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# IMPACT OF EDUCATION ON FOOD SECURITY IN RURAL PAKISTAN

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## ABSTRACT

*Education and food security are pillars of national development. Education builds human capital, raises income potential, and increases awareness of health and nutrition, all of which contribute to improved food security. This study aims to evaluate household food security status in rural Pakistan and to examine the impact of education levels (Basic, Secondary, and Higher) on food security in rural Pakistan. The study utilizes data from 15,737 rural households obtained from the Household Integrated Economic Survey (HIES) 2018–2019, while the Food Consumption Table (FCT) of Pakistan is used to estimate calorie intake. Food security was measured through the caloric intake method, with households consuming at least 2550 kcal per adult equivalent per day considered food secure. To determine the impact of education on household food security, a logistic regression model is utilized. Results show that 39.32% of rural households are food insecure. Logistic regression analysis reveals that Basic education negatively affects food security, while Secondary and Higher education have positive impacts, with Higher education showing the strongest effect. Control variables from categories such as household head characteristics, household characteristics, household economic factors, basic life necessities, and regional characteristics are also included to isolate the effect of education on household food security. Considering the findings, the government should improve basic education with practical skills and health awareness, expand schools in rural areas, support secondary and higher education through scholarships, and promote the value of education with community engagement and technology to improve food security.*

***Keywords:*** *Education levels, Food security, Caloric intake method, Rural households, Human capital, Logistic regression, Pakistan.*

## 1. Introduction

Education and food security stand as a cornerstone for achieving the prosperity and development of a country (Mahmood et al., 2014). In achieving sustainable development goals (SDGS), education and food security are fundamental components. “SDG 4” aims to provide inclusive and quality education, recognizing it as a catalyst for empowerment and informed decision-making. While “SDG 2” is dedicated to end hunger, ensuring food security, and advancing sustainable agricultural methods.

Education strengthens food security through both economic and non-economic pathways. It empowers individuals with the essential knowledge and skills to enhance human capital formation and increase income potential, thereby improving food security (Food and Agriculture Organization [FAO], 2006). Beyond economic benefits, education also improves nutrition awareness, health practices, and sanitation behaviors, leading to better food utilization and a more secure household food environment (Feinstein et al., 2006; Luo et al., 2012).

Food security is defined as a condition in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life (World Food Summit, 1996). According to this definition, there are four distinct but interrelated elements essential to achieving food security: availability, accessibility, utilization, and sustainability. Availability relates to sufficient supply of quality food, accessibility to the resources needed to obtain it, utilization to the effective absorption of nutrients, and sustainability to the stability of food access over time (FAO, 2006; Babu & Sanyal, 2009; United Nations Economic and Social Commission for Asia and the Pacific [UN-ESCAP], 2009).

Given the study's focus on household-level food security in rural Pakistan, it is crucial to understand the ability to access food at all times. This access includes both physical and economic aspects. Economic access means having the ability to produce or purchase food (Timmer, 2000). Consistent market availability is necessary but not sufficient for food security. Lack of income or purchasing power can still lead to insecurity even when food is available (Hassan, 2021). Thus, food security requires both availability and access. Simply producing enough food globally does not ensure food security for everyone. Access to this food is essential.

Globally, food security remains a significant challenge, with millions of people affected by undernourishment and food insecurity. According to the World Health Organization (WHO, 2024), approximately 733 million people worldwide faced undernourishment in 2023, showing a slight decrease from 735.1 million in 2022 and 738.8 million in 2021. The same WHO findings also highlight a global moderate to severe food insecurity rate of 28.9% in 2023, reflecting a small decline from the previous year's figure of 29.6%. This indicates the enduring and evolving nature of the global food security challenge.

Similarly, in South Asia, a region grappling with substantial food security challenges, the WHO (2024) reported that in 2023, approximately 271 million people, constituting about 13.9% of the total population, faced undernourishment. This figure showed an improvement from 313.6 million (15.6%) in 2022. Furthermore, The same WHO noted that the prevalence of moderate to severe food insecurity in South Asia stood at 40% in 2023, reflecting a slight decline from 40.3% in 2022.

Reducing food insecurity remains a significant public policy challenge, particularly in developing countries. Pakistan is identified as a high-risk country for food insecurity by the Global Food Security Index (GFSI, 2022) ranking it 78th in terms of food security out of 113 countries, with a score of 56.8. According to WHO (2023), from 2020 to 2022, approximately 42.8 million people in Pakistan, constituting 18.5% of the population, faced undernourishment. This marked an increase from 36.3 million (16%) in the preceding period of 2019-2021. The same WHO reports that moderate to severe food insecurity rate in Pakistan rose to 42.3% in 2020-2022, up from 32.6% in 2019-2021.

Pakistan's population is predominantly rural, with about 62.3% residing in rural areas according to the World Bank (2023). These communities face considerable challenges not only in terms of food security but also in access to quality education. The Pakistan Social and Living Standards Measurement (PSLM, 2018–2019) reported that approximately 23.1% of the rural population experienced moderate to severe food insecurity, compared with 10.4% in urban areas. Similarly, PSLM (2020–21) reported the literacy rate at the national level to be 62.8%, with a marked rural–urban disparity—54% in rural areas compared to 77.3% in urban areas. Given the substantial share of the population residing in rural areas, addressing food security challenges is vital not only for improving rural well-being but also for fostering overall economic growth in the country.

In response to these challenges, a number of studies have investigated the determinants of food security in Pakistan. Some have adopted a nationwide perspective (Akbar et al., 2020; Rasheed et al., 2022; Hameed et al., 2020; Asghar et al., 2011; Hassan, 2021; Cheema et al., 2022), while others have focused specifically on rural contexts (Ejaz Ali Khan et al., 2012). Within rural settings, attention has often been directed toward particular regions, including

various areas of Punjab (Bashir et al., 2012; Bashir et al., 2013; Yousaf et al., 2018), Faisalabad (Naz et al., 2023), Malakand (Khan et al., 2018; Zhou et al., 2019), and District Dir (Sher et al., 2018).

