Ind. Jn. of Agri. Econ.
Vol.74, No.3, July-Sept.2019

SUBJECT III
AGRICULTURE, NUTRITION AND EMPLOYMENT NEXUS: WELFARE PERCEPTIVE

Dietary Diversity: Determinants and Its Relationship with Nutritional Outcomes in Uttar Pradesh

V. Sangeetha*, P. Venkatesh, Premlata Singh*, Satyapriya*, V. Lenin*, Sudipta Paul*, G.S. Mahra*, Muralikrishnan*, Sukanya Barua*, Sitaram*, Tushar Singh*, Sarvesh K. Dubey** and Monika Yadav***

ABSTRACT

Household consumption behaviour differs in many ways from each other. In this paper, we analyse the dietary diversity among households in Uttar Pradesh and try to understand whether the differences in the degree of variety in food consumption can be attributed to various characteristics of the household. Moreover, as diverse and healthy diets are recognised as an ultimate solution to malnutrition, we also examine the empirical connection between dietary diversity and nutritional outcomes. The study utilises household level food consumption data from the NSS 68th Round Survey and key nutritional indicators from the 4th National Family Health Survey. The Simpson index of dietary diversity shows that majority two-third of the households belonged to the medium category, followed by low diversity and high dietary diversity was found to be less than 5 per cent of the households. However, the households living in urban and western Uttar Pradesh were having a relatively higher degree of dietary diversity than rural and eastern Uttar Pradesh, respectively. The determinant analysis suggests that households' income, education level and type of occupation of head of the households, had a significant and positive influence on dietary diversity in both the rural and urban areas, however family size had a negative influence. In addition, land size and age of the head of the households were also important factors, but only for rural households. On an average, 1000 rupees increase in household's income would lead to 0.03 increase in the dietary diversity score of rural households, while 0.01 in case of urban households. The farming households' dietary diversity was significantly higher than labour households in the rural areas. Similarly, self-employed households had better dietary diversity than labour households in the urban areas. Malnutrition indicators clearly indicated that Bahraich and Shrawasti were the worst affected districts in Uttar Pradesh, while Gautam Buddha Nagar and Ghaziabad reported lowest incidence of malnutrition. Further, the multivariate regression analysis at the district level highlights that dietary diversity plays a significant role in improving the nutritional outcomes. It was found that a 10 per cent increase in the Simpson index would reduce the incidence of underweight by 1.4 per cent in case of adults and about 2 per cent in children. The study suggests that promotion of diversified food among the households is the most important for the reduction of incidence of malnutrition problems.

Keywords: Household consumption behaviour, Dietary diversity, Nutritional indicators, Uttar Pradesh.

JEL: D10, D11, D12, I10.

I

INTRODUCTION

Researchers from different disciplines like food and nutrition, economics, and agriculture have collaborated and devoted considerable efforts in recent years on the

*Division of Agricultural Extension and **Division of Agricultural Economics, ICAR-Indian Agricultural Research Institute, Pusa Campus, New Delhi-110 012.

The authors are very much thankful to the reviewer for his/her valuable comments.

topic of malnutrition and dietary diversity. This multi-stakeholder approach has helped in addressing the key knowledge gaps and has evolved our understanding of nutrition and its role in improving people's lives. Over the past few decades, India has made a significant dent in malnutrition levels. However, the analysis of the latest national-level data available from the National Family Health Survey (IIPS and ICF, 2017) points towards a number of challenges that still remains.

Malnutrition is an outcome of a wide range of problems such as access to nutritious and safe food, water and sanitation, health services and environmental factors to name a few (Sangeetha *et al.,* 2018a). Past studies and most healthy eating advice focus on eating a variety of foods, particularly meat, poultry, fish, eggs, fruits, and vegetables to ensure adequate intake of essential macro and micro-nutrients and to promote good health (Sangeetha *et al.,* 2018b). As households allocate their funds to a greater number of food items they are more likely to get everything that their body needs. Bringing a greater variety of foods to people's diet is regarded as the ultimate long-term solution to improve the nutritional outcomes. Further, with the emergence of the "triple burden" of malnutrition which is defined as the coexistence of undernutrition, over nutrition, and micronutrient deficiencies, dietary diversity is recognised as a key driver of change that can help build a generation free from nutritional maladies. In simple terms, dietary diversity is an important measure of a rich and healthy diet as it indicates the number of food items consumed over a period of time. Households and individuals vary in their consumption habits depending on various characteristics such as lifestyles, demographics, preferences, etc. Understanding these differences in their consumption behaviour can give informed recommendations for policy interventions. The purpose of the study is to firstly, understand the difference in the variety in food consumption among households and whether various household characteristics can explain these differences; secondly, to examine the empirical connection between dietary diversity and nutritional outcomes. Against this backdrop, the study aims to measure a dietary diversity index for the sample households in Uttar Pradesh and examine the major factors that affect dietary diversity and furthermore, to examine if any, the linkages between district level estimates of dietary diversity and nutritional outcomes.

II

DATA AND METHODOLOGY

2.1. *Data*

The analysis and results in this paper are based on unit level household data on food consumption and consumer expenditures available from National Sample Surveys (NSS). In addition to food consumption and purchases, the dataset also contains several socio-economic variables for each participating household. The paper utilises a sub-sample of the NSS 68th (2011-12) Round for households in Uttar

Pradesh where the respondents are asked to recall how much they had consumed and spent on each food item over the last 30 days. There are around 149 food items in the list, however, we have used the major food items to construct a dietary diversity index. A list of all food items considered is reported in Table 1. The total sample consists of 9014 households in Uttar Pradesh, out of which 5915 were rural households and 3099 were urban households. We have also used district-level estimates on many important health and nutrition indicators from the fourth round of the National Family Health Survey 2015-16 (NFHS-4) to investigate their relationship with dietary diversity and other socio-economic and demographic characteristics of the households.

