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Food insecurity, dietary diversity, nutritional status and consumption patterns: Status and trends across six cities in Bangladesh, Kenya, and Rwanda (2021-2025)

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Abstract

Objectives: To examine food insecurity, dietary diversity, nutritional status, consumption patterns, in secondary cities of the Nutrition in City Ecosystems (NICE) project.

Design: A cross-sectional nutrition survey conducted early 2025 using standardized, stratified sampling approaches. Data included socio-economic characteristics, Household Food Insecurity Score (HFIAS), Dietary Diversity Questionnaire (DDQ), Household Dietary Diversity Score (HDDS), agricultural and consumption practices, and anthropometric measurements. Similar data have been collected in 2021.

Setting: Six secondary cities: Dinajpur and Rangpur (Bangladesh), Busia and Bungoma (Kenya), and Rubavu and Rusizi (Rwanda).

Participants: Approximately 1200 households in malnutrition-prone areas.

Results: HFIAS has decreased since the COVID-19 pandemic but remained substantial across sites. HDDS was medium in Bangladesh (6.6-7.1) and Kenya (5.6-5.8), and low-to-medium in Rwanda (4.6-4.8). Women's Minimum Dietary Diversity (MDD-W) scores were low-to-medium: Dinajpur 4.8, Rangpur 4.8, Bungoma 4.7, Busia 4.5, Rubavu 3.5, Rusizi 4.3; with 19-56% achieving an adequately diverse diet (MDD-W≥5). Across sites, child stunting was medium-to-high (12-32%) and wasting low-to-medium (5-20%). Adult overweight affected 42-59% of women and 9-41% of

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men, while ultra-processed food consumption remained low (<1-12%). Exclusive breastfeeding until six months varied widely and ranged 43-86%, with complementary feeding introduced on average at 5.7-6.2 months. Knowledge about healthy diet composition was generally good (34-98%).

Conclusions: Secondary cities, involved in NICE, in Bangladesh, Kenya, and Rwanda face persistent food insecurity, limited dietary diversity, and the coexistence of child undernutrition with adult overweight. Addressing these challenges requires context-specific, multisectoral interventions improving food access and quality, supporting early-life nutrition, and targeting broader socioeconomic determinants.

Introduction

Rapid urbanization in Low- and Middle-Income Countries (LMICs) has accelerated dietary transition, by increased access to and consumption of energy-dense and processed foods and a concurrent lack of fresh nutrient-rich produce. This leads to an increasing double or triple burden (in case of nutrient deficiencies) of malnutrition, the coexistence of undernutrition and overnutrition; which especially impacts the most vulnerable, children and pregnant women [1].

The State of Food Security and Nutrition in the World (SOFI) 2025 report highlights persistent inequities in access to healthy diets across LMICs, particularly in Africa and South Asia [2]. Rising food prices and the escalating cost of a healthy diet have disproportionately affected low-income urban populations. Within countries, pronounced urban-rural and gender disparities persist: women and the urban poor are more likely to experience food insecurity, limited dietary diversity, and barriers to adequate nutrition [2]. Secondary cities, smaller than capital metropoles but experiencing rapid demographic growth, are particularly vulnerable. Due to rapid urbanization, evolving food environments, and changing livelihood structures secondary cities face unique challenges, combining rural food production constraints with expanding national and international market access and an increasing supply of processed foods [3,4].

Country-specific trends illustrate the complexity of urban nutrition challenges. In Bangladesh, data indicate progress in reducing child undernutrition, nevertheless, high levels of stunting, wasting, and micronutrient deficiencies persist, alongside a rising prevalence of overnutrition [5]. In Kenya, undernutrition remains a concern with marked regional disparities, while overweight and obesity are increasingly observed in urban populations, reflecting the coexistence of multiple forms of malnutrition [6]. In Rwanda, reported child stunting has declined substantially in recent years but continues to affect a large proportion of the population, particularly in rural areas, alongside limited dietary diversity and persistent micronutrient deficiencies [7,8].

Adequate dietary diversity for both children and mothers is essential to prevent micronutrient deficiencies. In early 2025, the UN Statistical Commission acknowledged the importance of adequate dietary diversity by adopting Minimum Dietary Diversity (MDD) as a new Sustainable Development Goal (SDG) indicator, providing a standardized measure to assess diet quality among women and children and to track progress toward SDG 2 (Zero Hunger) [9]. As early feeding shapes growth trajectories and lifelong metabolic risk, optimal infant and young child feeding practices remain a cornerstone of public health [10].