Although these contributions have enriched the understanding of food security, they tend to emphasize a broad set of socioeconomic determinants, while the role of education has received comparatively less attention. Only a few studies have examined education in relation to food security in rural Pakistan, such as those conducted in Punjab (Iftikhar et al., 2015; Mahmood et al., 2014), but comprehensive analysis across the country's diverse rural areas remains limited. This gap highlights the need for systematic investigation into how different levels of education shape food security outcomes in rural households.

This study addresses that gap by examining the role of education in shaping household food security across all rural areas of Pakistan. By focusing on the educational attainment of working-age members (15–64) and the impact of different levels of education, it highlights how education strengthens household resilience and improves access to food. The study assists policymakers in progressing towards the attainment of Sustainable Development Goals (SDGS), specifically addressing Goal 2 (Zero Hunger) and Goal 4 (Quality Education). Emphasizing education's pivotal role in breaking the cycle of poverty and food insecurity, it provides a foundation for policies aimed at expanding educational access and improving food security outcomes.

This study aims to assess the food security status of households in rural Pakistan using the caloric intake method and to examine the impact of basic, secondary, and higher education on household food security.

## 2. Literature review

### 2.1. Measurement of Food Security

Food security is measured using diverse indicators across global, regional, national, and household levels, varying by level of analysis. Global measurements often emphasize food production, while national studies focus on domestic output, import reliance, and food aid. For instance, Ahmad (2009) focused on wheat production as a key food availability indicator. However, availability alone does not guarantee security—accessibility and utilization are equally critical. Studies like Iftikhar et al. (2015) assess all three dimensions (availability, accessibility, absorption), while Hussain & Routray (2012) examine rural food security through self-sufficiency, consumption gaps, and national security benchmarks using agricultural and household survey data.

At the household level, methods like Dietary Intake Assessment (DIA), Household Food Insecurity Access Scale (HFIAS), and Household Dietary Diversity Score (HDDS) are widely applied (Yousaf et al., 2018). Others, like Asghar (2011), rely on expenditure surveys, while Ndhleve et al. (2012) classify households into access-based categories (adequate, moderate, or severely inadequate) using food accessibility scales. Rasheed et al. (2022) used the Food Security Index (FSI), classifying households as secure (FSI ≥ 1) or insecure (FSI < 1). DE Muro and Burchi (2007) applied anthropometric data, while Naz et al. (2023) used the Food Consumption Score (FCS). Ullah and Ahmad (2021) relied on the Household Food Insecurity Access Scale (HFIAS) and Household Dietary Diversity Score (HDDS).

Caloric intake, a commonly used metric, stands out as a primary indicator. Khan, Umar Farooq, and Rizwan Yaseen (2018), Iram and Butt (2004), and Asghar and Muhammad (2013) employed different caloric intake methods. Though widely used, this method also has some limitations. It overlooks diet diversity and nutritional quality. A key challenge is the inconsistent Minimum Dietary Energy Requirement (MDER) thresholds, which range from 1,700 to 2,550 kcal across studies (Khan et al., 2018; Hameed et al., 2020; Asghar & Muhammad, 2013). Despite its limitations, it remains a key metric for understanding the basic level of food security in rural Pakistan, particularly in regions where energy consumption is the primary concern for households.

### 2.2. Education and food security

The examination of various aspects of Household characteristics in economic literature plays a pivotal role in influencing food security. Education is an essential

component among these. As highlighted by the FAO (2005), Education plays a crucial role in addressing hunger and poverty. When examining the impact of education on food security, the focus often centers on its economic dimensions. The same FAO report highlighted that a lack of education does not solely affect personal productivity; it also decreases opportunities for securing employment and earning a livelihood, ultimately leading to poverty and hunger. Schultz (1988) and Becker (1993) argue that education enhances human capital, increasing wages and labor productivity. The impact of education on food security varies by context. In urban areas, education improves food security through employment, income, and decision-making (Mutisya et al., 2016). Higher education boosts incomes, enabling better access to nutritious food. The study found that each additional year of household schooling reduced food insecurity probability by 0.019 in Kenyan urban poor households.

In rural context, the impacts of education become even more multifaceted. Numerous studies highlight education's role in boosting agricultural productivity. For instance, Koffio-Tessio et al. (2005) in sub-Saharan Africa found that education significantly increases agricultural output, ensuring food security. Asfaw (2010) in Tanzania and Ethiopia highlighted that education promotes sustainable farming, increasing productivity while reducing poverty and food insecurity. The FAO and World Food Program (2010) linked low literacy to undernourishment, advocating for basic education to empower small-scale farmers and advance sustainable agriculture.

Beyond farming, education also enhances rural food security through off-farm activities by developing entrepreneurial skills and expanding non-agricultural job opportunities, improving access to diverse and nutritious food. Verner (2006) linked low education in rural Argentina to persistent poverty and hunger, as limited schooling restricted income growth and job opportunities. Similarly, Ndhleve et al. (2012) in rural South Africa also pointed out in their study that household experiencing insufficient access to food tended to have lower levels of education and income. De-Muro and Burchi (2007), analyzing 48 developing countries in the period of 1980 to 2004, stressed education's role in lifting 800 million from food insecurity and illiteracy by boosting productivity and income.

In the rural context of Pakistan, particularly in Punjab, Iftikhar et al. (2015) examined the role of literacy rates in agricultural production and food security. The findings revealed a positive and significant relationship between farmers' literacy rates and food security. The study advocated for targeted educational programs for farmers, believing increased literacy can fortify food security by empowering the agricultural community with knowledge and skills, contributing to overall well-being.

Most studies in Pakistan have focused on analyzing the determinants of household food security in different contexts. Among the determinants considered in those studies, household head education is commonly used as a proxy for overall household education. Educated household heads are more likely to earn higher incomes, adopt improved farming practices, and manage resources effectively, thereby contributing to better food production, quality, and security. In Pakistan, Mahmood et al. (2023), and Asghar and Muhammad (2013) found household head education to be a significant factor. Similarly, studies conducted in rural Punjab by Bashir et al. (2013a, 2013b) and Yousaf et al. (2018), as well as in the rural northern areas by Zhou et al. (2019), also identified household head education as an important determinant of food security.