TABLE 1. LIST OF FOOD ITEMS USED TO COMPUTE SIMPSON INDEX

S.No. (1)	Food groups (2)	Food items (3)	S.No. (4)	Food groups (5)	Food items (6)
	Cereals			Green leafy vegetables	
1.		Wheat	19		Palak
2.		Rice	20		Cabbage
	Pulses			Other vegetables	
3.		Arhar	21		Brinjal
4.		Masur	22		Ladies finger
5.		Urd	23		Parwal
	Milk products		24		Cauliflower
6.		Milk	25		Pumpkin
7.		Curd	26		Beans
	Sugar			Fruits	
8.		Sugar	27		Tomato
	Fats and edible oil		28		Watermelon
9.		Ghee	29		Guava
10.		Mustard oil	30		Papaya
11.		Refined oil	31		Mango
	Seafood and flesh		32		Kharbooza
12.		Fish	33		Pears
13.		Meat	34		Berries
14.		Chicken	35		Leechi
	Roots and tubers		36		Apple
15.		Potato	37		Grapes
16.		Onion			
17.		Radish			
18.		Carrot			

2.2. *Methodology*

Measure of Dietary Diversification

The theory of food diversity is based on a number of different indicators computed to measure dietary diversity. These indicators can be classified into two categories, (1) count measures which record the number of food items consumed, (2) distribution index which take both the number and the quantities of individual food items consumed. Though count measures are easy to compute and interpret as they

just count the number of food groups consumed in a given time frame, they have the disadvantage that they do not take into consideration the distribution of quantity shares across food categories (Thiele and Weiss, 2003). For this reason, our analytical framework utilises a more appropriate index namely Simpson Index for measuring dietary diversity which indicates both, the richness and evenness of a diet (Venkatesh *et al.,* 2016; Sangeetha *et al.,* 2017). It is one of the most common indexes used in ecological studies for measuring species diversity in a given community. The same index was adopted and modified by Orris C. Herfindahl for application in economic studies. In the present study, it was estimated as follows:

$$SIDD_i = 1 - H_i = 1 - \sum_{j=1}^{n} S_{i,j}^2 \quad \ldots.(1)$$

where, $SIDD_i$ is the Simpson Index of Dietary Diversity for the i-th individual, $S_{i,j}^2$ is the proportion of the j-th food group in total monthly consumption of all food groups by the members of a household. The range of the Simpson index is [0, 1-(1/n)] where 0 indicates that household i only consumes one food group in the time frame considered and 1 refers to a situation when all food groups have an equal share. Based on the NSS survey we computed the Simpson index variable using quantity shares on nine food groups, namely, cereals, pulses, milk and milk products, fats and edible oil, seafood and flesh, roots and tubers, green leafy vegetables, other vegetables, and fruits.

Empirical Framework: Linkages between Dietary Diversity and Household Socio-Economic Factors

The relationship between dietary diversity and different characteristics of the households have been analysed econometrically with dietary diversity as the response variable. As the extent of influence of explanatory variables on response variable may vary from rural to urban areas, separate regression analysis have been carried out for rural and urban areas. Furthermore, as Simpson index is a proportion bounded by 0 and 1 the obvious concern is of the assumption of normality as using a proportion in a linear regression model can predict values that are not possible – values below 0 or above 1. Logit transformation on the data is one traditional way to alleviate this problem where the response variable which in our case is the Simpson index becomes:

$$TSIDD = \ln\left[\frac{SIDD_i}{1-SIDD_i}\right] \quad \ldots.(2)$$

where, *TSIDD* refers to Transformed Simpson Index (Baum, 2008; Thiele and Weiss, 2003). After mapping the original Simpson index to the real line, we have fitted a multiple linear regression model using several socio-economic and demographic

variables. The descriptive statistics for these variables are given in Table 2. The empirical model used to study the determinants of dietary diversity is as follows:

$$Y = \beta_0 + \beta_1 HI + \beta_2 HS + \beta_3 lnLandOwned + \beta_4 Age + \beta_5 \frac{Age^2}{100} + D_1 Sex + D_2 Region + D_3 Education + D_4 Occupation + u \quad \ldots.(3)$$

where *Y* is the logit transformed Simpson index, *HS* is the household size, and *HI* is the households' monthly income computed by taking the product of household size and monthly per capita consumption expenditure. The above equation is specified as logarithmic in land owned for convenience and making results more interpretable. We have also included both age and its quadratic transformation in the model following Lee and Brown (1989) who report that age has a non-linear relationship with dietary diversity. Regional dummy variable has been used to allow for more in-depth analysis of the process of dietary diversification unfolding in Uttar Pradesh as most of the states' well-off districts are clustered in its westernmost part (Livemint, 2015). The dummy variables education and occupation introduced in the model provides information about the capabilities of the head of the household. The above equation has been estimated using Ordinary Least Square regression techniques.

