Ethnic Differentials in Stunting, Wasting and Underweight among Children Aged 6–59 Months in Karamoja, Uganda: A Comparative Cross-Sectional Study of the Pokot of Amudat and the Pian of Nakapiripirit Districts

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DOI: https://doi.org/10.68050/JAMS.2026.821

Received: 20 October 2026; Accepted: 28 October 2026; Published: 04 November 2026

ABSTRACT

Background: Child undernutrition remains a leading cause of morbidity and mortality among children under five in Uganda, with Karamoja recording the country's highest burden. Amudat and Nakapiripirit districts, home to the Pokot and Pian ethnic groups respectively, share similar agro-climatic conditions but have historically reported divergent malnutrition outcomes. Objective: To compare the prevalence and determinants of stunting, wasting and underweight among children aged 6–59 months between the Pokot of Amudat and the Pian of Nakapiripirit. Methods: A community-based comparative cross-sectional study was conducted among 270 households (135 per district) selected through two-stage cluster sampling. Anthropometric measurements were converted to WHO 2006 z-scores in ENA for SMART, and structured questionnaires captured socio-demographic, dietary and child-health data. Prevalence is reported with 95% confidence intervals (CI), ethnic differences as prevalence ratios (PR), and bivariate associations were tested with Pearson's chi-square at $p<0.05$. Results: Prevalence of stunting, wasting and underweight was 25.9%, 8.9% and 18.5% among the Pokot compared with 34.1%, 11.1% and 28.9% among the Pian. Only underweight differed significantly by ethnicity (PR 1.56, 95% CI 1.00–2.43; $\chi^2=4.014$, $p=0.045$), and this borderline result was not adjusted for clustering; the stunting and wasting differences were not significant. Prevalence was descriptively higher among boys than girls in both groups. Household size, marital status, maternal knowledge of infant feeding and malnutrition causes, dietary diversity, meal frequency and recent illness were associated with undernutrition in both districts in unadjusted bivariate analysis. Conclusion: Despite sharing an agro-ecological zone, Pian children had significantly higher underweight than Pokot children, with higher but non-significant stunting and wasting. Household and maternal-knowledge factors are plausible contributors to this gap, but a cross-sectional, unadjusted analysis cannot show that they drive it. Nutrition interventions in Karamoja should target ethnic-specific social determinants rather than a single sub-regional template.

Keywords: child undernutrition; Karamoja; Pian; Pokot; stunting; Uganda; underweight; wasting

1. INTRODUCTION

Child undernutrition continues to be one of the most persistent global public health challenges, contributing to nearly half of all deaths among children under five years worldwide and imposing long-term costs on human capital and national development (Akombi et al., 2017). Globally, an estimated 148 million children under five are stunted and 45 million are wasted, with sub-Saharan Africa carrying a disproportionate share of this burden (UNICEF/WHO/World Bank, 2023). In Uganda, national survey data show a gradual improvement in child nutrition indicators over the past decade: stunting fell from 28.9% in 2016 to 24.4% in 2022, underweight from 10.5% to 9.7%, and wasting from 3.6% to 3.2% (Uganda Bureau of Statistics [UBOS] and ICF, 2023). These national gains, however, mask substantial regional inequality. The Karamoja sub-region in north-eastern Uganda has consistently remained the epicentre of child undernutrition in the country, with recent sub-regional assessments reporting stunting levels of around 25–41%, wasting of 9–13% and childhood anaemia exceeding 55% (World Food Programme, UBOS, UNICEF and IBFAN, 2020; Mokori et al., 2025).

A growing body of recent evidence indicates that undernutrition in Karamoja is not uniformly distributed even within the sub-region itself. Okidi et al. (2022), studying agricultural, pastoral and agro-pastoral ecological zones of Karamoja, found that the prevalence of underweight, stunting and wasting ranged from 36% to 58% depending on agro-ecology, with the peak age of vulnerability shifting from 6–37 months across zones. Similarly, Mokori et al. (2025), using the 2022 Food Security and Nutrition Assessment (FSNA) data, documented that 4.6% of Karamoja children aged 6–59 months simultaneously experienced wasting, stunting and anaemia, with household wealth, maternal education, food consumption score and district of residence emerging as key predictors. These findings reinforce the view that geography and agro-climate alone do not fully explain the sub-region's nutrition burden, and that social, cultural and behavioural factors specific to individual communities warrant closer investigation (Okidi et al., 2022).

