32nd International Conference of Agricultural Economists
2-7 August 2024 I New Delhi I India

The Impact of Women's Income on Household Nutrition

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Abstract

This study examines the association between women's income and household nutrition using the India Human Development Survey (2005, 2011). Assuming that the household head and his/her spouse are the primary members who influence household nutrition, we explore the association between the primary woman's income as a share of the total income of the primary couple, with household nutrition and diet diversity. The results show that the primary woman's income share has a positive and significant association with household calorie intake especially with calories obtained from carbohydrates, but a significant negative association with calories from fats and no association with calories obtained from protein. Additionally, the positive association of the primary woman's income share with household calorie intake is weaker in the presence of other educated women that have specific hierarchical relationship with the primary woman. The study thus underscores the importance of women's relative bargaining power in improving household nutrition.

JEL Codes: D130, I150, O120

1. Introduction

According to the Global Hunger Index 2021, India falls under the 'serious hunger' category, with 15.3% of the population being undernourished (von Grebmer et al., 2021). Protein intake for adults averages 47 grams per adult per day against the global average of 68 grams per adult per day (Gaiha et al., 2014; Suri, 2020). Average per capita calorie and protein intake has also declined from 1993-94 to 2011-12 (Deaton & Drèze, 2009; Basole & Basu, 2015; Duh & Spears, 2017). In the wake of the Covid pandemic since 2020, household nutrient consumption could have declined further due both to supply and demand side factors such as lockdowns, income losses, inflation, and inaccessibility of government food safety nets (Gupta et al., 2022).

As primary caregivers, women are responsible for ensuring that the household has access to food and essential nutrients (Kurz & Welch, 2001). They may prioritise expenditures on food and essential nutrients over other household expenditures (Yoong et al., 2012) if their income share or bargaining power is strengthened (Hoddinott & Haddad, 1995; Quisumbing et al., 1995). If women control a small proportion of the total household income, then, a change in the woman's income could influence household nutrition (Haddad, Hoddinott & Alderman, 1997).

The collective model of intra-household resource allocation, states that men and women may have different consumer preferences and their ability to influence household consumption allocation depends on their relative bargaining power (Chiappori, 1992; Opata et al., 2020) This could be influenced by individual incomes earned by men and women (Aromolaran, 2010). Therefore, we test the impact of the total income share of women (including both earned and unearned transfer income) on household nutrition using the India Human Development Survey (IHDS) for 2005 and 2011.

Studies examining the association between woman's income and household food expenditure find mixed evidence. In Ecuador, Schady & Rosero (2008) find that transfers made to women increase the household's food expenditure share. Hoddinott & Haddad (1995), Schmeer (2005) and Opata et al. (2020) find that the share of income controlled by the wife has a positive and significant impact on the food budget share in Cote D' Ivoire, the Philippines, and Nigeria respectively. The positive association is attributed to the primary caretaking responsibility assumed by women. In contrast, Lakshmanasamy (2003) finds an insignificant association between woman's non-labour income and household food expenditure in India possibly because the non-labour income coming from old age pensions and other government benefits is not enough to influence women's bargaining ability. Rubalcava & Thomas (2000) find that the association between transfer payments received by women and food expenditure in the United States is negative and significant. Gummerson and Schneider (2013) find that the income share of women decreases food expenditure share in South Africa. It is argued that as women start earning income, they may prioritise spending money on facilities that enable them to work, such as safe transport facilities.

There is little research on the association of woman's income with household nutrition (Aromolaran, 2010). Household nutrition incorporates quantitative and qualitative aspects. Securing household nutrition requires adequate calorie intake and that sufficient calories are obtained from proteins and better-quality sources such as milk, egg, fish, meat, fruits, and vegetables (Tian & Yu, 2015; Sharma et al., 2020). The composition of household nutrition may also be linked to a household's diet diversity (Tian & Yu, 2015). In our study, we consider indicators that capture both the quantitative as well as compositional aspects of household nutrition such as total calorie intake and calorie composition and diet diversity.

First, we explore the association between the income of the 'primary' woman as a share of the total income of the 'primary' couple with quantitative and compositional aspects of household

nutrition. The head of the household and his/her spouse is defined as the 'primary couple'. Second, we explore if the association between the income share of the primary woman and household nutrition is influenced by presence of other adult members, especially those, that may be in a hierarchical relationship with the primary woman. Households have a hierarchical structure which could affect the relative bargaining power of the primary woman, thus influencing her ability to change household nutrition (Gummerson & Schneider, 2013).

Section 2 sets up the conceptual framework. Section 3 defines the hypothesis, gives empirical strategy and specification, and describes the data. Section 4 presents the results and Section 5 concludes.

2. Theoretical framework

Assume that a utility maximising household consists of a primary man (m) and primary woman (w) who have different utility functions, i.e., U^m and U^w respectively, that are additively separable (Bourguignon et al., 1994; Chiappori, 1992). Assume U^m and U^w are quasi-concave, increasing, and continuously differentiable function in their arguments (Chiappori, 1992). Further assume, that each of these functions depends on the quantity consumed of food F and the quantity consumed of the composite non-food good (N). Since N is a composite good, its price is taken to be 1 while it is assumed that food F is purchased at market price P_F. The household maximises a weighted welfare function subject to the household budget constraint (Bourguignon et al., 1994). The utility maximisation problem is as follows:

$$\text{Maximise} \quad \mu_w\, U^w(F^w, N^w) + (1 - \mu_w) U^m(F^m, N^m); \tag{1}$$

$$subject \quad to \quad Y^h = P_F(F^w + F^m) + N^w + N^m; \tag{2}$$

$$and \quad Y^h = Y^w + Y^m \tag{3}$$

where F^i, N^i denote consumption of food and the non-food for individual $i(= w, m)$ respectively. μ_w and (1- μ_w) are the Pareto/welfare weights assigned to the woman and the man respectively and represent the bargaining power of the woman and the man respectively. If these weights sum to unity, then other members (c) who have no bargaining power have zero weights, i.e. $\mu_c = 0$.