TABLE 2. DESCRIPTIVE STATISTICS OF THE VARIABLES

	Rural		Urban	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
(1)	(2)	(3)	(4)	(5)
Simpson Index of Dietary Diversity	0.52	0.13	0.58	0.12
Household income (in '000 Rs)	7.33	5.93	9.48	8.21
Household size (in No.)	5.82	2.92	5.12	2.63
Land owned by the household (in '000 ha)	0.73	1.44	0.24	0.98
Age of the principal wage earner (in No.)	46.37	13.72	45.39	13.48
	Frequency			
Sex dummy: principal wage earner				
Female	558		303	
Male	5357		2796	
Region dummy:				
Eastern	3869		1661	
Western	2046		1438	
Education dummy: principal wage earner				
Not literate	2351		802	
Literate without formal schooling	42		30	
Literate with formal schooling	3082		1627	
Diploma and above	440		640	
Occupation dummy: principal wage earner				
Self-employed			1534	
In agriculture (Farming)	2254		-	
In non-agriculture (Trade)	1363		-	
Service	504		909	
Labour			380	
Agricultural labour	345		-	
Non-agricultural labour	1189		-	
Other	260		276	

Empirical Framework: Linkages between Dietary Diversity and Nutritional Outcomes

Here, we hypothesise that poor nutritional outcomes in individuals arise in response to the underlying community and basic characteristics of the district. Therefore, Simpson indices for each of the 71 districts in Uttar Pradesh as well as separate estimates for rural and urban areas have been calculated using the equation previously described and averaging over sample observations in each district and sector. On similar lines the average monthly per capita consumption expenditure have also been calculated for each district and sector using data from the NSS 68th round surveys. In addition, several other key nutrition and development indicators have been used in the analysis from the fourth series of the NFHS surveys. In this framework of analysis, the data from the rural and urban areas have been pooled and a regression model has been estimated. However, the crucial question with pooled regression is whether the coefficients generated from two different regressions, estimated on two different samples are equal or not. Taking this into account a dummy variable approach has been used to determine whether the data could be pooled together. An insignificant F-value justified pooling the data (Gujarati, 1970). A description of each of these variables along with statistics has been included in Table 3. We employed a multivariate multiple regression model to study the effect of dietary diversity on nutritional outcomes. The general form of the model can be expressed as follows:

$$(uwc, uww, uwm) = f(dws, san, hs, ml, wl, sid, mpce, sector) + u \quad \ldots.(4)$$

TABLE 3. DESCRIPTIVE STATISTICS OF THE VARIABLES

Variables (1)	Mean (2)	Std. Dev. (3)
Underweight children	39.64	6.95
Underweight women	25.79	5.46
Underweight men	26.21	7.39
Households with an improved drinking-water source	96.43	8.18
Households using improved sanitation facility	32.32	18.61
Households with any member covered by a health scheme	6.05	4.14
Men who are literate	82.22	8.12
Women who are literate	60.37	11.29
Simpson Index district level	54.01	6.83
Monthly per capita consumption expenditure	1651.63	943.79
	Frequency	
Sector dummy:		
Rural	71	
Urban	71	

All the variables except sector dummy are in percentages.

where *uwc*, *uww* and *uwm* refers to the prevalence rates of underweight in children, women, and men respectively, *dws* refers to the percentage of households with an improved drinking-water source, *san* is the percentage of households using improved

sanitation facility, *hs* refers to households with any usual member covered by a health scheme, *ml* refers to men who are literate, *wl* refers to women who are literate, *sid* is district level Simpson index, *mpce* is average monthly per capita consumption expenditure for each district, *sector* is a dummy indicating rural or urban area. The error term *u* represents the factors which are not taken into account explicitly in the model.

Limitations of the Study

The analysis is not without limitations. A major limitation of the study is the simultaneity bias arising out of the following reasons; firstly, it is possible that due to data constraints some unobserved factors may not have been controlled for in the determination of dietary diversity, resulting in omitted variable bias. Secondly, as the analysis draw on cross-sectional data having information from households at one time point only, it was not possible to examine the process of dietary diversification longitudinally, which would have given a better insight. Thirdly, in our empirical framework linking dietary diversity and nutritional outcomes, it is likely that our variable of interest, Simpson index district level might be affected by the same factors affecting the underweight in children and adults. However, this issue will be a focus of future research. Lastly, the research design followed to compute the Simpson index may limit the explanatory power of the empirical analysis due to two constraints which should be noted: (a) not all food items have been used in the analysis as in measuring diversity using quantities of food items, a common measure (e.g. kilograms) is required for aggregating across foods. As some cooked products and few other items have been reported in counts in the NSS survey they have been dropped from the analysis. In addition, some other products which are not relevant to the locale of the study have also been dropped. (b) typical recall error associated with NSSO approach for collecting information on food consumption on a 30-day recall period.

III

RESULTS AND DISCUSSION

3.1. *Pattern of Dietary Diversity*

The results from the summary statistics of the variables in our model show that the average value of the Simpson index is 0.52 in rural area and 0.58 in urban area. In order to further understand the disparity in our sample, the households were categorised into low (sidd<0.5), medium (0.5≤sidd≤0.7), and high dietary diversity (sidd>0.7). The distribution of households based on their dietary diversity score has been illustrated graphically in Figure 1.

