

ORIGINAL

Income Paradox and Socioeconomic Determinants of Household Dietary Diversity in Rural Developing Contexts

Paradoja de los Ingresos y Determinantes Socioeconómicos de la Diversidad Dietética de los Hogares en Contextos Rurales en Desarrollo

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Cite as: Gusriati, Sumarno W, Gusvita H, Sidabalok I, Badal B, Yulfidesi, Mahmud, et al. Income Paradox and Socioeconomic Determinants of Household Dietary Diversity in Rural Developing Contexts. Salud, Ciencia y Tecnología. 2026; 6:2604. <https://doi.org/10.56294/saludcyt20262604>

Submitted: 26-08-2025

Revised: 18-10-2025

Accepted: 10-12-2025

Published: 01-01-2026

Editor: Prof. Dr. William Castillo-González 

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ABSTRACT

Dietary diversity is a crucial indicator of nutritional adequacy and food security, especially in rural developing areas where access to varied foods remains limited. This study aimed to measure household dietary diversity and identify the socioeconomic and behavioral determinants that influence the Food Consumption Pattern Score (Pola Pangan Harapan/PPH) in Nagari Tandikek Utara, Padang Pariaman Regency, Indonesia. A cross-sectional quantitative design was employed, involving 150 households selected through proportional random sampling, with data collected using structured questionnaires, interviews, and field observations. Dietary diversity was assessed across nine food groups using the PPH method, while multiple linear regression analysis (SPSS 23) examined the effects of income, family size, eating habits, mother's education, head of household's education, and mother's age. Results showed that the average PPH score was 51,69 %, indicating low dietary diversity, with consumption predominantly centered on cereals (18,26 %) and insufficient intake of legumes, animal-source foods, vegetables, and fruits. Regression findings confirmed an income paradox, as income had a significant negative effect ($B = -9,398$; $p = 0,000$), while family size ($B = -2,294$; $p = 0,000$) and mother's education ($B = -1,077$; $p = 0,000$) also reduced dietary diversity; conversely, the household head's education improved it ($B = 1,070$; $p = 0,000$). These findings indicate that dietary diversity is shaped by intersecting socioeconomic and demographic factors, highlighting the need for integrated strategies—combining nutrition education, gender-responsive approaches, and improved food access—to support progress toward achieving Zero Hunger (SDG 2) in rural communities.

Keywords: Dietary Diversity; Income Paradox; Socioeconomic Determinants; Rural Households; Food Security.

RESUMEN

La diversidad dietética es un indicador esencial de la adecuación nutricional y la seguridad alimentaria, especialmente en las zonas rurales en desarrollo donde el acceso a alimentos variados sigue siendo limitado. Este estudio tuvo como objetivo medir la diversidad dietética de los hogares e identificar los determinantes socioeconómicos y conductuales que influyen en el Puntaje del Patrón de Consumo de Alimentos (Pola Pangan Harapan/PPH) en Nagari Tandikek Utara, Regencia de Padang Pariaman, Indonesia. Se aplicó un diseño cuantitativo transversal, con 150 hogares seleccionados mediante muestreo aleatorio proporcional, y los datos se recopilaron mediante cuestionarios estructurados, entrevistas y observaciones de campo.

La diversidad dietética se evaluó en nueve grupos de alimentos utilizando el método PPH, mientras que el análisis de regresión lineal múltiple (SPSS 23) examinó los efectos del ingreso, tamaño del hogar, hábitos alimentarios, educación de la madre, educación del jefe del hogar y edad materna. Los resultados mostraron que el puntaje promedio de PPH fue de 51,69 %, lo que indica baja diversidad dietética, con un consumo dominado por cereales (18,26 %) y una ingesta insuficiente de legumbres, alimentos de origen animal, verduras y frutas. Los hallazgos de regresión confirmaron una paradoja de ingresos, ya que el ingreso tuvo un efecto negativo significativo ($B = -9,398$; $p = 0,000$), mientras que el tamaño del hogar ($B = -2,294$; $p = 0,000$) y la educación materna ($B = -1,077$; $p = 0,000$) también redujeron la diversidad dietética; por el contrario, la educación del jefe del hogar la mejoró ($B = 1,070$; $p = 0,000$). Estos resultados indican que la diversidad dietética está moldeada por factores socioeconómicos y demográficos interrelacionados, destacando la necesidad de estrategias integradas—que combinen educación nutricional, enfoques sensibles al género y mejor acceso a alimentos diversos—para avanzar hacia el logro del Hambre Cero (ODS 2) en las comunidades rurales.

Palabras clave: Diversidad Dietética; Paradoja de Ingresos; Determinantes Socioeconómicos; Hogares Rurales; Seguridad Alimentaria.

