

RESEARCH ARTICLE OPEN ACCESS

Distress Financing for Food in an Urban Slum: Insights From the Nutri-CAP Study in Bangladesh

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Received: 2 November 2025 | **Revised:** 23 August 2026 | **Accepted:** 11 September 2026

Keywords: Bangladesh | distress financing | food insecurity | food shortage | urban slum

ABSTRACT

Objective: Distress financing (DF) refers to financial strategies adopted by households to secure funds in response to stressor events, potentially leading them into a persistent cycle of poverty. We aimed to estimate the prevalence of DF for food and identify factors associated with it in an urban Bangladeshi slum.

Methods: This cross-sectional study utilised data from the community survey component of the Nutrition for Children, Adolescent Girls and Pregnant Women in Slums of Dhaka City (Nutri-CAP) study (NCT05311436), conducted in Bauniabadh slum, Dhaka, Bangladesh. The current analysis included 2826 households. Unadjusted logistic regression analyses and a multiple logistic regression model were used to examine associations with DF. A classification and regression tree was constructed to identify household subgroups with differing prevalence of DF. DF included taking loans, mortgaging or selling assets, begging, receiving salary advances, or seeking assistance from relatives.

Results: The prevalence of DF was 23.5%, while 73.3% of households were food secure. Higher monthly income was associated with lower odds of DF (adjusted odds ratio [aOR]: 0.88, 95% CI: 0.82–0.94), as was postprimary education of the female household manager (FHM) (aOR: 0.61, 95% CI: 0.46–0.80). Compared with food-secure households, the odds of DF were higher among mildly (aOR: 28.31, 95% CI: 16.79–47.72), moderately (aOR: 36.96, 95% CI: 27.81–49.14) and severely food-insecure households (aOR: 53.57, 95% CI: 35.09–81.78). Households with a monthly income <12,000 BDT and lower FHM's education had the highest observed prevalence of DF.

Conclusion: The findings highlight important socioeconomic and household characteristics associated with DF and may inform the development of targeted policy interventions, particularly for low-income households and those where the FHM has limited education. Potential measures include conditional cash transfers, education-based subsidies, livelihood programmes, subsidised food provision and improved housing conditions in slum areas.

Trial Registration: ClinicalTrials.gov Identifier: NCT05311436

Summary

- What is already known on this topic
- Urban slum households in low- and middle-income countries face chronic food insecurity driven by poverty, overcrowding and weak social protection.

- Distress financing (borrowing, selling assets, or seeking assistance) is well documented for healthcare but rarely quantified for food acquisition.
- What this study adds

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- Provides a large-scale quantitative estimate of distress financing for food in an urban Bangladeshi slum, with almost one in four households affected.
- Shows that some food-secure households also reported distress financing, highlighting financial vulnerability not fully captured by contemporaneous food-security status.
- Identifies household income and female household manager's education as independently associated with distress financing, while socioeconomic gradients were observed across social class and asset index.
- How this study might affect research, practice or policy
- Guides policymakers to target interventions such as conditional cash transfers, subsidised food and education-focused subsidies towards the most at-risk groups.
- Encourages integration of financial coping mechanisms into food security assessments and future research.
- Highlights the role of women's education and employment as protective factors against household distress financing.

1 | Introduction

The United Nations Decade of Action on Nutrition (2016–2025) and the World Health Organization's (WHO) Sustainable Development Goals (SDGs) for 2030 affirm that nutrition and food security constitute fundamental human rights and essential public health priorities [1]. The first two goals of the SDGs focus on (1) eliminating poverty in all its forms globally and (2) eradicating hunger, ensuring food security, enhancing nutrition and promoting sustainable agriculture [2]. Nevertheless, an estimated 820 million people experience hunger daily, while more than two billion individuals suffer from micronutrient deficiencies, posing serious risks to health and longevity [3]. One of the key determinants of this fundamental right is household food security (HFS). The Food and Agriculture Organization (FAO) defined HFS as a state in which all individuals, at all times, have both physical and economic access to adequate, safe and nutritious food that aligns with their dietary needs and preferences, enabling an active and healthy life [4].

Household food insecurity (HFI) arises when households struggle to access sufficient, safe and nutritious food [5]. Driven by factors such as poverty, income level and education, it disproportionately affects low-income populations [5, 6]. Vulnerable communities face heightened risks of hunger, chronic illness, psychological distress and social inequalities due to HFI [5]. It has been reported that approximately 26.4% of the global population was affected by HFI [7]. The COVID-19 pandemic has only exacerbated the situation by affecting the accessibility and availability of food [8]. The concentration of HFI-affected individuals centres mostly among the LMICs [9]. It is reported that, only in Asia and the Pacific, an estimated 351 million people are at risk of experiencing food insecurity in the coming decade [9].

Bangladesh is also at risk of being ranked 75th on the Global Hunger Index and 95th on the Global Food Security Index [9].

The food supply chain is a crucial determinant of a country's overall food availability [10]. It can be influenced by factors other than food availability, like currency, market, export and import structure, lack of agricultural labour for agriculture-dependent countries like Bangladesh, hikes in food prices and economic hardship [10]. Another study focusing on sub-Saharan African firms also highlighted the importance of crop production, additional income sources, household size, market access, and others, on food availability [11].

