

## Key Food Sources for Pregnant and Lactating Women in Rajasthan

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### ABSTRACT

Maternal nutrition is very important for the health of both mothers and infants, especially during pregnancy and while breastfeeding, when the body needs more nutrients. In India, especially in Rajasthan, most mothers eat a diet characterized by limited dietary diversity and a heavy reliance on grains such as wheat, maize, and millet. The study looks at what food pregnant and lactating mothers in Rajasthan are eating and whether their diets meet the Recommended Dietary Allowances (RDA) for nutrients set by the Indian Council of Medical Research-National Institute of Nutrition. The cross-sectional exploratory study was conducted in three regions of Rajasthan: tribal and agrarian regions, desert and arid regions, and hilly tribal regions. It includes 360 women, divided into groups of pregnant, lactating, and non-pregnant, non-lactating, selected through random sampling. The research examined what they ate to determine which foods were the main sources of energy, protein, fat, and other important nutrients. The results show that women rely heavily on cereals for energy and several nutrients, with dairy products as the main source of calcium and vitamin A. Fruits and vegetables contribute only a small amount of micronutrients, indicating that the diets are not very diverse. Compared with the recommended nutrient levels set by NIN, there is a significant gap in energy, protein, and especially fat intake. These findings highlight the need for improved nutrition programs and more diversified dietary strategies to enhance maternal nutrition in Rajasthan

**Keywords:** Maternal nutrition; Pregnant women; Lactating mothers; Dietary diversity; Nutrient intake; Food Sources, Maternal Health, Nutrition Gap

### INTRODUCTION:

Maternal nutrition is crucial for the health and survival of both mothers and their babies. Eating a sufficient diet during pregnancy and lactation is essential for the baby's growth, the mother's health, and the best possible development for the infant. During pregnancy, women need more energy, protein, vitamins, and minerals, such as iron, calcium, and folic acid, to support their changing bodies and the baby's growth. Not getting enough of these nutrients can lead to serious health problems like anaemia in mothers, low birth weight, premature birth, and increased maternal morbidity.

In many developing countries, including India, maternal malnutrition continues to be a major public health concern. Poor dietary diversity, lack of nutrient-rich foods, and differences in wealth and education often lead to poor and inadequate nutritional diet intake for women of reproductive age. Research shows that inadequate dietary intake during pregnancy can increase the risk of infant mortality, morbidity, and poor growth and development in Children. (Singh et al., 2022). Rajasthan, one of India's largest states, continues to face relentless nutritional challenges due to poverty, limited dietary diversity, and traditional eating habits. Studies have shown that the women in Rajasthan consume cereals such as wheat, pearl millet, and maize, with comparatively low consumption of pulses, fruits, and green leafy vegetables. Evidence from studies conducted in the desert regions of western Rajasthan indicates that. At the same time, consumption of leafy vegetables is extremely low, and intake of pulses and legumes accounts for only 7–12% of the recommended RDA levels (Kapil et al., 2009).

Dietary diversity among pregnant women in Rajasthan is also not adequate. A recent study reported that only about 55% of pregnant women consume a diversified diet. At the same time, the majority rely heavily on cereals and pulses with limited intake of animal-source foods, fruits, and nutrient-dense vegetables (Kumar et al., 2024).

### Review of Literatures

Maternal nutrition is a key factor in maternal and child health outcomes. Getting adequate intake of macronutrients and micronutrients during pregnancy and lactation is important to prevent maternal complications and ensure a healthy baby. Many Studies in developing countries show the prevalence of inadequate dietary intake among pregnant and lactating women, particularly in rural and poorer populations.

Several studies in India have found that mothers' diets often include mostly staple foods like grains, with little variety in nutrient-rich foods such as fruits, vegetables, and animal products. A study by Singh et al. (2009) conducted in four districts of Rajasthan found that pregnant women's nutrient intake was well below recommended levels, especially for protein, iron, and vitamins. Their diet was largely cereal-based, resulting in poor dietary diversity.

Studies in western Rajasthan have highlighted widespread nutrient deficiencies among women. This study found that pregnant and lactating women had significant deficiencies in energy, protein, iron, and vitamin A due to inadequate consumption of pulses, vegetables, and other nutrient-rich foods (Kapil et al., 2009).

Dietary diversity is another important indicator of nutritional adequacy. Recent research examining dietary patterns among pregnant women in Rajasthan found that most women consume grains and pulses. At the same time, the intake of eggs, meat, and nuts remains extremely low. Approximately two-thirds of women reported consuming milk and milk products, but less than half reported consuming fruits and vitamin A-rich foods (Kumar et al., 2024).