Studies often examine the relationship between education and food security through income, human capital, and work efficiency, but its influence extends further. As highlighted by Cutler et al. (2006), education plays a pivotal role in disseminating critical knowledge on health, hygiene, and nutrition, enabling informed decisions about dietary habits, sanitation, and food production. Burchi (2006) specifically explored education's impact on rural food security, demonstrating its dual role in enhancing economic productivity and driving social change, with findings suggesting that doubling school attendance could reduce food insecurity by 19%. The study thus advocates for prioritizing educational investment as a key strategy to address food security challenges.

While the majority of studies demonstrate

education's positive association with food security, significant exceptions exist across different contexts. Dassou et al. (2019) and Amali (2012) reported counterintuitive negative impacts of secondary education in Benin and Nigeria respectively. Similarly, multiple studies found statistically insignificant relationships, including Mukaila et al. (2021) and Oguh (2020) in Nigeria, Njura et al. (2020) in Kenya, and Acheampong et al. (2022) in Ghana. These exceptions suggest that education's impact may be mediated by local economic structures, education quality, or measurement approaches.

### 2.3. Other Socioeconomic determinants of food security

Food security depends on multiple factors beyond education, including climate, disasters, civil unrest, social norms, and issues related to food production, access, and absorption. The determinants vary across different levels of analysis such as global, national, regional, household, and individual level. Ahmad et al. (2016) warned of South Asia's precarious food security situation, where despite agricultural progress since 1961, low cereal availability persists alongside threats from population growth, urbanization, and climate change, potentially leading to crisis by 2050.

At the district level, Ejaz Ali Khan et al. (2012) analyzed rural Pakistan's food security through regression models, finding wheat, rice, maize and livestock production improved availability, while electrification and literacy surprisingly reduced accessibility. Conversely, healthcare access and clean water enhanced food absorption. Hussain et al. (2020) specifically examined Peshawar district, identifying population growth, biofuel production, poverty, and social unrest as key negative factors affecting food security. These localized studies reveal the complex interplay of socioeconomic and environmental factors shaping food security outcomes at community levels.

At the household level, Mutisya et al. (2016) studied education's impact on urban Kenyan food security with control variables including Household Wealth Index Score, Household Shocks, and Household Size, finding educational factors crucial in urban food insecurity dynamics. Van der Veen and Tagel (2011) used logit models and concluded that agricultural technologies, farm size, educated household heads, and off-farm activities positively influence food security. Ndhleve et al. (2012) analyzed 159 rural South African households, identifying social grants, small businesses, and farming as key to food access, while Halam et al. (2017) found education and income significantly affect rural South African households' living standards and food security.

In Pakistan, at the household level, Akbar et al. (2020) found household head education, income, and agricultural income significantly improve food security. Rasheed et al. (2022) showed education, livestock ownership, and remittances positively impact security, while poverty has negative effects. Hameed et al. (2020) revealed male-headed households and larger family sizes increase insecurity, whereas education and sanitation reduce it. Hassan (2021) confirmed income increases food security while food prices harm it. Cheema et al. (2022) highlighted education's disproportionate impact, being four times more effective for educated versus poorest households.

As food security remains a primary concern in the rural areas of Pakistan, some studies examined the socioeconomic determinants influencing household food security in these particular regions. For instance, Bashir et al. (2012) found monthly income, livestock assets, and education levels improve food security, while household head's age, joint family systems, and family size reduce it. Bashir et al. (2013) confirmed income and livestock's positive impacts, with education showing region-specific effects in Punjab. Naz et al. (2023) observed similar patterns in Faisalabad, noting education, income, and livestock's benefits versus family size's negative effect.

Khan et al. (2018) identified education and earning members as positive factors, while household head age negatively affected security. Zhou et al. (2019) and Sher et al. (2018) emphasized education, employment, and market access as critical determinants, with larger farms paradoxically increasing insecurity when isolated from markets.

### 2.4. Theoretical Framework

This study is guided by two influential perspectives: Human Capital Theory, formulated by Gary Becker and Theodore Schultz in the 1960s, and the Capability Approach, developed by Amartya Sen in the 1980s. Together, these theories provide complementary insights into the relationship between education and household food security. The theoretical framework guiding this research is presented in Figure 1.