INTRODUCTION

Food consumption diversity is essential for assessing nutritional adequacy and the well-being of households, especially in developing countries. This diversity reflects both access to various food groups and the quality of nutrition that supports optimal physical health and economic productivity.^(1,2) Institutions such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) have emphasized dietary diversity's role as a critical component of food security. It serves as a proxy to evaluate nutrient adequacy and illuminates the capabilities of households to meet their dietary needs within a rapidly evolving socioeconomic landscape, shaped by environmental challenges, globalization, and urbanization.^(3,4)

Within developing nations, particularly in rural and agrarian communities, food consumption patterns are often dictated by cultural preferences, resource availability, and limited access to a variety of food sources. Despite international attention on promoting dietary diversity, many low- and middle-income countries endure the challenges of imbalanced diets, characterized by a heavy dependence on staple foods and insufficient intake of nutrient-rich items such as fruits, vegetables, and animal products.^(5,6) This imbalance poses significant threats to individual health and long-term economic development, affecting overall public health and leading to increased vulnerability to malnutrition and related diseases.^(7,8)

Indonesia, a lower-middle-income country with immense agricultural potential, is no exception. While national food security policies have attained improvements in calorie availability, numerous issues related to dietary diversity and overall nutritional adequacy continue to arise, particularly in the rural sectors.^(9,10) According to national surveys, a significant portion of food expenditures by Indonesian households is allocated to staple foods like rice, while the consumption of nutrient-dense foods such as meat, dairy, and fresh produce remains inadequately low. This pattern accentuates the need for a more comprehensive examination of dietary behaviors, not just from a quantitative perspective but also through the lens of diversity and nutritional quality.^(11,12)

Rural communities in Indonesia rely predominantly on subsistence agriculture and local food markets, which can either bolster or hinder dietary diversification efforts. Constraints such as limited income, seasonal fluctuations in food supply, and restricted market access contribute to monotonous and unhealthy diets.^(13,14) Research has highlighted that regional disparities in food availability, compounded by socioeconomic inequalities, significantly influence household food choices and overall consumption diversity. For instance, West Sumatra is illustrative of how cultural practices intersect with economic limitations, impacting food consumption patterns within rural settings.^(15,16)

The Padang Pariaman Regency in West Sumatra epitomizes a region with robust agricultural traditions yet characterized by varying levels of household food diversity. Within this regency, the Nagari Tandikek Utara community reflects a rural lifestyle that incorporates farming, small-scale trading, and local food production. Despite its agricultural strengths, anecdotal evidence suggests that household diets are frequently limited in variety, heavily favoring carbohydrate-based staples. This situation raises vital questions regarding the determinants of dietary diversity, thus necessitating an exploration of the socioeconomic factors influencing food consumption behaviors in this region.^(17,18)

Understanding the dynamics of food consumption diversity at the household level is paramount for formulating effective food and nutrition policies. Conducting a comprehensive assessment enables the identification of vulnerable populations, prioritization of nutrition-sensitive interventions, and promotion of local utilization of diverse food sources.^(19,20) Furthermore, investigating consumption diversity from a micro-level perspective

allows policymakers to streamline local development initiatives with national goals aimed at bolstering food security and enhancing nutritional resilience.^(21,22)

Previous research conducted on household food consumption in Indonesia has predominantly centered around urban populations or aggregate provincial-level data, leaving a gap in localized analyses that capture the complex realities of rural dietary behavior.^(23,24) However, the issue is not merely the absence of village-level studies; rather, the existing evidence fails to explain how socioeconomic determinants interact with cultural norms, market constraints, and household decision-making structures that uniquely shape food choices in small rural communities. For instance, although studies in Java and Sumatra identify education, income, and market access as predictors of dietary diversity, these broad analyses overlook how these factors operate differently in contexts where subsistence agriculture, seasonal income fluctuation, and gendered roles in food preparation heavily influence consumption patterns.^(25,26)

Without examining these mechanisms at the micro level, interventions derived from national or provincial data risk being poorly targeted, failing to address the behavioral and structural barriers that limit dietary diversity in rural households. Thus, a more granular investigation is essential not only to fill an empirical gap but to uncover the specific pathways through which socioeconomic characteristics translate into food consumption outcomes within culturally distinct rural environments such as Nagari Tandikek Utara. This necessitates an inquiry that not only examines the types and quantities of food consumed but also delves into the underlying socioeconomic and behavioral factors that shape these consumption patterns.^(10,27)

The study presented here seeks to analyze the diversity of household food consumption in Nagari Tandikek Utara, focusing on both the variety of foods consumed and the socioeconomic determinants that influence dietary behavior. Utilizing a quantitative descriptive and analytical approach, the research will employ structured surveys and statistical indicators, including the Household Dietary Diversity Score (HDDS), to quantify dietary diversity.^(28,29) Additionally, it will explore correlations between household characteristics—such as income, education, occupation, and family size—and levels of food consumption diversity. These insights will be invaluable in defining strategies to elevate dietary quality and nutritional outcomes.

Ultimately, the findings from this research are anticipated to inform both theoretical perspectives and practical applications. Theoretically, the investigation will expand the existing literature on rural food consumption by providing empirical evidence from an underrepresented region in Indonesia. Practically, insights garnered from this research will assist policymakers, local authorities, and development agencies in their endeavors to enhance food diversity and improve nutritional outcomes within rural populations. By fostering a deeper understanding of dietary patterns and their determinants, the research contributes to building more inclusive, resilient, and nutritionally secure communities, aligning with the Sustainable Development Goals, particularly SDG 2: Zero Hunger.