According to national census data collected in 2022, almost 17 million people reside in urban slums in Bangladesh, with Dhaka hosting the highest number of slum households [12]. These slum households are more vulnerable to food shortages and hunger, despite the country making significant strides in food production [13]. It has been reported that rice production, which is the staple food of Bangladesh, has increased 2.5 times from 1970 to 2020 [13]. However, national-level food availability does not necessarily translate into household-level food security [13–15]. It has been reported that food insecurity prevalence rates range from 35% to 44% in Bangladesh [13]. Moreover, data from 2016 indicate that 51.73% of slum households are food insecure, which highlights the persistent food-related challenges faced by slum and informal settlement residents in Bangladesh [13].

Food-insecure households adopt various coping strategies to manage their vulnerability. During food price surges or natural disasters, they employ food- and nonfood-based strategies, or a combination of both, to meet their basic needs [16]. Common food-related coping strategies include purchasing less preferred foods, reducing meal sizes, consuming only rice, skipping meals and selling assets during food scarcity [17]. Historically, households used strategies like adjusting cropping practices, taking loans, selling assets in Africa, and selling livestock in Zimbabwe [18]. To sustain food intake, households sell nonfood crops and assets, borrow money, delay debt repayments, cut nonfood expenditures, or rely on food aid [17, 19].

Distress financing (DF) refers to financial strategies such as borrowings, mortgaging or the sale of physical assets to secure funds to cope with a stressor event [20, 21]. While primarily used for healthcare financing in the biomedical sector, in principle, it can be used for any event that causes financial strain on the household. In other words, DF is one of the coping mechanisms for household financial hardship. Data regarding the prevalence and factors for DF among urban slum households in Bangladesh are limited. Additionally, identifying factors associated with DF may help inform programmes targeting households experiencing financial hardship. DF may contribute to financial hardship and has been associated with adverse economic consequences, potentially exacerbating household vulnerability [22]. Hence, it is necessary to investigate DF properly among vulnerable households in Bangladesh. Our study aimed to estimate the prevalence of DF for food and identify factors associated with it in an urban Bangladeshi slum.

2 | Materials and Methods

2.1 | Study Setting and Design

The study employed a cross-sectional design and was implemented in the Bauniabadh slum, located in the Mirpur administrative zone of Dhaka, Bangladesh. Bauniabadh is a densely populated informal urban settlement, with an estimated population density of 50,000 persons per square kilometre [23]. The slum is segmented into five blocks, labelled A through E, with each block containing approximately 22 narrow lanes or alleys. Each lane contains 24 small plots, where each plot accommodates a dwelling with 8 to 12 rooms, sharing a communal toilet and kitchen. The total population is estimated at 61,000 individuals, residing in roughly 16,500 households [24]. The area is predominantly inhabited by lower-middle-income and economically marginalised populations. Living conditions reflect those commonly found in high-density urban slums, including limited access to adequate housing, water and sanitation services.

Participants were recruited using purposive sampling. Eligible participants comprised three groups: pregnant women aged 18–39 years who were at < 16 weeks of gestation and intended to remain in the study area until delivery; adolescent girls aged 11–19 years; and children aged 0–24 months who were the youngest child in the household and whose families intended to remain in the study area until the child reached two years of age. Participants were not eligible if they were enrolled in another nutrition project or programme at the time of recruitment. Households were included through the enrolment of an eligible participant. Individuals were excluded if informed consent was not provided, they were expected to migrate from the study area during the study period, or they had a reported or diagnosed chronic disease. Extremely obese pregnant women and children with congenital anomalies were additionally excluded.

2.2 | Data Source and Sampling

Data were obtained from the community survey component of the Nutri-CAP initiative (Nutrition for Children, Adolescent Girls and Pregnant Women in Slums of Dhaka City), a quasi-experimental research project conducted between April 2022 and July 2024. The survey was administered at a single time point. Households meeting the predefined eligibility criteria were enrolled from those available in the study area until the required sample size was reached. The study sample comprised 2826 households and did not represent a census of all households in the Bauniabadh community. Household interviews were conducted using standardised tools, aligned with the project's monitoring and evaluation framework.

3 | Operational Definitions

3.1 | Outcome Variable

3.1.1 | DF

The primary outcome was household DF for food. DF was defined as the use of financial coping mechanisms to obtain resources for food, including taking loans, mortgaging assets, selling productive or nonproductive property, begging, receiving salary advances, or seeking assistance from relatives in the preceding 1 month [21]. Information was obtained from the

household head (HH) using multiple survey items. The outcome was constructed from eight items: taking loans for food in the last month; mortgaging property; selling productive or non-productive property; taking a loan; begging; taking a salary in advance; and seeking assistance by visiting a relative's house. The specific survey items used to construct the distress-financing outcome are presented in Supporting Table 1. A household reporting at least one of these mechanisms was classified as having experienced DF. The eight items were combined to construct a binary outcome, coded as yes for one or more reported mechanisms and no otherwise. Multiple mechanisms could be reported by the same household and were subsequently examined descriptively as sources of DF. No minimum monetary amount or additional hardship threshold was applied; households were classified based on the reported use of at least one specified financial coping mechanism during the preceding month.

