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Consumer Behavioural Patterns Towards Milk and Dairy Products: An Analytical Investigation of an Indian Dairy Supply Chain

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ABSTRACT

Background: India has the most significant milk production and consumption level in the world. Fluid milk consumption will rise to 90 million metric tons in FY 2024 (Annual Report 202-23, United States Department of Agriculture). Milk is an essential component of daily diet in every age segment in India. Consumers' behaviour and consumption patterns are based on their choices and preferences about product quality, price and preferences. This article critically investigates the consumer perception towards indigenous dairy markets and their consumption and behavioural pattern.

Methods: Quantitative approach and Multiple Logistic Linear Regression Analysis (MLLRA) technique was used to test the hypothesis to establish a direct and indirect relationship among endogenous and exogenous variables. The sample was drawn from rural and urban regions of India's top ten milk-producing states.

Result: The research findings suggested a significant relationship between the direct and indirect role of consumers buying behaviour characteristics towards milk and dairy products and their satisfaction level. This research is limited to milk processors, dairy companies and dairy scientists in the field of marketing and dairy research. Dairy Farmers, Processors and Producers are vigilant about the quality of food products, especially milk delivered to their end users and their value-addition in the Milk Supply Chain (MSC) and logistics. In the past three years, during the unprecedented COVID-19, consumers' consciousness level about health and well-being has been argued.

Key words: COVID-19, Demographic characteristics, MLLRA, MSC.

INTRODUCTION

The Indian dairy sector accounts for about 22% of global milk production and has the highest milk consumption with 20% of total world consumption (USDA, Report, Feb. 2020). The current demand for milk will be between two hundred to two hundred ten million tonnes and is expected to increase by an average of three per cent in the coming decades (DHAD, FAO, 2022). Milk production is expected to increase by three to five per cent in FY 2022-23. India's dairy market will reach a value of INR 30,840 Billion at a CAGR of 14.8% by 2027 (Report, ICAR, 2019-2020).

In recent years, with the increasing demand for superior quality products and its brand's value diversifying the customer expectations and satisfaction level in India (Diwakar *et al*., 2020)., the usage of milk has been shifting from traditional dairy products to value-added and sustainable milk products. It is estimated that the recent trends in consumption patterns and production levels have significant growth in the Indian dairy sector (Squicciarini *et al*., 2017) .

The earning population of India lies between the age group of fifteen to sixty years of age, which is a progressive indicator of the demographic pattern. In the past few years, health consciousness, high disposable income and willingness to spend in the younger population stimulated the retail sales of milk and dairy products (Laura, 2016). The consumption pattern of milk users varies from 55.4% in 1991 to 67% in 2019. It is observed that in India, a large amount of milk, about twenty-five to thirty per cent consumed by children below the age of fourteen. A paradigm shift in family setup reflects the changes in the standard of living and consumption patterns.

The Indian dairy industry comprises both formal and informal sectors for the large production of raw milk and dairy products. Among India's top ten milk-producing states, Uttar Pradesh produced the highest amount of milk, about 30.52 million metric tons, followed by Rajasthan, 23,67 million tons in 2019 (Fig 1). However, milk production from an individual milch animal has been reduced over the past few years shown in figure (Table 1).

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The motivation of the research is to understand the role of observed and unobserved demographic characteristics like household income, age group, employment, education level, food habits and others in the consumption pattern of milk users.

The conceptual framework shown in (Fig 2), is a natural progression of the phenomenon that describes the relationship between crucial indicators or constructs to be studied based on the proposed model of the study.

Related literature

Consumer behaviour pattern

It is evident that in present studies, the wide spread of epidemic diseases like COVID-19 and lockdown situations in various parts of the world changes the buying behaviour pattern of consumers related to health and hygiene products (Alejandro Acosta *et al*., 2021). Infectious diseases like the coronavirus mainly impact immunity and mental health. Naturopathy, yoga and Ayurveda as supportive intervention in the COVID-19 treatment of patients helps to improve immunity (Golechha, 2020).

Emerging trends in dairy markets

During the pandemic in India, digitalisation and localisation of Inbound logistics in the dairy supply chain (DSC) mitigate the risks in dairy processing activities to ensure dairy milk collection, supply to the end-users with taking all precautionary measures, production of milk in case of shortage of staff to avoid spreading of infection. Distribution channels are working correctly to maintain an efficient supply chain (Alejandro *et al*., 2021).