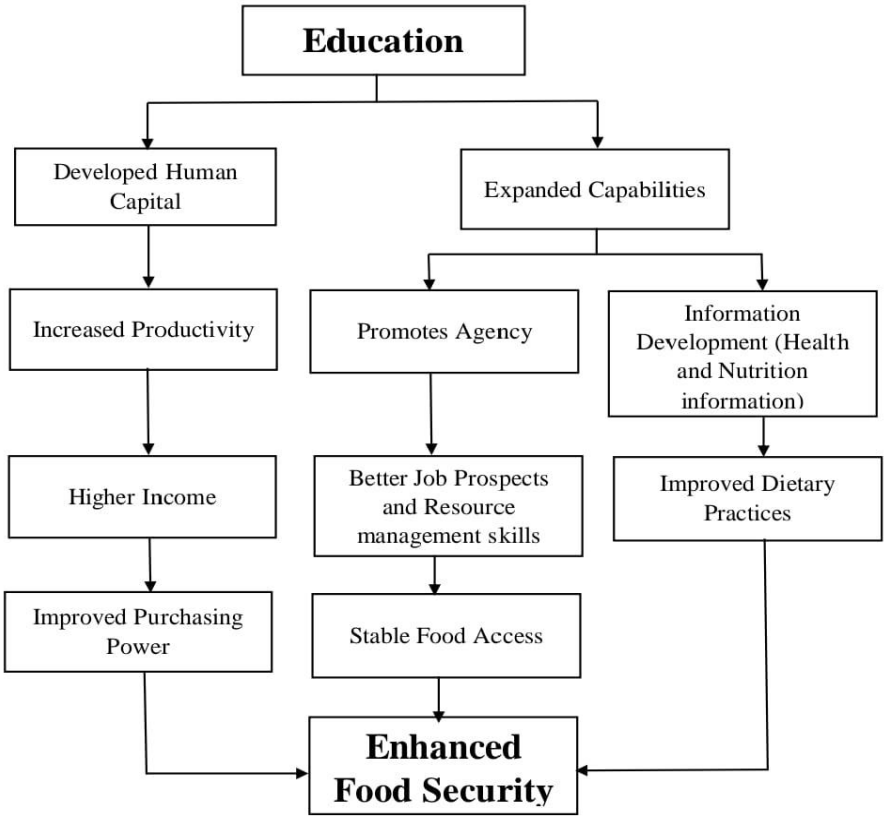


**Figure 1: Flow chart of theoretical framework**

## 3. Methodology and Data

### 3.1. Data Source and sampling techniques

This study uses data from the Household Integrated Economic Survey (HIES, 2018–19), conducted by the Pakistan Bureau of Statistics (PBS) under the Pakistan Social and Living Standards Measurement (PSLM) program. The HIES provides nationally representative information on household income, expenditure, and social indicators, with detailed data on education and food consumption. These features make it particularly suitable for analyzing food security. Food Composition Table (FCT), revised by Allama Iqbal Open University (AIOU, 2001) is also used in converting food consumption into calories intake.

The PSLM survey employs a detailed two-stage stratified sampling method to ensure precise and representative data. The study concentrates solely on rural households within the survey.

Each district in Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan is treated as a stratum, totaling 129 across the provinces. These are further divided into Primary Sampling Units (PSUs), each containing about 200–250 households.

In the first stage, 1,013 PSUs were selected using probability proportional to size (PPS). In the second stage of sampling, the study selects Secondary Sampling Units (households) within the sample PSUs with equal probability using a systematic sampling technique with a random start. This produced a sample of 15,936 households—7,836 from Punjab, 3,497 from Sindh, 3,035 from Khyber Pakhtunkhwa, and 1,568 from Balochistan. After data cleaning, 15,737 households were retained for analysis.

### 3.2. Household Food Security status

This study measures Household Food Security status using the Household Expenditure Survey (HES) method, which combines data from the Household Integrated Economic Survey (HIES 2018-19) and the Food Composition Table (FCT) of Pakistan. The HIES provides food quantities and expenditures, while the FCT provides caloric values, allowing the transformation of food consumption and expenditure data into a standardized measure of dietary energy consumption (DEC), expressed in tkcal/day/adult equivalent. The HIES 'Household Expenditure' section is used to collect data covering items consumed within households (quantities and values) and outside the home (monetary values only). The study calculates household food security status in two steps.

**Step 1:** *Determination of Household Daily Dietary Energy Consumption per Adult Equivalent (DDEC_h)*

The conversion of food quantities into kilocalories (kcal) encounters complications due to data limitations in the Household Integrated Economic Survey (HIES). These includes missing conversion factors for non-standard local measurement units like ready-made foods, chapatti, and halwapuri, a lack of specification for non-edible portions, the presence of undefined food items such as dinner, lunch, and beverages, the absence of certain food items in national or regional Food Composition Tables or Databases, and the inability to calculate nutrient values for poorly defined local food items like other cereals or meats. To address these limitations, the study follows two procedures proposed by (Moltedo et al., 2014).

***Procedure 1:*** *Standard Measurement Units (d Food Items)*

This procedure applies to food items for which defined quantities are reported using standard measurement units. The following steps are taken to calculate the total kilocalories for the household. These food items are referred to as'd' food items.

1) *Conversion of food Quantities into Grams*

To ensure consistency with the Food Composition Table (FCT), all reported food quantities are converted into grams. Items recorded in kilograms are multiplied by 1,000, while liquids reported in liters are first converted into milliliters and then transformed into grams using their respective density values. This standardization allows accurate estimation of caloric intake across all food items.

2) *Adjustment of Food Quantities for Inedible Portions*

Since reported food quantities include both edible and inedible parts, adjustments are made by excluding the inedible portion from each item. The percentage of inedible parts for different food items is taken from the FAO/INFOODS Guidelines for Converting Units, Denominators and Expressions (FAO, 2012). This ensures alignment with the Food Composition Table (FCT), which lists calories exclusively for edible parts of food items.

3) *Estimate Total Calories per Household per Day*

The per-day edible quantity of each food item is multiplied by its corresponding calorie value from the Food Composition Table (FCT), and the sum across all items provides the total daily calories consumed by each household.

***Procedure 2:*** *Expenditure-Based Conversion (f Food Items)*

This method is used for food items where only expenditures are reported, or where quantities cannot be converted to grams of edible portion. These food items are referred to as 'f' food items. It assumes that calories consumed away from home, on average, cost the same as those consumed at home.

*1) Estimation of Price per Calorie*

The price per calorie for each household is estimated by dividing each household's expenditure on 'd' food items by the total calories obtained from those items. This gives the unit value (price) of calories for each household, indicating the expenditure per kilocalorie consumed.

*2) Deciles Generation*

To mitigate the impact of measurement errors in HIES and to accommodate variations in spending patterns and dietary habits among different groups of households, deciles are generated within each province.

*3) Calculation of Median Price per Calorie*

To mitigate the influence of outliers or extreme values, the median price per calorie is computed for each decile. This process yields 40 distinct average prices (4 provinces * 10 deciles = 40),

providing a representative measure of the average price per calorie within each group.

*4) Application of Median Prices*

Household per-day expenditures on f food items are divided by the corresponding median price per calorie to estimate daily kilocalories consumed from f food items.

*Calculation of Household Daily Dietary Energy Consumption per Adult Equivalent (DDEC_h)*

Total daily calories consumed by a household per adult equivalent is calculated by dividing total daily calories obtained by households from procedure 1(calories obtained from d food items) and 2 (calories obtained from f food items) by adult equivalent size of households.

Household adult equivalent size is used instead of simple household size because dietary energy requirements vary by age and gender. It is calculated by summing the adult equivalent factor (AE_i) for each household member, derived from the equivalence scale provided in the Poverty Reduction Strategy Paper for Pakistan (PRSP-I, 2003). This scale has also been employed by Cheema (2002) and Mahmood & Idrees (2010).

***Step 2:*** *Determination of Household Food Security status (FSS_h)*

Household food security status is assessed by comparing Daily Dietary Energy Consumption (DDEC_h) with the Minimum Dietary Energy Requirement (MDER). FAO (2008) defines MDER as the minimum dietary energy required for an individual to maintain a healthy weight relative to height, support overall well-being, and engage in light physical activity.