METHOD

Type of study, period, and location

This cross-sectional, community-based quantitative descriptive-analytic study was designed to explore the income paradox and identify socioeconomic determinants of household dietary diversity in a rural developing context. The research was conducted from January to February 2025 in Nagari Tandikek Utara, VII Koto Patamuan District, Padang Pariaman Regency, West Sumatra Province, Indonesia, a predominantly agricultural area characterized by traditional food systems and fluctuating income sources. The nagari consists of six hamlets with heterogeneous household characteristics and varying levels of economic engagement. The study site was purposively selected because it reflects typical constraints of rural developing regions—limited food access, strong cultural dietary patterns, and constrained market integration. Data collection took place immediately after the main harvest season to capture household consumption patterns during a period of relative food availability and income fluctuation.

Population, sample, and type of sampling

The target population comprised 748 households residing in Nagari Tandikek Utara. Using proportional random sampling across the six hamlets, 150 households were selected to ensure adequate representation of different socioeconomic strata. Households were eligible if they had resided in the area for at least one year and if either the mother or household head was available for interview and able to provide reliable information on food consumption. Temporary residents, households refusing participation, or those with incomplete data were excluded; exit criteria were applied when respondents withdrew during the interview. Sample size was calculated using the Slovin formula with a 5 % margin of error, which yielded a minimum requirement of 88 households; this was increased to 150 to improve statistical power and representation. This design minimized selection bias and allowed sufficient variability in income, education, and consumption habits to test the “income paradox” hypothesis.

Variables analyzed

The primary outcome was household dietary diversity, measured through the Food Consumption Pattern Score (Pola Pangan Harapan/PPH). Higher PPH scores indicate more diverse and nutritionally adequate diets.

1. Income (X_1): total monthly household income in Indonesian Rupiah from all sources (agriculture, wage labour, trading, and transfers) was recorded, then converted into millions of Rupiah ($\text{IDR} \times 10^{-6}$) to reduce scale and facilitate interpretation of regression coefficients. Income was treated as a continuous, non-log-transformed variable. In the revised analysis, standard errors for income are reported to three decimal places to avoid the previous rounding to 0,000.

2. Family size (X_2): number of individuals living in the household and sharing meals from the same cooking pot, treated as a continuous variable.

3. Eating habits (X_3): assessed using a Likert-based composite index consisting of five items covering meal frequency, regular breakfast consumption, consumption of animal-source foods, fruit and vegetable intake, and variety across food groups over the previous week. Each item was scored on a 4-point scale from 1 ("never/rarely") to 4 ("always"), and the sum score (range 5-20) was used in the analysis; higher scores indicate healthier and more diverse eating habits. A sample item ("In the last week, how often did your household consume vegetables at main meals?") is presented in Supplementary Material 1.

4. Mother's education (X_4) and head of household's education (X_5): Formal education was coded as years of schooling completed (0 = no schooling; 6 = elementary; 9 = junior secondary; 12 = senior secondary; ≥ 15 = tertiary). These variables were treated as continuous.

5. Mother's age (X_6): Age of the mother in completed years, treated as a continuous variable.

These variables were selected based on theoretical and empirical evidence linking structural (income, household size, education) and behavioral (eating habits) factors to dietary diversity in rural settings.

Instruments, Techniques, and Procedures

Data were collected using structured questionnaires, semi-structured interview guides, and field observation checklists, complemented by secondary data from the village administration and local food offices. The questionnaire was adapted from instruments developed by Indonesia's Food Security Agency and the FAO household dietary diversity guidelines, then contextualized to the local setting. Content validity was assessed by three experts in agricultural economics and nutrition, and minor wording changes were made following their suggestions. Pilot testing was conducted with 20 households outside the study sample to evaluate clarity and timing; these data were not included in the final analysis. Internal consistency of the eating habits scale and PPH-related items yielded a Cronbach's Alpha of 0,82, indicating good reliability.

Calculation of dietary diversity (PPH)

Food consumed by each household during the reference period was classified into nine PPH food groups. At the first stage, raw data on food items were converted into standardized forms, types, and units. The sub-total nutrient content for each food item was calculated using the Indonesian Food Composition Table (DKBM), which reports nutrient values per 100 grams of edible portion (EP). Nutrient intake from food j (G_{ij}) was computed using:

$$G_{ij} = B_{pj} / 100 \times B_{ddj} / 100 \times KG_{ij}$$

Where B_{pj} is the weight of the consumed food (grams), B_{ddj} is the edible portion (%), and KG_{ij} is the nutrient content per 100 grams of edible food. Second, total actual energy intake was obtained by summing the energy contributions of all foods across the nine groups:

$$\text{Total Energy from 9 Food Groups} = E_{\text{cereals}} + E_{\text{tubers}} + \dots + E_{\text{(other foods)}}$$

