Article

Impact of Food Security on Dietary Diversity and Nutritional Intake Among Pregnant Women in Low-Resource Settings

Abeer Mohammad Hossain [1], Zubaida Iftekhar [2], Rajib Das [3], Sujit Kumar Banik [4], Mohammad Shamsul Huda [4], Abu Ansar Md Rizwan [5,*]

[1] Department of Public Health, Daffodil International University, Dhaka, Bangladesh

[2] Symbiotic Infotech BD Limited, Bangladesh

[3] University of Chester, United Kingdom

[4] Society for Health Extension and Development (SHED), 207 New Circuit House Rd, Cox's Bazar 4700, Bangladesh

[5] W A N Research & Consultancy, Dhaka, Bangladesh

*Correspondence: Abu Ansar Md Rizwan (aamdrizwan@gmail.com)

Abstract

Background: Food security and dietary diversity are essential determinants of maternal health, particularly among pregnant women in refugee populations who face heightened vulnerabilities due to displacement and inadequate living conditions. This study examines the impact of food security on dietary diversity and nutritional intake among pregnant Rohingya women residing in the makeshift camps of Ukhiya, Cox's Bazar. **Methods:** A descriptive cross-sectional study was conducted among 96 pregnant Rohingya women from June to September 2022. Data were collected using structured questionnaires assessing socio-demographic characteristics, food security, and dietary diversity. Food security was evaluated using the Household Food Insecurity Access Scale (HFIAS), while dietary diversity was assessed through a 24-hour dietary recall and a 7-day food frequency questionnaire. Data were analyzed using SPSS (Version 26) and Stata (Version 13), employing descriptive statistics and chi-square tests to examine associations. **Results:** Most participants (57.3%) were food secure, and 85.4% demonstrated high dietary diversity, consuming seven or more food groups. However, 21.9% of households experienced severe food insecurity, highlighting ongoing challenges in food access. The highest consumption was observed for starch, flesh foods, dark green leafy vegetables, and vitamin A-rich fruits and vegetables (99.0%), while dairy products (69.8%) and organ meat (34.4%) were consumed less frequently. Despite high dietary diversity, severe food insecurity persists, indicating gaps in food assistance programs. **Conclusions:** While food support programs appear to contribute to high dietary diversity among pregnant Rohingya women, severe food insecurity remains a significant concern. Strengthening food security interventions, improving access to diverse nutrient-rich foods, and integrating sustainable food assistance models are essential to addressing these challenges. Future research should explore long-term strategies to enhance food security and assess the impact of targeted nutritional interventions on maternal health outcomes in refugee settings.

Keywords: Food security, Dietary diversity, Maternal nutrition, Rohingya refugees, Pregnancy outcomes

What is Known on the Topic

- Food security and dietary diversity are crucial determinants of maternal health, especially during pregnancy, due to increased nutritional needs.

- Pregnant women in low-resource settings, like refugee camps, face significant risks of food insecurity which adversely impacts their dietary diversity and nutritional intake.
- Limited access to diverse and nutrient-rich food sources in these settings can lead to various health complications such as anemia and gestational diabetes.

What this Paper Adds

- Provides empirical data on the relationship between food security and dietary diversity among pregnant Rohingya women in makeshift camps, highlighting the specific impact of food assistance programs.
- Details the high prevalence of food security (57.3% of households) and dietary diversity (85.4% consuming seven or more food groups) among the study participants.
- Identifies severe food insecurity in 21.9% of households, underscoring persistent gaps in food access and the need for enhanced food support programs.

Key Findings

- A significant proportion of pregnant women in the study demonstrated high dietary diversity, attributed partly to food assistance programs, despite a notable percentage experiencing severe food insecurity.
- The study revealed that food-secure households tended to have higher dietary diversity, suggesting a direct correlation between food access and nutritional intake quality.
- Despite the availability of food support, challenges remain in ensuring adequate and diverse dietary intake among pregnant women, with a need for more targeted interventions to improve food security and dietary outcomes in refugee settings.

1. Introduction

Food security is a fundamental determinant of maternal health and nutritional well-being, particularly during pregnancy when dietary requirements are heightened [1]. Pregnant women in low-resource settings are at an increased risk of food insecurity, which can adversely impact their dietary diversity and overall nutritional intake [2]. Limited access to nutrient-rich foods and unstable food supply chains in such environments contribute to deficiencies that can negatively affect both maternal and fetal health outcomes [3]. The consequences of food insecurity among pregnant women extend beyond malnutrition, leading to increased risks of anemia, gestational diabetes, hypertension, and other complications that may compromise pregnancy outcomes [4, 5, 6, 7]. The Rohingya crisis, one of the most significant humanitarian emergencies of the past decade, has further underscored the impact of food insecurity among vulnerable populations like pregnant women [8]. The mass displacement of refugees into Bangladesh, particularly in Cox's Bazar, has created conditions where access to adequate food and healthcare is severely constrained [9]. Studies by Parmar et al. (2018) [10] have documented the dire health outcomes among Rohingya women, emphasizing the need for targeted investigations into their food security status and dietary patterns. Nutritional deficiencies in these populations are often exacerbated by young maternal age, as highlighted by Souza et al. (2024) [11], who reported an increased prevalence of anemia, hypertension, and other morbidities in younger pregnant women, particularly in resource-constrained settings. Dietary diversity is a key indicator of nutritional adequacy [12], yet it is often compromised in food-insecure households. Limited access to diverse food groups can lead to nutrient deficiencies that may result in adverse pregnancy outcomes, including low birth weight and poor maternal health [13, 14, 15, 16]. Research has established a strong link between food insecurity and suboptimal dietary practices,