3.2 | Independent Variables

We considered several independent variables for the analysis, which included age of the HH in complete years, monthly income (in international dollars [I\$]), number of people sleeping in the household, sex of the HH (male/female), HH involved in earning activities (yes/no), education of the HH (up to primary/postprimary), religion of the HH (Islam/others), education of the female household manager (FHM) (up to primary/postprimary), FHM involved in earning activities (yes/no), overcrowding (yes/no), food security (secure/insecure), social class (lower/middle/upper) and asset index (poorest/poor/middle/rich/richest). For the current study, we defined 'female household manager' as the primary female member responsible for household and food management.

3.2.1 | Monthly Income

Monthly household income was adjusted for inflation using the consumer price index (CPI) to reflect 2023 values and expressed in I\$ to enable cross-national comparison. Inflation refers to the general increase in prices over time, which reduces the purchasing power of money. To account for this effect, the CPI is used to track changes in the cost of a standardised basket of goods and services. This study applied a standard formula to adjust historical values to their equivalent in 2023, which can be found elsewhere [25]. Due to availability, we used the yearly average general CPI value of 2023 and the general CPI for June 2024 for our analysis [26]. Costs are often converted into U.S. dollars (USD) or I\$ for better comparison [27]. The I\$ is a hypothetical currency unit designed to account for differences in purchasing power across various economies [28]. I\$1 represents the same purchasing power in Bangladesh as USD 1 does in the United States. To convert local currency values to I\$, the amount in local currency is divided by the country's purchasing power parity (PPP) for that specific year [28]. For 2023, the PPP for Bangladesh was 28.63 [29]. Monthly household income was converted to I\$ for regression analysis to facilitate interpretation across purchasing-power-adjusted income levels and was rescaled per 100 I\$. For the Classification and Regression Tree (CART) analysis, income was retained in Bangladeshi taka after converting to 2023 values to facilitate interpretation of the data-driven income thresholds within the local context.

3.2.2 | Overcrowding

According to the UN-Habitat, overcrowding occurs if there are more than three people per habitable room [30]. This variable was dichotomised as 'yes' (> 3 persons per room) and 'no' ($\leq$ 3 persons per room).

3.2.3 | Food Security

HFS was assessed using the Household Food Insecurity Access Scale (HFIAS), developed by the Food and Nutrition Technical Assistance Project III [31]. The instrument comprises nine occurrence questions assessing experiences related to uncertainty about food access, insufficient food quality and insufficient food intake during the preceding 30 days. For each affirmative occurrence, a frequency-of-occurrence question was used to assess how often the condition occurred. Responses were scored according to the standard HFIAS procedure, and households were classified as food secure, mildly food insecure, moderately food insecure, or severely food insecure [31].

3.2.4 | Social Class

Several studies have identified a country's middle class as having 75% to 125% of the population's median income [25, 32, 33]. We also used this definition and, using the cutoffs proposed by Al Fidah et al., categorised social class as 'Lower (Monthly income < 12,900 BDT)', 'Middle (Monthly income between 12,900 BDT and 21,500 BDT)' and 'Upper (Monthly income > 21,500 BDT)' [25]. The variable 'social class' was calculated to compare the study households with the national standard.

3.2.5 | Asset Index

The study categorised households into different socioeconomic groups using an asset index, which estimates a household's economic status based on ownership of assets, access to services and available amenities [34]. Household socioeconomic status was assessed using an asset index constructed through principal component analysis (PCA). The index incorporated household asset ownership, housing characteristics and access to basic services, including household possessions such as mattresses, irons, refrigerators and tables; housing materials for floors, roofs and walls; and access to drinking water and sanitation facilities. All variables were converted into binary indicators to ensure comparability, and variables with a category represented by fewer than 5% of households were excluded. PCA was used to derive the first principal component, which explained the greatest variation in household asset ownership and living conditions. Each household was assigned an asset score based on the PCA factor loadings, and households were subsequently ranked and divided into five quintiles, ranging from the lowest to the highest asset status.

3.3 | Data Analysis Procedure

STATA for Windows (Version 15; StataCorp LLC., Texas, USA) was used for data management and analysis. RStudio (Version 2024.12.1 Build 563) and R (4.4.1) were used for the CART algorithm. Categorical variables were summarised as frequencies and percentages and compared using the chi-square test or

Fisher's exact test, as appropriate. The normality of the continuous variables was examined using the Shapiro–Wilk test, and the Mann–Whitney U test was used for non-normal data. The p value of < 0.05 was considered statistically significant. We first conducted unadjusted logistic regression analyses to examine associations between household characteristics and DF. Variables were selected a priori based on their conceptual relevance and evidence from previous literature. Records with complete information on the outcome and variables included in the respective analyses were used. All selected variables were subsequently entered simultaneously into a multiple logistic regression model to estimate adjusted odds ratios (aORs). Monthly household income was rescaled and entered into the regression model per 100 IS increase to improve the interpretability of the estimated odds ratios. Interaction effects were not evaluated. Model goodness of fit was assessed using the Pearson goodness-of-fit test, while multicollinearity was assessed using variance inflation factors (VIFs), where $VIF > 5$ was considered as indicative of collinearity. Model discrimination was assessed using the area under the receiver operating characteristic curve (AUC). This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

