Multivariate Analysis of Consumption Pattern of Milk and Milk Products vis-à-vis Food Items Across Different Income Groups in Kamrup District of Assam

Sweta Brahma, Biswajit Sen, Udita Chaudhary, Sanjit Maiti, Sangita Ganguly & Ajay Verma*
ICAR- National Dairy Research Institute,
ICAR-Indian Institute of Wheat and Barley Research, Karnal (Haryana), India.

(Corresponding author: Ajay Verma*)

ABSTRACT: The sample households were divided into three income groups based on monthly family income using the cumulative square root frequency approach. These groups were classified as low-income (up to ₹30,000), middle-income (₹30,001-₹80,555), and high-income (above ₹80,555). The majority of households (57.5 per cent) belonged to the middle-income group, followed by 38.5 per cent in the high-income group, and only 4 per cent in the low-income group. The analysis of Monthly Per Capita Expenditure (MPCE) on milk and milk products across different income groups revealed that households in high income group (income > ₹80,555) exhibit the highest expenditure on liquid milk (₹619.36), ghee (₹45.56), butter (₹44.69), paneer (₹69.66), and sweets (₹181.32), indicating that higher income correlated with increased consumption of these items. Conversely, households in lower income group (income < ₹30,000) spend less on these products, with the lowest expenditure on ghee (₹4.97) and minimal expenditure on butter or ice cream. The analysis employed the Newey-West HAC method and Pooled OLS on expenditures on cereals, pulses, and fruits and vegetables as key positive predictors. Conversely, family size had a negative impact on MPCE, suggested that larger households tend to spend less per capita on dairy & dairy products. Age also showed a significant negative effect, with a coefficient of -5.133. Furthermore, the vegetarian dietary pattern notably elevated MPCE with a coefficient of 407.857, while self-employment status was positively associated with expenditure. The multivariate test results indicated significant differences in the consumption patterns of milk and milk products, as well as overall food products, across the dietary pattern groups. With a p-value of 0.001 for both the analyses, the null hypothesis (H_0) was rejected, confirming that vegetarians and non-vegetarians exhibited distinct consumption patterns. Specifically, the applied tests demonstrated that dietary choices had a substantial impact on monthly per capita consumption expenditure (MPCE), highlighted the varying priorities and preferences between the two groups in the study area.

Keywords: MPCE, Newey-West HAC, Pooled OLS, KRLS.

INTRODUCTION

The overall domestic consumption of milk was over 207 million metric tons in 2023 and the daily uptake of milk was nearly equal among men and women (Statista, 2024). Some common milk products include: Ghee, Curd, Butter, Ice Cream, Powder milk and Condensed milk etc (Chaudhari *et al.,* 2024). The demand for milk and milk products is rising sharply, driven by population growth, increasing incomes, and urbanization (Goyal *et al.*, 2024). This increased demand is expected to be met by domestic production. However, the quantity and types of milk consumed vary significantly across regions due to disparities in purchasing power across socioeconomic groups, differences in taste and dietary habits shaped by agro-climatic conditions, regional resource availability, and temporal variations in milk supply within different areas (Sharma and Omena 2024). Though India is self-sufficient in milk production, there exist significant

regional variation in milk production and in this regard, the North Eastern Region is deficit in milk production (Ray and Singh, 2023). Assam was purposively selected for the study as the organized milk marketing is still quite small despite previous attempts to create and advance collective market mechanisms in North-East Region of India (Mili and Dutta 2024). According to the 20th Livestock Census, total livestock population of Assam was recorded as 180.92 lakhs where the cattle population constitutes the largest group with 60% followed by goat population 24% and pig 12%. During 2022-23, the total milk production was recorded to be 1006.42 MT and per capita availability of milk was only 78 gm/day in Assam which is below all national average (Devi *et al.,* 2023). The state records only 12% per capita milk availability of milk among other North-eastern states. Assamese consumers favor raw milk over processed liquid or powdered milk due to the way milk is used in the state - either as a tea whitener or in milk sweets (Nicolini *et al.,* 2022).

