

Water insecurity was highly prevalent among the three livelihood zones (70%–75%). Ordinarily, water is mainly sourced from open unprotected water bodies such as streams, rivers, and boreholes, and used in households without treatment. One-quarter of households reported traveling more than 2 km round trip to fetch water, a task that was performed almost exclusively

by women and girls (98%). Use of improved toilet facilities was reported by 6% of pastoralists, 34% of agro-pastoralists, and 54% of urban/peri-urban dwellers.

Health-seeking behavior

Although nearly 90% of mothers or caregivers had sought antenatal care for their most recent pregnancy, only about one in five had at least four antenatal visits. Delivery with a skilled birth attendant was highest among agro-pastoralists (78%), then pastoralists (36%) and urban/peri-urban dwellers (58%). Use of iron and folate supplements during pregnancy was low; only 20% of mothers or caregivers reported taking 90 or more tablets in their previous pregnancy, with the highest percentage among agro-pastoralists (46%) and the lowest among urban/peri-urban dwellers (8%). Vaccination coverage for all basic vaccines (the Bacille Calmette-Guerin vaccine for tuberculosis, vaccine for measles, and three doses each of pentavalent and polio vaccines [excluding polio vaccine given at birth]) among children was consistently low at 24%. One-third and 43% of children had received deworming tablets or a vitamin A supplement in the previous 6 months, respectively. Children of mothers or caregivers who delivered at health facilities had significantly lower GAM rates.

Gender, women's time poverty, decision-making, and control over resources

More than 80% of married mothers and caregivers in urban/peri-urban settings make all decisions by themselves or jointly with their husbands or partners on usage of household income, child health, their own health care, food purchases, major household purchases, and visits to friends/relatives. Sole or joint decision-making was as follows in the other livelihood zones: agro-pastoral (54%) and pastoral (33%). There was no significant difference in decision-making by size of the household or by type of marriage (polygamous versus monogamous). But there was a significant effect of level of education, with only 35% of non-educated women making significant decisions at the household level compared to around 55% of women with primary or secondary or more education. Just under one-quarter of mothers or caregivers reported being employed in the last 12 months.

Response to and experience with shocks

Household shocks were common; almost all households in the agro-pastoral livelihood zone, 96% of households in the pastoral livelihood zone, and three-quarters of households in the urban/peri-urban livelihood zone reported experiencing a shock in the 4 months before the survey. The type of shock experienced by households varied by livelihood zones: climatic shocks were more prevalent in agro-pastoral zones (90%) and pastoral zones (84%). Economic shocks were more prevalent in pastoral zones (93%). Responses to shocks also varied by livelihood zone. The main response was selling of livestock in pastoral zones, whereas the main response was looking for a top-up wage in agro-pastoral and urban/peri-urban zones. Reducing food intake as a response to shocks was notable across all livelihood zones. Surprisingly, coronavirus disease was not reported as a shock.

Surveillance

The difference between the results from WHZ and MUAC suggests a non-linear relationship between the two measures, which should be considered in light of the current nutrition surveillance system, which uses only MUAC. The results show that the estimated prevalence of GAM will be much lower when MUAC rather than WHZ is used.

Conclusion and next steps

Our results show that the prevalence of acute malnutrition among children younger than 3 years old exceeded the emergency threshold of 15% when assessed by WHZ but not when assessed by MUAC. Although a chi-square analysis showed that prevalence rates of GAM were marginally significant when assessed by the three commonly used survey zones, when assessed by livelihood zone, children of pastoralists were far more likely to be acutely malnourished compared to children of agro-pastoralists or urban/peri-urban dwellers. However, GAM did not vary by child sex, age, mother or caregiver age, parity, or education, MDD-W, or household water insecurity.

Regression analysis taking into consideration child, mother or caregiver, household, and community characteristics showed that only children of mothers or caregivers who delivered with skilled personnel were significantly less likely to suffer from GAM compared to children whose mothers or caregivers delivered with unskilled personnel. This result likely reflects the fact that mothers or caregivers who deliver with skilled personnel are very likely to be more highly educated and have better access to health care than those who do not—characteristics that are associated with better child nutrition generally.

With respect to next steps, the information generated by the quantitative results of the baseline of the longitudinal study highlights some specific immediate actions that include:

- A focus on interventions to promote exclusive breastfeeding among mothers of children younger than 5 months and to promote increased dietary diversity and increased meal frequently among older children. Interventions to reduce use of feeding bottles for children of all ages should be undertaken.

Furthermore, research into why children are not fed with similar frequency the nutritious foods consumed by mothers and caregivers and the barriers and facilitators for changing these practices is warranted.

Lastly, the information generated from this report must be integrated with the rich findings from the qualitative results. Integration of the two complementary research methods will lead to a more in-depth understanding of how interventions to improve nutrition with respect to both the immediate causes of undernutrition and the underlying causes can be best addressed in the short and long term.

1 STUDY BACKGROUND AND GAP ANALYSIS

The causal pathways leading to persistent acute malnutrition (PAM)—including poor maternal, infant, and young child nutrition (MIYCN)—in Turkana are complex; are interlinked; and require in-depth assessment and analysis to fully understand the contextual, seasonal, and shock-specific factors associated with acute malnutrition. Although cross-sectional research has been conducted in Turkana on PAM and its immediate and underlying factors associated with undernutrition, virtually no evidence exists on how these factors vary by season, within the same households, and by the synergistic effects of increasingly frequent and severe climate-related and other shocks.

The longitudinal study aims to discern evidence-based insights for developing overarching solutions as well as micro-solutions for sustainably reducing PAM. It will also inform subsequent pilot studies and Phase 2 Nawiri activities in Turkana. Its two main objectives are to:

- Understand and map how a variety of immediate, underlying, basic, and systemic drivers interact to influence PAM over time among infants and young children living in different livelihood zones; and
- Identify and prioritize opportunities and barriers to achieve sustained reductions in PAM.

Thus, the study takes a systems-based approach to crafting contextualized and sustainable interventions to address modifiable factors contributing to PAM, including but not limited to strategies to improve food systems and livelihoods; social and behavior change (SBC); community health systems; water, sanitation, and hygiene (WASH); and gender dynamics, among others.

The conceptual framework for Acute Malnutrition in Africa's Drylands [1] was used as the basis for the study design (**Figure 1**). This conceptual framework highlights the need to deepen the understanding of underlying and basic causes of PAM beyond the traditional linear pathways, looking at synergies between factors as well as existing and emergent trends and patterns that vary over time. Environment and seasonality are at the base of the framework, acknowledging the unique environmental conditions of the drylands. The conceptual framework also emphasizes the need to deepen our understanding of systems, institutions, and livelihoods, as it is hypothesized that natural hazards or climatic shocks do not cause disasters but only trigger them. Therefore, learning about the roles of social and political systems and coping and adaptive strategies and responses is a key to understanding vulnerability to shocks, their impact on food and health systems, and their ultimate effect on nutrition outcomes.

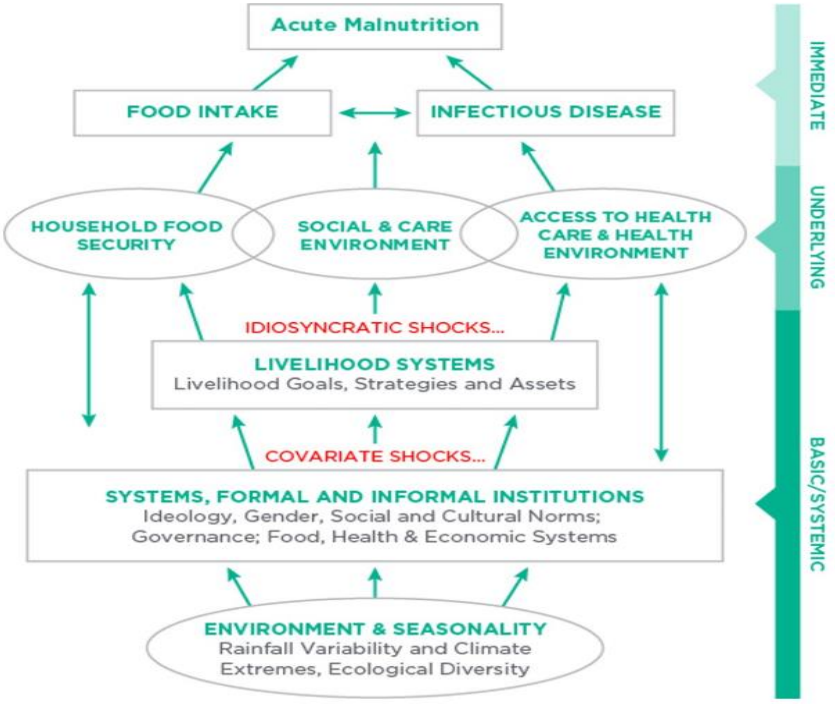
In keeping with this framework, the longitudinal study goes beyond collecting information on immediate and underlying factors, such as maternal and infant and young child dietary intake and disease (e.g., why knowledge about optimal IYCF and care behaviors is not necessarily translated into practice), household food security, health services, and water and sanitation.

While understanding these immediate and underlying factors is critical, to address the basic and systemic factors that create the conditions that enable acute malnutrition to persist, we must also gather information on a broader range of basic and systemic factors such as livelihoods and

sources of income, gender relations, and dynamics, as well as women's time poverty, decision-making power, and control over resources. In addition, we will examine strategies that households with children less than 3 years old use to cope with and respond and adapt to shocks and stresses and will collect information relevant to improving existing nutrition surveillance systems. By gathering information on a broader range of factors through our analysis, we can look at interconnections and feedback loops to fully understand the complex causality of acute malnutrition.

The longitudinal study will assemble critical evidence to better explain the connections and relative importance of the household dynamics from the Nawiri theory of change. It will answer the questions: What are the dynamics of the household system? And what are the most promising entry points to modify them? These entry points are interfaces with the systems examined in other formative research areas. This household information can be seen as the "demand" side of the intervention, and all other areas are the "supply" side. Specific examples of implementation design that can be influenced by the longitudinal study include adaptation of SBC strategies and mother and caregiver support groups to enhance IYCF and care practices, tailoring community health services (CHS) interventions to respond to the specific general and integrated management of acute malnutrition (IMAM) services needs of households, and tailoring livelihoods systems to sociocultural dynamics in play in the context.

Figure 1. Conceptual framework for addressing acute malnutrition in Africa's drylands



Source: Young, Helen. *Nutrition in Africa's drylands: A conceptual framework for addressing acute malnutrition.* Boston: Feinstein International Center, Tufts University, 2020.

1.1 EVIDENCE GAP ANALYSIS

An evidence gap analysis exercise was conducted before refining the specific research questions. The exercise aimed to identify key gaps – i.e. where little or no evidence is available – from both literature and practice. The exercise involved consultations with county and national stakeholders and a detailed desk review around key themes (shared with our Nawiri Consortium). Key programming gaps that emerged from the analysis are described next.

The Nawiri learning agenda was a primary topic of discussion early in the program, through ongoing county engagement with inception meetings in November 2019, followed by a meeting with county leaders and technical leads across multiple government sectors in March 2020. In June 2020, specific details of the longitudinal study design informed by preliminary consultations were presented and discussed in meetings convened with key technical leads drawn from multiple sectors (health, agriculture, National Drought Management Authority [NDMA], social services, public health, and United Nations Children's Fund [UNICEF]). There were also sub-county and ward-level sensitization meetings with government officials and community leaders. Input and feedback received shaped the focus, scope, and design of the longitudinal study.

There was a consensus that the longitudinal study should generate critical evidence on immediate, underlying, and basic factors associated with PAM in specific livelihood zones to inform evidence-based and contextualized intervention design. The longitudinal study findings will uncover over time how the complex factors interact and are influenced by various dynamics, including seasonality and shocks. Thus, the results will contribute to adaptation or co-creation and design of robust and evidence-informed programs that are sensitive to shocks and seasonal dynamics related to MIYCN, livelihoods, CHS, and WASH, among other thematic areas.

Key gaps identified included:

- Inadequate understanding and evidence of the effect of increasingly unpredictable seasonality and shocks on PAM, including immediate and increasingly frequent and severe climate-related and other shocks (including COVID-19). This topic also includes an inadequate understanding of the government's response to the unpredictable seasonality and shocks over time.
- Inadequate understanding of the interaction and nuances of various factors and their relative importance at the individual, household, and community levels.
- Inadequate understanding and insufficient community input on the factors driving PAM and possible solutions.
- Lack of vital data on trends based on a longitudinal cohort of the same households that provide a high level of internal validity. By applying this method, we can be sure that changes observed are related to external factors (shocks, seasons, COVID-19) and are not occurring solely because we are sampling a different population during each wave of data collection.

1.2 UTILITY OF THE LONGITUDINAL STUDY AND LINKAGES WITH THE REST OF THE NAWIRI LEARNING AND RESEARCH AGENDA

The longitudinal study is adopting a systems-based approach to surface contextualized and sustainable interventions to address modifiable factors contributing to PAM, including but not limited to strategies to improve SBC, MIYCN behaviors, CHS, WASH, and nutrition-sensitive programming such as the Rural Entrepreneur Access Project (REAP) for Nutrition and gender equality, among others. Information generated by the study will contribute substantially to adaptations of Nawiri's theory of change.

The longitudinal study will link to several other parts of the learning and research agenda such as MIYCN, adolescent sexual and reproductive health (ASRH), livelihoods and nutrition resilience, CHS, WASH, REAP for Nutrition, and the fecal–oral (FO) pathogens pathways study.

- Data from the baseline survey, as well as qualitative/participatory data collected during the longitudinal study, will fill knowledge and information gaps and will be triangulated with data from other formative research studies such as CHS, MIYCN, and REAP for Nutrition.
- Data from Years 1 and 2 will clarify how determinants of acute malnutrition vary by season and in response to shocks and stresses. This information will be useful for adapting Nawiri implementation early in Phase 2 of the project so that interventions better accommodate seasonality and shocks/stresses, which in turn will contribute to the goal of reducing PAM and global acute malnutrition (GAM). In addition, information from the longitudinal study will be useful to the county governments to quantify issues related to acute malnutrition and help them direct funding to pull the relevant levers.

The following are examples of how data from the longitudinal study will feed into other research and learning thematic areas and inform action:

- Maternal, infant, and young child nutrition and care: The longitudinal study will inform program design by identifying the most salient modifiable factors that lead to poor MIYCN, care practices, and PAM, and by offering evidence-based insights for developing overarching solutions as well as micro-solutions for sustainably reducing PAM, refined through the human-centered design (HCD) process in Years 2–3.
- Livelihoods and resilience: The longitudinal study will generate seasonal information and trends on livelihoods, assets, expenditure, market access, household food security, and household coping strategies. We will gather data on other sources of support to households—such as cash transfers—and how these vary by season and during shocks. Cumulatively, this information will paint a picture of household nutrition resilience that will contribute to the design of contextualized and shock responsive interventions in Year 3.
- CHS: Evidence generated of the influence of seasonality and shocks on health and nutrition service-seeking behavior for moderate and severe acute malnutrition and related health and nutrition issues, morbidity patterns, and community perception and utilization of CHS will support co-creation of solutions that are adapted to local household and community realities in Year 3 and subsequent years.
- ASRH: The longitudinal study will identify seasonality factors that affect timely delivery of ASRH services and potential effective platforms to reach adolescents with ASRH and

nutrition SBC services. These findings will support prototyping and testing of effective solutions to improve ASRH through the HCD process. Further, the study will provide information on how PAM affects adolescent mothers, and on what potential household and community factors are associated with the effects. This information will be triangulated with that from the ASRH thematic area and contribute to evidence that will inform collaborative strategies and program actions to enhance agency in decision-making among youth; prevent early pregnancies; and improve access to vital services, health, and nutrition of young mothers in Years 2 and 3 and beyond, thereby contributing to breaking the intergenerational cycle of undernutrition in target communities.

- WASH: We will triangulate information on household water insecurity and its relationship to women's time use and feeding/caring practices within evidence derived from the FO pathogens pathways study, from the water governance desk review, and from the WASH bottleneck analysis. The cumulative results will aid co-decision-making on Nawiri's programmatic niche and actions on WASH in Year 2 and Year 3.
- FO pathogens pathways study: The longitudinal study will gather social, economic, and demographic characteristics of households sampled for the FO study. It will also surface evidence on social, structural, and behavioral determinants of FO pathogens' transmission pathways in target households and communities. We will triangulate the data generated with that from the FO study in Year 3.
- REAP: The HCD process will draw upon results of the formative research, the secondary data analysis, other past and present research and learning by The BOMA Project, and preliminary findings of the longitudinal study. Nawiri will rapidly test and iterate ideas to inform what adaptations will be necessary to REAP to enhance its utility in improving nutrition among children under 2 years old in participant households and in communities in Years 2 and 3.
- Nutritional surveillance: The longitudinal study will generate information and learning that will contribute to improvement of the nutrition information system, including enhanced surveillance for food and nutrition security, early warning systems, and information needed for policy changes and programming.

2 STUDY OBJECTIVES, RESEARCH QUESTIONS, AND METHODS

2.1 STUDY OBJECTIVES AND RESEARCH QUESTIONS

As stated in Section 1, this longitudinal study has two overall research objectives. It is designed to answer six interrelated research questions.

1. ***Infant and young child feeding and morbidity and maternal diet***—How do immediate causes of acute malnutrition (e.g., IYCF and childhood illness) vary across time and space? How do these causes vary for children of adolescent versus adult mothers or caregivers? How do they vary for younger children (< 2 years) compared to children between 2 and 5 years? How do they vary by different livelihood zones?
2. ***Livelihoods***—How does the vulnerability linked to livelihood systems and socioeconomic status vary over time and interact with other factors associated with PAM? Which types of households are more vulnerable? Which types of households have the weakest capacity to

respond or the least ability to recover from livelihoods' disruptions? What intra-household dynamics explain capacities to adapt and be resilient?

3. ***Access to and availability of water, household hygiene, and food safety***—How do access to and availability of water vary over time and influence hygiene and sanitation practices, including food safety? How do access and availability vary by livelihood zone?
4. ***Health-seeking behavior***—How does caregiver health-seeking behavior for various services, including IMAM, vary over time? How do caregiver perceptions of the quality of and accessibility to services offered influence health-seeking behaviors?
5. ***Gender, women's time poverty, decision-making, and control over resources—***How do gender identity, women's time poverty, decision-making power, and control over resources impact the determinants identified in the preceding questions? Is there a differential impact by household structure (e.g., polygamous versus monogamous households, men-headed versus women-headed) and mother's or caregiver's age?
6. ***Response to shocks***—How do households experience and cope with shocks (including COVID-19, conflict, household violence, etc.)? How do shocks disrupt livelihoods and impact nutritional status? How do government interventions in response to shocks affect the ability of households to respond to shocks?

In addition, the study is intended to shed light on how sampling and indicators used by NDMA, and other relevant government entities can effectively generate reliable surveillance data to inform decision-making aimed at reducing acute malnutrition.

While these questions will be answered through the full period of the study, the Wave 1 quantitative survey findings presented in this report are intended to provide baseline information to compare with findings from other survey waves conducted across different seasons and shocks. We also will triangulate the findings with information from qualitative methods, in a companion report, to fill gaps in knowledge and facilitators and barriers to behaviors that can feed into the initial design of Nawiri implementation activities and pilots.

2.2 STUDY METHODOLOGY

2.2.1 Study design and target populations

This study uses a 24-month longitudinal mixed-methods observational design. Households with target populations were recruited and will be followed every 4 months for a total of six waves of data collection. A description of the indicators, methods, and frequency of data collection for survey data collection at each wave appears in ***Annex A.***

The baseline quantitative survey included caregivers and their children from households with children less than 3 years of age at enrollment. The choice of sampling children under 3 years will facilitate the follow-up of the entire cohort without the burden of replacing those that age out (i.e., reach 5 years before the end of the study). However, anthropometric measurements were taken from all under-5 children in the sampled households to guarantee sufficient numbers of under-5 children to enhance the generalizability of the findings to estimate under-5 GAM prevalence.

2.2.2 Sampling strategy

Survey

A representative sample of children aged less than 3 years and their caregivers was obtained using a multistage sampling approach, with survey zones as units of stratification. The survey zones were delineated based on the unique nature of the vulnerability of communities in various geographies, which is occasioned by repeated shocks and stresses associated mainly with specific livelihoods. There are three survey zones in Samburu (North, Central, and East) covering all three livelihood zones (pastoral, agro-pastoral, and urban/peri urban). We treated villages as clusters, and within each stratum, drew a random sample of 20 villages. We then conducted a household listing in each of the selected villages to identify and enumerate all households with children under 3 years old, which formed a sampling frame for the final stage of random selection. Households were then randomly selected to participate in the study. For sampled households with more than one child under 3, the youngest child and their caregiver were selected to participate in the study.

One of the aims of the study is to estimate malnutrition status across different livelihood zones. Stratification by livelihood zones was not possible since the livelihood zones are not aligned to administrative units. Information on the number of villages within livelihood zones and respective household listing was also not readily available as population data from the Kenyan National Bureau of Statistics (KNBS) are based on administrative zones.

Information on livelihood zones was collected during the baseline survey and was used to generate estimates of interest by livelihood zones by recomputing the weights based on the population size by livelihood zones using post-stratification analyses method. This approach generates reasonably good estimates per livelihood zone. See ***Annex B*** for details on the methods used for post-stratification analysis.

2.2.3 Sample sizes

We computed the sample size for the quantitative survey using the household survey sample size formula created by the United Nations Statistical Division [2]. We assumed an under -3 GAM prevalence of 12.5% and adjusted for a design effect of 1.3. (These decisions yielded a maximum design effect of 1.5 due to stratification and clustering, based on estimates from the 2019 SMART survey [3]; and a design effect of 1.12, due to repeated data collection on the same individuals at six time points.) A common correction of 0.02 was assumed based on estimates from a previous study that estimated an intraclass correlation of 0.0044 for clustering of children within a household [4]. We assumed a margin of error of ± 5 percentage points, 95% confidence interval (CI), a nonresponse and attrition rate of 20%, the proportion of the population targeted for the study at 7.6% per the 2019 Kenya Census and the average household size of five [5, 6]. Based on these assumptions, the required estimated minimum sample size was 699 households.

The number of households was allocated proportionally to the population size of each stratum (or survey zone) as shown in **Table 1.** In each stratum a random sample of 20 villages was targeted using probability proportional to the population size of the cluster. Equal numbers of households (North 8, Central 18, and East 9) were then sampled from each village in each of the survey

zones to ensure each of the households had the same probability of being selected. In some villages, the target number of sampled households was not achieved because of insecurity or immigration, and a spare household was sampled randomly from the remaining households and used to complete the target sample size. A total of 664 villages from the whole of Samburu County were considered. The county is divided into 3 sub-counties, 15 wards, and 108 sub-locations.

