

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 9; September 2026; Page No. 606-611

Received: 16-07-2026
Accepted: 23-08-2026

Indexed Journal
Peer Reviewed Journal

Are food subsidies working well in improving the dietary quality? Evidence from rural Himalayas

¹Himanshu Kumar Arya, ²Shweta Chaudhary, ³Abhipsa Jena and ⁴Charu Bisht

^{1,3}M.Sc. Scholar, Department of Agricultural Economics, College of Agriculture, GBPUAT, Pantnagar, Uttarakhand, India

²Assistant Professor, Department of Agricultural Economics, College of Agriculture, GBPUAT, Pantnagar, Uttarakhand, India

⁴Assistant Professor, Department of Genetics and Plant Breeding, Teerthanker Mahaveer College of Agriculture Sciences, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i9h.4245>

Corresponding Author: Shweta Chaudhary

Abstract

While cereal based food subsidies are important in alleviating hunger, their role in improving food quality is debatable, especially in geographically small rural areas. The objective of this study is to explore the association between subsidized food grains and dietary diversity of the households in Bageshwar district in Uttarakhand. In May 2025, primary data were gathered from 120 farm households in six villages. The Household Food Insecurity Access Scale (HFIAS) was used to measure the food security impact on household food security and the socio-economic factors that influenced food insecurity were determined using a Generalized Ordinal Logistic Regression (GOLR) model. The Simpson Index of Dietary Diversity (SIDD) was used for assessing dietary quality. The Quadratic Almost Ideal Demand System (QUAIDS) was used to simulate a no-subsidy counterfactual and paired t-tests were performed to compare the observed SIDD with the simulated counterfactual values. The results showed that 20 per cent of households were food secure whereas 80 per cent experienced varying levels of food insecurity. Family size was also an important factor which significantly increased the risk of food insecurity; however household income and cattle, buffalo and poultry ownership decreased the risk. Only a marginally significant negative effect was found on landholding. The observed SIDD was always higher than the QUAIDS-predicted no-subsidy SIDD for all categories of food insecurity, with the largest decline being among moderately food insecure households. The counterfactual analysis also showed that without subsidies, there are changes in diets towards cereal-rich foods and lower intake of nutrient-rich food groups. These findings indicate that apart from calorie security, the Public Distribution System also influences dietary diversity which shows a need to build nutrition sensitive food assistance programmes in the hill regions.

Keywords: Public distribution system, food subsidy, SIDD, QUAIDS, HFIAS, food security

1. Introduction

The nutrition quality issue is emerging as a problem for food-security policy. Hunger, food insecurity and malnutrition continue to be a major development concern and the cost of nutritious food is a key concern in food-policy design, as has been observed globally ^[1]. In India there is significant population that is covered under the provisions of National Food Security Act (NFSA) and Public Distribution System (PDS) with legal coverage of population under priority-household (PH) and Antyodaya (AA) up to 75% population in rural areas and 50% in urban areas ^[2]. The PDS is important in terms of social protection and the basic basket continues to be dominated by cereals. Hence a household can be spared of staple food deficiency but eating a less diversified diet in terms of pulses, fruits and vegetables, dairy and animal source foods.

Calorie security and diet quality is of special concern in the Himalayan region. Mountain areas are characterized by high transport costs, low market density, isolated settlements and transport disruptions and limits in local production due to seasonality. There are also significant challenges for child

nutrition and anaemia in Uttarakhand as seen in the NFHS-5 and state nutrition profiles, which includes district-level variations in an indicator of child under nutrition, stunting. A cereal subsidy may be implemented in such situations in at least three ways. It may have an income-relief effect by decreasing the amount of money spent on the food staples, a substitution effect by making cereals relatively more attractive than non-subsidised foods, and a risk-buffer effect by decreasing the probability of a decline in minimum food access when responding to market and income shocks.