Bovine milk plays a vital role in the human diet and possesses multiple health benefits to fight against cancer and cardiovascular and bacterial disease. Milk contains about 3.5 cents of Protein as an essential constituent of milk components (Surya *et al*., 2017).

Chemical constitution and complexities in milk

The pigmentation and colouration of milk and dairy products depend on factors related to primary and transformation processes. Carotenoids are chemical constituents which play a significant role in the colour of dairy products. The composition of carotenoids and retinol in milk depends on several dietary and non-dietary factors, like animal breed and feeding management (Gabriela *et al*., 2018).

Buying intentions and rethinking strategies

Milk users pay a premium price when receiving health benefits from indigenous cow milk (Kumar *et al*., 2018). In the Milk Supply Chain (MSC), new technology facilitates techniques like robotic milking systems, making collecting and testing milk samples easier. Developments in analytical techniques have helped fractionate as well as characterise milk components (Priyadarshini, 2018). Knowledge of the biosynthesis of milk components has rapidly progressed over the past fifty years. Milk testing has also been transformed from a slow procedure done in the laboratory to rapid testing of multiple components (Lucey *et al*., 2017).

Buying theories to understand consumer pattern

The TPB (Theory of Planned behaviour) in this context is pertinent to understanding the role of the decision-making ability of an individual. It also acts as an effective tool to choose various alternatives in a planned manner influenced by an individual's past experiences and future expectations (Posthuma and Dworkin, 2000). This theory explains the cognitive factors like motivation, attitude and purchase intention of milk consumers (Wang and Kajungiro, 2019).

MATERIALS AND METHODS

The study was conducted between July 2019- December 2019 in Rajasthan Technical University, Kota Rajasthan. Secondary Information retrieved from previous literature available in the dairy sector in the Indian and global context. Responses are gathered from the significant top ten milk-producing states of rural and urban populations in India. 472 responses are gathered from the finite population of milk users. An appropriate sample size is 384 (Bartlett *et al*., 2001). A systematic stratified random sampling technique was used for data collection. The survey was conducted six months online during the COVID-19 pandemic outbreak. Responses are measured based on the previously tested multiple-choice questions five point rating scale.

Instrument and measurement

Based on previous literature Semi-structured questionnaire is designed to understand the purchase intention of milk users towards the quality of milk and dairy products. Fifteen items are retrieved from the demographic profile of the survey of milk consumers shown in (Table 2 and 3).

Statistical analysis

In this study, statistical analysis can be used to interpret the data gathered through surveys and studies, conceptual or statistical models and explore the relationship between the variables or set of items from which a sample can be drawn. Multiple Logistic Linear Regression (MLLRA) technique can confirm a connection between the target variable and two or more explanatory variables (Fung, 2013).

Table 1: Livestock (Indigenous cow species) population in India.

Number of years	1951-52 (in millions)	1991-92	2011-12	2018-19
Total no. of female cattle	54.4	64.4	76.7	81.4

Source: Annual Report 2018-2019; Department of Animal Husbandry, Fisheries and Dairying.

In the statistical approach, Logistic Regression, the target variable can be taken as the value 0 with a probability of failure (1-θ) and value 1 with the chance of success (θ). The objective of this technique is to predict an outcome of discrete variables.

$$\log (p/1-p) = \beta_0 + \beta_1 X_1 + \beta_2 X_{2+} \ldots\ldots + \beta_k X_k$$

This expression represents the relationship between the categorical explained variable (DV) and the predictor variables (IVs) to estimate the probability of certain events, where β_0, β_1, β_2……,βk. as a regression coefficient, computed from the dataset. When Y=1 and X_1, X_2,……, X_k are the predictor variables. The predictor variable log (p/1-p) is also a known explanatory variable in a linear equation.[7]4.1 Generalised Linear Model Framework in logistic Regression, the target variable is categorical, as. The factor function is used through R Software to convert the variables into factors (non-numeric to numeric) and run the logistic regression command. The glm function predicts binary outcomes from continuous explanatory variables to estimate the given data set.