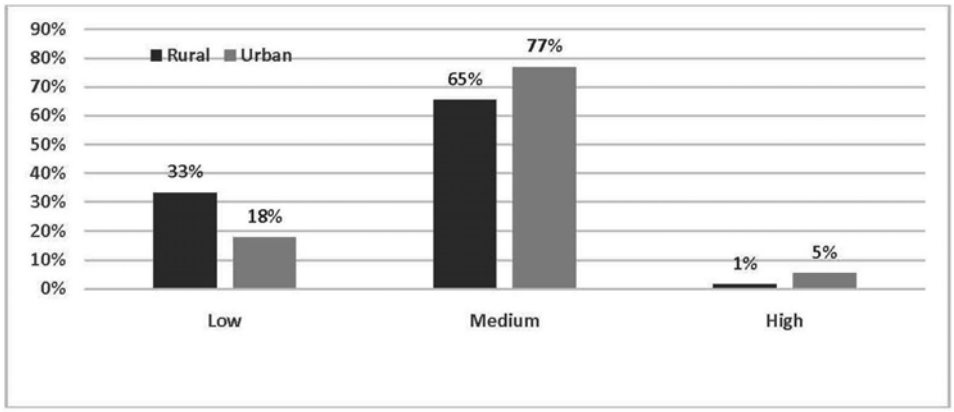

Figure 1. Distribution of Households Based on their Dietary Diversity Score.

3.2. *Determinants of Dietary Diversity*

Simpson index estimates for the empirical model specified to study the determinants of dietary diversity are presented in Table 4. Based on the t-ratios and our expectations of the association between dietary diversity and various characteristics of the household and household head, the relationships are found to be similar to those reported in previous studies.

Association between Dietary Diversity and Household Income

As suggested by Jackson (1984) the results from our findings confirm the expected positive relationship between income and dietary diversity. The results show that one unit (Rs.1000) increase in household income is associated with a 0.03 increase in TSIDD in rural Uttar Pradesh and a 0.01 increase in TSIDD in urban Uttar Pradesh. Since a diverse food basket is generally more appetising and is expected to benefit health, it seems highly reasonable that households change their consumption behaviour and shift to a more diverse diet as their income increases.

Favourable Effects of Land on Dietary Diversity

The analysis reflects that the effect of land owned by households vary across rural and urban areas. The parameter estimates for the size of land owned indicates that a one per cent increase in the amount of land owned by households in rural areas increases TSIDD by 0.02 units. However, land do not affect urban consumption patterns. Intuitively, the positive and significant impact of land owned by households in rural areas supports the conviction that land is an asset and the scope of possible sources of revenue that can be derived from it, this result is in line with Ochieng *et al*. (2017) study. The economy of the farmers is fundamentally dependent on land and the wealth effects have led to modest increases in dietary diversity.

TABLE 4. DETERMINANTS OF DIETARY DIVERSITY

Variables (1)	Coefficient (2)	Rural standardised coefficient (3)	t-value (4)	Coefficient (5)	Urban standardised Coefficient (6)	t-value (7)
Y: Dietary Diversity (TSIDD)						
Constant	0.821***			0.608***		
X_1: Household Income	0.034***	0.274***	7.56	0.011***	0.235***	4.9
X_2: Land Owned	0.026***	0.099***	4.34	- 0.001	- 0.004	- 0.15
X_3: Household Size	- 0.050***	- 0.240***	- 9.51	- 0.046***	- 0.274***	- 8.64
X_4: Age	- 0.020***	- 0.490***	- 4.59	- 0.005	- 0.159	- 1.06
X_5: $Age^2/100$	0.000***	0.491***	4.53	0.000	0.163	1.14
D_1: Sex(1=female ; 0=male)	- 0.013	- 0.007	- 0.31	0.036	0.027	0.8
D_2: Regional dummy (1=east ; 0=west)	- 0.378***	- 0.325***	- 20.05	- 0.186	- 0.229	- 9.03
Education dummy (base is illiterate)						
D_3: Education (1=literate without formal schooling; 0=otherwise)	0.160*	0.026*	1.68	0.225**	0.050**	2.19
D_4: Education (1=literate with formal schooling ; 0=otherwise)	0.110***	0.100***	4.95	0.110***	0.135***	3.99
D_5: Education (1=diploma and above ; 0=otherwise)	0.199***	0.073***	4.91	0.102***	0.098***	2.87
Occupation dummy for rural (base is farming)						
D_6: Occupation (1=trade ; 0=otherwise)	- 0.045	-0.030	-1.48	-	-	-
D_7: Occupation (1=service ; 0=otherwise)	0.004	0.002	0.11	-	-	-
D_8: Occupation (1=agricultural labour ; 0=otherwise)	- 0.049	- 0.028	- 1.01	-	-	-
D_9: Occupation (1=non-agricultural labour ; 0=otherwise)	-0.051*	- 0.035*	- 1.66	-	-	-
D_{10}: Occupation (1=other ; 0=otherwise)	- 0.117**	- 0.042**	- 2.01	-	-	-
Occupation dummy for urban (base is self-employed)						
D_{12}: Occupation (1=service ; 0=otherwise)	-	-	-	0.086***	0.094***	3.54
D_{13}: Occupation (1=labour ; 0=otherwise)	-	-	-	- 0.060*	- 0.051*	- 1.69
D_{14}: Occupation (1=other ; 0=otherwise)	-	-	-	- 0.030	- 0.019	- 0.73
Number of observations		5807			2574	
R-squared		0.25			0.23	

The t-ratios are based on robust standard errors. ***, **, * Significant at 1, 5, 10 per cent level, respectively.

