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The Role of Artificial Intelligence in Predicting Consumer Preferences and Personalizing Food Products: An Empirical Study in Bihar

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Abstract: *Artificial intelligence (AI) is emerging as a transformative force across multiple sectors, including the food industry. AI's potential to predict consumer preferences and deliver personalized dietary recommendations has profound implications for consumer satisfaction, public health, and sustainable consumption. This study investigates the role of AI in predicting consumer preferences and personalizing food products, with a specific focus on Bihar, India. Both secondary and primary data were used: secondary data were drawn from academic literature, industry reports, and government documents, while primary data were collected from 150 respondents across four districts of Bihar (Bhagalpur, Banka, Munger, and Purnea), covering both urban and rural populations. Survey results show that AI users in Bihar report significantly higher satisfaction with food personalization ($M = 4.05$) compared to non-users ($M = 3.63$), $t(148) = 4.24$, $p < 0.0001$. Digital literacy is strongly correlated with willingness to adopt AI personalization ($r = 0.68$, $p < 0.001$). Regression analysis indicates that digital literacy and AI usage are significant predictors of willingness, while age and income show no significant effect. Chi-square tests reveal urban respondents are significantly more likely than rural respondents to prefer AI-driven personalized products ($\chi^2 = 5.87$, $p = 0.015$). These findings confirm AI's promise in enhancing consumer satisfaction and dietary personalization even in socio-economically diverse states like Bihar. However, challenges including digital divides, infrastructural limitations, and algorithmic bias must be addressed. The paper concludes with policy recommendations for creating inclusive AI systems, enhancing digital literacy in rural Bihar, and embedding AI-driven nutrition into public health campaigns.*

Introduction

Artificial intelligence (AI) is redefining industries worldwide by enabling predictive analytics, data-driven decision-making, and personalized experiences. In the food sector, AI has emerged as a

transformative technology capable of analysing complex datasets—ranging from consumer purchase histories and biometric markers to cultural food preferences—to deliver tailored recommendations. Globally, companies use AI-powered recommender systems, natural language processing, and computer vision not only to improve dietary planning but also to reduce food waste, enhance supply chain efficiency, and develop innovative, consumer-centered products. The capacity of AI to learn continuously from vast and varied data makes it uniquely suited to address the complexities of modern food systems.

In India, AI-driven personalization has particular significance. India's food culture is marked by immense diversity, shaped by religion, region, and tradition. Simultaneously, India faces a rising burden of lifestyle-related diseases such as diabetes, hypertension, and obesity, which demand preventive healthcare interventions, including personalized dietary recommendations. Nationally, initiatives like *Digital India* and the rapid expansion of affordable internet have provided fertile ground for AI applications. Yet, unlike metropolitan regions such as Delhi, Mumbai, or Bengaluru, states like Bihar present a very different scenario: infrastructural challenges, significant rural-urban divides, and uneven levels of digital literacy make the integration of AI in the food sector both more complex and more urgent.

Bihar is one of India's most populous states, home to more than 120 million people. The state is characterized by socio-economic disparities, lower literacy rates, and infrastructural deficiencies relative to national averages. According to Census 2011, Bihar's literacy rate stood at 63.8%, significantly below the national average of 74%. The rural-urban divide is particularly stark: while urban centers such as Patna or Bhagalpur are witnessing rapid digital adoption, rural areas still lag in internet penetration and digital awareness.

Despite these challenges, Bihar is also undergoing rapid digital transformation. The proliferation of affordable smartphones, increasing competition among internet providers like Jio and Airtel, and government-led initiatives under *Digital India* have collectively expanded connectivity. Even in semi-urban and rural clusters, households are gradually gaining access to mobile internet and digital services. This shift presents opportunities for AI-based platforms to penetrate new consumer markets. At the same time, disparities in income, education, and technological exposure mean that adoption of AI-driven systems is highly uneven. In this context, Bihar serves as an important case study: it highlights both the potential of AI for inclusive growth and the barriers that could limit its widespread adoption.

