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Research

Complementary feeding, dietary diversity, and diarrhea morbidity in some rice-growing regions of Kenya: insights for targeted nutrition interventions

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Background

Diarrhea and malnutrition remain major contributors to child morbidity and mortality in Kenya, particularly among children under five. Inadequate complementary feeding, poor dietary diversity, and weak hygiene practices exacerbate these risks, especially in rural, food insecure areas. In several rice-growing regions in Kenya, disparities in food access, caregiver practices, and sanitation contribute to nutritional inequality and a higher disease burden among young children.

Objective

To assess in selected rice-growing counties in Kenya factors that can affect child nutrition, including complementary feeding practices, diarrhea incidence and management, and household dietary diversity.

Methods

A cross-sectional survey was conducted among 1,218 households with children aged 6–59 months in Kirinyaga, Kisumu, and Kwale counties. Data on socio-demographic characteristics, feeding practices, hygiene behaviors, diarrhea morbidity, and dietary diversity were collected through structured interviews. Descriptive and inferential statistics, including chi-square tests, were used for analysis.

Results

Complementary feeding was introduced at six months in 76.5% of households, with significant differences across counties (p=0.007). Feeding frequency was notably suboptimal in Kwale, where 50.7% of caregivers fed children only twice a day or less. Diarrhea morbidity affected 28.4% of children overall, with the highest incidence reported in Kwale (36.7%, p=0.001). Household dietary diversity score (HDDS) also showed significant variation, with 19.7% of households falling into the low HDDS category.

Conclusions

The study reveals regional variations in feeding practices, hygiene behaviors, and dietary diversity that contribute to childhood diarrhea and malnutrition. Targeted interventions, focusing on nutrition education, improved water, sanitation, and hygiene practices, and food-based strategies such as reintegrating nutrient-rich rice bran, are essential to address underlying inequalities and improve child health outcomes in these rice growing regions.

INTRODUCTION

Diarrhea remains a major public health concern globally and is one of the leading causes of morbidity and mortality among children under five years of age, particularly in low- and middle-income countries (Troeger et al., 2018). In Kenya, diarrhea accounts for a significant share of under-five deaths, with approximately 15% of children affected

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annually, placing a heavy burden on families and the healthcare system (KDHS 2023; Manetu et al. 2021). Closely linked to this burden is malnutrition, which not only weakens immune function and increases susceptibility to infections like diarrhea but also impairs physical and cognitive development in early childhood (Black et al., 2013; Nel & Steyn, 2022).

The first two years of life are recognized as a critical window for interventions to ensure healthy growth, development, and disease prevention (Black et al., 2016; Ssekajja et al., 2022). WHO and UNICEF recommend exclusive breastfeeding for the first six months, followed by timely and appropriate complementary feeding while continuing breastfeeding up to two years or beyond (WHO, 2023). However, adherence to these recommendations remains low in many parts of Kenya, where fewer than one-third of children meet minimum dietary diversity and feeding frequency standards (Kimani-Murage et al. 2011; Mwangome and Berkley 2014). This gap contributes to persistent rates of stunting, undernutrition, and increased vulnerability to infectious diseases like diarrhea (Guillaume et al. 2020; Pickering et al. 2019). These challenges are particularly evident in rice-growing regions in Kenya, including Kirinyaga (Mwea), Kisumu (Ahero), Kwale (Vanga), Busia (Budalangi) and Tana River (Bura), which face varying levels of food insecurity, inconsistent complementary feeding practices, and poor sanitation (Pickering et al. 2019; Reynolds et al. 2021; Simiyu et al. 2017). Seasonal changes in food availability and limited access to health education further impact household dietary diversity and child health outcomes (Ipara et al., 2025). The interplay between inadequate feeding practices, poor hygiene, and food insecurity creates a cyclical pattern where diarrhea exacerbates malnutrition and vice versa (Lamberti et al., 2011).