The Nutrition in City Ecosystems (NICE) project is a multisectoral initiative implemented in secondary cities in Bangladesh, Kenya and Rwanda, addressing food-system determinants of malnutrition through combined supply-and demand-side interventions [11]. The 2021 inception survey documented among others, high household food insecurity, variable but substantial under-five stunting rates, and a high prevalence of overweight among women of reproductive age, illustrating double and even triple burden of malnutrition in urban and semi-urban settings [3]. The present analysis focuses on findings from the 2025 end-of-phase survey, providing updated evidence on dietary patterns and nutritional status among the most vulnerable populations. Where relevant, comparisons with the 2021 survey are drawn to illustrate temporal shifts, offering insights to inform ongoing urban nutrition policy activities and programmatic strategies in secondary cities.

Methods

Study design

A household survey was conducted in the six secondary cities of the NICE project, namely Dinajpur and Rangpur in Bangladesh, Bungoma and Busia in Kenya, and Rubavu and Rusizi in Rwanda [11]. In 2025, the same sampling design as in the inception survey (2021) was applied [3]. In short, a two-stage sampling procedure was used whereby sectors with high prevalence of malnutrition were purposively selected within each city, followed by systematic random sampling of households meeting eligibility criteria (at least one woman of reproductive age (WRA, 15-49 years) and one adolescent (10-19 years) / youth (15-24 years), and/or child <5 years) until the sector-specific target sample size for the households was reached. Hence, the respondents in 2021 and 2025 were not necessarily the same. The total sample size targets were 150 per city in Kenya and Rwanda and 300 per city in Bangladesh due to the average city population size being larger in Bangladesh than in the other two countries.

Data collection

Data collection took place February and March 2025. In each household, the Woman of Reproductive Age (WRA) primarily responsible for food preparation was selected as the main respondent. Administration of the questionnaire required,

on average, 45 minutes per household, while anthropometric measurements took an additional 15 minutes, depending on the number of eligible household members assessed.

The household surveys were conducted by qualified and experienced enumerators carefully trained in the data collection for this survey. After the training of the enumerators, the questionnaires translated into the local language, anthropometric tools and procedures were thoroughly piloted in each country. The comprehensive questionnaire addressed questions on household characteristics, such as household location and size, ownership or access to land and livestock, monthly income, as well as food expenditure. The questionnaire further applied the Household Food Insecurity Access Score (HFIAS) [12], a 24-hour dietary recall for food consumed in the household (Household Dietary Diversity Score (HDDS)) [13], and questions on child feeding (including breastfeeding and complementary feeding). Furthermore, a 24-hour dietary recall was administered to one WRA per household using country-adapted versions of the Diet Quality Questionnaire (DQQ) [14]. The DQQ was used to derive multiple indicators, including the Minimum Dietary Diversity for Women (MDD-W)) [15], the All-5 indicator (consumption of at least one starchy staple, one vegetable, one fruit, one pulse/nut/seed, and one animal-source food), and indicators related to Non-Communicable Disease (NCD) risk. These included the NCD-protect (0-9), reflecting consumption of nine food groups aligned with WHO recommendations for health-protective diets, and the NCD-risk (0-9) capturing intake of food groups associated with elevated NCD risk. A composite Global Dietary Recommendations (GDR score, 0-18), integrating both NCD-protect and NCD-risk components, was also calculated, with higher scores indicating greater adherence to WHO global dietary recommendations for health-promoting diets [14].

Dietary knowledge was assessed using the framework of the countries' food pyramids to guide question design and scoring. Participants indicated (without the visual aid of the pyramid) which of the following food groups should be consumed liberally, moderately, or sparingly, using locally relevant examples: 1) Dairy, fish, meat, eggs; 2) Cereals, rice, beans, potatoes; 3) Sugary drinks, sweets and snacks; 4) Nuts, oils, and fats; 5) Vegetables and fruits; 6) Water and plain tea or coffee. Responses were scored according to concordance with food pyramid recommendations, whereby fruits, vegetables, and water were recommended for high consumption (liberally), foods high in fat and sugar for limited consumption (sparingly), and all remaining food groups for moderate consumption (moderately), thereby yielding a standardized measure of basic dietary knowledge.

Furthermore, in each household, height, weight and Mid-Upper Arm Circumference (MUAC) were collected from all household members present, aged ≥2 weeks and providing informed consent for these measures at the time of the visit. Body weight and height, in light clothes and without shoes, were measured in kilograms (kg) and centimeters (cm) using an electronic scale and a portable stadiometer. The MUAC (in mm and color) was assessed using the UNICEF measuring tapes.