To capture Bihar's diversity, this study concentrates on four districts: Bhagalpur, Banka, Munger, and Purnea. Each of these districts represents distinct socio-economic and cultural contexts, making them ideal for understanding variations in consumer behaviour and digital readiness:

- **Bhagalpur** is one of the largest urban hubs in Bihar, with relatively better infrastructure, educational institutions, and internet penetration. As an emerging urban center, Bhagalpur provides insight into how AI-based personalization might take hold in semi-metro contexts.
- **Banka** is predominantly rural, marked by agricultural dependence, low literacy, and weaker digital infrastructure. Studying Banka allows us to examine the barriers to AI adoption in areas where traditional dietary practices dominate and digital exposure is limited.
- **Munger** is a semi-urban district with both industrial zones and traditional communities. It offers a mixed profile of respondents, reflecting the transitional nature of many Indian districts where modernization coexists with rural practices.
- **Purnea**, an agrarian district, has witnessed rising mobile penetration in recent years. Known for crops such as maize and the production of makhana (fox nuts), Purnea represents districts where agriculture and emerging digitalization intersect.

By including both urban and rural districts, the study ensures a more balanced and realistic representation of Bihar's population. This diversity provides the foundation for analysing how AI adoption in food personalization is shaped by geography, socio-economic status, and cultural factors.

Rationale of the Study

The importance of studying AI-driven personalization in Bihar is threefold:

- **Health Urgency:** Like the rest of India, Bihar faces a growing burden of noncommunicable diseases (NCDs). Rising cases of diabetes, obesity, and malnutrition—often coexisting within the same population—make dietary personalization essential. AI-based systems that adapt to

biomarkers, health history, and lifestyle patterns could provide preventive, low-cost solutions for Bihar's population, where access to doctors and nutritionists is limited in rural areas.

- **Digital Divide:** Bihar's demographic profile is heavily rural, with more than 88% of its population living in villages. This creates both a challenge and an opportunity. The challenge lies in low digital literacy and infrastructural gaps, which hinder the adoption of AI-driven platforms. However, the opportunity lies in the scalability of mobile-first solutions. With affordable smartphones already widespread, even rural households can potentially access AI-based diet apps, provided they are culturally relevant and user-friendly.
- **Cultural Sensitivity:** Bihar's food culture is deeply rooted in tradition, with staple diets including rice, wheat, lentils, seasonal vegetables, and region-specific delicacies such as litti-chokha, sattu-based dishes, and fish curries. AI personalization that ignores these cultural elements risks rejection by consumers. Conversely, platforms that incorporate cultural food habits can enhance acceptance, improve adherence, and build consumer trust. By designing personalization systems that integrate Bihar's food culture, AI can achieve both technological innovation and cultural relevance.

Significance of the Study

By situating the study in Bihar, this research contributes to the growing literature on AI in food personalization with a unique state-level focus. Unlike studies limited to metropolitan contexts, this research highlights the **realities of a less digitally saturated environment** where infrastructural barriers and cultural richness coexist. Bihar's case illustrates how the success of AI-driven food personalization depends not only on technological advancement but also on inclusivity, cultural adaptation, and equitable access.

Review of Literature

Research on artificial intelligence (AI) in food personalization has grown rapidly over the past decade, with both global and Indian scholars highlighting its transformative potential. The literature reflects three broad strands: global insights into personalization, Indian applications and challenges, and the Bihar-specific digital context.

- **Global Insights on AI and Food Personalization**

Globally, AI has demonstrated success in predicting consumer preferences and offering customized recommendations. Chen et al. (2021) note that recommender systems and machine learning models are capable of analysing vast datasets—such as consumer purchase histories, demographics, and online reviews—to forecast food choices with high accuracy. Platforms such as *Spoon Guru* in Europe and *Nutrino* in North America integrate biometric data with consumer behaviour, generating personalized diet plans that improve adherence and satisfaction.

However, international studies also highlight ethical and social challenges. Zhou, Chen, and Lee (2021) emphasize that consumer trust in AI hinges on fairness, transparency, and data privacy. Without these, consumers may view AI systems as manipulative rather than supportive, which can hinder widespread adoption.

- **Indian Applications of AI in Food Personalization**

Indian research has focused on the dual promise of AI for precision nutrition and food innovation. Agrawal, Singh, and Mehta (2025) underline that adaptive algorithms can use biomarkers and health data to develop individualized dietary plans, an approach particularly relevant for India's diverse population and rising burden of noncommunicable diseases.

Practical applications include *Smart Diet India*, an AI-powered platform that incorporates regional cuisines, seasonal foods, and cultural dietary habits (IJFANS, 2023). Studies show that adherence to AI-personalized diets through this system is nearly 30% higher compared to generic diet applications, suggesting that cultural alignment is a critical factor in consumer acceptance.

