Research Article

Simultaneous Wasting and Stunting (WaSt), Wasting and Anaemia (WaAn), and Wasting, Stunting, and Anaemia (WaStAn) Among Children Aged 6–59 Months in Karamoja, Uganda

Alex Mokori[1], Nicholas Kirimi[2], Amos H Ndungutse[3], Zakaria Fusheini[2], Muzafaru Ssenyondo[2]

1. UNICEF Uganda, Uganda; 2. UNICEF, New York City, United States; 3. Independent researcher

Child malnutrition remains a significant public health concern in Karamoja, Uganda. This study investigated the prevalence and determinants of simultaneous wasting, stunting, and anaemia (collectively termed WaStAn) among children aged 6-59 months in Karamoja. Secondary data from the Food Security and Nutrition Assessment (FSNA) collected by the World Food Program, UNICEF, and the Uganda Bureau of Statistics in February 2022 were used. The participants included women aged 15-49 years and children aged 0-59 months living with their mothers. The analysis revealed a high prevalence of wasting (13.0%), stunting (41.4%), and anaemia (55.1%), with younger children (12-23 months) disproportionately affected. A worrying 4.6% of children presented with WaStAn, highlighting the need for comprehensive approaches targeting multiple forms of undernutrition. Factors associated with WaStAn included age, sex (males more affected), geographical location, socioeconomic status, maternal education, food consumption score (wasting), and residence type (stunting). The study underscores the urgency for multisectoral interventions addressing these risk factors across various levels. Recommendations include improved screening and treatment, promotion of optimal feeding practices, micronutrient supplementation, deworming, hygiene improvements, women's empowerment, enhanced food security, and strengthened district-level capacity for nutrition management.

Corresponding author: Alex Mokori, alexkmokori@gmail.com

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1. Introduction

Child undernutrition is a persistent public health concern in low- and middle-income countries, with stunting identified as the predominant condition among children under 5 years[1][2][3][4]. Key indicators for undernutrition include underweight, stunting, and wasting, with stunting having the highest prevalence in low- and middle-income countries[3][4]. Contributors to undernutrition include insufficient food intake, recurrent infections, poor sanitation practices, and low parental education[3][4]. Despite a decline in stunting prevalence in sub-Saharan Africa (SSA), rates remain above 40%, with persistently high rates in countries like Burundi[3]. Implementation of interventions to address childhood undernutrition has been slow, contributing significantly to child mortality in these regions[5][6]. In 2021, global estimates reported 148.1 million stunted children and 45 million children with wasting[7]. Children aged 1 to 3 years face a heightened risk of coexisting stunting, underweight, and wasting due to inadequate complementary feeding practices[8]. Globally, 45 million children under five suffer from wasting, with 14 million experiencing severe wasting, significantly elevating the risk of mortality. Stunting, affecting 144 million children, hampers physical and cognitive development, while anaemia, impacting 273 million children, poses risks such as fatigue, weakened immunity, and increased susceptibility to infections[8]. Africa bears a substantial burden of wasting, stunting, and anaemia, with prevalence rates exceeding World Health Organization (WHO) thresholds[9]. The Karamoja region in Uganda, characterized by high poverty, illiteracy, conflict, and climate shocks, reports elevated rates of wasting (13.1%) and stunting (30.7%) among children aged 6 to 59 months in 2020[10]. The prevalence of anaemia in this region is notably high at 53%, surpassing the national average of 49%[10][11]. A study explored risk factors for the coexistence of stunting, underweight, and wasting in Sub-Saharan Africa, revealing variations among countries and regions linked to healthcare access, nutritional practices, beliefs, and governmental health policies[8]. Simultaneous wasting and stunting (WaSt) represent a severe form of malnutrition in children, significantly increasing the risks of mortality and morbidity[12]. WaSt is often associated with chronic exposure to stressors, including food insecurity, infections, poor sanitation, and violence[13]. Unfortunately, readily available data on the prevalence of WaSt among children aged 6-59 months in the Karamoja region is scarce. However, a study that utilized Demographic and Health Survey (DHS) and Multiple Indicator Cluster Survey (MICS) data from 2000 to 2016 across 84 countries estimated the prevalence of WaSt in Uganda at 2.3%, with regional variations ranging from 0.9% to 4.5%[13].

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Considering the elevated rates of wasting and stunting in the Karamoja region, it is reasonable to infer that the prevalence of WaSt in this region could range between 3% to 5%, although specific data for Karamoja is not directly available[13].

The prevalence of wasting, stunting, and anaemia (WaStAn) among children is influenced by a myriad of interconnected factors operating at various levels, including individual, household, community, and national levels[14]. A range of common risk factors associated with these conditions can be identified at individual, household, community, and national levels. Individual factors contributing to wasting, stunting, and anaemia encompass age, sex, birth weight, prematurity, genetic influences, infections, parasitic infestations, chronic diseases, dietary intake, dietary diversity, breastfeeding practices, complementary feeding practices, micronutrient deficiencies, and immunization status[14][15][16]. In the household context, risk factors include household size, income, food security, maternal education, maternal age, maternal health and nutrition status, maternal anaemia, maternal infections, maternal mental health, maternal care practices, paternal education, paternal involvement, sibling competition, household hygiene and sanitation practices, and access to safe water and health services[17][14][18]. Factors at the community level encompass community poverty, food availability and accessibility, social norms and beliefs, support networks, health and nutrition programs and policies, hygiene and sanitation infrastructure and services, water quality and quantity, exposure to natural disasters and conflicts, and environmental aspects such as climate change and pollution[14][19]. At the national level, key factors include economic development, food security and sovereignty, health and nutrition systems and governance, legislation and regulation on food quality and safety, social protection and safety nets, education and literacy levels, gender equality and women's empowerment, peace and security, and participation in regional and global initiatives[17][14].

Addressing the complex issue of WaStAn in the Karamoja region necessitates a comprehensive and multisectoral approach, focusing on the underlying causes and determinants of malnutrition across various levels. Several interventions can be considered. At the individual level, key interventions include screening and identification of children with WaStAn, providing timely appropriate treatment and care, promoting optimal infant and young child feeding practices, supplementing diets with micronutrients, deworming and immunization, preventing and managing infections, promoting hygiene and sanitation practices, and offering psychosocial support for both children and caregivers[16][18]. For households, effective strategies involve improving food security and dietary diversity, empowering women in decision-making, educating and counseling caregivers on child

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health and nutrition, enhancing household hygiene and sanitation facilities, providing safe water sources or water treatment options, bolstering household resilience to shocks, and offering cash transfers or vouchers to vulnerable households[18][19]. At the community level, mobilization and sensitization efforts, establishment of community-based management of acute malnutrition (CMAM) services, strengthening of community health systems and referral mechanisms, involvement of community leaders in nutrition interventions, promotion of supportive social norms and behaviors, creation of community gardens or animal husbandry projects, and implementation of community-based water, sanitation, and hygiene (WASH) interventions are crucial[18][19]. Interventions at the district level should focus on coordination and collaboration among different sectors and stakeholders, developing and implementing district-specific nutrition plans and policies, allocating adequate resources for nutrition, monitoring and evaluating interventions and outcomes, advocating for nutrition, capacity building and training of district health and nutrition staff, and strengthening district health systems and infrastructure. Additionally, district-level WASH interventions should be considered[18][19]. On a national scale, integrating nutrition into development plans and strategies, formulating and enforcing national nutrition policies, standards, and guidelines, establishing and supporting national coordination mechanisms for nutrition, generating and disseminating evidence-based information on nutrition, mobilizing and allocating sufficient funds for nutrition, engaging in partnerships with regional and international actors, and promoting and protecting human rights related to nutrition are vital interventions[18][19].