Although child malnutrition and diarrhea have been widely studied in Kenya, little focus has been given to how feeding practices, hygiene, and dietary diversity differ across rice-growing regions, areas that grow food but still struggle with child nutrition. In addition, the use of locally available, nutrient-rich foods like rice bran has been largely overlooked in nutrition programs. In this study we investigated complementary feeding practices, household dietary diversity, hygiene behaviors, and diarrhea incidence among children aged 6–59 months in Kirinyaga, Kisumu, and Kwale counties. We also aimed to identify regional differences and underlying drivers of child malnutrition and illness to inform context-specific interventions. In addition, we explore the potential of reintegrating heat-treated rice bran, a nutrient-dense by-product typically discarded or used as animal feed, into local diets as a sustainable solution to improve child nutrition outcomes (Black et al. 2013; Codjia et al. 2022; Kamudoni et al. 2024; Sheflin et al. 2017; Younas et al. 2011).

METHODS

STUDY DESIGN AND POPULATION

A total of 1,218 households were surveyed in this cross-sectional study conducted between January and March 2023 in Kirinyaga, Kisumu, and Kwale counties. In Kirinyaga County, the study was conducted within the Mwea Irrigation Scheme in Mwea Sub-county (37° 21' 14" East, 0° 42' 55" South). In Kisumu County, data were collected from Ahero in Nyando Sub-county (0° 11' 0" South, 34° 55' 0" East), while in Kwale County, the survey was carried out in Lunga Sub-county (4° 33' 0" South, 39° 7' 0" East). The target population consisted of households with at least one child aged 6 to 59 months. Where more than one child in this age group was present in a household, data were collected for the youngest child. A multistage sampling method was used to ensure equal representation from each county.

SAMPLE SIZE DETERMINATION AND SAMPLING DISTRIBUTION

The sample size for this study was determined using Cochran's formula, which is commonly applied for large populations. Using a 95% confidence level, an assumed proportion of 0.5 for maximum variability, and a 5% margin of error, the minimum required sample size per county was approximately 384 children. To account for potential design effect due to multistage sampling and a 10% non-response rate, the sample was adjusted to 427 children per county and rounded to 429 for operational convenience, resulting in a total of 1,287 children across Kirinyaga, Kisumu, and Kwale counties. A multistage sampling approach was used to ensure broad geographic representation. In each sub-county, a list of rice-farming villages was compiled, and 13 villages were randomly selected. Within each village, 33 households with children aged 6–59 months were sampled using simple random sampling, yielding approximately 429 households per county in alignment with the target sample size.

DATA COLLECTION PROCEDURES

Eligible participants were households with children aged 6–59 months and caregivers who were available and willing to participate. Households were excluded if they lacked children in the target age range, had children with chronic illnesses unrelated to malnutrition, were recent migrants, participated in other nutrition programs, or declined to provide the necessary data. Trained research assistants conducted data collection after obtaining informed consent from caregivers. Structured interviews were used to gather information on demographic characteristics, complementary feeding practices, diarrhea incidence and management, and household dietary diversity. A two-stage cluster sampling method was applied, with Mwea (East and West), Ahero, and Lunga sub-counties purposively selected as key rice growing areas in their respective counties. For this study, diarrhea morbidity was defined as the passage of three or more loose stools in a 24-hour period within the two weeks preceding the survey (World Health Organization, 2009). The Household Dietary Diversity Score (HDDS) was calculated based on the consumption of ten food groups and classified as low (0–4), medium (5–7), or high (8–10) (Swindale & Bilinsky, 2006). The food groups assessed were: cereals; vitamin A-rich fruits and vegetables; dark green leafy vegetables; other vegetables; fruits; flesh foods (meat); eggs and egg products; legumes; nuts and seeds; and dairy products.

STATISTICAL ANALYSIS

Descriptive statistics were used to summarize demographic characteristics and complementary feeding practices. Chi-square tests were applied to assess regional differences in diarrhea prevalence and its management. A p-value of less than 0.05 was considered statistically significant. To handle missing data, pairwise deletion was used to allow the inclusion of all available data for each specific analysis by excluding only the missing values relevant to that particular test, to maximize the use of the dataset while minimizing data loss. All statistical analyses were done using SPSS Statistics version 26 (IBM Corp, 2019).

