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Dietary and Nutrition Transitions in Indigenous Communities: The Role of Income and Market Access in Nagaland, India

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Abstract: Despite extensive evidence linking urbanization, market access, and rising incomes to dietary transitions and nutritional outcomes, both globally and within India, Indigenous communities, particularly in the North East Region (NER) of India, have received little attention in this context. This paper examines how income and market access shape the diets and nutrition of Indigenous Naga women in a geographically isolated and culturally distinct setting, providing a unique context to study the early stages of dietary and nutritional change. Using primary survey data from more than 800 women across cities, villages, and remote hamlets, we find that most women meet the minimum dietary diversity threshold and maintain adequate diet quality even in low-income, low-market access settings. However, higher income is consistently associated with more diverse diets, particularly through increased consumption of oils, meats, and pulses. Higher market access is associated with increased frequency of oil and fat consumption, reflecting a shift away from traditional food practices. Women in high-access regions also exhibit higher Body Mass Index (BMI), indicating a shift toward overweight and obesity with increased proximity to food markets. By focusing on an isolated and understudied region, this study provides new evidence on the dual role of income and market access in shaping diets and nutrition, while highlighting the importance of Indigenous food systems in ensuring adequate diet quality. These findings have broader relevance for communities and regions undergoing similar transitions.

Key Words: Indigenous communities; dietary transition; market access; women; North-East Region, India; nutrition

JEL: F63, I15, Q18

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1. Introduction

With increasing urbanization, economic development, and globalization of markets, dietary patterns have undergone rapid and significant transformations, particularly in low- and middle-income countries (LMICs) (Baker & Friel, 2016; Popkin, 2021; Popkin et al., 2020; Schmidhuber & Shetty, 2005). While diets have diversified, this transformation has also been characterized by the globalization or "Westernization" of diets (Azzam, 2021; Pingali, 2007; Popkin, 1993), where traditional, localized diets are increasingly displaced by dietary patterns high in fats, oils, sugars, refined grains, and processed foods. At the same time, consumption of nutrient-dense foods such as vegetables, fruits, legumes, lean meats, poultry, dairy, nuts, and seeds remains insufficient for many in LMICs (Springmann et al., 2021; Hawkes et al., 2017).

These changes have contributed to the emergence of what Popkin et al. (2020) describe as the "new nutrition reality," or the triple burden of malnutrition (Gómez et al., 2013; Pinstrup-Andersen, 2007), where undernutrition (including stunting, wasting, and underweight), overnutrition (overweight and obesity), and micronutrient deficiencies coexist within populations, households, and even individuals (Doak et al., 2005). Diet-related non-communicable diseases (NCDs) (Adolph & Tilg, 2024) are now a major contributor to the global burden of disease (Zhou et al., 2024). While improvements in undernourishment and micronutrient deficiencies have been limited, the rates of overweight and obesity (Welthungerhilfe et al., 2024) have risen worldwide, with consistently higher obesity prevalence among women (WHO, 2024; Zhou et al., 2024). Recent estimates suggest approximately one billion adult males and 1.11 billion adult females globally are now overweight or obese with a large share in LMIC (Ng et al., 2025).

India presents particular nutritional challenges among the LMICs. Rising incomes, urban expansion, and development of food markets have driven significant dietary shifts away from staples toward more diversified diets (Aiyar et al., 2021; Law et al., 2019; Pingali et al., 2019). However, improvements in diet quality remain inadequate, and micronutrient deficiencies continue to be widespread (Pandey et al., 2020; M. Sharma et al., 2020; Tak et al., 2019). About 53% of women (15-49 years) are anemic, with no improvement between 2012 and 2022 (FAO, IFAD, UNICEF, WFP, & WHO, 2024). At the same time, the prevalence of obesity and diet-related NCDs is rising rapidly (Chaudhary & Sharma, 2023; Siddiqui & Donato, 2020). In 2021, approximately 180 million adults are classified as overweight or obese, ranking India second globally after China (Ng et al., 2025).

Many studies focusing on India have examined this ongoing nutrition transition. However, indigenous populations, particularly those in India's North East Region (NER), represent an important yet understudied group that has received limited attention in existing literature. Historically autarkic, these tribal communities maintain strong cultural beliefs, ritual significance of food, and distinct dietary practices, shaped in part by their geographical isolation within mountainous and densely forested terrain (Albert, 2016; Sharma, 2024).

Globally, indigenous food systems are undergoing rapid transitions, contributing to shifts in both dietary patterns and nutritional outcomes (FAO, 2023). In the NER, however, there is little empirical evidence on how culturally embedded dietary patterns are changing in response to urbanization, emergence of modern food markets, and increasing road connectivity[1] (Ellena & Nongkynrih, 2017; Mungreiphy & Kapoor, 2010; Mishra & Upadhyay, 2017; Green et al., 2016). Importantly, little is known about the extent to which rising incomes and market access reshape dietary quality and nutritional outcomes.

This paper addresses these research gaps by first examining how rising incomes and improved market access influence traditional dietary patterns and diet quality among women in tribal communities in Northeast India. Second, it investigates how women's nutritional outcomes, measured by Body Mass Index (BMI), are affected by variations in income and market access.

Our analysis draws on primary data collected from tribal regions inhabited by the Naga communities, who have historically relied on traditional food systems deeply embedded in their cultural practices, ecological reciprocity, and communal subsistence-based economies (Das, 2021; Shimray, 2013). However, increasing urbanization, rural-to-urban migration, and the expansion of modern food markets have begun to challenge and reshape these longstanding dietary traditions. By focusing on a geographically distinct region that exhibits considerable variation in both income levels and market access, our study provides a unique context to examine dietary transitions among indigenous populations in the NER, with broader relevance for understanding similar transitions unfolding among indigenous communities globally.

The key findings from the study are: first, Naga women across income groups, market access levels, and tribes generally meet the minimum dietary diversity threshold, indicating adequate micronutrient intake and overall diet quality; second, rising incomes and improved access to

[1] Studies in anthropology, sociology and political ecology have examined the transition from traditional to modern food systems in Northeast India (NER), highlighting the role of commercial agriculture, urbanization, migration, and the shift to contemporary governance models (Singh, 2020; Kikon & Karlsson, 2019; C. K. Sharma, 2024; Dasgupta & Subba, 2024).

food markets are associated with increased consumption of specific food groups, particularly oils and fats, and meat. Third, higher market access is associated with higher BMI among women: those in low market access areas are significantly less likely to be overweight or obese compared to women in high-access areas.

The paper is structured as follows: Section 2 outlines the materials and methods, including a brief background on the tribal food systems of the Nagas, details of data collection, construction and description of key variables, and the statistical analysis. Section 3 presents the results, beginning with descriptive statistics, followed by regression results estimating the role of income and market access in explaining food consumption patterns and women's BMI. Section 4 concludes the paper, with key findings from the study.

2. Materials and methods

2.1. Tribal food systems of Nagas

The NER is known for its rich biodiversity, including diverse wild food species and dense forest cover. Geographically, the region is largely mountainous, with two-thirds of the terrain being hilly, covered by dense forests and steep elevations reaching over 7,000 meters above sea level which weakens accessibility and road connectivity (Banerjee & Ghosh, 2023). In the past decade, there has been a strong policy and investment push to improve road connectivity in the region, driven by initiatives such Act East Policy and the North East Special Infrastructure Development Scheme (Government of India, 2024).

Following India's independence, the region has experienced persistent political conflicts (Kikon, 2019). The region also shares over 5,812 kilometres of international borders with China, Bhutan, Nepal, Myanmar, and Bangladesh, and is geographically connected to the rest of India through a narrow corridor (Bose, 2019). Demographically, the region is distinct from the rest of the country, inhabited by diverse indigenous populations with unique cultural, linguistic, and historical identities (Banerjee & Ghosh, 2023).

Among these indigenous communities, the Nagas represent a diverse set of tribes. Historically, they have maintained an intimate connection with their natural environment, shaping distinct tribal food systems. Nagas have practiced autarkic subsistence farming, relying primarily on their land and forests for food with no dependence on formal food markets (Longvah et al., 2017). Each Naga tribe has unique methods of preparing and preserving food, drawing from the practice of foraging a diverse array of wild and cultivated plants, roots and tubers, and leafy greens. Domesticated livestock for meat consumption also forms an important part of their diet, supplemented by traditional hunting practices. Boiling is considered the most common and simplest method of cooking, typically involving no oil and often used to prepare vegetables or meat. Other traditional cooking methods include smoking, steaming, and charcoal grilling (Chaudhuri & Chophy, 2023). Food markets within these tribal communities have historically been scarce and informal, while community food-sharing practices are common within villages (Shimray, 2004).

However, the region is now undergoing a significant food system transition. Improved connectivity and urbanization, especially in the state of Nagaland, have facilitated the growth of modern food markets (Singh & Singha, 2020). These evolving food markets vary significantly in structure and offerings: smaller *paan* shops primarily stock basic commodities such as rice, sugar, and edible oil, along with limited perishables and non-food items. Street and stall vendors typically supply locally sourced fruits and vegetables. In bigger cities like Dimapur and Kohima, departmental stores and supermarkets have emerged, providing a wider selection of both perishable and non-perishable food products, including meat, seafood and fruits. This shift highlights an ongoing transition toward more commercialized, diversified, and market-driven food environments.