There is a distinct gap in addressing the coexistence of wasting, stunting, and anaemia in policy, guidance, programming, and financing, which needs urgent attention[20]. This is due to limited research in SSA, especially in regions like Karamoja in Uganda, with protracted emergencies and high levels of childhood undernutrition. The research lag underscores the need for more studies utilizing current, representative data to investigate risk factors associated with WaStAn among children under 5 in SSA. Hence, it is important to understand its magnitude to appropriately plan for the prevention, control, and management of children under 5 years with WaStAn in the Karamoja region, Uganda. This paper investigates the prevalence and factors associated with WaStAn in children 6 to 59 months in 2022 in Karamoja. The aim is to contribute to evidence-based policies and interventions tailored to the nutritional needs of children in the sub-region, with potential lessons for other regions within and outside Uganda that are facing similar challenges.

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2. Materials and Methods

2.1. Study design

This study used secondary data from the district and population-representative 2022 Karamoja FSNA survey. The original survey computed the sample sizes for each of the nine districts in Karamoja based on the prevalence of malnutrition, food security, and anaemia in the Karamoja FSNA 2021. In the calculation of the sample size for anthropometry, a design effect of 1.5 was used across all districts, but the precision varied depending on the prevalence of Global Acute Malnutrition (GAM). A 5% non-response rate was factored into the determination of the number of children to be assessed during the anthropometric survey.

2.2. Sampling frame and procedure

The sampling frame used in the nine districts was based on the 2014 Uganda National Population and Housing Census (NPHC) as approved by the Uganda Bureau of Statistics (UBOS). The census frame is a complete list of all census enumeration areas (EAs) created for the 2014 NPHC. In Uganda, an EA is a geographic area that covers an average of 130 households. Currently, Uganda is divided into administrative districts, each district is sub-divided into sub-counties, each sub-county into parishes, and each parish into villages. The sampling frame contains information about the EA location, type of residence (urban or rural), and the estimated number of residential households at the time of the assessment. The adopted sample for FSNA in the Karamoja sub-region was stratified and selected in two stages (two-stage cluster sampling methodology). Samples from each district were selected independently in each stratum in two stages. Implicit stratification and proportional allocation were achieved at each of the lower administrative levels by sorting the sampling frame within each sampling stratum before sample selection, according to administrative units at different levels, and by using probability proportional to size selection (PPS).

In the first stage, a probability sample of EAs was randomly and independently selected from each stratum using an updated list of parishes that constitute a district. The sampling frame was sorted by district, sub-county, parish, village, and EA. A household listing operation was carried out in the EAs, and the resulting lists of households served as the sampling frame for the selection of households in the second stage. Some selected EAs were large in size, with more than 250 households. To minimize the task of household listing, the large EAs were segmented, and only one segment, with probability proportional to the segment size, was selected for the assessment. Household listing was conducted only in the selected segment, and therefore, the adopted cluster in the survey was either an EA or a segment of an EA.

In the second stage, a fixed number of households was systematically sampled from a newly established household listing for each selected EA, and interviews were conducted in the sampled households. Systematic random sampling methodology was assumed for all districts and was done by ensuring a random start and a calculated sampling interval from the list of village households generated by the Listing Teams. A sampling interval for each village was determined by dividing the total number of verified households by the estimated sample. The first household was determined randomly using the lottery method by drawing a random number within the sampling interval. The interval was thereafter applied across the sampling frame to generate the list of households to be visited in the field. Each team was provided with a list of households to be surveyed daily.

No replacements or changes of the selected households were allowed during the survey implementation stages to minimize bias. If an individual or an entire household was absent, the teams were instructed to return to the household or revisit the absent individual up to two times on the same survey day. If they were unsuccessful after this, the individual or the household was recorded as an absence and not replaced with another household or individual. If the individual or an entire household refused to participate, then it was considered a refusal, and the individual or the household was not replaced with another.

2.3. Study setting

The study took place in the Karamoja sub-region, which covers an area of 27,528 km and comprises the nine districts of Abim, Amudat, Kaabong, Karenga, Kotido, Moroto, Nabilatuk, Nakapiripirit, and Napak. The region is projected to have a population of 1.4 million in 2022 by UBOS (https://en.wikipedia.org/wiki/Karamoja).

2.4. Participants, recruitment, and sampling

The study participants were identified from the April 2022 Karamoja FSNA database, with a sample size of 5,023 children. The initial sample was reduced to 3,657 children after excluding duplicates, children with missing information, and those under six months or above 59 months of age. Out of the 3,657 children, 57 were excluded for incomplete data on the four nutrition indices, resulting in a final sample of 3,600 children included in the analysis. The final sample consisted of 3,600 children, of which 50.3% were male and 49.7% were female. The children in the sample were divided into two age groups, with 33.0% aged 6-23 months and 67.0% aged 24-59 months.