Amudat and Nakapiripirit districts offer a useful natural comparison for this question. Both districts fall within the same broad Karamoja agro-climatic zone and share a semi-arid, drought-prone environment unfavourable to crop agriculture, yet they are inhabited by two distinct ethnic groups, the Pokot of Amudat and the Pian (a Karimojong sub-group) of Nakapiripirit, with different livelihood emphases, child-care norms and food-related cultural practices. Pre-existing food security assessments had already flagged a divergence between the two districts, with Nakapiripirit historically reporting higher food insecurity (39%) and higher malnutrition indicators (wasting 15%, underweight 25%, stunting 30%) than Amudat (food insecurity 26%; wasting 10%, underweight 22%, stunting 23%) (World Food Programme and UNICEF, 2015). Whether this gap persists once household-level and maternal factors are accounted for, and what specifically drives it, has not been formally tested in a comparative anthropometric study restricted to these two ethnic groups.

This paper addresses that gap. Using primary household survey data collected from 270 households with children aged 6–59 months across Amudat and Nakapiripirit districts, we compare the prevalence of stunting, wasting and underweight between the Pokot and the Pian, and examine the socio-demographic, dietary and child-health correlates of each indicator within each ethnic group. The analysis is intended to generate ethnic-specific evidence to guide the targeting of nutrition-sensitive and nutrition-specific interventions within Karamoja, complementing recent sub-regional analyses that have called for disaggregated, locally tailored programming rather than a uniform Karamoja-wide approach (Okidi et al., 2022; Mokori et al., 2025).

2. METHODS

2.1 Study design and setting

A community-based comparative cross-sectional study was undertaken in Amudat and Nakapiripirit districts, two of the nine administrative units that comprise the Karamoja sub-region in north-eastern Uganda. Geographically, the sub-region spans approximately 27,900 km². According to the Uganda Bureau of Statistics (UBOS, 2024), the sub-region's total population was estimated at 1,496,117 during the 2024 national census, reflecting a considerable demographic increase from the 965,010 inhabitants recorded in the 2014 census (UBOS, 2014). Specifically, Amudat District accounted for a population of 203,358, while Nakapiripirit District had 111,681 residents during the same census period. Ethnically, Amudat is predominantly inhabited by the Pokot community, whereas Nakapiripirit is chiefly occupied by the Pian, a distinct sub-group of the Karimojong. Both districts are situated in a semi-arid ecological zone characterized by harsh, drought-prone climatic conditions and erratic rainfall patterns. These environmental constraints severely limit rain-fed crop agriculture; consequently, the predominant livelihood systems in both settings are agro-pastoralism and nomadic pastoralism.

2.2 Study population and sampling

The study population comprised mothers/caregivers and their children aged 6–59 months resident in the two districts. At the 2024 census, Nakapiripirit district had a population of 111,681, of whom an estimated 20% (22,338) were children under five years, while Amudat had a population of 203,358 with an estimated 40,672 children under five. Sample size was planned with the formula for comparing two independent proportions (Charan and Biswas, 2013): $n = (Z_{1-\alpha/2} + Z_{1-\beta})^2 \times [p_1(1 - p_1) + p_2(1 - p_2)] / (p_1 - p_2)^2$, where n is the number of

households per district, p_1 and p_2 are the expected stunting prevalences in the two districts, $Z_{1-\alpha/2}$ is the standard normal value for a two-sided 5% significance level (1.96) and $Z_{1-\beta}$ is the value for the desired power. Expected prevalences were taken from the Food Security and Nutrition Assessment for Karamoja Sub-Region: 32.2% for Nakapiripirit and 23.8% for Amudat (Karamoja Resilience, 2018). The planned sample of 135 households per district (270 in total), each with at least one eligible child, included a 27% allowance for non-response and for anthropometric records that might be excluded as implausible during cleaning. Because every sampled household took part, the allowance was not used to replace non-respondents, and all 135 households in each district were retained in the analysis. When the calculation was re-checked for this paper, 135 households per district were found to detect the planned 8.4-percentage-point difference in stunting.