The conversation about the policy of food in India has also broadened from one of the availability of grain to one of social protection that is nutrition sensitive. Pingali *et al.* has advocated for a paradigm change in the food policy framework from food security to nutrition security in India ^[3]. Narayanan and Gerber summarised the evidence that safety nets, like PDS can improve both food expenditure and calorie intake and nutrient intake and dietary diversity ^[4]. George and McKay pointed out that the PDS continues to be an important tool for food security, although there are differences in performance and access levels by region ^[2]. At

the same time, food system studies in India show an increased complexity of the food system in the shift towards healthy eating and purchasing and availability of processed foods [5]. These debates drive empirical research at the district level, in order to clarify the effect of subsidies on cereal consumption versus supporting overall dietary diversity.

Bageshwar district is a policy-relevant case as it is an agrarian, hilly and market constrained district of Uttarakhand. The study accounts for the heterogeneity at household level and breaks down the results by food-security status, rather than by state averages. The main research question is: Will subsidised food grains enhance dietary diversity of the households in a rural Himalayan context or will they mostly insure cereal intake? The study can be useful to agricultural economics and rural policy in the following ways. Firstly, it is based on the village-level household evidence gathered in an area with constrained structural access to food-markets. Second, it combines the food-security classification (based on HFIAS) with a diet-diversity index. Third, it uses a counterfactual estimation method based on QUAIDS to investigate whether there is a difference in dietary diversity with the elimination of subsidies. The counterfactual is model-based, therefore, the results are viewed as estimates of counterfactual associations, not experimental causal estimates.

The hypotheses to be tested are: (H1) higher income as well as larger landholding and livestock ownership negatively influence food insecurity and larger family size has a positive influence on food insecurity, (H2) the observed SIDD under the subsidy regime is higher than the estimated SIDD under a no-subsidy counterfactual, and (H3) the protective association of subsidy is stronger for more vulnerable households because they have more restricted food budgets.

2. Materials and Methods

2.1 Study Area and sampling design

This study was carried out in Bageshwar district of Uttarakhand, India. Structured household survey schedule has been used as the main data collection tool to gather data on socio-economic status, food consumption, agricultural activity, livestock ownership, ration-card access and food expenditure etc in May 2025. The information taken from the market was Primary and the information taken from the district sources and Krishi Vigyan Kendra (KVK) Bageshwar was Secondary.

A multistage stratified random sampling design was used. The district was divided into three blocks Bageshwar, Garur and Kapkot. Two villages were selected in each block – Rikhari and Khantoli in Bageshwar block, Fulwari Goonth and Mathuron in Garur block and Utroura and Farsalipalli in Kapkot block. The farm households were selected, 20 households in each village (120 farm households). 120 farm households were selected from 20 households in each village of the subsidized food programmes. A summary of the sampling design is presented in Table 1.

2.2 Measurement of Food Security

The Household Food Insecurity Access Scale (HFIAS), a nine-question experiential scale that reflects food-security status by measuring anxiety about food supply, insufficient food quality and insufficient food intake [6] was used to measure food-security status. Each answer was scored 0 = not

at all, 1 = very few times, 2 = some times and 3 = many times. The total HFIAS scores are on a 0-27 scale with higher scores representing greater food insecurity. Households were then categorized into food secure (0-1), mildly food insecure (2-7), moderately food insecure (8-14) and severely food insecure (15-27) based on the results of the source classification.

2.3 Determinants of food insecurity

The dependent variable had four categories based on HFIAS which was ordinal. Since the Brant test indicated that the proportional-odds assumption was not met, a generalized ordinal logistic regression (GOLR) model was used instead of the ordered logit model. The Brant test is a standard proportionality test for proportional-odds logistic regression [7] and when parallel-lines assumption is violated, generalized/partial proportional-odds models are used for ordinal regression which allow some coefficients to differ at the thresholds [8]. The variables that were used for explanations were age and sex of the household head, education, family size, family income, land holding and livestock ownership.