All data were collected electronically using Open Data Kit (ODK). Data flow was automated (skip patterns) and constraints set to data entry fields, to increase quality assurance. Furthermore, regular data checks were conducted by the supervisors prior to uploading the data, ensuring quality and completeness.

Statistical analysis

Anthropometric measurements (weight and height) were used to calculate Body Mass Index (BMI) for individuals aged 19 years and above with the standard formula (BMI=kg/m2). For children and youth under the age of 19 years, sex-specific z-scores for height-for-age (HAZ), weight-for-age (WAZ), BMI-for-age, and Weight-for-Height (WHZ) were calculated using the reference equations recommended by WHO [16,17]. These equations account for the skewness of the respective distributions. Z-scores of - 1.96 and 1.96 correspond to the 2.5th and the 97.5th percentiles, respectively. Stunting was defined as HAZ<-2, wasting as WAZ<-2, and underweight as WHZ<-2. For participants under 19, overweight was defined as BMI-for-age z-score>2. For participants aged 19 or higher, overweight was defined as BMI≥25. The prevalence of stunting, wasting and overweight was further classified according to their public health significance using the thresholds proposed by de Onis et al. Prevalence cut-offs for stunting were defined as <2.5%: very low, 2.5 to <10%: low, 10 to <20%: medium, 20 to <30%: high, ≥30%: very high. For wasting and overweight, corresponding cut-off were<2.5%: very low, 2.5 to <5%: low, 5 to <10%: medium, 10 to <15%: high, ≥15%: very high [18].

Results for quantitative continuous variables are reported as mean and those for binary variables as prevalence, stratified by city and year. Longitudinal changes in mean values and prevalences from 2021 to 2025 were assessed using country-specific mixed linear and logistic regression models, respectively. These models included a factor variable for city and city-specific indicator variables for the year 2025, as well as random effects of administrative

subunits. In the case of the anthropometric variables, models were further stratified by gender, and random effects of households were added. In the analyses for children under the age of 5 years, a further random effect level for multiple births was included.

Estimation of the frequency distributions for the Duration of Exclusive Breast Feeding (DEBF) and the Age at Start of Complementary Feeding (ASCF) was restricted to children aged ≥6 months. Missingness in DEBF was substantial, particularly in Bangladesh, whereas ASCF was largely complete. Accordingly, the ASCF distribution was obtained using the Kaplan-Meier method. To deal with the considerable fraction of missing DEBF-values, data imputation was used. The applied imputation method is described in the online supplement (Supplement statistical imputation method for exclusive breastfeeding).

Results

Household characteristics

Households in the survey varied in their sociodemographic, socioeconomic, and livelihood characteristics. Table 1 presents these indicators for the 1206 participating households in 2025.

Household food insecurity access score

Household food insecurity, defined as the inability to eat the desired variety, quality or quantity of food due to a lack of resources, was assessed using the HFIAS. Figure 1 shows the percentage of households with any indications of food insecurity using the HFIAS in 2025 compared to 2021 (during the COVID-19 pandemic) and pre-COVID-19 (early 2020) estimations in all cities [3].

Table 1: Household characteristics of the 2025 survey.

		Household head				Income		Land		Livestock	
Country	City (n)	Gender (% female)	Age (average, years)	Household members (average)	Location peri-urban or urban (% urban)[1]	Average monthly income[2]	% of income spent on food	Own (%)	Cultivate land owned by others (%)	Own (%)	Most frequently mentioned
Bangladesh	Dinajpur (303)	11.2	40.7	4.4	83.5	22211	50-75	72.6	1.0	56.8	chicken
	Rangpur (303)	9.9	42.1	4.5	44.2	26281	50-75	66.7	1.7	56.8	chicken
Kenya	Bungoma (150)	20.0	38.8	4.9	85.3	16887	25-50	38.7	7.3	30.7	chicken
	Busia (150)	23.3	37.0	5.1	56.1	18616	25-50	36.7	15.3	42.7	chicken
Rwanda	Rubavu (150)	23.3	37.7	5.9	14.7	65833	50-75	48.7	25.3	40.7	chicken
	Rusizi (150)	10.7	40.6	6.2	17.3	83522	>75	42.0	46.0	45.3	cattle

[1]Urban and peri-urban households were defined using country-specific criteria during sampling, based on settlement density, land use, and access to infrastructure, with peri-urban areas representing transitional zones between rural and urban settings.