with gestational diabetes and anemia being common consequences among food-insecure pregnant women [17]. In the context of the Rohingya crisis, Akter et al. (2020) [18] highlighted the multifaceted challenges influencing maternal nutrition, including economic instability, environmental factors, and cultural food preferences. These findings underscore the necessity of addressing food security and dietary diversity as central components of maternal health interventions in refugee and resource-limited settings. Assessing the extent of food insecurity and its impact on dietary intake among pregnant women is crucial for developing targeted nutrition policies and programs. Tools such as the Household Food Insecurity Access Scale (HFIAS) have been widely used to measure food security status and dietary diversity in vulnerable populations [19]. However, there remains a significant gap in research regarding the association between food security, dietary diversity, and nutritional intake among pregnant women in low-resource settings. This study aims to address this gap by examining the impact of food security on dietary diversity and nutritional intake among pregnant women, providing empirical evidence to inform nutrition-focused interventions. By exploring these relationships, this research contributes to a broader understanding of food insecurity's role in maternal health disparities and offers insights into strategies for improving pregnancy outcomes in marginalized populations.

2. Methodology

A descriptive cross-sectional study was conducted among Rohingya pregnant women residing in the makeshift camps of Ukhiya, Cox's Bazar, from June to September 2022. The sample size was 96, using the statistical formula, with a 95% confidence interval and a 5% significance level. Severely ill and mentally unstable pregnant women were excluded from the study. Participants were selected through a simple random sampling technique, adhering to specific inclusion criteria with the cooperation of the community leaders in the camps [20]. Data was collected using a structured questionnaire developed for this study consisting of different types of questions to capture a broad range of information [21, 22], such as socio-demographic characteristics, food security status, and dietary diversity. The socio-demographic section collected data on age, educational level, and marital status. Food security was assessed using a modified Household Food Insecurity Access Scale (HFIAS) [19], which included nine questions about the household's experiences with food insecurity over the past 30 days. Responses were categorized on a frequency-based scale (never, rarely, sometimes, often), allowing households to be classified into varying levels of food security. Dietary diversity was evaluated through a 24-hour dietary recall method [23] and a 7-day food frequency questionnaire [24]. In the 24-hour dietary recall, participants reported all foods consumed in the previous 24 hours, assessing dietary variety and quality. The 7-day food frequency questionnaire captured the frequency of consumption of specific food groups over the past week, providing insights into dietary patterns and nutrient intake. Data collection was conducted by trained enumerators fluent in the Rohingya language. Enumerators administered the questionnaires face-to-face at participants' homes or in designated safe spaces within the camps, ensuring privacy and comfort. Questions were read aloud, and enumerators assisted participants in responding. Translators were available to address language barriers when necessary. To ensure data accuracy, collection and entry were performed simultaneously, and multiple review and cross-checking procedures were implemented to remove the error from the dataset [25]. Data entry, cleaning, and analysis were conducted using SPSS (Version 26), while SPSS (Version 26), Stata (Version 13), and R were utilized for statistical analysis. Descriptive statistics, correlation analyses, and regression models were employed to examine relationships between food security and dietary diversity. Food security and Food Consumption Scores were assessed using the Household Food Security & Nutrition Assessment [26] scale, and dietary diversity scores were calculated following FAO guidelines for Individual Dietary Diversity Scores [27].

Mediating variables, including age, duration of pregnancy, and educational level, were controlled to isolate the effects of food security on diet. The analysis aimed to identify significant predictors of health disparities and provide guidance for future nutritional interventions. Ethical approval for the study was obtained from the Faculty of Allied Health Sciences Research Ethics Committee of Daffodil International University. Verbal informed consent was acquired from all participants before data collection. Anonymity and confidentiality were maintained throughout the study, adhering to strict ethical guidelines.

3. Results

A total of 96 pregnant women participated in the study. The ages ranged from 15 to 33 years, with a mean age of 22.83 years (SD = 4.02). This indicates that most of the pregnant women in this sample were relatively young, which reflects early reproductive age groups commonly observed in similar settings. The household size of the participants showed significant variation, ranging from 1 to 12 members, with an average household size of 5.29 members (SD = 2.60). This suggests that many participants lived in moderately sized families, a pattern commonly seen in rural or low-income settings where extended families may reside together. Regarding family structure, most women (70.8%) reported living in single/nuclear families, while 29.2% resided in joint-family households. This reflects a shift towards nuclear families, which may have implications for the support systems available to pregnant women in this population. The predominance of nuclear family settings may indicate a societal trend toward smaller, independent households, which can affect family support during pregnancy (Table 1).