The generalized model is $\text{logit}[P(Y_i > j)] = \alpha_j + \beta_j X_i$, with $j = 0, 1$ or 2 , and with β_j allowed to vary across thresholds in the event of a violation of proportionality. The coefficients reflect the direction and strength of association with an increase in the severity of food-insecurity categories. Variance inflation factors: Variance inflation factors (VIFs) were checked for multicollinearity in the source analysis.

2.4. Dietary Diversity Index and Counterfactual Estimation

Simpson Index of Dietary Diversity (SIDD) was used to assess the dietary quality. SIDD is calculated as $1 - \sum(p_i^2)$, where p_i is the share of the i th food group in the total food consumption. For this application, the greater the SIDD value, the more evenly distributed and varied the food basket. Since the purpose of the application was to measure concentration/diversity, original Simpson's diversity index (SIDD) was used, and the higher SIDD value indicates more even and diversified food basket.

Household food allocation scenarios were estimated under a counterfactual scenario where no subsidy was given to the households, and using a Quadratic Almost Ideal Demand System (QUAIDS) approach. QUAIDS allows the shares of the budget to be non-linear in relation to the total expenditure (quadratic Engel curves [10]). This paper does not differentiate between subsidised and non-subsidised food grains and estimates the volumes and expenditure of food groups by households without the subsidy. The counterfactual estimates assume the treatment of price indexes and expenditure aggregation and household substitution as in the model and should not be interpreted as directly experimental evidence. Time series t-tests were conducted for each HFIAS group in comparing observed SIDD and no-subsidy counterfactual SIDD. Two-tailed p-values reported due to lack of pre-registration of one-tailed tests. Before formatting, all tables in the manuscripts have been double checked with the source thesis, and paper outputs. Descriptive tabulation, paired comparison tabulation and figures preparation were checked using Python 3.11. The econometric interpretation is based on the conventional levels of 10%, 5% and 1%, respectively,

and paired SIDD comparisons are based on two-tailed p-values as reported in the source analysis (generalized ordinal logistic regression and QUAIDS).

3. Results

3.1. Household Food-Security Status

The results clearly indicate that there is a significant food insecurity problem in the villages surveyed (Table 1). 20.0%

of all 120 households were food secure. The other 80.0% were food insecure with 39 being mildly food insecure, 32 moderately and 25 severely food insecure. Spatial heterogeneity was evident. Bageshwar block reported the highest food insecurity level (severe) at 32.5% while Kapkot had the highest proportion of food secure household 35%. Rikhari was the most vulnerable site at the village level with 45% of households being severely food insecure.

Table 1: Distribution of Households according to Household Food Insecurity Status

Block	Bageshwar			Garur			Kapkot		
Village	Rikhari	Khantoli	Total	Fulwari Goonth	Mathuron	Total	Utroura	Farsalipalli	Total
Food Secure	4 (20)	3 (15)	7 (17.5)	1 (5)	2 (10)	3 (7.5)	5 (25)	9 (45)	14 (35)
Mildly Food Insecure	4 (20)	9 (45)	13 (32.5)	9 (45)	8 (40)	17 (42.5)	5 (25)	4 (20)	9 (22.5)
Moderately Food Insecure	3 (15)	4 (20)	7 (17.5)	8 (40)	5 (25)	13 (32.5)	9 (45)	3 (15)	12 (30)
Severely Food Insecure	9 (45)	4 (20)	13 (32.5)	2 (10)	5 (25)	7 (17.5)	1 (5)	4 (20)	5 (12.5)
Total	20 (100)	20 (100)	40 (100)	20 (100)	20 (100)	40 (100)	20 (100)	20 (100)	40 (100)

Note: Figures in parentheses indicate the percentage of the total.