[2]for Kenya in Kenya Shillings (KES), for Bangladesh in Bangladesh Taka (BDT), for Rwanda in Rwanda Francs (RWF).

Table 2: MDD-W score (0-10), All-5 indicator, NCD-protect indicator (0-9), NCD-risk indicator (0-9), and the GDR score (0-18) assessed through the DQQ in 2025 and 2021).

		2025					2021				
		MDD-W score	All-5 (%)	GDR score	NCD protect	NCD risk	MDD-W score	All-5 (%)	GDR score	NCD protect	NCD risk
Bangladesh	Dinajpur	4.75*	26.07*	10.68	2.79*	1.11*	5.37	39.74	11.85	3.50	0.65
	Rangpur	4.76*	17.82*	10.50	2.68*	1.18*	5.35	39.13	11.37	3.24	0.88
Kenya	Bungoma	4.68	18.00	11.41	2.75	0.33*	4.59	12.67	11.40	2.72	0.32
	Busia	4.49	11.33	11.24	2.74	0.50*	4.46	14.00	11.31	2.77	0.46
Rwanda	Rubavu	3.53*	6.00	11.80*	2.86*	0.06	3.79	9.33	12.13	3.25	0.12
	Rusizi	4.25	12.00	12.11	3.28	0.17*	4.14	14.67	12.33	3.60	0.27

*2025 and 2021 are statistically significant p<0.05.

Table 3: Percentage of children (<5 years) being stunted, wasted, underweight and overweight in the two survey rounds.

					Stunting(%)		Wasting (%)		Underweight (%)		Overweight (%)	
			Male (n)	Female (n)	Male (n)	Female (n)	Male (n)	Female (n)	Male (n)	Female (n)	Male (n)	Female (n)
2025	Bangldesh	Dnajpur	109	96	17.4	15.6	9.2*	9.4	6.4*	7.3	3.7	0.0
		`Rangpur	124	125	12.9	16.0	8.9	5.6	8.1	5.6	0.0+	2.4
	Kenya	Bugoma	79	75	11.3	17.3	13.9	20.0	13.9+	21.3	13.9	10.7
		Busia	98	77	18.4	14.3+	15.5	13.0	14.4	13.0	14.4	10.4
	Rwanda	Rubavu	92	101	30.4	31.7+	4.4	0.0+	4.4	0.0+	6.6	7.9
		Rusizi	105	104	21.9	21.2	4.8	4.8	4.8	5.8	8.6	7.7
2021	Bangldesh	Dinajpur	146	159	15.1	16.4	18.5	12.6	15.1	10.1	4.8	1.3
		Rangpur	142	131	19.7	24.4	12.0	9.2	4.9	10.7	3.5	4.6
	Kenya	Bugoma	71	88	15.5	10.2	5.6	11.4	2.8	12.5	9.9	5.7
		Busia	90	89	14.4	1.1	14.4	11.2	13.3	12.4	4.4	4.5
	Rwanda	Rubavu	84	94	47.6	45.7	1.2	4.3	1.2	4.3	8.3	11.7
		Rusizi	92	99	33.7	23.2	2.2	2.0	2.2	2.0	10.9	11.1

Stunting defined as height-for-age Z-score <-2, wasting defined as weight-for-age Z-score <-2, underweight defined as weight-for-height Z-score <-2 and overweight defined as BMI-for-age Z-score >2. Significant difference from 2021: + p<0.1, * p<0.05. Public health significance: stunting: <2.5% = very low, 2.5 to <10% = low, 10 to <20% = medium, 20 to <30% = high, ≥30% = very high. Public health significance: wasting and overweight <2.5% = very low, 2.5 to <5% = low, 5 to <10% = medium, 10 to <15% = high, ≥15% = very high [18].

Table 4: Percentage of children (age ≤2 years and >2 to <5 years separate) being wasted, stunted, underweight and overweight in the two survey rounds.