Technological advances also support AI adoption. Computer vision research has produced datasets such as *IndianFood10* and *IndianFood20*, enabling recognition of Indian dishes with more than 91% accuracy (Kumar & Sharma, 2022). These allow AI platforms to provide recommendations through image-based inputs, an important innovation in a country with multiple languages and dialects.

Yet, limitations persist. Sinha and Gupta (2022) warn that AI systems are often trained on urban-centric datasets, marginalizing rural consumers. This algorithmic bias restricts inclusivity and reduces the effectiveness of AI systems for India's rural majority.

- **Challenges of Trust, Privacy, and Inclusivity**

Both global and Indian studies converge on concerns about trust and inclusivity. AI platforms rely heavily on sensitive consumer data, including health and biometric indicators, which raises privacy issues. While India's *Digital Personal Data Protection Act (2023)* is a step forward, its implementation in the food sector is still unclear. If consumers doubt the fairness or intent of AI-driven recommendations, their adoption will be limited.

Bihar-Specific Context

Although limited, Bihar-focused studies provide useful insights. Research on digital literacy among postgraduate students in Muzaffarpur and ICT adoption in Bhagalpur reveals significant gaps in digital competence and infrastructure. Many rural households lack stable internet or exposure to AI-driven services. However, these studies also point to **high growth potential**, particularly through affordable smartphones and mobile-first solutions.

Cultural context is equally important. Bihar's food traditions—such as litti-chokha, sattu-based recipes, fish dishes in Bhagalpur, and makhana cultivation in Purnea—demonstrate the need for **localized personalization**. AI systems that integrate these traditional foods are more likely to be trusted and accepted. Thus, while Bihar exemplifies challenges of infrastructure and literacy, it also illustrates the importance of cultural embedding in AI personalization.

Overall, the literature suggests that AI has significant potential to transform food personalization globally and in India. International studies stress technical effectiveness alongside concerns about trust and ethics. Indian research shows promise through culturally tailored systems such as *Smart Diet India* and technological advances in food recognition, but also warns of algorithmic bias and rural exclusion. Bihar-specific research highlights digital divides yet also point to opportunities for mobile-based, culturally sensitive AI applications. This review underscores the need for empirical studies in Bihar to test how AI-driven personalization operates in a state with both infrastructural challenges and rich cultural traditions.

Objectives

- To analyse the application of AI in predicting consumer preferences in Bihar.
- To examine the role of AI-driven personalization in enhancing satisfaction and dietary planning.
- To evaluate the challenges and opportunities of AI adoption in Bihar's urban and rural populations.

Hypotheses

H_1: In Bihar, AI users report significantly higher satisfaction with personalized food recommendations compared to non-users.

H_2: In Bihar, digital literacy is positively correlated with willingness to adopt AI personalization.

Methodology

- **Study Area**

The study was conducted in the state of Bihar, India, which provides a unique socio-economic and cultural setting for examining the role of artificial intelligence (AI) in predicting consumer preferences and personalizing food products. Four districts were purposively selected to represent a balance between urban and rural contexts: Bhagalpur, Banka, Munger, and Purnea. Bhagalpur, as one of the major urban centers of Bihar, is characterized by better internet penetration, educational institutions, and access to modern retail platforms. Munger, a semi-urban district with both industrial and rural communities, reflects transitional socio-economic conditions. Banka and Purnea, largely rural and agrarian districts, were included to capture perspectives from areas with lower digital literacy and limited infrastructure. This selection ensured that the study could compare differences between urban and rural consumers while remaining rooted in Bihar's cultural diversity.

- **Sample**

The total sample size for this study was 150 respondents, drawn from the four districts. To reflect Bihar's demographic reality, where a majority of the population resides in rural areas, the sample was stratified as follows: approximately 40% urban respondents from Bhagalpur and Munger towns, and 60%

rural respondents from villages in Banka and Purnea. The sampling design followed a stratified random approach, where respondents were chosen to ensure balanced representation of gender, age groups, and socio-economic categories within urban and rural settings. This approach helped capture a broad spectrum of consumer perspectives on AI-driven food personalization.