ETHICAL CONSIDERATIONS

Ethical approval for the study was granted by the Kenya Methodist University Institutional Scientific Ethics Review Committee (Reference: KeMU/SERC/INT/1/2022), and a research permit was issued by the Kenya National Commission for Science, Technology and Innovation (NACOSTI), Reference: 195627. All participants provided informed consent, confirming their voluntary involvement in the study. To ensure confidentiality, the questionnaire did not include any personal identifiers.

RESULTS

Socio-Demographic and Economic Characteristics

The socio-demographic and economic characteristics presented in Table 1 reveal some notable regional differences among respondents. The majority of participants across all counties were aged between 31 and 50 years (56% overall), with Kirinyaga having the highest proportion of female-headed households (41%) compared to Kisumu (14%) and Kwale (25%). Most respondents were married (79%), with Christianity being the predominant religion in Kirinyaga and Kisumu, while Islam was most prevalent in Kwale. Primary education was the most common across all counties (60%). Farming was the leading occupation in Kirinyaga and Kisumu, while business was more common in Kwale. Overall, a significant proportion of households (62%) earned below KES 10,000 per month, indicating widespread low income levels.

Table 1. Socio-demographic and economic characteristics of respondents

Characteristic		Kirinyaga (n=423)	Kisumu (n=394)	Kwale (n=401)	Total (n=1218)
Age (years)	13-30	164 (40)	103 (27)	108 (27)	375 (32)
	31-50	213 (52)	216 (56)	238 (61)	667 (56)
	51-87	35 (8)	64 (17)	47 (12)	146 (12)
Gender of household head*	Male	250 (59)	340 (86)	301 (75)	891 (73)
	Female	173 (41)	54 (14)	100 (25)	327 (27)
Marital status	Single	63 (15)	30 (8)	31 (8)	124 (11)
	Married	305 (74)	325 (85)	303 (79)	933 (79)
	Divorced	31 (8)	5 (1)	37 (10)	73 (6)
	Widowed	12 (3)	24 (6)	12 (3)	48 (4)
Religion	Christianity	412 (98)	392 (99)	115 (30)	919 (77)
	Islam	0 (0)	0 (0)	267 (68)	267 (22)
	Others	8 (2)	1 (1)	6 (2)	15 (1)
Education attained	No formal schooling	10 (3)	12 (4)	64 (16)	86 (8)
	Primary	164 (52)	182 (58)	266 (69)	612 (60)
	Secondary	116 (36)	89 (29)	45 (12)	250 (25)
	Tertiary	28 (9)	29 (9)	12 (3)	69 (7)
Occupation	Formal employment	27 (6)	28 (7)	45 (11)	100 (8)
	Business	76 (18)	59 (15)	107 (27)	242 (20)
	Farming	159 (38)	145 (37)	107 (27)	411 (34)
	Casual labor	113 (27)	102 (26)	76 (19)	291 (24)
	Unemployed	28 (6)	38 (10)	24 (6)	90 (7)
	Others	20 (5)	22 (5)	39 (10)	81 (7)
Monthly income (KES)	>20,000	30 (7)	18 (5)	13 (3)	61 (5)
[US $1=KES 130]	10,000- 20,000	106 (25)	126 (32)	94 (24)	326 (27)
	<10,000	255 (60)	231 (59)	257 (66)	743 (62)
	None	32 (8)	16 (4)	27 (7)	75 (6)

*A household head is the individual identified by household members as the primary decision-maker or the person responsible for managing household affairs, regardless of their age, gender, or financial contribution.

DIARRHEA INCIDENCES AND MANAGEMENT

Table 2 presents diarrhea-related outcomes and treatment practices across the three study counties. There was diarrhea (28.4%) in all the children surveyed. Notable differences were observed in diarrhea prevalence and treatment-seeking behavior, with Kwale reporting the highest morbidity (36.7%). Use of ORS and zinc was the most common treatment, and most cases (89.7%) resolved after intervention. Differences across counties were statistically significant for diarrhea morbidity (p=0.001), highlighting regional variation.