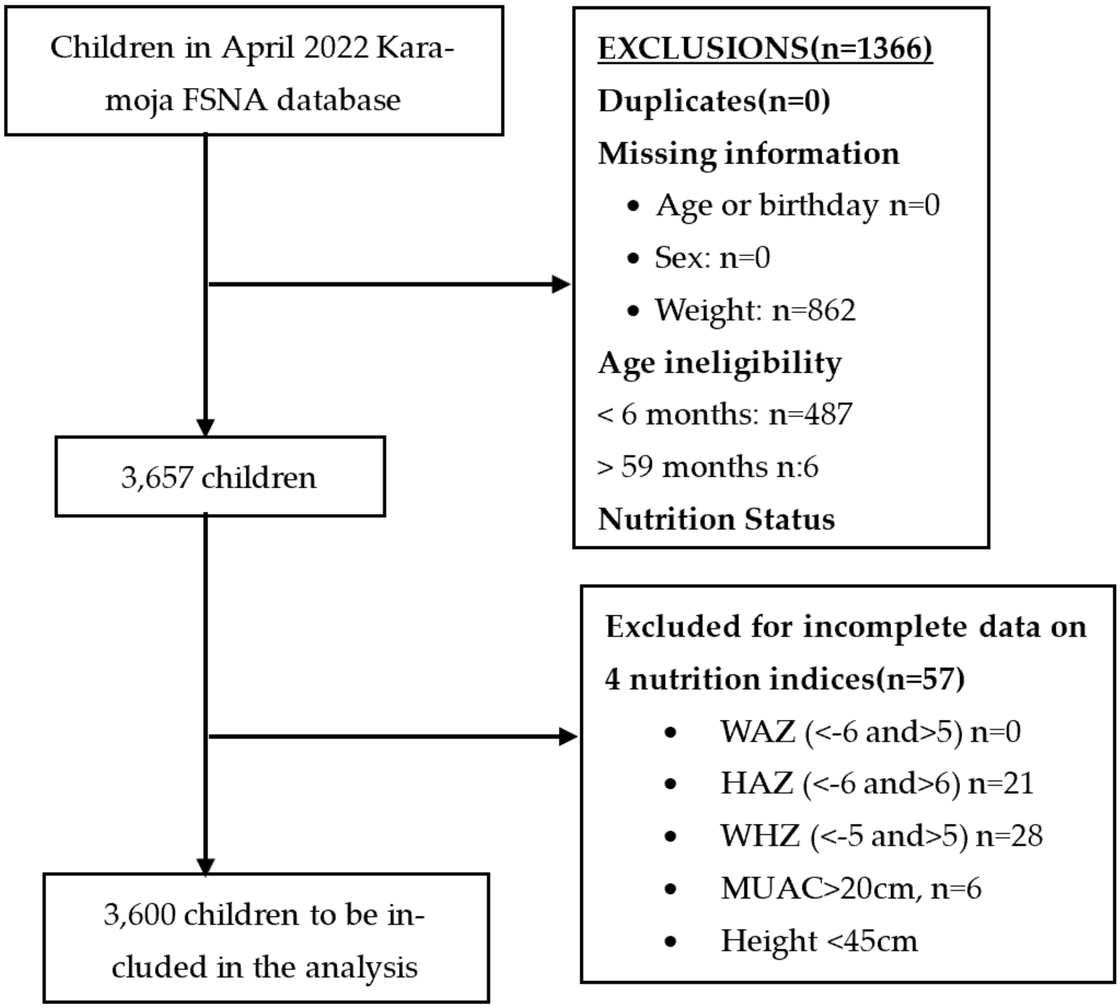

Figure 1. Flow chart showing study participants' selection from the April 2022 FSNA database.

2.5. Ethical considerations

The 2022 Karamoja FSNA data set was requested for and shared by the World Food Programme (WFP) for re-analysis for this study. No individual identifiers that could jeopardize the respondents were used for the study.

2.6. Data collection

The primary data used for this study were collected using an electronic version of the quantitative data collection questionnaire, which was specifically prepared for use on the Open Data Kit (ODK) platform. The tool was administered through face-to-face interviews with mothers, caregivers, and/or household heads in the households of the respondents. To ensure privacy and minimize bias, the interviews were conducted in a private place out of reach of non-participants. This was done using mobile tablets provided by the WFP. Data collection involved the active participation of the local and civic leaders, who were carefully selected and used as guides to identify households for interviews and provided support during the anthropometric measurements.

The enumerators introduced themselves to the respondents and obtained informed consent before conducting interviews. They briefly explained the purpose of their visit, who funded and supported the study, how data would be collected, the expected duration of the interview, and how the results would be used. Consent was derived from the actual people involved. Care was taken to ensure that information was obtained from a reliable and knowledgeable source, who was an adult member of the household and, in most cases, was the household head or her/his spouse. Field data collection lasted an average of 11 days in the selected districts. A capillary blood sample was taken from the fingertips of children 6-59 months of age and all women 15-49 years old (non-pregnant, pregnant, and breastfeeding). The haemoglobin (Hb) concentration was recorded to the closest gram per decilitre using the portable HemoCue Hb 201+ Analyser. Where severe anaemia was detected, the child and/or woman were immediately referred for treatment.

2.7. Outcome and exposure factors

The outcome of this study was child wasting, stunting, and anaemia. Anaemia was defined as having a haemoglobin of <11g/dl, wasting as a weight for height z-score (WHZ)<-2, and stunting as a height for age z-score (HAZ) <-2. WaStAn was defined as having WHZ<-2, HAZ<-2, and Hb<11g/dl. The exposure variables were broadly categorized into individual child demographic, health, and nutrition characteristics; maternal demographic, health, and nutrition characteristics; and household socio-economic characteristics. All the information used in this study was self-reported by the respondents.

2.8. Data management and analysis

Entry of findings during data collection happened simultaneously at the time of administering the questionnaire, given the use of the mobile tablets based on the ODK software. Data from properly filled questionnaires was submitted online, mainly daily, but was subject to the availability of internet connectivity in the field. All the submitted data was stored on the World Food Programme servers, from where it was accessed for final cleaning and analysis. Data was exported from the database software to Microsoft Excel, SPSS, and ENA for SMART for processing and analysis.

Anthropometric data was exported and analysed using the WHO child growth software https://www.who.int/childgrowth/software/en/ for the generation of z-scores, which were used to determine nutritional indicators of WHZ and HAZ. Other data was analysed using IBM Statistics (SPSS) ver22. Morbidity and other health and sanitation data, such as the prevalence of diseases and conditions occurring two weeks prior to the survey, latrine coverage, and health indicators, were reported using descriptive statistics.

Food security data was handled systematically to generate the household wealth index from ownership of household property using principal components analysis. The wealth index was derived from the first principal component, which was then ranked and categorized into quintiles. Household food consumption scores were generated based on the standardised food groups that were weighted using pre-assigned codes. The other facets of food security, such as food sources, expenditures on food, and coping mechanisms, were analysed largely using descriptive statistics.

Factors associated with malnutrition and food security independently associated with the outcome variables were assessed using binary logistic regression since it was a dichotomous variable (1 = WaStAn, 0 = no WaStAn). Multinomial logistic regression was used for household food consumption diversity (food consumption scores). The variable Food Consumption Group, with 3 categories (1) poor consumption, (2) borderline consumption, and (3) acceptable consumption, was used. The category for acceptable food consumption was used as a reference category in the multinomial logistic regression model. The covariates modelled included household socio-economic status, mothers' education, health and sanitation practices, and morbidity factors; and history of crop cultivation in the case of the food security models.

Frequency tabulation was used to describe the demographics and other study population variables of importance. Measures for central tendency and dispersion (means and standard error of means) were used to describe the variables of importance. Mean and standard error of means (SEM) were used for continuous variables and percentages for categorical variables. One-way ANOVA was used to determine the mean variation in haemoglobin of children 6-23 months in 2006 and 2011. All data management and statistical analysis were performed with STATA/MP version 11.00 (2007; Stata Corporation, College Station, TX) and IBM SPSS 22. All the statistics were considered significant at a p-value of less than 5%.

2.9. Statistical methodology

Non-parametric statistical classification tree modelling methodologies, as described in Kajungu's research, were applied for the analysis of data used in this study[21]. The classification and regression tree (CART) analysis was used to investigate direct and indirect measures of predictors of risk of childhood anaemia in children 6-23 months in Uganda. Kajungu and colleagues presented four main reasons for the use of the CART technique over other multivariate analytical methodologies: 1) contrary to classical regression that uses linear combinations, this method does not require the data to be linear or additive; 2) classification tree analysis does not require predefining possible interactions between factors; the resulting classification trees accommodate intuitively more flexible relationships among variables, missing covariate values, multi-collinearity, and outliers; 3) when values for some predictive factors are missing, they can be estimated using other predictor ("surrogate") variables, permitting the use of incomplete data sets when generating regression trees; 4) it allows for the calculation of the overall discriminatory power, or relative importance, of each explanatory variable.