For a given level of household income Y^h, higher levels of Y^wwould imply higher bargaining power for the primary woman or higher μ^w (Phipps & Burton, 1998; Aromolaran, 2010). Thus, μ^w is assumed to be an increasing function of the income share of the primary woman, i.e. $Y^w/_{Y^h}$ (Aromolaran, 2010). This can be expressed formally as

$$\mu_w = \mu_w\left(\frac{Y^w}{Y^h}\right); \frac{\partial \mu_w}{\partial\left(\frac{Y^w}{Y^h}\right)} \geq 0; \tag{4}$$

From the constrained maximisation problem (1), the household demand function for food F as a function of its price, household income and the Pareto weight is defined as follows:

$$F = F(P_F, Y^h, \mu_w\left(\frac{Y^w}{Y^h}\right)) \tag{5}$$

Differentiating (5) with respect to the woman's income share in household income, i.e., $\frac{Y^w}{Y^h,}$ we get

$$\frac{\partial F}{\partial\left(\frac{Y^w}{Y^h}\right)} = \frac{\partial F}{\partial \mu_w}\frac{\partial \mu_w}{\partial\left(\frac{Y^w}{Y^h}\right)} \tag{6}$$

Equation (6) implies that a change in the primary woman's income share will change the Pareto weight assigned to her and thus affect the overall household demand for food. Since the bargaining power of the primary woman, μ^w is assumed to be an increasing function of her income share, i.e., $\frac{\partial \mu_w}{\partial\left(\frac{Y^w}{Y^h}\right)} \geq 0$, the direction of change in household food demand in response

to a change in the woman's income will depend on the sign of the term $\frac{\partial F}{\partial \mu_w}$. This in turn depends on the food preferences of the woman while its magnitude depends on the woman's bargaining ability to operationalise her preferences.

3. Data and Methodology

3.1 Data

The first-round of IHDS collected data on 41,554 households from 1503 rural and 971 urban neighbourhoods. The second round re-interviewed 83% of the households interviewed in the first round plus any split households if they were located in the same village or town. The survey represents data from all the states and union territories of India (except for the Andaman & Nicobar Islands and Lakshadweep). IHDS used multi-stage stratified random sampling; more details on sampling can be obtained from the documentation of IHDS (https://ihds.umd.edu/system/files/2020-03/Docrelinfo.pdf).

We use the household and the individual file in 2005 and the household, individual, and women file in 2011 to get information on the household's consumption, income, size and its composition, and other socio-economic characteristics, data on wages and salaries and government benefits received by individuals, and the age and education of ever-married women in the age group of 15-49 years.

We use data on calorie (and nutrient) conversion factors from the Indian food composition tables by Gopalan et al. (1971).

3.2 Association between primary woman's income share and household calorie, protein, carbohydrate, and fat intake

To calculate the household calorie (or protein or carbohydrate or fat) intake, the monthly quantity consumed of jth food ($q_j, \mathrm{j} = 1, \ldots., \mathrm{f}$) is multiplied by its calorie (or carbohydrate or protein or fat) content (c_j) and then the resulting value is aggregated across all food items. The protein, carbohydrate, and fat content of each food item is obtained from the food composition tables based on the work by Gopalan et al. (1971). The per capita daily calorie (or protein or carbohydrate or fat) intake of household i at time t, indexed by n_{it} is obtained by dividing the monthly household calorie (or protein or carbohydrate or fat) intake by the household size and further dividing it by 30.

$$n_{it} = \left(\sum_{j=1}^{f} q_{jit} * c_j\right) / (30 * household\ size_{it}) \qquad (7)$$

The quantity of calories obtained from carbohydrates (protein) is multiplied by four and divided by total calories from all sources to get the share of calories from carbohydrates/proteins (one gram of carbohydrates/proteins provides four calories). Similarly, fat consumption is multiplied by nine (each gram of fat provides nine calories) and divided by the total calories from all sources (Misra et al., 2011). Total food expenditure is divided by the total calorie intake to get unit prices of calories.

We consider nine food groups: cereals, pulses, meat, egg, oil, sweeteners, milk, fruits, and vegetables to calculate the diet diversity score. Using method 1, we add the number of food groups consumed by the household in the last thirty days. Using method 2, we use the Herfindahl-Hirschman index to calculate Berry's index of diet diversity (Akerele et al., 2017). Berry's index measures the degree of concentration of food expenditure. If Berry's index takes the value 0, it implies all food expenditure is concentrated on one food group while if it takes

a value close to 1, it implies that food expenditure is not concentrated to any specific food group.

$$Berry's \text{ index} = 1 - \sum_{g=1}^{F} s_{git}^2 \qquad (8)$$

where

s_{git}^2 is the expenditure share of food group g in the total food budget of household i in time t; and F is the total number of food groups.

The household's share of calories from carbohydrates, protein and fat, and the unit price of 1000 kcals capture the composition of calories by household i at time t. The household's diet diversity captures diet diversification for household i at time t.

The income share of the primary woman is calculated by adding her wage/salary, government benefits, and her notional farm income. While data on wages, salaries and government benefits received are identified for everyone in the household, farm income is reported at the household level. We attribute farm income to the primary decision-maker.[1] The income received from remittances is excluded because this data cannot be disaggregated by gender. The primary woman's income share is calculated by dividing her income by the total income of the primary couple.