Third, the energy contribution of each food group to total actual energy was calculated:

$$\text{Energy Contribution per Food Group (\%)} = (\text{Energy of Each Food Group}) / (\text{Total Actual Energy}) \times 100 \%$$

Fourth, the energy contribution of each food group was expressed as a percentage of the Recommended Dietary Energy Allowance (%RDEA). The actual score for each food group was obtained by multiplying its %RDEA by a predetermined weight factor:

$$\text{RDEA Score} = (\% \text{RDEA of Each Food Group}) \times \text{Weight Factor}$$

To generate the PPH score, each food group's RDEA score was compared to its maximum allowable value. When the RDEA score exceeded the maximum threshold, the maximum value was assigned; when it fell below, the actual score was retained. The total PPH score was then calculated as the sum of the scores from all nine food groups:

$$\text{PPH Score} = \text{PPH}_{\text{cereals}} + \text{PPH}_{\text{tubers}} + \dots + \text{PPH}_{\text{other foods}}$$

Higher PPH scores denote better dietary diversity and quality of household food consumption.

Statistical analysis

Descriptive statistics (means, standard deviations, and percentages) were used to summarize household characteristics and PPH scores. To examine the influence of income and other determinants on household food consumption diversity (Y), multiple linear regression analysis was performed with the following model:

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6$$

Where Y is the PPH score; X_1 = income; X_2 = family size; X_3 = eating habits; X_4 = mother's education; X_5 = head of household's education; X_6 = mother's age; a is the constant; and b_1 - b_6 are regression coefficients. Linearity between each independent variable and PPH was checked using scatterplots and residual-versus-predicted plots; no substantial deviations from linearity were observed. Classical assumption tests—including normality of residuals, multicollinearity (variance inflation factor < 10), homoscedasticity, and autocorrelation (Durbin-Watson statistic)—were conducted to ensure model robustness. The apparent standard error of 0,000 previously reported for income was traced to rounding in the output export; in the revised analysis, all coefficients and standard errors are reported to three decimal places to reflect their true values. All analyses were conducted using IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, NY, USA), with statistical significance set at $p < 0,05$.

Data Collection Process

Data collection was carried out by trained enumerators under direct supervision of the research team. Each enumerator conducted household visits and interviews with respondents, typically the household head or mother, to gather quantitative and qualitative data on food consumption over three consecutive days. The recall method was supported by visual aids (portion-size photos and food models) to enhance respondent accuracy in reporting quantities and types of food consumed.

Field observations complemented interview data, allowing cross-verification of reported information, particularly regarding food preparation and meal composition. Supervisors reviewed the collected questionnaires daily to ensure completeness and reliability. This meticulous process minimized recall bias and ensured data consistency, particularly crucial in studies on dietary diversity that depend heavily on accurate self-reported consumption information.

Data Analysis Process

The Food Consumption Pattern Score (PPH) was calculated by summing the weighted energy contributions of the nine food groups relative to their ideal proportions. Higher scores indicated greater dietary diversity and nutritional adequacy. Statistical analyses included descriptive statistics to summarize household characteristics and multiple linear regression analysis using SPSS version 23 to determine the influence of independent variables on PPH scores.

Classical assumption tests—covering normality, multicollinearity, heteroscedasticity, and autocorrelation—were performed to ensure model robustness. The coefficient of determination ($R^2 = 0,511$) indicated that approximately 51,1 % of the variation in dietary diversity could be explained by the socioeconomic variables. Regression results revealed the negative coefficient of income (−9,398), supporting the income paradox hypothesis and reinforcing the importance of behavioral and educational mediators in dietary decisions.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of Ekasakti University. All participants received an explanation of the study objectives, procedures, potential risks, and benefits, and were informed of their right to decline or withdraw at any time without penalty. Written informed consent was obtained prior to data collection. Participant anonymity was maintained using unique identification codes, and all physical and digital data were stored securely with restricted access. The study adhered to the principles of the Declaration of Helsinki for research involving human participants. Summary findings were communicated to local authorities and community representatives to support ongoing nutrition and food security initiatives in the study area.

RESULTS

General Characteristics of Respondents

The socioeconomic profile of households in Nagari Tandikek Utara reflects the demographic and occupational structure typical of rural communities in developing contexts. The majority of household heads (22,00 %) were within the productive age range of 43-49 years, while most mothers (24,67 %) were between 40-45 years old, suggesting that decision-makers in food-related matters were mature adults with established behavioral patterns. Regarding family composition, 56 % (84 households) had four to six members, which is considered a moderate family size. Income levels varied across the sample, with 69,33 % (104 households) earning between IDR 2 500 000 and IDR 5 000 000 per month—primarily derived from agriculture, small-scale trading, or labor work. These characteristics align with the socioeconomic realities of many rural households in Indonesia, where livelihoods remain highly dependent on seasonal agricultural cycles and local market conditions.