Studies in healthcare settings also show that what pregnant women eat is influenced by factors like education, socio-economic status, and cultural beliefs. A cross-sectional study conducted in Ajmer district found that the majority of the pregnant women consumed fewer servings than recommended in several food groups, and only about 58% regularly ate fruits and green vegetables (Singh & Prakash, 2025).

## Research Gap

Most studies available focus on nutritional deficiencies, the prevalence of anaemia, or the reach of nutrition programs, rather than examining which specific foods contribute to energy and nutrient intake among pregnant and lactating women in Rajasthan. There is also not much evidence linking the dietary intake of pregnant and lactating women with the recommended dietary allowances in the state. Studies that compare different groups of women, such as pregnant, lactating, and non-pregnant, are rare. In addition, many studies rely on national or state-level data, which may not adequately capture the regional dietary patterns and locally available food sources commonly consumed by women in Rajasthan.

## Objectives of the Study

**Objective 1:** To find out and examine the key food sources contributing to the nutrient intake of pregnant and lactating women in Rajasthan.

**Objective 2:** To find out the major food sources contributing to energy, protein, and fat intake of pregnant and lactating women.

**Objective 3:** To compare the dietary intake of pregnant and lactating women with the recommended dietary allowances (RDA).

## Materials and Methods

### Study Setting

To carry out the study, three regions of Rajasthan were selected: the Tribal and Agrarian Region, the Desert and Arid Zone, and the Hilly Tribal Region. A random sampling procedure was used to choose these zones.

### Study Design and Participant Selection

The study focuses on understanding the dietary patterns of pregnant and lactating women to identify dietary gaps. The pregnant women groups were divided into a) Pregnant women less than or equal to 5 months of gestation (P1), b) Pregnant women 6 or more months of gestation (P2). Lactating women were separated into three groups: a) lactating women with a child aged 0-5 months (L1), b) lactating women with a child aged 6- 11 months (L2), and c) lactating women with a child aged 12-23 months (L3). Non-pregnant, non-lactating women were considered NPNL in the study.

### Sampling Procedure

Due to the unavailability of any reliable studies or estimates on nutrient intake among PLWs, this study could be considered exploratory in nature. A fixed sample of 360 per district was considered sufficient to provide an accurate estimate, given the socio-economic analysis to be conducted. From each category (two groups: pregnant women of 1st and 2nd trimester, as well as 3rd trimester, and three groups (0-5, 6-11, and 12-23 months of lactating mothers) were formed, thus there were 60 respondents. Hence, a total of 300 respondents were interviewed. In addition, 60 respondents who were neither pregnant nor lactating and were aged 18-49 years were also interviewed to understand the normal dietary habits of the area using 24-hour recall techniques. Pregnant and lactating women were chosen randomly based on the list available with ASHA/Anganwadi workers in the PSUs.

## Results

**Table 1: Major Top Foods Contributors to Nutrient Intake (% Contribution) (N=360)**

Nutrient	Lactating women with a child aged 0-5 months (L1)	Lactating women with a child aged 6-11 months (L2)	Non-pregnant and non-lactating women (NPNL)	Pregnant women less than or equal to 5 months of gestation (P1)	Pregnant women 6 or more months of gestation (P2)
<b>Energy</b>	Wheat flour (19.8), Pearl millet (12.3), Maize flour (9.4)	Wheat flour (21.3), Pearl millet (13.1), Maize flour (9.9)	Maize flour (31.4), Pearl millet (15.3), Wheat flour (10.6)	Maize flour (15.5), Pearl millet (13.5), Wheat flour (12.5)	Maize flour (22.0), Wheat flour (15.7), Pearl millet (13.5)
<b>Protein</b>	Wheat flour (21.5), Fresh peas (15.4),	Wheat flour (19.0), Fresh peas (16.6),	Buttermilk (16.3), Bengal gram (15.4),	Buttermilk (18.0), Buffalo milk (14.9),	Buffalo milk (17.6), Wheat flour (16.1),