Table 1. Demographic characteristics of the respondents (N = 96)

Demographic characteristics		
Age	*Min*	*Max*
Age (year)	15	33
Age ($M \pm SD$)	22.83 $\pm$ 4.02	
Household size	*Min*	*Max*
Household size (number)	1	12
Household size ($M \pm SD$)	5.29 $\pm$ 2.60	
Family type	*n*	*%*
Single/nuclear	68	70.8%
Joint	28	29.2%

Most participants (*n* = 49, 51.0%) received religious education from Madrasha/Religious institutions. A notable proportion of the women (*n* = 26, 27.1%) were 2nd-grade pass, while 15.6% (*n* = 15) had completed elementary school. Only 6.3% (*n* = 6) of the women reported having no education. These findings indicate that most participants had limited formal education, with a significant reliance on religious schooling, which might impact their health literacy and access to health information. Most of the pregnant women were married, with 93.8% (*n* = 90) currently in a marital relationship. Only 6.3% (*n* = 6) reported being separated from their spouses. The high percentage of married women is consistent with cultural norms in many communities where early marriage is common. Regarding the duration of pregnancy, 43.8% (*n* = 42) of the women were in the first trimester (less than 4 months pregnant). Another 32.3% (*n* = 31) were in the second trimester (4-6 months), while 24.0% (*n* = 23) were in the third trimester (more than 6 months pregnant). This distribution shows an even representation across different stages of pregnancy, providing a comprehensive look at pregnant women across all trimesters (Figure 1).
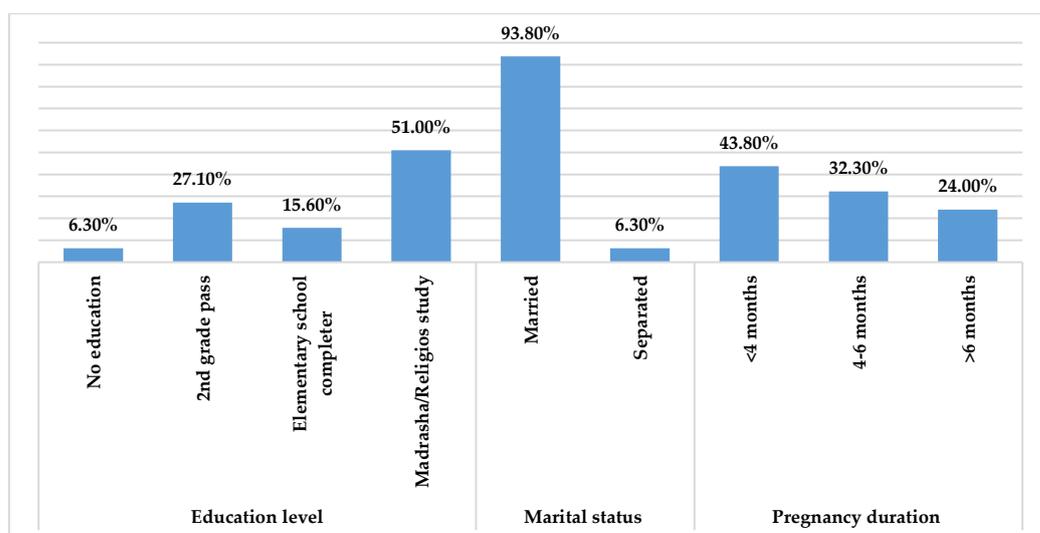
Figure 1. Socio-economic characteristics of the respondents (*N*=96)

All pregnant women in the study (*n* = 96, 100%) reported receiving rations. This indicates that every participant had access to some form of supplementary food assistance, likely as part of a government or community-based food support program aimed at ensuring adequate nutrition during pregnancy. The respondent's household food security was assessed using the formula of HFIAS for measurement guidelines [19]. Most of the households (*n* = 55, 57.3%) were classified as food secure, indicating that these families had consistent access to sufficient food. However, 20.8% (*n* = 20) of the households experienced mild to moderate food insecurity, and 21.9% (*n* = 21) faced severe food insecurity. This suggests that many pregnant women in the sample lived in households where food insecurity was a concern, potentially impacting their overall health and nutritional status during pregnancy. In the last 24 hours, including both day and night, the food eaten at home was divided into 9 food groups. The consumption of each food group during the last 24 hours (day and night) was recorded as 0 (not eaten) or 1 (eaten). Then, the dietary diversity score (WDDS) was calculated at the personal level by counting the daily consumption of 9 food groups, with scores ranging from 0 to 9 [28]. This study showed that the majority (*n* = 82, 85.4%) consumed seven or more food groups, reflecting a relatively diverse diet. A smaller proportion of the women (*n* = 12, 12.5%) consumed six food groups, while only 2.1% (*n* = 2) reported consuming five food groups. This high level of dietary diversity among most participants suggests that many pregnant women had access to a variety of foods, which is crucial for meeting their nutritional needs during pregnancy. To calculate household-level food consumption scores (FCS), data was collected on the frequency of food consumption over the past seven days [29]. Households reported how many days they consumed various food items, which were categorized into 8 key food groups: staple (e.g., rice, wheat, potatoes, maize), lentils (pulses, nuts, seeds), milk & milk products, meat, fruits, vegetables, sugar and oil [29]. These food groups are essential for a nutritionally adequate diet if consumed daily. Each food group was assigned a weight based on its nutritional importance, and the FCS was calculated by multiplying the number of days each food group was consumed by its respective weight [29]. This score reflects the diversity and frequency of food consumption at the household level, indicating the dietary quality of the household [29]. According to this study, all participants (*n* = 96, 100%) were classified as having an "acceptable" food consumption score, indicating that they were consuming an adequate quantity and quality of food. This aligns with the high dietary diversity observed, suggesting that the food support programs in place may be contributing to the overall nutritional well-being of pregnant women (Figure 2).
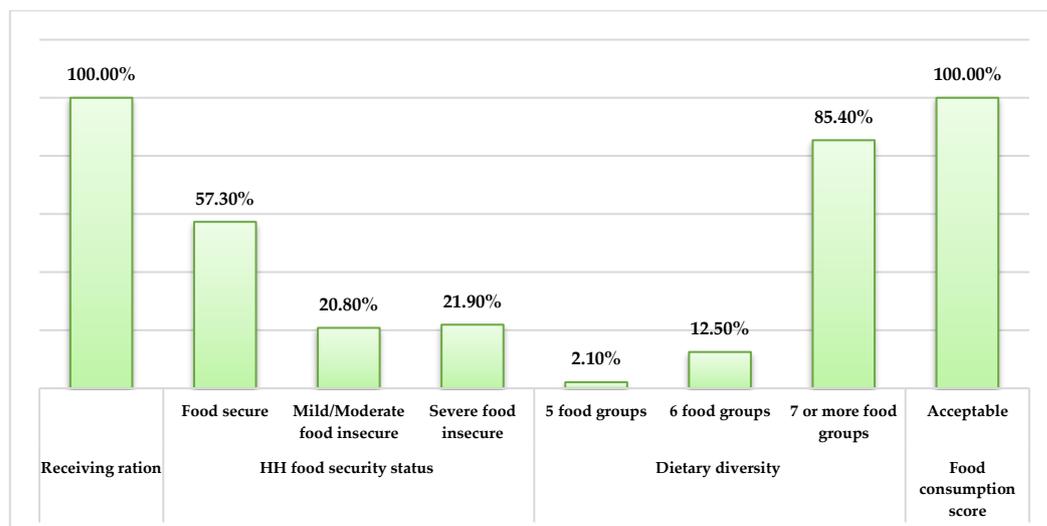
Figure 2. Dietary status of the respondents (*N*=96)