3.3.1 | The Slope Index of Inequality (SII)

The SII was used to assess socioeconomic gradients in DF across the asset index and social class [35]. Households were ranked on a relative socioeconomic scale from the *most disadvantaged position* (Rank 0) to the *most advantaged position* (Rank 1), with ranks weighted according to the proportional population size of each subgroup. The fractional rank was entered as a continuous predictor in a logistic regression model, with DF as the binary outcome. The resulting SII coefficient represents the regression coefficient on the log-odds scale across the socioeconomic rank. A coefficient of zero indicates no socioeconomic gradient, while a negative coefficient indicates lower odds of DF with increasing socioeconomic position [36].

3.3.2 | CART Algorithm to Identify the Most At-Risk

A CART analysis was conducted to identify household subgroups with differing observed proportions of DF [35, 37]. Following the Leaving No One Behind (LNOB) methodology, a binary regression tree using the ANOVA sum-of-squares splitting criterion was constructed in R using the rpart package [35, 37]. Age of the HH, monthly household income, education of the FHM and HH, and overcrowding were included as candidate circumstances. Tree complexity was controlled using a complexity parameter, with a maximum depth of six and a minimum terminal node size of 5% of the sample. Tree pruning and selection were based on the complexity parameter table and cross-validation. The optimal complexity parameter was 0.00097, with a minimum cross-validated relative error of 0.909 (SE: 0.022). Model performance was modest (RMSE: 0.400, MAE: 0.320, R^2 : 0.110). The analysis was exploratory, and the resulting tree was used to identify subgroups with the highest and lowest observed proportions of DF. It was not intended as a predictive model.

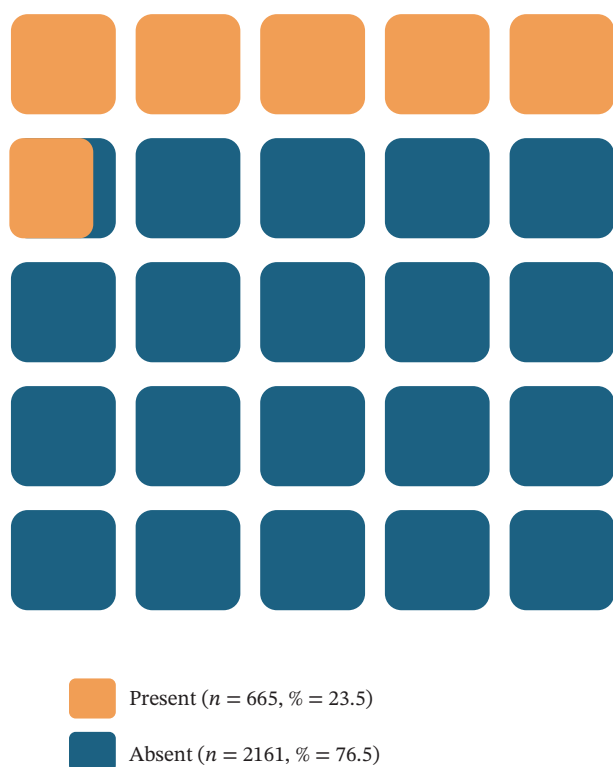


FIGURE 1 | Prevalence of distress financing.

3.3.3 | Ethical Approval and Consent to Participate

We used data from the ‘Nutrition for Children, Adolescent Girls, and Pregnant Women in Slums of Dhaka City (Nutri-CAP)’ study, which received ethical clearance from the institutional review board of icddr,b. Written informed consent was obtained from the HHs prior to data collection.

4 | Results

The analysis included data from 2826 households. We found that 23.5% (95% CI: 22.0%–25.1%) of households reported DF (Figure 1).

Significant associations were found between DF and monthly income in I\$ ($p < 0.001$), education of the HH ($p = 0.044$), education of the FHM ($p < 0.001$), presence of overcrowding ($p < 0.001$), food insecurity level ($p < 0.001$), social class ($p < 0.001$) and asset index ($p < 0.001$). The median (IQR) age of the HH was 39.0 (32.0–45.0) years, with a median monthly income of 698.6 (558.9–1047.8) I\$. Postprimary education level was reported by 34.7% of HH and 53.9% of FHMs. Most (47.4%) households belonged to the upper class, while 22.3% belonged to the poorest quintile families. Among food-secure households, 16.9% still reported DF (Table 1).

Among the 665 households reporting DF, multiple coping mechanisms could be reported. Loans were the most frequently reported mechanism (91.8%), followed by seeking support from relatives (10.1%) (Figure 2).