2.2. Data collection

2.2.1. Sampling frame

A cross-sectional survey was conducted using stratified random sampling across four districts in Nagaland: Kohima, Dimapur, Phek, and Wokha. These districts were selected based on the rural-urban population distribution of Nagaland, as per the Indian Census of 2011 (Government of India, 2011), to capture variations in road connectivity and access to food markets. The survey covered households in cities, towns, villages, and remote hamlets across different terrains.

Within each district, one block[2] containing the district headquarter was selected, along with two additional blocks randomly chosen to represent varying proximities to the district headquarters, where major food markets are located. In each block, the survey covered the block headquarters town and two to three villages or hamlets, randomly selected from the

[2] In administrative terms, a block in Nagaland refers to a sub-division within a district, used primarily for administrative convenience, planning, and implementation of rural development programs. A block typically consists of multiple villages (Tumbe, 2010).

census list. In each town, village, and hamlet (and wards in cities), approximately 10–13 households were surveyed. The selection of lanes and households was conducted randomly using a dice roll to ensure an unbiased sample.

Data collection was conducted during the harvest and post-harvest period (September to November 2023), selected for several reasons. First, this period ensured high household presence in rural areas, as most agricultural work occurs closer to home and seasonal migration is limited. Second, while the season is generally one of relative food abundance, not all households rely equally on own production. Households in urban and peri-urban settings remain dependent on markets for a significant portion of their diet. Third, the timing coincides with the aftermath of the monsoon, when road conditions often worsen due to rainfall, exacerbating isolation for remote communities. This extreme variation in physical connectivity provides an opportunity to assess how road connectivity influences household access to food markets and the consumption of market-dependent foods. Collectively, these conditions offer a relevant empirical context for examining how market access shapes dietary patterns in tribal regions of Nagaland.

2.2.2. Household and women survey

A total of 809 women from the selected households were interviewed by locally hired trained enumerators using Computer-Assisted Personal Interviewing (CAPI) tools. The study targeted women aged 18–52 who were the primary caretakers and decision-makers in their households. In cases where multiple women were present, the woman largely responsible for cooking and other household chores was selected for the interview. Surveys were conducted in Nagamese or local dialects of the respondent.

The survey collected detailed information on household socio-economic characteristics, including weekly and monthly food purchases, quantities, expenses, sources, and the time and distance required to access different food markets. Data on non-food expenditures were also gathered. Additionally, GPS coordinates of households were recorded to calculate spatial distances and travel times to the nearest food markets using OpenStreetMap and Google Earth.

To measure women's dietary diversity and food consumption frequency, a 7-day food consumption recall was conducted..A comprehensive food list was developed through Focus Group Discussions (FGDs) at the block level to capture the diversity of locally consumed food items, and was subsequently adapted into an illustrated pictorial format to assist respondents during the survey.

Women's anthropometric data, including height and weight, was also collected using standardized measurement tools. Due to missing consent, anthropometric measurements were not collected for 67 respondents, reducing the sample size to 742 for analyses requiring these measures. Additionally, respondents were asked health-related questions, including information on medical history and any chronic or recent illnesses. The survey obtained ethical approval from the Ethics Committee of the University of Göttingen and the ethics committee of The Highland Institute, Nagaland.

2.2.3. Market survey

A food market survey was conducted covering approximately 280 vendors located within the same geographical areas as the household survey. This was undertaken to understand and assess the types of food markets that exist in the study region and the extent of household access to these markets.

The role of food markets in shaping diets depends on the type of markets and the availability of diverse food items. In Nagaland, food markets exhibit significant variation in their structure and product offerings. These range from small *paan* shops primarily stocking basic commodities such as rice, sugar, and edible oils, with limited availability of perishables, to street and stall vendors selling local fruits and vegetables. In urban areas such as towns and cities, markets typically include larger departmental stores and supermarkets with greater shelf space, offering a wider variety of perishable and non-perishable food items, including meat and seafood. These markets are largely concentrated in central locations of the towns and cities. Household shopping patterns also vary depending on market accessibility. Perishable items are typically purchased weekly, while non-perishable products, such as cooking oil, sugar, and powdered milk, are generally bought monthly.

Vendors surveyed in the market study were identified based on household respondents' reports of the markets they regularly visit. In rural hamlets and villages, vendor selection was straightforward since households typically have a limited number of available shops. In urban areas, the primary food markets surveyed were identified based on responses from participants regarding their usual shopping locations and proximity to their residences. Information collected from vendors included the type of shop, the range of available food items and their prices (both perishable and non-perishable).

We recognize the price variation across markets may influence access to specific food groups reliant on formal markets. Vendor survey confirmed that small rural shops typically offered a narrow range of non-perishables at relatively uniform prices (e.g., rice, edible oil and sugar and powered milk), while urban markets carry a variety of higher priced goods, including processed foods.

2.3. Construction and description of main variables

2.3.1. Women's dietary quality and nutritional status

The survey collected information on women's dietary diversity and food consumption frequency based on two standardized indicators. First, dietary diversity was measured using the Dietary Diversity Score (DDS) and the Minimum Dietary Diversity for Women (MDD-W), both based on the ten food groups defined by FAO & FHI 360, (2016). The DDS captures the number of food groups consumed,while the MDD-W is a dichotomous indicator positively correlated with diet micronutrient adequacy (Chakona & Shackleton, 2017). It indicates whether women have consumed at least five out of ten defined food groups in the previous day or night to meet the minimum dietary requirements. For this study, the DDS and MDD-W were adapted and calculated based on a 7-day recall period to smooth out anomalies in food consumption (e.g., festival days or fasting days).

Second, to capture the variety and frequency of foods consumed by women over seven days, we use the Food Consumption Score (FCS), developed by the World Food Programme (World Food Programme, 2008). The FCS captures the frequency of consumption across eight food groups over the previous seven days. Each group's consumption frequency is multiplied by a WFP-assigned weight, and summed to derive an overall score. Respondents are then classified into categories of Poor (0–21), Borderline (21.5–35), or Acceptable (>35) food consumption. Although the FCS is conventionally calculated at the household level, it was adapted for this study to the individual level for women, using a 7-day recall.

The height and weight measurements were used to calculate and classify women's Body Mass Index (BMI) according to two guidelines. Firstly, the World Health Organization (WHO, 1995) criteria were used, categorizing BMI as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (≥25.0 kg/m²), and obese (≥30.0 kg/m²). Secondly, we use the Asian Indian-specific guideline defining overweight as BMI between 23.0–24.9 kg/m² and obesity as BMI ≥25.0 kg/m². These lower thresholds are used because South Asian adults exhibit higher body fat and greater cardiometabolic risk at lower BMI than the standard WHO thresholds indicate. (Misra et al., 2025).

2.3.2. *Market access*

Market access in this study is measured using Principal Component Analysis (PCA), incorporating both distance to the nearest food markets and travel time using either a two-wheeler or a four-wheeler. Nearest food markets were identified based on information collected in the household survey and market survey. This composite measure better reflects real-world constraints to access in hilly and remote terrain. For robustness, we also re-estimate the models using continuous distance to market town in Appendix Table A3.

Market access was classified using cut-off points based on the distribution of the PCA index. Initially, three categories were defined: high, moderate, and low access. However, as households with moderate and low access exhibited similar outcomes, these were combined into a single classification of moderate/low market access. High market access refers to households located closer to food markets, with shorter travel times that facilitate easier and more frequent access to a variety of food sources. In contrast, moderate/low access includes households situated farther from markets, typically requiring longer travel times. This classification provides a structured framework for analysing spatial differences in market access and their implications for household food purchasing and consumption patterns. For ease of interpretation, we refer to the combined moderate/low market access category simply as 'low market access' throughout the paper.

The starting point of the study area was Kohima, the capital city of Nagaland and a major market hub (Figure 1). Kohima city is well connected to Dimapur, another significant commercial city in the plains to the west, via an asphalt road that remains navigable throughout the year. However, communities in the east and north of Kohima, particularly in the districts of Phek and Wokha, experience considerable variations in market accessibility due to rugged terrain and limited road infrastructure. In these areas, markets are often confined to district or block headquarters, and some villages are difficult to access, especially during the rainy season, due to unpaved roads.

In Figure 1, major highways are marked in navy blue, representing asphalt roads that are passable year-round, while light blue roads indicate gravel roads, which are prone to erosion, especially during the rainy season. The figure also shows the sample households based on their food market accessibility. Green dots are households with high market access and red are with low market access based on the PCA index. District headquarters are marked with grey dots.

