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Food Security, Dietary Diversity and Nutritional Outcomes among Rural Households in Parbhani District, Maharashtra, India: A Cross-Sectional Study

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Abstract

The present study was conducted to assess food security, dietary diversity, and nutritional status among respondents (n = 120). Socio-economic analysis revealed that 43.3% of respondents belonged to the 31-45 years age group, with 33.3% having secondary education and 40.0% engaged in agriculture. Overall, 45.8% of households were food secure, while 54.2% experienced varying levels of food insecurity, including 23.3% mildly, 18.3% moderately, and 12.5% severely food insecure, with higher vulnerability observed among females. Dietary diversity was significantly higher among food-secure households (DDS: 5.9-5.7) compared to food-insecure households (3.3-3.1; t = 9.35). Consumption of nutrient-rich foods such as pulses, fruits, milk, and animal products was notably lower among food-insecure groups. Nutritional assessment showed a higher prevalence of underweight among food-insecure respondents (36.7% males, 40.0% females) compared to food-secure groups (13.3% males, 12.0% females), while normal BMI was more prevalent among food-secure individuals (66.7% males, 68.0% females).

Hemoglobin status indicated a greater burden of anaemia among food-insecure respondents, with moderate and severe anaemia affecting up to 23.3% and 13.3% males and 28.6% and 11.4% females, respectively, compared to lower levels in food-secure groups. Public Distribution System (PDS) coverage was 71.7%, ensuring cereal availability (88.3%) but contributing less to dietary diversity (41.7%). Food-secure respondents demonstrated better health indicators, including higher mean BMI (23.0 vs 19.5), haemoglobin levels (12.2 vs 10.2 g/dl), and good health status (68% vs 36%), along with lower morbidity (15% vs 38%) compared to food-insecure groups. The study concludes that food insecurity significantly affects dietary diversity, nutritional status, and health outcomes, highlighting the need for nutrition-sensitive interventions and improved access to diverse foods.

Keywords: Food Security, Dietary Diversity, Nutritional Status, Anaemia, Body Mass Index (BMI), Public Distribution System (PDS), Food Insecurity, Rural Health, Micronutrient Deficiency, India.

1. Introduction

Food security remains a critical global and national challenge, particularly in developing countries such as India, where socio-economic inequalities continue to influence access to adequate and nutritious food. Food security is defined as a condition in which all individuals have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs for an active and healthy life (FAO, 2021). Despite significant economic growth, a considerable proportion of the Indian population still experiences food insecurity, especially among rural and economically disadvantaged households (Gupta *et al*., 2022).

Dietary diversity is a key indicator of diet quality and micronutrient adequacy, reflecting the variety of food groups consumed over a given period. A diversified diet that includes cereals, pulses, fruits, vegetables, milk, and animal-source foods is essential for ensuring optimal nutrient intake. However, food-insecure households often rely on monotonous cereal-based diets, resulting in inadequate intake of essential micronutrients and increased risk of "hidden hunger" (Kumar, 2021; Ruel, 2003). Studies have consistently demonstrated a strong positive association between food security and dietary diversity, highlighting that limited economic access restricts the consumption of nutrient-dense foods (Gupta *et al*., 2022).

Recent national data further underscore the magnitude of nutritional challenges in India. The National Family Health Survey (NFHS-5, 2019-21) reported that anaemia affects approximately 57% of women and 25% of men aged 15-49 years, indicating a persistent public health concern (IIPS & ICF, 2021). Similarly, Ghosal (2023) observed that anaemia prevalence among Indian women has shown an increasing trend over time, despite improvements in socio-economic

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indicators. These findings suggest that inadequate dietary diversity and poor nutrient intake remain key determinants of poor health outcomes. Nutritional status, commonly assessed using indicators such as Body Mass Index (BMI) and haemoglobin levels, provides critical insights into the health implications of food insecurity. Undernutrition, particularly underweight and anaemia, is more prevalent among food-insecure populations due to limited access to balanced diets (Jasrotia, 2023). At the same time, India faces a dual burden of malnutrition, where undernutrition coexists with overweight and obesity, further complicating public health challenges (Popkin *et al*., 2020).