Among the study participants, the highest frequency of consumption was observed for starch, flesh foods, dark green leafy vegetables, and vitamin A-rich fruits and vegetables, with 95 participants (99.0%) reporting intake from these groups. Similarly, high consumption was observed for other fruits and vegetables, with 94 participants (97.9%) including them in their diet. The intake of eggs was also relatively high, with 80 participants (83.3%) reporting consumption, and legumes were consumed by 82 participants (85.4%). In contrast, dairy products were less frequently consumed, with only 67 participants (69.8%) reporting intake. Organ meat had the lowest consumption frequency, with 33 participants (34.4%) indicating intake from this food group (Table 2). These findings indicate that most study participants have a diet that includes starches, flesh foods, dark green leafy vegetables, and vitamin A-rich fruits and vegetables, suggesting an inclination towards these food groups in their dietary patterns. The high consumption of other fruits and vegetables also indicates a general preference for or availability of plant-based foods in the participants' diet. However, the lower consumption of dairy products and especially organ meat suggests either a lack of availability, cultural preferences, or dietary habits that do not prioritize these food groups. The variation in consumption frequencies across food groups reflects the diversity and preferences within the study population's dietary practices.

Table 2. Descriptive statistics of consumption from different food groups among study participants (*N* = 96)

Food groups	*n*	*%*
Starch	95	99.0%
Legumes	82	85.4%
Dairy products	67	69.8%
Organ meat	33	34.4%
Eggs	80	83.3%
Flesh food	95	99.0%
Dark green leafy vegetables	95	99.0%
Vitamin A-rich fruits & vegetables	95	99.0%
Other fruits and vegetables	94	97.9%

Table 3 presents the association between dietary diversity and food security status among the study participants. Among participants who consumed food from five food groups (*n* = 2), none were food secure or mildly/moderately food insecure, while both participants (2.1%) were categorized as severely food insecure. For those who consumed six food groups (*n* = 12), five participants (5.21%) were food secure, two (2.08%) were mildly/moderately food insecure, and five (5.21%) were severely food insecure. Most participants (*n* = 82) consumed food from seven food groups, of whom 50 (52.08%) were food secure, 18 (18.75%) were mildly/moderately food insecure, and 14 (14.58%) were severely food insecure. A chi-square test revealed a statistically significant association between dietary diversity and food security status (χ^2 = 11.011, *df* = 4, *p* = 0.026), indicating that individuals with higher dietary diversity were more likely to be food secure. These findings suggest a potential relationship between food security and dietary diversity, highlighting the importance of diverse food consumption in maintaining food security among participants.

Table 3. Association between dietary diversity and food security status of the participants

Dietary diversity	Food security status						χ^2	*df*	*p*
	Food secure (55)		Mild/moderate food insecure (20)		Severe food insecure (21)				
	n	*%*	*n*	*%*	*n*	*%*			
5 food groups (2)	0	0%	0	0%	2	2.10%			
6 food groups (12)	5	5.21%	2	2.08%	5	5.21%	11.011	4	.026
7 food groups (82)	50	52.08%	18	18.75%	14	14.58%			