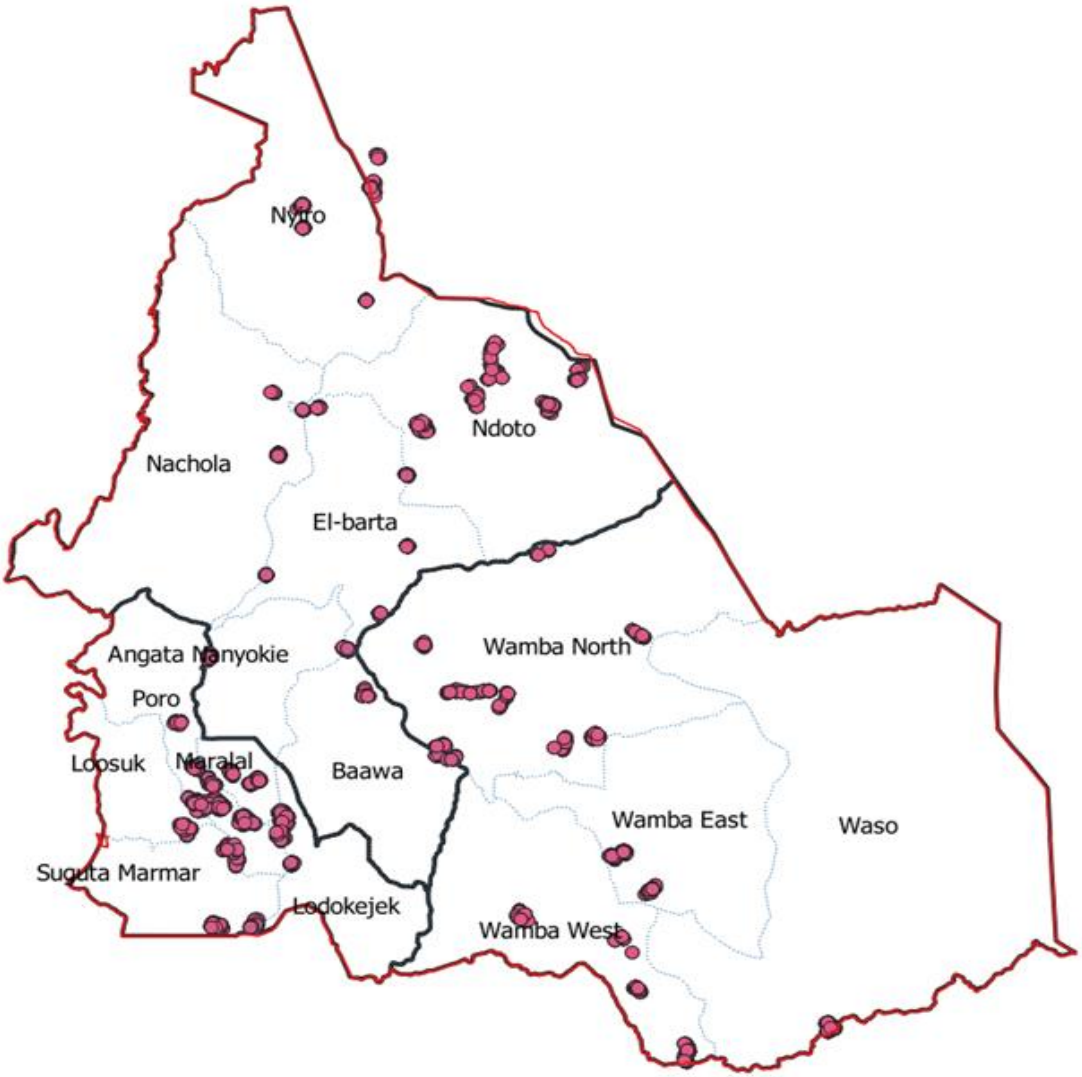
Table 1. Household allocation and sample size per survey zone

Survey zone	Sub-counties	Population	Villages	Sample size (by proportional allocation)	Sampled villages
Central	Central	164,942	366	356	20
North	North	67,391	111	160	20
East	East	77,994	187	179	20
Total		**310,327**	**664**	**698**	**60**

Household listing process

A team of 22 field workers and three team leaders visited all the sampled villages and conducted a listing of all households to establish a sampling frame of all households with children under 3 years old. Three villages from the Central sub-county (Amaiya Center, Maasai, and Lmichomi) and one from North (Suruan) were replaced due to insecurity, migration, and inaccessibility respectively. They were replaced by Kusoro, Morijo A, Loloworu, and Kawap, respectively. About 88% of the households were occupied, with 5% not having someone at home at the time of household listing. Almost two-thirds (57.2%) of the occupied households had at least one child under 3 years (***Annex C***). **Figure 2** summarizes pictorially all the households listed during the 3-week exercise.

Figure 2. Map of all households sampled from all sampled villages



Sampled households

The sample size required for the study was 669 households with children under 3 years. This was divided proportionally among the three survey zones according to their population sizes (**Table 2**). For each survey zone, we randomly sampled an equal number of households from each of the 20 sampled villages. The target number of households for each survey zone was derived by dividing the target sample size of the zone by the number of villages (20). The number was then rounded up to the nearest integer, and this led to an actual sample size of 698 households (an extra 29 households) as summarized below.

Table 2. Summary of sampled households

Sub-counties	Actual sample size	Computed sample size	Target per village	Extra households
Central	359	356	18	3
East	179	168	9	11
North	160	145	8	15
Total	**698**	**669**		**29**

From the enlisted villages (60) in the household listing exercise, the villages were categorized based on the county livelihood zoning: pastoral, agro-pastoral, and urban/peri-urban (**Table 3)**.

Table 3. Distribution of listed villages per livelihood zone in Samburu County

Sub-counties	Pastoral	Agro-pastoral	Urban/peri-urban
Central	0	15	5
East	18	0	2
North	18	0	2
Totals	**36**	**15**	**9**

2.2.4 Data collection procedures

The quantitative data were collected using SurveyCTO, a survey platform for electronic data collection that has in-built skips and quality checks. Using this software increased efficiency and reduced the time needed for cleaning the data. In addition, the platform supported offline data capturing for regions with slow or no internet connectivity and data transmission when the internet became available. Fieldwork was conducted by trained fieldworkers using digital tablets with the questionnaire loaded in SurveyCTO. The questionnaire included the following modules: (1) identification and tracking, (2) demographics and household composition, (3) anthropometry of children <5 years and mothers, (4) socioeconomics, (5) household food security, (6) WASH, (7) health-seeking behavior, (8) MIYCN, (9) shock experience/exposure, and (10) shock preparedness and response. Data were uploaded from the tablets onto a secure African Population and Health Research Center (APHRC) server after each day of data collection. Data were synchronized automatically to a server when the tablet was in a location with network coverage. The uploaded data were then checked for quality daily by a data manager and a team dedicated to coordinate field procedures and at the APHRC head office in Nairobi.

2.2.5 Training of fieldworkers

A total of 31 experienced women (15) and men (32) fieldworkers were recruited and trained thoroughly on data collection processes for a total of 10 days. All fieldworkers were recruited from the local communities because they were familiar with the local area and customs, spoke the local languages, and were effective at ensuring community participation in study activities.

They received intensive training using APHRC's training protocol, which included both theoretical training and practical exercises. They were also trained on (1) the overall aims of the study and study tools, (2) research ethics (including obtaining informed consent/assent), (3) techniques in interviewing, (4) mock interviews, (5) field-based pilots, and (6) debrief sessions after the pilots regarding lessons learned. The team also received training in the use of tablet-based questionnaires and anthropometric measurement techniques.

2.2.6 Monitoring of data quality

Data quality monitoring processes and checks were implemented throughout the data collection process, during the time of developing the data collection tools (through built-in quality control in the tablet-based platform), during training of fieldworkers, in real time during data collection (routine monitoring by the research team and periodic cross-checks against the protocols), and during the data cleaning process. During fieldwork, data quality was enhanced through regular spot checks and sit-ins by supervisors to verify the authenticity of data collected. Data were then reviewed and certified by the field coordinator before they were transferred to the server.

Field operations supervision was done in two layers: a daily supervision by team leaders, and a weekly review of activities and data quality by the data coordination team which included a research officer, a data analyst, a software programmer, and a postdoctoral research scientist. At a higher level, a weekly report on issues arising from the field and discrepancies observed in data were shared with the senior research team which included the co-principal investigators and co-investigators who advised on the necessary actions to be taken. Team officials from the county government and the national government (NDMA) were also involved in the whole process from training of fieldworkers to supervising data collection activities in all the three survey zones.

2.2.7 Monitoring of anthropometric data quality

After procurement and before use, the anthropometric equipment was calibrated, with the procedure repeated daily during fieldwork to ensure accurate measurements. We used a calibrated digital electronic mother/caregiver–child pair weighing scale (Seca 874–200 kg) to measure the weight of study children. For very young children or those who could not stand on the weighing scale, weight was measured using tared weighing, whereby the weight of the mother or caregiver was measured first, after which she was asked to hold the child and stand on the scale. We then subtracted the mother's or caregiver's weight from the combined weight of the mother/caregiver and child to obtain the child's weight. For older children, mothers or caregivers assisted in removing shoes and outer clothing. Mothers/caregivers were also asked to talk with their child about the need to stand still. This was done in a sensitive and nonfrightening way. The stadiometer (Seca 213; height to 2010 cm) and length board (wooden: length/height to 130 cm) were used to measure the height of the adult and child, respectively. The boards were calibrated using piping of a known length, while each scale was tested with a standard weight of 5 kg. Child and adult MUAC was measured to the nearest 0.1 cm using UNICEF-simplified MUAC tapes that showed three classes: red, yellow, and green. All the equipment was daily calibrated during data collection. Each of the weight and height measurements was taken twice and an average was calculated to ensure accuracy. For accuracy in the measurements,

respondents were asked to remove all excess clothing (e.g., sweaters, coats, etc.) and other items (shoes, all items from pockets, watches, eyeglasses, belts, necklaces, and jewelry). Data on edema were collected for all children. Fieldworkers were trained on how to identify children with the condition, using visual aids.

2.2.8 Ethical considerations

Ethical and research approvals and research permits were obtained from the AMREF Ethical and Scientific Review Committee and The National Commission for Science, Technology, and Innovation of Kenya, respectively. A reliance agreement between RTI's and APHRC's Institutional Review Boards was put into place. Fieldworkers were trained on the meaning and process of informed consent or assent and the importance of protecting the privacy and confidentiality of the information obtained from participants. All potential study participants were given information about the study before being asked for their consent to participate. They were adequately informed about the purpose of the study and methods to be used; institutional affiliation of the researchers; anticipated indirect benefits, the lack of direct benefits such as material compensation, and potential risks and follow-up of the study; possible discomfort; the right to abstain from or to withdraw from study at any time, without reprisal; and measures to ensure confidentiality of information provided.

All questionnaires used for data collection, including informed consent forms, were translated from English into the Kiswahili and Samburu Language(s). Informed consent was obtained from all participants including adolescent mothers, less than 18 years, who were regarded as emancipated minors. Informed consent was obtained by signing or thumb-printing for those mothers not able to write. All consent forms were kept in a secure location in APHRC offices in Nairobi. With respect to COVID-19, all risk-reduction mandates issued by the Government of Kenya were followed. Also, all survey staff and participants wore masks, and hand sanitizer was made readily available.

2.2.9 Data management and analysis

Data entry and cleaning procedures

We captured survey data by using preprogrammed tablets. The tablets used preset ranges of plausible responses to variables and anthropometric measures; the data collector could not move on to a next field for further input until plausible values were entered for the initial field. Data were then uploaded from the tablets onto a safe APHRC server daily and checked for quality by the data manager on a continual basis. Verifications with the field team were conducted as needed. Before we conducted any analysis, collected data were then subjected to a process of cleaning. The cleaning process included labeling of variables; labeling of value labels; computation of new variables, such as the age of the respondents; recoding of open-ended variables, etc.

Survey data analysis

The quantitative data analyses were performed using Stata. For this baseline survey, descriptive data analysis on socio-demographic variables, individual level characteristics, anthropometric

indicators, and drivers of acute malnutrition were conducted. Associations between independent, mediating, and dependent variables were evaluated using bivariate and multivariate logistics regression models. Tests for independence and association between variables were established using statistical tests such as the chi-square test for independence as well as the maximum likelihood method. We also explored interactions between various drivers and shocks, and how they interacted with each other, and outcomes using logistics regression models. All analyses were done at the individual level using computed survey weights at livelihood zone level to ensure that appropriate precision estimates were obtained to guarantee proper inference and generalization of the results at livelihood zone level. Independent and mediating variables include drivers of acute malnutrition at various levels, consistent with the Framework on Acute Malnutrition in Africa's Drylands [1]:

Immediate drivers – child diet and other IYCF indicators (using the World Health Organization [WHO] IYCF questionnaire) and child morbidity (2-week recall).

- ***Underlying drivers*** – IYCF knowledge and attitudes; WASH knowledge, attitudes, and practices; household food security; use of community health services; health seeking behaviors; and Household Water Insecurity Experiences Scale (HWISE)
- ***Basic drivers – Livelihood systems*** – livelihood strategies; household coping mechanisms, food produced by the household; sources of income (including transfers); expenditures
- ***Basic/systemic drivers – systems and institutions*** – gender (women's time use, decision-making power); community conflict, household violence

The primary dependent variable was GAM (weight-for-height z-score [WHZ] < –2 standard deviations [SD] or MUAC < 125 mm). The secondary dependent variables were stunting (HAZ < –2 SD) and underweight (weight-for-age z-score [WAZ] < –2 SD). The World Health Organization (WHO) Child Growth Standards [7] were used to calculate both the primary and secondary dependent variables from the anthropometric measurements and child age. To classify a child as acutely malnourished using MUAC, a cutoff of less than 12.5 cm was used.

The height and weight of mothers and caregivers were measured and used to compute maternal BMI. The BMI was computed by dividing weight (in kg) by height in meters squared and categorized into underweight (BMI < 18.5 kg/m^2), normal weight (BMI = 18.5–24.99 kg/m^2), overweight (BMI = 25–29.99 kg/m^2), and obesity (BMI > 30 kg/m^2).

Underweight for pregnant women was assessed using MUAC and a cutoff value of 21 cm, and short stature was assessed using the cutoff value of 145 cm recommended by the Pan American Health Organization/World Health Organization [8].

We assessed IYCF practices using indicators from WHO and partners [9]. We assessed the children's minimum dietary diversity (MDD) using the WHO 7-food group child dietary diversity indicator. We first assessed the consumption of the individual food groups and proceeded to categorize the indicator into whether a child achieved MDD (4 or more food groups). Women's MDD (MDD-W) was determined using a cut-off value of 5 out of the 10 food groups, recommended as a cut-off by the Women's Dietary Diversity Project Study Group [10]. Household water insecurity was measured using the HWISE Scale [11].

A context-specific CSI was also developed to compare food security across livelihood zones and other background characteristics. The CSI was calculated using a specific set of behaviors with a universal set of severity weightings for each behavior [12]. The five standard coping strategies and their severity weightings used in CSI calculation included: eating less-preferred foods (1.0), borrowing food/money from friends and relatives (2.0), limiting portions at mealtime (1.0), limiting adult intake (3.0), and reducing the number of meals per day (1.0).

The creation of the wealth index for the households comprised of productive and non-productive assets, and the household's utilities like walls, floor and roof materials, and light sources. We then selected the variables using the rule of thumb that if a variable /asset is owned by more than 95% or less than 5% of the sample was excluded from the analysis. We then run the frequencies of the different livelihood zones separately and if certain assets were owned by very few in either of the zones, we did not include them in the analysis. The variables were then recoded into binary variables, taking values 0 and 1. The wealth index was created using the principal component analysis (PCA). Finally, we created wealth quintiles by dividing the wealth index into five equal groups; 1 = lowest/first/poorest, 2 = second, 3 = middle, 4 = fourth, and 5 = highest/richest/wealthiest.

Regression models

We built four regression models per outcome variable. The rationale for doing so was to understand the effects of the various putative factors at each modeling stage. The child-level factors were entered into the first model (model 1), and then adjusted for maternal, household, and community-level factors in models 2, 3, and 4, respectively. In addition to the 0–35 month age group, we stratified the analysis by 6–23 months so as to make it possible for us to use all the IYCF practice indicators. We estimated the adjusted odds ratios (aORs) of the associations between the various factors and child malnutrition.

We first looked at the consumption per each food group by livelihood zones. We then proceeded to assess whether women's dietary intake in these settings met the standard for MDD-W.

We created the interaction terms by multiplying two independent variables. Two common techniques can be used to aid in interpretating interactions: preparing numerical summaries of a series of odds ratios and plotting predicted probabilities. We opted to use plotting predicted probabilities in this analysis. Interaction is said to occur if the lines of the plots cross each other or are nonparallel.

The interaction effect is based on the premise that a third variable influences the relationship between an independent and dependent variable. In other words, we want to know whether an effect of one independent variable (A) on the dependent variable depends on (varies) the values of another independent variable (B) (effect modifier or moderator). As a practical example of interaction, both water and food are essential for a child's survival. Having just one in abundance would negatively affect the child's health, while having both (interaction between water and food) would enhance the probability of securing a child's nutrition. Thus, missing a vital interaction effect can lead to adverse health outcomes. The quantitative data analyses were performed using Stata Version 15.

2.3 CHALLENGES ENCOUNTERED DURING DATA COLLECTION

The baseline survey faced the following challenges:

- ***Out migration and insecurity***: Villages of nomadic communities have migrated to different areas due to recent drought as well as insecurity in some areas. Sampled villages that had migrated to unknown areas were replaced.
- ***Distance and inaccessible road/terrain***: The villages and households were far apart in some areas; hence, the field team had to travel for a long distance before reaching the next village/household. Additionally, there were impassable roads due to heavy rain in some areas, and sloppy and hilly terrain led to teams walking to access the villages.
- ***Pandemic effect***: The COVID-19 pandemic resulted in a significant delay in initiating data collection.

3 HOUSEHOLD CHARACTERISTICS

3.1 HOUSEHOLDS' DEMOGRAPHIC AND SOCIOECONOMIC INDICATORS

Overall, 85.1% of the households were headed by males while the remaining 14.9% households were headed by females. The percentage of female-headed households was higher in the urban/peri-urban areas, where nearly half of households were female headed compared to only about 10% in the pastoral and agro-pastoral livelihood zones (**Table 4**). About one-third of household heads were 35 to 49 years old, whereas about one-fifth were 25–29 years old. Just over 10% of household heads were between 14 and 25 years old; however, this percentage was nearly tripled in urban/peri-urban areas. Nearly, three-quarters of household heads had no education, with the highest proportion among pastoralists, followed by agro-pastoralists. Primary and post-primary education levels were highest in urban/peri-urban settings and lowest in the pastoral livelihood zone. Half of the households consisted of six or more persons. Overall, three-quarters of households included both male and female adults and just under a quarter included only female adults. Just over 1% included only a male adult.

Livestock herding was the main (71.1%) occupation of household heads in the pastoral livelihood zone, while wage labor was the main occupation of household heads in the urban/peri-urban (62.4%) and agro-pastoral (47.3%) livelihood zones. Overall, the unemployment rate was low (4.9%), with the lowest percentage in urban/peri-urban settings (2.1%).

The main sources of income varied across livelihood zones. Sale of livestock (73.9%) and petty trade for products of livestock (15.0%) were the main sources of household income in the pastoral livelihood zone. The sale of livestock (25.6%) and casual labor (21.5%) were the main sources of income in the agro-pastoral livelihood zone. Casual labor (52.5%) and petty trading (27.0%) were the main sources of income in urban/peri-urban setting. The highest percentage of households reporting no income was in the agro-pastoral livelihood zone (32.1%), whereas only about 1% of households reported no income in the two other livelihood zones. Not surprisingly, ownership of livestock, including poultry, was highest among pastoralists (94.7%), followed by agro-pastoralists (62.5%) and urban/peri-urban dwellers (38.5%).

Only 5.5% households reported receiving cash transfers or social assistance, with only 1.3% in urban/peri-urban settings so reporting. The distribution of households by wealth index varied across all livelihood zones. Across all livelihood zones, 9 out of 10 households reported severe food insecurity. Water insecurity was reported by close to 75% of households.

Table 4. Percentage distribution of households by demographic and socioeconomic characteristics and by livelihood zone

Characteristic	Livelihood zone			*N* and Overall (%)
	Pastoral	Agro-pastoral	Urban/peri-urban	
***N* (number of households)**	**364**	**129**	**101**	**594**
Household head: Sex				
Male	89.2	90.7	48.6	85.1
Female	10.8	9.3	51.4	14.9
Household head: Age				
15–24 years	8.2	9.3	39.6	11.5
25–29 years	21.8	9.5	13.0	20.3
30–34 years	19.3	19.0	13.9	18.7
35–49 years	33.8	50.6	20.3	33.2
50+ years	16.8	11.6	13.2	16.2
Household head: Highest education				
No education	80.9	58.7	16.6	73.1
Primary	11.3	24.3	49.3	15.9
Secondary+	7.8	17.0	34.2	11.0
Household gender composition				
Male and female adults	81.0	51.8	39.9	75.4
Female adults	17.6	46.4	59.7	23.3
Male adults	1.4	1.8	0.4	1.3
Household size				
2–3	11.4	10.7	15.3	11.8
4–5	37.8	52.8	32.9	38.0
6+	50.8	36.5	51.8	50.3
Household head: Occupation				
Livestock herding	71.1	26.6	0.5	61.6
Crop farming/own farm labor	0.3	9.6	0.4	0.7
Employed/wage labor	9.7	47.3	62.4	17.0
Petty trade/merchant	10.8	6.6	27.4	12.3

Characteristic	Livelihood zone			*N* and Overall (%)
	Pastoral	Agro-pastoral	Urban/peri-urban	
Self-employment, e.g., boda boda driver	3.1	2.2	7.3	3.5
Unemployed	5.1	7.8	2.1	4.9
Household main current source of income				
No income	1.1	32.1	0.6	2.5
Sale of livestock	73.9	25.6	0.1	63.8
Sale of crops	0.1	5.2	0.0	0.4
Petty trading – e.g., sale of firewood	15.0	6.2	27.0	15.9
Casual labor	3.6	21.5	52.5	9.6
Employed (permanent/temporary/ contractual)	3.9	8.1	13.3	5.1
Own business (merchant/trader)	2.4	1.2	6.5	2.8
Household ownership of livestock/poultry				
No	5.3	37.5	61.5	12.7
Yes	94.7	62.5	38.5	87.3
Households receiving a cash transfer/social assistance from government or nongovernmental organization (NGO)				
No	94.0	93.7	98.7	94.5
Yes	6.0	6.3	1.3	5.5
Wealth quintile[a]				
Lowest	18.4	12.1	49.5	21.3
Second	22.9	18.1	27.0	23.1
Middle	29.2	42.6	2.2	27.0
Fourth	14.9	13.7	3.2	13.6
Highest	14.7	13.6	18.1	15.0
Household food insecurity				
Minimal/no	0.5	2.7	3.3	0.9
Moderate	6.1	16.6	10.2	7.0
Severe	93.4	80.7	86.5	92.1
Household water insecurity				
No	29.1	24.9	26.3	28.6
Yes	70.9	75.1	73.7	71.4
Mean (and standard deviation [SD]) of household probability poverty index (PPI)[b]	34.6 (12.4)	41.4 (15.1)	42.6 (18.2)	37.4 (14.6)

Note. Total percentages may not add up to 100% because of households with missing information.
[a] The petty/merchant trade category includes businesses dealing with products and services.
[b] The wealth quintiles are classifications of wealth index by proxy of household possessions and property ownership using PCA.
[c] PPI is the average of individual household poverty.

3.2 HOUSEHOLDS' PRODUCTIVE ASSETS

Almost all households in the pastoral livelihood zone owned their own dwelling, as did most in the agro-pastoral zone as well. In contrast, 59.4% of households in urban/peri-urban settings reported owning a dwelling with the remainder paying rent (**Table 5**). About 60% of households in the pastoral and agro-pastoral livelihood zones owned between one and five local/indigenous cattle, and 12% owned six or more. In contrast, 90% of households in urban/peri-urban settings reported owning no cattle. Ownership of other animals varied across livelihood zones, though households in urban/peri-urban livelihood zones owned the least. The exception was for chickens, for which the highest percentage of ownership was in urban/peri-urban settings. About half (50.9%) households in pastoral, 70.3% in agro-pastoral, and 25.0% in urban/peri-urban livelihood zones had access to agricultural/grazing land. Among pastoralists, nearly all lands were owned communally, and among agro-pastoralists nearly 80% were communal. In contrast, in urban/peri-urban settings, only 45% of lands were owned communally.