Household nutrition indicators are regressed on the primary woman's income share, at the household level:

[1] . Besides the income categories identified above, non-farm business income is also reported at the household level. However, the data identifies the primary decision-maker in business only for the second round of the survey (2011). To eliminate systematic bias from the analysis, we exclude households with a non-farm business income to run the main specification. It is important to exclude households with business income from the analysis because it is possible that men are more likely to earn from non-farm businesses than women.

$$n_{it} = \beta_0 + \beta_1 p\omega_{it} + \beta_2 y_{it} + \beta_3 x_{it} + \beta_4 \rho_{it} + \beta_5 \pi_{it} + \gamma_s + \gamma_t + \varepsilon_{it} \quad (9)$$

$$\theta_{it} = \beta_0 + \beta_1 p\omega_{it} + \beta_2 y_{it} + \beta_3 x_{it} + \beta_4 \rho_{it} + \beta_5 \pi_{it} + \gamma_s + \gamma_t + \varepsilon_{it} \quad (10)$$

Where

n_{it} is the daily per capita calorie (or protein, carbohydrate or fat) consumed by household 'i' at time 't';

θ_{it} are t nutrition composition indicators (share of calories from protein, carbohydrates and fat, the unit price of 1000 kcals and diet diversity) for household 'i' at time 't'. For each of these indicators of the composition of household nutrition, we estimate specification (10) separately.

$p\omega_{it}$ is the primary woman's income share as a proportion of the total income earned by her and her husband in household 'i' at time 't';

y_{it} is the log of real monthly per capita expenditure of household 'i' at time 't';

x_{it} is a vector of household characteristics of household 'i' at time 't', including household size, proportion of dependent members, rural/urban dummy, dummy for gender of the head (male/female), dummy for the main income source of the household (farm/non-farm), dummy for caste and a dummy for religion.

ρ_{it} is a vector of the characteristics of the primary woman of household 'i' at time 't'. The vector ρ_{it} includes the age at marriage and education of the primary woman;

π_{it} is the vector of real prices of six food groups of household 'i' at time 't';

γ_s captures state fixed effects;

γ_t captures time fixed effects.

Specifications (9) and (10) are robust to inclusion/exclusion of variables and have a low variance inflation factor suggesting no severe instances of multi-collinearity. We use robust standard errors clustered at the village level.

There is likely to be a simultaneity bias in estimating specifications (9) and (10) because the decisions to undertake a particular kind of employment and to purchase food could be simultaneously determined (Haddad, 1999). Daily or weekly income tends is likely to be spent on subsistence needs of the household such as food. If women are likely to engage in informal

jobs that pay daily or weekly wages, the positive association between a woman's income share and household's food choices could reflect this simultaneity bias.

Along with the Ordinary Least Square (OLS) model, we estimate the household's fixed effect (FE) model for specifications (9) and (10) to address simultaneity bias. Further, we do robustness checks to ensure that the association between the woman's income share and household nutrition is robust to simultaneity bias. If decisions to undertake a particular kind of employment and to spend on food are taken together, then the positive association between primary woman's income share and household nutrition should be stronger among primary women having casual jobs and getting paid daily or weekly wages. To test this, we define a dummy variables that takes value 1 if the primary woman has a permanent job and takes value 0 otherwise. A second dummy variable takes value 1 if the primary woman has a pay period equal to or greater than the pay period of the primary man. These dummy variables interacted with the primary woman's income share test if the nature of the job and the length of the pay period of the primary woman influences the association of the primary woman's income share with household calorie, protein, carbohydrate and fat intake.

Specifications (9) and (10) are also subject to a reverse causality bias because households with stronger preferences to spend on food may encourage the primary woman to work more and, so she may have a higher income share (Beznoska, 2019). To check for reverse causality, we regress household calorie, protein, carbohydrate and fat intake in 2011 on the primary woman's income share in 2005 using the panel nature of our data.

3.3. Association of the primary woman's income share with household calorie intake in presence of other household members.

To examine if the presence of other household members influences the association between the primary woman's income share and household calorie intake, we introduce interaction terms

between the primary woman's income share and the dummy variable that indicates whether the household has other adults present in the household. Additionally, we introduce an interaction term between the primary woman's income share and the dummy variable that indicates whether the household has other men, besides the primary man, and an interaction term between the primary woman's income share and the dummy variable that indicates whether the household has other women, besides the primary woman.

Further, we explore if the presence of other women in a hierarchical relation with the primary woman influences the association between the primary woman's income share and household calorie intake. A categorical variable mil takes the value 0 if the mother-in-law of the primary woman is absent, 1 if she is present but uneducated, and 2 if she is present and educated.

$$n_{it} = \beta_0 + \beta_1 p\omega_{it} * \text{other adults}_{it} + \beta_2 y_{it} + \beta_3 x_{it} + \beta_4 \rho_{it} + \beta_5 \pi_{it} + \gamma_s + \varepsilon_{it} \quad (11)$$

$$n_{it} = \beta_0 + \beta_1 p\omega_{it} * \text{other men}_{it} + \beta_2 y_{it} + \beta_3 x_{it} + \beta_4 \rho_{it} + \beta_5 \pi_{it} + \gamma_s + \varepsilon_{it} \quad (12)$$

$$n_{it} = \beta_0 + \beta_1 p\omega_{it} * \text{other women}_{it} + \beta_2 y_{it} + \beta_3 x_{it} + \beta_4 \rho_{it} + \beta_5 \pi_{it} + \gamma_s + \varepsilon_{it} \quad (13)$$

$$\begin{aligned} n_{it} = {} & \beta_0 + \beta_1 p\omega_{it} + \beta_2 mil_{it} + \beta_3 dil_{it} + \beta_4 sil_{it} + \beta_5 other_{it} + \beta_6 (p\omega_{it} * mil_{it}) + \\ & \beta_7 (p\omega_{it} * dil_{it}) + \beta_8 (p\omega_{it} * sil_{it}) + \beta_9 (p\omega_{it} * other_{it}) + \beta_{10} y_{it} + \beta_{11} x_{it} + \\ & \beta_{12} \rho_{it} + \beta_{13} \pi_{it} + \gamma_s + \gamma_t + \varepsilon_{it} \end{aligned} \quad (14)$$

where

other adults_{it} is a dummy variable indicating if other adults, besides the primary couple, are present in household 'i' at time 't';

other men_{it} is a dummy variable indicating if other men, besides the primary man, are present in household 'i' at time 't';

other women$_{it}$ is a dummy variable indicating if other women, besides the primary woman, are present in household 'i' at time 't'.