Table 4 presents the association between the consumption of different food groups and food security status among the study participants. The consumption of starch was reported by 95 participants, with 54 (56.3%) being food secure, 20 (20.8%) mildly/moderately food insecure, and 21 (21.9%) severely food insecure. A statistically significant association was observed between starch consumption and food security status (χ^2 = 8.564, *df* = 2, *p* = 0.018). Similarly, legumes were consumed by 82 participants, among whom 50 (52.1%) were food secure, 18 (18.8%) were mildly/moderately food insecure, and 14 (14.6%) were severely food insecure, with a significant association detected (χ^2 = 7.596, *df* = 2, *p* = 0.022). Dairy product consumption was recorded in 67 participants, with 42 (43.8%) being food secure, 16 (16.7%) mildly/moderately food insecure, and 9 (9.4%) severely food insecure. A significant relationship was found between dairy consumption and food security status (χ^2 = 9.341, *df* = 2, *p* = 0.009). Organ meat was consumed by 33 participants, with 22 (22.9%) being food secure, 9 (9.4%) mildly/moderately food insecure, and 2 (2.1%) severely food insecure, showing a significant association (χ^2 = 7.521, *df* = 2, *p* = 0.023). Egg consumption was reported by 80 participants, with 46 (47.9%) food secure, 18 (18.8%) mildly/moderately food insecure, and 16 (16.7%) severely food insecure. However, no statistically significant association was found (χ^2 = 1.415, *df* = 2, *p* = 0.493). Similarly, flesh food consumption (*n* = 95) did not show a significant association with food security status (χ^2 = 3.609, *df* = 2, *p* = 0.165), with 55 (57.3%) food secure, 20 (20.8%) mildly/moderately food insecure, and 20 (20.8%) severely food insecure. Consumption of dark green leafy vegetables (*n* = 95) and vitamin A-rich fruits and vegetables (*n* = 95) followed the same distribution, with 55 (57.3%) food secure, 19 (19.8%) mildly/moderately food insecure, and 21 (21.9%) severely food insecure, but no significant associations were detected (χ^2 = 3.840, *df* = 2, *p* = 0.147 for both). Other fruits and vegetables (*n* = 94) were consumed by 55 (57.3%) food-secure participants, 20 (20.8%) mildly/moderately food insecure, and 19 (19.8%) severely food insecure, showing a significant association with food security status (χ^2 = 7.295, *df* = 2, *p* = 0.026).

Table 4. Association between consumption from different food groups and food security status among the participants

| Food groups | Food security status | | | | | | χ^2 | df | p |
| | Food secure (55) | | Mild/moderate food insecure (20) | | Severe food insecure (21) | | | | |
	n	%	n	%	n	%			
Starch (95)	54	56.3%	20	20.8%	21	21.9%	8.564	2	.018
Legumes (82)	50	52.1%	18	18.8%	14	14.6%	7.596	2	.022
Dairy products (67)	42	43.8%	16	16.7%	9	9.4%	9.341	2	.009
Organ meat (33)	22	22.9%	9	9.4%	2	2.1%	7.521	2	.023
Eggs (80)	46	47.9%	18	18.8%	16	16.7%	1.415	2	.493
Flesh food (95)	55	57.3%	20	20.8%	20	20.8%	3.609	2	.165
Dark green leafy vegetables (95)	55	57.3%	19	19.8%	21	21.9%	3.840	2	.147
Vitamin A-rich fruits & vegetables (95)	55	57.3%	19	19.8%	21	21.9%	3.840	2	.147
Other fruits and vegetables (94)	55	57.3%	20	20.8%	19	19.8%	7.295	2	.026

4. Discussion

This study examined the impact of food security on dietary diversity and nutritional intake among pregnant Rohingya women residing in the makeshift camps of Ukhiya, Cox's Bazar. The findings provide critical insights into the nutritional challenges faced by this marginalized population, highlighting both the strengths and gaps in existing food support programs. A significant proportion of the study participants (57.3%) were classified as food secure, with 85.4% demonstrating high dietary diversity by consuming seven or more food groups. These findings suggest that food assistance programs in Ukhiya may be contributing to improved dietary diversity among pregnant women. When compared to findings from Bhasan Char, where 46% of pregnant mothers had low WDDS (<4) [30], a notable disparity in dietary diversity emerges between the two settings. This discrepancy may reflect differences in food distribution systems, infrastructure, and accessibility, emphasizing the role of effective food aid programs in improving maternal nutrition. However, despite these relatively positive dietary diversity indicators, this study found that 21.9% of households experienced severe food insecurity, highlighting persistent gaps in food access despite intervention efforts. The issue of food insecurity among refugee populations is not unique to Ukhiya. Studies on Syrian refugees in Lebanon have reported that over half of refugee households experience food insecurity, relying on an e-voucher system that presents socio-technical challenges and power asymmetries [31]. These parallel underscores the global need for adaptive, context-specific approaches to food assistance that address both immediate nutritional needs and systemic barriers to food access. Given that severe food insecurity persists despite ongoing aid, further research is needed to assess the effectiveness, distribution equity, and sustainability of food support programs in these settings. Dietary diversity is a well-established indicator of nutritional adequacy and is crucial for maternal and fetal health [13]. The high dietary diversity observed in this study aligns with findings by Akter et al. (2020) [18], who reported that food assistance programs in refugee camps contributed to improved dietary intake. However, while these programs may enhance dietary diversity, they do not fully mitigate food insecurity. Households experiencing severe food insecurity may still struggle with insufficient food availability, meal frequency, and access to nutrient-dense foods, potentially affecting maternal health outcomes. The analysis of food intake from nine different food groups over the past 24 hours further highlights the