There is no universally fixed MDER value, as it must be adjusted to the specific energy needs of the studied population. This study adopts an MDER of 2550 Tkcal per day per adult equivalent for rural areas, in line with previous research on poverty and food security (Jamal, 2012; Jamal, 2016; Malik et al., 2010; Hameed et al., 2020).

Household food security status (FSS_h) is defined as:

FSS_h = 1 if DDEC_h ≥ 2550 Tkcal per day per adult equivalent (food secure household).

FSS_h = 0 if DDEC_h < 2550 Tkcal per day per adult equivalent (food insecure household).

### 3.3. Variables Description and Unit of measurement

In our econometric model, the study encompasses variables spanning basic to higher education levels, alongside an array of control variables. These control variables are drawn from categories like household head characteristics, Household characteristics, household economic characteristics, household basic life necessities and regional characteristics. A comprehensive description of these variables is essential to ensure clarity, consistency, and transparency in the research analysis. This is shown in table 1.

**Table 1: Variables and Measurement**

| Variables | Variable Nature | Variable Description | Unit of Measurement |
|---|---|---|---|
| **Dependent variable** | | | |
| Household Food Security status | Categorical (Binary) | Whether a household is Food secure or not | 1 for Food secure, 0 for Food insecure |
| **Independent variables** | | | |
| **Main variables** | | | |
| **Household education** | | | |
| Basic education | Continuous | Percentage of Household members with primary or middle education | Percentage |
| Secondary education | Continuous | Percentage of Household members with lower Secondary or Higher Secondary education | Percentage |
| Higher education | Continuous | Percentage of Household members with more than 12 years of education | Percentage |
| **Control variables** | | | |
| **Household head's characteristics** | | | |
| Household head's age | Continuous | Age of the head of household | Complete years |
| Household head's gender | Categorical (Binary) | Gender of the head of household | 1 for male, 0 for Others |
| Household head's schooling | Continuous | Highest class passed by the head of household | Class |
| **Household characteristics** | | | |
| Household size | Continuous | Total number of members in a household | Count (Number of members) |
| Household overcrowding | Continuous | Number of members living per room in a household | Ratio of Persons to room |
| **Household economic characteristics** | | | |
| Agricultural land ownership | Categorical (Binary) | Whether the household owns agricultural land or not | 1 for owned, 0 for not owned |

| | | | |
|---|---|---|---|
| Livestock ownership | Categorical (Binary) | Whether the household owns livestock or not | 1 for owned, 0 for not owned |
| Household income(Log transformed) | Continuous | Log-transformed income | Logarithmic units |
| Occupancy status | Categorical (Binary) | Whether the household owns house or not | 1 for owned, 0 for not owned |
| **Household basic life necessities** | | | |
| Access to safe drinking water | Categorical (Binary) | Whether households have access to safe drinking water or not | 1 for access, 0 for no Access |
| Access to proper toilet facility | Categorical (Binary) | Whether households have access to proper toilet facility or not | 1 for access, 0 for no Access |
| **Regional characteristics** | | | |
| Punjab (used as a reference category) | | | |
| Khyber Pakhtunkhwa | Categorical (Binary) | whether the household resides in Khyber Pakhtunkhwa province or not | 1 for KP, 0 for Others |
| Sindh | Categorical (Binary) | whether the household resides in Sindh province or not | 1 for Sindh, 0 for Others |
| Balochistan | Categorical (Binary) | whether the household resides in Balochistan province or not | 1 for Balochistan, 0 for Others |

### 3.4 Empirical Methodology

In economics, many outcomes are binary in nature. This study uses a binary dependent variable to determine whether a household is food secure. The Linear Probability Model (LPM), which applies linear regression to binary outcomes, has serious limitations: it gives biased and inconsistent estimates, suffers from heteroscedasticity and boundedness (predicted probabilities outside the 0–1 range), and often reports low R-squared. Collectively, these issues can lead to incorrect inferences. Therefore, probit or logit models are more appropriate for the analysis.

The logit model is applied when it is based on logistic distribution and the probit model is applied when it is based on normal distribution. The study has a number of variables and it is not essential that all of them are following normal distribution because it is rare. Therefore, the study applies the logit model to get the best results. The following is the logistic regression model:

$$ln(P/(1-P))FSS\_h = \alpha + \beta 1 * Basic\_edu + \beta 2 * Secondary\_edu + \beta 3 * Higher\_edu + \beta 4 * HH\_age + \beta 5 * HH\_gender + \beta 6 * HH\_schooling + \beta 7 * H\_size + \beta 8 * H\_overcrowd + \beta 9 * Agri\_land\_own + \beta 10 * Livestock\_own + \beta 11 * H\_income + \beta 12 * H\_occupancy + \beta 13 * Water\_access + \beta 14 * Toilet\_access + \beta 15 * SN + \beta 16 * KP + \beta 17 * BA + \varepsilon$$

The research's central objective is to examine how education affects food security. For this reason, three education variables are included in the model: basic education, secondary education, and higher education. These variables are central to the analysis as key explanatory factors. While the focus lies on education, control variables are also incorporated to isolate the specific effect of education. These control variables have been selected based on their established relationship with food security in previous studies.

In logistic regression, coefficients associated with the independent variables do not directly show the strength or direction of relationships as in linear regression; rather, they reflect changes in the log-odds of the outcome for a one-unit change in an independent variable. To better understand the practical implications of the independent variables on the probability of the event, researchers often turn to the concept of marginal effects.

Marginal effect shows how a one-unit change in an independent variable influences the probability of the dependent variable while keeping other variables constant. Using it enables a more direct and understandable assessment of how independent variables affect the outcome in logistic regression analysis. It is widely recognized as the most effective method for explaining the logit model (Zelner, 2009). Thus, this study employs it to present a clear and practical interpretation of the logistic regression model's results.

## 4. Results and Discussion

### 4.1. Descriptive analysis

The descriptive analysis starts with a pie chart illustrating the percentage of food-secure households. Key summary statistics, including mean, standard deviation, and min–max values,

are presented in the summary table. Moreover, to enhance understanding, the study employs a table depicting the relationship between education variables and food security.