HYGIENE AND SANITATION PRACTICES

The results in Table 3 indicate significant variations in hygiene and sanitation practices across the three counties. Kirinyaga consistently reported higher rates of good hygiene behaviors, including the use of soap (85.8%) and handwashing after toilet use (95.5%), compared to Kisumu and Kwale. Kwale showed the lowest adherence to hygiene practices across nearly all indicators, with less than half of

households using soap (46.9%) and a high prevalence of open defecation (47.6%). Overall, the differences across counties were statistically significant ($p<0.05$) for most practices, highlighting disparities in sanitation infrastructure and hygiene behaviors.

Table 2. Diarrhea morbidity and management among children aged 6-59 months

Characteristic	Kirinyaga (n=423)	Kisumu (n=394)	Kwale (n=401)	Total (n=1218)	X (*P-value*)
Diarrhea morbidity[a]					
Yes	110 (26.0)	89 (22.6)	147 (36.7)	346 (28.4)	**21.2 (0.001)**
No	313 (74.0)	305 (77.4)	254 (63.3)	872 (71.6)	
Sought diarrhea treatment					
Yes	115 (81.6)	69 (69.7)	114 (73.1)	298 (75.2)	5.1 (0.80)
No	26 (18.4)	30 (30.3)	42 (26.9)	98 (24.8)	
Place of treatment					
Government hospital	101 (77.7)	59 (79.7)	115 (84.5)	275 (80.9)	
Private hospital	14 (10.8)	4 (5.4)	6 (4.4)	24 (7.1)	
Mission hospital	5 (3.8)	1 (1.4)	1 (0.8)	7 (2.1)	
Pharmacy	10 (7.7)	10 (13.5)	14 (10.3)	34 (9.9)	
Diarrhea management					
Zinc	3 (2.5)	4 (5.9)	9 (6.9)	16 (5.0)	
ORS	29 (23.8)	6 (8.8)	18 (13.7)	53 (16.5)	
Zinc & ORS	78 (63.9)	45 (66.2)	83 (63.4)	206 (64.2)	
Antibiotics	12 (9.8)	11 (16.2)	14 (10.7)	37 (11.5)	
Others	0 (0.0)	2 (2.9)	7 (5.3)	9 (2.8)	
Did the diarrhea stop after treatment[a]					
Yes	129 (94.2)	81 (87.1)	129 (87.2)	339 (89.7)	4.65 (0.97)
No	8 (5.8)	12 (12.9)	19 (12.8)	39 (10.3)	
Did the child lose weight during diarrhea					
Yes	84 (61.8)	57 (68.7)	99 (66.4)	240 (65.2)	1.25 (0.535)
No	52 (38.2)	26 (31.3)	50 (33.6)	128 (34.8)	

[a]*Passage of three or more loose stools in a 24-hour period within the two weeks preceding the survey. This refers to diarrhea episodes that happened within that timeframe and the other questions such as whether they stopped also refer to the same two-week period.*

Table 3. Hygiene and sanitation practices among households

Characteristic	Kirinyaga (n=423)	Kisumu (n=394)	Kwale (n=401)	Total (n=1218)	X (P-value)
Use Soap to wash hands					
Yes	357 (85.8)	293 (75.1)	179 (46.9)	829 (69.8)	151.20 (0.001)
No	59 (14.2)	97 (24.9)	203 (53.1)	359 (30.2)	
Hand washing after visiting the toilet					
Yes	295 (95.5)	296 (84.3)	249 (66.4)	840 (81.2)	97.11 (0.001)
No	14 (4.5)	55 (15.7)	126 (33.6)	195 (18.8)	
Hand washing before handling food					
Yes	203 (65.7)	215 (61.3)	210 (56.0)	628 (60.7)	6.74 (0.034)
No	106 (34.3)	136 (38.7)	165 (44.0)	407 (39.3)	
Hand washing before eating					
Yes	224 (72.5)	240 (68.4)	243 (64.8)	707 (68.3)	4.63 (0.099)
No	85 (27.5)	111 (31.6)	132 (35.2)	328 (31.7)	
Hand washing before feeding children					
Yes	185 (59.9)	176 (50.1)	166 (44.3)	527 (50.9)	16.63 (0.001)
No	124 (40.1)	175 (49.9)	209 (55.7)	508 (49.1)	
Hand washing after handling dirt					
Yes	215 (69.6)	189 (53.8)	134 (35.7)	538 (52.0)	78.48 (0.001)
No	94 (30.4)	162 (46.2)	241 (64.3)	497 (48.0)	
Toilet type					
Flush toilet	39 (9.3)	10 (2.6)	44 (11.0)	93 (7.7)	
Pit latrine	381 (90.5)	373 (95.2)	166 (41.4)	920 (75.8)	464.25 (0.001)
Open defecation/ bush	1 (0.2)	9 (2.2)	191 (47.6)	201 (16.6)	