The Public Distribution System (PDS) serves as a major food security intervention in India, ensuring access to subsidized staple foods for vulnerable populations. While PDS has been effective in improving calorie intake through cereal distribution, its contribution to dietary diversity and nutritional quality remains limited due to inadequate inclusion of protein- and micronutrient-rich foods (Khera, 2018; Dreze & Khera, 2017). This limitation restricts its potential to address micronutrient deficiencies and improve overall health outcomes. In this context, the present study aims to assess the relationship between food security status, dietary diversity, and nutritional outcomes among respondents. It further examines the role of socio-economic factors and public food distribution systems in influencing dietary patterns and health status. Understanding these relationships is essential for developing targeted, nutrition-sensitive strategies to improve dietary diversity and reduce the burden of malnutrition in India.

2. Material and Methods

2.1. Study Design and Study Area

The present study employed a cross-sectional, community-based research design to evaluate food security status, dietary diversity, and nutritional outcomes among rural households in Parbhani district, Maharashtra, India. The district is predominantly agrarian, characterized by semi-arid climatic conditions, variable rainfall, and socio-economic heterogeneity. These features make it a suitable setting for investigating food security and nutrition-related challenges in rural populations.

2.2. Sample Size and Sampling Technique

A total of 120 respondents were included in the study, comprising equal representation of males (n = 60) and females (n = 60). A purposive sampling technique was adopted to ensure inclusion of households from diverse socio-economic backgrounds.

The inclusion criteria were:

i). Age ≥18 years,
ii). Permanent residency in the selected villages, and
iii). Willingness to participate in the study.

Respondents who provided incomplete information or declined participation were excluded from the study.

2.3. Development of Data Collection Tool

Data were collected using a structured and pre-tested questionnaire developed based on standardized guidelines and relevant literature. The instrument comprised multiple sections, including socio-demographic characteristics (age, education, occupation), household food security status, dietary intake and diversity, anthropometric measurements, haemoglobin status, health indicators, and utilization of the Public Distribution System (PDS). The questionnaire was pilot-tested on a subsample (n = 10) outside the study area to assess clarity, reliability, and validity. Necessary modifications were incorporated prior to final data collection.

2.4. Data Collection Procedure

Primary data were collected through face-to-face interviews using the structured questionnaire. Informed consent was obtained from all participants prior to data collection. Ethical protocols, including confidentiality, anonymity, and voluntary participation, were strictly maintained throughout the study.

2.5. Assessment Methods

i). **Assessment of food security:** Household food security status was assessed using a standardized experience-based food security questionnaire. Based on the frequency and severity of food access constraints, households were categorized into four groups: food secure, mildly food insecure, moderately food insecure, and severely food insecure.

ii). **Dietary assessment and dietary diversity score (DDS):** Dietary intake was assessed using the 24-hour dietary recall method. All food items consumed by respondents in the preceding 24 hours were recorded and classified into six major food groups: cereals, pulses, vegetables, fruits, milk and milk products, and animal-source foods. A binary scoring system was applied, assigning a score of '1' for consumption and '0' for non-consumption of each food group. The Dietary Diversity Score (DDS) was calculated by summing the scores, with higher values indicating greater dietary diversity and improved diet quality.

iii). **Anthropometric measurements:** Height was measured using a portable stadiometer (Seca/Equinox type), with respondents standing erect without footwear and head positioned in the Frankfurt plane. Measurements were recorded to the nearest 0.1 cm. Body weight was measured using a calibrated digital weighing balance (e.g., Omron/Equinox), with respondents wearing light clothing and no footwear, and recorded to the nearest 0.1 kg. To ensure accuracy, instruments were calibrated daily using standard reference weights, and duplicate measurements were obtained, with the mean value used for analysis.

iv). **Body mass index (BMI):** Body Mass Index (BMI) was calculated as the ratio of weight in kilograms to the square of height in meters.

$$BMI = \text{Weight (kg)} / \text{Height (m)}^2$$

Participants were classified according to World Health Organization (WHO, 2000) criteria into underweight (<18.5 kg/m²), normal (18.5-24.9 kg/m²), and overweight (≥25 kg/m²).

v). **Haemoglobin estimation and anaemia classification:** Haemoglobin concentration was measured using a portable haemoglobinometer (e.g., HemoCue Hb 201+ system) or Sahli's method under standardized conditions. Quality control measures included calibration of the instrument using standard reference solutions, verification of reagent validity, and adherence to standardized protocols. Anaemia was classified into normal, mild, moderate, and severe categories based on WHO cut-off values.

vi). **Assessment of health indicators:** Health status was evaluated using self-reported measures, including general health condition (categorized as good or poor) and the presence of morbidity during the reference period.

vii). **Assessment of public distribution system (PDS) utilization:** Information on PDS utilization was collected, including enrollment status, regularity of ration access, availability of food commodities (cereals, pulses, edible oil), and perceived contribution to dietary diversity.