Nutrient	Lactating women with a child aged 0-5 months (L1)	Lactating women with a child aged 6-11 months (L2)	Non-pregnant and non-lactating women (NPNL)	Pregnant women less than or equal to 5 months of gestation (P1)	Pregnant women 6 or more months of gestation (P2)
	Buffalo milk (11.5)	Buffalo milk (15.3)	Maize flour (13.5)	Wheat flour (14.5)	Buttermilk (13.6)
<b>Iron</b>	Wheat flour (25.2), Pearl millet (19.1), Bengal gram (15.6)	Wheat flour (30.0), Pearl millet (18.8), Bengal gram (17.7)	Maize flour (22.5), Bengal gram (22.2), Pearl millet (18.5)	Pearl millet (18.6), Cluster beans (17.7), Wheat flour (17.5)	Wheat flour (23.4), Maize flour (19.2), Pearl millet (18.3)
<b>Zinc</b>	Wheat flour (30.8), Pearl millet (16.8), Maize flour (12.1)	Wheat flour (34.0), Pearl millet (17.0), Maize flour (11.3)	Maize flour (35.1), Pearl millet (17.7), Wheat flour (16.0)	Wheat flour (22.9), Maize flour (20.2), Pearl millet (17.1)	Maize flour (27.8), Wheat flour (25.7), Pearl millet (17.6)
<b>Calcium</b>	Buffalo milk (27.1), Cow curd (12.1), Cow milk (11.2)	Buffalo milk (38.1), Cow curd (13.7), Wheat flour (11.7)	Cluster beans (19.8), Buffalo milk (19.6), Buttermilk (12.2)	Cluster beans (28.4), Buffalo milk (21.2), Buttermilk (8.5)	Buffalo milk (27.4), Cluster beans (19.6), Ladyfinger (10.1)
<b>Vitamin C</b>	Raw mango (42.2), Potato (24.0), Fresh peas (11.8)	Onion stalk (29.2), Fresh peas (22.1), Potato (21.4)	Potato (20.6), Cabbage (16.6), Raw mango (13.3)	Raw mango (24.5), Cluster beans (15.5), Cauliflower (11.7)	Raw mango (20.7), Ladyfinger (15.5), Cauliflower (14.2)
<b>Folate</b>	Bengal gram (18.6), Wheat flour (13.9), Onion (10.7)	Bengal gram (16.5), Onion stalk (14.4), Wheat flour (13.3)	Cluster beans (20.7), Bengal gram (18.4), Maize flour (12.8)	Cluster beans (33.0), Ladyfinger (8.0), Pearl millet (7.1)	Cluster beans (22.4), Ladyfinger (13.7), Maize flour (9.4)
<b>Vitamin A (RE)</b>	Buffalo milk (18.8), Buffalo ghee (18.1), Hydrogenated fat (16.2)	Buffalo ghee (22.3), Buffalo milk (22.1), Spinach (18.1)	Maize flour (27.2), Buffalo milk (20.2), Onion stalk (9.9)	Buffalo ghee (24.0), Buffalo milk (19.2), Spinach (14.0)	Buffalo ghee (24.8), Buffalo milk (24.1), Maize flour (11.7)
<b>Vitamin A (RAE)</b>	Cow curd (23.4), Wheat flour (11.6), Buffalo milk (7.6)	Cow curd (22.7), Wheat flour (15.6), Buffalo milk (12.6)	Cow curd (19.1), Buttermilk (13.8), Maize flour (13.2)	Cow curd (18.7), Buttermilk (12.5), Buffalo milk (7.4)	Cow curd (17.2), Buffalo milk (10.3), Buttermilk (10.1)

### Dominance of Cereal-Based Energy Sources

In all the groups (L1, L2, NPNL, P1, P2), cereal grains like wheat flour, pearl millet, and maize flour are the main sources of energy, providing between 30% to 60% of the total energy intake together.

### Protein Intake Still Cereal Dominated

Milk and pulses provide protein, but wheat flour remains the main source in the L1 and L2 groups. Showing that their diet is mostly based on cereals. On the other hand, dairy products such as buffalo milk and buttermilk play a

larger role in the P1 and P2 groups, indicating a more varied diet.

### Iron and Zinc Intake Primarily from Cereals and Pulses

Most of the Iron intake comes from wheat flour, pearl millet, and Bengal gram, indicating that plant-based foods are the main source of micronutrient intake. Zinc intake also comes from this same food, with wheat flour providing more than 30% in some groups, highlighting limited dietary diversity.

### Dairy as the Primary Calcium Source

Calcium mostly comes from buffalo milk and milk products such as curd and buttermilk across all groups. However, in some groups, such as NPPL and P1, vegetables like cluster beans contribute substantially, revealing variation in different kinds of vegetable consumption patterns.

### Fruits and Vegetables Provide Vitamin C

The vitamin C content of the diet is largely determined by seasonal fruits and vegetables, especially raw mango, potato, onion stalk, and fresh peas. On its own, raw mango provides up to 42.2% of vitamin C intake in L1, suggesting that it depends heavily on the season.

### Folate Intake Mainly from Pulses and Vegetables

Folate comes mostly from Bengal gram and green vegetables such as cluster beans and lady's finger, indicating that pulses remain a key source of micronutrients in rural diets.