Table 5. Percentage distribution of households by ownership of productive assets, by livelihood zone

Characteristic	Livelihood zone			Overall (*N*) and percentages
	Pastoral	Agro-pastoral	Urban/peri-urban	
***N* (number of households)**	**337**	**117**	**50**	**504**
Ownership of current dwellings				
Owns	99.5	93.4	59.4	88.1
Pay rent/lease	0.5	4.8	27.4	10.9
No rent	0.0	1.8	13.3	5.0
Owns local/indigenous cattle[a]				
None	28.5	26.7	90.7	31.3
1–5	59.0	61.4	7.6	56.7
6+	12.5	11.9	1.7	12.0
Owns grade cattle[b]				
None	99.7	88.3	97.5	99.2
1–5	0.2	10.1	2.5	0.7
6+	0.1	1.6	0.0	0.1
Owns donkey(s)				

Characteristic	Livelihood zone			Overall (*N*) and percentages
	Pastoral	Agro-pastoral	Urban/peri-urban	
None	70.0	99.3	97.8	72.3
1–5	28.5	0.7	1.9	26.3
6+	1.5	0.0	0.3	1.4
Owns camel(s)				
None	69.9	99.4	100.0	72.3
1–5	28.0	0.0	0.0	25.7
6+	2.1	0.6	0.0	2.0
Owns goat(s)				
None	2.0	26.9	58.0	5.4
1–5	31.4	33.6	31.4	31.5
6+	66.6	39.5	10.6	63.1
Owns sheep				
None	12.8	22.4	64.0	15.5
1–5	55.2	28.6	23.2	52.8
6+	32.0	49.0	12.9	31.7
Owns chicken(s)				
None	69.9	28.3	20.3	66.2
1–5	24.2	42.7	58.6	26.4
6+	6.0	28.9	21.1	7.4
Access to agricultural/grazing land	50.9	70.3	25.0	49.1
Agricultural/grazing land ownership				
Owned communally	95.7	79.4	45.4	91.9
Owned individually	4.3	20.6	54.6	8.1
Size of agricultural/grazing land				
Less than hectare	0.9	9.4	56.8	4.4
1–3 hectares	1.8	4.7	4.2	2.1
3+ hectares	97.4	85.9	39.0	93.5

Note. Total percentages per variable may not add up to 100% because of households with missing information.

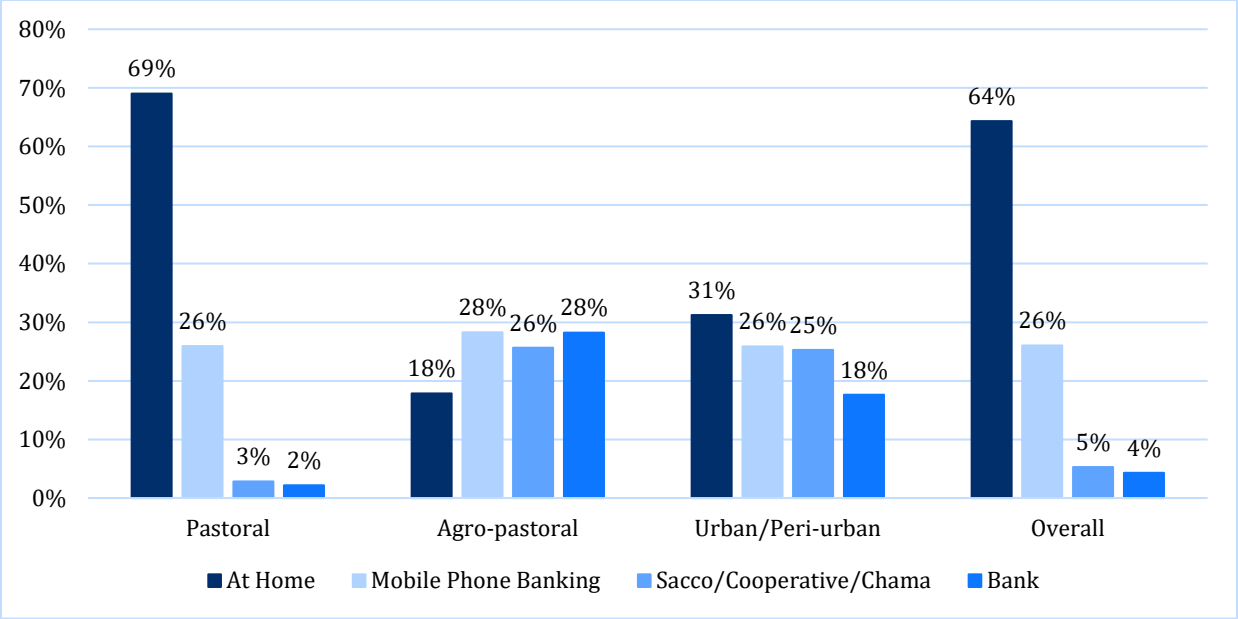
[a] Local/indigenous cattle are traditional cattle.

[b] Grade cattle are exotic breeds or cross breeds between exotic and indigenous breeds.

3.3 HOUSEHOLD SAVINGS AND LOAN HABITS

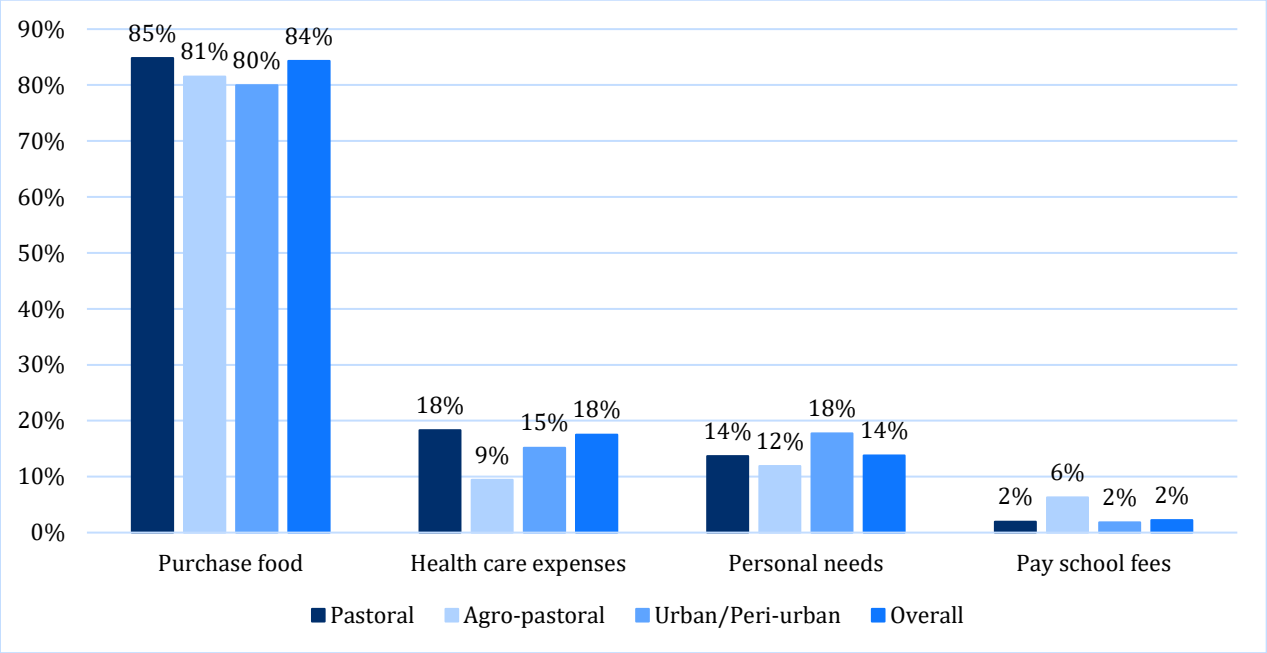
More than two-thirds (64.3%) of the households save their earnings at home followed by mobile phone banking (26.1%), sacco/cooperative/chama (5.3%) and bank (4.3%) (**Figure 3**). Nearly 7 in 10 households (69.0%) in the pastoral livelihood zone reported that they save their cash at home. Mobile phone banking (28.3%) was the main saving platform for households in the agro-pastoral livelihood zone whereas it was home (31.2%) for households in the urban/peri-urban livelihood zone.

Figure 3. Location of household savings, by livelihood zone



More than 90% of households in pastoral, 88.6% in agro-pastoral, and 86.3% in urban/peri-urban livelihood zones borrowed money from someone else in the last 4 months. More than 80% of money borrowed was spent on food purchases (**Figure 4**). On average, health care and personal needs expenses were 18% and 14%, respectively. Only 2% of funds were spent on school fees. More than half of the households that borrowed money reported borrowing the money from friends or family members (data not shown).

Figure 4. Reasons reported by households for borrowing money, by livelihood zone



3.4 HOUSEHOLDS' ACCESS TO FINANCIAL SUPPORT AND CASH TRANSFERS

Between 0.6% and 3.4% of households across the livelihood zones reported receiving financial support in the last 4 months, with the lowest percentage among urban/peri-urban and the highest among pastoralists (**Table 6**). Sources of financial support varied across livelihood zones as did method of transfer. Only 6.4% of pastoralist households reported that financial support was not received when promised, though receipt of support when promised was reported by more than two-thirds and one-quarter of agro-pastoralists and urban/peri-urban dwellers, respectively.

Table 6. Percentage distribution of financial support or cash transfer in the past 4 months, by livelihood zone

Characteristic	Livelihood zone			*N* and Overall (%)
	Pastoral	Agro-pastoral	Urban/peri-urban	
***N* (number of households)**	**364**	**129**	**10**	**594**
Percentage receiving any financial support in the past 4 months	3.4	1.3	0.6	3.0
Source of cash transfer				
Government programs (elderly; orphans and vulnerable children)	51.3	100.0	36.7	52.0
NGO	10.1	0.0	41.5	10.6
Remittance	4.1	0.0	21.8	4.4
Gift	35.8	0.0	0.0	34.3
Mode of transfer used for the financial support				

Characteristic	Livelihood zone			*N* and Overall (%)
	Pastoral	Agro-pastoral	Urban/peri-urban	
Bank	50.4	67.1	13.6	49.9
Mobile networks	16.9	0.0	44.9	17.1
Cash	31	32.9	0.0	30.3
Food aid	1.8	0.0	41.5	2.6
Mode of household selection for support from government or NGO				
Attended an organized meeting	62.8	0.0	41.5	61.1
Filled out forms for support	9.7	67.1	13.6	11.0
Other(s)	27.5	32.9	44.9	27.9
Financial support received came at the time indicated	6.4	67.1	23.1	8.0

3.5 HOUSEHOLD EXPERIENCES WITH SHOCKS AND COPING STRATEGIES

More than 9 out of 10 households in the pastoral and agro-pastoral livelihood zones reported having experienced one or more types of shocks in the last 4 months (**Table 7**). Climatic (drought/famine) and economic shocks were the dominant types experienced across all livelihood zones. These were followed by biologic and conflict-related shocks. Different shocks experienced by households varied somewhat by different background characteristics. For example, although more than 50% of households in the urban/peri-urban livelihood zone reported climatic shocks and 28.2% reported biological shocks, these percentages were far lower than the other two livelihood zones. Although households in the highest income quintile reported the lowest percentage of household shocks, it was still high (84.2%).

Table 7. Percentage distribution of households that experienced of shocks in the past 4 months, by livelihood zone

Characteristic	Percentage of households experiencing shock(s)	Total no. of households	Percentages of households by type of shock				
			Climatic	Biological	Conflict	Economic	No. of households experiencing shock(s)[a]
Overall averages and totals	**93.8**	**594**	**81.8**	**57.3**	**36.2**	**78.3**	**575**
Livelihood zone							
Pastoral	95.7	364	84.9	61.3	37.5	78.2	**350**
Agro-pastoral	99.5	129	90.4	50.9	48.5	93.0	**128**
Urban/peri-urban	75.8	101	52.7	28.2	19.5	72.8	**97**
Household head: Sex							
Male	95.2	503	84.8	59.1	37.1	78.4	**487**

Characteristic	Percentage of households experiencing shock(s)	Total no. of households	Percentages of households by type of shock				
			Climatic	Biological	Conflict	Economic	No. of households experiencing shock(s)[a]
Female	85.8	91	65.0	47.1	30.5	78.2	**88**
Household head: Age							
15–24 years	83.3	65	59.1	41.5	32.1	75.9	**61**
25–29 years	98.3	112	86.6	69.4	45.4	85.8	**110**
30–34 years	91.7	113	82.8	48.4	22.3	77.9	**110**
35–49 years	93.0	214	81.5	56.3	33.3	74.7	**205**
50+ years	99.7	90	91.6	65.6	49.2	78.5	**89**
Household size							
2–3	98.4	81	85.7	58.4	31.0	90.0	**78**
4–5	95.1	216	82.6	54.8	44.9	73.4	**213**
6+	91.7	297	80.3	58.9	30.8	79.3	**284**
Household head: Highest education							
No education	95.7	352	87.0	58.8	35.7	77.8	**340**
Primary	81.1	132	68.4	54.3	32.6	73.1	**127**
Secondary+	99.7	110	66.7	51.7	44.5	89.5	**108**
Main source of income for the household in the past 4 months							
No income	100.0	27	69.6	12.4	46.5	97.6	**27**
Sale of livestock/crops	96.0	299	89.6	67.2	35.3	78.2	**291**
Petty trading	99.1	100	82.7	47.4	52.9	84.7	**98**
Casual/permanent employment	77.9	168	51.9	37.1	19.6	68.2	**159**
Wealth quintile							
Lowest	98.4	116	75.8	68.2	43.0	91.9	**114**
Second	90.5	126	81.3	50.8	29.8	77.2	**121**
Middle	97.1	136	87.9	51.2	36.9	74.6	**132**
Fourth	96.2	114	91.0	73.1	37.0	86.4	**110**
Highest	84.2	102	71.7	48.4	34.1	60.1	**98**
Household food insecurity							
Minimal/no	98.6	17	61.7	79.5	2.2	76.5	**16**
Moderate	97.4	85	80.3	90.7	39.3	86.2	**81**
Severe	93.5	492	82.1	54.5	36.3	77.8	**478**

[a] *Note.* All the reported percentages are weighted while the frequencies are unweighted.

Strategies adopted by households to cope with shocks varied across livelihood zones (**Table 8**). By far, the most common strategy among pastoralists was selling or sending livestock in search of pasture; 92.3% and 81.9% of households reported using these strategies, respectively. Reducing food consumption, reducing non-essential household expenditures, and accessing food on credit were practiced by a majority of the households across all livelihood zones. Other reported coping strategies included taking up new or additional work and taking loans (with interest or with no interest). About one-quarter of households reported receiving money as an unconditional gift.

Table 8. Percentage distribution of households by strategies adopted to cope with shocks in the past 4 months, by livelihood zone

Coping strategy	Livelihood zone			Overall (%)
	Pastoral	Agro-pastoral	Urban/ peri-urban	
Sent livestock in search of pasture	81.9	42.1	10.4	72.5
Sold livestock	92.3	36.5	15.5	81.6
Slaughtered livestock	72.2	16.8	3.1	62.3
Reduced food consumption	81.7	88.5	53.3	79.0
Reduced nonessential household expenses	73.5	48.8	40.3	68.9
Got food on credit from a local merchant	70.0	54.7	31.8	65.3
Took up new/additional work (casual labor, wage labor)	44.4	60.7	43.1	45.0
Took out a loan (no interest) in the community (bonding)	21.4	14.8	6.5	19.5
Took out a loan (with interest) from a money-ender/mobile money	10.6	12.1	23.0	12.0
Unconditional gift of money (not remittance)	24.2	3.6	9.3	21.6

4 MATERNAL AND CHILD NUTRITION

4.1 ANTHROPOMETRY

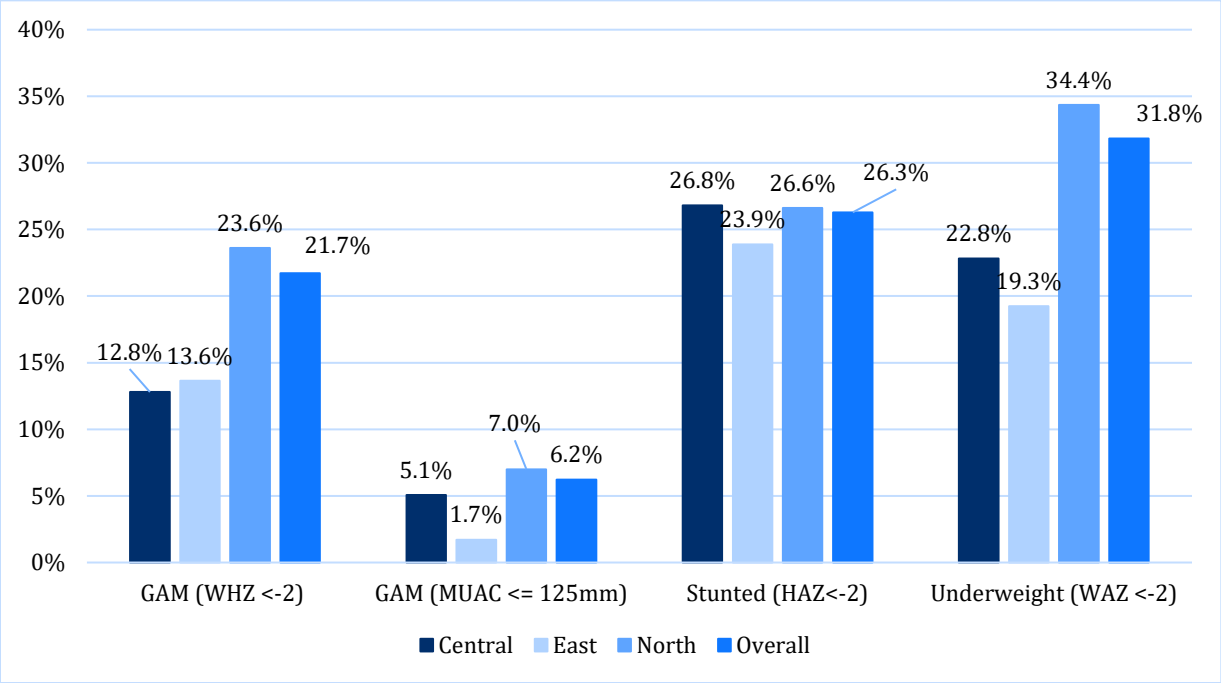
4.1.1 Prevalence of child undernutrition by survey zones

Depending on whether WHZ or MUAC was used as the indicator, the prevalence of GAM was 19.3% or 8.4%, respectively (**Figure 5**). By far, the North had the highest prevalence using either indicator (21.4% using WHZ and 9.7% using MUAC). Using WHZ, the prevalence in the other two survey zones was just over 10%. In contrast, when MUAC was used as the indicator, GAM was 7.2% and 2.5% in the Central and East, respectively. Thus, although if using WHZ the North would be declared in a nutritional emergency as the prevalence was above the threshold of 15%, it would not if MUAC was used. An emergency situation would not be triggered in either of the other two zones using either indicator.

The 2019 SMART survey reported that among children less than 5 years old, the WHZ GAM was 15.8%; whereas assessed by MUAC, it was only 3.6% [3]. Thus, similar to our findings,

prevalence rates as measured by WHZ were significantly greater than when measured by MUAC. However, compared to the 2019 survey, the prevalence rates reported on our survey were greater. The SMART survey does not report prevalence rates by survey zone, so it is not possible to compare findings across the two surveys.

Figure 5. Prevalence of malnutrition among children 0–35 months, by survey zone

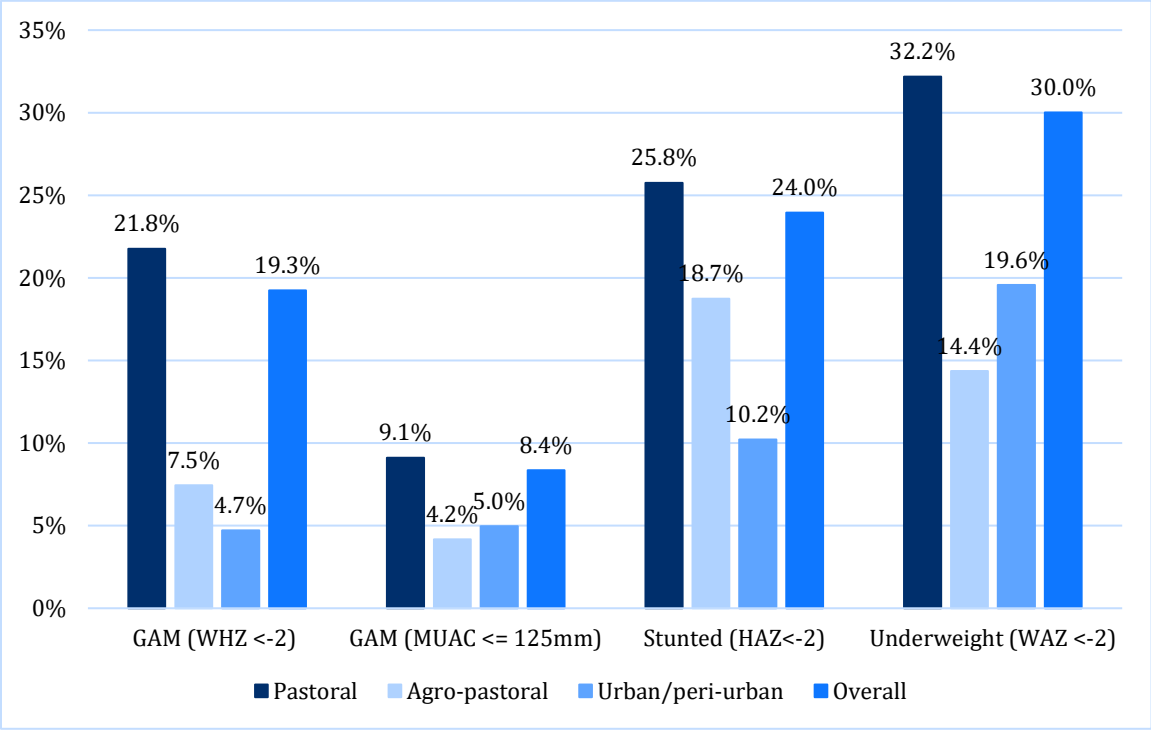


4.1.2 Prevalence of child malnutrition by livelihood zone

Analysis by livelihood zones suggested that GAM was highly prevalent in the pastoral livelihood zone (23.9%) relative to the agro-pastoral livelihood zone (8.6%) and urban/peri-urban livelihood zone (5.7%) (**Figure 6**). When MUAC was used as the indicator, GAM incidence was reduced to 6.2%, and highest among pastoralists. Thus, the high prevalence of acute malnutrition in the country was primarily driven by the very high rates among pastoralists.

Consistent with our findings, the prevalence of GAM when assessed by WHZ is often greater compared to assessment by MUAC. An analysis of 733 population-representative surveys from 41 countries assessed the correlation between WHZ < –2 and MUAC < 125 mm among children 6–59 months and found that the prevalence of GAM was 10.5% and 6.7% when WHZ and MUAC were used, respectively [11]. However, another study that used 1,832 population-representative surveys from 47 countries found that both the magnitude and direction of the discrepancy between the two indicators varied among countries [12]. In some countries, more children were classified with GAM by MUAC, whereas in others nearly all children were diagnosed by WHZ alone. The authors of this study concluded that the two indicators are complementary and should be used independently to guide admission for treatment.

Figure 6. Prevalence of malnutrition among children 0–35 months, by livelihood zone



4.1.3 Prevalence of undernutrition by child's age and sex

Analysis by child age showed that when assessed by WHZ, GAM was almost evenly distributed across age groups, with children less than 12 months having a rate of about 18% and older children a rate of about 20%, a difference of only 2 percentage points (**Figure 7**). In contrast, when assessed by MUAC, the prevalence of GAM was highest among infants 0–5 months (10.8%) followed by children 24–35 months (9.1%). Prevalence rates by child sex were not reported in the 2019 SMART survey and so cannot be compared to our results.