Influence of Household Size on Dietary Diversity

Household size is found to have a significant negative impact on the dietary diversity of the household in both urban and rural areas. This impact could be

because of the peculiar characteristic of the Indian households defined by gender stereotypes and patriarchal norms. Women of the households are responsible for cooking and other domestic chores and as the household size increases it leaves less time for her to prepare a broad range of different meals and cater to the needs of all the members of the household. This leads to a reduced variety of food products demanded and prepared in the household. Powell *et al*. (2017) also suggest that even though larger family size presents an obstacle to a varied diet and food security by decreasing the households' ability to support the family financially, in some cases, it may increase it.

Importance of Regional Characteristics in Affecting Dietary Diversity

The distribution of the Simpson index of dietary diversity in rural and urban Uttar Pradesh and eastern and western Uttar Pradesh have been illustrated graphically in Figure 2.

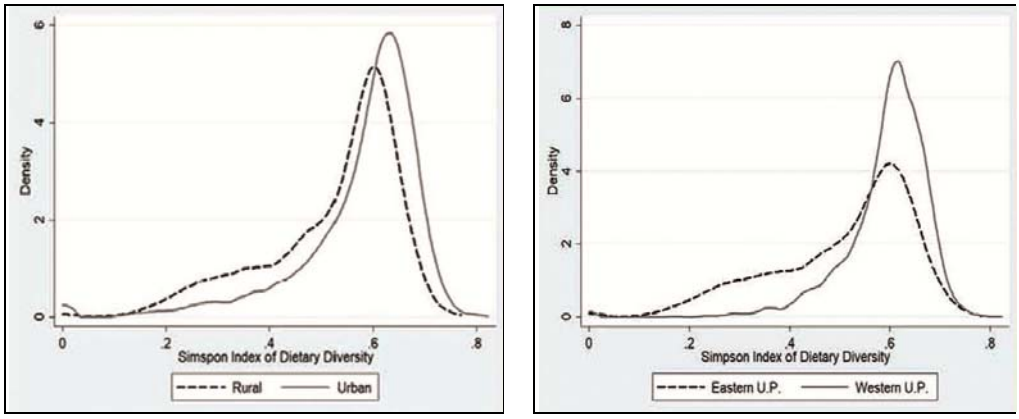

Figure 2. Distribution of Simpson Index of Dietary Diversity across Sectors and Regions.

The figures reveal large disparity in dietary diversity among households in Uttar Pradesh. The dummy variable region considered in the analysis has a significant impact on dietary diversity. It appears from our results that after controlling for various household characteristics, living in western Uttar Pradesh increases the degree of dietary diversity. There are intersectoral and interregional differences in growth and economic inequality that greatly affects the quality of life of individuals and social groups. From this perspective, this result may be attributed to the relatively better standards of living and employment opportunities present in western Uttar Pradesh. The negative sign of the dummy variable 'Eastern Uttar Pradesh' can be explained by an ostensible east-west classification of Uttar Pradesh. Apparently, the eastern part of the state is plagued by underdevelopment, poverty, and backwardness

which seems a plausible reason why the region has not performed well in the food diversity dimension. These underlying characteristics of the regions regarding various issues of development considerably influence the consumption behaviour of the households.

Household Characteristics and Dietary Diversity

Rural Uttar Pradesh

Table 4 clearly shows that all parameter estimates relating to the characteristics of the household head are highly significant, except the estimate for female-headed households and some categories of the dummy variable occupation. However, the negative sign of the dummy variable female is in conformity with our expectation of female-headed households being more vulnerable to poverty. We have included both age and its quadratic transformation in our analysis following Lee and Brown (1989) who report that age has a non-linear relationship with food diversity. The estimate of age is negative while that of age-squared is positive suggesting that dietary diversity of the households with the middle-aged individual as the household head is lower than the households having younger and older individuals as household head. It appears that middle-aged households consume the same basic foods and their lower dietary diversity can be due to a combination of favourable conditions such as low income, nature of the job, household composition, etc.

Many past studies expect education and demand for a diverse diet to be positively correlated as highly educated people are more likely to buy a variety of food items as they are better aware of the potential benefits of eating a diverse diet (Moon *et al*., 2002; Lee, 1987). In conformity with the past studies, the education level of the household head has been found to have a significant positive impact on the dietary diversity of the households. Finally, the type of occupation of the household head may also help to increase the dietary diversity of the households. The results reveal that families self-employed in agricultural activities such as farming have a significantly higher dietary diversity than families which are either employed as labourers in non-agricultural jobs or are involved in other activities. The dummy variables for other rural occupations do not significantly affect dietary patterns.

Urban Uttar Pradesh

The results show that the characteristics such as age and gender of the household head do not affect the consumption pattern in the urban areas. However, education and occupation of the principal wage earner contribute significantly in increasing the variety in food consumption.

Educational attainment is positively correlated to the demand for a variety of food. All dummy variables have been found to have a parameter estimate

significantly different from zero at α=0.05 level of significance. Moreover, as a relatively higher income is one of the major factors in affecting the dietary diversity as it helps in accessing high-value commodities like fresh fruits and vegetables, as well as healthier alternatives to processed food items, households' head employed in service sector tend to purchase a significantly diverse food basket than those working as traders and labourers. The parameter estimate for the dummy variables is significant at α=0.10 level of significance.

3.3. *Dietary Diversity and Nutritional Outcomes*

Pattern of Nutritional Outcomes

Figure 3 shows the prevalence of undernutrition among children and adults by the type of residence. As shown in the figure children in urban areas are slightly less likely to be underweight (38.5 per cent) than those in rural areas (40.8 per cent). Moreover, women in urban areas are slightly less likely to be underweight (23.8 per cent) than those in rural areas (27.8 per cent). The pattern of underweight among men is similar to those among women.