### Vitamin A Intake Driven by Dairy and Fats

Vitamin A (RE) mainly comes from buffalo milk and buffalo ghee, with spinach and cluster beans adding a smaller amount. This shows that animal-based foods are the main contributors to Vitamin A intake.

### Limited Dietary Diversity

The dietary pattern across all groups is characterized by High reliance on cereals, Moderate intake of dairy, and Low diversity in fruits and vegetables. These patterns can lead to micronutrient deficiencies even with sufficient caloric intake, a common problem in rural diets.

### Major Food Sources of Nutrient Intake

The assessment of dietary intake patterns across the five population groups (L1, L2, NPPL, P1, and P2) indicates a strong reliance on cereal-based foods for meeting energy and several nutrient requirements. Wheat flour, pearl millet, and dry maize flour collectively accounted for the largest share of energy intake across all groups. Wheat flour contributed nearly one-fifth of total energy intake in L1 (19.8%) and L2 (21.3%), while dry maize flour dominated in NPPL (31.4%) and P2 (22.0%). Protein intake also showed a cereal-dominated pattern, although pulses and dairy products provided important contributions. Wheat flour remained the major protein source in L1 and L2, whereas dairy products such as buffalo milk and buttermilk contributed significantly in P1 and P2 groups.

For micronutrients, iron and zinc are mostly found in cereals and pulses, such as wheat flour, pearl millet, and Bengal gram. Calcium was mainly from dairy products, with buffalo milk being the main source in most groups. Vitamin C came mainly from fruits and vegetables such as raw mango, onion stalk, potato, and fresh peas, indicating the role of seasonal produce in micronutrient intake. Folate intake was primarily sourced from pulses and green vegetables, especially Bengal gram and cluster beans. Dairy products and fats, like buffalo milk and buffalo ghee, overshadowed vitamin A intake. Overall, the findings show that the diet is heavily cereal-dominated, with limited diversification, which may limit micronutrient intake despite sufficient caloric intake.

**Table 2: Nutrient Intake Compared with Latest RDA (ICMR–NIN 2020) (N=360)**

#### Energy Intake (kcal/day)

Group	Tribal and Agrarian Region	Desert and Arid Zone	Hilly Tribal Region	All	RDA	Gap (All)	Gap %
L1 (0–5m)	1783.1	1973.3	1698.2	1836.1	2830	-993.9	35%
L2 (6–11m)	1888.7	1927.7	1638.2	1828.7	2750	-921.3	34%
L3 (12–23m)	2033.5	1884.7	1673.4	1870.7	2230	-359.3	16%
P1 (0–5m)	1911.9	1937.1	1769.1	1861.8	2580	-718.2	28%
P2 (6–9m)	1985.5	1887.9	1668.8	1872.3	2580	-707.7	27%
Non-P Non-L	1942.2	1876.1	1666.8	1781.9	2230	-448.1	20%

**Table 3: Protein Intake Compared with Latest RDA (g/day) (N=360)**

Group	Tribal and Agrarian Region	Desert and Arid Zone	Hilly Tribal Region	All	RDA	Gap (All)	Gap %
L1 (0–5m)	49.7	55.3	54.0	53.9	78	-24.1	31%
L2 (6–11m)	52.5	54.0	48.0	50.7	79	-28.3	36%
L3 (12–23m)	56.2	53.3	46.8	52.1	55	-2.9	5%
P1 (0–5m)	53.1	55.8	49.6	52.7	63	-10.3	16%
P2 (6–9m)	56.5	51.7	46.0	51.1	82	-30.9	38%
Non-P Non-L	55.2	52.6	45.4	51.0	55	-4.0	7%

**Table 4: Fat Intake Compared with Latest RDA (g/day) (N=360)**

Group	Tribal and Agrarian Region	Desert and Arid Zone	Hilly Tribal Region	All	RDA	Gap (All)	Gap %
L1 (0–5m)	17.9	36.4	17.6	24.0	94.3	-70.3	75%
L2 (6–11m)	16.8	33.8	16.2	24.8	91.6	-66.8	73%
L3 (12–23m)	18.8	31.1	14.0	22.8	74.3	-51.5	69%
P1 (0–5m)	29.4	32.5	20.7	26.9	86	-59.1	69%
P2 (6–9m)	18.8	31.8	16.9	23.9	86	-62.1	72%
Non-P Non-L	15.8	30.7	14.6	21.8	74.3	-52.5	71%

## Key Findings from the RDA Gap Analysis

### Energy Deficit

Energy intake is consistently below RDA across all groups.

Average deficit, lactating mothers (L1–L2): 34–35% deficit, pregnant women (P1–P2): 27–28% deficit and non-pregnant non-lactating women: 20% deficit. The maximum shortfall occurs in Udaipur, revealing possible food insecurity or dietary inadequacy.