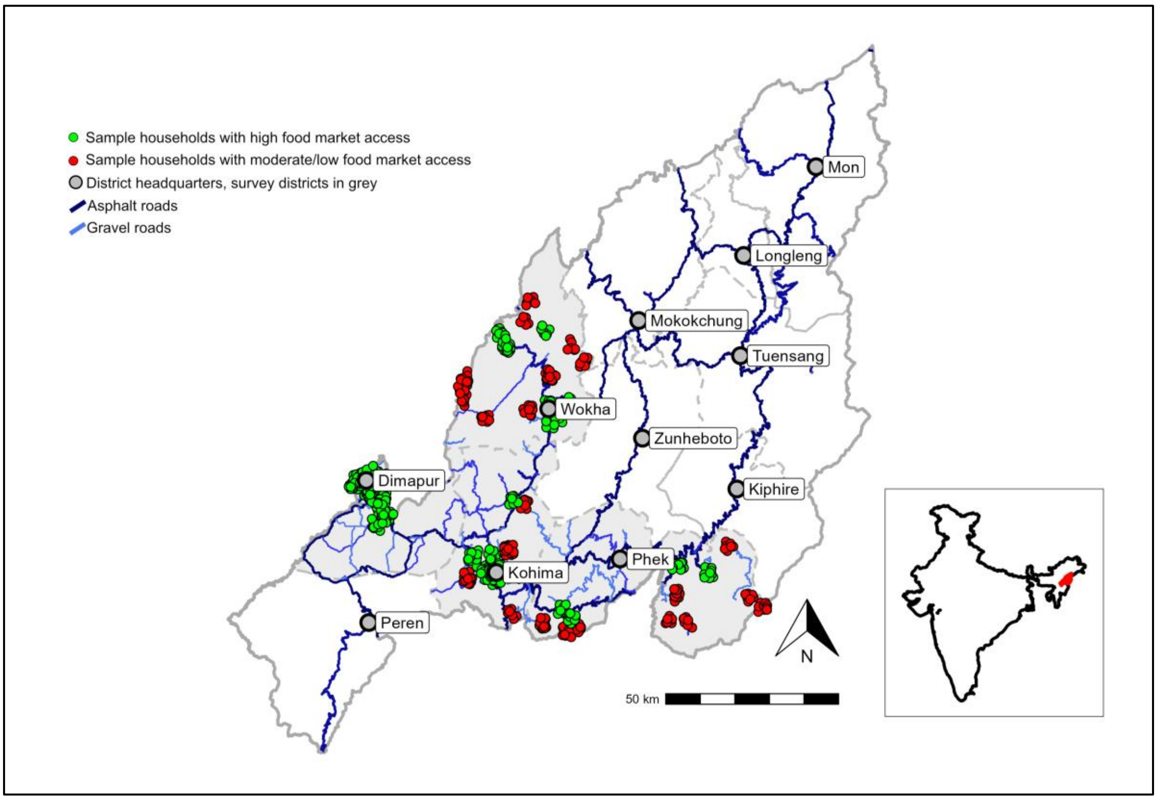

Figure 1. Map of Nagaland with sample districts and households by market access (high/low) *(Source: authors' own analysis)*

2.3.3. *Household income*

Monthly Per Capita Consumption Expenditure (MPCE) serves as a proxy for household income. It was calculated based on total monthly household consumption expenditure, which includes both food and non-food consumption expenditures collected in the household survey. To assess the influence of different income levels on diets, we divide MPCE into quartiles (Q1–Q4), with Q1 representing the lowest 25% and Q4 the highest 25% of households.

2.4. Statistical analysis

First, we empirically examine the relationship between women's dietary quality, measured using DDS and the FCS, both treated as continuous variables, household income (proxied by Monthly Per Capita Expenditure, MPCE), market access and other individual-level and household-level factors. In equation 1, $\boldsymbol{Z_{iv}}$, is the outcome variable representing DDS and FCS for an individual woman *i* who was interviewed in village *v*.

Equation 1:

$$\boldsymbol{Z_{iv}} = \beta_0 + \sum_{q=2}^{4} \beta_q \cdot MPCE_{qi} + \beta_1 \cdot Women's\ age_i + \beta_2 \cdot Women's\ education\ level_i + \beta_3 \cdot HH\ size_i + \beta_4 \cdot RationCard_i + \beta_5 \cdot Market\ access_v + \sum_{\substack{k=1 \\ k \neq 5}}^{8} \beta_k \cdot Tribes_i + \epsilon_{iv}$$

We use OLS regression to examine whether the variables in Equation 1 are associated with women's dietary quality, measured by DDS and FCS.

Second, we examine the association between the frequency of consumption (number of days per week) of the eight different food groups and income, and market access. We use the same eight food groups used in the construction of the FCS. Equation 2 shows the marginal effects from the Poisson regression model, estimating the change in the expected number of days a food group is consumed per week. $Freq_{ij}$ captures the expected number of days a specific food group *j* is consumed by women *i* in village *v* conditional on income, market access, and other household characteristics, as follows:

Equation 2:

$$\boldsymbol{Freq_{ijv}} = exp\ (\beta_0 + \sum_{q=2}^{4} \beta_q \cdot MPCE_{qi} + \beta_1 \cdot Women's\ age_i + \beta_2 \cdot Women's\ education\ level_i + \beta_3 \cdot HH\ size_i + \beta_4 \cdot RationCard_i + \beta_5 \cdot Market\ access_v + \sum_{\substack{k=1 \\ k \neq 5}}^{8} \beta_k \cdot Tribes_i + \epsilon_{ijv})$$

In equation 3, we examine the association between income, market access and other factors on women's nutritional status, using BMI as the outcome variable. We analyse using an OLS regression model.

Equation 3:

$$\boldsymbol{BMI_{iv}} = \beta_0 + \sum_{q=2}^{4} \beta_q \cdot MPCE_{qi} + \beta_1 \cdot Women's\ age_i + \beta_2 \cdot Women's\ education\ level_i + \beta_3 \cdot HH\ size_i + \beta_4 \cdot RationCard_i + \beta_5 \cdot Market\ acces_v + \beta_6 \cdot FCS_i + \sum_{\substack{k=1 \\ k \neq 5}}^{8} \beta_k \cdot Tribes_i + \epsilon_{iv}$$

In Equation 4, we estimate a Linear Probability Model (LPM) using OLS, to examine the association between income, market access, and other socio-demographic factors on women's nutritional status. The outcome variable is a binary indicator equal to 1 if the woman is overweight or obese and 0 otherwise. We analyze using both the Asian-Indian BMI guideline and the WHO guideline.

Equation 4:

$$\mathrm{E}(\boldsymbol{BMI_{high,iv}}) = \beta_0 + \sum_{q=2}^{4} \beta_q \cdot MPCE_{qi} + \beta_1 \cdot Women's\ age_i + \beta_2 \cdot Women's\ education\ level_i + \beta_3 \cdot HH\ size_i + \beta_4 \cdot RationCard_i + \beta_5 \cdot Market\ access_v + \beta_6 \cdot FCS_i + \sum_{\substack{k=1 \\ k\neq 5}}^{8} \beta_k \cdot Tribes_i + \epsilon_{iv}$$

In all equations, β_q represents the estimated coefficients for each MPCE quartile (Q2, Q3, and Q4, in logarithmic terms), capturing the association between income levels and the outcome variable. Q1 serves as the baseline group for comparison and represents woman in lowest income level, while Q4 represents woman in the highest income level. The variable $Tribe_i$ captures the different tribal categories, with the reference group being the non-tribal women. The variables $Rationcard_i$ and $Market\ access_v$ are binary indicators, where 1 indicates that the woman holds a ration card and resides in a village/ward classified as having high market access, respectively. $Women's\ education\ level_i$ is a continuous variable measuring the number of years of formal education completed by the respondent and ϵ_{iv} is the error term in the equations. To account for potential correlation of error terms within geographically proximate areas, standard errors are clustered at the village level to address intra-cluster correlation. For robustness, inference is based on the wild cluster bootstrap-t procedure, clustered at the village level, to obtain more reliable p-values (Cameron, Gelbach, & Miller, 2008).

3. Results

3.1. Descriptive statistics

Table 1 presents descriptive statistics for women, household, and tribal characteristics across the entire sample and by market access status (High vs. Low).

On average, women's FCS is about 81.6 for the full sample, indicating a high level of dietary diversity and frequency. This average is higher (85) among households with high market access compared to 73.5 for those with low market access. Similarly, women consume on average of 7 out of 10 of the MDD-W recommended food groups for the total sample, with 7.2 in high-access areas and 6.6 where market access is limited.

Despite these differences, the average FCS and MDD-W across both market access groups exceed the minimum recommended levels, indicating relatively adequate dietary diversity and food consumption among women in the sample. Approximately 93% of women in high market access areas and 91% in low market access areas meet the MDD-W threshold by consuming at least five food groups. Similarly, about 94% of women in high market access areas and 91% in low market access areas have an acceptable Food Consumption Score (FCS) above 35.

In terms of nutritional status, women's average BMI is 23.23 overall, with a slightly higher mean in high market access areas (23.46) compared to low access areas (22.72). Under the WHO guidelines (WHO, 1995), these values fall within the normal range, whereas the revised guidelines for Asian-Indian populations classify an average BMI of 23.23 as overweight (Misra et al., 2025). Notably, in high market access areas, 22% of women are overweight and 31% are obese under the new guidelines, compared to 26% overweight and 5% obese using WHO cutoffs. In low market access areas, the figures are 19% overweight and 25% obese with the new guidelines versus 21% overweight and 5% obese under WHO standards.

The average age for women in the sample is 37.8 years, with slightly younger women in high-access areas (37.2) compared to low-access areas (38.5). In terms of education, women in high-access areas have completed about 12 years of schooling on average, compared to 8.9 years in low-access areas, indicating a significant educational variation. On average, women have about 1.8 children, with little variation observed across the different market access groups.

Household-level demographics indicate an average household size of approximately 4 members, with minimal difference between high- and low-access areas. About 65% of households in the total sample report access to a ration card, although this proportion is somewhat lower (57%) in high-access areas and significantly higher (81%) in low-access areas. In Nagaland, rice, sugar and pulses are the most availed food commodities through the ration shops. Households with migrants constitute around 31% of the overall sample, but this figure is notably lower (26%) among high-access households and higher (43%) among low-access households, reflecting people moving away from rural to urban areas.