					Stunting (%)		Wasting (%)		Underweight (%)		Overweight (%)	
			Male (n)	Female (n)	Male	Female	Male	Female	Male	Female	Male	Female
Children ≤2 years												
2025	Bangladesh	Dinajpur	45	45	15.6	6.7	15.6	6.7	11.1+	4.4	4.4	0.0
		Rangpur	51	57	15.7	21.1	11.8	5.3	13.7	5.3*	0.0	5.3
	Kenya	Bungoma	36	29	19.4	20.7	11.4	13.8	11.4+	17.2	20.0	17.2
		Busia	47	36	13.9	13.9	17.4	8.3	17.4	8.3	17.4	16.7
	Rwanda	Rubavu	42	50	19.0	34.0	9.5	0.0	9.5	0.0	9.5	10.0
		Rusizi	48	49	22.9	16.3	4.2	4.1	4.2	6.1	12.5	14.3
2021	Bangladesh	Dinajpur	53	53	13.2	11.3	24.5	11.3	26.4	9.4	3.8	1.9
		Rangpur	50	48	20.0	27.1	8.0	16.7	4.0	20.8	4.0	10.4
	Kenya	Bungoma	36	38	16.7	5.3	2.8	15.8	0.0	15.8	8.3	10.5
		Busia	41	39	9.8	2.6	22.0	12.8	22.0	15.4	2.4	10.3
	Rwanda	Rubavu	23	32	52.2	21.9	4.3	3.1	4.3	3.1	21.7	18.8
		Rusizi	39	37	28.2	24.3	0.0	2.7	0.0	2.7	15.4	18.9
Children >2 to <5 years												
2025	Bangladesh	Dinajpur	64	51	18.8	23.5	4.7	11.8	3.1	9.8	3.1	0.0
		Rangpur	73	67	11.0	11.9	6.8	6.0	4.1	6.0	0.0	0.0
	Kenya	Bungoma	44	46	4.5	15.2	15.9	23.9	15.9	23.9+	9.1	6.5
		Busia	51	41	14.6	14.6	13.7	17.1	11.8	17.1	11.8	4.9
	Rwanda	Rubavu	49	51	40.8	29.4	0.0	0.0	0.0	0.0	4.2	5.9
		Rusizi	57	54	21.1	25.9	5.3	5.6	5.3	5.6	5.3	1.9
2021	Bangladesh	Dinajpur	93	106	16.1	18.9	15.1	13.2	8.6	10.4	5.4	0.9
		Rangpur	92	83	19.6	22.9	14.1	4.8	5.4	4.8	3.3	1.2
	Kenya	Bungoma	35	50	14.3	14.0	8.6	8.0	5.7	10.0	11.4	2.0
		Busia	49	50	18.4	0.0	8.2	10.0	6.1	10.0	6.1	0.0
	Rwanda	Rubavu	61	62	45.9	58.1	0.0	4.8	0.0	4.8	3.3	8.1
		Rusizi	53	62	37.7	22.6	3.8	1.6	3.8	1.6	7.5	6.5

Stunting defined as height-for-age Z-score <-2, wasting defined as weight-for-age Z-score <-2, underweight defined as weight-for-height Z-score <-2 and overweight defined as BMI-for-age Z-score >2. Public health significance: stunting: <2.5% = very low, 2.5 to <10% = low, 10 to <20% = medium, 20 to <30% = high, ≥30% = very high. Public health significance: wasting and overweight <2.5% = very low, 2.5 to <5% = low, 5 to <10% = medium, 10 to <15% = high, ≥15% = very high [18].

Table 5: Percentage of children (age ≤2 years and >2 to <5 years separate) being wasted, stunted, underweight and overweight in the two survey rounds.

		2025		2021	
		Female (% (n))	Male (% (n))	Female (% (n))	Male (% (n))
Bangladesh	Dinajpur	59.0 (324)	37.5 (120)	53.6% (349)	42.6% (61)
	Rangpur	56.3 (341)*	40.8 (130)+	45.3% (340)	26.9% (78)
Kenya	Bungoma	52.2 (157)	21.1 (19)	55.3% (152)	10.0% (10)
	Busia	42.2 (161)*	37.5 (24)	53.9% (154)	30.0% (10)
Rwanda	Rubavu	50.0 (162)	9.1 (44)*	42.1% (145)	29.0% (31)
	Rusizi	51.8 (164)	20.4 (49)	44.8% (143)	6.9% (29)

Overweight defined as BMI ≥25 kg/m^2. Significant difference from 2021: + p<0.1,
* p<0.05. Note: 2021 data published [3].

Table 6: Knowledge about healthy diets using the country-specific food pyramid framework in the 2025 survey.