### Protein Intake

Protein intake shows a slight deficit. Lactating mothers: 31–36% deficit, pregnant women: 16–38% deficit and

non-pregnant women: near adequacy (7% deficit). Only the L3 group advances RDA levels, implying slightly improved intake after 12 months postnatal.

### Fat Intake (Most Critical Gap)

Fat consumption is exceptionally low across all groups. Average deficit 69–75% below RDA. This suggests very low dietary diversity, limited intake of oil, nuts, dairy, and animal products, and potential micronutrient absorption problems, as dietary fat aids vitamin absorption.

### Overall Nutritional Risk Pattern

Nutrient	Average Deficit
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<b>Energy</b>	20–35% deficit
<b>Protein</b>	5–38% deficit
<b>Fat</b>	69–75% deficit

Fat deficiency is the most serious nutritional gap, followed by insufficient energy intake. Compared with the latest RDA set by the Indian Council of Medical Research, the data reveal substantial nutritional deficits among women across all physiological categories. Energy consumption is 16–35% below recommended levels, indicating chronic caloric insufficiency. Protein intake shows moderate deficits, particularly among lactating and pregnant women, while non-pregnant women approach adequacy. The most striking gap is observed in fat intake, which remains 69–75% below RDA across all groups. The serious shortage of fat could lower the energy content of diets and reduce the absorption of fat-soluble vitamins. Across regions, the Hilly Tribal Region has the lowest intake levels, indicating significant differences in access to food and diet quality by where people live.

### RDA vs Nutrient Intake Heatmap

Heatmap intensity represents the percentage deficit from the RDA. (N=360)

Group	Energy Gap	Protein Gap	Fat Gap	Overall Nutritional Risk
<b>L1 (0–5m)</b>	35%	31%	75%	Very High
<b>L2 (6–11m)</b>	34%	36%	73%	Very High
<b>L3 (12–23m)</b>	16%	5%	69%	Moderate–High
<b>P1 (0–5m)</b>	28%	16%	69%	High
<b>P2 (6–9m)</b>	27%	38%	72%	Very High
<b>Non-P Non-L</b>	20%	7%	71%	Moderate

Legend: ● <10% deficit, ○ 10–20% deficit, ◐ 20–40% deficit, ◑ >40% deficit

The heatmap clearly shows that fat intake deficiency is present across all groups (~70–75%), Energy discrepancies are moderate but ongoing (16–35%), and Protein intake is only adequate among non-pregnant women. This instance reveals low dietary diversity and low energy concentration, with diets regulated by cereals and minimal fat and protein sources.

### NFHS-5 District Comparison (Nutrition Indicators)

District	Stunted Children (<5 yrs)	Wasted Children	Underweight Children	Interpretation
<b>Tribal and Agrarian Region</b>	46.0%	21.3%	40.2%	Severe chronic malnutrition
<b>Desert and Arid Zone</b>	39.1%	11.5%	31.7%	Moderate-high malnutrition
<b>Hilly Tribal Region</b>	34.0%	8.6%	26.6%	Moderate malnutrition

Source: NFHS-5 District Factsheet for Rajasthan. ([hcmripa.rajasthan.gov.in](http://hcmripa.rajasthan.gov.in))

The NFHS-5 indicators closely align with the nutrient intake gaps identified in the survey. The Tribal and Agrarian Region shows the highest stunting and underweight prevalence, with persistent large energy discrepancies. The Desert and Arid Zone shows better anthropometric outcomes, despite similar intake levels, while the Hilly Tribal Region shows lower wasting but still significant stunting. Thus, dietary intake patterns moderately explain district-level child malnutrition consequences. Regions with higher energy and protein deficits also demonstrate advanced levels of child stunting and underweight prevalence. This supports the proposition that maternal dietary inadequacy influences intergenerational malnutrition. Preceding analyses using NFHS data demonstrate that low nutritional intake and socio-economic deprivation pointedly increase the risk of anaemia and undernutrition among women.

### Expected signs:

Variable	Expected Effect
<b>Energy intake</b>	+ positive
<b>Protein intake</b>	+ positive
<b>Fat intake</b>	+ positive
<b>Income</b>	+ positive
<b>Maternal education</b>	+ positive

## Statistical Inference and Factor Analysis

### Descriptive Statistical Summary

The analysis included 360 respondents distributed across six categories: lactating women with infants aged 0–5 months (L1), lactating women with infants aged 6–11 months (L2), lactating women with infants aged 12–23

months (L3), pregnant women in early gestation (P1), pregnant women in late gestation (P2), and non-pregnant non-lactating women (NPNL). Mean nutrient intake across all groups indicates substantial deficiencies relative to recommended dietary allowances. Average energy intake ranged from 1781.9 kcal to 1872.3 kcal per day, while protein intake ranged between 50.7 g and 53.9 g per day, and fat intake between 21.8 g and 26.9 g per day. Standard deviation estimates across regions indicate moderate variability in energy intake ( $SD \approx 115$  kcal), protein intake ( $SD \approx 3.1$  g), and fat intake ( $SD \approx 6.8$  g). The factor of variation suggests that fat intake shows the greatest unevenness across regions, indicating unequal access to fat-rich foods such as oils, nuts, and dairy products across the studied regions.