The asset index (based on Principal Component Analysis) also varies markedly across groups. Households with high market access have a higher average asset index (0.56), whereas those in low market access have negative average (-1.19), highlighting a pronounced wealth gap. This gap aligns with monthly per capita expenditure, which averages about INR 5,387 for the full sample, rising to INR 6,174 among high-access households but dropping to INR 3,724 for low-access households.

The Nagas are divided into sub-tribes concentrated in specific regions, while cities tend to have a more mixed tribal composition. About 7% are non-tribes in the overall sample, 9% in high-access areas and only 1% in low-access areas. The *Lotha* tribe is the largest group at 24% overall (34% in low-access areas), while the *Angami* tribe accounts for about 20% (18% in high-access, 23% in low-access). Smaller tribes such as *Chakhesang* (13%) and *Pochury* (9%) also appear more concentrated in low-access areas. Taken together, these statistics suggest that women in higher market access areas have, on average, modestly better dietary outcomes (FCS and MDD-W), higher BMI, and higher household wealth and expenditure.

Figure 2 presents mean number of days of food group consumption among women, according to their access to food markets. Staples and vegetables are the most consistently consumed food groups across both high and low market access areas, highlighting their central role in women's diets and their availability even in regions with fewer or no formal food markets. In contrast, the consumption frequency of pulses, meat, fruit and oils & fats is higher in high market access areas. There is a high frequency of sugar and milk (mostly referring to powdered milk) consumption across locations, likely due to their easy availability in small *paan* shops, which are present even in locations with limited market infrastructure.

Table 1: Women, household and tribal characteristics

	Total		**High Market Access**		**Low Market Access**	
	Mean	SD	Mean	SD	Mean	SD
Outcome variables						
Women's dietary quality						
Food Consumption Score (FCS)	81.6	21.7	85	20	73.5	22
Diet Diversity Score (DDS)	7.08	1.7	7.2	1.7	6.6	1.5
Observations (full sample)	**809**		**549**		**260**	
Women's nutritional status						
Body Mass Index (BMI)	23.23	3.6	23.46	3.6	22.72	3.6
Observations	**742**		**505**		**237**	
Individual and Household Characteristics						
Women demographics						
Age (years)	37.8	9.2	37.2	8.9	38.9	9.6
Number of kids	2.1	1.7	1.9	1.6	2.5	1.9
Education level (years completed)	11	5.4	12.1	5.4	8.6	4.8
Household demographics						
Household size (members)	3.8	1.6	3.8	1.5	3.7	1.6
Access to ration Card (1=yes)	0.65	0.47	0.57	0.49	0.81	0.39
Households with migrants (1=yes)	0.31	0.46	0.26	0.43	0.43	0.49
Asset index (based on PCA)	0.00	2.03	0.56	1.97	-1.19	1.59
Monthly per capita expenditure (INR)	5,387	5,640	6,174	4,900	3,724	3,502
Tribal Composition	(1=yes)		(1=yes)		(1=yes)	
Non-Tribes	0.07	0.26	0.09	0.29	0.01	0.10
Ao	0.07	0.26	0.10	0.30	0.00	0.00
Chakhesang	0.13	0.34	0.10	0.30	0.19	0.39
Angami	0.20	0.40	0.18	0.38	0.23	0.42
Lotha	0.24	0.43	0.20	0.40	0.34	0.47
Pochury	0.09	0.29	0.04	0.20	0.19	0.39
Other Naga tribes	0.07	0.26	0.14	0.35	0.02	0.14
Observations	**809**		**549**		**260**	

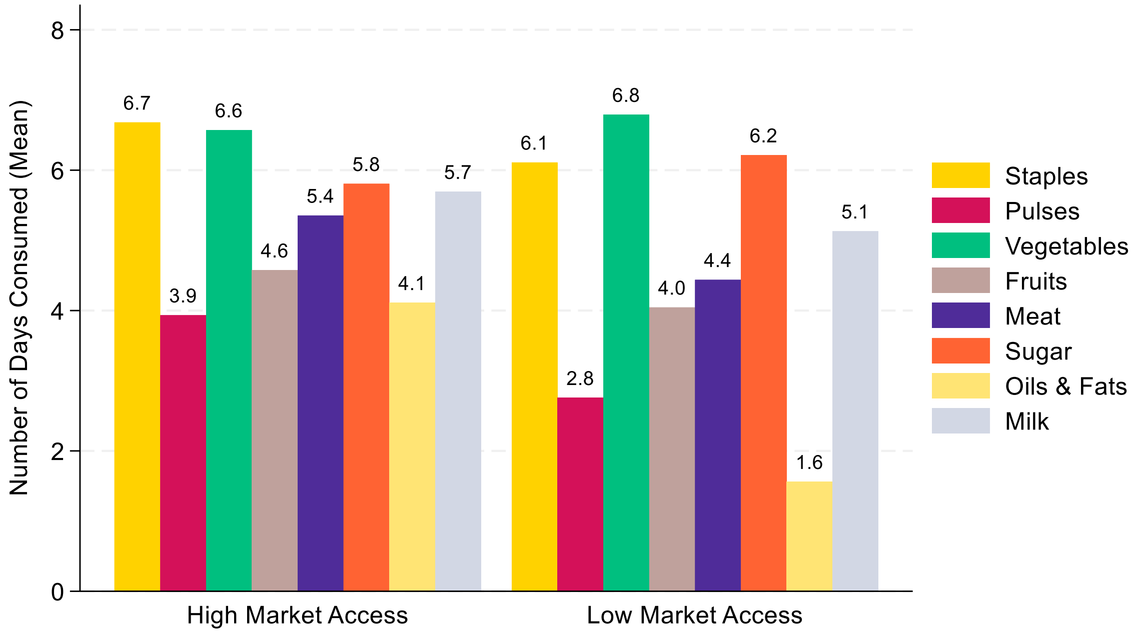

Figure 2. Food groups consumed by women based on market access

(Source: authors' own analysis)

3.2. Income, market access, and dietary quality: examining DDS and FCS across MPCE quartiles

Table 2 presents results from OLS regressions with DDS and FCS as outcome variables, examining the associations between women's dietary quality and key variables such as Monthly Per Capita Expenditure (MPCE) quartiles (a proxy for income) and market access. Higher income is significantly associated with improved dietary diversity (DDS) and higher FCS. Women in MPCE Q4 households have an FCS that is 15.09 points higher and consume approximately one additional food group compared to those in Q1. Market access does not show a statistically significant association with DDS or FCS.

Although, when examining the predictive margins of FCS by income levels and market access (Table 3), we find FCS in low market access regions to be lower than high market access regions for all income groups, with the results being statistically significant. Within each income level, households in high market access areas consistently achieve higher FCS scores than those in low access areas.

As shown in Figure 3, higher MPCE is consistently associated with improved food consumption, with FCS increasing from 76.52 in Q1 to 91.61 in Q4 among women in high market access areas. Among households in low market access areas, FCS also rises with income, although the absolute levels remain lower. The FCS gap between high and low market access widens with income, from 4.86 points in Q1 to 8 points in Q4. This suggests that while income is a key driver of food consumption, limited market access constrains its full effect, particularly at higher income levels.

Household and individual characteristics also play a significant role in shaping women's diets (Table 2). Women's education is positively associated with both DDS and FCS, with each additional year of schooling associated with 0.46 points higher FCS. Larger households are associated with slightly higher FCS and DDS, suggesting a modest positive relation between household size on dietary outcomes.

Access to ration cards is linked to a higher FCS by 5.74 points and DDS by about 0.39. Tribal identity also influences dietary patterns. While some tribes show no significant differences from non-tribal women, those belonging to the *Chakhesang* and *Pochury* tribes exhibit significantly lower FCS, by as much as 13 points, compared to non-tribal women. The constant terms in both models (5.2 for DDS and 61 for FCS) suggest that, on average, women meet minimum dietary requirements even among the lowest income group. For robustness, we also re-estimate the OLS model using continuous distance to nearest market town in Appendix Table A3. The results are consistent with the main specification: FCS increases with income, while greater distance to market is associated with lower dietary quality.

Table 2: Effects of income and market access on DDS and FCS of women

	Dietary Diversity Score – (DSS)		Food Consumption Score (FCS)	
Variables	(1)	(2)	(3)	(4)
MPCE (in log) (*Reference category first quartile)*				
MPCE Q2	0.640***		6.868***	
	(0.191)	(0.005)	(2.529)	(0.015)
MPCE Q3	0.506***		7.418***	
	(0.189)	(0.015)	(2.535)	(0.011)
MPCE Q4	1.319***		15.09***	
	(0.202)	(0.000)	(2.725)	(0.000)
Market Access: markets in the closest town (reference = High access)				
Low access	0.0826		-4.856	
	(0.206)	(0.695)	(3.107)	(0.132)
MPCE Q2 # Low access	-0.378		-1.437	
	(0.282)	(0.200)	(4.088)	(0.739)
MPCE Q3 # Low access	-0.360		-1.250	
	(0.355)	(0.306)	(4.879)	(0.774)
MPCE Q4 # Low access	-0.339		-3.134	
	(0.289)	(0.256)	(4.394)	(0.497)
Women's age	0.00567		-0.00460	