Our study identified several factors significantly associated with DF. Higher monthly household income per 100 I\$ increase (aOR: 0.88; 95% CI: 0.82–0.94) and postprimary education of the FHM (aOR: 0.61; 95% CI: 0.46–0.80) were associated with lower odds of

DF. In contrast, compared with food-secure households, mildly food-insecure (aOR: 28.31; 95% CI: 16.79–47.72), moderately food-insecure (aOR: 36.96; 95% CI: 27.81–49.14) and severely food-insecure households (aOR: 53.57; 95% CI: 35.09–81.78) were associated with higher odds of DF (Table 2).

The SII analysis demonstrated significant socioeconomic gradients in DF. Across the asset index, the SII coefficient was -0.22 (95% CI: -0.27 to -0.17), indicating lower odds of DF across increasing socioeconomic position. A larger negative coefficient was observed across social class (-0.32 ; 95% CI: -0.38 to -0.27 ; $p < 0.001$), indicating a steeper socioeconomic gradient in DF (Figure 3).

The exploratory CART analysis identified monthly household income, FHM’s education and household-head age as the variables contributing to the observed subgroup structure. The subgroup with the highest observed prevalence of DF comprised households with monthly income below 12,000 BDT, in which the FHM had up to primary education (52.9%, $n = 170$). Conversely, households with monthly income of at least 34,000 BDT and postprimary FHM education had the lowest observed prevalence (2.8%, $n = 282$). Internal cross-validation identified an optimal complexity parameter of 0.000972, with a minimum cross-validated relative error of 0.909 (Figure 4).

5 | Discussion

DF is a coping mechanism whereby households sell assets, take loans, or seek assistance to meet essential needs. Although DF has been extensively examined in the context of healthcare financing, similar strategies may also be used to address other forms of household financial stress. Our study examined DF for food among households living in an urban slum in Dhaka City. Nearly one in four households reported DF, including 16.9% of food-secure households. Slum households may experience a higher burden of HFI, as suggested by an earlier study [13]. While national food availability has improved over recent decades, this does not necessarily translate into household-level food security [13–15]. In addition to food availability, the quality and variety of food and the stability of food access may also influence household reliance on financial coping strategies. The presence of DF among some food-secure households may indicate that financial coping mechanisms are used to maintain access to food despite underlying economic constraints. Thus, DF may reflect household financial vulnerability that is not fully captured by contemporaneous food-security status. However, the cross-sectional design does not permit determination of the temporal relationship between food insecurity and DF.

Among households reporting DF, informal loans were the most commonly reported mechanism, while a smaller proportion sought assistance from relatives. Two studies, one conducted before the COVID-19 pandemic and another afterwards, similarly reported that households may take loans or seek support from relatives as financial coping mechanisms during food shortages [16, 17]. Another study reported that approximately three-quarters of vulnerable households preferred borrowing as a coping strategy [38]. Such reliance may contribute to a cycle of indebtedness, potentially increasing future financial stress and constraining household expenditure on food [17]. These patterns also highlight the potential importance of informal credit and

TABLE 1 | Association between independent variables and distress financing.

Variable	Categories	Distress financing		Total <i>n</i> (%)	<i>p</i> value
		No, <i>n</i> (%)	Yes, <i>n</i> (%)		
Age of the HH (in complete years)*		39.0 (32.0–45.0)	38.0 (32.0–45.0)	39.0 (32.0–45.0)	0.260
Monthly income (I\$)*		761.4 (571.1–1051.3)	571.1 (456.9–761.4)	698.6 (558.9–1047.8)	< 0.001
No. of people sleeping in the household*		4.0 (3.0–5.0)	4.0 (3.0–5.0)	4.0 (3.0–5.0)	0.366
Sex of the HH	Male	1728 (80.0)	514 (77.3)	2242 (79.3)	0.137
	Female	433 (20.0)	151 (22.7)	584 (20.7)	
HH involved in earning activities	No	248 (11.5)	77 (11.6)	325 (11.5)	0.942
	Yes	1913 (88.5)	588 (88.4)	2501 (88.5)	
Education of the HH	Up to primary	1390 (64.3)	456 (68.6)	1846 (65.3)	0.044
	Postprimary	771 (35.7)	209 (31.4)	980 (34.7)	
Religion of the HH	Islam	2138 (98.9)	655 (98.5)	2793 (98.9)	0.356
	Others**	23 (1.1)	10 (1.5)	33 (1.1)	
Education of the FHM	Up to primary	892 (41.3)	411 (61.8)	1303 (46.1)	< 0.001
	Postprimary	1269 (58.7)	254 (28.2)	1523 (53.9)	
FHM involved in earning activities	No	1268 (58.7)	379 (57.0)	1647 (58.3)	0.441
	Yes	893 (41.3)	286 (43.0)	1179 (41.7)	
Overcrowding	No	1374 (63.6)	339 (51.0)	1713 (60.6)	< 0.001
	Yes	787 (36.4)	326 (49.0)	1113 (39.4)	
Food security level	Secure	1958 (90.6)	113 (16.9)	2071 (73.3)	> 0.001
	Mildly food insecure	27 (1.3)	49 (7.4)	76 (2.7)	
	Moderately food insecure	138 (6.4)	353 (53.1)	491 (17.5)	
	Severely food insecure	38 (1.7)	150 (22.6)	188 (6.7)	
Social class	Lower	218 (10.1)	164 (24.7)	382 (13.5)	< 0.001
	Middle	810 (37.5)	296 (44.5)	1106 (39.1)	
	Upper	1133 (52.4)	205 (30.8)	1338 (47.4)	
Asset index	Poorest	436 (20.2)	195 (29.3)	631 (22.3)	< 0.001
	Poor	371 (17.2)	147 (22.1)	518 (18.3)	
	Middle	407 (18.8)	140 (21.1)	547 (19.4)	
	Rich	461 (21.3)	111 (16.7)	572 (20.2)	
	Richest	486 (22.5)	72 (10.8)	558 (19.8)	

Note: I\$, international dollars (for 2023, 1 I\$ = 28.63 BDT based on the purchasing power parity conversion factor for Bangladesh).