2.6. Statistical Analysis

Data were coded, tabulated, and analyzed using statistical software (SPSS version XX/IBM Corp., Armonk, NY, USA, or Microsoft Excel). Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the data. Differences in dietary diversity scores between food-secure and food-insecure groups were analyzed using the independent sample t-test. Statistical significance was set at $p < 0.05$.

2.7. Ethical Considerations

The study adhered to standard ethical guidelines. Informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity were strictly maintained, and participation was entirely voluntary, with respondents free to withdraw at any stage without any consequences.

3. Results and Discussion

Table 1: Socio-economic characteristics of respondents (n = 120)

S. No.	Variable	Category	Male n (%)	Female n (%)	Total n (%)
1	Age (years)	18–30	33.3 (20)	30.0 (18)	31.7 (38)
		31–45	43.3 (26)	43.3 (26)	43.3 (52)
		>45	23.3 (14)	26.7 (16)	25.0 (30)
2	Education	Illiterate	13.3 (8)	23.3 (14)	18.3 (22)
		Primary	26.7 (16)	33.3 (20)	30.0 (36)
		Secondary	36.7 (22)	30.0 (18)	33.3 (40)
		Higher	23.3 (14)	13.3 (8)	18.3 (22)
3	Occupation	Agriculture	46.7 (28)	33.3 (20)	40.0 (48)
		Labor	30.0 (18)	23.3 (14)	26.7 (32)
		Service/Business	23.3 (14)	43.3 (26)	33.3 (40)

The socio-economic characteristics (Table 1) revealed that the majority of respondents (43.3%) were in the 31-45 years age group, indicating a predominance of economically active individuals. Similar findings were reported by Srivastava A. (2021), who observed that over 40% of rural households belonged to the middle-age category, significantly influencing household food access. Educational status showed that most respondents had secondary (33.3%) and primary education (30.0%), while female illiteracy (23.3%) remained higher than males (13.3%). This trend is consistent with National Family Health Survey (2019-21), which reported that nearly one-fourth of rural women lack formal education, affecting nutrition awareness and health practices.

Occupation-wise, agriculture was the dominant livelihood (40.0%), particularly among males, whereas females showed higher participation in service and business sectors. Comparable results were documented by Patel K. (2020), indicating that 38-45% of rural households depend on agriculture, with increasing diversification into non-farm activities. Overall, these findings highlight that socio-economic factors, particularly education and occupation, play a crucial role in shaping household food security and nutritional outcomes.

Table 2: Distribution of respondents by food security status (n = 120)

S. No.	Food Security Category	Male n (%)	Female n (%)	Total (n=120) n (%)
1	Food Secure	30(50.0)	25(41.7)	55(45.8)
2	Mildly Food Insecure	14(23.3)	14(23.3)	28(23.3)
3	Moderately Food Insecure	10(16.7)	12(20.0)	22(18.3)
4	Severely Food Insecure	6(10.0)	9(15.0)	15(12.5)
Total		60(100)	60(100)	120(100)

The data in Table 2 show that 45.8% of respondents were food secure, while a higher proportion (54.2%) experienced some level of food insecurity. Among the food-insecure groups, 23.3% were mildly, 18.3% moderately, and 12.5% severely food insecure. Gender-wise, a slightly higher proportion of males (50.0%) were food secure compared to females (41.7%), whereas severe food insecurity was more prevalent among females (15.0%) than males (10.0%), indicating greater vulnerability among women. These findings suggest that food insecurity remains a significant concern, with more than half of the respondents affected. Similar patterns have been reported in national surveys such as NFHS-5 (2019-21) and studies like Gupta *et al*. (2022), which highlight higher food insecurity among rural households and increased vulnerability among women.