Diet knowledge score	Dinajpur (%)	Rangpur (%)	Bungoma (%)	Busia (%)	Rubavu (%)	Rusizi (%)
Good understanding	57.1%	34.3%	98.0%	96.7%	40.0%	47.3%
Average understanding	39.9%	64.0%	2.0%	3.3%	53.3%	48.0%
Insufficient understanding	3.0%	1.7%	0.0%	0.0%	6.7%	4.7%

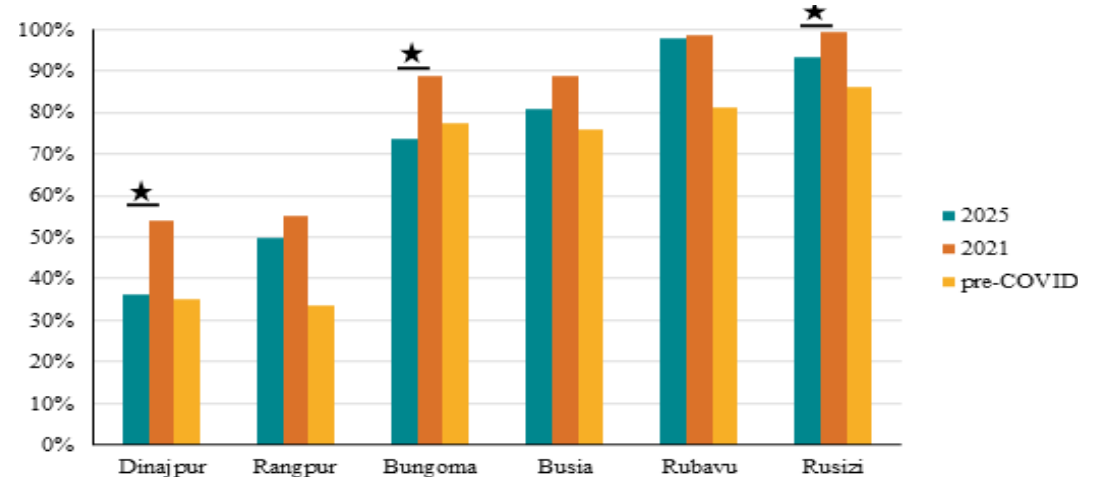

Figure 1: Percentage of households showing indications of food insecurity using the household food insecurity score (HFIAS) in 2025, 2021 and pre-COVID-19 (early 2020). *significant changes from 2021 to 2025 ($p<0.05$).

Figure 2: Household dietary diversity scores in the six secondary cities in 2025 and 2021.

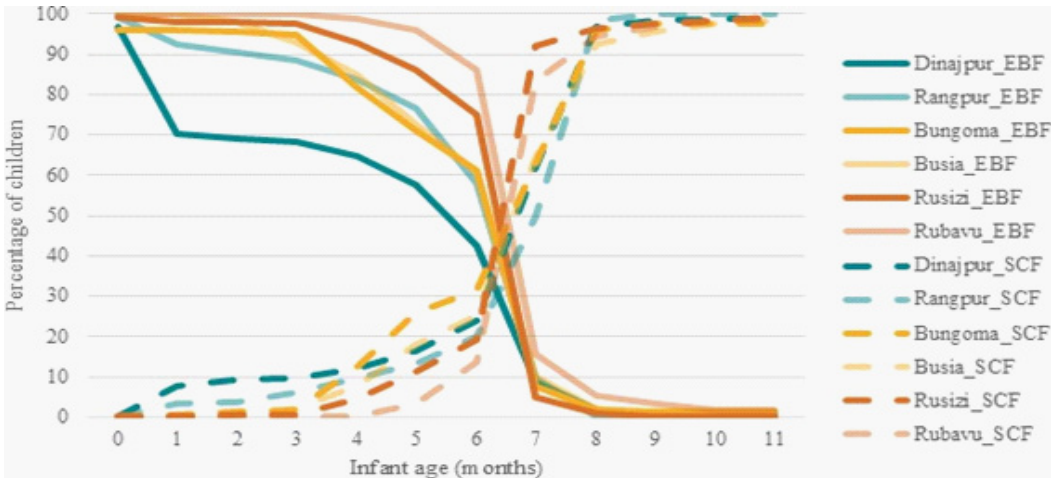

Figure 3: Percentage of children being Exclusively Breastfed (EBF, solid lines) and start of complementary feeding (SCF, dashed lines) in the surveyed infants in each country (2025).

Household dietary diversity score

Respondents provided information on the number of foods (out of a total of 12) consumed by household members at home over the past 24 hours. Figure 2 presents the HDDS in both survey rounds. The average number of food groups consumed in the household (±SD) in 2025 was: 6.6±1.9 in Dinajpur, 7.1±1.9 in Rangpur, 5.8±2.1 in Bungoma, 5.6±2.0 in Busia, 4.6±2.7 in Rubavu, and 4.8±2.8 in Rusizi.