3.2. Social and economic factors that contribute to food insecurity

The generalized ordinal logistic regression results in Table 2 confirm the pathway of the household-resource. Family size was positively associated with food insecurity and the association was statistically significant; this suggests that larger families are under more pressure with their income and food supplies. Family income and the presence of livestock

had negative and statistically significant relationships with food insecurity, implying that income and livestock are protective against food insecurity. Land holding was negative but not statistically significant, which is reasonable in a small, fragmented and production limited farm system, such as that found in hill agriculture. The reported model did not show gender of the household head to be statistically significant.

Table 2: Results of the Generalized Ordinal Logistic Regression Model

Variable	Coefficient	Standard Error	z-value	p-value	95% Confidence Interval
Common coefficients					
Age of household head	0.04	0.03	1.35	0.18	-0.01, 0.08
Gender of household head	-0.56	0.53	-1.06	0.29	-1.59, 0.47
Family size	1.02	0.24	4.16	<0.001***	0.53, 1.49
Family income	-0.14	0.04	-3.93	<0.001***	-0.20, -0.06
Landholding	-4.77	2.53	-1.88	0.06*	-9.72, 0.19
Cattle ownership	-1.24	0.49	-2.54	0.01**	-2.20, -0.28
Buffalo ownership	-1.55	0.47	-3.32	<0.001***	-2.46, -0.63
Goat ownership	-0.05	0.41	-0.11	0.91	-0.85, 0.76
Poultry ownership	-2.53	0.65	-3.90	<0.001***	-3.80, -1.25
Variables violating the proportional odds assumption					
Education of household head (Threshold 0)	-1.62	0.46	-3.54	<0.001***	-2.51, -0.72
Education of household head (Threshold 1)	-0.45	0.29	-1.55	0.12	-1.00, 0.11
Education of household head (Threshold 2)	0.05	0.36	0.14	0.89	-0.65, 0.75
Threshold (cut-point) parameters					
Cut-point 1	7.42	2.39	3.11	<0.001***	2.74, 12.09
Cut-point 2	1.86	2.14	0.87	0.39	-2.33, 6.05
Cut-point 3	-1.06	2.18	-0.48	0.63	-5.33, 3.22

** Indicates significance at 1 per cent level of probability.

* Indicates significance at 10 per cent level of probability.

3.3. The advantages and disadvantages of subsidies and dietary diversity

Dietary diversity was also greater in all the food security categories than the no-subsidy counterfactual in the absence of any dietary changes that would be expected that would occur under QUAIDS (Table 3). The difference was significant for all four paired test. Households that were moderately food insecure had the largest absolute drop in

SIDD, dropping from 0.64 to 0.55. This group seems to be particularly sensitive to cuts in subsidy payments, as households are vulnerable to go without the subsidy, and yet they are not so constrained that their diets are at an absolute lower bound. The other food-secure households also experienced a substantial decrease, and the mildly food insecure group experienced a slight, but statistically significant, decrease.

Table 3: Paired t-test Results Comparing Observed and QUAIDS-Predicted Simpson Index of Dietary Diversity (SIDD) across Household Food Insecurity Categories

Household Food Insecurity Category	Observed SIDD	QUAIDS SIDD	Observations	Pearson Correlation	t-statistic	df	p-value
Food Secure	0.80	0.74	25	-0.92	5.26	24	<0.001***
Mildly Food Insecure	0.72	0.71	39	0.87	6.27	38	<0.001***
Moderately Food Insecure	0.64	0.55	32	0.66	19.22	31	<0.001***
Severely Food Insecure	0.61	0.57	25	0.44	6.11	24	<0.001***

Note: The size of the households in the HFIAS groups is based on Table 2 and totals up to the full sample of 120 households. Observed and QUAIDS no-subsidy group means and two-tailed significance conclusions are reported in SIDDs comparisons.