Table 3: Comparison of dietary diversity score (DDS) between food secure and food insecure households (n = 120)

S. No.	Food Group	Male FS (Mean ± SD)	Female FS (Mean ± SD)	Male FI (Mean ± SD)	Female FI (Mean ± SD)	Overall t-value
1	Cereals	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	-
2	Pulses	0.92 ± 0.28	0.88 ± 0.32	0.62 ± 0.38	0.58 ± 0.42	3.85
3	Vegetables	0.82 ± 0.34	0.78 ± 0.36	0.52 ± 0.40	0.48 ± 0.44	3.21
4	Fruits	0.72 ± 0.38	0.68 ± 0.42	0.32 ± 0.36	0.28 ± 0.40	4.76
5	Milk & Products	0.92 ± 0.26	0.88 ± 0.30	0.42 ± 0.44	0.38 ± 0.46	5.12
6	Animal Foods	0.62 ± 0.46	0.58 ± 0.50	0.22 ± 0.38	0.18 ± 0.42	4.18
7	Total DDS	5.90 ± 0.55	5.70 ± 0.65	3.30 ± 0.48	3.10 ± 0.52	9.35

The results in Table 3 highlight a clear and statistically significant disparity in dietary diversity between food-secure (FS) and food-insecure (FI) households. While cereals were universally consumed across all groups (Mean = 1.00), indicating basic food availability, substantial differences were observed in the intake of nutrient-rich food groups. Food-secure households reported higher consumption of pulses, vegetables, fruits, milk and milk products, and animal foods compared to food-insecure households. In contrast, FI

households showed notably lower mean scores, particularly for milk and milk products (0.42-0.38), fruits (0.32-0.28), and animal foods (0.22-0.18), reflecting limited access to protein- and micronutrient-rich foods.

The statistically significant t-values for pulses (3.85), vegetables (3.21), fruits (4.76), milk and milk products (5.12), and animal foods (4.18) confirm that these differences are not due to chance. The highest variation observed in milk and milk products suggests that economic constraints strongly influence the consumption of relatively expensive food items. The overall Dietary Diversity Score (DDS) was significantly higher among FS households (5.90 ± 0.55 for males and 5.70 ± 0.65 for females) compared to FI households (3.30 ± 0.48 and 3.10 ± 0.52), with a highly significant t-value (9.35), indicating better diet quality among food-secure groups.

These findings are consistent with earlier studies. Kumar R. (2021) reported that food-secure households had significantly higher DDS and greater intake of pulses, milk, and fruits, whereas food-insecure households relied mainly on cereals with limited dietary variety. Similarly, national-level data from NFHS-5 (2019-21) indicate that economically weaker households in India have lower consumption frequency of nutrient-dense foods such as milk, fruits, and animal products. Studies by Gupta *et al*. (2022) also observed DDS values ranging from 5.0-6.0 in food-secure groups and 2.5-3.5 in food-insecure groups, closely aligning with the present findings.

Overall, the results reinforce that food insecurity not only affects the quantity of food intake but also significantly compromises diet quality and diversity. The reduced intake of micronutrient-rich foods among FI households increases the risk of hidden hunger, undernutrition, and related health issues, emphasizing the need for nutrition-sensitive interventions, improved food access, and awareness programs.

Table 4: Nutritional status (BMI) by respondents and food security status (n = 120)

S. No.	BMI Category	Male FS n (%)	Female FS n (%)	Male FI n (%)	Female FI n (%)
1	Underweight (<18.5)	4 (13.3)	3 (12.0)	11 (36.7)	14 (40.0)
2	Normal (18.5–24.9)	20 (66.7)	17 (68.0)	14 (46.7)	16 (45.7)
3	Overweight (>25)	6 (20.0)	5 (20.0)	5 (16.6)	5 (14.3)
Total		30 (100)	25 (100)	30 (100)	35 (100)

The data in Table 4 reveal clear differences in nutritional status (BMI) between food-secure (FS) and food-insecure (FI) respondents. A higher proportion of underweight individuals was observed among FI households (Male: 36.7%, Female: 40.0%) compared to FS households (Male: 13.3%, Female: 12.0%), indicating a greater prevalence of undernutrition in food-insecure groups. In contrast, the majority of FS respondents fell within the normal BMI category (Male: 66.7%, Female: 68.0%), whereas a lower proportion of FI respondents were in the normal range (Male: 46.7%, Female: 45.7%). The prevalence of overweight was slightly higher among FS households (20.0% for both males and females) compared to FI households (16.6% males, 14.3% females), suggesting relatively better energy intake and possible lifestyle differences.