dietary patterns among study participants. The highest frequency of consumption was observed for starch, flesh foods, dark green leafy vegetables, and vitamin A-rich fruits and vegetables, with 95 participants (99.0%) reporting intake from these groups. High consumption rates were also recorded for other fruits and vegetables (97.9%) and legumes (85.4%), indicating a relatively diverse plant-based diet. However, the study found lower consumption of dairy products (69.8%) and organ meat (34.4%), which are crucial sources of protein, iron, and calcium for pregnant women. The limited intake of organ meat is consistent with findings from other studies on refugee populations, where factors such as cultural dietary preferences, affordability, and accessibility influence food choices [32, 29]. Additionally, dairy product consumption was lower than expected, which may reflect the limited availability or affordability of milk and milk products within the camp settings. The observed dietary patterns align with findings from studies on displaced populations, which suggest that while staple foods and vegetables may be widely available through food distribution programs, access to protein-rich foods such as meat, dairy, and eggs remains a challenge [19, 29, 33]. The relatively high intake of fruits and vegetables among participants suggests that efforts to provide diverse food options in Ukhiya camps may be somewhat effective, though gaps remain in ensuring adequate intake of micronutrient-dense foods. Findings from this study emphasize the critical role of food security in ensuring adequate dietary intake among pregnant women in resource-constrained settings. The relationship between food security and dietary diversity underscores the importance of food assistance programs that not only provide sufficient caloric intake but also promote a diverse range of nutrient-rich foods. This is particularly relevant in refugee camps, where reliance on staple-based rations can lead to micronutrient deficiencies. The study's findings align with prior research on food security interventions in displaced populations, which have highlighted the need for diversified food baskets that include animal-source foods, legumes, and fresh produce to enhance nutritional outcomes [19, 29]. Moreover, the disparities in food security and dietary diversity observed in different refugee settings highlight the importance of localized program assessments. Studies on food security in refugee populations, such as those by Owoaje et al. (2016) [32] and Ekezie et al. (2020) [34], emphasize the variability in food access across different camps and the necessity of tailoring interventions to address these disparities. While Ukhiya appears to have better dietary diversity compared to Bhasan Char, challenges remain in ensuring equitable and sustained food access for all households. Addressing these challenges requires a multi-sectoral approach that integrates nutrition-focused interventions with broader improvements in food supply chains, market access, and infrastructure.

4.1. Implication for practice

- This study underscores the necessity of strengthening food security interventions to improve maternal nutrition in refugee settings.
- While current food aid programs in Ukhiya appear to be relatively effective in promoting dietary diversity, the persistence of severe food insecurity calls for targeted improvements.
- Strategies such as increasing access to fresh and nutrient-dense foods, enhancing food distribution efficiency, and providing nutrition education could help bridge the existing gaps. Additionally, incorporating cash-based transfers or market-based approaches could empower households to make diverse dietary choices and reduce dependency on external food assistance.

4.2. Limitations and Recommendations

This study provides valuable insights into the relationship between food security and dietary diversity among pregnant women in a refugee setting. However, certain limitations should be acknowledged.

- The cross-sectional design prevents causal inferences, and reliance on self-reported data may introduce bias.
- Additionally, while the study assessed food security and dietary diversity, it did not evaluate micronutrient intake, which is crucial for maternal health.
- Future longitudinal studies could offer a more comprehensive understanding of how food security fluctuations impact maternal nutrition over time.
- Furthermore, intervention-based research could evaluate the effectiveness of different food assistance models in improving food security and dietary outcomes among refugee populations.

5. Conclusion

The findings of this study highlight the complex interplay between food security and dietary diversity among pregnant Rohingya women in the Ukhiya refugee camps. While food assistance programs appear to contribute to high dietary diversity, the persistence of severe food insecurity underscores the need for more effective and sustainable food interventions. The findings on food intake from different food groups further emphasize the need to improve access to nutrient-rich foods such as dairy and organ meats. Enhancing access to diverse, nutrient-rich foods and integrating market-based strategies could improve the long-term nutritional well-being of pregnant women in resource-constrained settings. Addressing these issues is crucial for ensuring better maternal health outcomes and reducing the burden of malnutrition among displaced populations.

5.1. Human ethics and Consent to Participate declarations

This study meticulously adhered to ethical guidelines, obtaining approval from the Faculty of Allied Health Sciences Research Ethics Committee at Daffodil International University. A core aspect of its ethical rigor was ensuring that all participants, Rohingya pregnant women from makeshift camps in Ukhiya, Cox's Bazar, provided verbal informed consent. This consent was not merely procedural but was obtained by thoroughly explaining the study's aims, methods, potential benefits, and risks in an accessible manner, ensuring participants' full comprehension and voluntary participation. The research emphasized the participants' autonomy, allowing them to withdraw at any time without repercussion, thus upholding their dignity and rights. Additionally, the study's commitment to maintaining participants' confidentiality and anonymity showcases a strong adherence to the ethical principles of beneficence, non-maleficence, autonomy, and justice, which are particularly crucial when dealing with vulnerable populations in a research context.