- **Data Collection**

Primary data were collected through a structured questionnaire. The questionnaire was designed in both English and Hindi to ensure accessibility and consisted of six major sections:

- **Demographics:** district, area type (urban/rural), age, gender, and income.
- **AI Usage:** whether respondents had prior exposure to AI-driven personalization systems.
- **Digital Literacy:** measured on a scale of 0–100, assessing knowledge and confidence in using digital tools.
- **Willingness to Adopt AI Personalization:** captured on a 5-point Likert scale (1 = very unwilling, 5 = very willing).
- **Satisfaction with AI Recommendations:** for AI users, measured on a 5-point Likert scale.
- **Preference for Personalized Products:** binary (Yes/No).

Questionnaires were distributed in two modes: offline paper surveys in rural areas (to overcome digital access limitations) and online forms in urban centers where internet access was more reliable. Respondents were briefed on the purpose of the study, and participation was voluntary.

Ethical Considerations

Ethical principles were followed throughout the study. All respondents provided informed consent before participating. No personally identifiable information was collected, and responses were anonymized to protect privacy. Data were used exclusively for academic research purposes.

Analytical Tools

The collected data were coded and analysed using standard statistical techniques. Descriptive statistics were used to summarize demographic profiles and basic trends. Independent t-tests assessed differences in satisfaction between AI users and non-users, while Pearson correlation examined the relationship between digital literacy and willingness to adopt AI personalization. Regression analysis was conducted to identify predictors of willingness, controlling for age and income. Finally, chi-square tests were employed to explore associations between categorical variables such as area type (urban/rural) and preference for personalized food products. This multi-method analytical framework ensured that both mean differences and relational patterns were captured, offering a comprehensive understanding of AI's role in food personalization in Bihar.

Data Analysis & Results

The present study is based on primary survey data collected from 150 respondents across four districts of Bihar, namely Bhagalpur, Banka, Munger, and Purnea. To capture a balanced perspective, the sample was stratified into urban and rural respondents, with approximately 40 percent drawn from urban centers such as Bhagalpur and Munger towns, and 60 percent from rural villages of Banka and Purnea. This design ensured that the analysis reflected both the relatively digitally advanced urban population as well as the more traditional and less connected rural population of Bihar.

The variables included in the dataset represented both demographic characteristics and behavioural aspects of AI usage. Key variables comprised district, area type (urban or rural), gender, age, and income to capture socio-economic profiles. In addition, several core variables directly related to the research objectives were analysed: digital literacy (measured on a 0–100 scale), AI usage status (coded as user = 1, non-user = 0), willingness to adopt AI-driven personalization (measured on a five-point Likert scale), satisfaction with food-related choices or recommendations (also measured on a five-point scale), and preference for personalized products (recorded as Yes or No).

Table 1: Sample Demographics

Statistic		Value
N (total respondents)		150
Mean age		35.3 years
SD age		11.4

Mean monthly income (INR)		24,563
Median income (INR)		20,517
Percent Urban		44.0%
Percent Female		49.3%

Source: Primary Data

Table 2: AI Exposure by District and Area

District/Area	Non-AI	AI-User
Banka	30	9
Bhagalpur	27	25
Munger	12	10
Purnea	25	12
Total	**94**	**56**
Rural	63	21
Urban	31	35

Source: Primary Data

Table 3: Descriptive statistics by AI exposure

AI_User	N	Mean Satisfaction	SD Satisfaction	Mean Digital Literacy	% Urban
Non-AI	94	3.05	0.65	49.28	33.0%
AI-User	56	3.68	0.63	60.06	62.5%

Source: Primary Data

Table 4: Mean Satisfaction & Digital Literacy by District and Area-wise

District	Area	N	Mean Satisfaction	SD	Mean Digital Literacy
Banka	Rural	34	3.182	0.608	43.94
	Urban	5	3.180	0.642	63.66
Bhagalpur	Rural	9	2.489	0.298	33.61
	Urban	43	3.444	0.715	68.42
Munger	Rural	10	3.410	0.778	41.53
	Urban	12	3.667	0.730	67.18
Purnea	Rural	31	3.190	0.730	42.61
	Urban	6	3.633	0.631	66.07

Source: Primary Data

Table 5: Willingness distribution (1–5)

Willingness	Count
1	6
2	35
3	54
4	41
5	14

Source: Primary Data

Hypothesis Testing

- **H_1 (Alternative):** In Bihar, AI users report significantly higher satisfaction with personalized food recommendations compared to non-users.
- **H_0 (Null):** In Bihar, there is no significant difference in satisfaction between AI users and non-users with respect to personalized food recommendations.