	(0.00665)	(0.403)	(0.0659)	(0.937)
Women's education level	0.0453***		0.468***	
	(0.0117)	(0.001)	(0.158)	(0.004)
Household size	0.0998***		1.959***	
	(0.0304)	(0.003)	(0.392)	(0.000)
Ration card holder (Yes/No)	0.391**		5.789***	
	(0.152)	(0.014)	(1.892)	(0.005)
Tribes (reference = non-tribe women)				
Angami	0.367		0.292	
	(0.301)	(0.256)	(3.426)	(0.929)
Ao	0.404		1.800	
	(0.338)	(0.269)	(3.950)	(0.635)
Chakhesang	-0.301		-6.552	
	(0.325)	(0.392)	(4.150)	(0.134)
Lotha	-0.0410		2.531	
	(0.315)	(0.893)	(3.497)	(0.486)
Other Naga tribes	0.266		3.775	
	(0.309)	(0.419)	(3.500)	(0.289)
Pochury	-0.721**		-12.61***	
	(0.362)	(0.062)	(4.399)	(0.007)
Sumi	-0.335		-1.881	
	(0.384)	(0.403)	(4.380)	(0.668)
Constant	5.210***		61.33***	
	(0.420)	(0.000)	(4.399)	(0.000)
Observations	809		809	
R^2	0.190		0.217	
Clusters	**77**		**77**	

Notes: *(1) and (3) report the coefficients and cluster-robust standard errors (in parentheses), clustered at the village level. (2) and (4) report p-values based on the wild cluster bootstrap-t procedure with 999 replications, clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007). See table A1 (FCS) and A2 (DDS) in appendix for wild cluster standard errors clustered at the village and block levels, respectively.*

Table 3: Predictive margins of FCS by MPCE quartiles and market access

MPCE quartile	High market access	Low market access	FCS difference (high access – low access)
Q1 (lowest MPCE)	76.52*** (1.73)	71.66*** (2.75)	4.86
Q2	83.39*** (1.81)	77.09*** (2.30)	6.30
Q3	83.94*** (1.72)	77.83*** (3.20)	6.11
Q4 (highest MPCE)	91.61*** (2.04)	83.62*** (2.87)	7.99

*Note: Predictive margins and confidence intervals were computed from the full regression model using the Delta method, with standard errors clustered at the village level. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.*

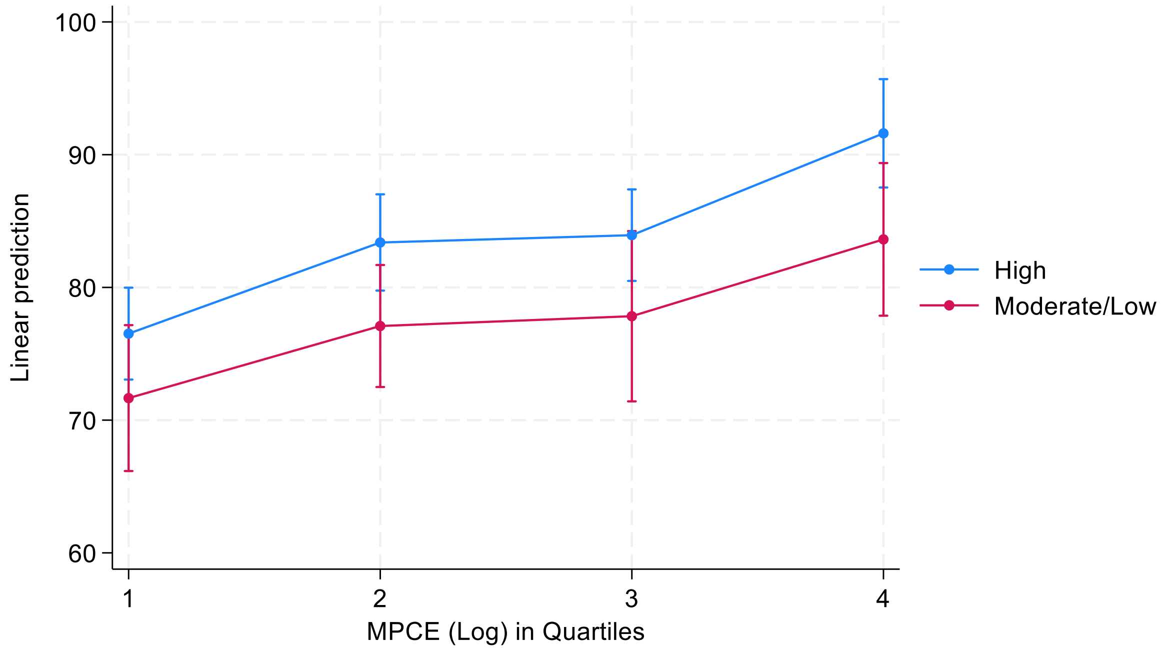

Figure 3. Predicted FCS across MPCE quartiles by market access
(Source: authors' own analysis)

3.3. Income, market access and women's food consumption frequency

While the earlier section established the associations between income levels and market access on DDS and FCS , we now examine the frequency of consumption across different food groups. This analysis allows us to explore variations in the consumption of specific food groups across income levels and market access, providing deeper insights into dietary patterns of Naga women.

Table 4 presents the average marginal effects of income levels and market access on women's food consumption frequency across different food groups, measured in the number of days per week consumed (based on 7 days recall). We have not added staples and vegetables to this analysis as the mean frequency of consumption was very high (above 6 out of 7 days) in both low and high market access locations (Figure 2).

Women in Q4 households consume significantly more of all six food groups compared to those in the lowest income quartile (Q1). The largest income-related gains are observed for oils and fats (+1.75 days), meat (+1.10 days), and milk (+0.90 days), all statistically significant at the 1% level. Notably, even in Q2 and Q3, there are positive and statistically significant effects for meat and oils & fats consumption. For example, women in Q2 households consume oils and fats 1.18 more days per week and meat 0.43 more days than those in Q1. Fruit, milk, and sugar consumption also increase with income, but significant effects appear mostly in Q4.

The effects of market access are more selective but still meaningful. Women in low market access areas consume oils and fats 1.33 fewer days per week and meat 0.55 fewer days compared to those in high-access areas, both statistically significant. While reductions are also observed for pulses, fruits, and milk, these effects are not statistically significant.

Figure 4 illustrates these trends, showing a clear upward shift in food consumption frequency as income increases across MPCE quartiles. In contrast, low market access is associated with a reduction in the frequency of consumption, as indicated by the negative bars in the graph. These findings highlight that while higher income is generally linked to more frequent consumption of nutrient-dense foods, limited market access constrains this potential, particularly for foods that are less likely to be sourced from home production. The case of oils and fats is especially striking: consumption increases steadily with income, from 1.18 additional days in Q2 to 1.75 days in Q4, making it the most income-responsive food group. However, households in low-access areas consume oils and fats 1.33 fewer days per week. This difference may reflect a range of factors, including possible differences in availability of oils and fats, cultural preferences, and traditional Naga cooking practices, in which food is often boiled rather than prepared with oil (Chaudhuri & Chophy, 2023), practices that may be more prevalent in remote communities.

Table 4: Average marginal effects of MPCE and market access on food consumption frequency

	Meat	Pulses	Fruits	Sugar	Oils & Fat	Milk
Variables	(1)	(2)	(3)	(4)	(5)	(6)
MPCE Q2	0.433*	0.517*	0.121	0.096	1.183***	0.518*
	(0.263)	(0.265)	(0.344)	(0.233)	(0.306)	(0.268)
MPCE Q3	0.710**	0.401	0.313	0.359	1.701***	0.409
	(0.277)	(0.307)	(0.346)	(0.256)	(0.348)	(0.263)
MPCE Q4	1.097***	1.195***	0.996***	0.929***	1.747***	0.898***
	(0.311)	(0.334)	(0.355)	(0.271)	(0.325)	(0.329)
Low access	-0.552**	-0.478	-0.215	0.074	-1.330***	-0.351
	(0.221)	(0.304)	(0.273)	(0.184)	(0.447)	(0.252)
Observations	809	809	809	809	809	809

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

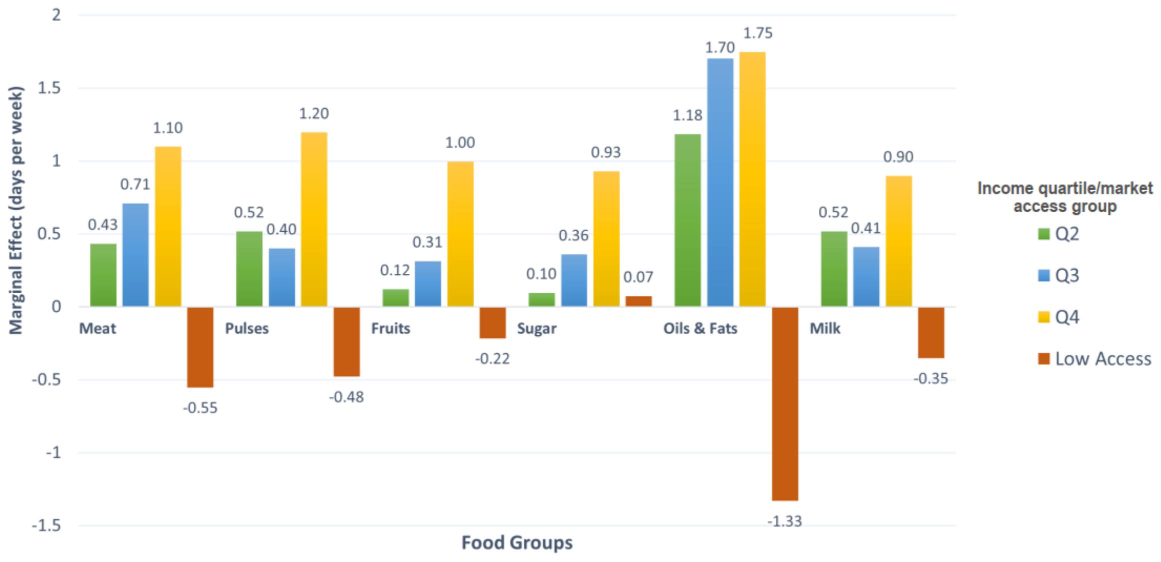

Figure 4. Average marginal effects of MPCE and market access on food consumption frequency by food group

(Source: authors' own analysis)

3.4. Effects of income, and market access on women's BMI

We assess women's BMI using both the WHO classification (WHO, 1995) and the Asian-Indian classification (Misra et al., 2025). Figure 5 presents the BMI kernel density, with colours indicating categories under each guideline. The distribution is concentrated around the normal range, with a right-tail extending into the overweight and obese categories. Under the Asian-Indian cut-offs, a larger share of women is classified as overweight (green; 23.0–24.9 kg/m²) and obese (yellow; ≥25.0 kg/m²) because the thresholds are lower. By contrast, the WHO classification places more women in the normal range, as overweight and obesity begin at ≥25.0 and ≥30.0 kg/m², respectively. In these figures, the colored bands partition a single density; the area of each band equals the share of women in that category.