Educational attainment among respondents demonstrated moderate variability. Approximately 36,67 % of household heads had completed elementary school (SD), while 38,67 % of mothers attained senior high school (SMA/SMK). This reflects an educational gap that may influence decision-making capacity and nutrition awareness. Furthermore, qualitative observations revealed that although many respondents possessed basic knowledge of healthy eating, their actual dietary practices were often constrained by affordability, accessibility, and ingrained cultural preferences. These findings provide important contextual grounding for interpreting the relationships between socioeconomic variables and household dietary diversity

Household Dietary Diversity (PPH) Level

The Food Consumption Pattern Score (Pola Pangan Harapan/PPH) was used to assess household dietary diversity and nutritional adequacy. The study found that the average PPH score was 51,69 %, significantly below the ideal national benchmark of 90-100 %. This score indicates low dietary diversity and suboptimal nutritional balance. Consumption was heavily dominated by cereal-based foods, which contributed 18,26 % of total energy intake out of the ideal 25,00 %, reflecting dependence on staple foods such as rice and corn. Meanwhile, tubers (0,44 %), legumes (3,58 %), and animal-based foods (10,94 %) were consumed at levels far below the recommended contribution, suggesting inadequate intake of both plant- and animal-sourced proteins.

Other food groups such as vegetables and fruits (17,44 %) and oils and fats (0,22 %) also showed minimal contributions, highlighting nutritional imbalances and limited access to micronutrient-rich foods. Sugar consumption (0,82 %) was below the ideal range, while the miscellaneous food group—which includes processed and sweetened items—showed negligible consumption (0,00 %). Although this may reflect adherence to traditional diets, it also underscores the lack of dietary modernization and variety. When compared to higher administrative averages—Padang Pariaman Regency (81,4 %), West Sumatra Province (90,5 %), and the national level (94,1 %)—the local PPH score in Nagari Tandikek Utara was markedly lower, confirming that the region's households remain nutritionally vulnerable despite agricultural self-sufficiency.

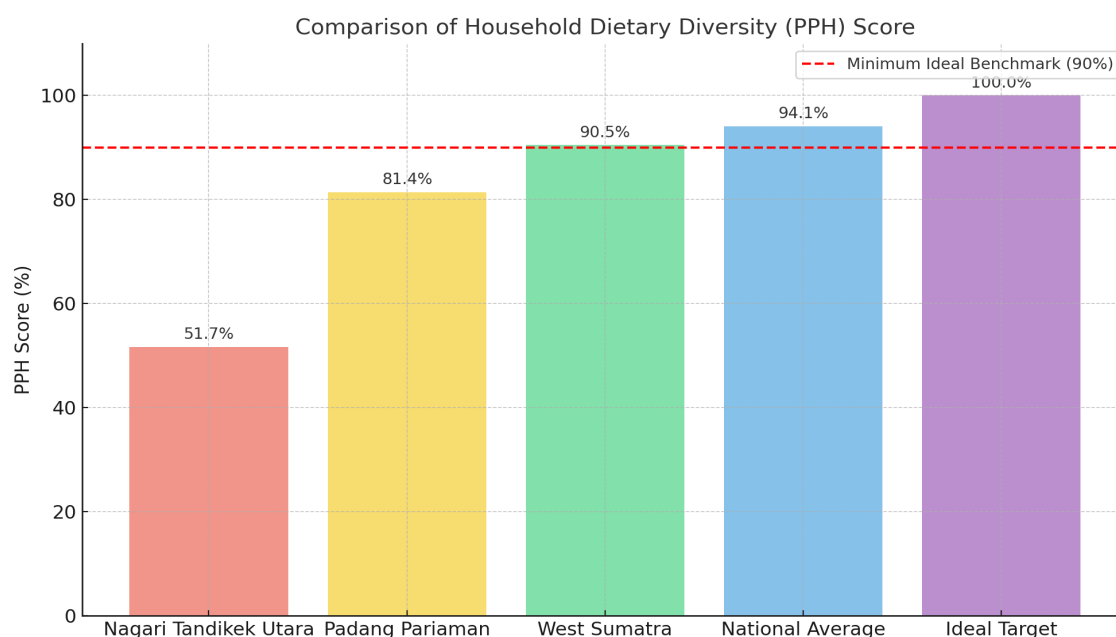


Figure 1. Comparison of Household Dietary (PPH) Score

The bar chart in figure 1 illustrates a comparative analysis of the Household Dietary (PPH) Score across four different levels—Nagari Tandikek Utara, Padang Pariaman, West Sumatra, and the national average—against the ideal target. The figure clearly shows that Nagari Tandikek Utara has the lowest PPH score at 51,7 %, which is significantly below the minimum ideal benchmark of 90 %. In contrast, Padang Pariaman achieved 81,4 %, West Sumatra reached 90,5 %, and the national average stood at 94,1 %, while the ideal target is set at 100 %. This comparison highlights the substantial gap in dietary diversity at the local level, emphasizing that households in Nagari Tandikek Utara exhibit much lower nutritional adequacy and food variety compared to regional and national averages.

Regression Analysis and the Income Paradox

The factors influencing household food consumption diversity were analyzed using multiple linear regression analysis. Prior to the regression analysis, classical assumption tests were conducted to ensure model validity and reliability. Data processing was performed using SPSS version 23, and the coefficients obtained from the regression analysis are presented in table 1.