mil_{it} takes the value 0 if the mother-in-law of the primary woman is not present in household 'i' at time 't', 1 if the mother-in-law of the primary woman is present but is uneducated, and 2 if the mother-in-law of the primary woman is present and educated;

sil_{it} takes value 0 if the sister-in-law of the primary woman is not present in household 'i' at time 't', 1 if the sister-in-law of the primary woman is present but is uneducated, and 2 if the sister-in-law of the primary woman is present and educated;

dil_{it} takes value 0 if the daughter-in-law of the primary woman is not present in household 'i' at time 't', 1 if the daughter-in-law of the primary woman is present but is uneducated, and 2 if the daughter-in-law of the primary woman is present and educated;

$other_{it}$ is a dummy variable that indicates whether women having other hierarchical relationships with the primary woman, such as the daughter, granddaughter, niece, etc., of the primary woman are present in household 'i' at time 't';

The other variables are the same as specifications (9) and (10). Because the woman's income is likely to be endogenous, along with the OLS model, we estimate the FE model for specifications (11) to (14).

4. Results

4.1 Summary statistics

Table 1 shows that the average daily per capita calorie intake rose from 1814 kcals in 2005 to 1994 kcals by 2011, which is below the recommended level of 2730 kcals per capita per day for rural areas and 2320 per capita per day for urban areas suggested by the Indian Council of Medical Research (ICMR) (Bellundagi et al., 2020). Average protein intake rose from 46.50

grams in 2005 to 51.69 grams by 2011, which is below the ICMR recommended level of 56 grams per day for an adult of average weight (Barril et al., 2018). The average carbohydrate and fat consumption was above the recommended quantity per person per day in both years (Yagalla et al., 1996; Misra et al, 2011).

The share of calories from carbohydrates declined from 74% in 2005 to 69% by 2011. Calories from protein increased marginally from 10.1% in 2005 to 10.3% by 2011 while those from fat increased from 15% in 2005 to 20% by 2011.

It cost around Rs.7.5 to obtain 1000 kcals of energy, on average, in both years. Households on average consumed about six to seven food groups in both 2005 and 2011. The average value of Berry's index of diet diversity in 2005 and 2011 is 0.74 and 0.77 respectively which indicates that the diet is somewhat diversified.

About 35% and 34% of the surveyed households resided in urban areas in 2005 and 2011 respectively. Only 10% of households in 2005 and 14% in 2011 are headed by females. Around 25% of the households are farm households in both years.

The proportion of dependent household members declined marginally from 39% in 2005 to 38% in 2011. On average, households have close to two other adult members besides the primary couple in both years. In addition, the mother-in-law lived with the primary woman in about 13% of the households.

Average income share of the primary woman is 0.11 in 2005 and 0.13 in 2011. The average education of the primary woman was 3 years and 6 months in 2005, increasing marginally to 3 years and 11 months by 2011. The age of the primary woman was slightly over 41 and a half years in 2005 and slightly over 44 and a half years in 2011.

Table 1: Household and primary woman's characteristics

Key variables	(1) 2005	(2) 2011	(3) Difference based on t test
Household characteristics			
Daily per capita calorie intake (kcals)	1814.76	1994.17	179.41***
Daily per capita protein intake (grams)	46.50	51.70	5.20***
Daily per capita carbohydrate intake (grams)	334.10	345.95	11.85***
Daily per capita fat intake (grams)	32.50	44.79	12.29***
Share of calorie from carbohydrates	0.74	0.69	-0.05***
Share of calorie from proteins	0.10	0.10	0.00***
Share of calorie from fats	0.16	0.20	0.04***
Unit price of 1000 kcals (Rs.)	7.52	7.59	0.08**
Number of food groups consumed in a month	6.26	6.63	0.37***
Berry's index of diet diversity in numbers	0.75	0.78	0.03***
Real monthly per capita consumption (Rs.)	955.09	1237.94	282.84***
Number of assets owned	12.25	14.85	2.60***
Proportion of poor households	0.20	0.16	-0.03***
Proportion of households owning land	0.42	0.45	0.03***
Proportion of urban households	0.36	0.35	-0.01***
Proportion of households with a female head	0.10	0.14	0.05***
Proportion of farm households	0.24	0.25	0.01**
Household size	5.19	4.85	-0.34***
Proportion of dependent members	0.40	0.38	-0.02***
Number of adult members besides primary couple	1.67	1.66	-0.01
Proportion of primary women living with the mother-in-law	0.13	0.13	0.00
Characteristics of the primary woman			
Income share of primary woman	0.11	0.13	0.02***
Education of primary woman	3 years 6 months	3 years 11 months	0.34***
Age of primary woman in years	41 years 7 months	44 years 7 months	2.98***
Observations	41554	42152	83706

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Real monthly expenditure in 2011-12 is calculated by multiplying the nominal monthly per capita expenditure by the deflator variable given in the data. The deflator variable is calculated by dividing the consumer price index for agricultural labourers in 2011 with the consumer price index for agricultural labourers in 2005.

4.2 Income of the primary woman and her autonomy

The degree of autonomy is indicated by the proportion of women having cash for household expenditures, proportion of women having the most say in making major or minor household decisions, and the proportion of women being mobile.

The percentage of the primary women having the most say in whether to make expensive purchases is 8% among those who do not earn an income; this rises to 9% among those who do, and the difference is statistically significant.

Table 2: Relationship between income of primary woman and her autonomy

	(1)	(2)	(3)
Variables representing the autonomy of the primary woman → Proportion of primary women	Do not earn income	Earn income	Difference based on t test
Having cash in hand for household expenditures	0.89	0.90	0.01***
Taking work decisions	0.38	0.57	0.18***
Having most say in whether to make expensive purchases	0.08	0.09	0.01***
Having most say in whether to invest in land or property	0.04	0.05	0.01***
Having most say in how much to spend on social functions	0.13	0.14	0.01**
Having a say in what to cook on a daily basis	0.79	0.81	0.01***
Needs permission to go to a health centre alone	0.73	0.73	0.00
Needs permission to go to a relative's place alone	0.79	0.76	-0.03***
Need permission to go to *kirana* shop	0.82	0.79	-0.03***

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] The primary woman is defined to have the most say in making expenditure decisions if she is the only one involved in taking that decision or she has the most say even when others are involved in taking that decision.