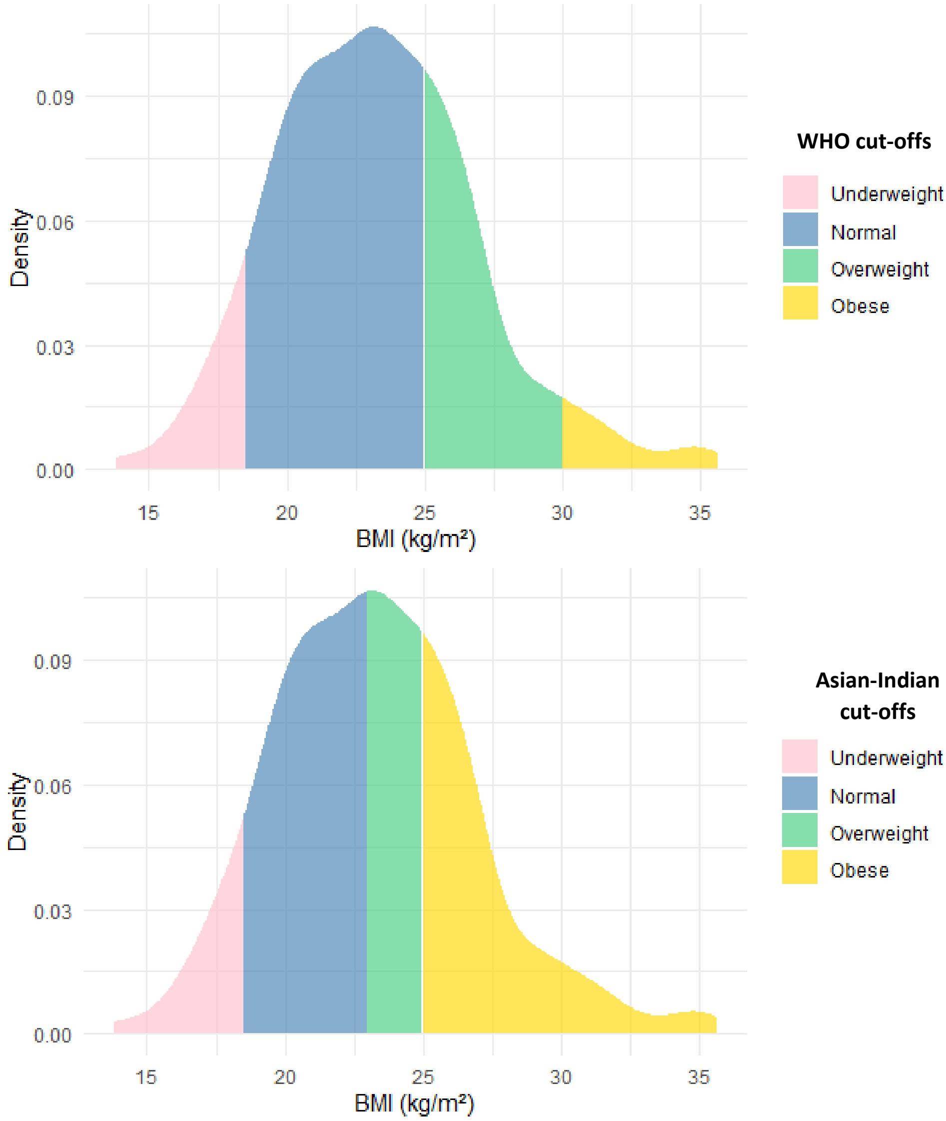

Figure 5. BMI distribution among women using WHO and Asian-Indian classification
(Source: authors' own analysis)

Table 5 presents the OLS regression results examining the relationship between BMI and income, and market access. Low market access is associated with lower BMI (0.84 points) statistically significant at the 1% level. Women's age and household size are positively associated with BMI, while education does not show a significant association. There are notable tribal differences in women's BMI. Women from the *Ao* and *Lotha* communities have significantly lower BMI compared to non-tribal women, while those from the *Angami* tribe exhibit higher BMI levels.

Table 5: Association between women's BMI, income, and market access

	BMI	
Variables	(1)	(2)
MPCE (in log) ***(Reference MPCE Q1)***		
MPCE Q2	-0.349	
	(0.412)	(0.4114)
MPCE Q3	0.751*	
	(0.426)	(0.0891)
MPCE Q4	0.337	
	(0.464)	(0.4865)
Market Access: markets in the closest town (reference = High access)		
Low Access	-0.843***	
	(0.290)	(0.012)
Women's age	0.118***	
	(0.0156)	(0.000)
Women's education level	0.0376	
	(0.0323)	(0.2533)
Household size	0.165**	
	(0.0705)	(0.025)
Ration card holder (Yes/No)	0.274	
	(0.294)	(0.367)
Tribes (reference = non-tribe women)		
Angami	1.048*	
	(0.614)	(0.1061)
Ao	-1.127*	
	(0.585)	(0.0621)
Chakhesang	-0.532	
	(0.558)	(0.3634)
Lotha	-1.121**	
	(0.544)	(0.0551)
Other Naga tribes	-0.812	
	(0.558)	(0.1942)
Pochury	-0.431	
	(0.720)	(0.5536)
Sumi	-0.677	
	(0.749)	(0.358)
Constant	18.01***	
	(0.890)	(0.000)
Observations	742	
Clusters	**77**	
R-squared	0.168	

Notes: *(1) reports the coefficients and cluster-robust standard errors (in parentheses). (2) reports p-values based on the wild cluster bootstrap-t procedure with 999 replications. All standard errors are clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007). See table A4 in appendix for wild cluster standard errors clustered at the village.*

In table 6, we can see the effects from two Linear Probability Models estimating the likelihood of women being overweight or obese. The Asian-Indian guideline uses a lower BMI threshold for overweight or obesity ($\geq$ 23 kg/m²), while WHO uses a higher cutoff ($\geq$25 kg/m²).

Across both BMI guidelines, market access and women's age are the strongest predictors of overweight or obesity across both BMI guidelines. Women living in low market access areas are 10.7 percentage points less likely to be classified as overweight or obese under the Asian-Indian guideline and 9.4 percentage points less likely under the WHO guideline. Age is also associated with increase in overweight or obesity. Income, education, and tribe show no significant effects on BMI. The Asian-Indian model explains twice as much variation as the WHO model, highlighting the importance of using context-specific BMI cutoffs in assessing overweight and obesity among women.

Table 6: Linear probability model estimates of association between income, market access, and overweight/obesity among women

	Overweight/obese (Asian-Indian Guideline)	Overweight/obese (WHO Guideline)
Variables	(1)	(2)
MPCE (in log) (*Reference category first quantile)*		
MPCE Q2	-0.0463	0.00507
	(0.0561)	(0.0467)
MPCE Q3	0.0901	0.0525
	(0.0568)	(0.0518)
MPCE Q4	0.00915	-0.00798
	(0.0671)	(0.0644)
Market Access: markets in the closest town (reference = High access)		
Low Access	-0.107**	-0.0939**
	(0.0456)	(0.0361)
Women's age	0.0163***	0.00910***
	(0.00214)	(0.00198)
Women's education level	0.00660	0.00166
	(0.00440)	(0.00437)
Household size	0.0196*	0.00269
	(0.0115)	(0.0106)
Ration card holder (Yes/No)	0.0678*	0.0153
	(0.0380)	(0.0382)
Tribes (reference = non-tribe women)		
Angami	0.133	0.0888
	(0.0846)	(0.0774)
Ao	-0.0588	-0.0860
	(0.0903)	(0.0866)
Chakhesang	0.0579	-0.0234
	(0.0763)	(0.0751)
Lotha	-0.0680	-0.0902
	(0.0822)	(0.0686)
Other Naga tribes	0.00819	-0.0426
	(0.0872)	(0.0718)
Pochury	0.0176	0.0450
	(0.0835)	(0.0827)
Sumi	0.0244	-0.113
	(0.0864)	(0.0832)

	(1)	(2)
Constant	-0.299**	-0.0526
	(0.114)	(0.114)
Observations	742	742
Clusters	77	77
R-squared	0.137	0.064

Notes: *(1) and (2) report the coefficients and cluster-robust standard errors (in parentheses). All standard errors are clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. (2) Table A5 in the appendix reports wild cluster standard errors and p-values at the village level based on the wild cluster bootstrap-t procedure with 999 replications. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007).*

4. Conclusion

This paper provides empirical evidence on how income levels and market access are linked to dietary patterns and nutritional outcomes among tribal Naga women in Northeast India, a region undergoing a rapid transition from traditional to more market-dependent food systems. Drawing on primary data from over 800 women sampled in regions that largely differ in terms of road connectivity, access to food markets and tribal composition, the study offers three key insights.