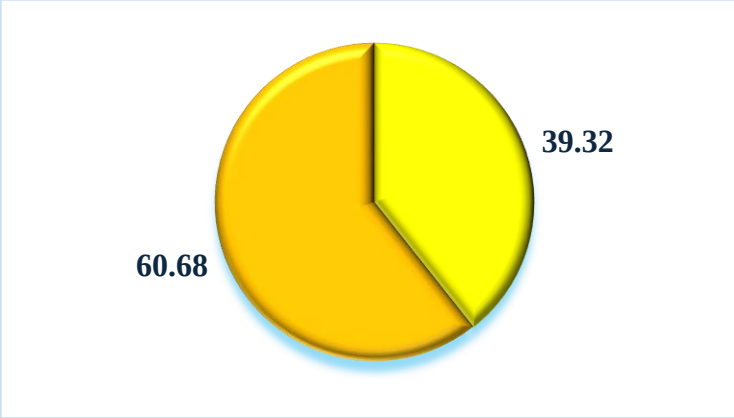


**Figure 2: Distribution of Households by Food Security Status**

Figure 2 shows that 60.68% of rural households are food secure, while 39.3% remain food insecure, based on the 2550 kcal threshold. This indicates a higher risk of food insecurity in this region.

**Table 2: Summary Statistics of Study Variables**

| Summary Statistics of Continuous Variables | | | | | |
|---|---|---|---|---|---|
| **Variable Name** | **Number of observations** | **Mean** | **Standard Deviation** | **Minimum** | **Maximum** |
| Basic education | 15737 | 32.89 | 24.36 | 0 | 100 |
| Secondary education | 15737 | 23.05 | 19.67 | 0 | 100 |
| Higher education | 15737 | 18.01 | 18.48 | 0 | 100 |
| Household head's age | 15737 | 45.40 | 13.78 | 16 | 99 |
| Household head's schooling | 15737 | 4.04 | 4.73 | 0 | 18 |
| Household size | 15737 | 6.60 | 3.21 | 1 | 31 |
| Household overcrowding | 15737 | 3.54 | 2.18 | 0.091 | 7 |
| Household income | 15737 | 112767.3 | 158503.1 | 5620 | 2980000 |

| Tabulation of Categorical Variables | | | |
|---|---|---|---|
| **Variable Name** | **Number of observation** | **Percentage (Value 1)** | **Percentage (Value 0)** |
| Household Food Security status | 15737 | 60.68% (Food Secure) | 39.32% (Food Insecure) |
| Household head's gender | 15737 | 89.89% (Male) | 10.11% (Female) |
| Agricultural land ownership | 15737 | 31.77% (Land Owned) | 68.23% (Land Not Owned) |
| Livestock ownership | 15737 | 39.53% (Livestock Owned) | 60.47% (Livestock Not Owned) |
| Occupancy status | 15737 | 71.75% (House Owned) | 28.25% (House Not Owned) |
| Access to safe drinking water | 15737 | 54.31% (Access to Safe Water) | 45.69% (No Access to Safe Water) |
| Access to proper toilet facility | 15737 | 45.34% (Proper Toilet Access) | 54.66% (No Proper Toilet Access) |
| Khyber Pakhtunkhwa | 15737 | 19.15% (Residing in KP) | 80.85% (Not Residing in KP) |
| Sindh | 15737 | 22.10% (Residing in Sindh) | 77.90% (Not Residing in Sindh) |
| Balochistan | 15737 | 9.94% (Residing in Balochistan) | 90.06% (Not Residing in Balochistan) |

Table 2 presents summary statistics of the study variables. For continuous variables, it reports the number of observations, means, standard deviations, and ranges. For categorical variables, it shows the number of observations and the percentage of households in each category, indicating their distribution of responses within the dataset.

Table 3: Education and Food Security

| Education variables | Households with percentage of educated members | Percentage of food secure households |
|---|---|---|
| Basic education | 0-25 | 68.68 |
| | 25-50 | 59.96 |
| | 50-75 | 51.55 |
| | 75-100 | 28.77 |
| Secondary education | 0-25 | 59.94 |
| | 25-50 | 67.84 |
| | 50-75 | 66.67 |
| | 75-100 | 80.56 |
| Higher education | 0-25 | 60.65 |
| | 25-50 | 79.48 |
| | 50-75 | 76.92 |
| | 75-100 | 84.50 |

Table 3 presents the relationship between education levels and household food security. As the proportion of basic-educated members increases, food security declines from 68.68% in households with 0–25% basic-educated members to 28.77% in those with 75–100%. In contrast, food security rises with the proportion of secondary-educated members, increasing from 59.94% in households with 0–25% secondary-educated members to 80.56% in those with 75–100%, despite a slight dip in the 50–75% range. Similarly, households with higher-educated members show increased food security, from 60.65% in the 0–25% range to 84.50% in households with over 75% higher-educated members, again with a minor decrease in the 50–75% range.

### 4.2. Estimates of Logistic Regression for Household Food Security Status

Before estimating the logistic regression model, correlations among continuous explanatory variables were checked, and multicollinearity was found to be negligible, allowing reliable model estimation.

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Table 4: Presentation of Logistic Regression Estimates