5.2. Declarations

Ethics approval and consent to participate

This study was conducted in strict adherence to ethical standards and received approval from the Faculty of Allied Health Sciences Research Ethics Committee at Daffodil International University. Informed consent was obtained from all participants. For participants aged 18 and above, consent was obtained verbally after they were fully briefed on the study's objectives, methodology, potential benefits, and risks. For participants under the age of 18, informed consent was obtained from their parents or legal guardians by the ethical guidelines. All participants and the parents or guardians of minor participants were informed that participation was voluntary and that they had the right to withdraw at any time without any consequences.

Consent for publication

All authors have read and approved the final manuscript.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to ethical restrictions related to participant consent and confidentiality but are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests. There are no financial, personal, or professional conflicts of interest that could have influenced the work reported in this manuscript.

Authors' contributions

Abeer Mohammad Hossain conceptualized the study. Mohammad Shamsul Huda and Abu Ansar Md Rizwan designed the study. Abeer Mohammad Hossain, Zubaida Iftekhar, Rajib Das, and Sujit Kumar Banik were responsible for data collection, analysis, and interpretation of the results. Abeer Mohammad Hossain and Abu Ansar Md Rizwan wrote the initial draft of the manuscript with significant revisions and contributions from Zubaida Iftekhar, Rajib Das, Sujit Kumar Banik, and Mohammad Shamsul Huda.

References

[1] Biswas, S., Mohammed Khayam Faruqui, S. M. I., Sultana, S., Shormi, I. S., Mondal, P. K., Huda, M. S., ... & Yesmin, S. (2022). Impact of dietary behavior on the nutritional status of middle-aged pregnant women. *International Journal of Science & Business, 16*(1), 91-97.

[2] Rizwan, A. A. M., SM, Z. S., Chowdhury, A., & Khan, R. J. (2021). Dietary Behavior of Pregnant and Lactating Women of Bandarban Hill District, Bangladesh. *Journal of Nutrition & Food Sciences, 11*(1), 1-5.

[3] Azad, M. A. M., Begum, I. A., Huda, M. S., Roby, A. M. H., Anwar, A., Jahan, N., & Rizwan, A. A. M. (2021). KNOWLEDGE ON NUTRITION DURING PREGNANCY AMONG MOTHERS ATTENDING ANTENATAL CARE AT A SECONDARY LEVEL HOSPITAL IN COX'S BAZAR, BANGLADESH. *World Journal of Pharmaceutical Research, 10* (14), 1638-1649, 10.20959/wjpr202114-22483

[4] Toole, M. (2019). Health in humanitarian crises. In *The Health of Refugees: Public Health Perspectives from Crisis to Settlement* (pp. 54-84).

[5] Corley, A. G. (2021). Linking armed conflict to malnutrition during pregnancy, breastfeeding, and childhood. *Global Food Security, 29*, 100531.

[6] Naja, F., Shatila, H., El Koussa, M., Meho, L., Ghandour, L., & Saleh, S. (2019). Burden of non-communicable diseases among Syrian refugees: A scoping review. *BMC Public Health, 19*, 1-13.

[7] Rizwan, A. A., Hasan, F., Huda, M. S., Talukder, N., Siddique, R. A. H., Anwar, A., & Ali, O. E. (2021). Knowledge and attitude on anemia among the women attending a government tertiary level hospital at Cox's Bazar, Bangladesh. *World J Pharm Res, 10*(12), 84-94.

[8] Anwar, A., Ali, A. M., Yadav, U. N., Huda, M. N., Rizwan, A. A. M., Parray, A. A., ... & Mistry, S. K. (2024). Promotion of livelihood opportunities to address food insecurity in Rohingya refugee camps of Bangladesh. *Global Public Health, 19*(1), 2295446.

[9] Anwar, A., Faruqui, M. K., Zudan, M. M. R., Ali, Z., Huda, M. S., Mondal, P. K., & Rizwan, A. A. M. (2022). Dietary intake pattern among elderly people in the urban Cox's Bazar, Bangladesh. *International Journal of Multidisciplinary Research and Growth Evaluation, 3* (3), 376-380, https://doi.org/10.54660/anfo.2022.3.3.21

[10] Parmar, P. K., Jin, R. O., Walsh, M., & Scott, J. (2019). Mortality in Rohingya refugee camps in Bangladesh: Historical, social, and political context. *Sexual and Reproductive Health Matters, 27*(2), 39-49.

[11] Souza, J. P., Day, L. T., Rezende-Gomes, A. C., Zhang, J., Mori, R., Baguiya, A., ... & Oladapo, O. T. (2024). A global analysis of the determinants of maternal health and transitions in maternal mortality. *The Lancet Global Health, 12*(2), e306-e316.

[12] Rizwan, A. A. M., Banik, S. K., Anny, N. A., Ferdush, J., Nokshi, S. S., Hossain, A. M., & Hossen, A. M. (2023). Comparative analysis of dietary diversity and food consumption patterns among public and private University Students in Bangladesh. *International Journal of Biological and Pharmaceutical Sciences Archive, 06*(02), 191–198

[13] Schrey-Petersen, S., Tauscher, A., Dathan-Stumpf, A., & Stepan, H. (2021). Diseases and complications of the puerperium. *Deutsches Ärzteblatt International, 118*(25), 436.

[14] Jahan, N., Talukder, N., Taniim, T., Mohibbullah., Ali, Z., Mondal, P., Anwar, A., Rizwan, A. A. M., & Yesmin, S. (2022). Low birth weight and associated factors among newborn delivered in health facilities in Dhaka, Bangladesh. *International Journal of Multidisciplinary Research and Growth Evaluation, 3*(2), 464-468.