3.4. Food Group Reallocation under the No-Subsidy Counterfactual

The SIDD results are more meaningful when used in conjunction with food-group reallocations. The changes in food groups quantities-shares are summarized in Table 4. In food secure households, cereal share increased from 34% to 44% assuming no subsidy under the QUAIDS, and the share of pulses, fruit and dairy decreased. Cereal share increased from 55% to 64% while the share of dairy and animal-source

foods decreased amongst moderately food insecure households. The food insecure households in the severely food insecure category continued to rely on low cost energy sources, as cereals were still the dominant food and fats/oils grew. A small SIDD change could mask a nutritional-quality concern as for mildly food-insecure households, the reduction in the cereal share was offset by increases in sugars/sweets and fats/oils.

Table 4: Household Food Group Allocation under Observed and Counterfactual (No-Subsidy) Scenarios

Food Group	Food Secure		Mildly Food Insecure		Moderately Food Insecure		Severely Food Insecure	
	Observed	QUAIDS	Observed	QUAIDS	Observed	QUAIDS	Observed	QUAIDS
Cereals & Grains	34	44	55	48	55	64	64	62
Pulses & Legumes	4	3	3	4	3	3	3	3
Vegetables	22	20	18	18	18	16	17	19
Fruits	8	6	9	7	9	7	5	5
Meat, Fish & Eggs	7	7	4	5	4	2	2	1
Sugars & Sweets	9	6	2	6	2	2	4	4
Dairy & Milk Products	7	5	5	4	5	2	2	2
Fats & Oils	6	5	3	7	3	3	2	4
Others	3	4	1	1	<1	<1	0	0

4. Discussion

4.1. Food Subsidies as Dietary-Risk Buffer

The results indicate that the PDS in Bageshwar is more than just a source of calories. SIDD has been observed higher than the no-subsidy counterfactual estimate for all food-security groups estimated by QUAIDS. This means that the impact on households' food budgets from the cereals price shock can be mitigated by this subsidy and allow some to be spent on non-cereal food components. This is in line with the income-relief pathway outlined in Indian safety-net literature [2, 4]. It is in addition consistent with the larger policy messages on the potential of social-protection instruments to help enhance nutrition security by increasing the purchasing power of the poor and reducing price shock risks for poor households.

A significant finding is that there has been a SIDD decline of all moderately food-insecure households. These households seem to be at or close to the dietary quality limit. Food-secure households will have more resources and very food insecure households may experience a minimum level of dietary intake. But the moderately insecure households in contrast appear to be able to sustain the variety of food groups they eat in the subsidy system, and seem to be better off without it. This is relevant for targeting, since the poorest households are not necessarily the poorest households to be seen, but when they are given less support, their diet is likely to be affected significantly.

4.2. The key elements of Cereal-Centred Support and Hidden Hunger

The simulation outcomes also illustrate the reasons for which,

cereal subsidies are not sufficient to address hidden hunger. Subsidy removals led to a reduction of the nutrient dense foods in a few groups, and an increase of the concentration of cereal in a few groups. Some families cut back on their cereals intake and increased their sugar, sweets and/or fats/oils intake. This pattern is in line with the worry about access to staples and diet quality. Food security in a household does not necessarily mean that the household has sufficient access to staple foods, but it could also mean that it is not able to access sufficient micronutrients and poor quality diets.

This is in line with the Indian food-policy debate as a whole. A shift from calorie security to nutrition security is called for by Pingali *et al.* [3]. Narayanan and Gerber also propose to make nutrition-sensitive safety nets [4]. The results that are now available are micro evidence to help make this case for a hilly district. Whether the PDD should be abolished or not is not the question here, but whether the PDD does. It is not proved whether the PDS should be removed or not; the data show that the PDS is working towards the conservation of diversity of food. The question will be whether the PDD basket and free policies are nutritionally satisfactory.