These findings indicate that food insecurity is strongly associated with undernutrition, while food security supports better nutritional status. Similar results have been reported in studies such as Kumar R. (2021) and NFHS-5 (2019-21), where higher underweight prevalence was observed among economically weaker and food-insecure populations.

Table 5: Haemoglobin status and anaemia prevalence by respondents and food security status (n = 120)

S. No.	Category	Male FS n (%)	Female FS n (%)	Male FI n (%)	Female FI n (%)
1	Normal (>11 g/dl)	19(63.3)	15(60.0)	9(30.0)	9(25.7)
2	Mild Anaemia	8(26.7)	6(24.0)	10(33.3)	12(34.3)
3	Moderate Anaemia	2(6.7)	3(12.0)	7(23.3)	10(28.6)
4	Severe Anaemia	1(3.3)	1(4.0)	4(13.3)	4(11.4)
Total		30(100)	25(100)	30(100)	35(100)

The data in Table 5 indicate a clear disparity in haemoglobin status between food-secure (FS) and food-insecure (FI) respondents. A higher proportion of individuals with normal haemoglobin levels was observed in FS households (Male: 63.3%, Female: 60.0%) compared to FI households (Male: 30.0%, Female: 25.7%). In contrast, the prevalence of anaemia was considerably higher among FI respondents, with increased proportions in mild, moderate, and severe categories. Notably, moderate anaemia (Male: 23.3%, Female: 28.6%) and severe anaemia (Male: 13.3%, Female: 11.4%) were more prevalent in FI households compared to FS households, where these conditions were relatively low.

These findings suggest that food insecurity is strongly associated with poor haemoglobin status and a higher burden of anaemia, likely due to inadequate intake of iron-rich and nutrient-dense foods. Similar trends have been reported in NFHS-5 (2019-21) and Kumar R. (2021), which highlight a higher prevalence of anaemia among economically weaker and food-insecure populations.

Table 6: Access and utilization of public distribution system by respondents (n = 120)

S. No.	Indicator	Male n (%)	Female n (%)	Total n (%)
1	Enrolled in PDS	44 (73.3)	42 (70.0)	86 (71.7)
2	Regular access to ration	41 (68.3)	40 (66.7)	81 (67.5)
3	Adequate cereal availability	54 (90.0)	52 (86.7)	106 (88.3)
4	Access to pulses and oil	25 (41.7)	23 (38.3)	48 (40.0)
5	Contribution to dietary diversity	26 (43.3)	24 (40.0)	50 (41.7)

The data in Table 6 indicate that a majority of respondents were enrolled in the Public Distribution System (PDS), with 71.7% overall coverage, and a substantial proportion reported regular access to ration (67.5%). The PDS was highly effective in ensuring cereal availability, as reflected by 88.3% of respondents reporting adequate access to staple grains.

However, access to pulses and oil was comparatively low (40.0%), and only 41.7% of respondents perceived PDS as contributing to dietary diversity. This suggests that while PDS plays a crucial role in ensuring food security in terms of staple food availability, its contribution to improving overall diet quality and diversity remains limited. These findings are consistent with national reports such as NFHS-5 (2019-21),

which highlight that PDS primarily supports calorie security through cereals but has limited impact on the intake of protein- and micronutrient-rich foods.

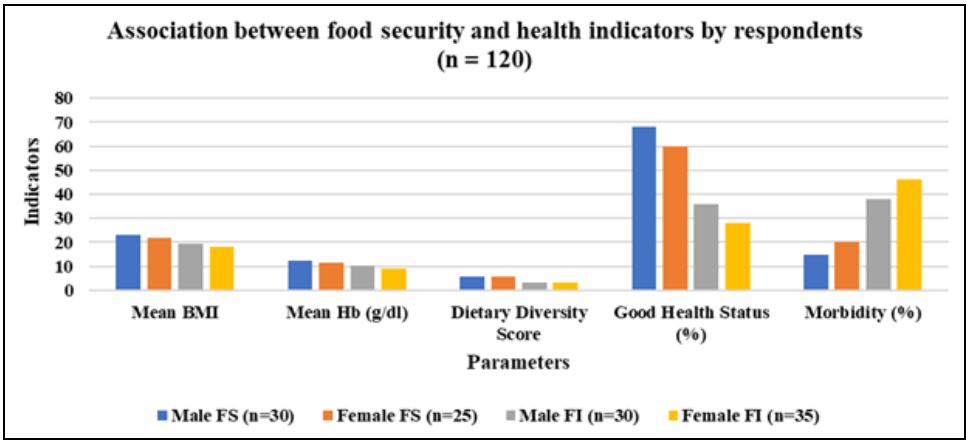
Table 7: Association between food security and health indicators by respondents (n = 120)