These are generalised linear equations for given set of data file COM_train with explanatory variables are as follows:

glm (formula= Customer satisfaction ~1, family = Binomial (), data= COM_train) …(1)

glm(formula = Customer satisfaction ~ Frequency of the milk intake + Food habit +Price of the milk , family = Binomial (logit), data=COM_train) …(2)

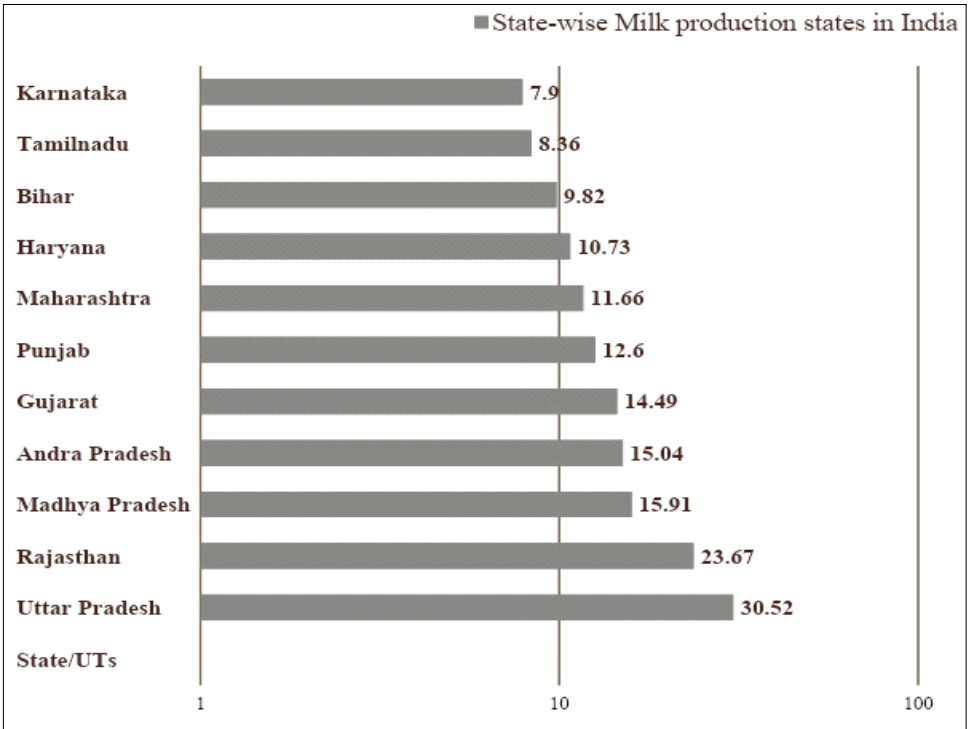
glm (formula = Customer satisfaction ~ Frequency of the milk intake + Price of the milk, family = Binomial (logit), data = COM_train) …(3)

RESULTS AND DISCUSSION

In this section, the strength of relationship among demographic variables measured in respect to gender male and female as respondents.

In contrast to western countries, consumers are more conscious about quality, convenience, and health concerns about dairy products and their value-addition (Silvia and Meiselman, 2010). There is a strong need to develop better awareness among consumers about the health benefits of milk, adulteration, harmonisation, and unfair trade practices (Reddy, 2016). From this study it has been observed that most of the respondents prefer the AMUL brand, and have the largest milk share as a dairy company. In some areas of north India, the mother dairy is the leading brand and most prominent consumer base (Mangla Kumar Sachin *et al*., 2019). Consumers prefer A2 milk dairy farms at nearly 17.8% and still an emerging market for dairy farms and milk processing units in India (Allison and Clarke, 2006). In dairy farming, sustainable supply chain practices and technological advancement of paramount importance for efficiency and productivity (Sinha and Mishra, 2023; Shruti and Latika, 2016).

Here, odd ratio is a measure of association between outcome and exposure; odds ratios are used to compute the relative odds of the occurrence of the outcome of interest



Source: Department of Animal Husbandry, Dairying and Fisheries (DAHD), Annual Report March 2019-20.