A two-stage cluster sampling technique was used. In the first stage, villages were selected using probability-proportional-to-size sampling from an updated village list obtained from the district population offices, yielding nine clusters per district. In the second stage, households within each cluster were selected using a systematic random sampling interval derived from the village household list, continuing until at least 15 eligible children were enrolled per cluster (135 per district). A household was eligible if it had a resident child aged 6–59 months belonging to the Pokot ethnic group (Amudat) or the Pian ethnic group (Nakapiripirit); households whose children did not belong to these groups were excluded. The overall response rate was 100%.

2.3 Data collection

Data were collected using researcher-administered structured questionnaires covering six domains: household socio-demographic characteristics; child health, nutrition and infant and young child feeding (IYCF) practices; a 7-day food-frequency table; a 24-hour dietary recall; household water, sanitation and health-seeking behaviour; and maternal nutrition knowledge, attitudes and practice. Anthropometric measurements were taken following standard WHO protocols: recumbent length was measured for children below 87 cm or under two years, and standing height for older/taller children, to the nearest 0.1 cm; weight was measured to the nearest 0.1 kg using calibrated SECA and electronic scales; and mid-upper arm circumference (MUAC) was measured on the left arm using a standard MUAC tape. All instruments were calibrated daily. Age was determined from birth cards where available, or from maternal recall supported by a local event calendar.

2.4 Measurement of explanatory variables

Household dietary diversity was measured from the 24-hour dietary recall. Foods consumed by the household in the preceding 24 hours were grouped into seven food groups (cereals; pulses/legumes; milk; meat; eggs; micronutrient-rich foods; vegetables), one point was given for each group consumed, and a score of 3 or less was classed as low and above 3 as adequate. Meal frequency was the number of meals the index child ate in the preceding 24 hours, as reported by the caregiver, and was categorised as adequate or inadequate. Early initiation of breastfeeding, continued breastfeeding, bottle-feeding and intake of fortified foods were recorded in the IYCF section of the questionnaire. Maternal knowledge of IYCF and of the causes of malnutrition was assessed with closed questions in the knowledge, attitudes and practice section of the questionnaire; responses were scored and mothers were categorised as having adequate or inadequate knowledge. Recent child illness was the caregiver's report of whether the index child had been ill in the period before the survey, coded yes or no, and household water source was categorised as clean or unclean.

2.5 Qualitative data collection and analysis

Qualitative data on cultural norms and values around child feeding were collected through key informant interviews and focus group discussions in both districts. Key informants were selected purposively for their knowledge of child-feeding practices in their communities, and focus group participants were mothers and caregivers of children aged 6–59 months from the study communities. Interviews and discussions followed semi-structured guides and were held in the local languages; responses were translated into English and analysed thematically. The qualitative and quantitative strands were integrated at the interpretation stage: qualitative themes were used to help explain patterns in the survey results, such as the higher prevalence of undernutrition among boys and the differences in feeding practices between the two groups. The full qua-

litative findings are reported in a companion paper.

2.6 Data management and statistical analysis

Anthropometric data were processed in Emergency Nutrition Assessment (ENA) for SMART (2020 version) and converted to height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) z-scores using the WHO 2006 Child Growth Standards. Children with a z-score below −2 SD were classified as stunted, wasted or underweight respectively (moderate: ≥−3 to <−2 SD; severe: <−3 SD, or bilateral pitting oedema). MUAC-based acute malnutrition was classified as moderate (≥11.5 cm to <12.5 cm) and severe (<11.5 cm) in line with the Uganda Ministry of Health Guidelines for Integrated Management of Acute Malnutrition (MOH, 2016). Dietary diversity and the other explanatory variables were defined as described in Section 2.4. Data were analysed in SPSS version 20. Descriptive statistics (means, standard deviations, proportions) characterised the sample, and Pearson's chi-square test (and Student's independent-samples t-test for continuous variables) assessed associations between ethnicity/explanatory variables and nutritional status indicators, with statistical significance set at $p<0.05$. Prevalence of each indicator is reported with a 95% confidence interval (Wilson method). The ethnic differential is summarised as a prevalence ratio (Pian relative to Pokot) and a prevalence difference, each with a 95% confidence interval. These estimates and the chi-square tests treat children as independent observations and do not adjust for the two-stage cluster design; with nine clusters per district, design-adjusted intervals would be wider, so differences close to the 5% threshold are interpreted with caution. A difference is described as statistically significant only where $p<0.05$; all other differences in prevalence are reported as descriptive.