COMPLEMENTARY FEEDING PRACTICES

The results in Table 4 shows notable differences in complementary feeding practices across the counties. Most caregivers introduced complementary feeding at 6 months (76.5%), with Kirinyaga having the highest adherence (81.8%). Feeding more than twice a day was common in Kirinyaga (80.2%) and Kisumu (78.7%) but less so in Kwale (40.0%). Boiling was the predominant method of food preparation in all counties (91.9%). Mothers were the primary feeders in the majority of households (91.9%), though Kisumu had a slightly higher involvement of other caregivers. Most of the observed differences were statistically significant ($p<0.05$), indicating regional variations in complementary feeding practices.

Table 4. Complementary feeding practices among the caregivers

Characteristic	Kirinyaga (n=423)	Kisumu (n=394)	Kwale (n=401)	Total (n=1218)	X (*P-value*)
Introduction of complementary feeding					
Before 6 months	52 (12.6)	65 (16.7)	57 (14.5)	174 (14.5)	14.24 (0.007)
At 6 months	338 (81.8)	279 (71.5)	298 (75.6)	915 (76.5)	
After 6 months	23 (5.6)	46 (11.8)	39 (9.9)	108 (9.0)	
Frequency of feeding					
Once a day	8 (2.0)	9 (2.4)	34 (9.3)	51 (4.4)	178.47 (0.001)
Twice a day	72 (17.8)	72 (18.9)	186 (50.7)	330 (28.6)	
>twice a day	325 (80.2)	300 (78.7)	147 (40.0)	772 (67.0)	
Predominant complementary food preparation method					
Boiling	334 (93.0)	305 (93.8)	314 (89.0)	953 (91.9)	15.67 (0.003)
Frying	22 (6.2)	17 (5.2)	23 (6.5)	62 (6)	
Stewing	3 (0.8)	3 (1.0)	16 (4.5)	22 (2.1)	
Who feeds the child during complementary feeding					
Mother	390 (94.2)	338 (87.1)	371 (94.2)	1099 (91.9)	17.58 (0.001)
Others	24 (5.8)	50 (12.9)	23 (5.8)	97 (8.1)	

HOUSEHOLD DIETARY DIVERSITY SCORE

The results in Table 5 show statistically significant (p=0.015) variation in household dietary diversity across the three counties. Kirinyaga had the highest mean score among households with low HDDS (3.10 ± 1.26), while Kwale had the lowest (2.43 ± 1.38). Medium HDDS scores were fairly consistent across counties, while high HDDS scores were highest in Kwale. In terms of distribution, low dietary diversity was more prevalent in Kisumu and Kwale than in Kirinyaga. Conversely, Kwale had the highest proportion of households with high dietary diversity (43.7%), followed by Kirinyaga (35.4%) and Kisumu (32.0%). Overall, most households fell within the medium HDDS category (43.2%), with 19.7% classified as low and 37.1% as high.