2.10. Classification tree modelling

To gain more insight into factors related to the dependent variables of simultaneous wasting, stunting, and anaemia among children 6-59 months in Karamoja in 2022, the binary classification tree modelling methodology, as applied by Kajungu, was used[21].

2.11. Ranking predictor variables by relative importance

The classification tree analysis aims at developing a simple tree structure for predicting data, resulting in relatively few variables that appear explicitly as splitters, a result that may suggest that the other variables are not important in understanding or predicting the dependent/outcome variable[21]. These researchers indicated that unlike a linear regression model, a variable in a

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classification tree modelling can be considered highly important even if it never appears as a node splitter. Because the method keeps track of 'surrogate' splits in the tree-growing process, the contribution a variable can make in prediction is not determined only by primary splits. To calculate a variable importance score, the classification tree analysis method looks at the improvement measure attributable to each variable in its role as either a primary or a surrogate splitter. The values of all these improvements are summed over each node and totaled, and are then scaled relative to the best-performing variable. The variable with the highest sum of improvements is scored 100, and all other variables will have decreasing lower scores. The importance score measures a variable's ability to perform in a specific tree of a specific size either as a primary splitter or as a 'surrogate' splitter. The relative importance ranking of variables tends to change dramatically when comparing trees of substantially different sizes. Therefore, the importance scores (rankings) are relative to a given tree structure and should not be interpreted as the absolute information value of a variable. The TREE command in IBM SPSS Statistics version 20 was used to generate the classification trees showing the classification rules generated through recursive partitioning and relative variable importance.

3. Results

3.1. Prevalence of child wasting, stunting and anaemia among children 6-59 months

The findings showed that 13.0% of the children 6-59 months in the sample had wasting (WHZ), 41.4% stunted, 9.8% wasted based on MUAC, and 17.4% had combined GAM (wasting by either WHZ or MUAC). More than half of the children 6-59 months (55.1%) were anaemic, with 29.5% and 23.9% being severely and moderately anaemic, respectively (Table 1).

Nutritional status	Wasting (WHZ)	Wasting (MUAC)	Combined GAM	Stunting (HAZ)	Anaemia (Hb)
	n (%)	n (%)	n (%)	n (%)	n (%)
Not malnourished	3,132 (87.0)	3,246 (90.2)	2,975 (82.6)	2,111 (58.6)	1,615 (44.9)
Malnourished	468 (13.0)	354 (9.8)	625 (17.4)	1,489 (41.4)	1,985 (55.1)
Moderately malnourished	369 (10.3)	274 (7.6)	606 (16.8)	775 (21.5)	859 (23.9)
Severely malnourished	99 (2.8)	80 (2.2)	150 (4.2)	714 (19.8)	1,062 (29.5)

Table 1. Nutritional Status among children 6-59 months in Karamoja in 2022.

3.2. Nutritional status among children 6-59 months by age group

The findings from the cross-tabulation analysis revealed the existence of a statistically significant association between the age group and all the nutritional statuses of wasting, stunting, and anaemia ($p<0.001$). The younger children (12-23 months) had a higher prevalence of malnutrition than those in the other age groups. However, it seems the risk of child wasting, indicated by WHZ, decreased with the age of the children, with the highest prevalence being in the age group of 12-23 months (17.1%) and decreasing in the older age groups [24-35 months (13.4%), 36-47 months (9.9%), 48-59 months (9.7%)].

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Age group (months)	n	Wasting (WHZ)	Stunting	Wasting (MUAC)	Combined GAM	Anaemia
		n (%)	n (%)	n (%)	n (%)	n (%)
6-11	385	64(16.6)	83 (21.3)	53 (13.8)	86 (22.3)	249 (6.9)
12-23	803	137 (17.1)	365 (45.5)	142 (17.7)	199 (24.8)	478 (13.3)
24-35	834	112 (13.4)	407 (48.8)	88 (10.6)	149 (17.9)	452 (12.6)
36-47	900	89 (9.9)	374 (41.6)	58 (6.4)	119 (13.2)	445 (12.4)
48-59	678	66 (9.7)	261 (38.5)	13 (1.9)	72 (10.6)	361 (10.0)
Total	3,600	468 (13.0)	148 (41.4)	354 (9.8)	625 (17.4)	1985 (55.1)

Table 2. Nutritional status among children 6-59 months by age group.

3.3. Prevalence of WaStAn among children 6 to 59 months in Karamoja

About 1 in 10 children aged 6-59 months (7.1%) in Karamoja have WaSt, with the highest prevalence being among the 12-23 months age group (11.5%) and the lowest in the 48-59 months age group (3.5%). The co-existence of stunting and anaemia (StAn) is at 11.6%, and the co-existence of wasting by combined MUAC and anaemia is at 10.5%. The prevalence of wasting, stunting, and anaemia (WaStAn) among children 6 to 59 months in Karamoja is 4.6%.

The cross-tabulations indicated a significant association between WaSt and child age ($p<0.001$), sex ($p<0.001$), district ($p<0.001$), wealth index ($p<0.001$), maternal education ($p<0.001$), and food consumption score ($p=0.023$). WaStAn was significantly associated with child age ($p<0.001$), sex ($p<0.001$), district ($p<0.001$), wealth level ($p<0.001$), and maternal education ($p<0.001$). StAn had a significant association with child age ($p<0.001$), sex ($p=0.012$), district ($p<0.001$), type of residence ($p=0.006$), wealth level ($p=0.005$), and maternal education ($p<0.034$). Combined WastingAn were associated with child age ($p<0.001$), sex ($p=0.006$), district ($p<0.001$), wealth level ($p<0.001$), and maternal education ($p<0.001$). It is evident that age group, sex, district, wealth index, and maternal education were significantly associated with WaSt, WaStAn, StAn, and Combined WastingAn. Type of residence and the food consumption score were only associated with StAn ($p=0.006$) and WaSt (0.023).

The children aged 12-23 months had the highest prevalence of WaSt (11.5%), WaStAn (1.6%), and combined WaStAn (3.3%), while those aged 48-59 months had the lowest prevalence. However, StAn was highest among the children aged 24-35 months (3.3%) and lowest in the age group 6-11 months (0.8%). Across all the nutritional status indices, the male child had a higher prevalence compared to the female counterparts.

Kotido district had the highest prevalence of WaSt (1.4%), WaStAn (1.2%), and combined WastingAn (2.7%), followed by Moroto district. StAn was only significantly associated with the area of residence. The children living in rural areas had a significantly higher prevalence of StAn (10.4%) compared to those in urban areas (1.2%).