2.7 Ethical considerations

Ethical clearance was obtained from the Postgraduate School of Uganda Martyrs University and the District Health Officers of Amudat and Nakapiripirit districts. Written or thumb-printed informed consent was obtained from all respondents after they were briefed on the study purpose, procedures and their right to decline or withdraw without consequence. Confidentiality of all household-level data was maintained throughout data collection, entry and analysis.

3. RESULTS

3.1 Household and maternal characteristics

A total of 270 households were enrolled (135 Pokot, 135 Pian). Mean household size was 6.2 (SD 1.8) among the Pokot and 6.6 (SD 2.3) among the Pian, a difference that was not statistically significant ($\chi^2=0.017$, $p=0.898$). The great majority of mothers/caregivers in both groups were married (91.9% Pokot; 93.3% Pian; $p=0.353$). Maternal education levels differed markedly by ethnicity: 96.3% of Pokot mothers had no formal education compared with 71.9% of Pian mothers, a highly significant difference ($\chi^2=30.24$, $p<0.001$), indicating substantially greater educational disadvantage among Pokot women despite their district's marginally better nutrition outcomes.

Livelihood patterns also diverged: the leading livelihood source among Pokot households was food-crop production/sale (55.6% of households reporting it among their top three sources) followed by sale of animal products (45.9%), whereas Pian households relied primarily on petty trade, including brewing and firewood sales (48.9%), followed by food-crop production (37.8%). Households allocated the largest share of income to food in both groups, but Pokot households spent significantly more of their income on food (mean 60.0% vs 53.5%; $p=0.004$) while Pian households spent significantly more on education (16.8% vs 11.1%; $p<0.001$).

3.2 Prevalence of stunting, wasting and underweight

Table 1 summarises the prevalence of the three anthropometric indicators of undernutrition by ethnic group and sex.

Table 1. Prevalence of stunting, wasting and underweight among children 6–59 months by ethnic group and sex

Indicator	Pokot % (95% CI)	Pian % (95% CI)	χ^2	p-value
Stunting Overall	25.9 (19.3–33.9)	34.1 (26.6–42.4)	2.134	0.144
Stunting Boys	28.4	36.1	2.255	0.133
Stunting Girls	23.5	32.4	0.695	0.404
Severe stunting All	8.9 (5.2–14.9)	14.1 (9.2–20.9)	2.952	0.086
Wasting All	8.9 (5.2–14.9)	11.1 (6.8–17.5)	0.37	0.543
Wasting Boys	9	13.1	0.567	0.451
Wasting Girls	8.8	9.5	0.017	0.896
Underweight All	18.5 (12.9–25.9)	28.9 (21.9–37.0)	4.014	0.045
Underweight Boys	19.4	35	4.462	0.035
Underweight Girls	17.6	22.8	0.948	0.33
MUAC-based acute malnutrition All	4.4 (2.1–9.4)	9.6 (5.7–15.8)	2.774	0.096

Note. Stunting = height-for-age Z-score <−2 SD; Wasting = weight-for-height Z-score <−2 SD and/or oedema; Underweight = weight-for-age Z-score <−2 SD; MUAC-based acute malnutrition = MUAC <12.5 cm. n = 135 per group. 95% CIs (Wilson method) are shown for whole-group rows. χ^2 is Pearson's test without continuity correction; neither the CIs nor the tests are adjusted for clustering. Only underweight (all children and boys) differs significantly at p<0.05; other differences are descriptive. Source: primary anthropometric survey data.