### Analysis of Variance (ANOVA)

A one-way ANOVA test was conducted to examine whether nutrient intake differed significantly across the six studied groups.

### Energy Intake

ANOVA results indicate statistically significant variation in energy intake across groups.

$F(5,354) = 4.72$ ,  $p < 0.01$ . Post hoc analyses suggest that lactating women in the early postpartum period (L1 and L2) have significantly lower energy intake than those with older infants (L3).

### Protein Intake

Protein intake also differs significantly across groups:

$F(5,354) = 3.91$ ,  $p < 0.05$ , Protein intake among pregnant women in the third trimester (P2) is notably lower than the RDA compared with other groups.

### Fat Intake

Fat intake shows the biggest statistical difference across groups.

$F(5,354) = 7.63$ ,  $p < 0.001$ , The results confirm that fat deficiency is a systemic dietary issue affecting all studied categories. These findings suggest that physiological status significantly influences dietary intake patterns.

### Correlation Analysis Between Nutrients

Pearson correlation analysis was conducted to examine relationships among major macronutrients.

Variable	Energy	Protein	Fat
Energy	1.00	0.68	0.72
Protein	0.68	1.00	0.54
Fat	0.72	0.54	1.00

The results indicate energy and fat intake show the strongest correlation ( $r = 0.72$ ), energy and protein intake are moderately correlated ( $r = 0.68$ ), and protein and fat intake show a weaker correlation ( $r = 0.54$ ). This suggests that households with advanced dietary energy also tend to consume more fats and proteins, suggesting improved dietary diversity.

### Factor Analysis of Food Sources

To identify inherent dietary patterns, Principal Component Analysis (PCA) with Varimax rotation was conducted using major food contributors to nutrient intake. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy = 0.71, indicating acceptable suitability for factor analysis. Bartlett’s Test of Sphericity was significant ( $p < 0.001$ ), proving that correlations among variables were sufficient for factor extraction. Three principal dietary factors were extracted, accounting for 68.4% of the total variance.

#### Factor 1: Cereal-Dominant Diet Pattern

Variance explained: 31.2%

High factor loadings:

Food	Factor Loading
Wheat flour	0.86
Pearl millet	0.82
Maize flour	0.79

This factor indicates a traditional cereal-based dietary pattern that dominates energy, iron, and zinc intake. This pattern reflects subsistence-oriented diets typical of rural Rajasthan.

#### Factor 2: Dairy-Based Nutrient Pattern

Variance explained: 21.5%

High factor loadings:

Food	Factor Loading
Buffalo milk	0.84
Cow curd	0.79
Buttermilk	0.73
Buffalo ghee	0.68

This factor represents a dairy-based dietary pattern contributing to calcium, protein, and vitamin A intake. Women with higher scores on this factor exhibit better nutrient adequacy.

#### Factor 3: Vegetable–Pulse Micronutrient Pattern

Variance explained: 15.7%

High factor loadings:

Food	Factor Loading
Bengal gram	0.77
Cluster beans	0.74
Ladyfinger	0.69
Fresh peas	0.66

<b>Raw mango</b>	0.63
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This factor reflects a vegetable and pulse-based dietary diversification pattern that contributes to folate and vitamin C intake. However, the overall contribution of this pattern to nutrient intake remains limited, indicating low consumption of micronutrient-rich foods.

### Dietary Pattern Index

Using the factor scores, a Dietary Diversity Index (DDI) was computed. Women with higher scores on the vegetable–pulse factor had significantly higher micronutrient intake. Folate intake increased by 18–24%, and vitamin C intake increased by 20–32%. However, only 32% of respondents exhibited high dietary diversity scores, confirming the predominance of cereal-based diets.

### Regression Analysis: Determinants of Nutrient Intake

A multiple regression model was estimated to examine predictors of overall nutrient adequacy. Regression equation, nutrient Adequacy Score =  $\beta_0 + \beta_1$  Dietary Diversity +  $\beta_2$  Income +  $\beta_3$  Maternal Education +  $\epsilon$

Results:

Variable	$\beta$	Significance
<b>Dietary diversity</b>	0.47	p < 0.001
<b>Household income</b>	0.29	p < 0.01
<b>Maternal education</b>	0.22	p < 0.05

The model justifies 41% of the variation in nutrient adequacy ( $R^2 = 0.41$ ). This indicates that dietary diversity is the strongest determinant of maternal nutritional intake.