[15] Rizwan, A. A. M., Huda, M. S., Begum, I. A. Azad, M. A. M., Hasan, M. F., & Islam, S. (2021). Knowledge and Attitude towards Nutrition among Pregnant women in Rural areas of Dhaka city, Bangladesh. *International Journal of Science and Business, 5*(7), 272-279. doi: https://doi.org/ 10.5281/zenodo.4904558

[16] Islam, M. T., Akter, T., Faruk, M. O., Rani, R., Nipo, J. H., Mita, A. R., & Rizwan, A. A. M. (2025). Knowledge related to umbilical cord care among mothers of neonates attending outpatient departments in Sherpur district, Bangladesh. *Open Journal of Medical Sciences*,5(1), 1262. Retrieved from https://www.scipublications.com/journal/index.php/ojms/article/view/1262

[17] Jahan, T. E. (2022). Assessment of knowledge & practices regarding antenatal care guidelines and impact of dietary practice on the nutritional status of pregnant women in the Rohingya community *(Doctoral dissertation, Chattogram Veterinary & Animal Sciences University).*

[18] Akter, F., Rahman, M., Pitchik, H. O., Winch, P. J., Fernald, L. C., Nurul Huda, T. M., ... & Tofail, F. (2020). Adaptation and integration of psychosocial stimulation, maternal mental health, and nutritional interventions for pregnant and lactating women in rural Bangladesh. *International Journal of Environmental Research and Public Health, 17*(17), 6233.

[19] Coates, J., Swindale, A., & Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for measurement of food access: Indicator guide Version 3. Washington, D.C.: *FHI 360/FANTA.*

[20] Lim, S. E. R., Meredith, S. J., Agnew, S., Clift, E., Ibrahim, K., & Roberts, H. C. (2023). Volunteer-led online group exercise for community-dwelling older people: A feasibility and acceptability study. *BMC Geriatrics, 23*(1), 461.

[21] Nedjat-Haiem, M., & Cooke, J. E. (2021). Student strategies when taking open-ended test questions. *Cogent Education, 8*(1), 1877905.

[22] Douthit, N. T., Norcini, J., Mazuz, K., Alkan, M., Feuerstein, M. T., Clarfield, A. M., ... & Biswas, S. (2021). Assessment of global health education: the role of multiple-choice questions. *Frontiers in Public Health, 9*, 640204.

[23] Steyn, N. P., & Labadarios, D. (2000). Dietary intake: 24-hour recall method. *The National Food Consumption Survey.* Pretoria: Department of Health.

[24] Zulkifli, S. N., & Stella, M. Y. (1992). The food frequency method for dietary assessment. *Journal of the American Dietetic Association, 92*(6), 681-686.

[25] Ahuja, L., Singh, B., & Simon, R. (2024). Data Cleaning: Paving a Way for Accurate and Clean Data. *Global Journal of Enterprise Information System, 16*(1), 18-25.

[26] HFSNA. (2009). Bangladesh Household Food Security and Nutrition Assessment Report 2009. Conducted by the World Food Programme, UNICEF, Institute of Public Health Nutrition, *Ministry of Health and Family Welfare, and Government of the People's Republic of Bangladesh.* Retrieved from www.unicef.org/bangladesh.

[27] Kennedy, G., Ballard, T., & Dop, M. (2011). Guidelines for measuring household and individual dietary diversity. Rome, Italy: *FAO.*

[28] FAO. (2010). Guidelines for measuring household and individual dietary diversity. Rome, Italy: FAO. https://doi.org/613.2KEN

[29] Rabbani, A. (2014). Household food security in Bangladesh: Going beyond poverty measures. *Bangladesh Development Studies, 37*(1-2).

[30] Fahim, S. M., Das, S., Rasul, M. G., Zaman, M. U., Alam, M. A., Afrin, S., ... & Ahmed, T. (2023). Nutritional status and dietary diversity of pregnant and nonpregnant reproductive-age Rohingya women. *Food Science & Nutrition, 11*(9), 5523-5531.

[31] Talhouk, R., Coles-Kemp, L., Jensen, R. B., Balaam, M., Garbett, A., Ghattas, H., ... & Montague, K. (2020). Food aid technology: The experience of a Syrian refugee community in coping with food insecurity. *Proceedings of the ACM on Human-Computer Interaction, 4*(CSCW2), 1-25.

[32] Owoaje, E. T., Uchendu, O. C., Ajayi, T. O., & Cadmus, E. O. (2016). A review of the health problems of the internally displaced persons in Africa. *Nigerian Postgraduate Medical Journal, 23*(4), 161-171.

[33] Khan, M. R., Wakeya, K. J., Rafi, M. S. U. I., Canadi, S., Iftekhar, Z., & Rizwan, A. A. M. (2024). Nutritional status, knowledge, and associated socio-demographic factors among adolescent girls in the coastal region of Bangladesh: A cross-sectional study. *International Journal of Biological and Pharmaceutical Sciences Archive, 08*(02), 134-145

[34] Ekezie, W., Adaji, E. E., & Murray, R. L. (2020). Essential healthcare services provided to conflict-affected internally displaced populations in low and middle-income countries: A systematic review. *Health Promotion Perspectives, 10*(1), 24.