First, dietary quality among Naga women is relatively high, with most women meeting the recommended diet diversity (MDD-W) and maintaining acceptable FCS, even in lower-income and low-access settings. However, income remains a strong and consistent determinant of dietary diversity and FCS. Women in the highest income quartile consume more food groups more frequently particularly nutrient-dense foods such as oils and fats, meat, milk, and pulses. These effects are most pronounced in the highest income quartiles.

Second, market access plays a nuanced but important role. Predictive margins and food group-specific analyses reveal that higher market access increases the consumption of certain food groups, including animal-source foods and fats and oils. While oil consumption is highly responsive to rising income, it remains notably lower in areas with limited market access likely reflecting a mix of limited availability, cultural preferences, and customary Naga cooking methods that rely more on boiling than oil-based preparation, especially in remote communities (Chaudhuri & Chophy, 2023).

Third, in terms of nutritional status, BMI is significantly associated with market access and age. Women in low-access areas have lower BMI and are less likely to be overweight or obese, using both the WHO and the stricter Asian-Indian BMI cutoffs, suggesting that increased proximity to food markets may contribute to dietary shifts associated with weight gain. This is further supported by linear probability models using both WHO and Asian-Indian BMI cutoffs. The Asian-Indian classification, which uses lower thresholds, identifies a significantly higher proportion of women at nutritional risk and explains more variation in BMI outcomes, highlighting the value of using context-appropriate metrics in public health research and policy.

Together, these findings highlight that indigenous food systems can sustain adequate dietary diversity among Naga women. Despite low incomes and severe market access constraints, traditional food systems continue to support adequate dietary quality across different Naga tribes. However, as these communities become increasingly connected to market systems, rising incomes and improved market access can present both opportunities and risks. Higher incomes and access to markets are linked to increased dietary diversity, particularly through increased consumption of oils and fats, meats, fruits and pluses. At the same time, the health implications of transitioning to modern food systems must be considered, as such shifts are associated with a higher risk of overweight and obesity.

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Appendix

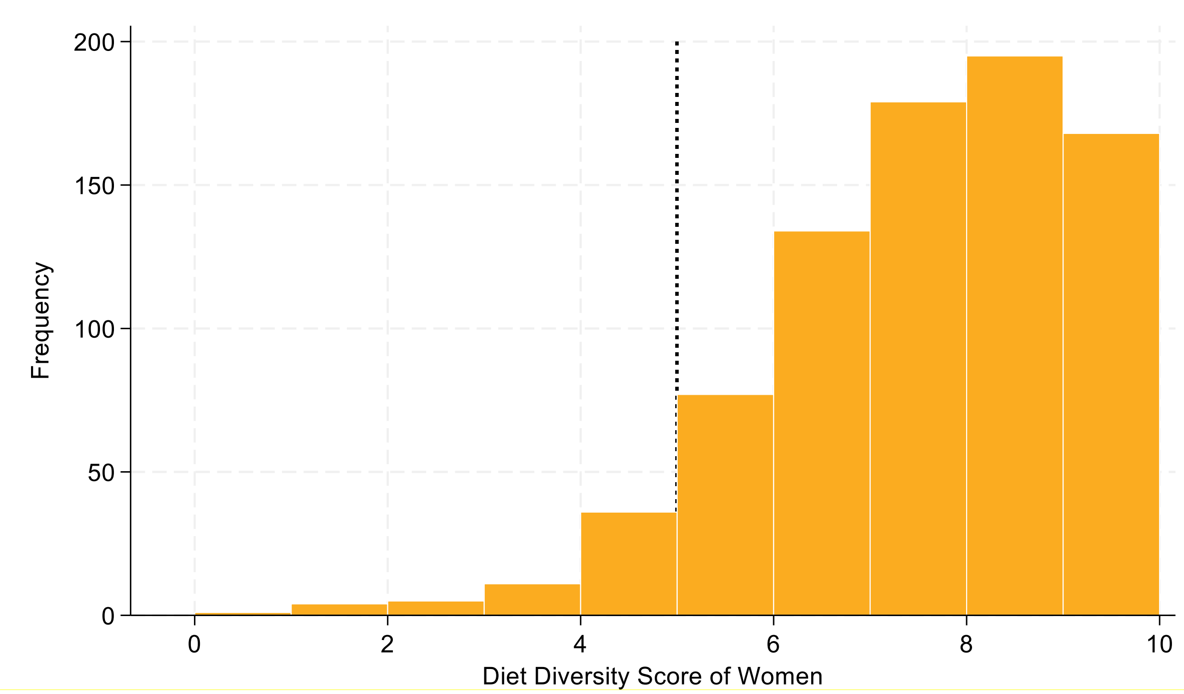

Figure A1: Distribution of women's Dietary Diversity Score (DDS) with cut-off based on MDD-W classification

(Source: authors' own analysis)

Table A1: Association between FCS, income and market access

	Food Consumption Score (FCS)					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
MPCE (in log) (*Reference category first quartile)*						
MPCE Q2	6.868***			6.868***		
	(2.529)	(2.528)	(0.015)	(2.008)	(2.007)	(0.000)
MPCE Q3	7.418***			7.418**		
	(2.535)	(2.535)	(0.011)	(2.604)	(2.604)	(0.007)
MPCE Q4	15.09***			15.09***		
	(2.725)	(2.724)	(0.000)	(2.809)	(2.809)	(0.000)
Market Access: markets in the closest town (reference = High access)						
Low Access	-4.856			-4.856***		
	(3.107)	(3.106)	(0.132)	(1.314)	(1.314)	(0.001)
MPCE Q2 # Low Access	-1.437			-1.437		
	(4.088)	(4.089)	(0.739)	(3.059)	(3.059)	(0.672)
MPCE Q3 # Low Access	-1.250			-1.250		
	(4.879)	(4.879)	(0.774)	(4.001)	(4.001)	(0.770)
MPCE Q4 # Low Access	-3.134			-3.134		
	(4.394)	(4.394)	(0.497)	(3.284)	(3.284)	(0.334)
Women's age	-0.00460			-0.00460		
	(0.0659)	(0.065)	(0.937)	(0.0826)	(0.082)	(0.971)
Women's education level	0.468***			0.468**		
	(0.158)	(0.158)	(0.004)	(0.161)	(0.161)	(0.009)
Household size	1.959***			1.959***		
	(0.392)	(0.391)	(0.000)	(0.346)	(0.345)	(0.000)
Ration card holder (Yes/No)	5.789***			5.789*		
	(1.892)	(1.892)	(0.005)	(2.741)	(2.740)	(0.060)
Tribes (reference = non-tribe women)						
Angami	0.292			0.292		
	(3.426)	(3.427)	(0.929)	(2.477)	(2.476)	(0.921)
Ao	1.800			1.800		
	(3.950)	3.950	(0.635)	(3.727)	(3.728)	(0.650)
Chakhesang	-6.552			-6.552**		
	(4.150)	(4.149)	(0.134)	(2.626)	(2.626)	(0.023)
Lotha	2.531			2.531		
	(3.497)	(3.496)	(0.486)	(2.058)	(2.057)	(0.188)
Other Naga tribes	3.775			3.775		
	(3.500)	(2.346)	(0.289)	(3.156)	(2.116)	(0.275)
Pochury	-12.61***			-12.61***		
	(4.399)	(4.397)	(0.007)	(4.182)	(4.180)	(0.051)
Sumi	-1.881			-1.881		
	(4.380)	(4.379)	(0.668)	(2.712)	(2.711)	(0.466)
Constant	61.33***			61.33***		
	(4.399)	(4.398)	(0.000)	(3.954)	(3.953)	(0.000)
Observations	809			809		
R^2	0.217			0.217		
Clusters	77			14		

Notes: *(1) and (4) report the coefficients and cluster-robust standard errors (in parentheses), clustered at the village and block levels, respectively. (2) and (5) report wild bootstrap standard errors, clustered at the village and block levels, respectively. (3) and (6) report p-values based on the wild cluster bootstrap-t procedure with 999 replications, clustered at the village and block levels, respectively. Significance levels: *** p<0.01, ** p<0.05, * p<0. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007)*