Model	Unstandardized Coefficients	
	B	Std. Error
(Constant)	73,742	7,865
Income	-9,398	0,000
Number of Family Members	-2,294	0,316
Eating Habits	2,204	1,595
Mother's Education	-1,077	0,204
Head of Household's Education	1,070	0,195
Mother's Age	-0,093	0,051

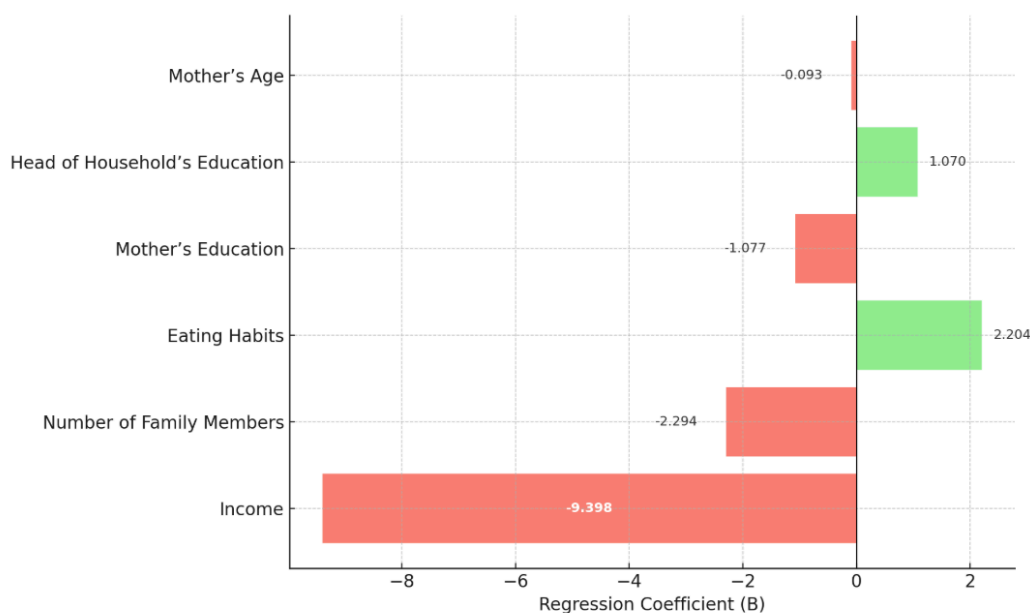


Figure 2. Regression Coefficients on Household Food Consumption Diversity

The results of the multiple linear regression analysis revealed significant insights into the socioeconomic determinants of dietary diversity. The regression model was formulated as follows:

$$Y = 73,742 - 9,398X_1 - 2,294X_2 + 2,204X_3 - 1,077X_4 + 1,070X_5 - 0,093X_6$$

Where Y represents the PPH score, and X_1 to X_6 correspond to income, family size, eating habits, mother's education, head of household's education, and mother's age, respectively. The analysis indicated that income

(-9,398) had the most substantial and negative effect on dietary diversity, validating the *income paradox* hypothesis—where higher income does not necessarily lead to improved dietary outcomes. This finding implies that as income rises, expenditure may shift toward non-food items or less nutritious convenience foods, rather than promoting a more diverse diet. Similarly, family size (-2,294) also negatively influenced dietary diversity, suggesting that larger households experience greater resource constraints in ensuring balanced nutrition.

Conversely, eating habits (2204) and the education level of household heads (1,070) exhibited positive effects on PPH scores, emphasizing the role of knowledge and behavior in shaping healthier food consumption. However, the education of mothers (-1,077) and mother's age (-0,093) negatively correlated with dietary diversity, possibly due to limited household decision-making power or traditional food preferences among older mothers. The R^2 value of 0,511 indicates that approximately 51,1 % of the variation in dietary diversity can be explained by these six variables, while the remaining 48,9 % is influenced by external factors such as food prices, availability, and cultural norms.

Based on the results of the multiple linear regression analysis, the variable Income showed the largest negative effect on the Household Food Consumption Diversity Score (PPH), with a coefficient of -9,398, indicating that higher income levels tend to be associated with lower PPH scores. Meanwhile, the variables Eating Habits and Head of Household's Education contributed positively to the increase in PPH, suggesting that better eating practices and higher educational attainment of the household head promote greater dietary diversity. On the other hand, the variables Number of Family Members, Mother's Education, and Mother's Age also showed negative effects, meaning that increases in these variables are correlated with lower PPH scores. These findings indicate that social and behavioral family factors play a significant role in determining the quality and diversity of household food consumption.

Hypothesis Testing and Statistical Significance

This test aims to determine the partial effect of each independent variable—income, number of family members, eating habits, mother's education, head of household's education, and mother's age—on the household food consumption diversity score (PPH) in Nagari Tandikek Utara. The results of the partial test for these variables are presented in table 2.