| Dependent variable: Household Food Security status | | | | | | |
|---|---|---|---|---|---|---|
| **Independent variables** | **Coefficient** | **Standard error** | **Z-value** | **P-value** | **Marginal effect** | **Sig** |
| **Main variables** | | | | | | |
| **Household education** | | | | | | |
| Basic education | -0.2021863 | 0.008417 | -24.02 | 0.000 | -0.0374308 | *** |
| Secondary education | 0.1173185 | 0.0106829 | 10.98 | 0.000 | 0.0217192 | *** |
| Higher education | 0.1954947 | 0.011839 | 6.51 | 0.000 | 0.036192 | *** |
| **Control variables** | | | | | | |
| **Household head's characteristics** | | | | | | |
| Household head's age | 0.0033404 | 0.0015706 | 2.13 | 0.033 | 0.0006184 | ** |
| Household head's gender | 0.9342072 | 0.0959423 | 9.74 | 0.000 | 0.1729501 | *** |
| Household head's schooling | 0.0179929 | 0.0046574 | 3.86 | 0.000 | 0.003331 | *** |
| **Household characteristics** | | | | | | |
| Household size | -0.147895 | 0.0076797 | -19.26 | 0.000 | -0.0273798 | *** |
| Household overcrowding | -0.0697499 | 0.0110472 | -6.31 | 0.000 | -0.0129128 | *** |
| **Household economic characteristics** | | | | | | |
| Agricultural land ownership | 0.525242 | 0.0507054 | 10.36 | 0.000 | 0.0972382 | *** |
| Livestock ownership | 0.7514689 | 0.0460422 | 16.32 | 0.000 | 0.1391197 | *** |
| Household income | 0.5436405 | 0.0353354 | 15.39 | 0.000 | 0.1006443 | *** |
| Occupancy status | 0.1622222 | 0.0698733 | 2.32 | 0.000 | 0.0300323 | ** |
| **Household basic life necessities** | | | | | | |
| Access to safe drinking water | 0.1717904 | 0.042785 | 4.02 | 0.000 | 0.0318036 | *** |
| Access to proper toilet facility | 0.1624926 | 0.0438819 | 3.70 | 0.000 | 0.0300823 | *** |
| **Regional characteristics** | | | | | | |
| Punjab (Used as a reference category) | | | | | | |
| Khyber Pakhtunkhwa | -0.2172775 | 0.05502 | -3.95 | 0.000 | -0.0402247 | *** |
| Sindh | -0.4562255 | 0.0538688 | -8.47 | 0.000 | -0.0844612 | *** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Balochistan | -0.3565636 | 0.0694962 | -5.13 | 0.000 | -0.0660107 | *** |
| Constant | -4.441393 | 0.3650562 | -12.17 | 0.000 | | *** |
| **Log likelihood** | -8166.3713 | | **Pseudo R2** | | 0.1855 | |
| **LR Chi2(20)** | 3719.51 | | **Number of observations** | | 15737 | |
| **Prob>Chi2** | 0.0000 | | | | | |

***** p< .01, ** p< .05, * p< .1**

Table 4 illustrates the estimates of logistic regression for determining household food security statusIn this study, marginal effects are calculated to interpret the logistic regression results. As discussed in data and methodology section, the study uses marginal effects to provide a more clear understanding of how each independent variable influences the probability of a household being food secure. The results for each variable are discussed below.

**Household Education**

Household education variables are core variables in the study. The impact of education on food security is multifaceted, operating through both economic and social channels.

Koffio Tessio et al. (2005) emphasized its role in enhancing agricultural productivity, while De Muro and Burchi (2007) noted its importance in generating non-farm income that sustains long-term food security. Mukudi (2003) showed that it improves the ability to acquire health and nutrition knowledge, leading to better food choices and stronger food security.

The analysis begins by examining the role of Basic education within households concerning its effects on food security. The logistic regression analysis identifies a statistically significant negative relationship, where each additional percentage-point of members with basic education is associated with a 3.7% decrease in the likelihood of a household being food secure. Hashmi et al. (2018) reached the same conclusion that the percentage of basic-educated members within a household and its food security status move in opposite directions.

The negative impact of basic education on food security may result from two factors. First, it provides only foundational knowledge, which can limit job opportunities. Second, while it improves literacy and essential skills, it may not be sufficient for making informed decisions about health, nutrition, and resource management.

Going further than Basic education, the study analyses how Secondary education within households affects food security. The logistic regression analysis revealed that the Secondary education of Household positively influences food security showing that a one-unit increase in the percentage of secondary educated members of household increases the probability of achieving food security by 2.1%. This aligns with Hashmi et al. (2018) and Gnedeka and Wonyra (2022). It is essential to recognize that Gnedeka and Wonyra (2022) based their analysis on individual-level data, in contrast to our study, which centers on the household level.

In addition, the analysis explores the impact of Higher education on food security, highlighting its significant contribution to ensure sufficient food access. Higher education of household shows a significant and positive relationship with food security. With every one-unit increase in the percentage of higher educated members, there is a corresponding 3.6% increase in the probability of achieving food security. This finding aligns with the research conducted by Hashmi et al. (2018).

**Household head's characteristics**

One of the important characteristics of the household head is age. The age of individuals plays a significant role in their maturity and life experiences, influencing their ability to acquire necessary resources, as highlighted by Hofferth (2003). In the logit model, age is statistically significant and shows a positive sign. If age goes up by one year, it will induce 0.062% increase in likelihood of achieving food security. This finding is in accordance with Khan et al. (2018).

Gender of household head also plays a crucial role. Maharajan and Joshi (2011) noted that female-headed households often face limited access to agriculture and land use, increasing their vulnerability to food insecurity. Our result

shows a positive relationship between household head's gender and food security. Households with a male head are likely to achieve 17% higher food security than their counterpart. This finding is comparable with Zhou et al. (2019), Khan et al. (2018), and Guirindola et al. (2023).

Apart from gender, the schooling of household heads also plays an important role in enhancing household food security. According to Hameed et al. (2020), higher education levels among household heads lead to a more diverse income environment and sustained improvements in living standards. The result shows that Household head schooling is statistically significant and has a positive sign. Each additional year of schooling contributes 0.33% increase in the likelihood of achieving food security. Bashir et al. (2012) also reached the same conclusion.

**Household characteristics**

Household characteristics like size and overcrowding affect food security by influencing consumption and allocation, with larger households facing higher expenses (Asghar & Muhammad, 2013). In our analysis, a significant and negative relationship emerged between household size and food security. Adding one more member to the household leads to a decrease of about 2.74% in the likelihood of achieving food security. Similar findings were reported by Drammeh, Hamid, and Rohana (2019) in sub-Saharan Africa and by Hameed et al. (2020) in Pakistan.

Overcrowding also negatively affects food security. With each additional person per room, there is a drop of about 1.29% in the likelihood of achieving food security. This aligns with the findings of Hashmi et al. (2018).