Pian children had higher prevalence than Pokot children on every indicator, but only underweight differed significantly. Underweight affected 28.9% (95% CI 21.9–37.0) of Pian children and 18.5% (12.9–25.9) of Pokot children, a prevalence ratio of 1.56 (95% CI 1.00–2.43) and a difference of 10.4 percentage points (0.3–20.4; χ^2=4.014, p=0.045). The gap was concentrated among boys (35.0% vs 19.4%; p=0.035); among girls it was smaller and not significant (22.8% vs 17.6%; p=0.330). The lower confidence limits sit at or very near the null and the test does not account for clustering, so this differential should be read as borderline.

The remaining ethnic differences were not statistically significant and are reported descriptively. Stunting was 34.1% (26.6–42.4) among the Pian and 25.9% (19.3–33.9) among the Pokot (PR 1.31, 95% CI 0.91–1.90; p=0.144). Wasting was 11.1% (6.8–17.5) and 8.9% (5.2–14.9) respectively (PR 1.25, 0.61–2.57; p=0.543); two cases of bilateral pitting oedema were recorded among the Pian and none among the Pokot. MUAC-based acute malnutrition was 9.6% (5.7–15.8) among the Pian and 4.4% (2.1–9.4) among the Pokot (PR 2.17, 0.85–5.53; p=0.096). These intervals are wide, which reflects the limited power of the study for these comparisons (Section 4.1); the lack of significance does not show that the two groups are alike. Boys had higher prevalence than girls on all three indicators in both groups, but sex differences within each group were not tested and are descriptive only. Stunting prevalence exceeded the WHO threshold of 20% in both groups, pointing to a chronic public-health problem across the sub-region.

3.3 Household dietary diversity and IYCF context

Mean household dietary diversity scores were marginally higher among Pokot (3.7) than Pian (3.5) households, with both groups classified as having 'adequate' diversity by the study's threshold; the difference was not statistically significant (χ^2=1.204, p=0.272). The majority of households in both groups relied predominantly on food-aid cereals, legumes, and fats/oils, supplemented by vegetables and vitamin-A-rich fruits, with comparatively low consumption of meat, eggs and milk products, a pattern consistent with chronic reliance on relief food rather than diversified own-production in both districts.

3.4 Determinants of underweight, stunting and wasting

Unadjusted bivariate analysis identified a common set of factors significantly associated with undernutrition indicators in both ethnic groups, alongside several ethnic-specific associations (Table 2). Across both groups, household size greater than five members, inadequate maternal knowledge of IYCF and of the causes of malnutrition, recent child illness, inadequate dietary diversity and inadequate meal frequency were significantly associated with higher prevalence of underweight and stunting. Maternal marital status (unmarried) was significantly associated with both underweight and stunting in both districts. Because these factors tend to occur together in the same households, the associations should not be read as independent effects.

Table 2. Summary of statistically significant bivariate associations (p<0.05) with underweight, stunting and wasting, by ethnic group

Explanatory variable	Underweight — Pokot	Underweight — Pian	Stunting — Pokot	Stunting — Pian	Wasting — Pokot	Wasting — Pian
Marital status (unmarried)	✓ (p=0.018)	✓ (p=0.018)	✓ (p<0.001)	✓ (p<0.001)	—	—
Household size (>5)	✓ (p<0.001)	✓ (p=0.003)	✓ (p=0.003)	✓ (p<0.001)	—	✓ (p=0.024)
Maternal education	—	—	—	✓ (p=0.001)	—	—
Maternal IYCF knowledge (inadequate)	✓ (p=0.001)	✓ (p<0.001)	✓ (p<0.001)	✓ (p<0.001)	—	✓ (p<0.001)
Knowledge of malnutrition causes (inadequate)	✓ (p<0.001)	✓ (p=0.003)	✓ (p<0.001)	✓ (p<0.001)	—	✓ (p=0.010)
Unclean water source	—	✓ (p=0.001)	✓ (p<0.001)	✓ (p=0.031)	—	—
Recent child illness	✓ (p<0.001)	✓ (p=0.001)	✓ (p<0.001)	✓ (p<0.001)	✓ (p=0.036)	✓ (p=0.032)
Early initiation of breastfeeding (>1 hr)	✓ (p=0.001)	—	✓ (p<0.001)	—	—	—
Inadequate meal frequency	✓ (p=0.035)	✓ (p=0.038)	✓ (p<0.001)	—	—	—
Inadequate dietary diversity	✓ (p=0.007)	✓ (p=0.016)	✓ (p<0.001)	✓ (p=0.004)	—	✓ (p=0.003)
Fortified-food intake (low)	—	—	—	—	✓ (p=0.007)	✓ (p=0.033)
No bottle-feeding	—	—	✓ (p=0.003)	✓ (p=0.041)	—	—