S. No.	Parameter	Male FS (n=30)	Female FS (n=25)	Male FI (n=30)	Female FI (n=35)
1	Mean BMI	23.0	21.8	19.5	18.3
2	Mean Hb (g/dl)	12.2	11.4	10.2	9.0
3	Dietary Diversity Score	5.9	5.7	3.3	3.1
4	Good Health Status (%)	68	60	36	28
5	Morbidity (%)	15	20	38	46

FS-Food security
FI-Food insecurity

The data in Table 7 demonstrate a strong association between food security and key health indicators. Food-secure (FS) respondents showed better nutritional and health outcomes compared to food-insecure (FI) groups. The mean BMI was higher among FS individuals (Male: 23.0; Female: 21.8) than FI individuals (Male: 19.5; Female: 18.3), indicating better nutritional status in food-secure households. Similarly, mean haemoglobin levels were higher in FS respondents (Male: 12.2 g/dl; Female: 11.4 g/dl) compared to FI respondents (Male: 10.2 g/dl; Female: 9.0 g/dl), reflecting lower prevalence of anaemia among food-secure groups. Dietary Diversity Score (DDS) was also significantly higher in FS households (5.9–5.7) than FI households (3.3-3.1), indicating better diet quality.

Furthermore, a greater proportion of FS respondents reported good health status (Male: 68%, Female: 60%) compared to FI respondents (Male: 36%, Female: 28%). In contrast, morbidity was notably higher among FI groups (Male: 38%, Female: 46%) than FS groups (Male: 15%, Female: 20%). These findings clearly indicate that food security is positively associated with improved nutritional status, better haemoglobin levels, higher dietary diversity, and overall better health outcomes. Similar trends have been reported in studies such as Kumar R. (2021) and NFHS-5 (2019-21), which show that food insecurity is linked with poor nutrition, higher anaemia prevalence, and increased morbidity.



Graph 1: Association between food security and health indicators by respondents (n = 120)

Conclusion

The present study demonstrates a strong and consistent association between food security status and nutritional as well as health outcomes among rural respondents. Although nearly half of the households (45.8%) were food secure, a substantial proportion (54.2%) experienced varying degrees of food insecurity, with greater vulnerability observed among females.

Food-secure households exhibited significantly higher dietary diversity (DDS: 5.9-5.7) compared to food-insecure households (3.3-3.1), reflecting better access to nutrient-rich foods such as pulses, fruits, milk, and animal products. In contrast, food-insecure households relied predominantly on cereal-based diets, indicating poor diet quality and increased risk of micronutrient deficiencies. This nutritional disparity was further evident in anthropometric and biochemical outcomes, where a higher prevalence of underweight (up to 40.0%) and anaemia (moderate and severe forms up to 28.6% and 13.3%, respectively) was observed among food-insecure respondents.

The study also highlights that while the Public Distribution System (PDS) effectively ensures cereal availability (88.3%), its contribution to dietary diversity remains limited (41.7%), suggesting a gap in addressing overall nutritional adequacy. Furthermore, food-secure individuals demonstrated better health indicators, including higher mean BMI, improved haemoglobin levels, greater proportion reporting good health status, and lower morbidity compared to their food-insecure counterparts.

Overall, the findings underscore that food insecurity not only affects food access but also significantly compromises dietary diversity, nutritional status, and health outcomes. Addressing this issue requires a shift from calorie-focused interventions to nutrition-sensitive strategies, including diversification of PDS food baskets, promotion of nutrient-dense foods, and targeted awareness programs. Strengthening these approaches is essential for reducing hidden hunger and improving public health outcomes in rural populations.

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