4.3 Income of the primary woman and household nutrition

Table 3 shows that the primary woman's income share has a positive and significant association with calorie, protein, and carbohydrate consumption, it has a significant negative association with fat consumption (column 7), or no association with fat consumption (column 8).

The elasticity with regard to the woman's income share is The estimated elasticity calculated by multiplying the coefficient of the primary woman's income share by her average income share,[2] suggests that if a woman's income share doubled from the current average of 0.13 to 0.26 (a 100% increase in the share), the household consumption of calories, proteins, and carbohydrates will increase by 0.7%, 0.7%, and 0.9% respectively.

The elasticity of calories, protein, carbohydrates and fat with respect to monthly per capita expenditure is estimated to be 0.29, 0.32, 0.26 and 0.48 respectively as per the FE model. Household size has a significant negative association with the per capita consumption of calories, protein, carbohydrates and fat, which is consistent with the literature (Sinha, 2005; Basole & Basu, 2015; Dutta, Kapoor & Pattanaik, 2020).

Both models suggest that a female headed household and an increase in the proportion of dependent members is associated with lower consumption of calories, protein and carbohydrates fat intake. Both models show that being a farm household is associated with a higher calorie, protein and carbohydrate consumption.

[2] The elasticity of calorie intake with regard to primary woman's income share is approximated by multiplying the coefficient of the income share in column 2 of Table 3 (0.05) with the average income share (0.13 as specified in Table 4.1). This gives us the approximated elasticity of 0.007 for calories with respect to the primary woman's income share. Similarly, the elasticity of protein, carb, and fat intake is 0.007, 0.009, and 0 respectively.

Table 3: Association of primary woman's income share with household calorie, protein, carbohydrate and fat intake

Dependent variable: Calorie, protein, carbohydrate, and fat intake	Ln of calorie		Ln of protein		Ln of carbohydrate		Ln of fat	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Primary woman's income share	0.02***	0.05***	0.03***	0.05***	0.04***	0.07***	-0.09***	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Log of per capita expenditure	0.26***	0.29***	0.30***	0.32***	0.22***	0.26***	0.50***	0.48***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)
Household size	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Urban household (dummy)	-0.10***	-0.10**	-0.09***	-0.02	-0.12***	-0.13**	-0.01	0.06
	(0.01)	(0.05)	(0.01)	(0.04)	(0.01)	(0.05)	(0.01)	(0.09)
Female head (dummy)	-0.06***	-0.08***	-0.06***	-0.10**	-0.07***	-0.08***	-0.01	-0.07
	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.08)
Proportion of dependent members	-0.10***	-0.07***	-0.08***	-0.06***	-0.11***	-0.07***	-0.06***	-0.07***
	(0.01)	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.01)	(0.02)
Farm household (dummy)	0.05***	0.04***	0.05***	0.04***	0.05***	0.04***	0.07***	0.04*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
2011 year (dummy)	0.01*	-0.02***	0.06***	0.02**	-0.02***	-0.07***	0.28***	0.29***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)
Observations	48569	48569	48569	48569	48569	48569	48569	48569

[a] * p < 0.1, ** p < 0.05, *** p < 0.01 for all tables. [b] Standard errors in parentheses for all tables. [c] Other controls include real food prices, caste, religion and whether household buys from PDS, education and age of the primary woman. [d] The base category, for urban dummy is rural household; dummy for female head is male head; farm dummy is non-farm household; 2011 dummy is survey year 2005.

4.4 Robustness tests

Table 4 shows that the positive association between the primary woman's income share and household nutrition is stronger if the primary woman has a permanent job as it strengthens the bargaining power of the primary woman. These results indicate that the positive association between the woman's income share and household nutrition is not subject to the simultaneity bias. Table 5 suggests that the positive association of the woman's income share with household nutrition holds even after accounting for reverse causality.

Among other coefficients in Table 5, household expenditure has a significant positive association with household calorie, carbohydrate, protein, and fat consumption while household size has a significant negative association. Farm households have a positive and significant association with household calorie, protein, carbohydrate, and fat consumption while being an urban household has a negative and significant association with household calorie, protein, and carbohydrate consumption. The proportion of dependent members has a negative and significant association with household calorie, protein, carbohydrate, and fat consumption.

Table 4: Association between the primary woman's income share and household nutrition accounting for the nature of the job and pay period of the job held by primary woman

Dependent variable: Household calorie, protein, carbohydrate and fat intake	Ln of calorie		Ln of protein		Ln of carbohydrate		Ln of fat	
	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) FE	(7) OLS	(8) FE
Primary woman's income share	-0.10***	-0.23***	-0.14***	-0.28***	-0.09***	-0.25***	-0.14**	-0.08
	(0.03)	(0.06)	(0.03)	(0.08)	(0.03)	(0.06)	(0.07)	(0.19)
Primary woman has a permanent job (dummy)	-0.07	-0.87***	-0.14**	-1.09***	-0.03	-0.92***	-0.39**	-1.42*
	(0.05)	(0.14)	(0.06)	(0.22)	(0.05)	(0.19)	(0.19)	(0.73)
Income share of the primary woman * primary woman has a permanent job (dummy)	0.06	0.55***	0.09*	0.53***	0.04	0.53***	0.24*	0.76
	(0.05)	(0.13)	(0.04)	(0.18)	(0.06)	(0.15)	(0.12)	(0.49)
Primary woman has an equal or a longer pay period than that of the primary man (dummy)	-0.01	-0.16**	-0.02	-0.13	-0.01	-0.24***	-0.05	-0.04
	(0.02)	(0.07)	(0.02)	(0.11)	(0.02)	(0.07)	(0.05)	(0.18)
Income share of the primary woman * primary woman has an equal or a longer pay period than that of the primary man (dummy)	0.08	0.49***	0.15**	0.65***	0.06	0.68***	0.20	0.39
	(0.06)	(0.15)	(0.07)	(0.21)	(0.05)	(0.20)	(0.19)	(0.53)

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses. [c] The base category for primary woman having a permanent job is that she has a casual job. [d] The base category for the pay period of primary woman is that she has a shorter pay period than the primary man.