Table 5. Mean household dietary diversity scores and proportional distribution across Household dietary diversity score categories by county

County	Kirinyaga (n=423)	Kisumu (n=394)	Kwale (n=401)	Total (n=1218)	*P-value*
*HDDS (Mean ± SD)					
Low HDDS	3.10 ± 1.26	2.91 ± 1.40	2.43 ± 1.38	2.78 ± 1.37	0.015
Medium HDDS	6.19 ± 0.79	6.03 ± 0.84	6.10 ± 0.85	6.11 ± 0.82	
High HDDS	8.67 ± 0.70	8.63 ± 0.78	9.10 ± 0.75	8.82 ± 0.77	
#HDDS proportional distribution [n (%)]					
Low HDDS	62 (14.7)	87 (22.1)	91 (22.8)	240 (19.7)	
Medium HDDS	211 (49.9)	181 (45.9)	134 (33.5)	526 (43.2)	
High HDDS	150 (35.4)	126 (32.0)	175 (43.7)	451 (37.1)	

* Mean Household Dietary Diversity Score (HDDS) based on the frequency of how the 10 food groups are eaten per week. Scores are based on summing 0 or 1 for each food group, with 0 indicating the food was not eaten and 1 indicating the food was eaten in the household at least once.
#Low HDDS (0-4 Food Groups); Medium HDDS (5-7 Food Groups); High HDDS (8-10 Food Groups)

DISCUSSION

These findings illuminate the socio-demographic and other factors likely to affect child health outcomes across Kirinyaga, Kisumu, and Kwale counties. Low levels of education and income remain substantial barriers to optimal child feeding and healthcare practices. These structural factors must be addressed through comprehensive public health strategies that combine nutrition-specific interventions with broader investments in education, economic empowerment, and healthcare access (Codjia et al., 2022; Kamudoni et al., 2024; Umallawala et al., 2022). For instance, while most households reported introducing complementary feeding at the WHO-recommended age of six months, regional disparities such as early and delayed initiation being more common in Kisumu and Kwale, respectively. This suggests that access to health information and services remains uneven (Troeger et al. 2018; Tsegaye et al. 2022; Kimani-Murage et al. 2011). Cultural norms and socioeconomic status likely shape both the timing and quality of child feeding practices, necessitating context-specific, equity-driven responses.

Feeding frequency was notably suboptimal in Kwale, where a significant proportion of caregivers reported feeding only twice per day. Boiling was the predominant method of food preparation across counties, likely due to its practicality and accessibility of resources like firewood (KDHS 2023; Mapesa et al. 2020). Mothers were the primary feeders of complementary foods but others were often involved, especially in Kisumu, pointing to the importance of extending education and support beyond mothers to the broader caregiving environment (Cunningham et al., 2015; Wanjihia et al., 2021). Tailored programs are needed to improve both feeding frequency and preparation practices, especially in areas with lower adherence to guidelines (Nguyen et al., 2014; Reynolds et al., 2021; Saldan et al.,

2016).

Poor hygiene and sanitation practices remain a major public health concern, particularly in Kwale, where handwashing with soap and safe disposal of waste are less consistently practiced. The widespread use of pit latrines and continued open defecation further elevate the risk of fecal-oral disease transmission (Fewtrell et al., 2005; Ngure et al., 2014; Subramanian et al., 2014). Although most households across counties reported handwashing before eating and after using the toilet, notable lapses were observed after handling dirt or cleaning children, practices directly linked to increased diarrheal risk (Kudan et al., 2023). These gaps in hygiene correlate with the high incidence of diarrhea observed in Kwale, where children not only experienced more episodes but also may have suffered associated weight loss (Guillaume et al., 2020; Solomon et al., 2022).

Despite high rates of treatment-seeking behavior, primarily from government hospitals, the data suggest there may have been delays in access and reliance on public systems due to cost and proximity. Integrated water, sanitation, and hygiene (WASH) programs, alongside nutrition and health interventions, are essential to reduce the burden of diarrheal disease and its nutritional consequences (Bhutta et al. 2013; Fewtrell et al. 2005; Haroon et al. 2013; Koletzko et al. 2020; Pickering et al. 2019). Strengthening public health infrastructure and ensuring the consistent availability of zinc, ORS, and other essential treatments are vital for improving child survival and well-being in regions like these (Bhutta et al., 2014).