Figure 7. Prevalence of malnutrition among children 0–35 months, by child's age

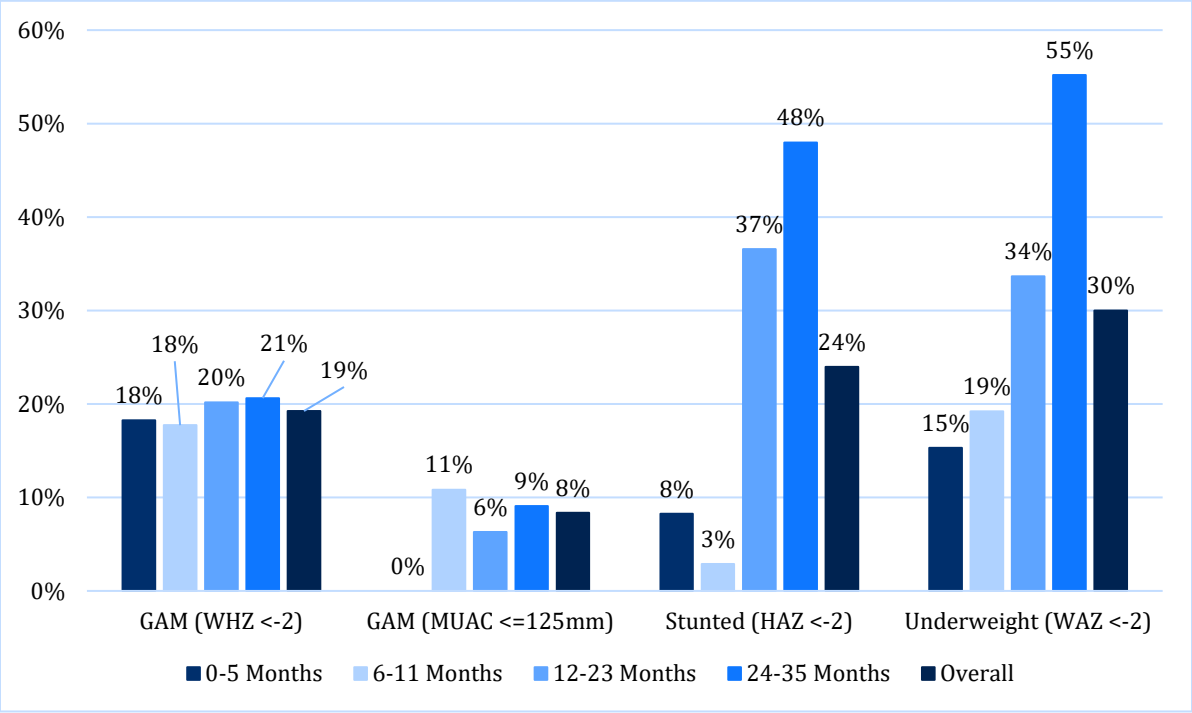
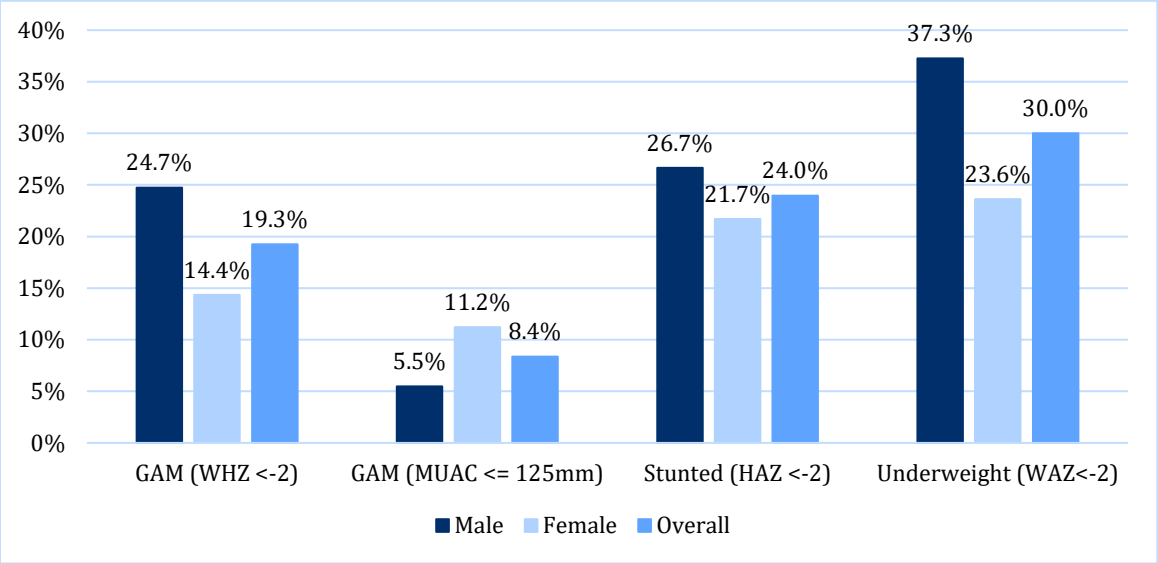


Figure 8 presents the analysis by the child's sex. The results showed that whether one sex or the other suffered more from GAM depended on the indicator used. Using WHZ, about 25% of boys versus 14.4% of girls had GAM. However, using MUAC, girls had higher rates of GAM (11.2%) than boys (5.5%). The 2019 SMART survey did not show a sex-specific difference in GAM as assessed by WHZ and only a one percentage point difference when assessed by MUAC [3]. The finding that boys were 10 percentage points more likely to suffer from GAM than girls using WHZ but 5 percentage points less likely to suffer from GAM using MUAC is difficult to explain. An analysis of four Demographic and Health (DHS) surveys conducted between 1993 and 2008-2009 reported at the national level no sex-specific differences using WHZ among children 6-59 months for three surveys [13]. However, the 2008-2009 survey showed that males were significantly more likely to have acute malnutrition than girls. The most recent Kenya DHS survey, showed nationally that 4.4% of boys and 3.7% of girls less than 59 months were acutely malnourished when assessed using WHZ [14]. The DHS surveys do not report sex-specific differences by region. Several studies, including one for Sub-Saharan countries only, found acute malnutrition higher among boys when WHZ was used [15, 16].

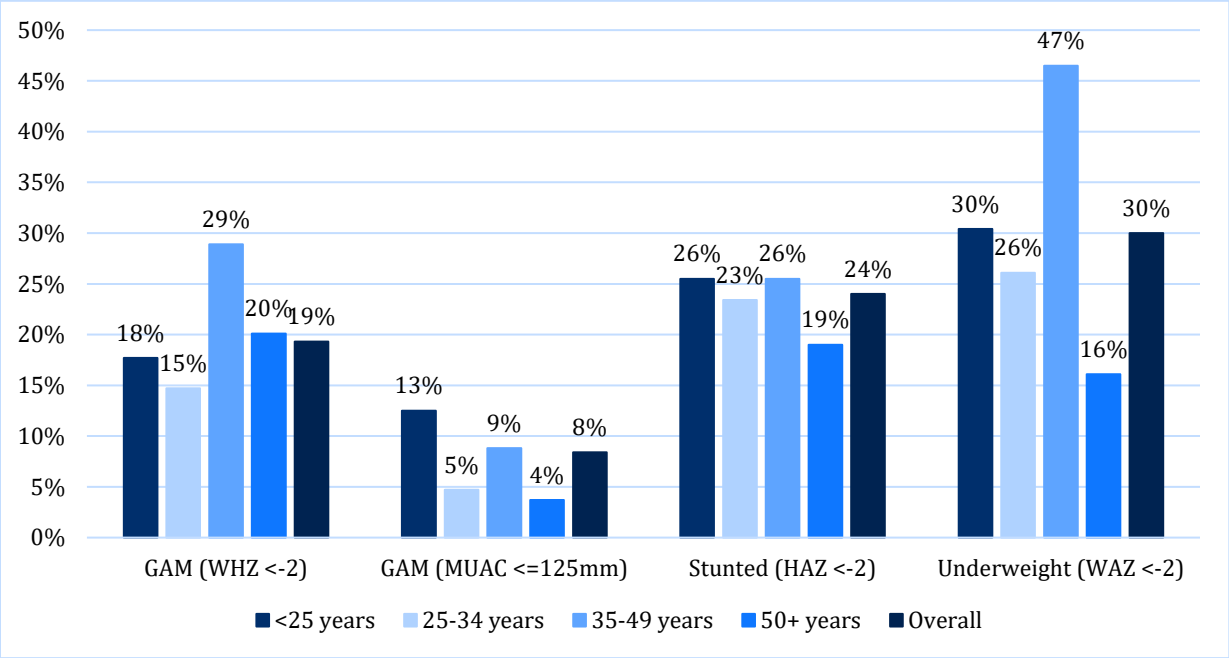
Figure 8. Prevalence of malnutrition among children aged 0–35 months, by child's sex



4.1.4 Prevalence of child malnutrition by mothers' or caregivers' age

Figure 9 presents the results of the prevalence of child undernutrition by mother's or caregiver's age. When assessed by WHZ, the highest prevalence was among children of mothers or caregivers aged 35-49 years old (29%), while the prevalence ranged from 15% to 20% among the other age groups. Prevalence rates when MUAC was used differed markedly. Using this indicator, GAM was highest among children of caregivers younger than 25 years old (13%), followed by children of caregivers 35–49 years old (9%). The 2019 SMART survey did not report on the prevalence of undernutrition by age of mother or caregiver and cannot be compared to our survey data.

Figure 9. Prevalence of childhood malnutrition, by mothers' or caregivers' age



4.1.5 Prevalence of child malnutrition by other maternal and household sociodemographic factors

Results from the chi-square analysis, when GAM is assessed by WHZ (**Table 9**), show the following:

- Children of pastoralists were significantly more likely to be underweight and to suffer from GAM compared to children in the other two livelihood zones.
- Children in the North were significantly more likely to be underweight and marginally more likely (p = .05) to suffer from GAM compared to children in the other two livelihood zones.
- Boys were also marginally more likely to suffer from underweight (p = .07) and GAM (p = .060) compared to girls.
- Children younger than 12 months were significantly less likely to suffer from stunting and underweight, but not GAM, compared to older children.
- Children of mothers or caregivers with no education were significantly more likely to suffer from GAM compared to children of those with primary or more education.
- Children of mothers or caregivers who were underweight were also significantly more likely to suffer from underweight and GAM compared to children of those who were of normal weight or obese.
- Children in households with livestock or poultry were also significantly less likely to suffer from stunting and GAM compared to children in households without livestock/poultry.

- Mother or caregiver characteristics were not associated with any indicator of undernutrition, including mother or caregiver age, polygamous marriage, mother or caregiver dietary diversity, and water and food insecurity.

Table 9. Prevalence of acute malnutrition by children, maternal and household socio-demographic factors

Characteristic	Stunted (HAZ <-2)		Number of children	Underweight (WAZ <-2)		Number of children	Wasted (WHZ <-2)		Number of children
	(%)	p-value[a]		(%)	p-value[a]		(%)	p-value[a]	
Livelihood Zone									
Pastoral	25.8	0.113	360	32.2	0.006	362	21.8	0.028	358
Agro-Pastrol	18.7		128	14.4		127	7.5		127
Urban/Peri-Urban	10.2		97	19.6		99	4.7		98
Survey Zone									
Central	23.1	0.945	291	18.6	0.001	292	11.9	0.051	291
East	23.6		143	17.4		143	11.1		142
North	24.1		151	33.2		153	21.4		150
Child gender									
Male	26.6	0.384	294	37.3	0.069	295	24.7	0.060	293
Female	21.7		291	23.6		293	14.4		290
Child Age									
0-5	8.2	<0.001	122	15.3	<0.001	122	18.2	0.974	117
6-11	2.9		127	19.2		128	17.7		128
12-23	36.6		203	33.7		202	20.2		202
24-35	48.0		133	55.2		136	20.6		136
Exclusively breastfed (0-6 months)									
No	13.5	0.261	50	16.4	0.832	50	16.1	0.747	48
Yes	4.4		72	14.5		72	19.7		69
Child age 6-23 months with minimum dietary diversity, 4 out of 7 food groups									
No	20.8	0.051	293	26.3	0.256	294	19.1	0.182	294
Yes	52.6		37	47.8		36	20.8		36

Characteristic	Stunted (HAZ <-2)		Number of children	Underweight (WAZ <-2)		Number of children	Wasted (WHZ <-2)		Number of children
	(%)	p-value[a]		(%)	p-value[a]		(%)	p-value[a]	
Caregiver Age									
<25	25.5	0.875	240	30.4	0.101	241	17.7	0.441	239
25-29	23.4		136	26.1		136	14.7		135
30-34	25.5		122	46.5		124	28.9		123
35+	19.0		87	16.1		87	20.1		86
Caregiver education									
No Education	24.6	0.369	389	31.2	0.093	390	22.4	0.003	385
Primary	25.4		143	31.4		144	7.8		144
Secondary+	6.1		53	2.9		54	1.1		54
Parity									
1-2	15.8	<0.001	223	23.9	0.284	225	20.4	0.068	223
3-5	38.8		217	36.4		217	10.3		215
6+	15.5		133	30.6		134	29.7		133
Polygamous Marriage									
No	25.4	0.396	430	32.2	0.464	432	21.1	0.476	429
Yes	21.1		155	25.5		156	15.5		154
Caregiver nutrition status (Non-pregnant)									
Normal	21.7	0.573	235	23.1	0.050	237	16.4	0.021	235
Underweight	22.9		262	35.4		264	21.9		262
Overweight or obese	6.4		42	1.9		41	1.2		40
Caregiver achieved minimum dietary diversity (15-49 years)									
No	24.6	0.151	518	31.4	0.069	522	20.1	0.247	518
Yes	11.1		59	12.7		58	9.5		57
Gender of the household head									

Characteristic	Stunted (HAZ <-2)		Number of children	Underweight (WAZ <-2)		Number of children	Wasted (WHZ <-2)		Number of children
	(%)	p-value[a]		(%)	p-value[a]		(%)	p-value[a]	
Male	24.3	0.781	497	28.8	0.384	499	19.2	0.955	494
Female	22.1		88	37.1		89	19.6		89
Household currently owns any livestock or poultry									
No	11.4	0.050	86	18.7	0.115	88	4.8	0.008	87
Yes	25.6		499	31.7		500	21.4		496
Household shocks experience									
Did not experince ANY shock	10.5	0.158	18	58.0	0.021	19	35.1	0.348	19
Yes	24.7		567	28.2		569	18.2		564
Household food insecurity									
Minimal/No	24.2	0.949	16	9.5	0.639	16	0.0	0.589	16
Moderate	25.3		84	30.1		84	19.4		84
Severe	23.9		485	30.2		488	19.4		483
Household water insecurity									
No	27.3	0.422	215	28.5	0.688	217	14.6	0.223	217
Yes	22.6		370	30.6		371	21.2		366

Note: The totals may vary due to different sample sizes of disaggregate variables or missing information
[a]The p-value from the test of independence between two categorical variables.

4.2 CHILD BREASTFEEDING AND COMPLEMENTARY FEEDING PRACTICES

The baseline findings show that breastfeeding practices were fairly good, though could be improved (**Table 10**). Slightly more than 85% of newborns initiated breastfeeding within the first hour of life, and more than 95% received colostrum. Exclusive breastfeeding for the recommended 6 months was lower (58.2%), though some interesting patterns emerged. It was highest among urban/peri-urban dwellers (88.9%) and lowest among pastoralists (55.8%). It was also lowest among mothers and caregivers less than 25 years old (44.7%). More than 95% of children between 12 and 15 months old continued to be breastfed, which is important as during this period breast milk continues to contribute substantially to intake of energy, high-quality fats, and key vitamins and minerals [17]. Breast milk also continues to provide immune protection. About a quarter of children were reported to have been fed something in a bottle, with 46.3% of urban/peri-urban dwellers reporting this practice. Bottle feeding was most common among mothers and caregivers less than 25 years old (31.3%). It was also about twice as high among mothers and caregivers with some education compared those with none. Our survey showed a lower prevalence of exclusive breastfeeding compared to the 2018 KAP survey (58% versus 78%), though the proportion of mothers reporting continued breastfeeding was higher in our survey than the KAP survey (95% versus 85%) [18]. Both surveys showed that about one in four children consumed something in a bottle the previous day.

Only two-thirds of infants, 6–8 months, were reported as having received a complementary food the day before the survey, illustrating a problem with timely initiation of complementary feeding (**Table 10**). The proportion of infants receiving a complementary food was highest among agro-pastoralists (83.1%), followed by urban/peri-urban dwellers (77.1%) and pastoralists (64.1%). It was highest among children of mothers and caregivers 30 to 34 years compared to children of mothers and caregivers in the other age groups. With respect to other mother and caregiver or household characteristics, timely complementary feeding tended to follow indicators of socioeconomic status with lower percentages among poorer and less educated mothers and caregivers.

Less than 8% of children 6–23 months met the MDD cutoff value (defined as receiving foods from at least four out of seven food groups the day before the survey), with the highest percentage in children of urban/semi-urban dwellers (14.9%) and children of mothers or caregivers younger than 25. Similar to the indicator for timely complementary feeding, MDD tended to follow indicators of socioeconomic status with lower percentages among poorer and less educated caregivers, among households in the lowest wealth quintile compared to higher wealth quintiles, and with severe food insecurity compared to households with minimal or moderate food insecurity. Minimum meal frequency (MMF) was low; only about 32% of children were fed at least two meals per day of complementary foods with rankings among mother or caregiver/household characteristics similar to that of MDD. Only about 17% and 9% of children received a vitamin-A rich food and iron-rich food, respectively.

With respect to MMF, both our survey and the 2018 KAP survey showed similar results [18]. However, the results with respect to MDD were strikingly different, with our survey and the KAP survey reporting figures of 8% and 60%, respectively.

Table 10. Percentage distribution of IYCF practices

Characteristic	Breast-feeding initiation 1 hour after birth	Feeding of colostrum	Currently breast-feeding	Exclusive breast-feeding (0–5 months)	Complementary feeding (6–8 months)	Complementary feeding (6–23 months)	Continued breast-feeding (12–15 months)	Minimum dietary diversity (6–23 months)	Minimum meal frequency (6–23 months)	Minimum acceptable diet (6–23 months)	Consumed vitamin A foods (6–23 months)	Consumed iron-rich food (6–23 months)	Bottle feeding with a nipple in the past 24 hours
Overall averages	**85.5**	**96.2**	**73.6**	**58.2**	**66.4**	**83.3**	**95.3**	**7.8**	**32.1**	**6.4**	**16.9**	**8.5**	**24.7**
Livelihood zone													
Pastoral	85.5	95.7	75.8	55.8	64.1	81.6	95.2	7.1	28.4	5.8	12.3	7.5	20.5
Agro-pastoral	84.7	97.4	76.6	60.6	83.1	92.7	97.5	4.8	59.9	2.3	63.7	6.3	52.6
Urban/ peri-urban	86.8	99.2	54.4	88.9	77.1	91.1	93.9	14.9	44.1	12.8	26.8	17.0	46.3
Mother or caregiver age													
<25 years	84.3	93.7	78.0	44.7	64.7	82.8	95.5	13.2	38.1	12.5	23.8	14.5	31.3
25–29 years	82.1	98.9	68.4	74.8	62.1	72.7	97.4	2.2	14.2	1.3	4.6	2.8	19.8
30–34 years	93.7	94.9	74.3	68.7	78.9	99.8	96.5	7.9	49.2	2.8	31.7	7.9	20.6
35+ years	87.1	99.3	71.1	55.6	63.8	89.7	79.1	1.1	30.7	0.7	2.5	0.9	21.5
Mother or caregiver education													
No education	83.9	95.7	76.3	60.8	64.0	80.2	95.8	3.6	27.8	3.1	10.2	5.3	20.8
Primary	94.1	97.5	62.7	42.1	74.6	95.9	92.4	25.5	50.4	22.5	38.3	16.3	42.6
Secondary +	89.8	100.0	60.5	57.8	83.2	100.0	100.0	28.7	51.4	14.2	73.1	42.8	37.5
Wealth quintile													
Lowest	71.4	98.1	83.3	42.3	58.3	76.2	95.8	6.5	31.9	3.9	19.9	10.0	39.8
Second	95.7	99.0	60.6	71.2	80.2	92.8	98.9	7.8	32.2	7.0	17.7	15.2	17.2
Middle	94.2	99.1	80.5	65.8	65.3	80.7	94.9	1.7	21.3	0.4	12.2	1.7	26.2
Fourth	64.8	81.2	61.5	49.9	57.6	79.4	85.1	2.1	31.8	0.9	6.0	3.1	16.5
Highest	95.1	97.4	78.7	60.8	66.5	88.1	100.0	26.2	53.2	25.4	28.3	12.5	19.6

Characteristic	Breast-feeding initiation 1 hour after birth	Feeding of colostrum	Currently breast-feeding	Exclusive breast-feeding (0–5 months)	Complementary feeding (6–8 months)	Complementary feeding (6–23 months)	Continued breast-feeding (12–15 months)	Minimum dietary diversity (6–23 months)	Minimum meal frequency (6–23 months)	Minimum acceptable diet (6–23 months)	Consumed vitamin A foods (6–23 months)	Consumed iron-rich food (6–23 months)	Bottle feeding with a nipple in the past 24 hours
Household food insecurity													
Minimal/ none	84.4	91.7	54.0	11.7	59.1	100.0	100.0	76.1	76.7	72.0	80.7	76.1	28.1
Moderate	97.2	97.0	65.9	45.6	86.0	98.4	95.6	53.3	48.2	41.6	66.5	25.6	29.6
Severe	84.7	96.2	74.4	59.6	65.0	82.0	95.2	3.7	30.5	3.1	12.6	6.7	24.3
Household shocks experience													
Did not experience any shock	100.0	97.7	62.6	94.9	71.2	100.0	100.0	0.7	55.7	0.0	2.5	0.0	0.4
Yes	84.8	96.1	74.4	55.5	66.1	82.7	95.3	8.1	31.1	6.7	17.6	8.9	26.3

Our survey found that that children consumed predominantly dairy products (79.3%), followed by grains, roots, and tubers (71.0%), and vitamin A rich fruits and vegetables and legumes and nuts (about 12%) (**Table 11**). Flesh foods and eggs were rarely consumed. Children of pastoralists were more likely to consume dairy products than children of urban/peri-urban dwellers (80.6% vs 65.2%), but less likely to consume grains, roots, and tubers. Interestingly, 62.3% of children of agro-pastoralists consumed vitamin A-rich foods compared to less than 15% among children in other livelihood zones. Consumption of other fruits and vegetables was high in urban/peri-urban settings compared to the other two livelihood zones. The 2018 KAP survey also reported high consumption of dairy products and cereals, but far higher consumption of eggs (36%) and flesh foods (42%) [18]. The reasons for the many widely divergent findings between the two surveys merits further investigation; however, one explanation is that it is due to a rapidly deteriorating situation related to food security.

Table 11. Mean and percentage distribution of food groups consumed by children 6–23 months of age in the previous day and MDD

Food group	Livelihood zones (%)			Overall (%) (*N* = 332)
	Pastoral (*n* = 198)	Agro-pastoral (*n* = 72)	Urban/peri-urban (*n* = 62)	
Dairy[a]	80.6	87.3	65.2	79.3
Grains, roots, and tubers	68.4	83.1	83.5	71.0
Vitamin A-rich fruits and vegetables	7.7	62.3	14.4	11.7
Other fruits and vegetables	2.6	1.1	58.7	9.0
Eggs	2.5	4.2	3.5	2.7
Flesh foods[b]	5.1	4.0	16.2	6.3
Legumes and nuts	12.9	7.6	10.5	12.3
Mean of consumed food group	1.8	2.5	2.52	2.16
MDD (4 out of 7 food groups)	7.1	4.8	14.9	7.8

[a] Dairy includes cheese, yogurt, milk, and other milk products.
[b] Flesh foods include red meat, poultry, fish, and organ meat.