Table 5: Association between primary woman's income share in 2005 and household calorie, protein, carbohydrate, and fat intake in 2011

Dependent variable: calorie, protein, carbohydrate, fat in 2011	Ln of calorie in 2011 (1) OLS	Ln of protein in 2011 (2) OLS	Ln of carbohydrate in 2011 (3) OLS	Ln of fat in 2011 (4) OLS
Primary woman's income share in 2005	0.02*	0.02**	0.03***	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Log of per capita expenditure	0.25***	0.28***	0.21***	0.42***
	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.05***	-0.05***	-0.05***	-0.05***
	(0.00)	(0.00)	(0.00)	(0.00)
Urban dummy	-0.07***	-0.05***	-0.09***	0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Female head dummy	-0.02	-0.03	-0.02	-0.01
	(0.02)	(0.03)	(0.02)	(0.02)
Proportion of dependent members	-0.08***	-0.07***	-0.08***	-0.07***
	(0.01)	(0.01)	(0.01)	(0.01)
Farm household (dummy)	0.04***	0.04***	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Observations	23120	23120	23120	23120

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses. [c] Other controls are same as Table 3.

4.2 Income of primary woman and household's calorie composition and diet diversity

Table 6 indicates that the primary woman's income share has a significant positive association with the percentage of calories from carbohydrates and a significant negative association with the percentage of calories from fats. Her income share has no association with the percentage of calories from protein or the unit price of 1000 kcals. The models indicate that the primary woman's income share is associated with a decrease in the Berry's index of diet diversity.

Table 6: Association of primary woman's income share with household's calorie composition and diet diversity

	Percentage of calorie from carb		Percentage of calorie from protein		Percentage of calorie from fat		Unit price of 1000 kcals		Found count index of diet diversity		HHI index of diet diversity	
	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) FE	(7) OLS	(8) FE	(9) OLS	(10) FE	(11) OLS	(12) FE
Primary woman's income share	1.63***	1.18***	0.08**	-0.02	-1.70***	-1.14***	-0.31***	-0.21**	-0.07**	-0.00	-0.01***	-0.01**
	(0.18)	(0.21)	(0.03)	(0.07)	(0.17)	(0.22)	(0.05)	(0.09)	(0.03)	(0.06)	(0.00)	(0.01)
Log of per capita expenditure	-3.33***	-2.35***	0.32***	0.30***	3.00***	2.04***	1.83***	1.39***	0.60***	0.59***	0.03***	0.03***
	(0.10)	(0.15)	(0.03)	(0.04)	(0.09)	(0.14)	(0.03)	(0.06)	(0.02)	(0.04)	(0.00)	(0.00)
Household size	0.01	-0.03	0.03***	0.03***	-0.04**	-0.01	0.05***	0.06***	0.10***	0.08***	-0.00**	0.00
	(0.01)	(0.03)	(0.00)	(0.01)	(0.02)	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)
Urban dummy	-1.47***	-2.07**	0.12***	0.78***	1.34***	1.30	0.75***	0.88***	0.23***	-0.20**	0.02***	0.01
	(0.21)	(0.96)	(0.03)	(0.22)	(0.22)	(0.79)	(0.06)	(0.25)	(0.02)	(0.10)	(0.00)	(0.02)
Female head dummy	-0.64**	-0.25	0.02	-0.24	0.62**	0.51	0.09	0.10	0.11	0.20	0.01	0.02**
	(0.32)	(0.86)	(0.16)	(0.31)	(0.23)	(0.78)	(0.23)	(0.15)	(0.15)	(0.29)	(0.01)	(0.01)
Proportion of dependents	-0.52***	-0.04	0.17***	0.12	0.36***	-0.08	0.28***	0.19**	0.06***	0.10**	0.01***	0.00
	(0.11)	(0.14)	(0.04)	(0.09)	(0.12)	(0.15)	(0.04)	(0.08)	(0.02)	(0.04)	(0.00)	(0.00)
Farm dummy	-0.29**	-0.10	-0.01	-0.00	0.30**	0.10	-0.04	-0.00	-0.11***	0.01	-0.01***	0.00
	(0.13)	(0.15)	(0.02)	(0.02)	(0.12)	(0.15)	(0.04)	(0.04)	(0.02)	(0.02)	(0.00)	(0.00)
Year dummy for 2011	-2.91***	-3.58***	0.35***	0.44***	2.53***	3.11***	-0.55***	-0.23***	0.23***	0.29***	0.03***	0.05***
	(0.30)	(0.37)	(0.04)	(0.06)	(0.31)	(0.40)	(0.06)	(0.05)	(0.03)	(0.03)	(0.00)	(0.00)
Observations	48569	48569	48569	48569	48569	48569	48569	48569	48602	48602	48583	48583

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses. [c] Other controls are same as Table 3.

An increase in the per capita household expenditure is associated with a decline in the percentage of calories from carbohydrates and an increase in the percentage of calories from protein and fat. Both models suggest that per capita household expenditure is associated with an increase in the unit price of 1000 kcals; the food count measure of dietary diversity; and the Berry's index of diet diversity.

In both models, household size has a positive and significant association with the percentage of calories obtained from protein, unit price of 1000 kcals and the food count measure of dietary diversity.

Urban households have a lower percentage of calories from carbohydrates and a higher percentage of calories from protein. and a higher unit price of 1000 kcals in both models. The OLS model shows that urban households have higher diet diversity while the FE model shows that urban households have lower food counts. However, according to the FE model, having a female head increases the Berry's index of diet diversity. This implies that when women have the autonomy to take household decisions, they may spend money on diversified food groups.