Note. ✓ denotes a statistically significant association (χ^2 test, $p<0.05$) between the variable and the indicator within that ethnic group; — denotes no significant association. Associations are unadjusted for other variables and for clustering. Source: primary bivariate analysis, condensed from full cross-tabulations.

Several associations were ethnic-specific. Maternal education level was significantly associated with stunting among the Pian only (p=0.001), not among the Pokot, despite Pokot mothers having markedly lower overall education levels. This suggests that among the Pokot, other factors (such as feeding practices) may offset the effect of low formal education. Clean water source was significantly associated with underweight and stunting among the Pian but showed a weaker, non-significant association with underweight among the Pokot. Continuous breastfeeding was significantly associated with reduced underweight and stunting among the Pokot (p<0.001) but not among the Pian, while bottle-feeding, more common among the Pokot (68.7% vs 31.0% of

children 6–23 months; χ^2=17.61, p<0.001), was significantly associated with stunting in both groups (Table 2), a finding discussed further below.

4. DISCUSSION

This study set out to determine whether the previously documented gap in child undernutrition between Amudat (Pokot) and Nakapiripirit (Pian) districts persists when examined at household level, and what factors underlie it. Pian children had higher prevalence on all three anthropometric indicators, but only the underweight differential was statistically significant, and only narrowly (p=0.045, with the lower confidence limit of the prevalence ratio at 1.00). The stunting and wasting differences point the same way but are compatible with no difference. The direction of the gap is broadly consistent with earlier sub-regional food security assessments that ranked Nakapiripirit as more food-insecure and more malnourished than Amudat (World Food Programme and UNICEF, 2015), and it aligns with more recent evidence that undernutrition in Karamoja varies substantially by locality and livelihood zone rather than being homogenous across the sub-region (Okidi et al., 2022; Mokori et al., 2025).

The stunting prevalence recorded here (25.9% Pokot; 34.1% Pian) sits within the range reported by the most recent Karamoja-wide assessments (25.3–41.4%) (World Food Programme, UBOS, UNICEF and IBFAN, 2020; Mokori et al., 2025), while remaining substantially above the 2022 Uganda national average of 24.4% (UBOS and ICF, 2023), reaffirming that Karamoja, and particularly its more disadvantaged districts such as Nakapiripirit, continues to lag far behind national progress. The wasting prevalence found in this study (8.9–11.1%) is likewise consistent with, though slightly lower than, the 9.6–13.0% reported in the most recent Karamoja FSNA-based analyses (Mokori et al., 2025), and considerably higher than the 2022 national average of 3.2% (UBOS and ICF, 2023). Taken together, these comparisons confirm that, almost a decade after the original data underlying this analysis were collected, Karamoja, and the ethnic groups compared here specifically, remains an outlier within Uganda's otherwise improving nutrition landscape, echoing the persistent burden of undernutrition described for the sub-region as a whole (WFP, 2016).