MATERIALS AND METHODS

The study was conducted to assess the existing milk consumption pattern and preferences by different socio-economic groups in the Kamrup district of Assam state, while surveyed the both Metropolitan and rural areas. The study was carried out using a multistage random sampling technique. Within the Kamrup Metropolitan area, the localities of Bhangagarh and Kahilipara were selected, while Palashbari and Boko were chosen from the Kamrup Rural region. Fifty households were sampled from each locality, resulted in 200 respondents for the study. Primary data was collected from each household using a pre-structured schedule through a personal interview method conducted between February to May 2024.

The Newey-West heteroskedasticity and autocorrelation-consistent (HAC) estimator had been considered to overcome the heteroskedasticity and autocorrelation in the cross-sectional data pertaining to the household consumption of milk and milk products. This estimator had provided robust standard errors, correcting for potential heteroskedasticity and serial correlation in the regression residuals (Bahety *et al.,* 2022). The general form of the regression model used in the analysis was as follows:

$$f(x) = \alpha_i + \sum_{i=1}^{9} \beta_i \ X_i + \gamma_i D_i + e_i$$

where, f(x)= Monthly per capita expenditure on milk and milk products (₹)

X_i, D_i denoted independent & dummy variables respectively enlisted below, β_i, γ_i denotes estimated coefficients for the independent variables and e_i denotes error term

X_1 = Monthly per capita expenditure on cereals (₹)
X_2= Monthly per capita expenditure on pulses (₹)
X_3= Monthly per capita expenditure on fruits and vegetables ( )
X_4 = Monthly per capita expenditure on meat (₹)
X_5= Monthly per capita expenditure on fish (₹)
X_6= Monthly per capita expenditure on egg (₹)
X_7= Monthly family income (₹/month)
X_8= Family size (no.)
X_9= Age of respondents (in years)
D_1= Location (0=Rural, 1=Metropolitan)
D_2= Dietary pattern (0=vegetarian, 1=non-vegetarian)
D_3= Occupation of household head (0=Service, 1= Self-employment, 2=Others)

Multiple Variable Regression Analysis. Individual household's food consumption behavior depends on a number of explanatory variables. The model of individual household's consumption behavior, monthly per capita consumption expenditure (MPCE) had been estimated by primary data. Further, the multiple variable regression analysis had been adopted following the below mentioned econometric framework.

$$MPCE_{veg} = \alpha_i + \sum_{i=1}^{n} \theta_i \ X_i + \varphi_i D_i + \varepsilon_i$$

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Where, MPCE denotes per capita monthly consumption expenditure, X denotes set of explanatory variables, D denotes set of dummy variables list.

The non-parametric Kernel-based Regularized Least Squares (KRLS) framework had been employed to assess the consumer preferences towards milk and milk products as mentioned by Ahmadi *et al.* (2019). KRLS has been established as an advanced non-parametric regression technique that allowed the flexible modeling of complex relationships between predictors and outcomes (Singh *et al.,* 2021). The cited technique particularly suited for this analysis, as it captured the non-linear effects of various factors on household preferences for milk and products. This method assumed that the target function would be expressed as:

$$y = f(x)$$

Here, *y* was the outcome of interest *i.e.,* milk or any milk product, and *x* represented the explanatory variables. The KRLS method then approximated the function *f(x)* as a weighted sum of kernel functions, as below:

$$f(x) = \sum_{i=1}^{N} c_i k(x, x_i)$$

In this equation, $k(x,x_i)$ represented the kernel function, which captured the similarity between the point of interest x and the covariate vector x_i, where *i* ranges from 1 to N. The weight c_i was assigned to each kernel function based on its contribution to the overall approximation.

RESULTS AND DISCUSSION

The households were divided into three income groups based on monthly family income using the cumulative square root frequency approach. These groups were classified as low-income (up to ₹30,000), middle-income (₹30,001-₹80,555), and high-income (above ₹80,555). The majority of households (57.5 per cent) belonged to the middle-income group, followed by 38.5 per cent in the high-income group, and only 4 per cent in the low-income group.

A. Multivariate tests for Consumption pattern

(i) Milk and Milk Products. This study compared the differences among the income groups through multivariate analysis, revealed substantial variations in monthly per capita expenditure (MPCE) on milk and milk products.

H_0: There was no difference in consumption pattern for milk and milk products (MPCE) in the study area across different income groups.

H_1: There was a significant difference in consumption pattern for milk and milk products (MPCE) in the study area across different income groups.