4.3 PREVALENCE OF EACH MATERNAL NUTRITIONAL STATUS, BY SURVEY AND LIVELIHOOD ZONE

Overall, just over 50% of nonpregnant mothers or caregivers were underweight (**Figure 10**) and slightly higher in the North compared to the Central and East survey zones. Surprisingly, about 10% of women in the Central and East livelihood zones were overweight or obese. Among pregnant women, 37% were underweight as assessed by MUAC, well in excess of the 11% prevalence reported in the 2019 SMART survey for pregnant and lactating women [3]. Analysis by livelihood zone suggests that 6 out of every 10 mothers or caregivers in the agro-pastoral zone were underweight, while 5 out of every 10 mothers or caregivers in the pastoral zone were underweight (**Figure 11**). Assessed by MUAC, 4 out of every 10 pregnant mothers or caregivers in the pastoral zone were underweight. Slightly less than 11% of pregnant mothers or caregivers

were underweight in the agro-pastoral zone, while none were underweight in urban/peri-urban areas.

Analysis of underweight by mother or caregiver age showed that almost 6 out of every 10 less than 25 years were underweight, while 5 out of every 10 of those 25–39 years were underweight (

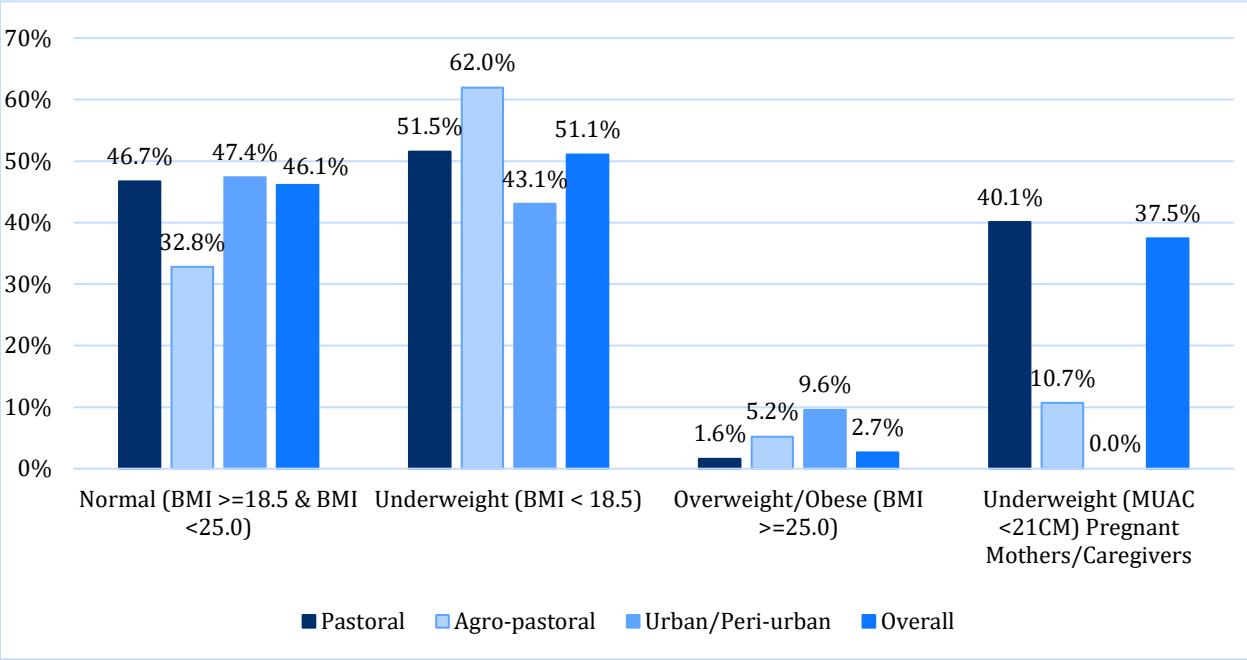


Figure 12). Among older mothers, 4 out of every 10 were underweight. Virtually no women were classified as having short stature (height < 145 cm), a finding similar to that reported in the 2014 Kenya DHS for the North Eastern region (data not shown) [14].

Figure 10. Prevalence of mothers' or caregivers' undernutrition and overweight/obesity, by survey zone

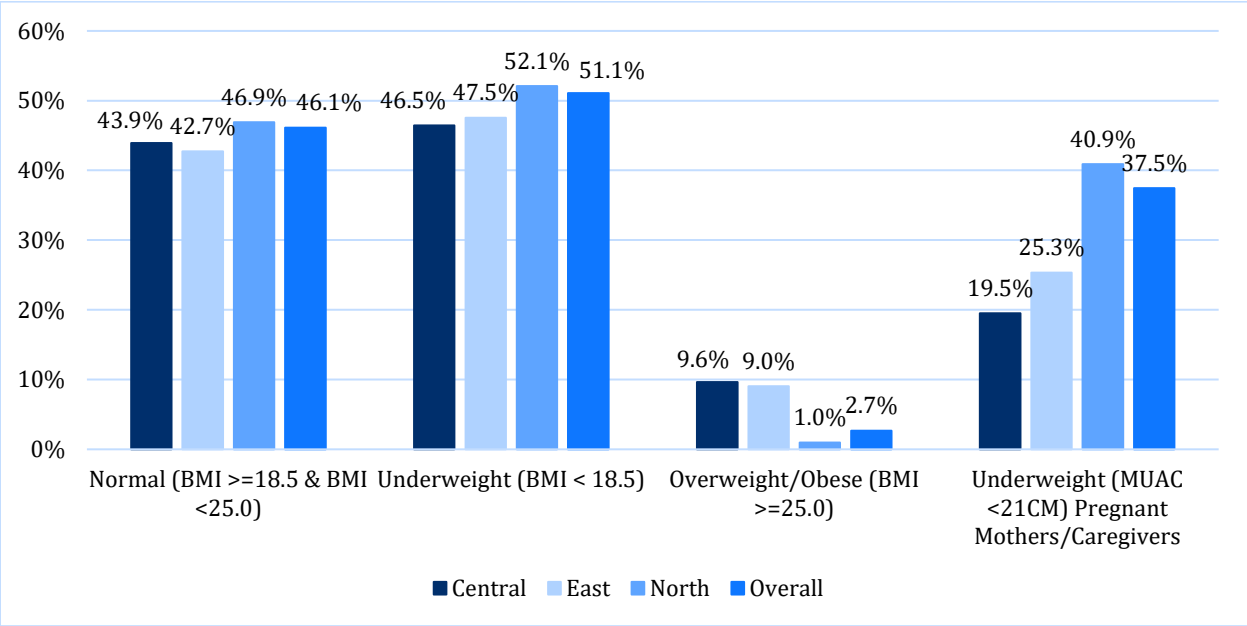


Figure 11. Prevalence of mothers' or caregivers' undernutrition and overweight/obesity, by livelihood zone

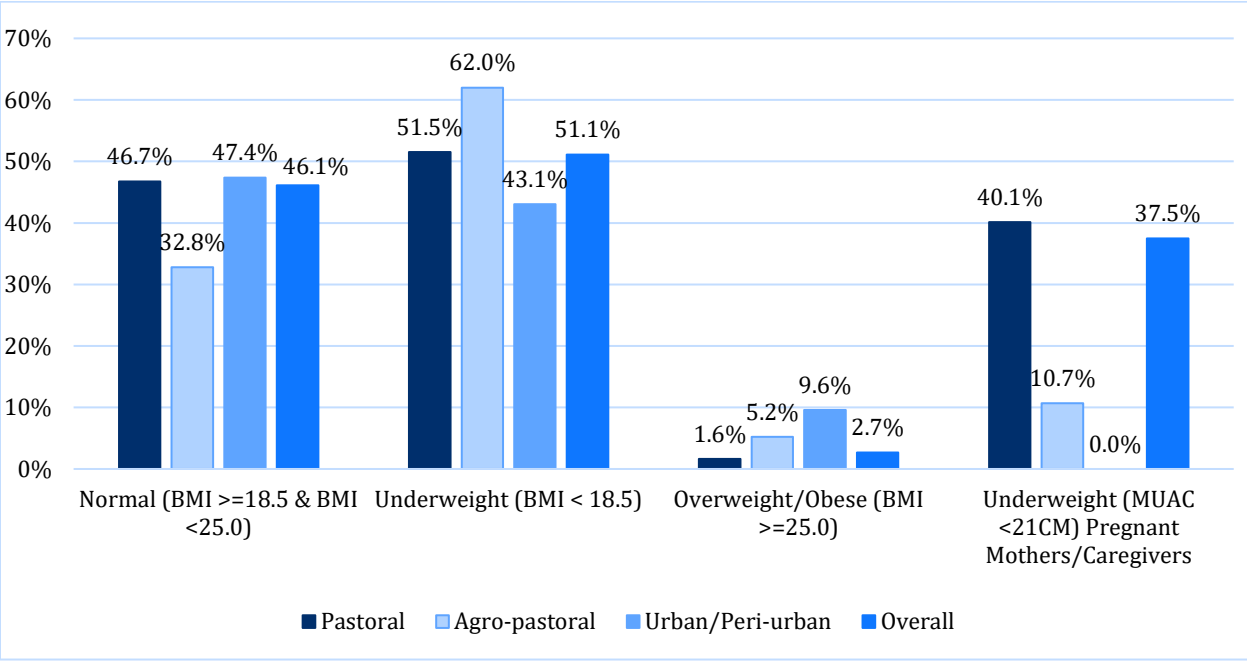
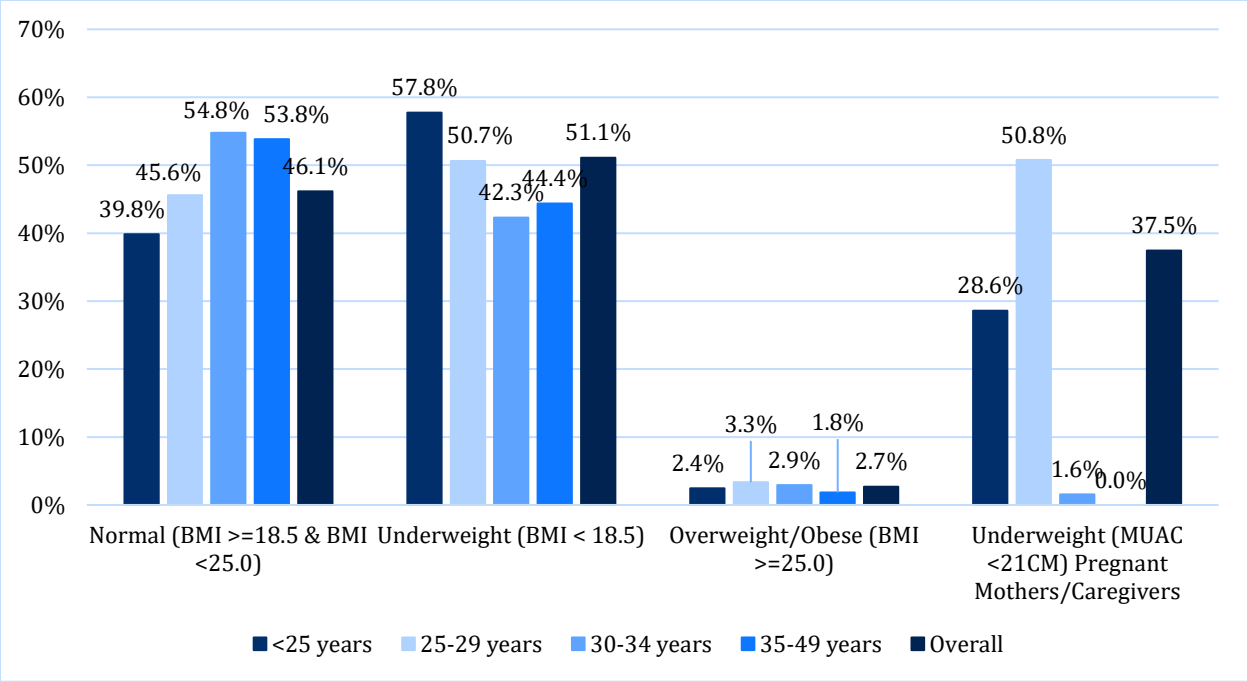


Figure 12. Prevalence of undernutrition and overweight/obesity, by mothers' or caregivers' age



4.4 MATERNAL DIETARY DIVERSITY

Food consumption among mothers or caregivers was dominated by grains, white roots and tubers, and plantains (97.7%), followed by dairy (59.1%) (**Table 12**). The next most consumed food group was pulses (40.9%). About 15% consumed other vegetables (defined as other vitamin A-rich vegetables and dark-green leafy vegetables) and flesh foods. Eggs were consumed by less than 5%. The MDD-W was only 5.8% and was highest among agro-pastoralists (12.1%), followed by urban/peri-urban dwellers (8.6%), and pastoralists (5.1%).

Not surprisingly, consumption of dairy was about twice as high among mothers or caregivers in pastoralist zones compared to those in the other livelihood zones. Consumption of pulses was also higher among pastoralists, whereas flesh foods were more highly consumed by mothers or caregivers in the agro-pastoral and urban/peri-urban zones.

Comparing mother or caregiver and child intake of food groups by livelihood zone revealed some interesting findings with respect to the consumption of highly nutritious foods. Among pastoralists, pulses, nuts, and seeds were consumed by about 45% of mothers or caregivers, but by only 13% of children, and flesh foods were consumed by about 12% of mothers or caregivers, but only 5% of children. Among agro-pastoralists, pulses, nuts, and seeds were consumed by 29% of mothers or caregivers but only 8% of children, and flesh foods were consumed by 36% of caregivers but only 4% of children. Among urban/peri-urban dwellers, pulses, nuts, and seeds were consumed by 27% of caregivers but only 11% of children, and flesh foods were consumed by 23% of mothers or caregivers but only 16% of children. The fact that mothers or caregivers were consuming these foods indicates their availability in the household and, pending a better understanding of why they were not given to children, that they might be candidate foods to promote for child feeding through social behavior change communication.

Table 12. Mean and percentage distribution of food groups consumed by women of reproductive age in the previous day and MDD-W

Food	Livelihood zone			Overall (*n* = 586)
	Pastoral (*n* = 360)	Agro-pastoral (*n* = 12)	Urban/peri-urban (*n* = 101)	
Grains, white roots and tubers, and plantains	97.4	98.5	99.7	97.7
Pulses	43.9	27.1	22.4	40.9
Nuts and seeds	0.5	1.5	4.4	1.0
Dairy	64.3	34.1	28.5	59.1
Meat, poultry, and fish	11.9	36.2	23.0	14.2
Eggs	4.4	8.2	3.8	4.5
Dark-green leafy vegetables	8.0	32.8	37.9	12.3
Other vitamin A-rich vegetables	1.5	8.1	20.5	3.8
Other vegetables	12.8	25.8	25.8	14.8
Other fruits	1.2	32.7	14.2	4.0
Mean of food groups consumed	2.5	3.1	2.8	2.7
MDD-W	5.1	12.1	8.6	5.8

4.5 CHILD MORBIDITY AND HOUSEHOLD CARE-SEEKING BEHAVIORS

The baseline findings indicate a high prevalence of common childhood illnesses (62.6%) in the last 2 weeks preceding the survey; 41.1% had a cough with difficulty in breathing; 29.3% had a fever, and 30.8% had diarrhea (**Table 13**). The prevalence of cough was higher in the urban/peri-urban (40.9%) and pastoral (40.1%) livelihood zones relative to the agro-pastoral livelihood zone. The prevalence of fever was the highest in pastoral zone (31.8%) relative to agro-pastoral (16.0%) and urban/peri-urban (14.3%) zones. The prevalence of diarrhea was 32.9%, 23.7%, and 16.9% in pastoral, agro-pastoral, and urban/peri-urban livelihood zones, respectively. In general, infants less than 6 months old had a lower prevalence of illness compared to older children and children 6–11 months old had a higher prevalence of illness compared to the other age groups. Care seeking for any illness was in excess of 50% and, except for child age did not vary by other characteristics. With respect to child age, care seeking was lowest for infants less than 6 months and highest for children 24–35 months.

Table 13. Child morbidity and health seeking behavior according to livelihood zones and background characteristics

Characteristics	Any of the illness in the past 2 weeks before survey			Type of illness in the past 2 weeks before survey					Sought treatment from health facility for ANY illness		
	(%)	p-value	Number of Children	Cough	Cough + Difficulty in breathing	Fever	Diarrhea	Diarrhea + Bloody stains	(%)	p-value[a]	Number of Children
Livelihood Zone											
Pastoral	64.7	0.110	364	40.1	42.8	31.8	32.9	4.9	59.6	0.242	207
Agro-Pastrol	42.6		129	14.7	42.2	16.0	23.7	5.1	72.4		73
Urban/Peri-Urban	55.3		101	40.9	27.8	14.3	16.9	3.0	35.9		52
Child Age											
0-5	51.8	0.016	125	35.6	22.2	16.6	27.3	0.0	43.5	0.031	57
6-11	81.5		128	51.6	58.3	35.3	41.3	1.0	64.3		83
12-23	56.4		205	35.1	42.2	26.4	26.1	8.0	50.4		117
24-35	67.0		136	36.4	37.9	44.2	32.1	11.3	74.3		75
Child gender											
Male	61.6	0.821	297	39.1	49.1	31.1	34.3	8.1	63.9	0.195	170
Female	63.5		297	38.9	34.0	27.6	27.7	1.2	52.5		162
Caregiver Age											
<25	68.3	0.484	242	45.9	37.9	30.2	34.4	2.7	55.6	0.944	138
25-29	60.1		139	31.5	46.9	34.1	32.3	2.4	58.4		74
30-34	53.8		126	39.2	43.9	25.8	23.5	11.8	57.3		69
35+	63.0		87	34.4	38.6	21.4	27.1	10.1	63.4		51
Caregiver education											
No Education	63.8	0.433	395	40.1	43.4	32.1	33.1	4.3	59.7	0.254	229
Primary	61.5		144	39.0	29.0	17.6	17.6	13.1	52.2		83

Characteristics	Any of the illness in the past 2 weeks before survey			Type of illness in the past 2 weeks before survey					Sought treatment from health facility for ANY illness		
	(%)	p-value	Number of Children	Cough	Cough + Difficulty in breathing	Fever	Diarrhea	Diarrhea + Bloody stains	(%)	p-value[a]	Number of Children
Secondary+	44.4		55	17.1	35.3	16.1	33.6	0.0	32.9		20
Wealth quintile											
Lowest (poorest)	70.1	0.706	116	48.6	33.2	35.4	32.9	4.5	45.0	0.336	71
Second	56.7		126	39.0	50.0	34.7	26.2	5.8	58.7		65
Middle	65.3		136	36.2	39.4	25.1	37.4	4.3	64.3		80
Fourth	64.4		114	30.2	35.6	33.8	29.5	8.1	69.0		65
Highest (Richest)	54.7		102	38.4	48.1	15.6	24.1	1.7	53.6		51
Total	62.6		594	39.0	41.1	29.3	30.8	4.8	57.8		332

[a]The p-value from the test of independence between two categorical variables.

4.6 VACCINATION COVERAGE IN CHILDREN

Coverage among children aged 12–35 months was nearly universal for the Bacille Calmette-Gurin (BCG), pentavalent, polio, and pneumococcal vaccines. However, it was only between 25% and 32% for measles **(Table 14)**. Vaccination rates for all vaccines was slightly higher in agro-pastoral and urban/peri-urban zones compared to pastoral zones (30% versus 22%). The 2019 SMART survey also reported a high coverage rate for the BCG and polio vaccines [3]. Although the SMART survey reported that measles vaccine was lower than for the other two basic vaccines, it was nearly twice as high as that reported in our survey. The 2014 Kenya DHS reported that 70% of children in the North Eastern region received a measles vaccine, also well in excess of the rate reported in our survey [14]. It is not clear from the data why vaccination coverage for measles was so low compared to coverage of other vaccines, given that all require cold chains for delivery; or why coverage of the measles vaccine has dropped so precipitously compared to the rates reported in SMART surveys and Kenya DHSs.

4.7 DEWORMING AND VITAMIN A SUPPLEMENTATION COVERAGE IN CHILDREN

Table 15 shows that only 1 in 3 children between 12–35 months in pastoral and agro-pastoral livelihood zones and about 6 in 10 children in urban/peri-urban livelihood zone were given deworming tablets in the previous 6 months. Higher proportions of children 12–35 months old were given vitamin A supplementation; proportions were highest (including those taken either once or twice) in the urban/peri-urban livelihood zone. The proportions receiving deworming tablets and vitamin A supplements were higher in children of mothers or caregivers with primary or more education compared to those with no education.

Table 14. Vaccination coverage for children 12–35 months old, by livelihood zone and background characteristics

Characteristic	BCG	Pentavalent			Polio				Measles	All basic vaccinations	Pneumococcal			Fully vaccinated	No vaccinations	Number of children
		1	2	3	0	1	2	3			1	2	3			
Overall averages and totals	**98.0**	**91.0**	**88.8**	**84.9**	**80.5**	**95.9**	**91.7**	**86.4**	**26.3**	**24.1**	**92.9**	**90.4**	**84.7**	**24.1**	**1.9**	**343**
Livelihood zone																
Pastoral	97.6	88.9	86.2	81.5	76.8	94.9	89.7	83.5	25.0	22.3	91.2	88.5	81.4	22.3	2.4	202
Agro-pastoral	99.2	98.5	98.0	97.3	99.2	99.2	98.5	98.5	29.4	29.4	99.2	97.9	97.9	29.4	0.8	71
Urban/peri-urban	99.9	99.9	99.5	99.1	92.7	99.9	99.5	97.6	32.2	32.2	99.9	97.8	97.6	32.2	0.1	70
Child age (months)																
12–23	96.8	88.1	85.0	81.4	75.4	93.4	87.2	81.2	12.7	9.3	88.7	85.2	80.5	9.3	3.2	204
24–35	100.0	95.9	95.1	90.9	88.9	100.0	99.1	95.1	48.6	48.6	100.0	99.0	91.7	48.6	0.0	136
Child sex																
Male	98.1	93.4	90.9	88.8	79.5	96.1	93.6	90.6	27.6	27.3	96.1	93.6	88.2	27.3	1.9	173
Female	98.0	88.6	86.6	81.0	81.5	95.7	89.6	82.2	24.9	20.9	89.7	87.1	81.2	20.9	2.0	170
Mother or caregiver age (years)																
< 24	100.0	87.4	83.8	78.3	78.3	100.0	90.8	82.7	20.3	14.8	91.8	87.3	78.5	14.8	0.0	125
25–29	95.6	91.0	90.0	87.5	68.3	92.2	91.2	87.0	40.5	39.9	92.2	91.2	86.2	39.9	4.4	74
30–34	97.0	92.3	89.2	86.9	92.1	92.3	89.3	87.0	16.1	16.1	92.3	89.3	87.0	16.1	3.0	84
35+	99.6	98.5	98.5	93.8	94.1	98.5	98.5	93.8	26.9	26.9	98.5	98.5	93.8	26.9	0.4	60
Mother or caregiver highest education																
No education	97.4	88.6	85.7	80.9	76.4	94.5	89.0	82.7	25.3	22.4	90.6	87.7	80.5	22.4	2.6	224
Primary	100.0	98.1	97.8	96.9	91.2	100.0	99.7	97.5	27.5	27.5	100.0	98.4	97.5	27.5	0.0	87
Secondary+	100.0	100.0	100.0	98.7	100.0	100.0	100.0	99.4	35.4	35.4	100.0	99.2	98.7	35.4	0.0	32

Characteristic	BCG	Pentavalent			Polio				Measles	All basic vaccinations	Pneumococcal			Fully vaccinated	No vaccinations	Number of children
		1	2	3	0	1	2	3			1	2	3			
Wealth quintile																
Lowest	100.0	93.3	93.3	93.0	99.0	94.3	94.3	92.9	22.4	22.4	94.3	92.6	92.6	22.4	0.0	62
Second	96.6	92.7	89.4	89.2	79.2	93.3	90.1	90.0	25.5	25.5	93.3	90.1	90.0	25.5	3.4	84
Middle	97.4	94.5	89.3	77.7	64.8	97.4	92.3	77.7	22.9	22.9	94.5	89.3	77.7	22.9	2.6	72
Fourth	99.5	84.4	84.4	81.6	76.6	98.4	84.4	81.6	34.2	20.5	84.6	84.4	81.6	20.5	0.5	70
Highest	98.0	86.2	85.8	81.8	90.0	98.0	97.6	90.2	29.9	28.7	96.2	95.9	79.0	28.7	2.0	55

Note. The number of children does not add up to the totals because of children missing information.