Diet quality questionnaire

Table 2 summarizes the dietary quality indicator for women of reproductive age, including the MDD-W score, All-5 indicator, NCD-protect indicator, NCD-risk indicator, and the GDR score. The proportion of women achieving an adequately diverse diet (MDD-W ≥5) in 2025 and 2021 were: 53.8% and 70.7% in Dinajpur, 52.5% and 70.6% in Rangpur, 56.0% and 52.7% in Bungoma, 46.7% and 52.3% in Busia, 19.3% and 26.7% in Rubavu, and 37.3% and 39.3% in Rusizi. Consumption of ultra-processed foods was relatively low, reported in 9-12% of households in Dinajpur and Rangpur, and below 1% in Busia, Bungoma, Rubavu, and Rusizi.

Nutrition status

The percentage of boys and girls under five years being malnourished (wasted, stunted, underweight and overweight) in 2025 are given in Table 3 and split for children ≤2 years and >2 to <5 years in Table 4. The percentage of women and men being overweight are shown in Table 5.

Exclusive breastfeeding and introduction of complementary feeding

The percentage of mothers who exclusively breastfeed their children during the first six months of life in 2025 and 2021 were 42.6% and 60.0% in Dinajpur, 57.9% and 53.7% in Rangpur, 61.0% and 63.8% in Bungoma, 60.8% and 63.3% in Busia, 86.1% and 94.8% in Rubavu, and 75.1% and 83.6%in Rusizi. The time pattern of exclusive breastfeeding and start of complementary feeding from the 2025 survey is shown in Figure 3. On average, the age of the start of complementary food in 2025 and 2021 was 5.7 and 6.1 months in Dinajpur, 5.7 and 5.9 months in Rangpur, 5.7 and 5.4 months in Bungoma, 6.0 and 5.6 months in Busia, 6.2 months in 2025 and 2021 in Rubavu, and 5.8 and 6.0 months in Rusizi.

Knowledge about healthy diets

Participants' knowledge of healthy diets was assessed by scoring responses for concordance with national food pyramid recommendations, providing a standardized measure across six key food groups. This metric enables evaluation of overall dietary knowledge and its distribution within the sample. Table 6 summarizes the knowledge scores for the family member responsible for food purchasing and meal preparation.

Discussion

The 2025 NICE survey across malnutrition-prone households in six secondary cities of Bangladesh, Kenya, and Rwanda provided a comprehensive assessment of nutrition-related outcomes and determinants. Findings indicate persistent household food insecurity, low to moderate dietary diversity, and a concurrent burden of child undernutrition and adult overweight, despite moderate to high knowledge of healthy diets. Exclusive breastfeeding until six months varied widely, from suboptimal in Bangladesh and Kenya to very high in Rwanda.

Rising food prices increasingly constrain dietary diversity and quality. Between 2017 and 2024, the cost of a healthy diet increased substantially in Kenya, Rwanda, and Bangladesh [2], a trend that is consistent with our observations of declining household dietary diversity and a persistently high share of household income allocated to food, thereby contributing to elevated levels of food insecurity. These patterns, together with persistent stunting in African sites, align with evidence linking food insecurity to inadequate dietary diversity and increased child stunting [19,20]. The coexistence of food insecurity and overweight, especially in adults, reflects documented pathways through which constrained resources promote reliance on inexpensive energy-dense foods and reduced physical activity [21-25]. Notably, respondents, especially in African cities, reported minimal consumption of ultra-processed foods, with diets instead characterized by deep-fried foods and sweetened beverages. This pattern aligns with modest NCD-risk scores and suggests that overweight is driven primarily by traditional energy-dense foods and low physical activity, rather than industrially manufactured products.

In Kenya and Rwanda, stunting in the 2025 survey was lower than national averages (Kenya DHS 2014, Rwanda DHS 2019-20) [6,7]. In contrast, wasting and overweight in our sites were higher than these national estimates, highlighting subnational

variation and the concurrent presence of acute malnutrition and emerging overnutrition. In Bangladesh, stunting and underweight in the 2025 survey were lower than reported in national surveys conducted during 2019-21 [5], while wasting was comparable and overweight remained low. This suggests that regional disparities in child nutrition persist and that localized surveys may capture dynamics not reflected in national data, although temporal differences should also be considered.