The FE model suggests that the proportion of dependent members has no association with calorie composition in terms of its protein, carbohydrate, and fat content but it increases the unit price of 1000 kcals. The proportion of dependent members has a positive association with the food count measure of diet diversity but has no association with Berry's index of diet diversity as per the FE model.

Being a farm household has no association with calorie composition but is associated with a decrease in the food count measure of diet diversity and Berry's index of diet diversity as per the OLS model but has no association with either measure of diet diversity according to the FE model.

4.3 Income of primary women and calorie share of food groups

Table 7 suggests that an increase in the woman's income share is associated with an increase in the share of calories from cereals; and a decrease in the calorie share of other food groups including pulses, meat and eggs, milk, sweeteners and oil.

According to Figure 1, cereals contribute the highest share to total carbohydrate consumption. Therefore, the increased consumption of cereals accompanying the increase in the woman's income share explains the positive association of the primary woman's income share with the percentage of calories obtained from carbohydrates (cereals) and the negative association with the percentage of calories obtained from fats (oils, milk) in Table 6.

Figure 2 illustrates that cereals provide cheap calories as they have the lowest unit price of 1000 kcals. Thus, the substitution of consumption towards cereals also explains the decrease in the average price of calories associated with an increase in the primary woman's income share (Table 6). Additionally, since the calorie share of eggs, meat, fruits, and vegetables is negatively associated with primary woman's income share, the primary woman's income share is negatively associated with Berry's index of diet diversity (Table 6).

Table 7: Association of primary woman's income share with calorie share of food group in % terms

Dependent variable: calorie share of food groups (%)	Cereal		Pulse		Meat and egg		Milk		Sweetener		Oil	
	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) FE	(7) OLS	(8) FE	(9) OLS	(10) FE	(11) OLS	(12) FE
Primary woman's income share	3.1***	2.4***	-0.2**	-0.8***	-0.1	-0.2*	-1.3***	-0.5**	-0.6***	-0.4**	-1.2***	-1.0***
	(0.28)	(0.30)	(0.10)	(0.25)	(0.04)	(0.14)	(0.15)	(0.21)	(0.11)	(0.17)	(0.16)	(0.24)
Observations	48557	48557	40258	40258	33444	33444	42477	42477	47657	47657	43311	43311

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses. [c] Other controls are same as Table 3.

Figure 1: Food groups contribution to total carbohydrate, fat and protein intake in %

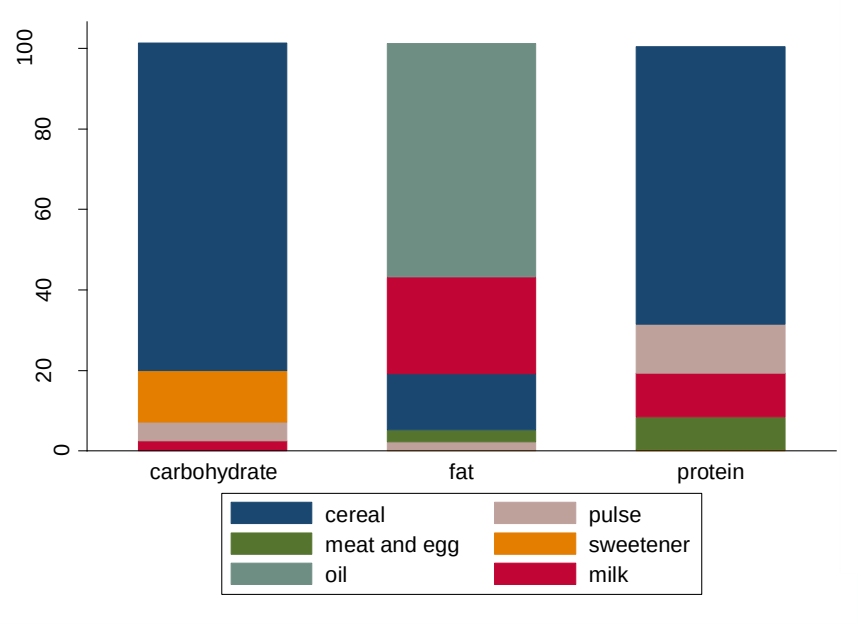
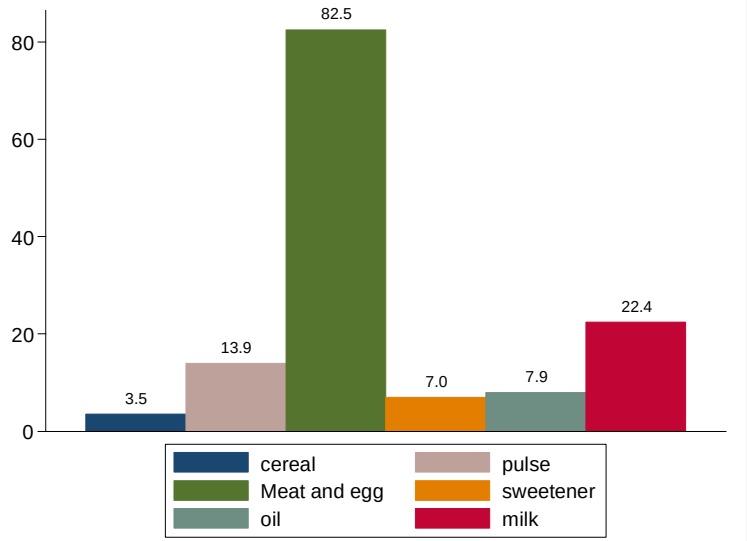


Figure 2: Price of 1000 kcals by food groups in rupee terms



4.4 Association between the primary woman's income share and household calorie intake in the presence of other adults

Table 8 shows that association between a woman's income and household calorie intake is negatively influenced by the presence of other adults, besides the primary couple, within the household (column 1). However, as per the FE model, the interaction term between the income share of the primary woman and the dummy variable on whether there are adults present is insignificant. Thus, the association between the income share of the primary woman and household calorie intake is not influenced by the presence of other adults within the household (column 2). The OLS model shows, the association between primary woman's income share and calorie intake is weaker in the presence of other men, besides the primary man. Both the OLS and the FE model suggest that the association of the primary woman's income share with household calorie intake is weaker in the presence of other women, besides the primary woman (columns 5 and 6).