Abbreviations: FHM, female household manager; HH, household head.

*Continuous variables are presented as median (IQR), and *p* values were calculated using the Mann–Whitney *U* test.

**Others include Hinduism and Christianity.



FIGURE 2 | Sources for distress financing.

family support networks in managing food-related financial pressures within urban informal settlements. The findings may therefore be relevant to social protection and community-based support systems aimed at reducing household vulnerability and reliance on DF.

Several studies have established associations between household income and coping strategies adopted in response to food insufficiency [16, 39]. In a study conducted in urban informal settlements, households with lower incomes reported insufficient food availability for consumption [13]. Higher household income may be associated with better food access and lower reliance on financial coping strategies. In our adjusted analysis, higher monthly household income was associated with lower odds of DF.

We also examined socioeconomic differences in DF using social class and asset index. The inequality analyses indicated that DF was more concentrated among households in lower social classes and those with fewer assets. However, social class and asset index were not independently associated with DF after adjustment for other household characteristics. The less pronounced inequality observed across asset quintiles may partly reflect the relative homogeneity of households residing within the same urban slum community, where differences in household assets may be less substantial than those observed across the wider population.

Food-insecure households had substantially higher odds of DF than food-secure households, with progressively higher odds observed across mild, moderate and severe food insecurity categories. Several Bangladeshi studies have reported that households experiencing food shortages adopt both restrictive strategies, such as rationing meals or switching to less preferred foods, and financial strategies, including borrowing and seeking assistance from relatives [16, 17]. Accordingly, the strong association observed between food insecurity and DF is consistent with previous evidence. However, 16.9% of food-secure households also reported DF, suggesting that financial coping mechanisms for food may be used even among households not

classified as food insecure and may reflect financial pressures or circumstances not fully captured by the food security measure. This association should be interpreted cautiously because food insecurity and DF may capture related dimensions of household vulnerability, and their temporal relationship cannot be established from the cross-sectional data.

In developing countries, women play an important role in maintaining household food and nutrition security. They contribute to food production, engage in economic activities to supplement household income, and often assume primary responsibility for household food-related decisions and family care [40]. Educated women may be better positioned to manage household resources and make informed decisions regarding food expenditure [40]. However, these roles operate within broader structural contexts, including income opportunities, decision-making power, care responsibilities and gender inequalities. In the present study, postprimary education of the FHM was associated with lower odds of DF. The underlying mechanisms for this association were not directly assessed and may reflect differences in educational opportunities, household socioeconomic circumstances, or other unmeasured factors.

Our study employed the CART algorithm to identify subgroups with a high observed prevalence of DF. The CART analysis indicated that households with a monthly income below 12,000 BDT, particularly those in which the FHM had attained only primary education, had the highest observed prevalence of DF. Conversely, households with educated FHMs and higher monthly income, defined in the CART analysis as at least 34,000 BDT, had the lowest observed prevalence of DF. These findings complement the regression analysis by illustrating how combinations of household characteristics may identify groups with differing levels of vulnerability.

The current study had several strengths. It used established criteria to define DF and examined its prevalence and associated factors among households living in an urban slum, a comparatively less explored population in relation to food-

TABLE 2 | Factors associated with distress financing for food among households in Bauniabadh slum, Dhaka, Bangladesh.