[a] Polio 0 is the polio vaccination given at birth. The data on polio vaccination were adjusted for a likely misinterpretation of polio 0 and polio 1; for children whose mothers reported that they received three doses of pentavalent and polio 0, polio 1, and polio 2, it was assumed that polio 0 was in fact polio 1, polio 1 was polio 2, and polio 2 was polio 3.

[b] BCG, measles, and three doses each of pentavalent and polio vaccine (excluding polio vaccine given at birth).

[c] BCG, measles, three doses each of pentavalent and polio (excluding polio vaccine given at birth), and pneumococcal vaccine.

Table 15. De-worming and Vitamin A supplementation coverage in 12–35 months children, by certain background characteristics

Characteristic	Deworming for children 12-35 months				Vitamin A Supplementation							
	De-worming coverage In the last 6 months	Number of times dewormed in the last 1 year		Number of children	Vitamin-A supplemen-tation coverage for children 6 to 35 months in the last 6 months	Number of children	Number of times the children 6-11 months supplemented with vitamin-A in the last 1 year		Number of children	Number of times the children 12-35 months supplemented with vitamin-A in the last 1 year		Number of children
		Once	Twice				Once	Twice		Once	Twice	
Livelihood Zone												
Pastoral	30.1	16.8	82.3	202	34.6	272	27.6	8.0	77	38.9	33.0	202
Agro-Pastoral	30.0	16.8	83.2	71	38.5	105	33.8	27.1	32	19.2	32.3	71
Urban/Peri-Urban	64.2	55.1	44.6	70	79.6	91	48.2	38.8	19	18.7	72.5	70
Child gender												
Male	34.3	22.3	77.4	173	46.7	241	41.0	4.3	59	32.8	38.6	173
Female	35.7	22.3	76.5	170	33.4	227	18.1	16.2	69	36.8	38.5	170
Caregiver Age												
<24	29.8	20.6	79.1	125	33.2	225	25.9	12.0	60	27.5	42.9	125
25-29	40.6	27.6	72.4	74	40.8	126	34.3	1.5	32	35.0	37.5	74
30-34	40.1	23.8	76.0	84	56.8	114	32.5	3.0	23	44.4	32.6	84
35+	28.5	13.1	82.4	60	8.5	3	25.4	31.6	13	38.7	38.8	60
Caregiver education												
No Education	27.9	16.8	82.3	224	33.8	291	26.5	10.1	90	37.3	29.2	224
Primary	53.7	34.1	65.6	87	59.7	128	41.4	13.4	24	21.4	71.7	87
Secondary+	67.6	57.2	42.2	32	68.8	49	80.3	17.2	14	47.2	52.2	32

Characteristic	Deworming for children 12-35 months				Vitamin A Supplementation							
	De-worming coverage In the last 6 months	Number of times dewormed in the last 1 year		Number of children	Vitamin-A suppleme-ntation coverage for children 6 to 35 months in the last 6 months	Number of children	Number of times the children 6-11 months supplemented with vitamin-A in the last 1 year		Number of children	Number of times the children 12-35 months supplemented with vitamin-A in the last 1 year		Number of children
		Once	Twice				Once	Twice		Once	Twice	
Wealth quintile												
Lowest (poorest)	51.9	38.4	61.4	62	48.3	99	34.0	1.2	29	33.2	61.0	62
Second	36.8	21.8	78.2	84	59.9	99	59.4	35.6	22	31.5	46.1	84
Middle	29.2	10.8	86.5	72	27.8	105	15.1	13.6	35	34.6	28.0	72
Fourth	36.4	27.5	71.9	70	23.6	88	41.3	9.6	17	48.7	15.6	70
Highest (Richest)	19.6	17.7	82.3	55	32.9	77	18.8	1.0	25	30.1	36.3	55
Total	**34.9**	**22.3**	**76.9**	**343**	**39.0**	**468**	**29**	**10.5**	**128**	**34.8**	**38.6**	**343**

5 MOTHERS' AND CAREGIVERS' SOCIODEMOGRAPHIC CHARACTERISTICS, EMPOWERMENT, AND HEALTH CARE UTILIZATION

5.1 MOTHERS' AND CAREGIVERS' SOCIODEMOGRAPHIC CHARACTERISTICS

Most mothers or caregivers (39.5%) were younger than 24 years old and were married or had partners (85.8%), with one-third of them in polygamous marriages (**Table 16**). Among pastoralists, 88.2% of mothers or caregivers reported having received no education, whereas only 54.0% and 30.1% among those in agro-pastoral and urban/peri-urban zones, respectively, did. About 28.0% of mothers or caregivers had given birth six or more times, and 7% were pregnant at the time of the survey.

Table 16. Percentage distribution of mother or caregiver characteristics, by livelihood zone

Characteristic	Livelihood zone			Overall
	Pastoral	Agro-pastoral	Urban/peri-urban	
Number of respondents	**364**	**129**	**101**	**594**
Age (years)				
< 24	38.7	28.7	50.5	39.5
25–29	29.3	16.4	23.8	28.1
30–34	15.8	43.3	24.4	18.0
35+ years	16.3	11.7	1.3	14.5
Highest level of education				
No education	88.2	65.0	30.1	81.0
Primary	8.7	28.9	57.1	14.8
Secondary+	3.1	6.1	12.8	4.2
Marital status				
Married (one husband)	52.5	78.9	32.9	51.7
Married (polygamous)	36.3	12.0	15.4	33.0
Currently living together	0.7	0	5.1	1.1
Separated or divorced	1.7	3.6	5.6	2.1
Widowed	4.4	2.0	7.7	4.6
Single/Never married	4.5	3.6	33.3	7.4
Length of stay in the community (years)				
< 15	74.2	76.3	62.2	73.0
15–30	20.4	20.0	36.4	22.1
30+	5.1	3.8	1.4	4.7

Characteristic	Livelihood zone			Overall
	Pastoral	Agro-pastoral	Urban/peri-urban	
Not specified	0.3	0.0	0.0	0.2
Current pregnancy status				
Yes	7.7	3.7	3.2	7
No	92.3	96.3	96.8	93
Parity				
1–2	33.6	57.4	42.1	35.6
3–5	35.4	21.7	40.7	35.3
6+	29.9	18.1	17.1	28
Missing	1.1	2.8	0.1	1.1
Gravida				
1–2	33.6	56	41.6	35.5
3–5	34.8	21.2	28.8	33.6
6+	30.5	20	29.4	29.9
Missing	1.1	2.8	0.1	1.1

Note. Column percentages within each characteristic may not add up to 100% because of households with missing information.

5.2 MOTHERS' AND CAREGIVERS' EMPOWERMENT AND AGENCY

Women's authority to make decisions is a critical factor for child nutrition, and gender norms with respect to decision-making authority by women underpin this authority [19]. In our survey, just over 80% of married mothers or caregivers from urban/peri-urban livelihood zone made six types of decisions by themselves or jointly with their husband or partner (**Table 17**). Among pastoralists, only one-third of mothers or caregivers made these decisions, and among agro-pastoralists only just over half did. Interestingly, the level of decision-making was similar among women regardless of whether they were in a polygamous marriage. The level of decision-making among caregivers differed by some socioeconomic characteristics. Caregiver education was inversely related to decision-making authority; the more educated the mother or caregiver the lower was her reported decision-making authority. Decisions around child health and food purchases are particularly relevant as they both directly underpin child nutrition. Most caregivers reported relatively high rates of decision-making, either jointly or by themselves, for child health (87.5%) and food purchases (73.2%). Nearly 8 out of 10 caregivers reported either joint or individual authority to visit friends and relatives. The ability to visit friends and family is likely to have benefits to maternal mental health with spillover effects for child nutrition [20].

Table 17. Percentage of currently married women who usually make specific decisions either by themselves or jointly with their husband/partner, by background characteristics and livelihood zone

Characteristic	Specific decisions						All six decisions	Number of women
	Usage of household income	Child health	Woman's own health care	Food purchase	Major household purchase	Visit to her friends/ relatives		
Overall averages and totals	**48.2**	**87.5**	**90.2**	**73.2**	**59.7**	**77.9**	**37.9**	**564**
Livelihood zone								
Pastoral	44.3	86.7	89.7	71.0	56.0	77.0	33.9	348
Agro-pastoral	68.3	92.4	91.0	89.5	83.0	78.7	54.5	123
Urban/peri-urban	85.1	94.1	95.8	91.1	91.5	90.0	80.5	93
Polygamous marriage								
No	49.8	85.7	89.6	72.1	59.5	80.2	39.2	407
Yes	45.5	90.4	91.2	75.1	59.9	74.4	36.0	1.57
Mother or caregiver age (years)								
< 24	40.7	87.9	93.4	64.1	60.7	71.3	35.1	218
25–29	43.3	81.4	83.2	67.0	46.8	78.1	29.8	134
30–34	68.0	92.1	91.7	88.8	71.3	83.5	53.9	125
35+	52.5	93.0	94.0	89.9	68.2	88.0	41.9	87
Mother or caregiver highest education								
No education	44.9	87.7	89.5	72.0	56.2	77.5	34.6	389
Primary	63.9	84.0	94.6	79.6	79.1	80.1	57.5	129
Secondary+	74.0	94.4	90.8	82.9	76.0	83.5	52.0	46
Parity								
1–2	42.3	85.3	91.7	64.1	56.0	69.8	37.3	202

Characteristic	Specific decisions							Number of women
	Usage of household income	Child health	Woman's own health care	Food purchase	Major household purchase	Visit to her friends/ relatives	All six decisions	
3–5	47.5	85.4	85.0	68.4	56.4	79.4	32.4	214
6+	55.7	92.2	94.6	88.8	66.5	84.8	45.3	136
Wealth quintile								
Lowest	59.1	89.1	89.7	84.1	66.8	81.5	42.8	108
Second	67.8	82.8	88.1	75.5	72.8	82.2	58.4	121
Middle	36.4	89.9	93.6	59.8	51.8	75.5	30.0	131
Fourth	34.5	90.6	95.0	80.0	56.8	69.1	25.0	109
Highest	34.3	84.9	82.3	72.6	43.8	79.3	23.8	95

Overall, 60.1% of mothers or caregivers from the agro-pastoral livelihood zone were employed in the last 12 months, followed by women in urban/peri-urban (48.0%) and pastoral (19.0%) livelihood zones (**Table 18**). The type of mother or caregiver employment varied by livelihood zone; pastoralists were more likely to be petty traders whereas agro-pastoralists and urban/peri-urban dwellers were more likely to be employed. Most reported being paid in cash. Employment was inversely related to caregiver education. Women with no education had the lowest rates (21.2%), followed by those with primary education (30.5%), and those with secondary or more education (40.8%). To the extent that employed women have control over their earnings, it may affect child nutrition, given the established fact that women tend to spend more on household and family needs than men.

Table 18. Percentage of women who were employed at any time in the past 12 months, kind of work, and type of earnings, according to background characteristics

Characteristic	Percentage employed in the past 12 months	No. of women	Kind of work		Type of earnings			Number employed in past 12 months
			Employed	Petty trade	Cash	Cash and in-kind	In-kind/ not paid	
Overall averages and totals	**22.9**	**510**	**50.1**	**49.9**	**75.1**	**20.9**	**3.9**	**175**
Livelihood zone								
Pastoral	19.0	315	37.6	62.4	79.7	15.2	5.2	87
Agro-pastoral	60.1	114	84.4	15.6	88.1	10.9	1.0	49
Urban/peri-urban	48.0	81	83.7	16.3	37.6	61.8	0.6	39
Polygamous marriage								
No	26.0	353	53.8	46.2	69.7	25.1	5.2	128
Yes	18.1	157	41.4	58.6	87.4	11.4	1.1	47
Mother or caregiver age (years)								
< 24	16.6	203	54.2	45.8	82.9	2.9	14.2	57
25–29	15.6	124	29.4	70.6	73.3	26.7	0.0	34
30–34	34.3	115	74.7	25.3	70.3	29.4	0.3	51
35+	40.0	68	35.1	64.9	73.1	26.9	0.0	33
Mother or caregiver highest education								
No education	21.2	352	48.2	51.8	73.5	24.0	2.5	114
Primary	30.5	118	43.1	56.9	89.9	9.3	0.8	44
Secondary+	40.8	40	94.2	5.8	55.1	13.1	31.7	17
Parity								
1–2	16.2	187	76.6	23.4	78.5	6.0	15.5	52
3–5	27.6	194	47.9	52.1	71.5	27.7	0.8	71

Characteristic	Percentage employed in the past 12 months	No. of women	Kind of work		Type of earnings			Number employed in past 12 months
			Employed	Petty trade	Cash	Cash and in-kind	In-kind/ not paid	
6+	25.8	123	33.9	66.1	77.3	22.7	0.0	52
Wealth quintile								
Lowest	24.2	100	50.6	49.4	80.7	3.8	15.5	39
Second	30.1	109	49.6	50.4	74.0	26.0	0.0	33
Middle	14.9	118	60.8	39.2	72.6	27.0	0.5	37
Fourth	19.4	100	56.7	43.3	49.2	48.7	2.2	33
Highest	29.1	83	33.4	66.6	90.8	8.4	0.8	33

Regarding house ownership, 41.9%, 37.3% and 5.8% of women from urban/peri-urban, agro pastoral, and pastoral livelihood zones, respectively, did not own a house while the remaining owned it alone, jointly, or alone and jointly (**Table 19**). Land ownership also varied across livelihood zones; 83.2% of women in the pastoral zone reported not owning land, compared to just over 50% in the other two livelihood zones Ownership of these assets by women varied by different characteristics, including household wealth index.

Table 19. Percentage distribution of women's ownership of housing and land, by background characteristics and livelihood zone

Characteristic	Percentage who own a house				Percentage who own land				No. of women
	Alone	Jointly	Alone and jointly	Does not own	Alone	Jointly	Alone and jointly	Does not own	
Overall averages and totals	**34.3**	**53.1**	**2.9**	**9.7**	**5.9**	**13.0**	**1.3**	**79.8**	**510**
Livelihood zone									
Pastoral	34.7	56.7	2.8	5.8	3.0	12.4	1.4	83.2	315
Agro-pastoral	24.9	30.3	7.5	37.3	23.5	21.5	0.4	54.7	114
Urban/peri-urban	36.8	21.4	0.0	41.9	31.8	14.6	0.3	53.4	81
Polygamous marriage									
No	36.4	51.2	1.9	10.6	6.5	14.1	1.8	77.6	353
Yes	31.1	56.1	4.5	8.3	5.0	11.2	0.5	83.3	157
Mother or caregiver age (years)									
< 24	38.6	45.2	4.8	11.5	3.5	6.9	1.8	87.9	203
25–29	32.8	61.1	0.7	5.5	3.6	9.8	1.5	85.1	124
30–34	36.0	42.1	2.0	19.8	15.5	23.4	0.2	60.9	115
35+	24.2	71.4	3.4	0.9	4.9	22.3	0.9	71.9	68
Mother or caregiver highest education									
No education	36.7	53.6	2.4	7.2	5.0	12.7	0.9	81.4	352
Primary	23.7	49.3	5.7	21.3	10.5	11.1	1.4	77.0	118
Secondary+	12.1	53.5	3.8	30.6	11.8	28.2	10.2	49.7	40
Parity									
1–2	30.9	49.5	4.9	14.6	5.1	8.5	2.2	84.2	187
3–5	36.2	53.6	3.2	7.0	8.1	12.7	1.1	78.1	194
6+	35.4	56.7	0.2	7.7	4.2	19.0	0.1	76.7	123

Characteristic	Percentage who own a house				Percentage who own land				No. of women
	Alone	Jointly	Alone and jointly	Does not own	Alone	Jointly	Alone and jointly	Does not own	
Wealth quintile									
Lowest	13.3	66.1	1.1	19.5	4.1	12.9	0.2	82.8	100
Second	30.9	59.1	5.2	4.8	11.8	16.5	1.4	70.3	109
Middle	41.4	48.8	0.3	9.6	3.6	10.4	0.5	85.5	118
Fourth	61.4	24.5	9.3	4.8	7.1	9.0	2.7	81.2	100
Highest	30.9	61.0	0.0	8.0	2.0	16.8	3.0	78.2	83

5.3 USE OF SERVICES DURING PREGNANCY, DELIVERY, AND POSTNATAL PERIOD

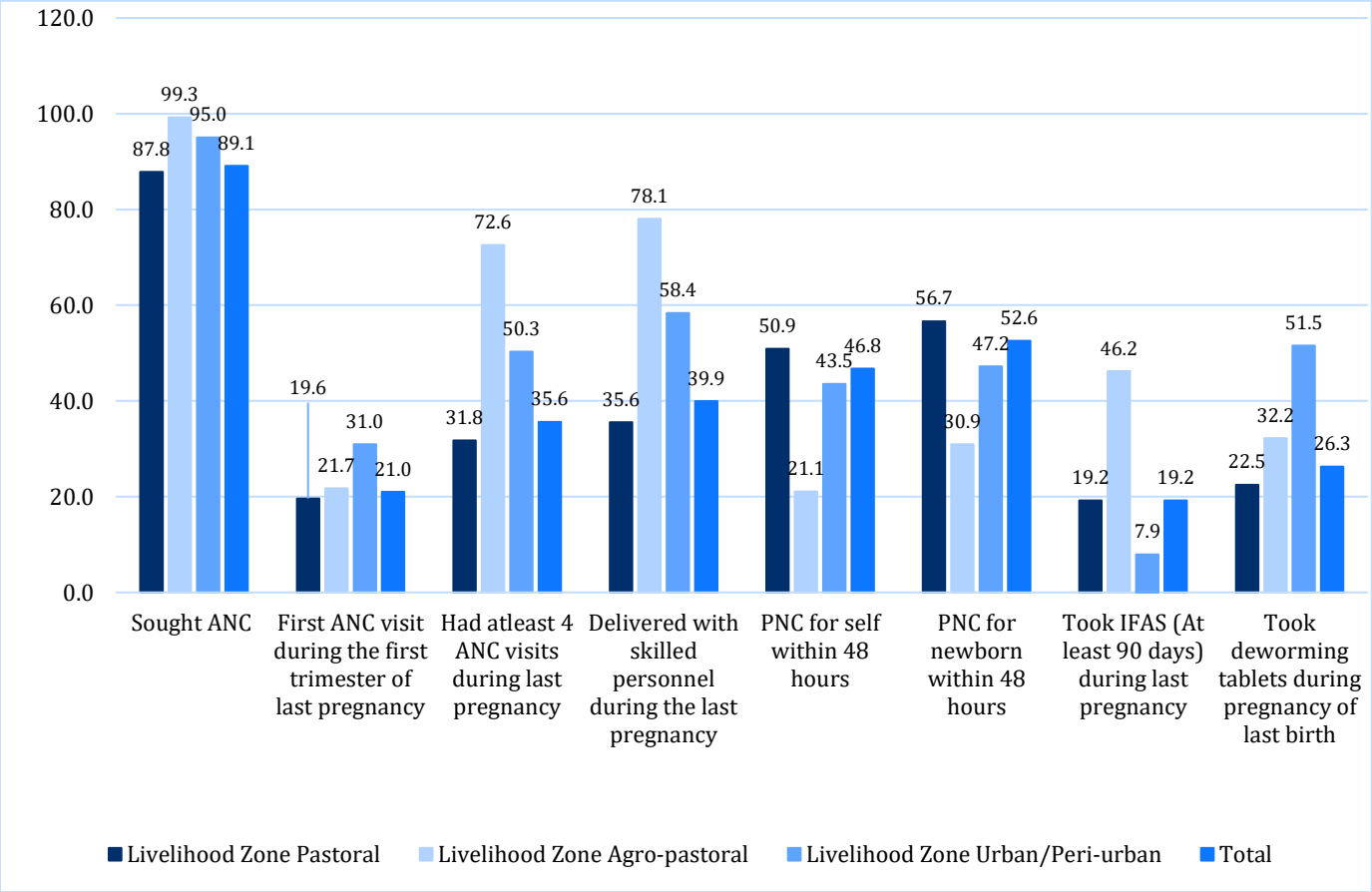
Nearly 9 out of 10 women reported seeking antenatal care during their last pregnancy (**Figure 13).** However, just over one-third reported receiving the recommended four visits, with the lowest percentage among pastoralists (19.6%), followed by urban/peri-urban dwellers (50.3%), and agro-pastoralists (72.6%). These numbers are not dissimilar to those reported in the 2018 KAP survey, where 85% of women reported attending at least one antenatal care visit [18]. However, the number receiving four or more visits was about 50%, higher than found in our survey. According to the KAP survey, the factors that discouraged antenatal care attendance included:

- High maternal workload, which included attending to livestock and fetching water and firewood.
- Discomfort in being by attended to by male health workers.
- Mandatory HIV testing.
- Availability and preferred use of traditional birth attendants.
- Some husbands who refused their wives attendance.

Our survey showed that just short of 40% of women reported delivering with a skilled birth attendant, with the lowest percentage among pastoralists (35.6%), followed by urban/peri-urban dwellers (58.4%), and agro-pastoralists (78.1%). Similar data were not reported in the KAP survey.

Iron/folic acid tablets are essential for preventing iron deficiency during pregnancy and risk of morbidity and mortality from post-partum hemorrhage [21]. WHO recommends that women take 90 tablets during pregnancy [22]. However, just one in five women met this goal; the highest percentage was in the agro-pastoral zone (46.2%) and the lowest in urban/peri-urban areas (7.9%). The 2018 KAP survey reported only 11% of women taking 90 or more iron/folate tables [18]. Only about one-quarter of women reported use of deworming tablets, though this number reached just over 50% in urban/peri-urban areas. It is interesting to note that agro-pastoralists had the highest prevalence of attending four or more antenatal care visits, delivering with skilled personnel, and consuming 90 or more iron/folate tablets compared to women in the other two livelihood zones. At the same time, intake of deworming tablets was highest in urban/peri-urban settings. The findings also show that pastoralists had the least access to health care and/or were less likely to choose this kind of care.

Figure 13. Caregivers' healthcare seeking/utilization by livelihood zones



6 FOOD SECURITY AND WASH

6.1 FOOD INSECURITY EXPERIENCES

Pastoral and agro-pastoral regions in Kenya are known to be vulnerable to food insecurity [28]. In our survey, 93.4% of households in pastoral livelihood zones experienced severe food insecurity, followed by those in the urban/peri-urban (86.5%) and agro-pastoral (80.7%) livelihood zones (**Table 20Table 20**). Minimal or no food insecurity was reported by 3% or less across all respondent characteristics, except for households where the mother or caregiver had a secondary or more education. Among these households, just under 15% reported minimal or no food insecurity.

Households had similar and high CSI scores across all household food insecurity experience items regardless of socioeconomic status and other characteristics. Those households with severe food insecurity had the highest CSI score (**Table 21**). The main coping strategies included relying on less preferred and expensive foods, borrowing food, or relying on help from a friend or relative. Other coping strategies included limiting portion size at mealtimes, restricting consumption by adults for small children to eat, and reducing number of meals.