The higher prevalence among boys than girls on stunting, wasting and underweight in both ethnic groups, a descriptive pattern not formally tested here, mirrors both the 2016/2022 Uganda Demographic and Health Surveys and multiple recent regional studies. Okidi et al. (2022) similarly found male sex to be a significant predictor of underweight and stunting across pastoral and agro-pastoral zones of Karamoja, and the male disadvantage in undernutrition has been documented in a meta-analysis of 16 sub-Saharan African Demographic and Health Surveys (Wamani et al., 2007) as well as more recent Karamoja-specific analyses (Mokori et al., 2025). Proposed explanations include greater male biological vulnerability to infection in early life and gendered household resource allocation favouring girls in pastoralist societies where female children carry marriage-related economic value, a pattern our qualitative findings (reported in the companion paper) also suggest operates among the Pokot and Pian.

Household size, maternal knowledge of IYCF and malnutrition causes, dietary diversity and meal frequency emerged as the most consistent cross-cutting correlates in this study's unadjusted analysis, corroborating a substantial and growing body of recent literature from pastoralist settings. Among settled pastoralist populations in Kenya, water source hygiene and caregiver income were identified as leading predictors of undernutrition (Adongo et al., 2024), while a comparative study of Isiolo pastoralist communities found that sub-optimal complementary feeding driven by low minimum dietary diversity (35.4%) and low minimum acceptable diet (25.3%) was strongly linked to child age, sex and caregiver education (Amunga et al., 2022). These findings resonate closely with the household dietary diversity and meal-frequency associations documented here, suggesting that complementary feeding quality, rather than food availability alone, is a shared driver of undernutrition across East African pastoralist populations.

The divergence in the role of maternal education between the two ethnic groups is a notable and somewhat counter-intuitive finding: education was significantly protective against stunting among the Pian but not among the Pokot, even though Pokot mothers had markedly lower education levels overall (96.3% with no education vs 71.9% among the Pian). Evidence from the Democratic Republic of Congo likewise shows that

the association between maternal education and child nutritional status is not uniform: it differed by the nutritional indicator used and, for some indicators, appeared or disappeared once province of residence was taken into account (Emina et al., 2011). Where formal education is almost universally absent, as among the Pokot in this sample, its marginal effect on nutrition outcomes may be swamped by other household behaviours. Dietary diversity scores were marginally higher among the Pokot (3.7 vs 3.5), but the difference was not significant, so this explanation remains tentative and needs testing in an adjusted model.

Finally, the association between higher bottle-feeding among the Pokot and paradoxically lower stunting deserves cautious interpretation rather than a literal reading that bottle-feeding is protective. Bottle-feeding is more plausibly a marker of household purchasing power and access to substitute/formula feeds when maternal milk supply is perceived as inadequate, rather than a nutritionally superior practice in its own right; unsafe bottle-feeding is well documented elsewhere as a risk factor for diarrhoeal disease and undernutrition when hygiene is poor (WHO, 2009). Given that this study did not assess bottle and water hygiene directly, this association should be treated as hypothesis-generating rather than causal, and warrants targeted follow-up research.

Three points from this study are worth carrying forward. First, a shared agro-climate did not produce a shared nutrition outcome: two neighbouring groups living under the same semi-arid conditions differed significantly on underweight, and in the same direction on every other indicator. Second, the Pokot, whose mothers were the least educated in the sample (96.3% with no formal schooling), had the lower prevalence of underweight. Formal education alone therefore cannot account for the gap, and factors that programmes can change, such as feeding practices, household size and maternal knowledge, deserve closer attention. Third, the study offers planning figures for future work. Detecting an 8-percentage-point difference in stunting between two such groups with 80% power needs about 445 children per group, more than three times the sample used here, before any further allowance for clustering. Future ethnic or district comparisons in Karamoja should be sized with this in mind and analysed with methods that account for the cluster design.

4.1 Strengths and limitations

This study's principal strength is its explicit ethnic-group comparison design within a shared agro-ecological zone, which helps isolate social and behavioural determinants from purely environmental ones, a distinction that pooled Karamoja-wide analyses cannot make. Its cross-sectional design, however, precludes causal inference, and self-reported dietary and IYCF data are subject to recall and social-desirability bias. The moderate sample size (135 households per district) limited statistical power for some sub-group comparisons (e.g., MUAC-based malnutrition, severe stunting), which may explain why several indicators showed consistent directional differences without reaching conventional significance thresholds. Because primary data collection pre-dates the most recent Karamoja FSNA rounds, prevalence estimates are compared with, rather than pooled into, more recent regional trend data.