Variables	uOR		aOR	
	95% CI	p value	95% CI	p value
Age of the HH (in complete years)	0.99 (0.98–1.00)	0.053	0.99 (0.98–1.00)	0.146
Monthly income (per 100 I\$ increase)	0.81 (0.78–0.84)	< 0.001	0.88 (0.82–0.94)	< 0.001
No. of people sleeping in the household	0.96 (0.91–1.01)	0.082	1.08 (0.98–1.19)	0.119
Sex of the HH		Ref: male		
Female	1.17 (0.95–1.45)	0.137	0.86 (0.58–1.28)	0.460
HH involved in earning activities		Ref: no		
Yes	0.99 (0.75–1.30)	0.942	1.00 (0.60–1.68)	0.987
Education of the HH		Ref: up to primary		
Postprimary	0.83 (0.69–1.00)	0.044	1.40 (1.04–1.88)	0.024
Religion of the HH		Ref: others		
Islam	0.70 (0.33–1.49)	0.359	0.88 (0.31–2.50)	0.811
Education of the FHM		Ref: up to primary		
Postprimary	0.43 (0.36–0.52)	< 0.001	0.61 (0.46–0.80)	< 0.001
FHM involved in earning activities		Ref: no		
Yes	1.07 (0.90–1.28)	0.441	1.22 (0.92–1.61)	0.160
Overcrowding		Ref: no		
Yes	1.68 (1.41–2.00)	< 0.001	1.08 (0.81–1.42)	0.610
Food security		Ref: secure		
Mildly food insecure	31.45 (18.95–52.19)	< 0.001	28.31 (16.79–47.72)	< 0.001
Moderately food insecure	44.32 (33.72–58.25)	< 0.001	36.96 (27.81–49.14)	< 0.001
Severely food insecure	68.40 (45.70–102.38)	< 0.001	53.57 (35.09–81.78)	< 0.001
Social class		Ref: lower		
Middle	0.49 (0.38–0.62)	< 0.001	1.08 (0.74–1.59)	0.684
Upper	0.24 (0.19–0.31)	< 0.001	1.46 (0.82–2.60)	0.196
Asset index		Ref: poorest		
Poor	0.89 (0.69–1.14)	0.352	1.13 (0.78–1.65)	0.515
Middle	0.77 (0.60–0.99)	0.044	1.00 (0.69–1.46)	0.993
Rich	0.54 (0.41–0.70)	< 0.001	1.18 (0.79–1.76)	0.426
Richest	0.33 (0.25–0.45)	< 0.001	0.96 (0.60–1.56)	0.884

Note: I\$, international dollar (for 2023, 1 I\$ = 28.63 BDT based on the purchasing power parity conversion factor for Bangladesh); reference level for distress financing: no; unadjusted odds ratios were estimated using univariable logistic regression. Adjusted odds ratios were estimated using a multiple logistic regression model in which all listed variables were entered simultaneously. The model demonstrated adequate goodness of fit (Pearson $\chi^2 = 2580.12$, $df = 2764$, $p = 0.994$), and multicollinearity was low (mean VIF = 1.6; maximum VIF = 3.53). Area under the receiver operating curve: 90.4%.

Abbreviations: CI, confidence interval; FHM, female household manager; OR, odds ratio.

related financial coping. Households were purposively recruited according to predefined eligibility criteria. The use of CART analysis also enabled further disaggregation of the data to identify household subgroups with differing observed prevalence of DF. However, the study also has several limitations. First, its cross-sectional design precludes establishing temporal or causal relationships between household characteristics and DF. Second, DF was operationalised as a composite measure comprising several financial and coping mechanisms that may differ in their severity and economic consequences. Therefore, the binary outcome should be interpreted as indicating the presence of DF rather than equivalent levels of financial hardship across affected

households. Third, DF was based on self-reported financial and coping behaviours and may therefore be subject to recall or reporting bias. In addition, although the recall period was restricted to the preceding month, some misclassification or underreporting of sensitive financial behaviours may have occurred. The CART analysis was exploratory and internally evaluated through cross-validation but was not externally validated; therefore, the identified household profiles should not be interpreted as validated predictive classifications. In addition, detailed information on the number of households approached, nonresponse, incomplete interviews, and reasons for exclusion was not available, which limited the reporting of participant flow and potential selection bias. Finally, as the

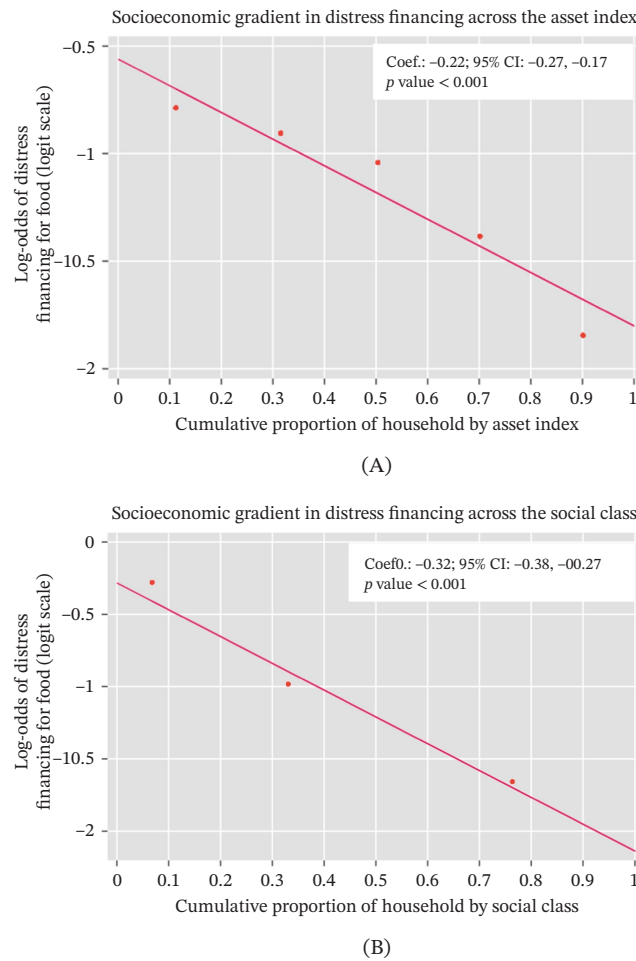


FIGURE 3 | Slope index of inequality for distress financing. (A) Socioeconomic gradient in distress financing across the asset index; (B) socioeconomic gradient in distress financing across the social class. *Note:* Represents the log-odds (likelihood) of households suffering from distress financing (negative values indicate a lesser likelihood); SII: slope index of inequality; coefficient: coefficients were estimated using logistic regression and are presented on the log-odds scale.