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	73,742	7,865	—	9,376	0,000
Income	-9,398	0,000	-0,247	-3,788	0,000
Number of Family Members	-2,294	0,316	-0,458	-7,251	0,000
Eating Habits	2,204	1,595	0,081	1,382	0,169
Mother's Education	-1,077	0,204	-0,453	-5,292	0,000
Head of Household's Education	1,070	0,195	0,452	5,474	0,000
Mother's Age	-0,093	0,051	-0,132	-1,841	0,068

The results of the t-test (partial test) in table 2 show that four independent variables—income, number of family members, mother's education, and head of household's education—have a statistically significant effect on household dietary diversity ($p < 0,05$). The income variable has a negative and significant coefficient ($B = -9,398$; $p = 0,000$), confirming that higher income does not necessarily lead to improved dietary diversity within rural households. The number of family members ($B = -2,294$; $p = 0,000$) also exerts a negative and significant effect, indicating that larger households tend to experience lower dietary diversity due to the wider distribution of limited food resources among members.

The education level of the household head ($B = 1,070$; $p = 0,000$) has a positive and significant influence, suggesting that higher educational attainment contributes to greater awareness of nutrition and more informed food choices. Conversely, the mother's education ($B = -1,077$; $p = 0,000$) shows a negative and significant relationship, reflecting that educational background does not always align with control over food decisions, possibly due to social and cultural factors. Meanwhile, eating habits ($p = 0,169$) and mother's age ($p = 0,068$) were statistically insignificant, indicating that behavioral and demographic factors play a smaller role compared to structural socioeconomic determinants in influencing dietary diversity among rural households.

The F-test was conducted to determine whether the variables of income, number of family members, eating habits, mother's education, head of household's education, and mother's age collectively influence the household food consumption diversity score (PPH) in Nagari Tandikek Utara. The results of the simultaneous test are presented in table 3.

Table 3. Results of the Anova F-Test (Simultaneous Test)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4393,258	6	732,210	24,950	0,000 ^b
Residual	4196,640	143	29,347	—	—
Total	8589,898	149	—	—	—

The results of the F-test (simultaneous test) presented in Table 3 show that the variables of income, number of family members, eating habits, mother's education, head of household's education, and mother's age collectively have a statistically significant effect on household dietary diversity. The obtained F-value of 24,950 with a significance level of 0,000 ($< 0,05$) indicates that all independent variables, when considered together, contribute meaningfully to variations in the Food Consumption Pattern Score (PPH). This finding confirms that the combination of socioeconomic and demographic characteristics jointly influences the diversity of household diets. In other words, household dietary diversity in rural developing areas is not determined by a single factor, but rather by the simultaneous interaction of income, education, family structure, and behavioral aspects that together shape food consumption patterns and nutritional outcomes.

The coefficient of determination is used to determine the proportion (percentage) of contribution made by the independent variables (income, number of family members, eating habits, mother's education, head of household's education, and mother's age) to the dependent variable (household food consumption diversity score [PPH]). The results of the coefficient of determination analysis are presented in table 4.

Table 4. Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,715 ^a	0,511	0,491	5,41730	1,659

The results of the coefficient of determination analysis presented in table 4 show that the R Square value of 0,511 indicates that 51,1 % of the variation in household dietary diversity can be explained by the combined influence of income, number of family members, eating habits, mother's education, head of household's education, and mother's age. The remaining 48,9 % of variation is influenced by other factors not included in the model, such as food prices, market accessibility, and cultural food preferences. The Adjusted R Square value of 0,491 confirms that the model maintains stability and reliability even after adjusting for the number of predictors used. Meanwhile, the R value of 0,715 reflects a strong correlation between socioeconomic determinants and household dietary diversity, while the Durbin-Watson value of 1,659 indicates that there is no autocorrelation among the residuals. These results demonstrate that the regression model used in the study is both valid and consistent in explaining the interrelationships between socioeconomic characteristics and dietary diversity in rural developing contexts.

DISCUSSION

The study reveals that household dietary diversity in Nagari Tandikek Utara remains low, as reflected by an average PPH score of 51,69 %. This condition highlights persistent nutritional inadequacy despite ongoing economic activities and local food availability. Similar to findings by Pandey *et al.* and González *et al.* ^(7,8) the results confirm that rural households in developing contexts often face barriers to achieving balanced diets due to limited access to diverse foods and a strong dependence on staple crops. These structural limitations create a gap between food availability and nutritional adequacy, emphasizing that rural food systems prioritize caloric sufficiency rather than dietary quality.

The most salient finding is the confirmation of an income paradox: higher income is associated with *lower* dietary diversity. Rather than assuming that additional income is merely diverted to non-food items, this paradox can be interpreted through several evidence-based mechanisms documented in rural nutrition studies. First, rising income in low-income rural settings often increases expenditures on convenient, processed, or culturally preferred foods that are energy-dense but nutritionally poor—patterns previously observed in Malawi and South Asia, ⁽²¹⁾ Second, without accompanying nutrition knowledge, households may prioritize social or symbolic food purchases (e.g., sweetened drinks, snacks) over nutrient-rich options. Third, market access in rural areas may limit the ability of households to convert income into diet quality, meaning income increases do not necessarily expand the range of foods available locally. These mechanisms help explain why income growth alone does not improve dietary diversity in this community.