Overweight in our study population was generally more prevalent in children ≤2 years than in those aged 2-5 years, a pattern also observed in national surveys from LMICs, potentially reflecting infants' greater likelihood of crossing growth percentiles or measurement variability [26]. Stunting and wasting share common determinants and frequently co-occur, showing complementary age patterns: incidence peaks in early infancy, particularly between birth and three months [27], while prevalence, cumulative number of children affected, is higher among older children, increasing steadily during the first two years, peaking at 24-30 months, and declining modestly thereafter [28]. High early-life incidence therefore contributes to elevated prevalence at older ages, although this gradient was not evident in our dataset, likely due to limited sample size and reduced age-specific resolution.

Breastfeeding and complementary feeding patterns, particularly the reduced adherence to exclusive breastfeeding recommendations along with early or inconsistent complementary feeding, mirror findings from other LMICs where suboptimal feeding practices contribute to undernutrition [29].

The variability across cities suggests that contextual factors, including socioeconomic constraints and local norms, influence early feeding behaviors. Despite good awareness of healthy diets, as seen in our respondents, affordability and availability of nutrient-rich foods likely constrain dietary practices, consistent with evidence that improving the food environment enhances consumption of healthy foods [30,31].

A major strength of this study is the inclusion of comparable data from two survey rounds and across diverse urban and peri-urban contexts in six cities and three countries, allowing examination of temporal changes. The multi-dimensional assessment, bringing together household food security, dietary diversity, breastfeeding practices, and anthropometry across age groups, provides an integrated perspective on nutrition vulnerabilities. Strengths of this study include comparable data across two survey rounds, diverse urban contexts, and a multi-dimensional assessment integrating food security, dietary diversity, feeding practices, and anthropometry. The study has several limitations. Dietary outcomes relied on self-reported indicators, which may be subject to recall and social desirability bias, and the survey did not allow estimation of quantitative nutrient intakes. Comparisons between survey rounds may also be influenced by unmeasured macroeconomic and seasonal factors (data collection was in February and March 2025 and April to June 2021). In addition, the 2021 survey was conducted during the COVID-19 pandemic. For Rwanda the 2025 survey coincided with insecurity in eastern Democratic Republic of Congo (DRC), including armed conflict in Goma, which affected travel and cross-border movement in the Rwanda-DRC border region, including Rubavu and Rusizi. These contextual differences may have influenced food access, consumption patterns, and participant responses, thereby limiting the comparability of findings across survey rounds.

Future efforts should examine pathways linking food insecurity, dietary patterns, and malnutrition in secondary cities, with particular attention to how rising food costs shape household food choices and how adequate diverse diets can be maintained within planetary boundaries. Interventions along the farm-to-fork value chain, balancing consumer and producer responsibilities, are needed for sustainable food systems transformation. A deeper understanding of local food environments, including availability, affordability, equity, behavior, health effects, marketing, and agricultural factors, can guide targeted, context-specific interventions. Concurrently, policies improving access to nutrient-rich foods, strengthening local food value chains, regulating energy-dense and nutrient-poor products, and integrating breastfeeding and complementary feeding support into routine health services are likely to yield measurable benefits, particularly when combined with strategies addressing broader determinants of urban poverty such as income instability and limited livelihood opportunities.

Declarations

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Authorship: TB-J led the development of country-specific protocols, coordinated and monitored data collection, supported data analysis, and drafted the manuscript. CSP and CS contributed to data analysis and manuscript drafting. SK, CMU, FP, and SI supported protocol development, ethical approvals, trainings and supervised data collection. JW and AI contributed to data collection and data analysis. EI, SH, MAT, and JI supported protocol development and ethical approvals. JM contributed to interpretation of results and manuscript review. HP supported protocol development, study implementation, and manuscript drafting. All authors reviewed and approved the manuscript.

Ethical standards disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki. Ethical approval was obtained through the local research institutions from the relevant ethics committee in each participating country: in Bangladesh, the Institutional Review Board of the Institute of Health Economics (IHE-IRB, DU/72/2024/Final); in Kenya, the Amref Ethics and Scientific Review Committee (ESRC P1810/2024); and in Rwanda, the National Research Ethics Committee (RNEC 657/2024). In addition, the study was approved by the Ethics Committee of Northern and Central Switzerland (EKNZ, AO_2024-00122, AO_2024-00123, AO_2024-00125). Written informed consent was obtained from all study participants prior to data collection, including interviewed women, household members, and adult legal guardians of children and adolescents under 18.

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