Table 20. Percentage distribution of household food insecurity experience and scale of severity in the past 12 months, by livelihood zone and other characteristics

Characteristic	Household food insecurity experience: Questionnaire items								Scale of severity[a]			
	Worried would not have enough food to eat	Unable to eat healthy and nutritious food	Ate only few kind of foods	Skipped meals	Ate less	House-hold run out of food	Hungry	Went without eating whole day	Minimal / none	Mild /mod-erate	Severe	Number of households
Overall averages and totals	**95.7**	**97.6**	**97.6**	**90.3**	**94.6**	**93.1**	**88.0**	**79.5**	**0.9**	**7**	**92.1**	**594**
Livelihood zone												
Pastoral	96.9	98.3	98.5	91.0	95.1	94.4	88.9	79.4	0.5	6.1	93.4	364
Agro-pastoral	93.2	93.2	94.0	83.7	84.6	86.3	81.7	73.2	2.7	16.6	80.7	129
Urban/peri-urban	87.8	93.7	91.6	87.5	95.2	85.7	83.6	83.7	3.3	10.2	86.5	101
Sex of household head												
Male	96.3	98.0	98.3	90.3	94.1	93.5	89.0	79.5	0.7	6.4	92.9	503
Female	92.3	95.3	93.8	90.6	97.1	90.5	82.3	79.9	2.1	10.4	87.5	91
Polygamous marriage												
No	95.5	96.9	97.3	88.3	94.2	91.5	86.7	76.1	1.1	9.5	89.4	437
Yes	96.2	99.1	98.1	94.5	95.5	96.3	90.7	86.4	0.6	1.9	97.5	157
Mother or caregiver highest education												
No education	97.5	99.2	98.9	94.3	95.8	96.5	92.4	83.1	0.3	3.6	96.1	395
Primary	91.2	96.4	94.4	79.5	92.9	81.4	75.9	69.2	0.4	19.4	80.3	144

Characteristic	Household food insecurity experience: Questionnaire items								Scale of severity[a]			
	Worried would not have enough food to eat	Unable to eat healthy and nutritious food	Ate only few kind of foods	Skipped meals	Ate less	House-hold run out of food	Hungry	Went without eating whole day	Minimal / none	Mild /mod-erate	Severe	Number of households
Secondary +	77.4	71.6	84.4	51.7	77.0	68.5	47.0	47.1	14.8	29.5	55.7	55
Mother or caregiver age (years)												
< 24	93.5	97.3	97.2	85.3	95.4	90.6	84.0	67.7	0.5	10.4	89.1	242
25–29	96.8	97.8	97.2	93.3	94.0	95.1	89.2	85.0	1.3	3.4	95.3	139
30–34	96.1	96.4	97.4	89.3	90.2	90.7	86.5	85.8	1.5	10.5	88.0	126
35+	99.4	99.4	99.5	99.4	99.2	98.8	98.6	93.2	0.5	0.6	98.9	87
Parity												
1–2	92.0	96.2	96.3	85.3	93.3	92.1	83.6	63.0	1.4	10.0	88.6	226
3–5	96.7	97.8	98.2	88.9	93.5	90.7	86.6	85.2	1.1	7.3	91.6	220
6+	99.1	99.0	98.3	98.1	97.3	97.1	95.1	92.9		3.2	96.8	136
Wealth quintile												
Lowest	92.0	91.8	96.0	82.3	90.4	86.0	76.6	73.0	3.1	11.3	85.6	116
Second	98.1	98.9	99.2	94.5	95.5	94.7	94.4	82.4	0.6	4.0	95.4	126
Middle	95.9	99.7	99.6	95.0	96.0	98.8	91.8	88.2	0.2	3.7	96.1	136
Fourth	97.8	98.3	98.2	90.8	97.6	94.6	90.7	70.2	0.1	7.2	92.7	114
Highest	95.4	99.4	93.4	86.4	94.0	89.1	85.1	77.1	0.4	11.3	88.3	102

Note. The mild and moderate food insecurity categories were merged because of small percentages.

[a] Household food insecurity experience was classified as per item, with items 1 through 3 corresponding to mild food insecurity; items 4 through 6 corresponding to moderate food insecurity; and items 7 and 8 corresponding to severe food insecurity

Table 21. CSI by livelihood zones and other characteristics

Characteristic	Mean frequency score (0-7 days)					Average weighted CSI score[a]	No. of households
	Rely on less preferred and less expensive foods	Borrow food, or rely on help from a friend or relative	Limit portion size at mealtimes	Restrict consumption by adults in order for small children to eat	Reduce number of meals eaten in a day		
Overall averages and totals	3.6	1.8	2.6	1.5	2.5	16.8	594
Livelihood zone							
Pastoral	4.0	2.1	2.9	2.1	2.9	20.3	364
Agro-pastoral	3.5	1.9	2.7	1.7	2.8	17.8	129
Urban/peri-urban	4.6	2.3	3.5	2.3	3.1	22.5	101
Sex of household member							
Male	4.0	2.1	23.0	2.1	2.9	20.2	503
Female	4.3	2.2	3.0	2.2	3.2	21.6	91
Household head: Age							
15–24 years	4.1	1.9	3.0	1.6	2.4	18.3	65
25–29 years	3.7	1.8	2.7	1.7	2.7	17.8	112
30–34 years	4.3	2.5	3.3	2.3	3.1	22.5	113
35–49 years	4.0	2.2	3.0	2.2	3.1	21.3	214
50+ years	3.9	2.00	2.8	2.4	3.1	21.0	90
Household size							
2–3	3.7	1.7	2.5	1.5	2.4	16.6	81
4–5	3.7	2.1	2.8	2.2	2.9	20.1	216
6+	4.3	2.2	3.2	2.2	3.1	21.5	297
Household head: Highest education							
No education	4.1	2.2	3.0	2.1	3.0	21.0	352
Primary	4.2	2.1	3.1	2.2	2.9	20.8	132
Secondary+	3.3	1.5	2.5	1.4	2.3	16.2	110

Characteristic	Mean frequency score (0-7 days)					Average weighted CSI score[a]	No. of households
	Rely on less preferred and less expensive foods	Borrow food, or rely on help from a friend or relative	Limit portion size at mealtimes	Restrict consumption by adults in order for small children to eat	Reduce number of meals eaten in a day		
Main source of income							
No income	3.5	3.3	3.5	2.5	4.1	25.1	27
Sale of livestock/crops	3.9	1.9	2.9	2.2	2.9	20.1	299
Petty trading	4.6	2.6	3.1	2.0	3.3	22.2	100
Casual/permanent employment	4.0	1.9	2.9	1.9	2.3	18.7	168
Wealth quintile							
Lowest	3.3	1.8	2.8	1.7	3.1	17.9	116
Second	4.1	1.8	3.0	2.2	2.9	20.3	126
Middle	4.3	2.4	3.2	2.3	3.0	22.1	136
Fourth	4.0	1.9	2.9	1.7	2.6	18.5	114
Highest	4.4	2.5	2.9	2.6	3.0	22.9	102
Household food insecurity							
Minimal/none	1.1	0.3	0.3	0.3	0.9	3.6	17
Moderate	2.6	0.9	1.4	0.8	1.7	10.1	85
Severe	4.2	2.2	3.1	2.2	3.0	21.4	492

[a] To obtain the weighted coping strategy index, we multiplied the universal severity weight with the respective frequency score.

6.2 WATER, SANITATION, AND HYGIENE

Water insecurity was highly prevalent (71.4%) and the main source of drinking water varied in households across livelihood zones (**Table 22**). Surface water (31.3%), pipped/tapped (26.7%), and unprotected dug well/spring (26.7%) were reported as the main sources of drinking water in households in the pastoral livelihood zone. Tanker/shop (31.9%) and borehole (29.8%) were the main sources of drinking water in agro-pastoral livelihood zones, whereas surface water was the main source in urban/peri-urban livelihood zones. Just over one-quarter of households in the pastoral livelihood zone reported travelling more than 2 kilometers round trip to obtain drinking water compared to about 15% in the other two livelihood zones. Overall, just over 3% of households were using an improved method for water treatment and over 9 in 10 households reported not having a safe method to store water. Only 12.5% of households reported the utilization of an improved latrine, with the highest percentage in urban/peri-urban areas (53.7%). Fetching drinking water was almost exclusively done by women compared to men (97.5% versus 2.5%).

Table 22. Percentage distribution of households by source of drinking water, time to obtain drinking water, person who usually collects drinking water, treatment of drinking water, and sanitation facilities, by livelihood zone

Characteristic	Livelihood zone			Overall
	Pastoral	Agro-pastoral	Urban/ peri-urban	
Number of households	**364**	**129**	**101**	**594**
Source of drinking water				
Piped/tapped	26.7	12.4	10.6	24.4
Tube well/borehole	7.1	29.8	11.3	8.6
Protected dug well/spring	5.1	4.8	5.7	5.1
Unprotected dug well/spring	26.7	10.4	16.2	24.8
Tanker/shop	3.1	31.9	15.3	5.7
Surface water	31.3	10.8	40.9	31.4
Time to obtain drinking water (round trip)				
Less than 500 m (less than 15 minutes)	29.9	51.7	53.8	33.4
More than 500 m to less than 2 km (15 to 1 hour)	39.2	30.2	20	36.7
More than 2 km (1–2 hours)	28.4	12.7	16.5	26.4
Don't know/missing	2.5	5.4	9.8	3.4
Person who usually collects drinking water				
Women/girls	97.1	100	99.8	97.5
Men/boys	2.9	0	0.2	2.5

Characteristic	Livelihood zone			Overall
	Pastoral	Agro-pastoral	Urban/ peri-urban	
Water treatment prior to drinking				
Boil	0.9	2.5	2.7	1.1
Water guard/Aqua tabs/Other chemical (chlorine)	0.8	3.8	0.8	0.9
Sitting to settle/sedimentation	0.1	1.4	0.1	0.1
Use water filter (ceramic, sand, composite)	1.7	0.4	0.6	1.6
No treatment	96.8	92.4	96.9	96.6
Percentage using an improved treatment method[a]	3.2	7.6	3.1	3.4
Water storage				
Safe	5.1	16.7	27.3	8.0
Unsafe	94.9	83.3	72.7	92.0
Seasons with short access to water				
Rainy season	17.9	23.1	0.9	16.3
Dry season	80.9	55	97.3	81.8
Don't know/missing	1.2	21.9	1.8	1.8
Percentage of households with water insecurity experience[b]	70.9	75.1	73.7	71.4
Type of facility				
Improved facility[c]	6.2	34.3	53.7	12.5
Non-improved facility[d]	93.8	65.7	46.3	87.5
Households sharing improved facility				
< 10	88.9	81.9	58.9	74.5
10+	11.1	18.1	41.1	25.5
Distance between the improved facility and the house				
Within the compound	70.1	78.9	71	71.7
Outside the compound, < 5 minutes	29.9	21.1	29	28.3
Number of households with improved facility	**51**	**58**	**62**	**171**

Note. Total percentages per characteristic may not add up to 100% because of households with missing information.

[a] Improved water treatment methods include boiling, bleaching/adding chlorine, filtering/straining, and solar disinfecting.

[b] Proportion of water-insecure households using the HWISE scale score (0–36), with household having a score of less than 2 classified as water insecure.

[c] Improved toilet facility includes flush, traditional pit, and ventilated improved pit latrine.

[d] Unimproved facility includes no facility, bush, field, and flying toilet, which is a plastic bag that is used to collect human waste.

7 FACTORS ASSOCIATED WITH CHILD UNDERNUTRITION

This section reports on the factors associated with GAM, stunting, and underweight at the child, maternal, household, and community levels.

7.1 FACTORS ASSOCIATED WITH GAM (0–35 MONTHS)

The results in Model 3 showed that a child being male increased the odds of suffering from GAM using WHZ as the indicator. However, the significant association disappeared after the inclusion of community level factors, showing that the finding was not robust (**Table 23**). Children who were delivered by a skilled health professional had 72% (adjusted odds ratio [aOR] = 0.28, CI = 0.12, 0.63) reduced odds of GAM compared to those who were not delivered by a skilled birth attendant. Delivery with a skilled birth attendant, in addition to being a proxy for access to health services, is also often a proxy for socioeconomic status and education, all factors that independently have a positive effect on child nutrition. None of the other child, mother or caregiver, or community characteristics examined had a significant effect on GAM across all four models.

Table 23. Multivariate logistic regression analysis (WHZ-GAM for children 0–35 months)

Variables	Model 1	Model 2	Model 3	Model 4
Overall totals	**577**	**569**	**569**	**569**
Child sex: female (base)				
Male	1.96	2.12	2.25*	2.21
	(0.90 - 4.28)	(0.94 - 4.81)	(1.00 - 5.06)	(0.98 - 4.97)
Child age (months): 0–11 (base)				
12–23	1.14	1.49	1.43	1.49
	(0.48 - 2.73)	(0.64 - 3.48)	(0.61 - 3.34)	(0.63 - 3.51)
24–35	1.07	1.63	1.81	1.81
	(0.38 - 3.00)	(0.52 - 5.13)	(0.56 - 5.80)	(0.56 - 5.86)
Mother or caregiver age (years): 30+ (base)				
<25		1.34	1.24	1.14
		(0.40 - 4.51)	(0.37 - 4.10)	(0.33 - 4.01)
25–29		0.82	0.75	0.70
		(0.27 - 2.49)	(0.25 - 2.24)	(0.23 - 2.16)
Parity: 1–2 (base)				
3-5		0.41	0.40	0.41
		(0.16 - 1.06)	(0.16 - 1.00)	(0.16 - 1.02)
6+		1.41	1.32	1.27
		(0.44 - 4.50)	(0.41 - 4.25)	(0.37 - 4.29)

Variables	Model 1	Model 2	Model 3	Model 4
Delivery with skilled personnel: No (base)				
Yes		0.26**	0.27**	0.28**
		(0.11 - 0.61)	(0.12 - 0.61)	(0.12 - 0.63)
Mother or caregiver achieved MDD: Yes (base)				
No		1.33	1.24	1.19
		(0.26 - 6.80)	(0.26 - 5.84)	(0.26 - 5.53)
Mother or caregiver education: Primary+ (base)				
No education		3.02*	1.92	1.69
		(1.03 - 8.91)	(0.73 - 5.04)	(0.58 - 4.91)
Household ownership of livestock/poultry: No (base)				
Yes			4.26*	3.36
			(1.19 - 15.25)	(0.77 - 14.58)
Household water insecurity experience: No (base)				
Yes			1.98	1.99
			(0.78 - 5.05)	(0.78 - 5.06)
Livelihood zone: Urban/Peri-urban (base)				
Pastoral				1.95
				(0.31 - 12.04)
Agro-pastoral				1.00
				(0.16 - 6.13)
N	**577**	**569**	**569**	**569**

Note. As described in Section 2.2, Study Methodology, Model 1 included only child factors; Model 2 included both child and maternal factors. Model 3 included child, maternal, and household factors. Finally, Model 4 adjusted for child, maternal, household, and community factors. 95% CI in parentheses. ***p < .01, **p < .05, *p < .1.7.2

7.2 FACTORS ASSOCIATED WITH CHILDHOOD STUNTING (0–35 Months)

A biological factor such as a child's age was associated significantly with stunting. Compared with children aged 0–11 months, children who were 12–23 months old and 24–35 months old were 12.24 (CI = 4.57, 32.78) and 18.55 (CI = 6.62, 51.99) times more likely to be stunted, which is not surprising as stunting is cumulative, and increases occurs over time (**Table 24**). The results further showed that compared to children of older mothers or caregivers, children of younger mothers or caregivers (< 25 years) had nearly two and a half times the probability of being stunted (aOR = 2.40, CI = 1.01, 5.70). Children whose mothers or caregivers achieved MDD were 74% (aOR = 0.26, CI = 0.075, 0.93) less likely to suffer from stunting compared to those whose mothers or caregivers did not achieve MDD. Surprisingly, household ownership of livestock/poultry appeared to increase the child's odds of stunting relative to children in households that did not own livestock/poultry, a finding that is difficult to interpret. None of the

other child, mother or caregiver, or community characteristics examined, including livelihood zone, had a significant effect on GAM.

Table 24. Multivariate logistic regression analysis (stunting for children 0–35 months)

Variables	Model 1	Model 2	Model 3	Model 4
Overall totals	**579**	**577**	**577**	**577**
Child sex: female (base)				
Male	1.12	1.15	1.28	1.23
	(0.55 - 2.31)	(0.55 - 2.39)	(0.63 - 2.60)	(0.60 - 2.51)
Child age: (months) 0–11 (base)				
12–23	9.43***	9.82***	11.81***	12.24***
	(3.53 - 25.24)	(3.66 - 26.35)	(4.41 - 31.6)	(4.57 - 32.78)
24–35	14.24***	17.20***	18.15***	18.55***
	(5.22 - 38.86)	(6.33 - 46.78)	(6.51 - 50.62)	(6.62 - 51.99)
Mother or caregiver age (years): 30+ (base)				
<25		2.03	2.40*	2.40*
		(0.85 - 4.85)	(1.03 - 5.60)	(1.01 - 5.70)
25–29		1.33	1.20	1.14
		(0.52 - 3.41)	(0.46 - 3.12)	(0.43 - 3.03)
Mother or caregiver achieved MDD-W: No (base)				
Yes		0.24*	0.24*	0.26*
		(0.07 - 0.88)	(0.06 - 0.90)	(0.08 - 0.92)
Household ownership of livestock/poultry: No (base)				
Yes			6.19**	3.49*
			(1.87 - 20.42)	(1.02 - 11.98)
Livelihood zone: Urban/peri-urban (base)				
Pastoral				2.65
				(0.58 - 12.10)
Agro-pastoral				1.92
				(0.37 - 10.09)

Note: The child-level factors were entered into the first model (model 1), and then adjusted for maternal, household, and community-level factors in models 2, 3, and 4, respectively.
95% CI in parentheses. *** $p<0.001$, ** $p<0.01$, * $p<0.05$

7.3 FACTORS ASSOCIATED WITH CHILDHOOD UNDERWEIGHT (0–35 MONTHS)

Similar to stunting, child age was associated with increased odds of being underweight. The results in **Table 25** show that compared to children aged 0-11 months, children aged 12–23 (aOR = 2.91; CI = 1.29, 6.57) and 24–35 (aOR = 7.16; CI = 3.01, 17.03) had higher odds of being underweight. Compared to children of mothers who did not MDD-W, children of mothers who did had 74% (aOR = 0.26, CI = 0.077, 0.88) reduced odds of suffering underweight. None of the other child, mother or caregiver, or community characteristics examined, including livelihood zone, had a significant effect on GAM.

Table 25. Multivariate logistics regression (underweight for children 0–35 months)

Variables	Model 1	Model 2	Model 3	Model 4
Overall totals	**582**	**580**	**580**	**580**
Child sex: Female (base)				
Male	1.67	1.69	1.95	1.93
	(0.84 - 3.32)	(0.85 - 3.39)	(0.99 - 3.85)	(0.96 - 3.85)
Child age (months): 0–11 (base)				
12–23	2.47*	2.50*	2.77*	2.91*
	(1.08 - 5.66)	(1.09 - 5.75)	(1.23 - 6.23)	(1.29 - 6.57)
24–35	5.69***	6.36***	6.91***	7.16***
	(2.53 - 12.82)	(2.75 - 14.69)	(2.91 - 16.41)	(3.01 - 17.03)
Mother or caregiver age (years): 30+ (base)				
<25		1.32	1.48	1.41
		(0.57 - 3.06)	(0.65 - 3.38)	(0.61 - 3.24)
25–29		0.77	0.77	0.73
		(0.32 - 1.86)	(0.31 - 1.93)	(0.29 - 1.84)
Mother or caregiver achieved MDD-W: No (base)				
Yes		0.24*	0.24*	0.26*
		(0.07 - 0.80)	(0.07 - 0.81)	(0.08 - 0.88)
Household ownership of livestock/poultry: No (base)				
Yes			3.23	2.07
			(0.98 - 10.68)	(0.76 - 5.63)
Livelihood zone: Urban/peri-urban (base)				
Pastoral				1.84
				(0.52 - 6.49)
Agro-pastoral				0.57

Variables	Model 1	Model 2	Model 3	Model 4
				(0.11 - 2.85)

Note. As described in Section 2.2, Study Methodology, Model 1 included only child factors; Model 2 included both child and maternal factors. Model 3 included child, maternal, and household factors. Finally, Model 4 adjusted for child, maternal, household, and community factors.
95% CI in parentheses. ***p < .01, **p < .05, *p < .1.

7.4 INDICATORS OF INFANT AND YOUNG CHILD FEEDING AND RISK OF GAM, STUNTING, AND UNDERWEIGHT (6–23 MONTHS)

To investigate the role of IYCF on GAM, stunting, and underweight, we stratified the analysis by the child's age (6–23 months). The results showed that none of the IYCF indicators included in the analysis were associated significantly with any of the three indicators of undernutrition (results not shown). This finding may be because of the extremely poor complementary feeding diet among all children, including those with adequate anthropometric measurements; but also because the indicators of IYCF were not designed for this purpose [9]. Other studies have shown that the IYCF feeding indicators are only weakly or not significantly associated with anthropometry [23, 24].

7.5 INTERACTION BETWEEN CHILD SEX, AGE, AND LIVELIHOOD ZONE AND RISK OF ACUTE MALNUTRITION

Figure 14, **Figure 15**, and **Figure 16** present the interaction effects of child sex, age, household size, and livelihood zones on GAM, stunting, and underweight. The results in **Figure 14** show a significant interaction between child sex and livelihood zone. Boys in the pastoral zone had increased risk of acute malnutrition compared to those in the other two livelihood zones, whereas girls in urban/peri-urban settings had increased risk of acute malnutrition compared to those in the other two livelihood zones. Among agro-pastoralists, child sex did not affect risk of acute malnutrition. A significant interaction was also found between a child's age and livelihood zones. The interaction effect between child sex and age was also significant, suggesting that the likelihood of a male or female child suffering from GAM depends on their age. Whereas for boys, the risk of GAM increased with age, for girls it decreased. Whereas in agro-pastoral zones, risk of GAM decreased as children grew older, it increased slightly in pastoral zones. Among children in urban/peri-urban zones, the relationship between GAM and child age was U-shaped, with decreasing risk until 20 months before increasing again. With respect to child stunting, a significant interaction effect was observed between the child's gender and livelihood zone, livelihood zone and age, and child's gender and age and livelihood zones and household size (**Figure 15**). Whereas risk of stunting was similar for female children across the livelihood zones, for male children it was highest in the pastoral zone and lowest in the peri-urban zone. Also, whereas risk of stunting was similar for male and female children until about 18 months, thereafter it increased more sharply for male children. Lastly, the age-specific risk of stunting, while similar until about 12 months, differed thereafter and was greater for children in pastoral zones and lowest for children in urban/peri-urban zones.

The interaction analyses for underweight were similar to those for stunting, showing the same relationships for child sex and livelihood zone, child sex and age, and livelihood zone and child age **(Figure 16)**.