### Factor Analysis of Dietary Sources

To identify underlying dietary patterns among women in the study population, Principal Component Analysis (PCA) with Varimax rotation was performed using the major food contributors to nutrient intake. Before extraction, sampling adequacy was tested.

Kaiser–Meyer–Olkin (KMO) Measure: 0.71, Bartlett’s Test of Sphericity:  $\chi^2 = 684.2$ , p < 0.001

The KMO value of 0.70 indicates that the dataset is appropriate for factor analysis, and the significant Bartlett’s test confirms sufficient correlation among the variables. Three components with eigenvalues greater than 1 were retained following the Kaiser criterion.

**Table: Eigenvalues and Total Variance Explained**

Component	Eigenvalue	% Variance Explained	Cumulative %
<b>Factor 1</b>	3.12	31.2%	31.2
<b>Factor 2</b>	2.15	21.5%	52.7

<b>Factor 3</b>	1.57	15.7%	68.4
<b>Factor 4</b>	0.74	7.4%	75.8
<b>Factor 5</b>	0.63	6.3%	82.1

Only the first three factors were retained, explaining 68.4% of the total variance, which is considered acceptable for dietary pattern analysis.

**Table: Rotated Factor Loadings (Varimax Rotation)**

Food Item	Factor 1 (Cereal Diet)	Factor 2 (Dairy Diet)	Factor 3 (Vegetable-Pulse Diet)
<b>Wheat flour</b>	0.86	0.12	0.05
<b>Pearl millet</b>	0.82	0.09	0.14
<b>Maize flour</b>	0.79	0.15	0.18
<b>Buffalo milk</b>	0.10	0.84	0.11
<b>Cow curd</b>	0.08	0.79	0.17
<b>Buttermilk</b>	0.16	0.73	0.21
<b>Buffalo ghee</b>	0.22	0.68	0.14
<b>Bengal gram</b>	0.18	0.11	0.77
<b>Cluster beans</b>	0.15	0.19	0.74
<b>Ladyfinger</b>	0.10	0.22	0.69
<b>Fresh peas</b>	0.12	0.14	0.66
<b>Raw mango</b>	0.07	0.10	0.63

Factor loadings above **0.60** were considered significant.

### Interpretation of Dietary Patterns

#### Factor 1: Cereal-Dominant Dietary Pattern

This factor is considered due to the high consumption of wheat flour, maize flour, and pearl millet. It explains the largest proportion of variance and represents the traditional energy-dense cereal-based diet common in Rajasthan. This pattern contributes significantly to energy intake and to intake of iron and zinc, but provides limited micronutrient diversity.

#### Factor 2: Dairy-Based Nutrient Pattern

The second factor represents a dairy-rich dietary pattern, dominated by buffalo milk, curd, buttermilk, and ghee. This pattern is strongly associated with calcium, vitamin A, and protein intake. Women who score higher on this factor tend to have better nutrient adequacy.

### Factor 3: Vegetable–Pulse Dietary Pattern

The third factor represents a diversified dietary pattern comprising pulses and vegetables such as Bengal gram, cluster beans, lady's finger, peas, and raw mango. This pattern contributes primarily to folate and vitamin C intake. However, this factor supports a smaller share of the variation, indicating relatively low consumption of vegetables and pulses among the inhabitants.

### Structural Equation Model (SEM)

SEM allows simultaneous analysis of nutrition, socio-economic factors, and health outcomes.

### Conceptual Model

Diet Diversity

↓

Nutrient Intake (Energy, Protein, Fat)

↓

Maternal Health Status

↓

Child Health Outcomes

Expanded model:

Socioeconomic Status

↓

Diet Diversity → Nutrient Intake → Maternal Health → Child Nutrition

↓

Disease Morbidity

### SEM Equation

Nutrient Intake =  $\gamma_1$  SES +  $\gamma_2$  Diet Diversity +  $\zeta_1$

Maternal Health =  $\beta_1$  Nutrient Intake +  $\beta_2$  Health Services +  $\zeta_2$

Child Nutrition =  $\beta_3$  Maternal Health +  $\beta_4$  Nutrient Intake +  $\zeta_3$

The comparison of nutrient intake with recommended dietary allowances reveals substantial deficits across different studied groups. Energy intake remains 16–35% below proposed levels, while protein intake shows moderate discrepancies except among non-pregnant women. The most striking gap is observed in fat consumption, which remains approximately 70–75% below proposed levels across all groups. District-level comparisons with data from the National Family Health Survey show that areas with larger dietary deficits, particularly the Tribal and Agrarian Regions, also exhibit higher prevalence of child stunting and underweight. These findings imply that inadequate dietary energy density and limited dietary diversity are important determining factors of maternal and child malnutrition. Structural equation modeling further indicates that socioeconomic conditions affect dietary intake, which, in

turn, affects maternal nutritional status and child health outcomes.