Table 9 shows that the presence of an educated mother-in-law of the primary woman and an educated daughter-in-law of the primary woman is associated with a weaker association between the primary woman's income share and calorie intake. This suggests that presence of educated women in hierarchical relationships with the primary woman may weaken the association between her income share and household calorie intake.

Table 8: Association between the primary woman's income share and calorie intake in presence of other members

Dependent variable: Ln of calorie intake	(1) OLS	(2) FE	(3) OLS	(4) FE	(5) OLS	(6) FE
Income share of primary woman	0.05***	0.06***	0.04***	0.07***	0.05***	0.08***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Other adults are present (dummy)	-0.01	0.02***				
	(0.01)	(0.01)				
Income share of primary woman * Other adults are present (dummy)	-0.05***	-0.02				
	(0.01)	(0.03)				
Other men are present (dummy)			0.00	0.01		
			(0.00)	(0.01)		
Income share of primary woman * Other men are present (dummy)			-0.04***	-0.04		
			(0.01)	(0.03)		
Other women are present (dummy)					-0.02***	0.00
					(0.00)	(0.01)
Income share of primary woman * Other women are present (dummy)					-0.06***	-0.06**
					(0.01)	(0.02)
Observations	48569	48569	48569	48569	48569	48569

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses.[c] The base category for other adults is that there are no other adults. [d] The base category for presence of other men and other women respectively are there are no other men and women present.

Table 9: Association between the primary woman's income share and calorie intake in presence of other women

Dependent variable: Calorie intake	(1) OLS	(2) FE
Income share of the primary woman	0.04	0.09
	(0.04)	(0.07)
Categorical variable indicating the presence of mother-in-law, sister-in-law, and daughter-in-law and whether they are educated (base category=mother-in-law, sister-i-law, daughter-in-law are absent) and its interactions with the primary woman's income share		
Mother-in-law is present and uneducated	-0.02***	0.01
	(0.01)	(0.02)
Mother-in-law is present and educated	-0.02**	0.09***
	(0.01)	(0.03)
Income share of primary woman *mother-in-law is present and uneducated	-0.03	-0.08
	(0.03)	(0.07)
Income share of primary woman *mother-in-law is present and educated	0.00	-0.31*
	(0.04)	(0.18)
Sister-in-law is present and uneducated	-0.02	-0.11**
	(0.01)	(0.04)
Sister-in-law is present and educated	0.02	-0.01
	(0.02)	(0.05)
Income share of primary woman *sister-in-law is present and uneducated	0.09	0.20
	(0.10)	(0.14)
Income share of primary woman *sister-in-law is present and educated	0.07	0.20
	(0.09)	(0.19)
Daughter-in-law is present and uneducated	-0.00	-0.02
	(0.01)	(0.02)
Daughter-in-law is present and educated	-0.04***	0.01
	(0.01)	(0.02)
Income share of primary woman *daughter-in-law is present and uneducated	-0.08*	-0.11
	(0.04)	(0.08)
Income share of primary woman *daughter-in-law is present and educated	-0.04	-0.15**
	(0.04)	(0.06)
Other women are present (dummy)	0.00	0.04***
	(0.01)	(0.01)
Income share of primary woman * other women are present	-0.01	0.01
	(0.03)	(0.04)
Observations	23557	23557

[a] * p < 0.1, ** p < 0.05, *** p < 0.01. [b] Standard errors in parentheses. [c] Other women present in the household includes daughter, granddaughter, niece, sister, grandmother, etc.

5. Discussion and conclusions

The primary woman's income share is significantly associated with household's calorie, protein and carbohydrates consumption and a significant positive association with the share of calories obtained from carbohydrates, a significant negative association with the share of calories obtained from fat, and no association with the share of calories obtained from proteins. Further, households switch away from food groups that are expensive sources of calories to food groups that provide cheaper calories. The woman's income share has a negative and significant association with household diet diversity. Further, her control over household expenditure and her bargaining power gets diluted in the presence of her mother-in-law even if she earns an income.

Many economists have pushed for the provision of a universal basic income (UBI) to individuals in developing countries (Banerjee et al. 2020), which aims to provide a fixed monthly income to all. Some Indian states, including Madhya Pradesh, Punjab and Tamil Nadu recently launched schemes that aimed to provide a basic income to individuals. Owing to fiscal concerns, these schemes were not designed to be universal in their initial phases. These schemes target women heads of families belonging to underprivileged backgrounds (Sivakumar, 2023). The income transfer to women heads of families is aimed at improving their own health and nutrition status and expand their bargaining power within the household. Our results suggest that provision of basic income to the women head of the families could improve household calorie, protein, and carbohydrate intakes. However, the effectiveness of such gendered income policies may depend on the household hierarchical structure. and may not improve the household calorie composition and household dietary diversity.

Hence, the basic income targeted at the woman household head needs to be accompanied by other policies that supplement the share of calories obtained from proteins and improve

household dietary diversity. The existing nutrition programmes thus have to be optimised for their protein quality by diversifying to good quality protein in its cover (Bandyopadhyay et al., 2020). The public distribution system (PDS) provides subsidised food grains (rice, wheat, and millet) to beneficiaries identified under the National Food Security Act. The protein supplementation through PDS averages 7.2 gm/day and 3.8 gm/day in rural and urban areas respectively (Suri, 2020). However, the recommended dietary allowance for protein and energy is unmet for the poorest households with low access to food. There is a need to start expanding the provision of protein-rich foods via the PDS at subsidised rates to make them more affordable and available. Under the POSHAN Abhiyan, launched in 2018, emphasis is placed on promoting dietary diversity and incorporating millets into existing nutrition programmes like the Integrated Child Development Scheme and the Mid-Day Meal Scheme (Varshney, 2021). The inclusion of millet can significantly boost the intake of proteins and other nutrients from meals provided under these government schemes.

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