Table A2: Association between DDS, income and market access

	Diet Diversity Score (DDS)					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
MPCE (in log) (*Reference category first quartile)*						
MPCE Q2	0.640***			0.640***		
	(0.191)	(0.1910)	(0.005)	(0.171)	(0.171)	(0.001)
MPCE Q3	0.506***			0.506***		
	(0.189)	(0.1887)	(0.015)	(0.163)	(0.163)	(0.006)
MPCE Q4	1.319***			1.319***		
	(0.202)	(0.2016)	(0.000)	(0.212)	(0.212)	(0.000)
Market Access: markets in the closest town (reference = High access)						
Low Access	0.0826			0.0826		
	(0.206)	(0.2062)	(0.695)	(0.136)	(1.336)	(0.5546)
MPCE Q2 # Low/Moderate Access	-0.378			-0.378*		
	(0.282)	(0.2821)	(0.200)	(0.201)	(0.201)	(0.081)
MPCE Q3 # Low/Moderate Access	-0.360			-0.360		
	(0.355)	(0.3555)	(0.306)	(0.283)	(0.283)	(0.265)
MPCE Q4 # Low/Moderate Access	-0.339			-0.339		
	(0.289)	(0.2889)	(0.256)	(0.312)	(3.313)	(0.290)
Women's age	0.00567			0.00567		
	(0.00665)	(0.0067)	(0.403)	(0.00801)	(0.008)	(0.485)
Women's education level	0.0453***			0.0453***		
	(0.0117)	(0.0117)	(0.001)	(0.0127)	(0.013)	(0.004)
Household size	0.0998***			0.0998***		
	(0.0304)	(0.0304)	(0.003)	(0.0241)	(0.024)	(0.000)
Ration card holder (Yes/No)	0.391**			0.391**		
	(0.152)	(0.1523)	(0.014)	(0.173)	(0.173)	(0.042)
Tribes (reference = non-tribe women)						
Angami	0.367			0.367**		
	(0.301)	(0.3004)	(0.256)	(0.141)	(0.141)	(0.043)
Ao	0.404			0.404		
	(0.338)	(0.3373)	(0.269)	(0.255)	(0.255)	(0.260)
Chakhesang	-0.301			-0.301*		
	(0.325)	(0.3248)	(0.392)	(0.153)	(0.153)	(0.060)
Lotha	-0.0410			-0.0410		
	(0.315)	(0.3147)	(0.893)	(0.141)	(0.141)	(0.754)
Other Naga tribes	0.266			0.266		
	(0.309)	(0.3091)	(0.419)	(0.203)	(0.203)	(0.194)
Pochury	-0.721**			-0.721*		
	(0.362)	(0.3616)	(0.062)	(0.348)	(0.348)	(0.233)
Sumi	-0.335			-0.335*		
	(0.384)	(0.3836)	(0.403)	(0.159)	(0.159)	(0.125)
Constant	5.210***			5.210***		
	(0.420)	(0.4204)	(0.000)	(0.418)	(0.418)	(0.000)
Observations	809			809		
R^2	0.190			0.190		
Clusters	**77**			14		

Notes: *(1) and (4) report the coefficients and cluster-robust standard errors (in parentheses), clustered at the village and block levels, respectively. (2) and (5) report wild bootstrap standard errors, clustered at the village and block levels, respectively. (3) and (6) report p-values based on the wild cluster bootstrap-t procedure with 999 replications, clustered at the village and block levels, respectively. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007).*

Table A3: Effects of income and market access (continuous distance) on DDS and FCS

Variables	Dietary Diversity Score (DDS)	Food Consumption Score (FCS)
	(1)	(2)
MPCE (in log) (*Reference category first quartile)*		
MPCE Q2	0.473***	6.344***
	(0.153)	(2.082)
MPCE Q3	0.421**	7.445***
	(0.159)	(2.313)
MPCE Q4	1.173***	14.02***
	(0.184)	(2.441)
Distance to the closest market town	-0.0948	-3.292***
	(0.0586)	(0.895)
MPCE Q2# Distance to the closest market town	0.107	2.876**
	(0.104)	(1.391)
MPCE Q3# Distance to the closest market town	0.163	3.376**
	(0.100)	(1.293)
MPCE Q4# Distance to the closest market town	-0.0255	-0.372
	(0.174)	(2.420)
Women's age	0.00369	-0.00644
	(0.00628)	(0.0694)
Women's education level	0.0459***	0.501***
	(0.0132)	(0.150)
Household size	0.113***	2.119***
	(0.0304)	(0.384)
Ration card holder (Yes/No)	0.393**	5.366**
	(0.168)	(2.400)
Tribes (reference = non-tribe women)		
Angami	0.361	-1.133
	(0.256)	(2.935)
Ao	0.419	1.821
	(0.345)	(4.248)
Chakhesang	-0.338	-8.627**
	(0.315)	(4.163)
Lotha	-0.0995	1.294
	(0.249)	(2.470)
Other Naga tribes	0.255	3.658
	(0.262)	(3.250)
Pochury	-0.707**	-12.37***
	(0.343)	(3.985)
Sumi	-0.330	-1.800
	(0.289)	(3.334)
Constant	5.319***	60.16***
	(0.389)	(4.714)
Observations	809	809
R-squared	0.196	0.214

Notes: *(1) reports the coefficient and cluster-robust standard errors (in parentheses). All standard errors are clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1*

Table A4: Association between women's BMI, income, and market access

	BMI		
Variables	(1)	(2)	(3)
MPCE (in log) ***(Reference MPCE Q1)***			
MPCE Q2	-0.349		
	(0.412)	(0.412)	(0.4114)
MPCE Q3	0.751*		
	(0.426)	(0.426)	(0.0891)
MPCE Q4	0.337		
	(0.464)	(0.464)	(0.4865)
Market Access: markets in the closest town (reference = High access)			
Low/Moderate Access	-0.843***		
	(0.290)	(0.290)	(0.012)
Women's age	0.118***		
	(0.0156)	(0.0156)	(0.000)
Women's education level	0.0376		
	(0.0323)	(0.3231)	(0.2533)
Household size	0.165**		
	(0.0705)	(0.070)	(0.025)
Ration card holder (Yes/No)	0.274		
	(0.294)	(0.293)	(0.367)
Tribes (reference = non-tribe women)			
Angami	1.048*		
	(0.614)	(0.614)	(0.1061)
Ao	-1.127*		
	(0.585)	(0.585)	(0.0621)
Chakhesang	-0.532		
	(0.558)	(0.557)	(0.3634)
Lotha	-1.121**		
	(0.544)	(0.544)	(0.0551)
Other Naga tribes	-0.812		
	(0.558)	(0.557)	(0.1942)
Pochury	-0.431		
	(0.720)	(0.720)	(0.5536)
Sumi	-0.677		
	(0.749)	(0.748)	(0.358)
Constant	18.01***		
	(0.890)	(0.890)	(0.000)
Observations	742		
Clusters	77		
R-squared	0.168		

Notes: *(1) reports the coefficient and cluster-robust standard errors (in parentheses). (2) reports wild bootstrap standard errors. (3) reports p-values based on the wild cluster bootstrap-t procedure with 999 replications. All standard errors are clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007).*

Table A5: Linear probability model estimates with wild cluster standard errors of association between income, market access, and overweight/obesity among women

	Overweight/obese (Asian-Indian Guideline)			Overweight/obese (WHO Guideline)		
	(1)	(2)	(3)	(4)	(5)	(6)
MPCE Q2	-0.0463			0.00507		
	(0.0561)	(0.0561)	(0.4194)	(0.0467)	(0.0467)	(0.9139)
MPCE Q3	0.0901			0.0525		
	(0.0568)	(0.0568)	(0.1101)	(0.0518)	(0.0518)	(0.3383)
MPCE Q4	0.00915			-0.00798		
	(0.0671)	(0.0670)	(0.8999)	(0.0644)	(0.0644)	(0.8939)
Low/Moderate Access	-0.107**			-0.0939**		
	(0.0456)	(0.0454)	(0.036)	(0.0361)	(0.0361)	(0.023)
Women's age	0.0163***			0.00910***		
	(0.00214)	(0.0021)	(0. 0000)	(0.00198)	(0.0019)	(0.0000)
Women's education level	0.0066			0.00166		
	(0.0044)	(0.0044)	(0.1512)	(0.00437)	(0.00435)	(0.7147)
Household size	0.0196*			0.00269		
	(0.0115)	(0.0115)	(0.0881)	(0.0106)	(0.0106)	(0.8018)
Ration card holder (Yes/No)	0.0678*			0.0153		
	(0.038)	(0.038)	(0.0881)	(0.0382)	(0.0382)	(0.7097)
Angami	0.133			0.0888		
	(0.0846)	(0.0847)	(0.1201)	(0.0774)	(0.0774)	(0.3083)
Ao	-0.0588			-0.086		
	(0.0903)	(0.0903)	(0.5285)	(0.0866)	(0.0866)	(0.3574)
Chakhesang	0.0579			-0.0234		
	(0.0763)	(0.0764)	(0.4374)	(0.0751)	(0.0751)	(0.7708)
Lotha	-0.068			-0.0902		
	(0.0822)	(0.0822)	(0.4334)	(0.0686)	(0.0686)	(0.1892)
Other Naga tribes	0.00819			-0.0426		
	(0.0872)	(0.0872)	(0.9179)	(0.0718)	(0.0718)	(0.5475)
Pochury	0.0176			0.045		
	(0.0835)	(0.0833)	(0.8589)	(0.0827)	(0.0827)	(0.6016)
Sumi	0.0244			-0.113		
	(0.0864)	(0.0864)	(0.7718)	(0.0832)	(0.0828)	(0.1942)
Constant	-0.299**			-0.0526		
	(0.114)	(0.114)	(0.008)	(0.114)	(0.114)	(0.6336)
Observations	742			742		
Clusters	77			77		
R-squared	0.137			0.064		

Notes: *(1) and (4) reports the coefficient and cluster-robust standard errors (in parentheses). (2) and (5) report wild bootstrap standard errors. (3) and (6) report p-values based on the wild cluster bootstrap-t procedure with 999 replications. All standard errors are clustered at the village level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Wild Standard errors and p-values follow the procedures suggested by Cameron, Gelbach, and Miller (2007).*