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Variables	WaSt		StAn		WaStAn		Combined WastingAn	
	n (%)	p	n (%)	p	n (%)	p	n (%)	p
Age group (months)		**<0.001**		**<0.001**		**<0.001**		**<0.001**
6-11	22 (5.7)		30 (0.8)		17 (0.5)		56 (1.6)	
12-23	92 (11.5)		96 (2.7)		59 (1.6)		119 (3.3)	
24-35	75 (9.0)		119 (3.3)		49 (1.4)		89 (2.5)	
36-47	42 (4.7)		99 (2.8)		25 (0.7)		72 (2.0)	
48-59	24 (3.5)		73 (2.0)		14 (0.4)		43 (1.2)	
Sex		**<0.001**		**0.012**		**0.001**		**0.006**
Male	165 (4.6)		234 (6.5)		104 (2.9)		216 (6.0)	
Female	90 (2.5)		183 (5.1)		60 (1.7)		163 (4.5)	
District		**<0.001**		**<0.001**		**<0.001**		**<0.001**
Abim	9 (0.2)		33 (0.9)		3 (0.1)		14 (0.4)	
Amudat	20 (0.6)		48 (1.3)		16 (0.4)		49 (1.4)	
Kaabong	32 (0.9)		39 (1.1)		12 (0.3)		44 (1.1)	
Kotido	52 (1.4)		52 (1.4)		44 (1.2)		96 (2.7)	
Moroto	40 (1.1)		46 (1.3)		22 (0.6)		39 (1.1)	

Variables	WaSt		StAn		WaStAn		Combined WastingAn	
	n (%)	p	n (%)	p	n (%)	p	n (%)	p
Nakapiripirit	24 (0.7)		54 (1.5)		19 (0.5)		34 (0.9)	
Napak	35 (1.0)		66 (1.8)		21 (0.6)		44 (1.2)	
Nabilatuk	22 (0.6)		45 (1.2)		14 (0.4)		38 (1.1)	
Karenga	22 (0.6)		34 (0.9)		13 (0.4)		24 (0.7)	
Type of residence		0.522		**0.006**		0.691		0.731
Urban	35 (1.0)		44 (1.2)		23 (0.6)		55 (1.5)	
Rural	220 (6.1)		373 (10.4)		141 (3.9)		324 (9.0)	
Polygamous marriage		0.802		0.795		0.939		0.575
No	152 (4.2)		243 (6.8)		97 (2.7)		218 (6.1)	
Yes	103 (2.9)		174 (4.8)		67 (1.9)		161 (4.5)	
Wealth		**<0.001**		**<0.001**		**<0.001**		**<0.001**
Zero	25 (0.7)		46 (1.3)		15 (0.4)		38 (1.1)	
Lowest	58 (1.6)		86 (2.4)		41 (1.1)		90 (2.5)	
Second	57 (1.6)		85 (2.4)		44 (1.2)		90 (2.5)	
Middle	57 (1.6)		81 (2.2)		36 (1.0)		75 (2.1)	
Fourth	44 (1.2)		64 (1.8)		21 (0.6)		59 (1.6)	
Highest	14 (0.4)		55 (1.5)		7 (0.2)		27 (0.8)	
Mother attending school		**<0.001**		**0.034**		**<0.001**		**<0.001**
No	235 (6.5)		358 (9.9)		156 (4.3)		352 (9.8)	

Variables	WaSt		StAn		WaStAn		Combined WastingAn	
	n (%)	p	n (%)	p	n (%)	p	n (%)	p
Yes	20 (0.6)		59 (1.6)		8(0.2)		27 (0.8)	
Food consumption score		**0.023**		0.230		0.800		0.662
Zero	25 (0.7)		46 (1.3)		15 (0.4)		22 (0.6)	
Acceptable	104 (2.9)		212 (5.9)		78 (2.2)		108 (3.00	
Borderline	104 (2.9)		131 (3.6)		63 (1.8)		91 (2.5)	
Poor	22 (0.6)		28 (0.8)		8 (0.2)		13 (0.4)	
Total	**255 (7.1)**		**417 (11.6)**		**164 (4.6)**		**379 (10.5)**	

Table 3. Prevalence of WaSt, WaStAn, StAn and combined WastingAn by Age Group.

3.4. Predicators of WaSt among children 6 to 59 months in Karamoja

Using the variables in table 3 to fit the model, the most important predictors of WaSt in Karamoja were investigated. The most important predictor of WaSt among children 6 to 59 months in Karamoja in 2022 was the district of origin, with discriminatory power of 100.0%. This was followed by wealth quintile with the power of 75.3%, child age (62.2%), food consumption score (35.6%), and sex of the child (34.1%).

Independent Variable	Power
District	100.0
Wealth quintile	76.7
Child age	63.5
Sex of the child	40.0
Food consumption score	35.7
Maternal education	33.7

Table 4. Ranking of predictors of WaSt among children 6-59 months by their overall discriminatory power.

Children aged 12-23 and 24-35 months had the highest prevalence of WaSt (10.2%) compared to those aged 6-11, 36-47, and 48-59 months (4.5%). Among the children aged 12-35 months, those from households with wealth index zero, second, and middle had the highest prevalence of WaSt (14.1%), followed by those from the lowest and fourth (9.6%) and the highest (2.9%). Among the children in the fourth and lowest household index, the male had a significantly higher prevalence of WaSt (13.6%) than the female ones (5.9%). Among the children aged 6-11 and 36-59 months, those from Moroto had a statistically significantly higher prevalence of WaSt (13.5%) than the other districts. This was closely followed by those from Amudat, Kaabong, Karenga, Kotido, Nakapiripirit, and Napak (4.5%), and Abim and Nabilatuk had the least prevalence of WaSt (1.8%). Similarly, the male children from Amudat, Kaabong, Karenga, Kotido, Nakapiripirit, and Napak had a higher prevalence of WaSt (6.2%) than the female (2.75%).

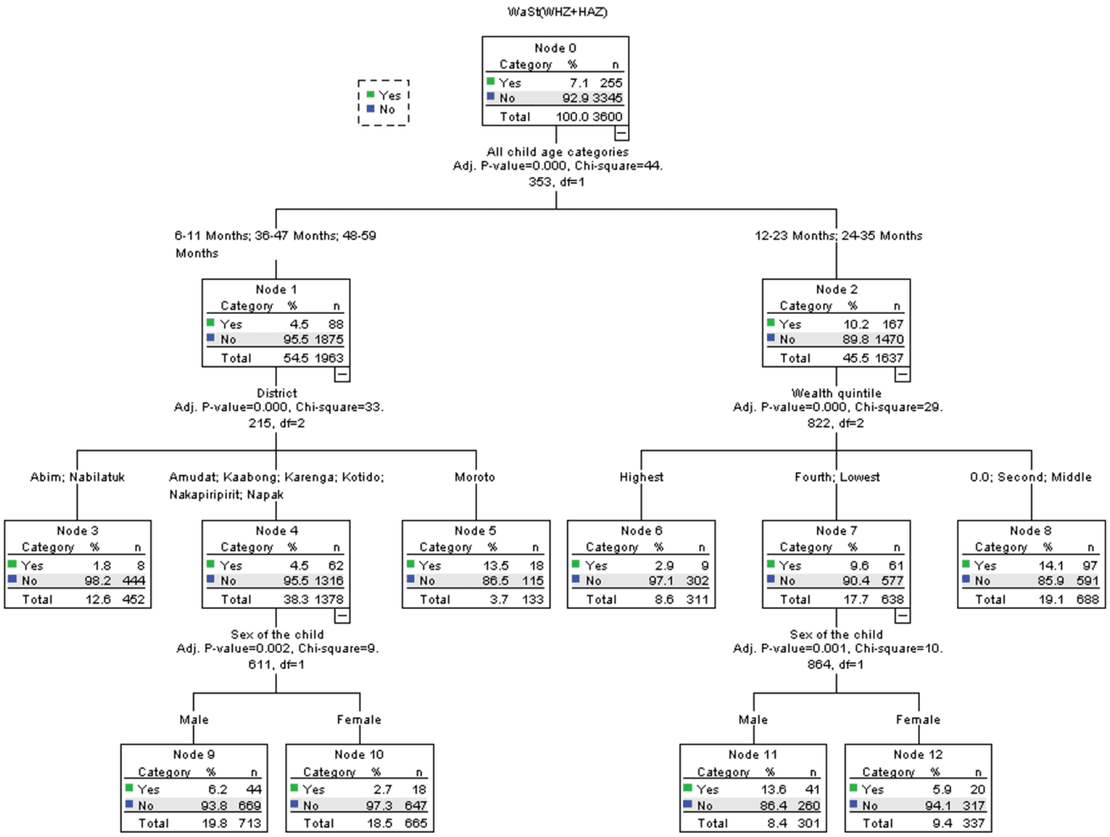

Figure 2. Predictors of WaSt among children 6-59 months by their overall discriminatory power.