The values of four multivariate test statistics had displayed in Table 1 —Wilks' lambda, Pillai's trace, Lawley-Hotelling trace, and Roy's largest root— showed p-values below 0.001, leading to the rejection of the null hypothesis. This confirmed that consumption patterns for milk and milk products had differed significantly across the income groups. Wilks' lambda, with a value of 0.7702, indicated that approximately 77% of the variance remains unexplained, pointing to a moderate difference between the groups. Additionally, Pillai's trace and Lawley-Hotelling trace both exhibited significant F-values, further reinforced this conclusion. Roy's largest root, the most sensitive indicator of group differences, yielded an F-statistic of 5.55, underscoring the substantial variation in consumption patterns among the income groups. Thus, the results clearly showed that income had a significant impact on the monthly per capita consumption expenditure of milk and milk products (Chale *et al.*, 2019). The consumption patterns of milk and milk products were significantly influenced by income disparities, typically displaying more diverse and frequent purchases of high value dairy products like butter, ghee, cheese etc., by high income household group as compared to other income groups (Lapar *et al.*, 2010).

(ii) Food items. Similarly the multivariate tests resulted significant differences in consumption patterns of food items across different income group's in the present study.

H_0: There was no difference in consumption pattern for food products (MPCE) in the study area across different income groups.

H_1: There was a significant difference in consumption pattern for food products (MPCE) in the study area across different income groups.

Table 2 presented the results of multivariate tests analysing the difference in the consumption pattern (MPCE) of food products across different income groups. The hypothesis tested is whether there is a significant variation in food consumption patterns based on income levels.

The table reported four multivariate test statistics: Wilks' lambda, Pillai's trace, Lawley-Hotelling trace, and Roy's largest root, all of which assess the variance between the groups. Wilks' lambda indicated that 79% of the variance is unexplained by income differences, but the p-value of 0.001 suggested a statistically significant difference (Mandal *et al.,* 2020). Pillai's trace also showed significant results, confirming that income groups differ in their food consumption patterns. Lawley-Hotelling trace and Roy's largest root further reinforce the conclusion that the consumption patterns significantly vary across income groups. Therefore, the null hypothesis was rejected, indicated that income significantly affects food consumption patterns in the study area.

B. Consumption pattern across different income groups

(i) Monthly Per Capita Expenditure (MPCE) on milk and milk products. The Monthly Per Capita Expenditure (MPCE) on milk and milk products compared were across different income groups and revealed significant spending patterns influenced by household income (Table 3). For liquid milk, households in the high-income group (>₹80,555) showed the highest mean expenditure at ₹619.36, followed by the middle-income group at ₹536.83 and the lower-income group at ₹409.69, indicated that higher income was associated with increased consumption of liquid milk (Singh *et al.,* 2021). In contrast, expenditure on powder milk remained relatively low across all groups, with the lower-income group spending the least (₹38.04) and the high-income group spending slightly more at ₹117.19. Variations in curd expenditure were moderate, with the middle-income group spending the most (₹99.24) which indicated a more consistent consumption pattern among middle-income households.

Spending on ghee and butter showed a stark difference, with the high-income group spending ₹45.56 on ghee and ₹44.69 on butter, while lower-income households exhibited negligible spending on both. Paneer consumption also increased with income, which suggested a preference for higher-quality dairy products among wealthier households. Ice cream and sweets followed similar trends, with high-income households allocating more towards these products. This highlighted the influence of income on dairy consumption choices. Overall, the results illustrated how changes in household income affected expenditure on milk and milk products.

(ii) Family expenditure on milk and milk products in different income groups. Table 4 compared family expenditure on milk and milk products across three income categories: lower (<₹30,000), middle (₹30,000–80,555) and high (>₹80,555). The data revealed that high-income households generally spend more on most dairy products. For liquid milk, mean expenditure increased with income, as low-income households spend ₹1631.25, middle-income households spends 1941.52 and high-income household group spends the

most at ₹2347.01. This suggested that while milk was a staple product across all income groups but higher-income families allocated more to it (Lipoeto *et al.,* 2013). Expenditure on powder milk also followed this trend where high-income households spend ₹468.75, significantly more than the lower-income household group, which s spends ₹97.83 only. Interestingly, curd expenditure was highest among middle-income households (₹339.92), while high-income households spend slightly less (₹266.27). For ghee and butter, high-income households allocated considerably more, with high-income households spending ₹152.95 on ghee and ₹185.45 on butter, compared to minimal spending by lower-income households. Paneer expenditure showed a gradual increase across income groups, while ice cream was purchased exclusively by high-income households. Notably, expenditure on sweets fluctuated, with high-income households spending the most (₹785.31), despite middle-income households spending less than low-income households.