Household dietary diversity varied markedly across the counties. Households in Kirinyaga demonstrated a more balanced dietary pattern, with the highest mean HDDS among those in the low diversity category. In contrast, Kwale had the highest mean score in the high HDDS group, suggesting a wide disparity in dietary access within that county. These differences point to region-specific dietary patterns influenced by a combination of socioeconomic, cultural, and agricultural factors. The coexistence of both high and low HDDS within Kwale suggests nutritional inequality, where some households access a wide variety of foods while others may remain food insecure. This may reflect uneven food distribution, varying household incomes, or inconsistent market access. Given these differences, region specific interventions are essential. In Kirinyaga, strategies could focus on sustaining and improving dietary stability, while in Kwale and Kisumu, efforts should aim at enhancing consistent access to diverse and nutritious foods. This may include promoting diversified farming practices, improving household purchasing power, and enhancing local market infrastructure (Nguyen et al., 2014; Ruel et al., 2018; Ruel & Alderman, 2013). Moreover, while diversity is critical, it must be paired with adequate feeding frequency and nutrient density to yield meaningful improvements in child nutrition (FAO, 2008). Public health efforts should also explore integrating underutilized but nutrient-rich resources, such as promoting the use of whole-grain (brown) rice and heat-treated rice bran, into local diets to boost micronutrient intake and dietary quality (Irakli et al., 2021; Odingo et al., 2025; Sheflin et al., 2015, 2017).

Together, these findings paint a broad picture of the interconnected factors shaping child health and nutrition in rice-growing rural regions of Kenya. Regional differences in complementary feeding, dietary diversity, hygiene, and diarrhea management all point to the need for multi-sectoral, county-level interventions that address underlying social determinants of health, while promoting evidence based practices in nutrition and hygiene (Bhutta et al., 2013; Haroon et al., 2013; Kuchenbecker et al., 2017; Rammohan et al., 2019; Shipanga et al., 2023; Waswa et al., 2015). Public health programs should prioritize education for caregivers, infrastructure for sanitation, access to health services, and innovative food solutions like rice bran fortification. Only through integrated, community-driven approaches can we hope to sustainably improve child nutrition and health outcomes in these and similar settings.

STUDY LIMITATIONS

This study relied on caregivers' self-reported information on complementary feeding, hygiene, and sanitation, which may be influenced by recall bias or social desirability bias, leading to potential over- or underreporting. Additionally, since the study focused on specific counties, its findings may not fully reflect the diverse cultural, economic, and environmental conditions across Kenya, limiting generalizability. Moreover, as a cross-sectional study, it captures a snapshot in time and cannot establish causality. The recommended frequency of feeding of infants varies by their age, but this was not disaggregated in our data.

CONCLUSIONS

Our study highlights the interplay between socioeconomic conditions, caregiver practices, dietary diversity, hygiene, and child diarrhea morbidity in rice-growing regions of Kenya. Despite general awareness of recommended complementary feeding practices, regional disparities persist, particularly in feeding frequency, food preparation methods, and access to diverse foods. Kwale emerged as the most nutritionally unequal, with both the highest and lowest dietary diversity scores and a greater burden of diarrhea, underscoring systemic challenges in food security and hygiene. Poor sanitation practices, especially in Kwale, further compound health risks, emphasizing the need for integrated water, sanitation, and hygiene interventions alongside nutrition programs. Addressing these gaps requires coordinated, region-specific public health strategies that not only promote nutrition education and improved feeding practices, but also tackle the root socioeconomic drivers of poor child health. Enhancing dietary diversity, empowering caregivers, especially mothers, and improving access to essential health services should be prioritized. Additionally, the potential of underutilized food resources like heat-treated rice bran should be explored as a sustainable solution to improve micronutrient intake and reduce malnutrition.

AUTHOR CONTRIBUTIONS

JJR, OBA, and MJ conceptualized and designed the study, while DH, OKS, JJR, and MJ developed the questionnaire. All authors participated in data collection, with DH and OKS handling data coding and analysis. DH and MJ drafted the initial manuscript and revised it together. OBA and MJ supervised the project’s implementation. All authors

reviewed and approved the final manuscript before submission.

CONFLICT OF INTEREST

The authors declare that they have no other potential conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN SCIENTIFIC WRITING

The authors used CHATGPT 4.0 as an editing tool to improve grammar and readability. No part of the content, data analysis, or interpretation was generated by AI. The authors take full responsibility for all aspects of the manuscript.

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