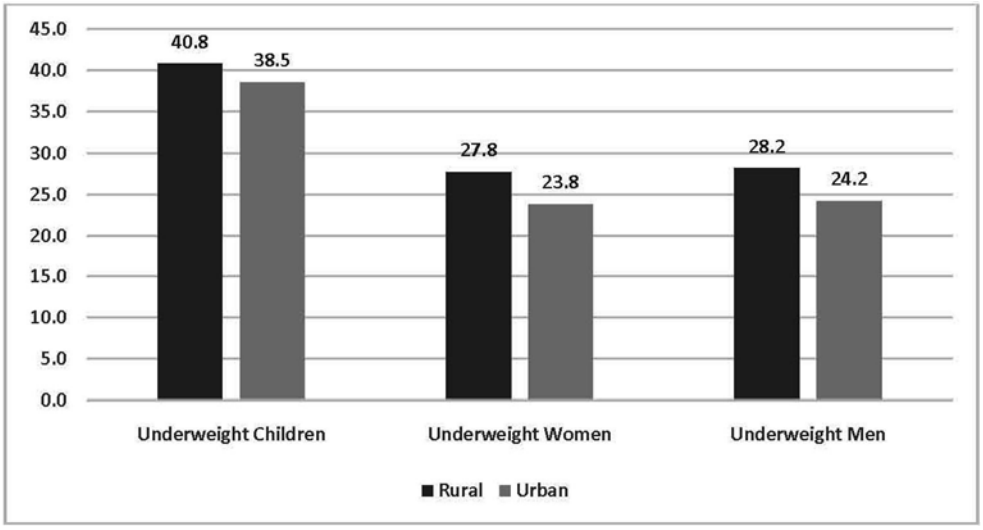

Figure 3. Prevalence of Underweight by Residence.

The poor and best performance districts in Uttar Pradesh in terms of nutritional outcomes have been depicted in Figure 4. Gautam Buddha Nagar and Ghaziabad have emerged as the top districts in terms of their performance in nutrition indicators. Bahraich and Shrawasti seem to be the worst performing districts.

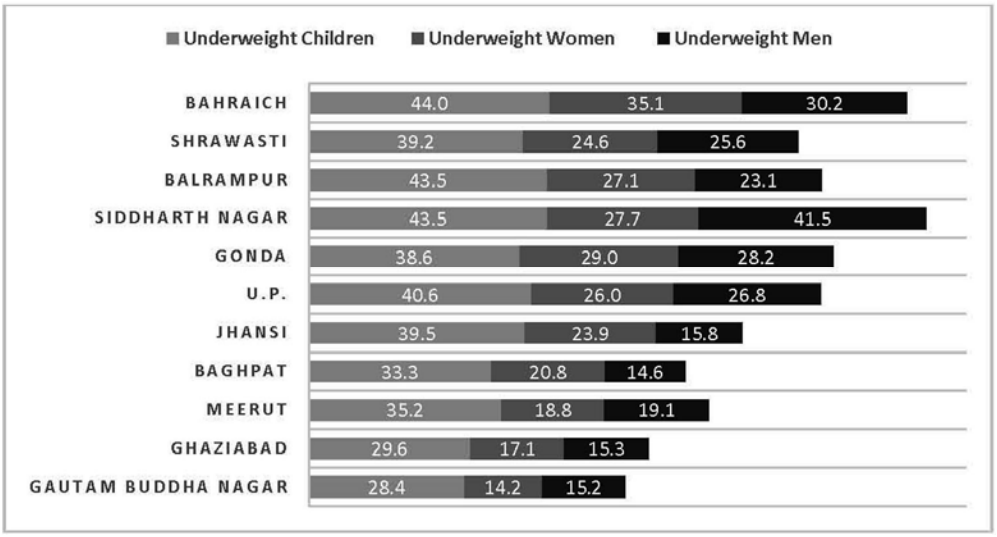

Figure 4. Districts in Uttar Pradesh with the Highest and Lowest Prevalence of Underweight.

A perusal of the figure suggests that the prevalence of underweight children is the highest in Bahraich (44 per cent), followed by Balrampur and Siddharth Nagar (43.5 per cent each). The highest proportion of underweight women is observed in Bahraich (35.1 per cent) and Gonda (29 per cent). Another interesting observation intruding from the figure reveals the exceptionally high prevalence of underweight men in Siddharth Nagar.

Relationship between Underweight and Dietary Diversity

The multivariate regression results are presented in Table 5. The results indicate that the model is statistically significant overall, regardless of the multivariate criteria used. Moreover, multivariate tests for each of the independent variables show that except monthly per capita consumption expenditure (*mpce*), men literacy (*ml*) and sector dummy all the five variables are statistically significant overall, no matter which multivariate test is used. The value of Wilks' Lambda (0.29) for the model shows that 71 per cent of the variance in the dependent variables has been accounted for by variation in the independent variables. Additionally, Pillai's trace indicates that about 81per cent of the variance in the dependent variables has been accounted for by variation in the independent variables.