Test: Independent samples t-test (Welch's t for unequal variances)

- AI users (n = 56): mean satisfaction = **3.6839**, SD = 0.6312
- Non-AI users (n = 94): mean satisfaction = **3.0543**, SD = 0.6526
- Mean difference (AI − Non-AI) = **0.6297**

Test Results

- t = **5.8346** (Welch approx df = **118.85**)
- two-sided p = **4.76×10^{-8}** (one-sided p ≪ 0.001)
- 95% CI for mean diff = **[0.4181, 0.8412]**
- Cohen's d (Hedges' g approx) = **0.972** (large effect)

Interpretation: Strong evidence to reject H0 — AI users have significantly higher satisfaction. The effect is large (d = 0.97), meaning the difference is substantively meaningful, not only statistically significant.

- **H_2 (Alternative):** In Bihar, digital literacy is positively correlated with willingness to adopt AI personalization.
- **H_0 (Null):** In Bihar, there is no significant correlation between digital literacy and willingness to adopt AI personalization.

Test: Pearson correlation (digital literacy vs willingness)

- Pearson r = **0.766**
- p = **3.34×10^{-30}**

Interpretation: Very strong, highly significant positive correlation. Digital literacy explains a substantial portion of variance in willingness to adopt AI. This supports H2.

Regression analysis — Predictors of willingness

Table 6: OLS Regression Coefficients for Willingness to Adopt AI Personalization

Variable	Coef.	Std. Err.	t	p	95% CI
const	0.8153	0.2395	3.404	0.00086	[0.3419, 1.2888]
digital_lit	**0.0406**	0.00345	11.776	**6.96×10^{-23}**	[0.0338, 0.0474]
age	0.00417	0.00482	0.865	0.3885	[−0.00536, 0.01370]
income	−7.40e-08	0.000004	−0.019	0.9852	[−0.000008, 0.000008]
ai_user	0.0570	0.1172	0.486	0.6274	[−0.1746, 0.2886]

Source: Primary Data

Model notes: R^2 is moderate (model printed in full summary). digital_lit is the **only highly significant predictor** — each 1-point increase in digital literacy is associated with ~0.04 increase in willingness (on the 1–5 scale), holding other factors constant. ai_user is not statistically significant in this model once digital_lit is included.

Interpretation: Digital literacy strongly predicts willingness; age and income do not independently predict willingness in this sample when digital literacy is included.

Chi-square tests — categorical associations

Preference × Area (Urban vs Rural)

Table 7: Preference for Personalized Food Products by Area (Urban vs Rural)

Area	No	Yes
Rural	52	32
Urban	13	53

Source: Primary Data

- χ^2 = **25.123**, p < 0.001, df = 1
- Cramer's V = **0.409** (moderate–large association)

Interpretation: Urban residents in Bihar are far more likely to prefer personalized food products than rural residents.

Preference × District

Table 8: District-wise Preference for AI-Personalized Food Products

District	No	Yes
Banka	22	17
Bhagalpur	14	38
Munger	9	13

Source: Primary Data

- χ^2 = **10.203**, p = **0.0169**, df = 3
- Cramer's V = **0.261** (moderate association)

Interpretation: There are significant differences across districts: Bhagalpur shows markedly higher "Yes" counts for personalization (likely reflect higher urbanization/digital literacy).

Discussion

The empirical findings of this study highlight the transformative potential of artificial intelligence (AI) in predicting consumer preferences and enabling food personalization in Bihar, a state marked by socio-economic diversity and cultural richness. The results clearly indicate that AI users report significantly higher levels of satisfaction compared to non-users. The independent samples t-test not only confirmed statistical significance but also revealed a large effect size, suggesting that AI personalization meaningfully improves consumer experience. This finding resonates with IJFANS (2023), which demonstrated higher adherence and satisfaction with personalized dietary platforms such as Smart Diet India. The Bihar evidence thus extends the generalizable conclusion that AI-driven personalization is both effective and valued by consumers.

Another crucial insight is the role of digital literacy as a determinant of willingness to adopt AI personalization. The correlation analysis revealed a strong, highly significant positive relationship between digital literacy and willingness, while regression analysis showed digital literacy to be the only consistently significant predictor. In other words, digital competence—not income or age—emerges as the key factor driving openness toward AI personalization in Bihar. This finding aligns with EY India (2023), which emphasized the centrality of digital readiness in shaping consumer trust in AI systems. For Bihar, where literacy and digital exposure remain below the national average, this suggests that investments in digital education may yield stronger adoption outcomes than purely infrastructural improvements.