Fig 1: Major milk production states in India.

like satisfaction or dissatisfaction in this model given exposure to the variable of interest like food habits, *i.e.* vegetarian or non-vegetarian, the odds ratio can also be used to determine whether a particular exposure is a risk factor for a specific outcome and to compare the magnitude of various risk factors.

Testing for logarithm function

Odds ratio in a linear regression model, the odd ratio logarithm function estimates the probability of success and failure to understand the presence of explanatory variables in response to predictor binomial variables.

Logistic regression provides the knowledge and strength of relationships among variables if it increases greater than 0.1 or decreases less than 0.1. We can say (odds for PV+1) (odds for PV), where PV is a predictor value, shown in the odd ratio table (Table 2).
Odds ratio: Satisfied: Dissatisfied=0.1/0.8=0.125/1

Conditional odds

For male =Satisfied/Dissatisfied=0.57/0.48=1.187.
If we consider satisfaction as success, then the probability of this event happening is more in males.
For Female = Satisfied/Dissatisfied= 0.69/0.51=1.352.

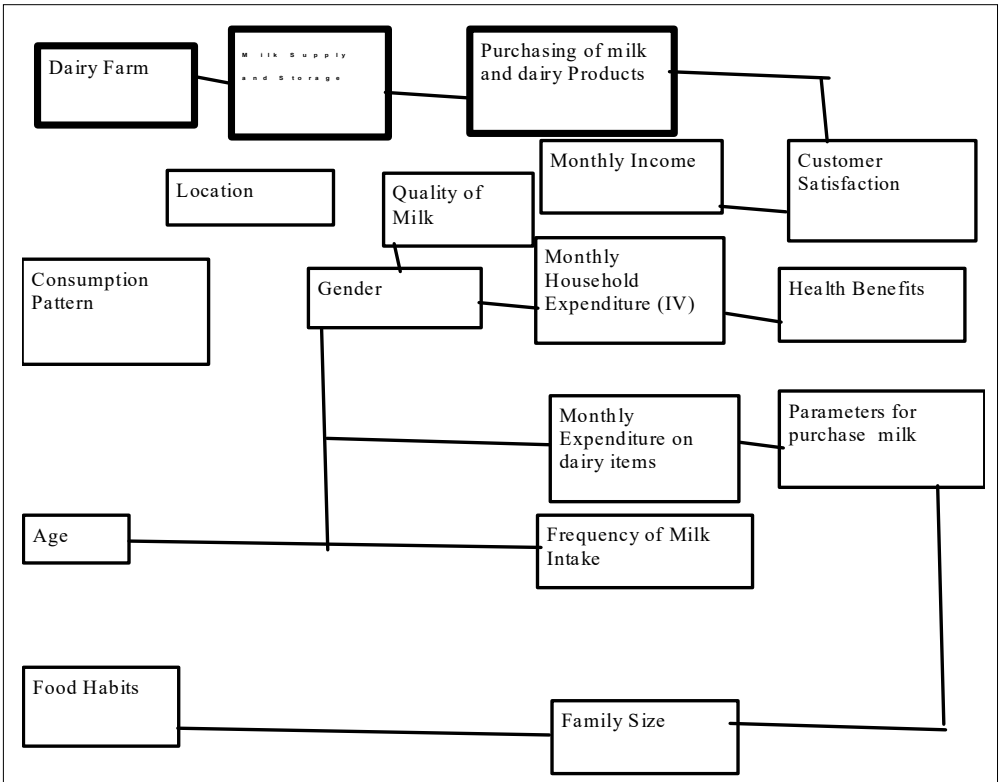


Fig 2: Diagrammatic representation of consumption pattern.

Table 2: List of response variables from consumer milk survey based on attitude and perception.

Variables	Set of items	Description
Milk consumption pattern	Quality	Consumer purchase intention based on certain parameters related to market strategies of milk and dairy products.
	Quantity	
	Freshness	
	Hormones/Additives	
	All of them	
	None of them	
Customer satisfaction	Five point rating scale	Awareness level about type of milk and consumption pattern.
	yes	
	No	
	May be	
	Can't say	
	No response	

If we consider satisfaction a failure, then the probability of this event happening is less in females.

$$odds=p\ (1-p),$$

Where;
p= Probability of the event occurring.
So if p=0.1, the odds are equal to 0.1/0.9=0.111 (recurring).