The Bageshwar findings also help in the evidence base on food insecurity at the household level in India. There are two parallel findings in the published literature on PDS reform and subsidy recipients: first, that a more inclusive policy in grain can free up household resources to purchase non-cereal food; and second, that subsidy recipients in remote areas may not be able to afford a diet that is more diverse than one based on cereals [11, 12]. The findings of HFIAS assessment from a rural agricultural community and from a systematic review of

the studies in India also provide evidence of significant and diverse household food insecurity ^[13, 14]. In the present results, cereal subsidies have shown a qualified protective effect, but they have not been found to ensure access to a diverse diet with cereal-dominated food baskets and limited local markets for nutrient-rich foods.

The results indicate that the welfare impact of food subsidies should not be evaluated based on the availability of calories or grain off take, from the agricultural-economics point of view. A subsidy can affect the food budget, relative prices of food items, and risk reduction and exposure of households. Hence, the policy issue is how much of the implicit income transfer policy for subsidised cereals is used to increase non-cereal dietary diversity. But these changes are limited in the remote hills due to transportation costs, market availability in dry season, low and scattered farms and dependence on livestock production and rural food production.

4.3. Crops and livestock, income and local food systems. Crops and Livestock, income and local food systems.

The regression analysis shows that the factors of livestock ownership and income reduce the probability of food insecurity. Livestock can impact diets in a number of ways: the availability of milk, livestock source of food, livestock sales income, and manure use for crop production and emergency asset liquidation. Livestock can be a specific asset representing a buffer in the economies of small land holdings, in which markets may be further away in the hills. The conclusion is that the negative livestock coefficient is strong and hence it is recommended to adopt the policy of subsidising food and implementing measures to improve the rural livelihood and livestock support.

The effect of dependency pressure was confirmed by the positive relationship between family size and likelihood of food insecurity. The subsidy benefit could be spread over a larger family and the amount of money the family has to spend on nutrient-rich foods may decrease. This means a policy of designing nutrition sensitive entitlements/complementary support should consider household size, especially in the most food insecure villages.

4.4. Policy Implications

The first is that those of rural Bageshwar should be covered by subsidies. The model-based removal scenario has a lower dietary diversity for all food-security groups. Secondly, the basket of the subsidized products ought to be diversified. The pulses, edible oils (in adequate amount), coarse cereals/millet (locally available) and regionally available food stuffs should be used as an adjunct to wheat and rice. Thirdly, the reform of the PDS should be made along with strengthening local markets because a household will not be able to diversify their food consumption unless non-cereal food is available or the price of non-cereal food is not too high in the local market. Fourth, the livestock-based nutrition strategies could be beneficial for food security risk reduction in the districts of the Himalayas, as those who have livestock are less vulnerable to food security risk. Fifthly, there is a need for Village level targeting: Village level support is required for villages like Rikhari, which are more in-depth than the normal level of support the villages receive in the districts.

5. Conclusion

This study reveals that with an increase in food subsidy, dietary diversity among the rural farm household in Bageshwar district is increased. The difference between observed and estimated SIDD (no subsidy) was observed across all categories of food-security, and was largest for moderately food-insecure households. Socio-economic factors also influence the food-insecurity risk; as household size increases the risk of food insecurity increases, but income, landholding, and ownership of livestock decreases the vulnerability to food insecurity. The results indicate that the PDS has the potential to act as a risk buffer which safeguards the minimum dietary diversity in the remote hill regions. But the current subsidy approach is not enough for nutrition security, as it focuses mainly on cereals. More nutrition-sensitive food-assistance strategy has to be put in place, involving continuation of the grain support and pulses, local coarse cereal, oil and livestock supports, and market access and targeting at a village level.