3.5. Predicators for WaStAn among children 6 to 59 months in Karamoja

Using the variables in table 5 to fit the model, the most important predictors of WaStAn were investigated. The most important predictor of WaStAn among children 6 to 59 months in Karamoja in 2022 was the district of origin, with discriminatory power of 100.0%. This was followed by wealth quintile with the power of 61.9%, child age (54.4%), and maternal education (28.5%).

Independent Variable	Power
District	100.0
Wealth quintile	61.9
Child age	54.2
Maternal education	28.5

Table 5. Ranking of predictors of WaSt among children 6-59 months by their overall discriminatory power.

Younger children aged 6-35 months tended to have WaStAn (6.2%) compared to the older ones (36-59 months) with a prevalence of 2.5%. The youngest children whose mothers did not have any formal education tended to be more affected by WaStAn (7.3%) than those with mothers with formal education (1.5%). Furthermore, the male children whose mothers did not have formal education were at a higher risk of WaStAn (9.4%) than the female children (5.3%). Among the older children aged 36-59 months, those from Moroto had the highest risk of having WaStAn (9.0%) compared to those from Amudat, Kaabong, Kotido, Nakapiripirit, and Napak (3.0%) or Abim, Karenga, and Nabilatuk (0.4%). The figure 3 below provides details of these findings.

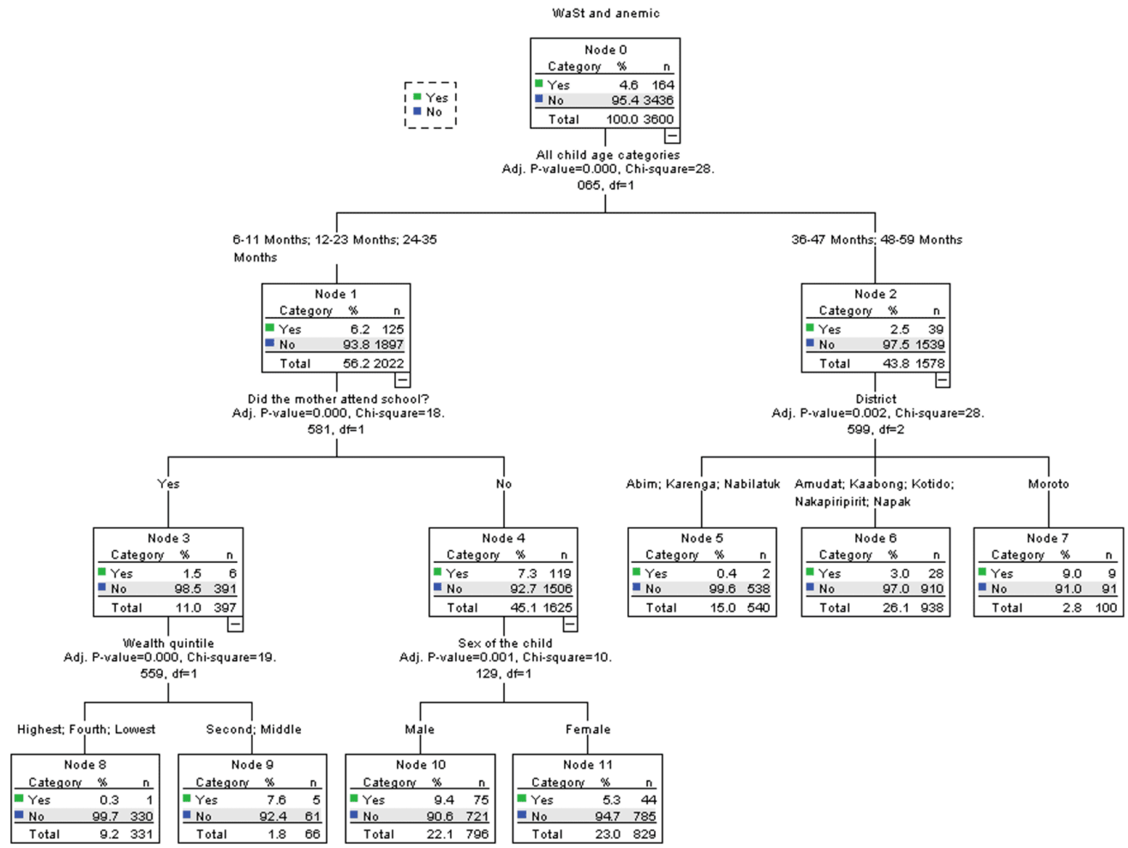

Figure 3. Predictors of WaSt among children 6-59 months by their overall discriminatory power.

3.6. Predicators for StAn among children 6 to 59 months in Karamoja

Table 6 below shows the relative importance of each of the dependent variables. The district of origin (100%), age of household head (54.7%), and total livestock owned (49.4%) were the most important predictors of StAn in Karamoja. These were followed by the level of education of the household head (41.3%), household wealth quintile (41.2%), marital status of the household head (29.7%), type of residence (28.1%), and child age (27.9%).

Independent Variable	Normalized Importance
District	100.0
Age of Household head	54.7
Total livestock owned	49.4
Highest level of school attended by the household head	41.3
Wealth quintile	41.2
Marital status of household head	29.7
Residence	28.1
All child age categories	27.9
Did the household head attend school	25.9
Sex of the child	18.9
Food Consumption Score	9.3
Did the mother attend school?	7.9

Table 6. Ranking of predictors of StAn among children 6-59 months by their overall discriminatory power.

The district was the most important predictor of StAn among children 6 to 59 months in Karamoja in 2022. Children from the districts of Moroto, Nakapiripirit, and Napak had a higher risk of StAn (16.9%) compared to those from Abim, Amudat, Kaabong, Karenga, Kotido, and Nabilatuk (9.6%). The children in the lowest wealth index in Moroto, Nakapiripirit, and Napak had a significantly higher risk of StAn (19.9%) compared to those from the highest wealth index (11.3%). Within the children from Abim, Amudat, Kaabong, Karenga, Kotido, and Nabilatuk, those in the age group of 24-35 months had the highest risk of StAn (12.8%) compared to those in 6-11 months (5.4%), and 12-23, 36-47, and 48-59 months (9.1%). Of those in the age group 24-35 months, the male was at a higher risk of StAn (15.7%) than the female (9.8%). This is similarly the case with the children in the age group of 6-11 months, in which the prevalence of StAn is 8.7% compared to 2.6% among the female. See figure 4 below for more specific details of these findings.