Overall odds ratio

1.187/1.352=0.87

• From the overall odds ratio value of 0.87, it is concluded that males are more likely to be satisfied than female consumers.

Model testing

Wald test is used to compute the statistical significance of each beta (β) coefficient in the logistic regression model. A Wald test calculates the z statistic, which is:

$$z = Var[\hat{}\beta|X] = \sigma^2(X'X)\text{-}1$$

Sigma (σ^2) is the variance of the residuals and has to be estimated from the data and is unknown and X is the design matrix.

Likelihood-ratio test (LRT)

This test measures the ratio of the maximised value of the likelihood function for the entire model. (L_i) over the

Table 3: List of variables from consumer milk survey based on demographic profile.

Variables/Constructs	Set of items	Description
Age	16-29 30-44 45-55 54 or above	Respondents are grouped between the age limit of 16-29 between 30-44 yrs. Old and 45-54 and 55 or above to understand the consumption pattern.
Size of family	No. family members range from 1 to 10 rating scale on the basis of size of family.	Number of residents or family members to understand the family setup: Nuclear or joint.
Monthly income level	Less than 10 k per month 10k-20k 20-30k 30-40k 40-50k 50k and more than one lakh	India is a country that has different social and sub-social classes based on caste, religion and ethnicity. The occupational status and income level of urban and rural populations are influenced by social class and educational background.
Price of the milk	1- 30-40 Rs.per liters. 2- 40-50 Rs./lit. 3- 50-60 Rs./lit. 4- More than 70 Rs./lit. 5- Not known	Price of the milk segmented into five categories based on the location and Income level of the respondents to understand their buying behaviour.
Monthly expenditure on dairy items	Ranges from 1 k to 10 k per month expenses 0-1: Negligible expense 2-4: Least expense 4-5: Moderate expense 5-7 highly moderate 7-10- High expense	Monthly income of different social groups in rural and urban populations. It helps with expenditure on dairy consumption.
Food habits	Vegetarian Non-vegetarian	Analyse the consumption pattern and focus towards lifestyle.
Location	Urban Sem-Urban Rural	Understand the composition of demographic profile.
Frequency of the milk intake	Multiple times in day Twice a day Once in a day Less often Not known	Consumer behaviour pattern towards milk consumption.
Parameters for purchase of milk	Taste Environment friendly Packaging The fat content in the milk No response	Choices and preferences of consumers and intention towards milk purchase.

maximised value of the likelihood function for the simple model (L_0).

(L_i) over the maximised value of the likelihood function for the simple model (L_0).

The likelihood-ratio statistic equals:

$$-2\text{Log}\ (L_0/L_1) = 2\ [\log\ (L_0) - \log\ (L_i)] = 2\ (L_0 - L_1) \quad \ldots(1)$$

The log transformation of the likelihood function yields a chi-square statistic that is considered in the case of backward stepwise elimination.

Results for model estimation

From the contingency table (Table 3), the contingency of transmission computes the conclusions as follows:

a. Probability of Food Habit if vegetarian: 336/446=0.07.

b. Probability of Food Habit if Non- vegetarian = 1-probability of Food Habit if vegetarian: 1-0.07 = 0.93 (*i.e.*, 5/17).

c. Odd ratio of food habits non-veg. as opposed to non-vegetarian food habit=140/336=0.42:1

d. Likewise, the odds of non-veg opposed to veg. Food habits are the inverse=336/140=2.4:1.

Model Base for logarithm function is written as H_0: β = 0, where (Constant is zero).

Generalised linear model (glm) ~ LOGIT model

In this study, customer satisfaction is the categorical dependent variable. Hence binomial function is used.

glm (formula = CS ~ 1, family = Binomial(), data = COM_train)

A test statistic is used to build a model to identify the probability of success of all the predictor variables through backward stepwise transformation.

The sample statistic of the output table (Table 4), drawn from the population ranges, lies between a min.-1.8528 and a maximum value of 0.6294. Inter- Quartile range one and 3Q is 0.6294 with a median of the same value, meaning there is a standardisation between observations scattered towards the central. The sample is approximately normally distributed. (Dispersion parameter for binomial family taken to be 1).