**Household economic characteristics**

Household economic characteristics, such as land and livestock ownership, are vital for food security. Haile et al. (2005) found that more land increases food production for consumption and income, while livestock provides food, income, and other resources. The result shows a significant and positive relationship between owning agricultural land and food security, indicating a marginal effect of 0.0972. This suggests that households with land ownership are 9.72% more likely to achieve food security compared to those without land. This finding is comparable with Zhou et al. (2019).

A positive and statistically significant relationship is observed between livestock ownership and food security, with a marginal effect of 0.1391. This indicates that households with livestock are 13.91% more likely to achieve food security compared to those without. Same results have been extracted by Zhou et al. (2019).

Household income also matters, as Asghar and Muhammad (2013) argued that higher income allows households to meet basic needs and allocate more to food, thereby increasing food security. A significant and positive relationship emerged between Household income (log transformed) and food security. An increase in log-income by one unit raises the likelihood of food security by 10.06%. Thus, while not directly measured in this analysis, higher levels of actual income in rupees are generally associated with improved food security outcomes within households. Asghar (2011) also highlighted the positive impact of higher income on household food security.

The occupancy status of a household also plays a critical role in influencing food security. It influences food security outcomes, particularly due to the burden of rent payments. Occupancy status, particularly homeownership, demonstrates a positive and significant relationship with food security, as indicated by a marginal effect of 0.030. Homeowners are 3.0% more likely to achieve food security compared to renters. McIntyre et al. (2016) in Canada also reached on the same conclusion.

**Household basic life necessities**

Household basic life necessities, such as access to safe drinking water and proper toilet facilities, not only influence the utilization aspect of food security by ensuring nutrient absorption but also significantly affect food accessibility due to increased health costs and thus reducing income for food. Access to safe drinking water is statistically significant and is positively related to food security. It increases the likelihood of households achieving food security by 3.18% compared to those without it. The finding aligns with Hashmi et al. (2018).

A positive and significant relationship is observed between access to proper toilet facilities and food security, with a marginal effect of 0.030. This indicates that households with access to toilet facilities are 3.0% more likely to achieve food security. This finding is comparable with Hameed et al. (2020).

**Regional characteristics (Punjab used as a reference category)**

Analyzing regional characteristics allows for understanding how different regions influence food security. By examining each province individually, the analysis reveals how geographical factors influence access to food, providing insights into regional disparities. For Khyber Pakhtunkhwa (KP), our analysis indicates a negative relationship with food security, reflected by a marginal effect of -0.040. This suggests that households in KP are 4.0% less likely to achieve food security compared to those in Punjab .For Sindh, the analysis shows a negative relationship with food security, represented by a marginal effect of -0.084. This indicates a decrease of 8.4 % in the probability of achieving food security compared to Punjab. For Balochistan, the analysis indicates a negative relationship with food security with a marginal effect of -0.066. This suggests a decrease of 6.6% in the likelihood of achieving food security compared to Punjab.

## 4. Conclusion and Recommendations

### 4.1. Conclusion

Rural areas of Pakistan contain the highest proportion of the country's population. However, these areas often face increased food insecurity challenges, which hinder overall economic development. About 60.68% of rural households in Pakistan are food secure, meeting the daily caloric intake threshold of 2550 kilocalories per adult equivalent, while 39.32% remain food insecure, reflecting a considerable share of the population at risk of inadequate food access. Among the various factors contributing to this issue, education levels emerge as an important socioeconomic factor.

The objectives of this study are to evaluate the food security status of rural households and to examine the influence of education levels on food security in rural areas of Pakistan. This study uses data from 15737 rural households obtained from the HIES survey (2018-2019). In pursuit of our objective to gauge household food security status, the study implemented the Household Expenditure Survey (HES) method. By applying this method, the daily caloric intake per household per adult equivalent was determined, with a threshold of 2550 kilocalories per day established to classify households as food secure or food insecure. To accomplish our objectives of analyzing the impact of education, the study used logistic regression analysis.

The estimates of the logistic regression demonstrate that Basic education is negatively related with food security. This indicates a decrease in the likelihood of achieving food security as the percentage of household members with basic education increases. The negative impact of basic education on food security stems from insufficient qualifications for most jobs and a lack of skills needed for informed decision-making about health, nutrition, and resource management. Conversely, secondary education exhibits a positive influence on food security. Therefore, households with a higher percentage of secondary educated members are more likely to attain food security. Similarly higher education also positively influences food security but with stronger coefficient.

The findings regarding secondary and higher education strongly support the role of education in enhancing food security. Education improves household food security through several key mechanisms. It opens doors to better job prospects, increasing household income and enabling households to afford a more diverse and nutritious diet, thus improving food security. Additionally, education increases awareness about nutrition and health, equipping individuals to make smarter dietary choices and manage resources more effectively. These elements collectively strengthen households' ability to achieve food security.

Besides education levels, various control variables were included in the model to isolate the effect of education on food security outcomes in rural Pakistan. Among them, Household head's gender, livestock ownership, household income and Agricultural land

ownership are the most influential in affecting food security, as indicated by their high marginal effect values. These findings underscore the importance of controlling for these variables to accurately isolate the effect of education on food security.

### 4.2. Recommendations

In light of the study's findings, the government should enhance the quality of basic education by integrating practical skills, health awareness, and resource management into the curriculum. This will better prepare individuals for employment and improve their decision-making regarding nutrition and household management. Expanding educational institutions in rural Pakistan is also essential to reduce travel distances and improve accessibility, as 29% of parents in these areas, cite distance as the main barrier to education (World Bank, 2022).

The government should introduce scholarships, subsidies, and incentives for secondary and higher education to reduce financial barriers for rural families. In addition, awareness campaigns targeting parents and community leaders should be launched to highlight the role of education in improving food security. Such initiatives can foster community support and encourage greater investment in education, ultimately enhancing food security in rural Pakistan.

### 4.3. Future recommendations

Future research should explore the role of equity in the education system and its potential impact on food security in rural Pakistan. While this study has examined the impact of education, further investigations should address disparities in access, particularly across socioeconomic and gender groups. Understanding how equitable access affects food security outcomes will provide deeper insights into whether marginalized groups benefit equally from educational advancements. This approach can inform the development of inclusive education policies aimed at improving food security for all households.

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