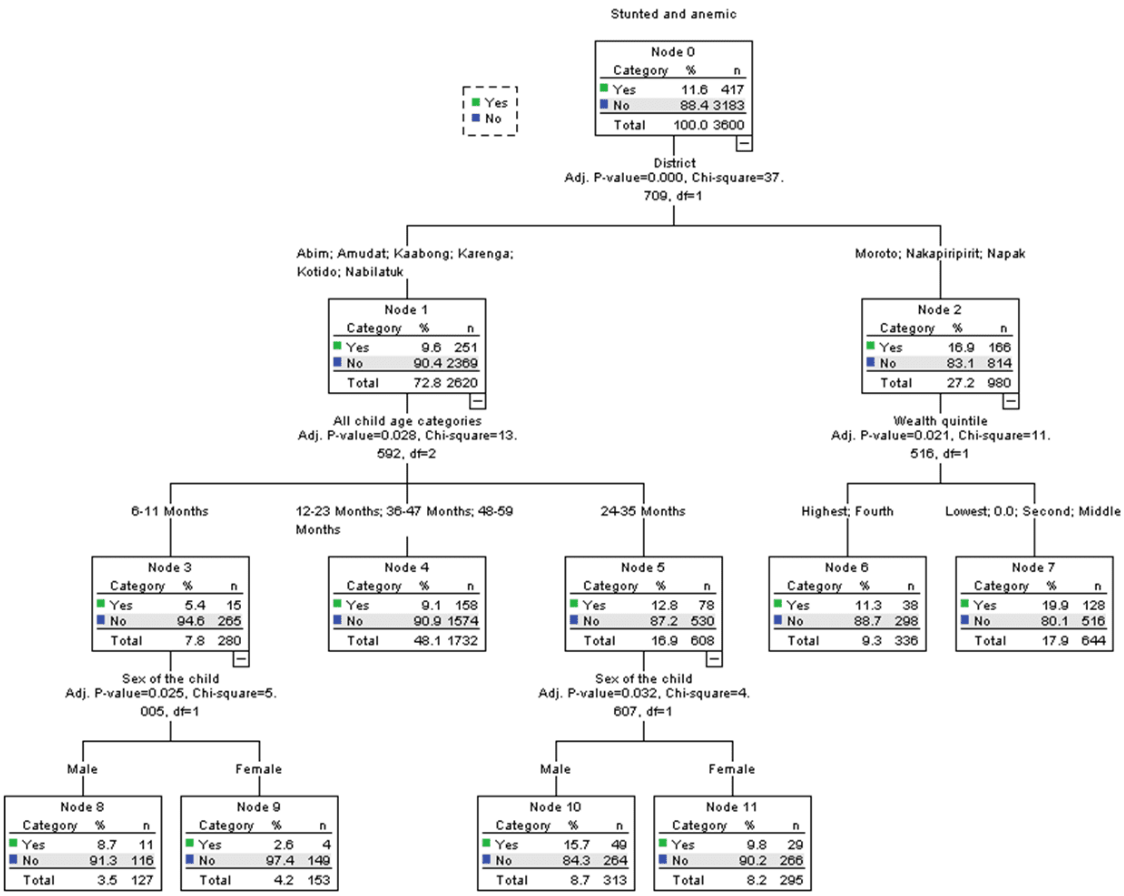

Figure 4. Predictors of StAn among children 6-59 months by their overall discriminatory power.

4. Discussion

This is the first study to use secondary data from a representative population sample of children 6 to 59 months from all the nine districts of Karamoja, and in Uganda, to document evidence of the prevalence of simultaneous existence of child wasting with stunting (WaSt), Stunting with anaemia (StAn), and wasting, stunting, and anaemia (WaStAn). It is also the first study to use TREE analysis to determine the predictors of WaSt, StAn, and WaStAn among children 6 to 59 months in the Karamoja region and in Uganda. The study therefore adds to the body of nutrition and public health literature on the prevalence and associated factors of simultaneous existence of child wasting, stunting, and anaemia (WaSt, StAn, and WaStAn) among children 6 to 59 months in Karamoja to inform program managers, policy makers, and academia of this increasing phenomenon.

The paper confirms the continued existence of a high public health nutrition burden of wasting, stunting, and anaemia among children 6 to 59 months in Karamoja. Child wasting at 13% and stunting at 41.4% are very high public health problems in Karamoja. Similarly, childhood anaemia (55.1%) is a severe public health problem in the region. The stunting, wasting, and anaemia levels in Karamoja are much higher than the national ones. These findings indicate a high prevalence of malnutrition in Karamoja, and given that the results are higher than national averages, they highlight the region's unique challenges and urgent need to improve food security and nutrition. In fact, it was earlier reported that malnutrition within the region was increasing, with stunting a public health concern[22]. This is in contrast to what is reported about child wasting and stunting declining over the past few decades globally[23][24][25]. It shows the dire situation in Karamoja and the need for multiple systems-based strategies to enhance nutrition service delivery, diets, and practices.

It is no surprise that the simultaneous existence of child wasting, stunting, and anaemia among children 6 to 59 months in Karamoja is high. The study reported that 7.1% and 11.6% of the children have WaSt and stunting and StAn, respectively, while 4.6% have WaStAn. It is agreed that children can be concurrently wasted and stunted[24]. However, this increases their mortality risk[12]. These findings are not surprising considering the multiplicity of deprivations faced by the children in Karamoja, including chronic food insecurity, inadequate consumption of quality diets, and a high level of malaria, diarrhoea, and other common childhood illnesses. It shows that there is a complex interplay of factors contributing to malnutrition in Karamoja. Thus, this myriad of factors could expose the same child to wasting, stunting, and anaemia at the same time. The study underscores the need for a holistic approach to preventing, controlling, and managing child wasting, stunting, and anaemia in Karamoja.

Whereas there is a myriad of factors contributing to child wasting, stunting, and anaemia in Karamoja, the findings from this study show that age, sex, district of residence, wealth index, and maternal education were significantly associated with WaSt, StAn, and WaStAn among children 6 to 59 months. The type of residence and the food consumption score were only associated with StAn and WaSt.