In the model base's summary output table (Table 5), there is no predictor variable. Hence, null and residual deviance have the same values of 445.51 on 472 degrees of freedom. In the base model, no predictor variable is used. In the base model's summary output of the ANOVA table, there is no predictor variable. Hence, null deviance and residual deviance have the same values.

Base: log (Odd ratio of food habit non-veg.-1)= -0.5447272

The intercept is <2e-16***, corresponding to the log odds for the target customer satisfaction variable. The logit of odds can be converted back to an odds ratio by taking the exponent of intercept exp(-0.5447272)= 0.58:1,

Odd ratios 0.58 can also be converted back to probabilities

$$\text{odds} = p\ (1\text{-}p)$$

p=0.58/1.58= 0.3670886

The p-value of (Wald-X^2) is 0.367, which is not significant and different from zero(0). In other words, we can say that the food habit of vegetarian consumers is 0.93 and non-vegetarian is 0.07 are no significant effect on customers satisfaction level about milk consumption.

Model: Fit

In this model, customers satisfaction =

$$\beta_0 + \beta_1\,(\text{FOMI}) + \beta_2\,(\text{Food habit}) + \beta_3\,(\text{PROM}) + \varepsilon$$

Where Frequency of milk intake (FOMI), Food Habits and price of milk (PROM) are included as predictor variables in the model.

$$H_0: \beta_0 = \beta_1 = \beta_2 = \beta_3\, 0$$

The sample statistic from the population range lies between a min.-2.2359 and a maximum value of 0.8971. Inter- Quartile range 1 is 0.4139 and 3Q is 0.7027 with a median of 0.5421, meaning there is a standardisation between observations scattered towards the central. The sample is positively skewed and has approximately a normal distribution.

From the output table (Table 6), the p-value of (Pr (>|z|) of the explanatory variable PROM and FOMI is less than equal to 0.05 and the p-value of variable food habit is more than 0.05 in the logistic linear model fit. So, the H0 is rejected and suggests a significant effect of two variables on the dependent variable CS. The null deviance of model fit is 335.03 on 362 degrees of freedom and residual deviance is 319.87 on 359 degrees of freedom. The residual deviance is lower than the null deviance. Hence the deviance value is considered a good indicator and the model is valid but needs more transformation.

Table 4: Odds ratio table.

	Satisfied	Dissatisfied	Total
Male	0.57	0.48	0.5
Female	0.69	0.51	0.5
Total	0.1	0.8	1

Table 5: Contingency of transmissions of variable food habit (Non-veg., veg.).

	Non-veg	Veg	Total
Food habit	140	336	446

Table 6: Summary table for base model.

Coefficients	Estimate std.	Error	z value	Pr (>|z|)
Response variable: CS				
Intercept	1.5184	0.1198	12.68	<2e-16***

Sign-if. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1''1.

Model: Fit 1

In this model, customers satisfaction (CS) =

$$\beta_0 + \beta_1(\text{FOMI}) + +\beta_2(\text{PROM}) + \varepsilon$$

Where frequency of milk intake (FOMI), Price of milk (PROM) are included as predictor variables in the model.

$$H_0: \beta_0 = \beta_1 = \beta_2 = 0$$

The sample statistic drawn from the population ranges lies between a min.-2.1929 and a maximum value of 0.8663. Inter- Quartile range 1 is 0.4351 and 3Q is 0.6960 with a median of 0.5526, meaning there is a standardisation between observations scattered towards the central. The sample is positively skewed and has approximately a normal distribution.

From the output table (Table 7), the p-value of (Pr (>|z|) of the explanatory variables PROM and FOMI is less than equal to 0.05 and all the predictor variables have significantly affected the target variables. Hence, the H_0 is rejected and suggests a significant effect of predictor variables on the dependent variable CS. The null deviance of model fit is 338.91 on 364 degrees of freedom and residual deviance is 326.26 on 362 degrees of freedom. The residual deviance is lower than the null deviance. Hence, the deviance value is a good indicator and the model is valid and robust.