TABLE 5. MULTIVARIATE REGRESSION RESULTS WITH CHILDREN UNDERWEIGHT, WOMEN UNDERWEIGHT AND MEN UNDERWEIGHT AS OUTCOME VARIABLES

	Coefficients			Multivariate Statistics			
Covariates	Children	Female	Male	W	P	L	R
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	85.33***	43.38***	48.49***				
X_1: Households with an improved drinking-water source	-0.11	0.06	0.11	0.94**	0.06**	0.06**	0.06**
X_2: Households using improved sanitation facility	0.04	-0.09***	-0.06	0.86***	0.14***	0.16***	0.16***
X_3: Households with any member covered by a health scheme	-0.47***	-0.29***	-0.31**	0.88***	0.11***	0.13***	0.13***
X_4: Men who are literate	-0.14	0.01	-0.14	0.96	0.03	0.04	0.04
X_5: Women who are literate	-0.16**	-0.22***	-0.17**	0.85***	0.15***	0.18***	0.18***
X_6: District level Simpson index of dietary diversity	-0.21**	-0.13***	-0.15*	0.93**	0.06**	0.07**	0.07**
X_7: District level monthly per capita consumption expenditure	0.00	0.00	0.00	0.99	0.00	0.00	0.00
D_1: Sector (1=rural ; 2=urban)	0.04	0.07	-0.60	0.99	0.00	0.00	0.00
Model				0.29***	0.81***	2.12***	1.95***
R-squared	0.26	0.65	0.38				
Number of observations	142	142	142				

***, ** and * Significant at 1, 5, 10 per cent level, respectively.

W refers to Wilks' Lambda; L refers to Lawley-Hotelling trace; P refers to Pillai's trace; R refers to Roy's largest root.

Most of the existing literature on the association between dietary diversity and child nutritional status reveals that underweight usually results from the cumulative effect of inadequate intake of food for an extended period of time (Lartey *et al*., 1999; Arimond and Ruel, 2004). It seems apparent that a lack of variety in the diet leads to poor nutrition which subsequently leads to a low body mass index. Our findings from the study also uncovered a negative relationship between dietary diversity and under nutrition. As one would expect, the pattern between dietary diversity and nutritional status in adults is similar to as found in children. However, the results show that the observed relationship in children is particularly strong. This may be owing to the fact that children in their childhood, particularly during infancy are fed with a variety of foods including fruits and vegetables to cover the nutritional needs of the growing child. Moreover, as fruits and more nutritious products are generally more expensive they are usually fed to children. This trend becomes more apparent in rural areas and among low-income families who live on the edge of financial survival, parents and specially mothers who skip their meals to provide for their children's nutritional requirements. Another explanation for the pronounced effect of dietary diversity in children's nutritional status is that the strength and the nature of the association between dietary diversity and nutritional outcomes are peculiar and varies between different age groups (Ruel, 2003).

Exploring the literature on the association between education and health suggest that education, income, and health are deeply entwined (Cutler and Lleras-Muney,

2006). While it may seem obvious as achieving dietary diversity is closely linked to education, it is worth mentioning that better nutritional outcomes do not result from a diverse diet alone and there are socio-economic factors at play which affect the overall development of individuals, especially children. Looking at the regression results, women literacy appears to be a strong factor in avoiding poor nutritional outcomes in children. One of the most important channel through which maternal education influences nutritional outcomes in children is the mother's care of children within the household context. Educated mothers are more likely to know the importance of a balanced diet and the nutritional requirements of children and infants and are thus more likely to engage in health-promoting behaviour. Moreover, they seem to have better knowledge about disease causation, prevention and cure (Cleland and van Ginneken 1988). It turns out that the improved nutritional outcomes in adults too are associated with higher literacy levels in women. It seems clear that better education leads to better income opportunities which are likely to lead to better health. However, it is important to note that better health too in many ways help individuals to become more educated.

In addition, Table 5 reports that under nutrition in children and adults is significantly lower in districts where there is a greater proportion of households' having members covered by a health scheme. This implies that educated individuals are more aware and better informed about the health risks and make better choices when it comes to health belief and health services. However, it is important to note that household income and affordability of health insurance is a major barrier to access health care services. Thus, health insurance here is also acting as a proxy for household income.

Further, access to clean drinking water and presence of basic toilets and sanitation facilities are considered to be important factors in determining the nutritional and health outcomes. Looking at the MANOVA output, we find that the multivariate test statistics for households with an improved drinking-water source and an improved sanitation facility are statistically significant which indicate that our covariates have a statistically significant relationship with the combined dependent variables of underweight in children and adults. However, the relationship between these covariates and nutritional outcomes, do not come out strong in the univariate models.

IV

CONCLUSION

The paper clearly confirms that inter-household differences in consumption behaviour are a function of the characteristics of the households and its members. The dietary pattern of the households in Uttar Pradesh have been analysed using a nationally representative sample survey data on food consumption obtained from the NSSO for the year 2011-12. The results from the econometric analysis reveals that:

(1) households are likely to diversify their diet as their income rises; (2) size of the land owned by households is strongly linked to eating habits and diet for rural households only; (3) dietary diversity is inversely related to the number of members in the household; (4) age of the household head is strongly correlated to dietary diversity in rural areas only, and has a non-linear effect on food diversity, indicating households with middle-aged individual as household head has the lowest degree of variety; (5) regional characteristics play important roles in affecting the diet of individuals; (6) Lastly, educational attainment and occupation level of the household head is a crucial factor in increasing the degree of variety in food consumption.

Moreover, the paper elaborates on the subject and as stated by other studies, it establishes promising links between dietary diversity and nutritional outcomes. Using key nutrition indicators from the annual report of NFHS-4 and constructing district level dietary diversity scores from nine food groups, the study found a negative relationship between the degree of variety in food consumption and under nutrition. In addition, the present study also stresses the importance of education in improving the nutritional outcomes in individuals.