C. Monthly per capita expenditure (MPCE) on food products

The Table 5 presented monthly per capita expenditure on various food categories across three income groups: lower (<₹30,000), middle (₹30,000-80,555) and high (>₹80,555). The data highlighted how expenditure on essential food items increased with increased income levels, reflecting different consumption patterns. For cereals, the mean expenditure increased from ₹417.81 in lower income household group to ₹560.06 in high income household group which indicated that higher-income households spend more on staple foods, possibly opting for higher-quality cereals. A similar trend was seen in pulses, where high income group spends ₹321.64, much higher than lower income household group ₹191.68.Expenditure on fruits and vegetables showed the largest variation, with high income household group spend significantly more than the other groups. This suggested that wealthier households might had more varied and nutritious diets. Meat and fish consumption expenditure followed a similar pattern where high-income household group spends more on these protein sources (Kadirvel *et al.,* 2019). However, fish expenditure peaks in middle income household group (₹367.13) and decreases slightly in high income

household group (₹359.31), potentially reflected a preference shift in high-income household group. Interestingly, egg expenditure showed a modest increase across all income groups, with high income household group spending ₹38.56 as compared to lower income group ₹22.75.

D. Family expenditure (₹/month) on food products based on different income categories

The table 6 highlighted the monthly family expenditures on various food products across different income categories: lower, middle and higher-income households. In terms of cereals, spending raised with income of households, from ₹1575.00 in lower-income households to ₹2176.40 in higher-income households which suggested that cereals were a staple item across all income groups, with a notable increase in expenditure among higher-income households. Expenditure on pulses also increased with income, from ₹685.13 in lower-income households to ₹1123.12 in higher-income households, reflected upward trends in pulse consumption expenditure as income grows. Edible oils show that the monthly family expenditure variations, with an average spending of ₹5003.75 for lower-income households and rising to ₹6548.92 among higher-income households, revealing that edible oils are a significant component of monthly spending in the households.

For fruits and vegetables, the expenditure ranges from ₹2081.25 in lower-income groups to ₹2815.33 in higher-income groups. This gradual increase across income levels suggests an emphasis on dietary diversity as household income rises. Meat expenditure also follows the same trend, with higher-income households spending more (₹2172.77) than lower-income households (₹1695.75). Expense on fish remain relatively stable across the three income categories, with only slight variations, while egg expenditures show a noticeable increase from ₹94.50 in lower-income households to ₹164.68 in higher-income households, indicating a growing preference for protein-rich foods with income growth.

Overall, with the increase in household income levels, households allocate more of their budget towards the diverse range of food products, particularly protein sources and high-valued items, underlining the impact of income on food consumption choices.

Table 1: Multivariate tests for consumption pattern (MPCE) of Milk and Milk Products.

Measure	F	(df_1)	(df_2)	F	Prob>F	Significance
Wilks' lambda	0.7702	18	378	2.93	0.001	e
Pillai's trace	0.2355	18	380	2.82	0.001	a
Lawley-Hotelling trace	0.2909	18	376	3.04	0.001	a
Roy's largest root	0.2628	9	190	5.55	0.001	u

(Note: e = exact, a = approximate, u = upper bound on F)

Table 2: Multivariate tests for consumption pattern (MPCE) of food products.

Measure	F	(df_1)	(df_2)	F	Prob>F	Significance
Wilks' lambda	0.7906	12	384	3.99	0.001	e
Pillai's trace	0.2134	12	386	3.84	0.001	a
Lawley-Hotelling trace	0.2597	12	382	4.13	0.001	a
Roy's largest root	0.2381	6	193	7.66	0.001	u

Table 3: Monthly per capita expenditure (MPCE) on milk and milk products.