From a given set of tain_data, Akaike Information Criterion (AIC) estimates the relative quality of statistical models and out-of-sample prediction error. AIC estimates the quality of each model relative to each other models. The threshold value for AIC is lower among all the tested models, considered the best model. The AIC of the base model is 447.51, the model fit is 335.03 and model fit1 is 332.26. So, from the above, all the statistics AIC of model fit1 is lower and considered the best fit for the data.

LRT (The likelihood ratio test) measures whether a model best fits a given data set if it demonstrates an improved model with fewer predictors to compare the existing model (fit1) with the base model. Moreover, the log difference between the current and base model is significantly different. The probability value of the model fit1 is less than five per cent in the given output table (Table 8). Hence the null hypothesis is rejected and provides evidence against a base model in favour of existing model fit1 for consideration as the goodness of fit and highly significant.

In the case of linear regression, the proportion of variance is explained by the response variable and predictor variables termed R^2. On the other hand, in logistic regression, the functional form of the equation contains a logarithmic function, So instead of pseudo-R^2, in the case

Table 7: Summary table for logistic regression model fit.

	Coefficients			
	Estimates	Standard error	Z-value	Pr (>|z|)
Intercept	1.79299	0.50637	3.541	0.000399***
FOMI	-0.26031	0.13317	-1.955	0.050619.
Food habit	-0.04948	0.31502	-0.157	0.875198
PROM	0.57058	0.17404	3.278	0.001044**

Table 8: Anova table for logistic regression model fit.

Response var.: Customer satisfaction	Df	Deviance residual	Df	Residual deviance	Pr (>Chi)
Null			362	353.03	
FOMI	1	3.7821	360	320.50	0.036103*
Food Habit	1	0.0085	359	320.49	0.874970
PROM	1	10.7499	361	324.28	0.001043**

Table 9: Summary table for logistic regression model fit1.

	Coefficients			
	Estimates	Standard error	Z-value	Pr (>|z|)
Intercept	1.7365	0.4883	3.556	0.000377 ***
FOMI	0.5077	0.1683	3.016	0.002559 **
PROM	-0.2375	0.1314	0.1314	0.070724.

Table 10: Summary statistics for LRT and goodness of fit.

	Df	LogLik	Df chisq	Pr (>Chisq)
Model fit 1: CS ~ PROM + Freq..of.Milk.Intake	3	-163.13		
Base model : Model 2: CS ~ 1	1	-169.45	-2 12.65	0.001791**