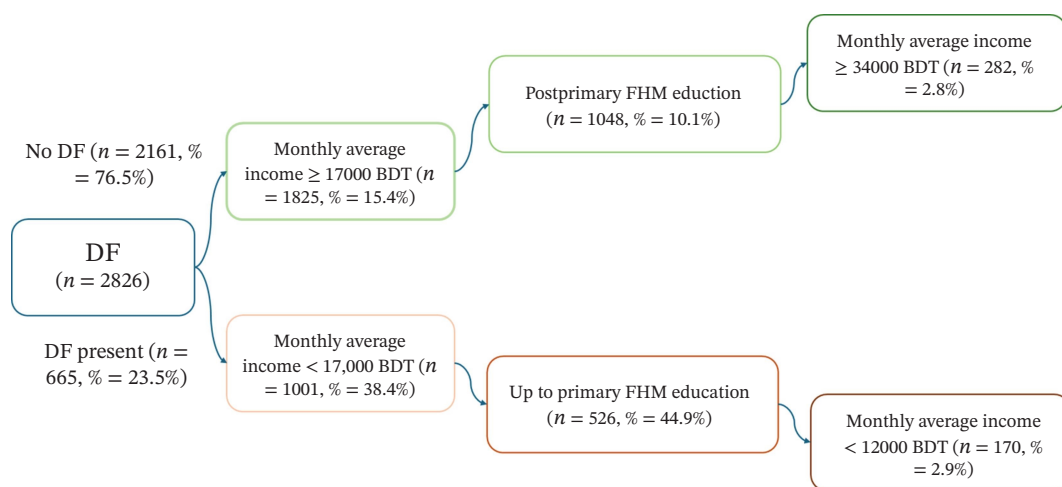


FIGURE 4 | Household subgroups with the highest and lowest observed prevalence of distress financing identified using the CART algorithm. DF, distress financing; FHM, female household manager.

study was conducted among households living in an urban slum, the findings may not be generalisable to other populations or to Bangladesh as a whole.

6 | Conclusion

This study highlights substantial household-level vulnerability to DF for food among households living in an urban informal settlement. Approximately one in four households reported DF. Higher monthly household income and postprimary education of the FHM were independently associated with lower odds of DF, whereas food insecurity was strongly associated with higher odds. The CART analysis further identified households with low income and limited FHM education as having the highest observed prevalence of DF. These findings underscore the potential relevance of household economic vulnerability, livelihood insecurity and access to informal and formal support systems within urban informal settlements. They may inform the development and future evaluation of social protection and community support strategies, including food assistance, livelihood support and measures addressing educational and economic disadvantage.

Author Contributions

Md Fuad Al Fidah, Tahmeed Ahmed, Fahmida Dil Farzana and Mustafa Mahfuz conceived and designed the study. Md Ridwan Islam and Ar-Rafi Khan were associated with data collection, curation, analysis and interpretation. Md Fuad Al Fidah, Md Ridwan Islam, Fahmida Dil Farzana and Ar-Rafi Khan wrote the manuscript. Tahmeed Ahmed and Mustafa Mahfuz critically reviewed and edited the manuscript.

Acknowledgements

The parent study was funded by the Department of Foreign Affairs, Trade and Development (DFATD), through Advancing Sexual and Reproductive Health and Rights (AdSEARCH), Grant number: SGDE-EDRMS #9926532, Purchase Order 7428855, Project P007358. icddr,b is also grateful to the Government of Bangladesh and Canada for providing core/unrestricted support.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process. This work has benefited from the use of artificial intelligence (AI) tools to support the writing and editing process. Specifically, OpenAI's ChatGPT (Version 4.0) was used to assist in language refinement, organisation of content and enhancement of clarity and academic tone. All substantive ideas, data interpretation and critical analysis are the original work of the authors. The AI was used solely as a linguistic and editorial aid, and its contributions were reviewed and approved by the authors to ensure accuracy and scholarly integrity.

Funding

This study did not receive direct sponsorship.

Disclosure

All the author(s) read and approved the final manuscript for submission.

Ethics Statement

All procedures involving research, consent of study participants, data analysis and publication were approved by the Institutional Review Board (IRB) of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), which comprises the Research Review Committee (RRC) and Ethical Review Committee (ERC).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data pertaining to this manuscript can be obtained upon request. Researchers who meet the criteria for access to confidential data are encouraged to contact Shiblee Sayeed (shiblee_s@icddr.org) at the Research Administration of icddr,b (<https://www.icddr.org/>).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Supporting Information 1.** Supporting Table 1. Survey items used to construct the household distress-financing outcome. **Supporting Information 2.** STROBE statement—checklist of items that should be included in reports of cross-sectional studies.