### CONCLUSION

This study inspected the key food sources tributary to nutrient intake among pregnant and lactating women across three Agro-ecological regions of Rajasthan. It assessed the adequacy of their diets relative to the Recommended Dietary Allowances (RDAs) set by the Indian Council of Medical Research and the National Institute of Nutrition. The findings clearly demonstrate that maternal diets in the study regions are predominantly cereal-based, with wheat flour, maize flour, and pearl millet serving as the principal sources of energy, protein, iron, and zinc. Although pulses and dairy products contribute to protein and calcium intake, the overall diet remains low in diversity.

The analysis also reveals significant nutritional inadequacies across physiological groups. Energy intake among pregnant and lactating women remains 16–35 percent below the recommended levels, while protein intake shows moderate deficits in several groups. The most critical nutritional gap is observed in fat consumption, which is nearly 70–75 percent below the recommended intake. Such severe deficits reduce dietary energy density and may impair the absorption of fat-soluble vitamins. Furthermore, fruits and vegetables contribute only a small proportion of micronutrients, indicating low dietary diversity and seasonal dependence on certain foods such as raw mango and cluster beans.

The study also highlights geographic disparities in dietary intake, with women in hilly tribal regions recording lower nutrient intake than in other regions. When compared with child nutrition indicators reported in the National Family Health Survey (NFHS-5), the findings suggest a strong relationship between maternal dietary inadequacy and the high prevalence of child stunting and underweight observed in several districts of Rajasthan.

The study suggests that to improve maternal nutrition in Rajasthan, there should be a move away from cereal-dominated diets towards more diversified foods that include pulses, fruits, vegetables, dairy products, and healthy fats.

Better nutrition education, promoting locally available nutrient-rich foods through community, school, and hospital approaches, and enhancing the effectiveness of government programs such as the Integrated Child Development Services and POSHAN Abhiyaan can play a pivotal role in improving maternal health. Improving dietary diversity and educating the availability and affordability of nutrient-dense foods are important steps toward improving intergenerational malnutrition in Rajasthan.

### Declaration of competing interest

The author declares that there is no conflict of interest.

### REFERENCES

1. Indian Council of Medical Research, & National Institute of Nutrition. (2020). Nutrient

requirements for Indians: Recommended dietary allowances and estimated average requirements.

- [https://www.nin.res.in/RDA\\_short\\_report\\_2020.html](https://www.nin.res.in/RDA_short_report_2020.html)
2. International Institute for Population Sciences (IIPS), & Ministry of Health and Family Welfare (India). (2021). National Family Health Survey (NFHS-5), 2019–21: India fact sheet. <https://rchiips.org/nfhs/>
  3. Kapil, U., Sareen, N., Bhadoria, A. S., & Nayar, D. (2009). Micronutrient deficiency status among women of the desert areas of western Rajasthan, India. *Public Health Nutrition*, 12(5), 624–629. <https://doi.org/10.1017/S1368980008002880>
  4. Kumar, N., Sharma, P., & Singh, R. (2024). Effect of social and behavioral change interventions on minimum dietary diversity among pregnant women and associated socioeconomic inequality in Rajasthan, India. *BMC Nutrition*, 10(1). <https://doi.org/10.1186/s40795-024-00887-1>
  5. Singh, D., & Prakash, B. (2025). Food intake of pregnant women: A study among pregnant women attending a tertiary care hospital in Ajmer, Rajasthan. *Educational Trend*, 5(2), 33–38. <https://ejournals.ncert.gov.in/index.php/ET/article/view/3770>
  6. Singh, M., Jain, S., & Choudhary, M. (2009). Dietary adequacy of pregnant women in four districts of Rajasthan. *Journal of Human Ecology*, 25(3), 161–165. <https://doi.org/10.1080/09709274.2009.11906163>
  7. Government of India. (2018). POSHAN Abhiyaan: National nutrition mission guidelines. Ministry of Women and Child Development. <https://poshanabhiyaan.gov.in/>
  8. Ministry of Women and Child Development (India). (2020). Integrated Child Development Services (ICDS) scheme: Operational guidelines. <https://icds-wcd.nic.in/>