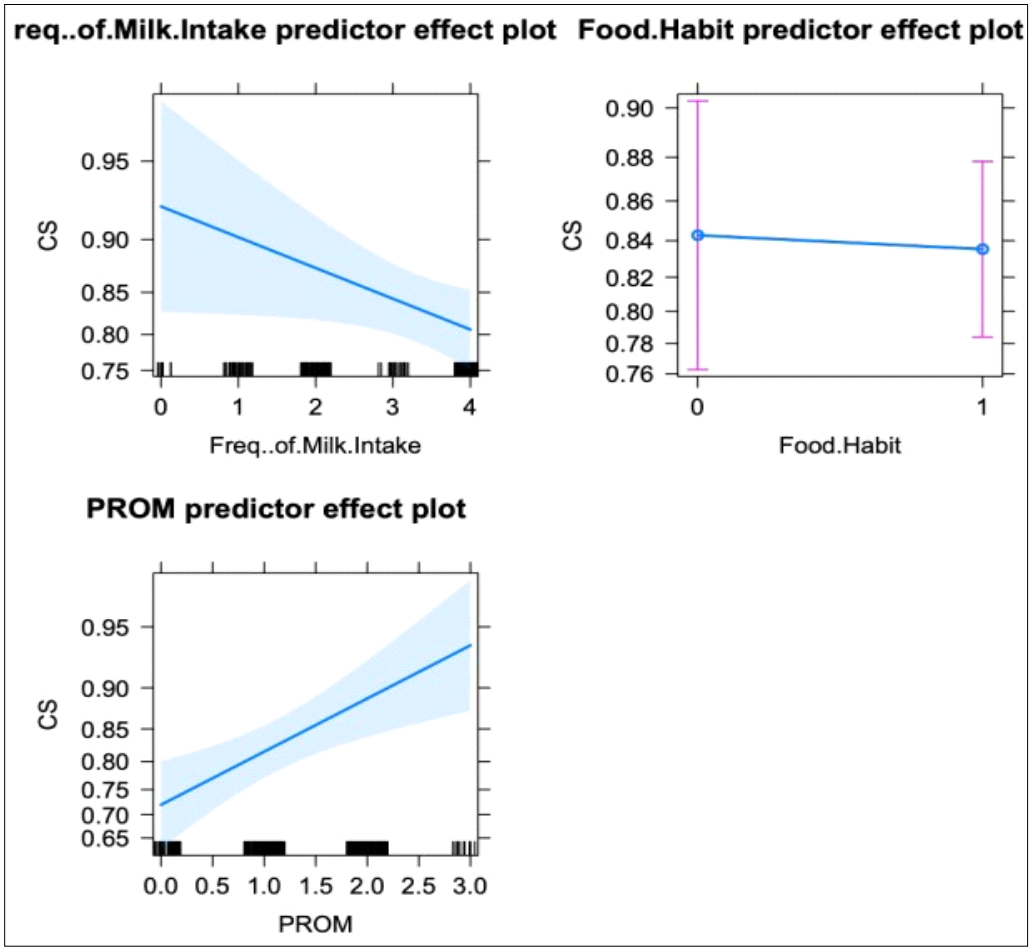


Fig 3: Predictor effectct diagnostic graph plot.

Table 11: Proportion of variance (Pseudo-R^2) for model fit1.

Fitting null model for pseudo-r2	llh	llhNull	G2	McFadden	r2ML	r2CU
	-163.12879427	-169.45382703	12.65006553	0.03732600	0.03406401	0.05631722

Table 12: Hosmer lemeshow statistics for model fit1.

Goodness of fit test	X-squared	Df	P-value
	4.5227	8	0.8072

Table 13: Relative importance of individual predictors in model fit1.

Variable importance	Overall
FOMI	1.807246
PROM	3.016264

of Multiple Logistic linear regression model R^2. McFadden's R^2 is used to define as 1- [ln (LM) / ln (LO)] where ln (LM) is the log-likelihood value for the fitted model and ln (LO) is the log-likelihood for the null model with only an intercept as the predictor. The measures range from zero to just under one, with a value close to zero indicating that the model possesses no predictive power. From the output table (Table 9), McFadden's R^2 is 0.03, ranging between zero to one and above 0.2 is considered satisfactory and variables can explain the proportion of the variance in the dependent variable.

From the output table (Table 10), Hosmer Lemeshow Statistic is a chi-square test statistic used to measure the predicted model is not significantly different in their observed values with a desirable outcome. It tests the goodness of fit if the probability value of the predicted model fit 1 in this study is not less than a five per cent level of significance and the null hypothesis fails to be rejected. Model fit 1 indicated that the p-value of Hosmer Lemeshow's goodness of fit is 0.8072, which is greater than the 5% significance level and fails to reject the null hypothesis. This output would suggest no difference

between observed and predicted values of model fit1 and adequately fitted with the data.

From the output table (Table 11), it is observed that the variable price of milk (PROM) strongly associates with other variables and is relevant in the logistic linear regression model fit1.

Confusion Matrix or classification table statistic is used to measure how well the model predicts the target variable in a tabular form to represent the actual and predicted values to determine the model's accuracy (Table 12). For the given logistic linear regression model fit 1, the recall matrix and sensitivity matrix for the actual and predicted values is 0.9918 with a cutoff of 0.3 on the train data, which is considered goodness of fit.

From the logistic linear equation for model,

glm (formula = CS ~ PROM + Fscore, family = Binomial (logit), + data = COM_train)

The output for manual transmission where probability is coded as 1. To understand the customer satisfaction level with observed variables, the price of milk is 0.47 and the F-score, *i.e.*, frequency of milk intake is -0.17, which has a negative linear relationship (Table 13). Probability is being fitted about 95% of the manual transmission in model fit1 from the graph plotted (Fig 3).

CONCLUSION

On the basis of previous studies and present findings of the study, in India, consumers are generally price sensitive and focus on the quantity of the milk. They are consuming milk and dairy products for nutritive value instead of focusing on quality of milk products, fat content and organic products.

Conflict of interest

All authors declare that they have no conflicts of interest.

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