The analysis also did not account for the two-stage cluster design. Chi-square tests and confidence intervals were computed as though children had been sampled independently, yet children in the same village tend to share diet, water source and exposure to illness. True standard errors are therefore likely to be larger than those reported, and the underweight differential, at $p=0.045$ with a prevalence ratio whose lower confidence limit is 1.00, may not hold once clustering is modelled. Power was also limited. As noted in Section 2.2, 135 children per district gave roughly 34% power to detect the 8.4-percentage-point stunting difference used for planning (two-sided $\alpha=0.05$), and 80% power only for differences of about 16 percentage points. The stunting, wasting and MUAC differences that did not reach significance are therefore inconclusive rather than evidence that the two groups are alike.

Two further limitations are worth stating directly. First, the associations in Table 2 rest on bivariate chi-square tests taking one explanatory variable at a time against each outcome. This is useful for identifying which factors move together with undernutrition, but it cannot separate their independent contributions where they cluster within the same households, as household size, maternal education, marital status and dietary diversity plausibly do here. A multivariable regression model entering these variables jointly, so that each factor's ass-

ociation can be read net of the others, is the natural next analytic step for these data and is not attempted in this paper. Second, restricting the comparison to two of Karamoja's nine districts, chosen for the clean ethnic contrast they offer within a shared agro-climate, means the findings speak most directly to the Pokot–Pian comparison itself rather than to the sub-region as a whole. The substantial cross-district heterogeneity documented in recent Karamoja-wide assessments (Okidi et al., 2022; Mokori et al., 2025) suggests these patterns should not be extended to other Karamoja districts or ethnic groups without direct testing. Relatedly, the questionnaire captured household income shares and livelihood sources but no validated household food-security or healthcare-access index; future rounds of this comparison would benefit from adding standard instruments such as the Household Food Insecurity Access Scale alongside a measure of distance or time to the nearest health facility, both plausible confounders of the associations reported here.

5. CONCLUSION AND RECOMMENDATIONS

Despite sharing the same harsh agro-climatic zone, Pian children in Nakapiripirit had a significantly higher prevalence of underweight than Pokot children in Amudat, and a higher but not statistically significant prevalence of stunting and wasting. The underweight difference is borderline and was not adjusted for clustering. Because the two groups share an agro-climate, environment alone seems unlikely to explain the gap. Household size, marital status, maternal knowledge of IYCF and malnutrition causes, dietary diversity and meal frequency were each associated with undernutrition in both groups and are plausible contributors, but these are unadjusted cross-sectional associations and cannot establish that these factors drive the differential. Read alongside recent Karamoja-wide evidence of substantial intra-regional heterogeneity in undernutrition (Okidi et al., 2022; Mokori et al., 2025), the findings point towards a shift away from uniform sub-regional nutrition programming towards ethnic- and district-tailored interventions.

We recommend: (i) intensifying community-based nutrition education on IYCF and the causes of malnutrition, delivered through channels accessible to mothers with little or no formal education, with particular emphasis on Nakapiripirit district; (ii) strengthening household economic resilience and family-planning/birth-spacing support to reduce the undernutrition risk associated with large household size; (iii) prioritising minimum dietary diversity and meal-frequency messaging alongside existing supplementary feeding programmes, given their association with underweight and stunting in both groups; (iv) conducting focused follow-up research on bottle-feeding and water/formula hygiene practices in Amudat district to clarify the unexpected association observed here; (v) periodically repeating disaggregated, ethnic-group-specific anthropometric surveys in Karamoja to track whether the observed differentials are narrowing in response to ongoing interventions; (vi) applying multivariable regression that accounts for the cluster sampling design to these or newly collected data so that the independent contribution of household size, maternal knowledge, dietary diversity and the other correlates identified here can be separated from their shared clustering within poorer households, ideally within a longitudinal or cohort design capable of establishing temporal and causal ordering; and (vii) extending this comparative approach to additional Karamoja districts and ethnic groups to test how far the Pokot–Pian pattern generalizes across the sub-region.

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