Policy Implementation

- **Maintain PDS support:** It is noted that there is a substantial reduction in dietary diversity in the no-subsidy scenario, thus the importance of maintaining PDS support. More attention should be given to providing nutrient-dense foods, including pulses and edible oils, as well as other nutritious commodities, in addition to cereals, to enhance the quality of the food provided.
- **Encourage livestock based livelihood promotion:** Ownership of livestock has a significant impact in reducing food insecurity, policies should encourage livestock development through improved veterinary services, improved quality breeds availability, availability of credit facilities, and livestock fodder development programmes.
- **Strengthen rural income opportunities:** livelihood diversification, employment opportunities, skill development and market access were negatively associated with household food insecurity, thus strengthening these can increase household purchasing power and resilience.
- **Improve nutrition and food security education:** Improve nutrition awareness and adult education programmes, which can lead to better food choices and household food diversity and effective use of food assistance programmes.
- **Least Cost Diet Planning for Nutrition Programmes:** Linear programming technique can be used to design most cost effective and nutritionally adequate food baskets of the different age and gender groups. This evidence can inform the planning of specific nutrition interventions as part of Government food and social protection programmes.

Scope for Future study

There are a number of caveats to be noted. The results can only be extrapolated to the 120 households in one district. The counterfactual estimates based on the QUAIDS are based upon assumptions about the treatment of price indexes, aggregation and substitution behavior of food groups, and should not be taken to be an observed policy experiment. No

estimates are available for the individual impacts of the different subsidy schemes (AAY, PHH or State Food Yojana). Differences in terms of altitude are also not well captured within Bageshwar, as altitude can impact production, market access and food availability. Finally, SIDD does not measure micronutrient intake, nutrient adequacy scores and anthropometric outcomes, but rather the diversity and evenness of food groups. Future studies should combine a Household Demand Modeling with nutrient-intake analysis, altitude stratified sampling and longitudinal data.

Acknowledgement

The first author sincerely thanks the respondent households of Bageshwar district for their cooperation during the field survey. First author also expresses her gratitude towards advisory committee for valuable inputs and guidance.

References

1. Banks J, Blundell R, Lewbel A. Quadratic Engel curves and consumer demand. *Rev Econ Stat*. 1997;79(4):527-539.
2. Brant R. Assessing proportionality in the proportional odds model for ordinal logistic regression. *Biometrics*. 1990;46(4):1171-1178.
3. Cunningham SA, Shaikh NI, Datar A, Chernishkin AE, Patil SS. Food subsidies, nutrition transition, and dietary patterns in a remote Indian district. *Glob Food Sec*. 2021;29:100506.
4. George NA, McKay FH. The Public Distribution System and food security in India. *Int J Environ Res Public Health*. 2019;16(17):3221.
5. Hirvonen K, Bai Y, Headey D, Masters WA. Affordability of the EAT-Lancet reference diet: a global analysis. *Lancet Glob Health*. 2020;8(1):e59-e66.
6. Jacob AM, Rajaram D, Manjunath B, Kunnavil R. Assessment of food insecurity and its correlates in a rural community of Karnataka: a case study. *Int J Community Med Public Health*. 2018;5(11):4896-4900.
7. Kishore A, Chakrabarti S. Is more inclusive more effective? The 'New Style' public distribution system in India. *Food Policy*. 2015;55:117-130.
8. Knueppel D, Demment M, Kaiser L. Validation of the Household Food Insecurity Access Scale in rural Tanzania. *Public Health Nutr*. 2010;13(3):360-367.
9. Kumar GS, Kulkarni M, Rathi N. Evolving food choices among the urban Indian middle-class: a qualitative study. *Front Nutr*. 2022;9:844413.
10. McKay FH, Sims A, van der Pligt P. Measuring food insecurity in India: a systematic review of the current evidence. *Curr Nutr Rep*. 2023;12:358-367.
11. Narayanan S, Gerber N. Social safety nets for food and nutrition security in India. *Glob Food Sec*. 2017;15:65-76.
12. Pingali P, Mittra B, Rahman A. The bumpy road from food to nutrition security: slow evolution of India's food policy. *Glob Food Sec*. 2017;15:77-84.
13. Simpson EH. Measurement of diversity. *Nature*. 1949;163:688.
14. Williams R. Generalized ordered logit/partial proportional odds models for ordinal dependent variables. *Stata J*. 2006;6(1):58-82.