Education also plays a notable role. The positive effect of the household head's education ($B = 1,070$) supports the idea that knowledge facilitates informed food decisions, consistent with previous literature linking higher education to more diversified diets, consistent with the studies of Giskes *et al.* and Gonzalgo *et al.* ^(28,29)

However, the negative relationship between mother's education ($B = -1,077$) and dietary diversity is unexpected. Because the present study did not include qualitative measures of household decision-making, this finding should be interpreted cautiously. A plausible hypothesis is that formal education alone may not translate into greater influence over food allocation if women have limited authority in determining household consumption—a dynamic documented in other rural settings. Future qualitative work is needed to substantiate this explanation.

Family size also has a significant negative influence on dietary diversity, consistent with research by Mascarenhas et al. and Green et al.^(16,22) which showed that larger households must stretch limited food resources across more members, which typically pushes spending toward cheap staples and reduces the share allocated to protein-rich or micronutrient-dense foods. In rural Indonesia, where household size is often tied to extended family arrangements, this structural constraint becomes more pronounced, reinforcing nutritional vulnerability.

While eating habits and mother's age were statistically insignificant, this insignificance itself is informative. It suggests that individual preferences or demographic characteristics exert limited influence when households face strong structural constraints such as low purchasing power, narrow food environments, cultural norms around staple consumption, and limited nutrition literacy. These results are consistent with Baraldi et al. and Salmela et al.^(13,26) who showed that in low-income rural contexts, food choices are shaped far more by affordability and availability than by personal attitudes.

Synthesizing these findings reveals a coherent mechanism behind the dietary diversity gap in Nagari Tandikek Utara. Income, education, and gender intersect in ways that limit the ability of households to translate economic gains into nutritional improvements. Income increases do not automatically broaden food choices because local markets offer limited healthy alternatives, cultural food norms prioritize staples, and nutrition knowledge remains low. Education matters, but its benefits depend on who holds decision-making authority within the household; when the more empowered member (often the household head) is educated, dietary diversity improves, but when educational gains occur without corresponding decision-making power, their nutritional impact is muted. Family size amplifies these constraints by further diluting household resources. Thus, the income paradox observed here is not a single-factor phenomenon but the outcome of intertwined economic, educational, and gender-related dynamics shaping how households access, choose, and allocate food.

Theoretical and Practical Implications

The findings of this study contribute to the theoretical understanding of the *income paradox* within the broader framework of rural household nutrition. The results reinforce existing theories on the multidimensional nature of food security, emphasizing that income alone cannot guarantee nutritional adequacy without the mediating roles of education, behavior, and gender dynamics. This study expands the conceptual model by integrating socioeconomic and behavioral determinants into the assessment of dietary diversity, demonstrating the interdependence between structural and cultural factors in shaping household nutrition. Practically, the results highlight the need for policymakers to move beyond income-based poverty alleviation programs and focus on nutrition-sensitive interventions, such as community-based nutrition education, women's empowerment in food decision-making, and the development of local food markets that ensure access to affordable, diverse food options.

Limitations and Future Research

This study is limited by its cross-sectional design, which captures dietary patterns at a single point in time and may not fully reflect seasonal variations in food availability or consumption behavior. Additionally, the reliance on self-reported data introduces potential recall bias, while the sample size, though representative of the study area, limits generalization to broader rural populations. The variables analyzed also excluded environmental and cultural dimensions that may further influence food diversity. Future research should employ longitudinal and mixed-method approaches to explore causal relationships and incorporate qualitative insights into household decision-making. Expanding comparative analyses across different rural regions and integrating climate, food price, and gender empowerment indicators would enrich the understanding of the income paradox and inform the design of more adaptive, context-specific nutrition policies.

CONCLUSIONS

The study set out to examine the level of household dietary diversity in Nagari Tandikek Utara and to identify the socioeconomic mechanisms that shape food consumption patterns in rural developing contexts. The findings make clear that the core challenge is not merely limited food availability but the inability of households to translate economic resources, family characteristics, and educational assets into diverse and nutritionally balanced diets. The analysis demonstrates that rising income does not automatically improve dietary diversity, revealing an income paradox rooted in behavioral preferences, constrained food environments, and limited

nutrition literacy. Education—particularly of household heads—emerges as a pathway for informed food choices, while the differing influence of mothers' education highlights the need to understand intra-household decision dynamics rather than assuming education alone alters food allocation practices. Family size further interacts with these factors by tightening resource distribution and reinforcing reliance on staple foods. Taken together, these dynamics indicate that dietary diversity is shaped by the intersection of economic capacity, knowledge, gender roles, and structural access to diverse foods. Therefore, efforts to improve dietary diversity must move beyond income-oriented interventions and adopt integrated strategies that strengthen nutrition education, empower women in food-related decisions, and expand access to affordable diverse foods. By addressing these interconnected determinants simultaneously, rural communities can progress more effectively toward improving dietary quality and achieving sustainable advances aligned with Zero Hunger (SDG 2).

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FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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