Income Group	Lower (< ₹30,000)		Middle (₹30,000-80,555)		High (> ₹80,555)	
Products	Mean	SD	Mean	SD	Mean	SD
Liquid Milk	409.69	120.86	536.83	278.75	619.36	342.38
Powder Milk	38.04	519.62	93.34	354.01	117.19	331.46
Curd	68.26	96.63	99.24	109.04	82.69	74.48
Ghee	4.97	10.17	16.20	33.02	45.56	111.97
Butter	0.00	0.00	27.61	57.57	44.69	80.45
Paneer	39.29	48.20	55.97	68.21	69.66	71.52
Ice-cream	0.00	0.00	3.06	27.02	56.60	131.41
Sweets	123.29	228.25	100.89	186.52	181.32	235.48

Table 4: Family expenditure on milk and milk products.

Income Group	Lower (< ₹30,000)		Middle (₹30,000-80,555)		High (> ₹80,555)	
Products	Mean	SD	Mean	SD	Mean	SD
Liquid Milk	1631.25	692.92	1941.52	776.91	2347.01	1385.92
Powder Milk	97.83	1325.83	340.91	779.18	468.75	1941.12
Curd	248.88	284.92	339.92	301.44	266.27	220.43
Ghee	24.85	50.87	62.57	130.42	152.95	318.03
Butter	0.00	0.00	102.26	205.09	185.45	300.82
Paneer	163.63	220.50	194.13	185.29	254.91	197.40
Ice-cream	0.00	0.00	0.00	0.00	12.18	38.41
Sweets	710.09	914.58	439.14	532.52	785.31	860.10

Table 5: Monthly per capita (MPCE) on food products.

Income Group	Lower (₹ <30,000)		Middle (₹30,000-80,555)		High (₹ > 80,555)	
Products	Mean	SD	Mean	SD	Mean	SD
Cereals (₹)	417.81	179.72	453.21	279.24	560.06	337.30
Pulses (₹)	191.68	60.74	226.03	89.80	321.64	136.50
Fruit & Vegetables (₹)	529.81	229.49	763.89	521.38	836.71	789.14
Meat (₹)	312.67	300.09	458.24	256.53	467.76	383.69
Fish (₹)	286.82	261.77	367.13	247.69	359.31	298.75
Egg (₹)	22.75	25.15	40.27	27.27	38.56	31.23

Table 6: Family expenditure on food products of sample households.

Income Group	Lower (₹ <30,000)		Middle (₹30,000-80,555)		High (₹ > 80,555)	
	Mean	SD	Mean	SD	Mean	SD
Cereals (₹)	1575.00	666.01	1660.92	801.33	2176.40	1133.97
Pulses (₹)	685.13	367.80	789.93	447.50	1123.12	579.26
Fruit & Vegetables (₹)	2081.25	1004.62	2651.22	1395.58	2815.33	1591.85
Meat (₹)	1695.75	1208.86	1898.83	967.66	2172.77	1598.65
Fish (₹)	1711.50	902.87	1659.64	798.91	1726.05	1114.45
Egg (₹)	94.50	104.70	161.30	101.04	164.68	119.69

SUMMARY AND CONCLUSION

The households were divided as low-income, middle-income, and high-income based on monthly family income using the cumulative square root frequency approach. The majority of households belonged to the middle-income group, followed by the high-income group, and the low-income group. The analysis of Monthly Per Capita Expenditure (MPCE) on milk and milk products across different income groups had revealed that households in high income exhibited the highest expenditure on liquid milk, ghee, butter, paneer, and sweets, indicated the higher income positively correlated with increased consumption of these items. Conversely, households in lower income group spend less on these products, with the lowest expenditure on ghee and minimal expenditure on butter or ice cream. Higher-income households generally spend more, on the liquid milk and Powder milk expenditure. More interestingly, curd expenditure peaked in middle income group while spending on ghee and butter was higher in high income group. The expenditures on cereals, pulses, and fruits and vegetables were the key positive predictors pointed out by the Newey-West HAC method and Pooled OLS analysis. Conversely, family size had a negative impact on MPCE, suggested that larger households tend to spend less per capita on dairy & dairy products. Age also showed a significant negative effect, the vegetarian dietary pattern notably elevated MPCE, while self-employment status was positively associated with expenditure.

FUTURE SCOPE

Dairy outlets need to be expanded in both rural and urban regions of Kamrup to meet up the increasing demand for liquid milk besides essential is to implement the policy measures which would guarantee to the access affordable dairy products, particularly for lower-income families of the region.

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