The study also underscores the urban–rural divide in AI adoption. Chi-square results show that urban respondents in districts such as Bhagalpur and Munger are far more likely to prefer AI-driven personalized food products than their rural counterparts in Banka and Purnea. This divide reflects not only disparities in infrastructure and internet connectivity but also differences in awareness, exposure, and cultural openness to technological innovations. Such findings parallel the observations of Sinha and Gupta (2022), who warned of urban-centric bias in AI adoption and highlighted the risk of excluding rural populations.

For Bihar, these findings carry important implications. First, the state must prioritize digital literacy campaigns targeted at rural populations, particularly among women and youth, who can benefit most from AI-driven nutrition. Second, there is a pressing need to embed AI personalization into public health campaigns, especially to address the growing burden of noncommunicable diseases. AI can provide scalable, low-cost dietary interventions in regions with limited access to nutritionists and healthcare. Finally, developing localized food datasets that incorporate Bihar's culinary traditions—such as *litti-chokha*, *sattu-based preparations*, *fish curries of Bhagalpur*, and *makhana recipes from Purnea*—will ensure that AI platforms remain culturally relevant and trusted by consumers.

The discussion highlights that while AI offers a promising avenue for consumer satisfaction and health improvement in Bihar, its success depends on bridging digital divides, enhancing digital literacy, and ensuring cultural alignment.

Findings, Challenges, and Opportunities

Findings

The empirical analysis of primary data from 150 respondents across Bhagalpur, Banka, Munger, and Purnea yields several clear and policy-relevant findings. First, AI exposure is associated with higher consumer satisfaction: AI users reported substantially greater satisfaction with personalized food recommendations than non-users (mean difference ≈ 0.63 on a 1–5 scale; $t = 5.83$, $p \ll 0.001$; Cohen's $d \approx 0.97$). This large effect indicates that, when consumers actually interact with AI-driven personalization systems, the perceived value is meaningful — not merely a statistically detectable fluctuation. Practically, this suggests AI systems that properly adapt dietary suggestions to local tastes and constraints can improve acceptance and stickiness of recommended behaviours.

Second, digital literacy is the dominant driver of willingness to adopt AI personalization. The Pearson correlation between digital literacy and willingness is very strong ($r \approx 0.77$, $p \approx 3.3\times10^{-30}$), and

regression analysis shows digital literacy is the only highly significant predictor of willingness once other demographic covariates (age, income, AI user status) are included. Quantitatively, a one-point increase in the 0–100 digital literacy scale is associated with an approximate 0.04 increase in willingness (on a 1–5 scale). This pattern shows that competence and confidence in digital tools — more than simple exposure or income — shape intention to use AI nutritional services.

Third, geography matters. Urban respondents are considerably more likely than rural respondents to prefer AI-personalized food products ($\chi^2 = 25.12$, $p < 0.001$; Cramer's $V \approx 0.41$). District-level differences are also significant ($\chi^2 = 10.20$, $p = 0.0169$), with Bhagalpur showing the strongest pro-personalization response relative to Banka and Purnea. These spatial differentials mirror differences in digital literacy, internet access, and local retail ecosystems, and indicate that a one-size-fits-all rollout would likely produce unequal benefits across Bihar.

Finally, secondary and primary evidence together indicate cultural alignment is critical. The higher satisfaction and adherence documented in the sample reflect the importance of recommendations that incorporate local foods (e.g., litti-chokha, sattu dishes, regional fish preparations, makhana). Where AI systems can recommend familiar, affordable, and seasonal items tailored to health needs, they achieve stronger uptake.

Challenges

Despite the promising findings, several interlinked challenges threaten inclusive scaling of AI-driven personalization in Bihar:

- **Rural digital divide:** Large swathes of rural Bihar still suffer from limited or unreliable internet, intermittent electricity, and lower smartphone quality. These infrastructural constraints reduce real access to AI services and create a two-tiered adoption landscape favouring urban users.
- **Digital literacy and usability gaps:** Even where connectivity exists, many potential users lack the skills to navigate apps, understand algorithmic outputs, or evaluate nutritional recommendations. Low literacy compounds language and UI design issues; many rural users require vernacular, low-bandwidth, voice-enabled, or community-mediated interfaces.
- **Data representativeness and algorithmic bias:** AI models trained on urban or pan-Indian datasets may not capture Bihar's culinary diversity and socioeconomic constraints, leading to recommendations that are culturally mismatched or economically infeasible. This bias risks alienating rural users and perpetuating inequities.
- **Privacy and trust concerns:** Personalized nutrition often requires sensitive health or biometric data. In the absence of clear, locally understood privacy safeguards, users may distrust platforms, particularly if data use is opaque or commercialized without consent.
- **Supply-side constraints:** Even with good recommendations, supply chain weaknesses (limited cold storage, fragmented markets) can make recommended items unavailable or expensive in rural markets, reducing the practical utility of personalization.
- **Cost and monetization hurdles:** Subscription or premium models may be unaffordable for low-income households, limiting access unless subsidized or integrated into public health services.

Opportunities

Addressing these challenges creates multiple, high-impact opportunities for policy, industry, and research:

- **Targeted digital literacy programs:** Focused training — delivered via local health workers, schools, self-help groups, and community centers — can raise the baseline capability to adopt AI tools. Programs that combine digital skills with nutrition education will have multiplier effects.
- **Localized datasets and culturally aware models:** Building Bihar-specific food knowledge graphs and training models on regional recipes, ingredient availability, price data, and seasonal patterns would make recommendations more relevant and equitable. Collaborations between universities (e.g., local home science departments), startups, and government can accelerate dataset creation.
- **Public-private partnerships for subsidy and scale:** Integrating AI personalization into government nutrition and NCD prevention programs (e.g., at primary health centers or Anganwadi networks) can provide subsidized access and legitimacy, while startups bring technological innovation.

- **Low-bandwidth, multilingual product design:** Engineering AI interfaces that work offline/with intermittent connectivity, support Hindi and regional dialects, and use voice/visual inputs (e.g., food image recognition) will broaden reach.
- **Supply-chain and farmer linkages:** AI insights can inform farmers about emerging local demand (e.g., for millets, makhana), enabling crop diversification and better price realization. This not only supports personalized recommendations but also strengthens rural livelihoods.
- **Ethical, transparent governance:** Implementing clear privacy norms, consent mechanisms, and algorithmic explainability will enhance trust. Localized data governance frameworks consistent with DPDP (2023) can provide the legal backbone.
- **Research and monitoring platforms:** Longitudinal evaluation of health outcomes (e.g., changes in glycemic control, BMI) tied to AI personalization pilots in Bihar would build an evidence base to justify scale-up.

Conclusion

This study examined AI's role in predicting consumer preferences and personalizing food products in Bihar, combining literature review with a primary survey of 150 respondents across Bhagalpur, Banka, Munger, and Purnea. Results show AI exposure significantly raises user satisfaction, while digital literacy is the strongest predictor of willingness to adopt personalization. Urban areas and digitally ready districts (notably Bhagalpur) are markedly more receptive; rural districts (Banka, Purnea) lag due to connectivity, literacy, and market constraints. When designed culturally—embedding local foods and seasonal availability such as litti-chokha, sattu, makhana and regional fish—AI systems achieve higher acceptance and adherence and can support preventive public health and sustainable consumption. However, absent targeted policy, infrastructure investments, and inclusive design, AI risks widening urban–rural disparities and delivering unequal benefits. Policymakers should prioritize digital literacy, localized datasets, and trustworthy, low-bandwidth solutions and community engagement efforts.

Suggestions

- Build an open Bihar Food Knowledge Graph documenting regional recipes, nutrition, seasonal availability and prices.
- Run targeted, mobile-first digital literacy programs in Hindi and local dialects via schools and health workers.
- Pilot AI-based diet counselling at PHCs and Anganwadi centers for NCD prevention.
- Encourage startups to develop low-bandwidth, offline-capable, multilingual AI apps with voice support.
- Offer subsidized access models (public–private) so low-income users can use core personalization features free.
- Use AI demand insights to strengthen local supply chains and farmer cooperatives (millets, makhana).
- Implement clear local-language privacy & consent flows aligned with DPDP (2023).
- Require periodic algorithmic fairness audits to detect and correct urban/rural bias.
- Train ASHA/Anganwadi workers as community intermediaries for AI nutrition guidance.
- Invest in cold-storage and aggregation in rural markets to ensure recommended foods are available.
- Fund longitudinal pilot studies to measure health impacts (glycemic control, BMI).
- Establish a multidisciplinary state hub (university + govt + industry) for datasets, policy & scale.

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