Figure 14. Interaction between child age, sex, and livelihood zone and risk of GAM

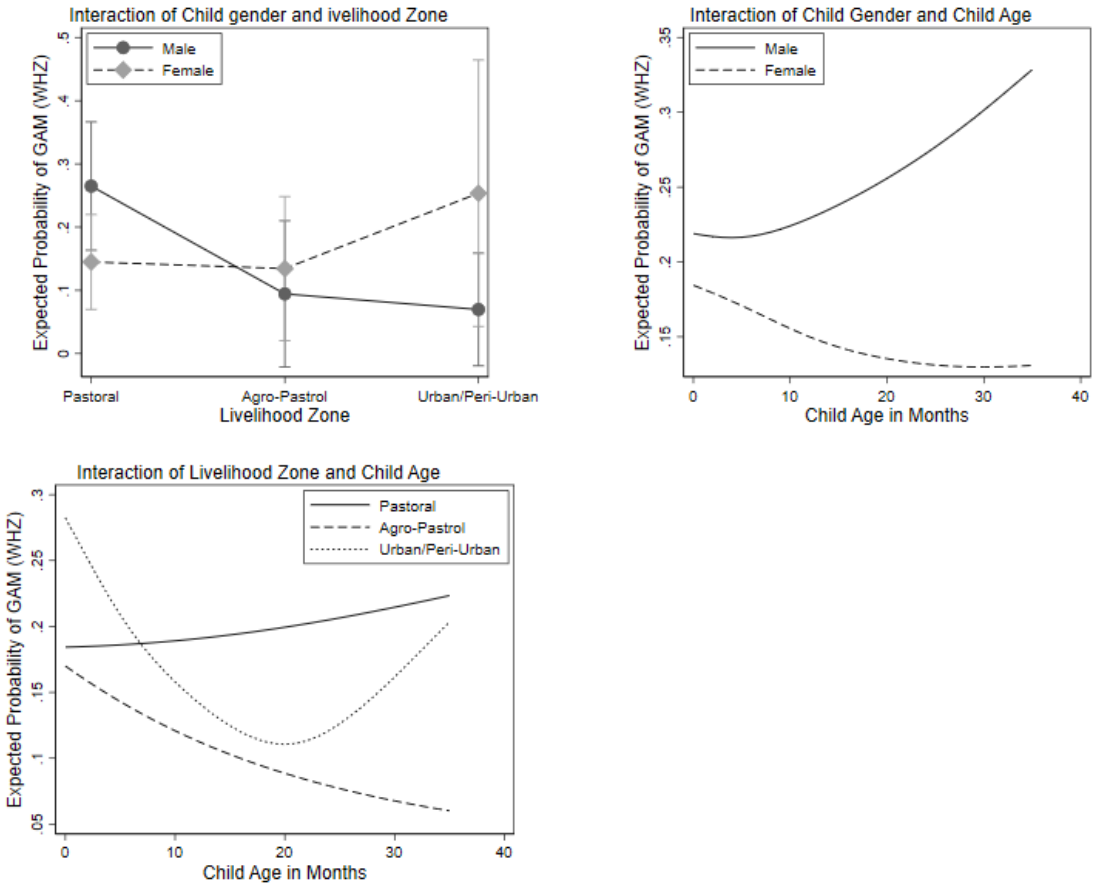
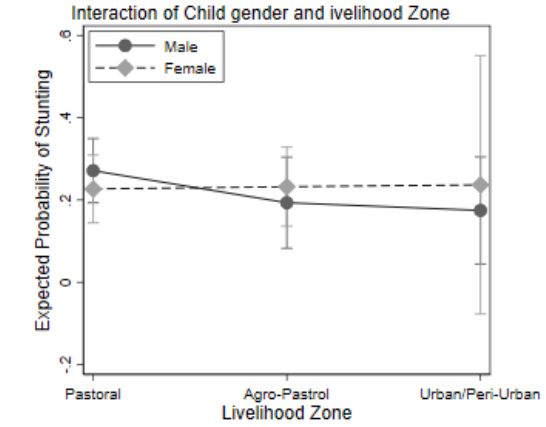
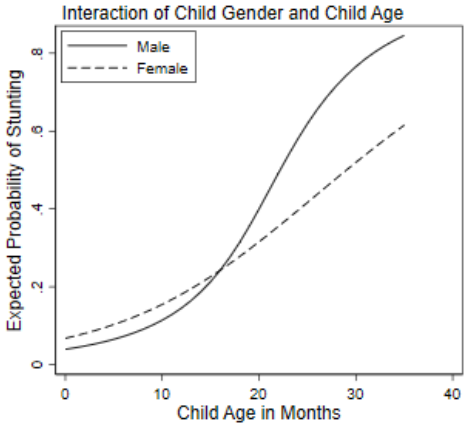


Figure 15. Interaction between child age, sex, and livelihood zone and risk of stunting





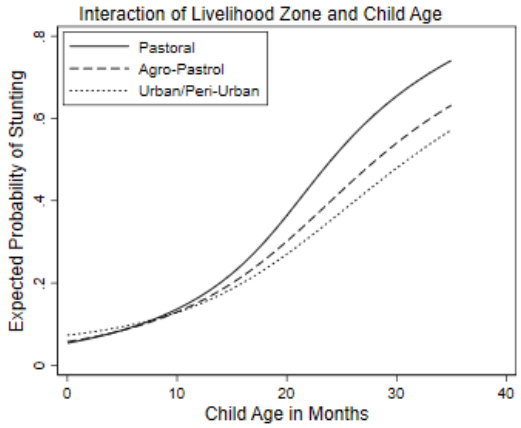
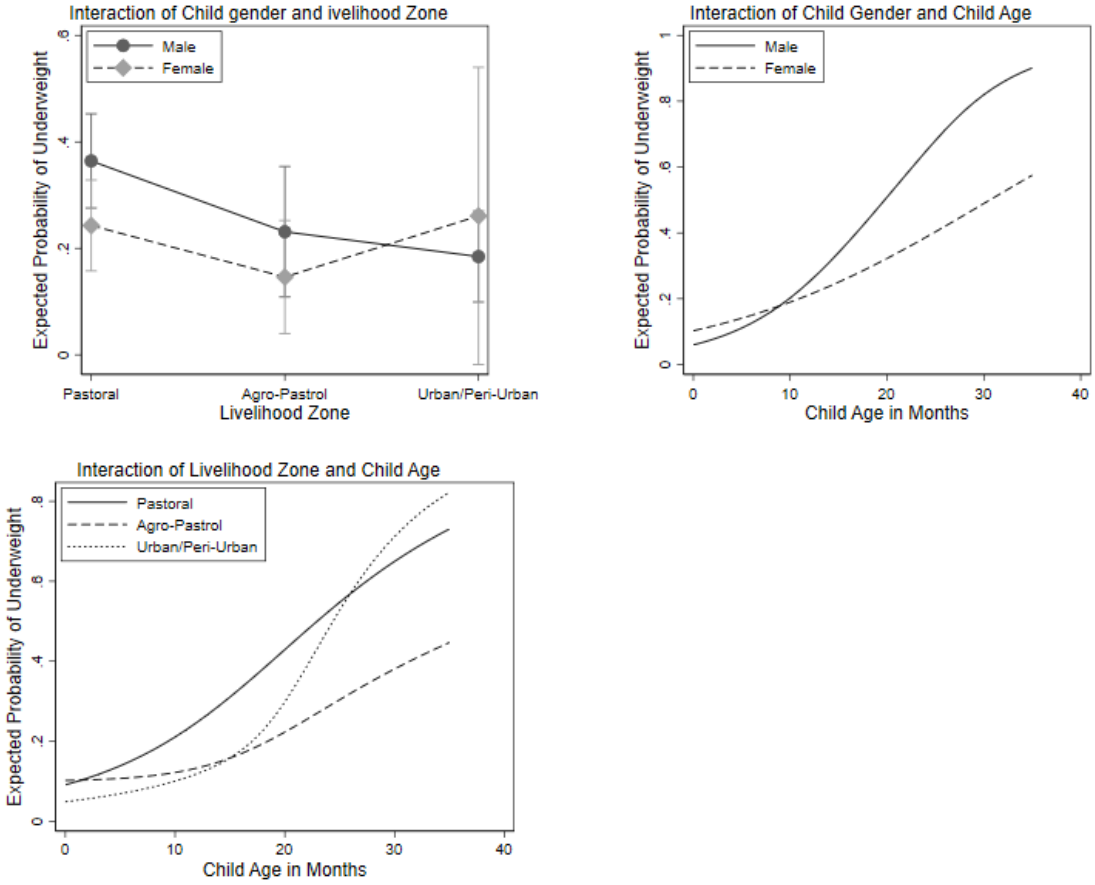


Figure 16. Interaction between child age, sex, and livelihood zone and risk of underweight



8 DISCUSSION, CONCLUSIONS, AND NEXT STEPS

The results show that GAM across all survey zones in Samburu has exceeded the emergency threshold (GAM > 15%). The high prevalence suggests that the interventions being implemented in the county over the years have not worked to reduce GAM rates sustainably. Alternatively, it could indicate that conditions affecting PAM have grown substantially worse over the years; therefore, programs have served at best to maintain the status quo. Nonetheless, there is a need to take a second look at the implementation of the existing interventions and introduce new robust programs or adapt existing programs to reduce the GAM rates sustainably. The longitudinal survey findings are consistent with those of recent SMART surveys, which have consistently shown a high prevalence of GAM and other undernutrition metrics [3, 25-27].

The vastly different prevalence rates of acute malnutrition when assessed by MUAC compared to WHZ as the indicator for GAM require further research and analysis for targeting based on mother- or caregiver-led MUAC and declaration of nutritional emergencies from surveillance data.

Our results showed that the prevalence of acute malnutrition among children younger than 3 years old exceeded the emergency threshold of 15% when assessed by WHZ but not when assessed by MUAC. Results from the chi-square analysis, when GAM is assessed my WHZ, showed that prevalence rates differed by livelihood zone, with children of pastoralists significantly more likely to be acutely malnourished compared to children in the other two livelihood zones and children in the North marginally more likely to be acutely malnourished compared to children in the other survey zones. This analysis also showed that children of mothers or caregivers with no education compared to mothers or caregivers with some education and children of mothers or caregivers who were underweight compared to mothers or caregivers of normal weight or overweight were significantly more likely to suffer from GAM. However, the regression analysis that took into consideration child, mother and caregiver, and household, and community characteristics showed that only children of mothers or caregivers who delivered with skilled personnel were significantly less likely to suffer from GAM. The positive effect of skill delivery on child nutrition outcomes may be attributed to maternal exposure to appropriate health education regarding infant and young child nutrition, including exclusive breastfeeding [28]. It could also be that those caregivers with access to skilled pregnancy and/or delivery care belong to a higher socioeconomic stratum, which means that their children may have access to nutritious food and other resources.

The low percentage of children who met the MDD (8%) and mothers or caregivers who met the MDD-W (6%) is deeply concerning and consistent with their mostly monotonous diets composed of cereals and dairy. It is also one of the few variables in our study that is vastly different from an earlier 2018 study that showed much higher levels of dietary diversity [18]. The finding, however, that mother or caregiver consumption of pulses and foods in other highly nutritious food groups was greater than that of children suggests household access to such foods. It also suggests that these foods could potentially be promoted for child feeding. The fact that only one-third of children met the MMF suggests that interventions must also focus on increasing meal frequency.

Reported illnesses of common acute conditions among young children in the 2 weeks before the survey was high (63%) and there was no difference among children in different livelihood zones. A large percentage of mothers or caregivers also sought treatment from a health facility for such illnesses (58%). Child illness is an immediate cause of undernutrition and interacts with diet to affect undernutrition [29]. Interventions to reduce the prevalence of common childhood illnesses, particularly diarrhea, are needed to reduce GAM.

With respect to next steps, the information generated by the quantitative results of the baseline of the longitudinal study highlights some specific immediate actions that include:

- A focus on interventions to promote exclusive breastfeeding among mothers of children younger than 6 months old and to promote increased dietary diversity and increased meal frequently among older children. Interventions to reduce use of feeding bottles for children of all ages should be undertaken.

Furthermore, research into why children are not fed with similar frequency the nutritious foods consumed by mothers and caregivers and the barriers and facilitators for changing these practices is warranted.

Lastly, the information generated from this report must be integrated with the rich findings from the qualitative results. Integration of the two complementary research methods will lead to a more in-depth understanding of how interventions to improve nutrition with respect to both the immediate causes of undernutrition and the underlying causes can be best addressed in the short and long term.

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ANNEX A. INDICATORS, METHODS, AND FREQUENCY OF DATA COLLECTION FOR HOUSEHOLD SURVEYS

Variable/indicator	Methods	Frequency of data collection
Identification and tracking ▪ Global positioning system (GPS) coordinates ▪ Village and community name, etc. ▪ Names and contact information of primary adults in the household ▪ Names and contact information for community leader(s)	Survey	Wave 1 with checks for any changes in subsequent waves
Demographics and household composition ▪ Number of household members, number of children <5 years, maternal/paternal education, paternal/maternal occupation, ethnicity, religion, etc.	Survey	Wave 1 with checks for any changes in subsequent waves
Anthropometry of children <5 years and mothers or caregivers ▪ Mid-upper arm circumference (MUAC) ▪ Weight ▪ Length/height	Survey	At all survey waves
Socioeconomics ▪ Household wealth ▪ Livelihoods (household asset base, income sources, social protection, livestock number, access to markets, access to land/pasture) ▪ Household decision-making and control over resources ▪ Women's time use	Survey	At all survey waves, with some modifications for indicators unlikely to vary sub-annually
Household food security ▪ Coping Strategy Index (CSI), Food Insecurity Experience Scale (FIES) ▪ Household Dietary Diversity Score (HDDS)	Survey	At all survey waves
Water, sanitation, and hygiene (WASH) ▪ Water source, access, availability, and seasonality ▪ Household Water InSecurity Experiences (HWISE) scale ▪ Hygiene practices	Survey	At all survey waves
Health-seeking behavior ▪ Integrated Management of Acute Malnutrition (IMAM) ▪ Community health service (CHS) experience ▪ Child morbidity	Survey	At all survey waves, with some modifications for indicators unlikely to vary sub-annually
Maternal, infant, and young child nutrition (MIYCN) ▪ Standard infant and young child feeding (IYCF) questionnaire and indicators (exclusive breastfeeding, minimum dietary diversity [MDD], minimum meal frequency [MMF], and minimum acceptable diet [MAD]) ▪ Minimum dietary diversity for women (MDDW) questionnaire	Survey	At all survey waves

Variable/indicator	Methods	Frequency of data collection
▪ Child morbidity ▪ IYCF knowledge, attitudes, and practices ▪ Food safety and WASH knowledge, attitudes, and practices		
Shock experience/exposure ▪ Drought ▪ Locusts ▪ COVID-19 ▪ Flooding ▪ Market shocks ▪ Livelihood disruption ▪ Illness/death etc. ▪ Violence and community conflict, etc.	Survey	At all survey waves
Shock preparedness and response ▪ Various coping strategies beyond CSI ▪ Participation in formal social safety nets and other humanitarian/development activities, particularly the Rural Enterprise Access Project (REAP) ▪ Role of informal social capital (including in-group/out-group dynamics) ▪ Psychosocial well-being, locus of control, and measures of aspiration	Survey	All survey waves

ANNEX B. SAMPLING AND POST-STRATIFICATION WEIGHTS

This annex summarizes the steps taken to compute the sampling weights based on the survey zones as well as the post-stratification weights based on livelihood zones for the Nawiri longitudinal study.

Sampling design

The sample was population-based stratified by survey zones. The sampling frame comprised households with children less than three years at baseline and their mothers. To obtain a representative sample of children and mothers, a multistage sampling method was adopted. In the first stage, we stratified the population according to survey zones. Within each stratum, a random sample of villages was drawn. Household listing was conducted in the sampled villages and a sampling frame of households with children under three years was established. Households were then randomly selected and included in the study from the sampling frame.

Sampling and stratification strategy

Although interest lies in comparing estimates across different livelihood zones, stratification by livelihood zones was a challenge since the livelihood zones are not aligned to administrative units. Information on the number of villages within livelihood zones and respective household listing was not available as population data is based on administrative zones. However, information on livelihood zones was collected during data collection and was used to generate estimates of interest by livelihood zones by performing post-stratification analyses. The survey zones in this context refer to the administrative sub-counties used by the June 2018 SMART Surveys for Samburu, respectively. In Samburu, there are three survey zones namely, Samburu Central, North, and East. **Table B-1** shows the administrative sub-counties covered in each of the survey zones. Villages within each survey zone were treated as clusters. Within each stratum, a random sample of villages were drawn. Household listing was conducted in the sampled villages to establish a sampling frame for the final stage of the sampling.

Sample size determination and allocation

The household survey sample size formula by United Nations Statistical Division [1] was used to compute the sample size needed, adjusting for design effect due to stratification and clustering, and design effect due to repeated data collection on the same study participants over the 24 months. The sample size was computed to estimate an expected prevalence of acute malnutrition assuming an under 3 global acute malnutrition (GAM) prevalence of 12.5% (SMART survey, June 2018). We adjusted for a design effect of 1.12 (using maximum design effect of 1.5 due to stratification and clustering based on estimates from the 2018 SMART Survey. A design effect of 1.12 due to repeated data collection on the same individuals at 7-time points and common correction of 0.02 was assumed based on estimates from a previous study [2] which estimated an intraclass correlation of 0.0044 for clustering of children within a household). A margin of error of +/-5 percentage points was assumed, 95% confidence level, a non-response and attrition rate of 20%, the proportion of the population targeted for the study (children less than 3 years) at 9.2% per the 2019 Kenya Census [3-5], and the average household size of 5. Based on these

assumptions, the required estimated minimum sample size is 699 households with the distribution by sub-county, population, villages, sample size by proportional allocation, and sampled villages as described below.

Table B-1. Household allocation and sample size per survey zone

Survey zone	Sub-counties	Population	Villages	Sample size (by proportional allocation)	Sampled villages
Central	Central	164,942	366	356	20
North	North	67,391	111	160	20
East	East	77,994	187	179	20
Total		**310,327**	**664**	**698**	**60**

Sampling weights calculation

We used the MEASURE DHS program document [6] as a guide in the calculation of sampling weights for both households and caregiver. We first computed the *design weight* of a sampling unit (household or caregiver) which is defined as the inverse of the overall probability with which the sampling unit was selected in the sample. The final *sampling weight* of a sampling unit was derived from the computed design weight correcting for non-response.

The longitudinal study sample was drawn with two-stage, stratified cluster sampling i.e. stratified by the three survey zones and two stages of sampling at village and household level. We computed the design weights based on the separate sampling probabilities for each sampling stage and for each village. First-stage sampling probability of the village in a survey zone and the second-stage sampling probability of a household within the village. The probability of selecting the i^{th} village in the sample was calculated as follows:

$$P_{1hi} = \frac{n_h M_{hi}}{\sum M_{hi}}$$

Where:

n_h be the number of villages selected in survey zone h
M_{hi} is the number of households in the selected village from the sampling frame
$\sum M_{hi}$ the total measure of size in the survey zone h.

The second stage selection probability for each household in the village was calculated as follows:

$$P_{2hi} = \frac{t_{hi}}{L_{hi}}$$

Where;

Let L_{hi} is the number of households listed in the household listing operation in village i in survey zone h

t_{hi} is the number of households selected in the village.

The overall selection probability of each household in village *i* of survey zone *h* was computed as the product of the selection probabilities of the two stages:

$$P_{hi} = P_{1hi} \times P_{2hi}$$

The design weight for each household in village *i* of survey zone *h* is the inverse of its overall selection probability:

$$d_{hi} = 1 / P_{hi}$$

Correcting for non-response rate

The design weight was then corrected for non-response at the village level and at the household level by dividing it by the response rate for each response group. Assuming that the response groups coincide with the sampling strata, we calculated the sampling weight by first calculating the various weighted response rates for unit non-response as shown below.

The village level response rate in survey zone *h* is therefore

$$R_{ch} = n_h^* / n_h$$

Where;

n_h is the number of village selected in survey zone *h*

n_h^* is the number of villages interviewed.

The household response rate in survey zone *h* is calculated by

$$R_{hh} = \sum d_{hi} m_{hi}^* / \sum d_{hi} m_{hi}$$

Where;

m_{hi} is the number of households found in village *i* of survey zone *h*

m_{hi}^* is the number of households interviewed in the village.

d_{hi} is the design weight of village *i* in survey zone *h, and*

the summation is over all villages in the survey zone *h*.

The individual response rate in survey zone *h* is calculated as

$$R_{ph} = \sum d_{hi} k_{hi}^* / \sum d_{hi} k_{hi}$$

Where;

k_{hi} is the number of eligible individuals found in village *i* of survey zone *h*

k_{hi}^* is the number of individuals interviewed.

d_{hi} is the design weight of village *i* in survey zone *h*

the summation is over all villages in the survey zone *h*.

The household sampling weight of village *i* in survey zone *h* was the calculated by dividing the household design weight by the product of the village and the household response rates, for each of the sampling survey zone:

$$D_{hi} = d_{hi} / (R_{ch} \times R_{hh}),$$ for village *i* of survey zone *h*.

The individual sampling weight of village *i* in survey zone *h* was calculated by dividing the household sampling weight by the individual response rate, or equivalently, by dividing the household design weight by the product of the village response rate, the household response rate and the individual response rate, for each of the sampling strata:

$$W_{hi} = D_{hi} / R_{ph} = d_{hi} /(R_{ch} \times R_{hh} \times R_{ph}),$$ for village *i* of survey zone *h*.

Post stratification

One of the objectives of the longitudinal study was to estimate GAM rates at livelihood zone level. There was no adequate information (i.e. population size, GAM rates and village details by livelihood zones) to enable us to stratify compute the sample size needed for the study by livelihood zones. An agreement was made to base the sampling strategy on known survey zones as used by previous studies (SMART surveys) and construct post-stratification survey weights to partially correct for the biases mathematically when estimating the GAM rates by livelihood zones. Post-stratification adjusts the weights of under sampled and over sampled sub populations so the overall sample is more representative of the true subpopulation distributions of the actual target population. Post-stratification re-weights observations based solely on the joint-distribution of the stratification variables and post-stratification variables. That is, you will require as auxiliary information, the population counts of each subgroup belonging to your post-stratification variables within each stratum of your survey.

Samburu County is divided into three main livelihood zones with population divided as follows; nearly 56.6% pastoral, 37.0% agro pastoral, 6.4% are in the urban/ peri-urban formal and informal employment [7]. This was taken as the 'truth benchmark' zones for population distribution by livelihood. We then used the information collected during the baseline survey on livelihood zones of the sampled households to compute the post-stratified sampling weights at county level as shown in **Table B-2** and further estimate the population by livelihood zone for each survey zone using information from the 2019 NDMA report to compute post-stratified sampling weights at survey zone level. The post-stratification weight was then computed as:

Table B-2. Computation of post-stratification sampling weights at county level

Survey zones	Livelihood zones	Population %	Population	Sample	Sample %	Poststratification weight
Overall	Pastoral	56.6%	429,004	366	61.1%	1.08
	Agro-pastoral	37.0%	280,444	130	21.7%	0.59
	Urban/Peri Urban	6.4%	48,509	103	17.2%	2.69
Central	Pastoral	30.0%	184,183	101	33.7%	1.12
	Agro-pastoral	50.0%	306,971	124	41.3%	0.83
	Urban/Peri Urban	20.0%	122,788	75	25.0%	1.25
North	Pastoral	90.0%	60,191	145	93.5%	1.04
	Agro-pastoral	3.0%	2,006	1	0.6%	0.22

Survey zones	Livelihood zones	Population %	Population	Sample	Sample %	Poststratification weight
	Urban/Peri Urban	7.0%	4,682	9	5.8%	0.83
East	Pastoral	88.0%	67,880	120	83.3%	0.95
	Agro-pastoral	2.0%	1,543	5	3.5%	1.74
	Urban/Peri Urban	10.0%	7,714	19	13.2%	1.32

The final weights ($Wpost_{hi}$) were then computed by multiplying the sampling weights (W_{hi}) by the post-stratification weights ($Wpoststr_h$):

Wpoststr =livelihood zone proportion in the population %/ livelihood zone proportion in the sample %

$Wpost_{hi} = W_{hi} * Wpoststr_h$

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ANNEX C. SUMMARY OF THE HOUSEHOLD LISTING EXERCISE

Indicator	Central	East	North	Total *(N)*	Total (%)
Residential status					
Nonresidential	1,111	194	30	1,335	21.3
Residential	1,769	1,292	1,883	4,944	78.7
Number of villages listed	20	20	20	60	
Replacement villages	2	—	1	3	
Dwelling status					
Occupied	1,325	1,143	1,784	4,252	87.8
Temporarily absent	78	78	79	235	4.9
Vacant	103	42	19	164	3.4
Nonresidential	1	7	1	9	0.2
Other	161	22	—	183	3.8
Total number of households with at least one under-3 child					
No	619	517	668	1,804	42.8
Yes	661	632	1,116	2,409	57.2

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