It is evident that the youngest children of the age group 12 to 23 months had the highest prevalence of WaSt (11.5%) and WaStAn (1.6%), while those of age 48 to 59 months had the lowest prevalence. Similar findings were also reported by a recent study which observed that the highest prevalence of wasting occurs in young children aged between 6 and 23 months[25]. Child age ranked as the third

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most important predictor of WaSt (62.2%). Collectively, children of age 12-23 and 24-35 months had the highest prevalence of WaSt (10.2%) compared to those of age 6-11, 36-47, and 48-59 months (4.5%). Similarly, child age (54.4%) was the third most important predictor of WaStAn among children 6 to 59 months in Karamoja. Younger children of age 6 to 35 months tended to have WaStAn (6.2%) compared to the older ones (36-59 months) with the prevalence of 2.5%. Child age (27.9%) was the least important predictor of StAn among children 6 to 59 months in the region. Among the children from Abim, Amudat, Kaabong, Karenga, Kotido, and Nabilatuk, those in the age group of 24-35 months had the highest risk of StAn (12.8%) than those in 6-11 months (5.4%), and 12-23, 36-47, and 48-59 months (9.1%). Of those in the age group 24-35 months, the male was at a higher risk of StAn (15.7%) than the female (9.8%). This is similarly the case with the children in the age group of 6-11 months, in which the prevalence of StAn is 8.7% compared to 2.6% among the female. An earlier study also confirmed that the prevalence of WaStAn increased in boys[24]. StAn was highest among the children aged 24 to 35 months (3.3%) and lowest in the age group 6 to 11 months (0.8%). These findings point to the known fact that child wasting starts during the age of the introduction of complementary food (6-8 months) and peaks at 9 to 23 months. Stunting, on the other hand, being a slow progressive morbidity, manifests in later childhood. Therefore, the children of age 24 to 35 months being the most affected by StAn is consistent with the available evidence elsewhere[22][25]. Early interventions and targeted programs for this age group are crucial.

Among the children of age 12-35 months, those from households with a wealth index of second and middle had the highest prevalence of WaSt (14.1%), followed by those from the lowest and fourth (9.6%) and the highest (2.9%). In fact, poor wealth status is associated with high levels of WaSt among children aged 6-24 months[25]. The youngest children whose mothers did not have any formal education tended to be more anaemic (7.3%) than those with mothers with formal education (1.5%). This finding is similar to that reported in the Karamoja FSNA report in 2018. The report revealed that there was a strong association between low levels of education among heads of households and mothers with a high prevalence of wasting, stunting, and underweight in children below the age of five[22]. This is a challenge given that maternal education is considered a contributor to the improvement of children's nutrition[23][24]. There is a need for interventions that address the social determinants of malnutrition in Karamoja.

Across all the nutritional status indices, the male child had the highest prevalence compared to their female counterparts. This is consistent with many studies in which the male children are more affected by wasting, stunting, and anaemia than the female ones[24]. This shows gender differences in the effect of malnutrition on children in Karamoja. However, further research is needed to explore the reasons why this is the case.

The study also reveals significant differences in malnutrition prevalence across districts in the Karamoja sub-region. Kotido district had the highest prevalence of WaSt (1.4%), StAn (1.2%), and combined WaStAn (2.7%), followed by Moroto district. StAn was only significantly associated with area of residence. The children living in rural areas had a significantly higher prevalence of StAn (10.4%) compared to those in urban areas (1.2%). The most important predictor of WaSt among children 6 to 59 months in Karamoja in 2022 was the district of origin, with a discriminatory power of 100.0%. Among the older children 36-59 months, those from Moroto had a higher risk of having WaStAn (9.0%) than those from Amudat, Kaabong, Kotido, Nakapiripiri, and Napak (3.0%) or Abim, Karenga, and Nabilatuk (0.4%). The district of origin (100%), age of household head (54.7%), and total livestock owned (49.4%) were the most important predictors of StAn in Karamoja. The district was the most important predictor of StAn among children 6 to 59 months in Karamoja in 2022. Children from the districts of Moroto, Nakapiripirit, and Napak had a higher risk of StAn (16.9%) compared to those from Abim, Amudat, Kaabong, Karenga, Kotido, and Nabilatuk (9.6%). The children in the lowest wealth index in Moroto, Nakapiripirit, and Napak had a significantly higher risk of StAn (19.9%) compared to those from the highest wealth index (11.3%).

In light of the above, future research should explore the causal relationships between identified factors and WaStAn. It should also investigate specific dietary deficiencies contributing to WaStAn in Karamoja.

5. Conclusions

This paper has provided evidence of the simultaneous existence of wasting, stunting, and anaemia (WaStAn) among children 6 to 59 months in Karamoja, Uganda. Despite the progress made, there is still a high public health nutrition burden of wasting, stunting, and anaemia among children 6 to 59 months in Karamoja. The study records a high prevalence of malnutrition, with wasting, stunting, and anaemia highly prevalent among children in Karamoja. This indicates a critical need for improved food security and nutrition interventions. Additionally, the study reports the co-existence of deficiencies, with a significant portion of children suffering from WaSt, StAn, and WaStAn respectively. This highlights a complex interplay of factors contributing to malnutrition in Karamoja.

Risk factors were also identified. Age, sex, district, wealth index, and maternal education were significantly associated with WaSt, StAn, and WaStAn. Younger children, males, those from poorer households, and children of mothers with lower education are at higher risk. Malnutrition prevalence also varied significantly across districts, with Kotido and Moroto having the highest burdens, while Abim and Nabilatuk had the lowest. This suggests a need for targeted interventions based on local needs. The study also demonstrated that the prevalence of wasting was highest among young children aged 12-23 months and that stunting manifests later at 24-35 months. This shows that early interventions for this younger age group are crucial.

Consequently, it is important for the program and policy makers to continue supporting age-specific interventions for the child-mother pairs. With the male children from poorer households whose mothers have low educational achievement and are food insecure, the interventions should be contextualized when designing and implementing approaches to address childhood undernutrition and anaemia in Karamoja. This evidence points to the need to continue with holistic programming for child nutrition without compactization to wasting, stunting, or anaemia alone. Targeted interventions such as improved screening and treatment, optimal feeding practices, micronutrient supplementation, deworming and immunization, hygiene and sanitation, empowerment of women, food security and dietary diversity, and district-level interventions are recommended for improving child health and well-being in Karamoja.

Statements and Declarations

Author Contributions: Conceptualization, Alex Mokori, Nicholas Kirimi, and Amos H Ndungutse; methodology, Alex Mokori and Nicholas Kirimi; validation, Alex Mokori, Nicholas Kirimi, Amos H Ndungutse, and Zakaria Fusheini; formal analysis, Alex Mokori and Nicholas Kirimi; investigation, Alex Mokori, Nicholas Kirimi, Amos H Ndungutse, and Zakaria Fusheini; resources, Zakaria Fusheini; data curation, Alex Mokori and Nicholas Kirimi; writing—original draft preparation, Alex Mokori; writing—review and editing, Amos H Ndungutse, Nicholas Kirimi, and Zakaria Fusheini; visualization, Nicholas Kirimi and Alex Mokori; supervision, Alex Mokori, Muzafaru Ssenyondo, and Zakaria Fusheini; project administration, Alex Mokori, Muzafaru Ssenyondo, and Zakaria Fusheini; funding acquisition, Zakaria Fusheini and Alex Mokori. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This research study did not require an Institutional Review Board Statement because secondary data shared by the World Food Programme was reviewed and analyzed by the authors of this research paper. There was no direct involvement or contact with human subjects, and therefore the study did not violate the Declaration of Helsinki code; thus, no protocol code or date of approval is required in our paper submission.

Informed Consent Statement: In this study, there was no direct contact with participating patients. The authors believe there was no need for informed consent to be obtained from the participating patients.

Data Availability Statement: The data set shared by WFP was analyzed. Series of FSNA reports conducted in Karamoja with joint efforts from WFP and UNICEF under the Karamoja Nutrition programme were used to compare and track the trend.

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Conflicts of Interest: The authors of this publication have no conflicts of interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

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Declarations

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