While a number of studies have well documented the impact of household socio-economic status on food security, not much research has been done on the impact on dietary diversity and quality. The linkages between nutrition and health are particularly strong and as it is clear from the results that dietary diversity improves health outcomes by providing the body with adequate micro and macro-nutrients, it is necessary to clearly understand and identify the major factors that can improve people's diet and consequently their health. Another important reason why the topic demands urgent-multidisciplinary attention and intervention is the emergence of the "third burden" of malnutrition – that is while some are deprived of adequate food supplies, others are getting too much of it. The country and society are under a dietary transition where technology and innovation are acting as a double-edged sword. Thus the study highlights that it is imperative to design nutrition and health policies that take into account the inherent dynamics of the complex food system. Moreover, it points out the importance of social and behavioural change principles in guiding people to adopt a healthy diet and live a healthy lifestyle.

REFERENCES

Arimond, M. and M.T. Ruel (2004), "Dietary Diversity is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys", *The Journal of Nutrition*; Vol.134, pp.2579–85.

Baum, C.F. (2008), "Stata tip 63: Modeling proportions", *Stata Journal*, Vol.8, pp.299–303.

Cleland, J.G. and J.K. Van Ginneken (1988), "Maternal Education and Child Survival in Developing Countries: The Search for Pathways of Influence", *Social Science Medicine*, Vol.27, No.12, pp.1357-68.

Cutler, David and Adriana Lleras-Muney (2006), "Education and Health: Evaluating Theories and Evidence", *National Bureau of Economic Research*, Working Paper No.12352, Massachusetts Avenue Cambridge, MA.

Gujarati, D. (1970), "Use of Dummy Variables in Testing for Equality between Sets of Coefficients in Two Linear Regressions: A Note", *The American Statistician,* Vol.24, No.1, pp.50-52.

International Institute for Population Sciences (IIPS) and ICF (2017), *National Family Health Survey (NFHS-4)*, 2015-16, India, Mumbai: IIPS.

Jackson, Laurence Fraser (1984), "Hierarchic Demand and the Engel Curve for Variety." *The Review of Economics and Statistics*, Vol.66, No.1, pp.8-15.

Lartey, A.; A. Manu, K.H. Brown, J.M. Peerson, K.G. Dewey (1999), "A Randomised, Community-Based Trial of the Effects of Improved, Centrally Processed Complementary Foods on Growth and Micronutrient Status of Ghanian Infants from 6-12 Months of Age", *American Journal of Clinical Nutrition,* Vol.70, pp.391-404.

Lee, Jonq-Ying and Mark G. Brown (1989), "Consumer Demand for Food Diversity." *Journal of Agricultural and Applied Economics,* Vol.21, No.2, pp.47.

Lee, Jonq-Ying (1987), "The Demand for Varied Diet with Econometric Models For Count Data", *American Journal of Agricultural Economics,* Vol.69, No.3, pp.687-692.

Livemint (2015), "The Regional Divide within Uttar Pradesh", *Livemint HT Media, New Delhi.*

Moon, Wanki; Wojciech J. Florkowski, Larry R. Beuchat, Anna V. Resurreccion, Pavlina Paraskova, Jordan Jordanov and Manjeet S. Chinnan (2002), "Demand for Food Variety in an Emerging Market Economy", *Applied Economics,*Vol.34, No.5, pp573-581.

Ochieng, J.; V. Afari-Sefa, P.J. Lukumay, T. Dubois (2017), "Determinants of Dietary Diversity and the Potential Role of Men in Improving Household Nutrition in Tanzania", *PLoS ONE,* Vol.12, No.12, pp.1-18.

Powell, B.; Kerr R. Bezner, S.L. Young, T. Johns (2017), "The Determinants of Dietary Diversity and Nutrition: Ethnonutrition Knowledge of Local People in the East Usambara Mountains, Tanzania", *Journal of Ethnobiology and Ethnomedicine*, Vol.13, No.1, pp23.

Ruel, M.T. (2003), "Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities", *The Journal of Nutrition*, Vol.133, pp.3922S-3926S.

Sangeetha, V.; P. Singh, G.S. Mahra, S. Sarkar, P. Venkatesh, Satyapriya, B.S. Tomar and M. Wason (2017), "Assessment of Food Consumption Pattern in Uttar Pradesh: A Dietary Diversity Study", *Indian Journal of Agricultural Sciences*, Vol.87, No.6, pp.846–52.

Sangeetha, V.; V. Lenin, P. Singh, Satyapriya, P. Venkatesh, S. Paul and S. Singh (2018a), "A Study of Rural Household Dietary Diversity: The Case of Raebareily District, Uttar Pradesh", *Annals of Agricultural Research,* Vol.39, No.3, pp.313-324.

Sangeetha, V.; P. Singh, Satyapriya, G.S. Mahra, P. Venkatesh, V. Lenin and A.K. Singh (2018b), "Nutritional Status and Food Consumption Pattern in Disadvantaged Areas of Madhya Pradesh", *Indian Journal of Extension Education,* Vol.54, No.3, pp.59-66.

Thiele, Silke, and Christoph Weiss (2003), "Consumer Demand for Food Diversity: Evidence for Germany", *Food Policy*Vol.28, No. 2, pp99-115.

Venkatesh, P.; V. Sangeetha and P. Singh (2016), "Relationship between Food Production and Consumption Diversity in India – Empirical Evidences from Cross Section Analysis", *Agricultural Economics Research Review*, Conference No.29, pp.139-148.