**Review Article**

**From Data to Diet: The Impact of Artificial Intelligence on Nutritional Science**

**Abstract**

The rise of artificial intelligence (AI) is reshaping nutrition science, offering groundbreaking ways to refine how we assess diets, tailor nutrition plans, monitor food quality, and enhance public health strategies. Traditional methods—often plagued by unreliable self-reporting, generic recommendations, and slow feedback loops—are being outpaced by AI’s ability to process complex, multidimensional data. By harnessing machine learning, deep learning, and computer vision, AI integrates insights from genetics, metabolism, lifestyle, and environmental factors, unlocking precision nutrition tailored to individuals and communities alike.

This review explores AI’s expanding role in nutrition, from smart diet-recommendation systems that craft hyper-personalized meal plans with near-dietitian-level accuracy, to wearable tech and mobile apps that eliminate guesswork in food tracking. Advanced algorithms now analyze real-time biometric data and multi-omics profiles to adjust dietary advice dynamically, bridging the gap between lab research and real-world eating habits. AI also acts as a high-tech food inspector, using spectral imaging and pattern recognition to detect adulterants, optimize nutrient content, and ensure safety from farm to fork.

On a broader scale, AI empowers public health initiatives by identifying dietary trends, forecasting disease risks, and enabling data-driven interventions. Yet these innovations aren’t without hurdles: privacy concerns, "black box" algorithms, and disparities in access demand urgent attention. For AI to fulfill its potential, the field must prioritize ethical frameworks, robust validation, and inclusive design. Ultimately, this review argues that AI’s true power lies in collaboration—melding cutting-edge tech with human expertise to deliver nutrition solutions that are as equitable as they are revolutionary.

**Keywords:** Artificial Intelligence, Nutritional Science, Wearable Health Technology, and Public Health Nutrition

**Introduction: The New Frontier of Nutrition**

The field of nutritional science stands at a pivotal crossroads, where decades of generalized dietary advice are giving way to hyper-personalized, data-driven recommendations—all thanks to artificial intelligence (AI). No longer constrained by the limitations of traditional methods—recall bias in food diaries, one-size-fits-all meal plans, or delayed intervention feedback—researchers and clinicians now leverage AI’s computational prowess to revolutionize how we understand and implement nutrition.

At the heart of this shift are machine learning (ML), deep learning (DL), and natural language processing (NLP), which collectively analyze sprawling datasets encompassing genomic profiles, metabolic biomarkers, and even socioeconomic factors (Ülker & Ayyildiz, 2021). For instance, Sharma and Gaur (2024) highlighted AI’s ability to correlate epigenetic markers with individual nutrient absorption rates, enabling diets tailored not just to a person’s weight goals but to their unique biology.

Yet for all its potential, AI’s integration into nutrition isn’t without hurdles. Ethical dilemmas—like algorithmic bias in underserved populations or the privacy risks of wearable-derived health data—loom large. This review unpacks AI’s multifaceted impact, from precision dietetics to food safety, while confronting the challenges that could make or break its role in global health.

**Diet Recommendation Systems: Precision Meets Practicality**

Static meal plans are relics in the era of AI-driven dynamic nutrition. Modern systems, such as the variational autoencoder framework proposed by Bhandari et al. (2025), demonstrate how AI transcends generic guidelines. Their model achieved **87% macronutrient accuracy** by synthesizing anthropometric data, taste preferences, and even budget constraints—effectively mirroring a dietitian’s expertise while scaling to millions of users.

What sets these tools apart is their adaptability. Papastratis et al. (2024) documented an AI system that iteratively refined its recommendations based on real-time user feedback. For example, if a diabetic patient’s glucose monitor flagged post-meal spikes, the algorithm would adjust carbohydrate distributions in subsequent meals while preserving flavor preferences—a feat impossible with manual planning.

Wearable technology amplifies this precision. Closed-loop systems, like those studied by Prasad and Raj (2025), sync continuous glucose monitors with AI analyzers to tweak meal timing and composition dynamically. Such innovations are particularly transformative for chronic conditions; Gavai and Hillegersberg (2025) reported a **30% improvement** in glycemic control among type 2 diabetics using AI-curated diets.

However, these advances hinge on data quality. Ferreira et al. (2025) cautioned that AI models trained on homogenous populations often fail to account for regional dietary customs—a gap that underscores the need for culturally inclusive datasets.

**Dietary Assessment: From Fuzzy Recall to Pixel-Perfect Accuracy**

For decades, nutrition research relied on flawed tools: food frequency questionnaires skewed by memory lapses, or 24-hour recalls warped by portion-size misestimations. AI is rewriting these standards.

Computer vision now deciphers meals with startling precision. NutriNet, a convolutional neural network (CNN) developed by Sak and Suchodolska (2021), classifies foods from images with **92% accuracy**, even distinguishing between similar dishes (e.g., quinoa vs. couscous). Kassem et al. (2025) expanded this with *goFOOD*, a smartphone app that pairs image recognition with nutrient databases to estimate caloric intake in real time—reducing underreporting errors by **40%** compared to pen-and-paper logs.

Passive monitoring tools are equally groundbreaking. The FRANI system (Armand et al., 2024) uses discreet wearable cameras to capture meals, then employs AI to log nutrients without user input. Validated in adolescents—a group notorious for erratic eating patterns—FRANI matched dietitian-analyzed recalls in accuracy while eliminating the Hawthorne effect (where subjects alter behavior due to observation).

Behind the scenes, AI cleans up messy data. Machine learning algorithms now flag inconsistencies in dietary surveys—like implausible calorie entries or missing micronutrient values—and either correct them using probabilistic models or prompt users for clarification (Kassem et al., 2025). This automation is pivotal for large-scale studies where manual data validation would be prohibitively time-consuming.

**Personalized Nutrition: Decoding the “Why” Behind Dietary Responses**

The myth of universal dietary truths has been debunked. Twin studies reveal stark variations in how individuals metabolize identical foods, influenced by genetics, microbiome composition, and even sleep patterns (Rouskas et al., 2025). AI’s ability to parse these variables is ushering in true personalization.

Take gut microbiome modulation. Rouskas’ team used ML to analyze metagenomic data from 10,000 individuals, identifying specific fibers that boosted beneficial bacteria in user subgroups. Participants receiving AI-tailored diets saw a **15% greater increase** in microbial diversity than those on standard prebiotic regimens.

Genomics further refines this approach. Sharma and Gaur (2024) reviewed AI models that cross-reference single-nucleotide polymorphisms (SNPs) affecting nutrient metabolism—like the MTHFR gene’s impact on folate processing—to design diets mitigating chronic disease risks. Meanwhile, platforms like *THE FIT AI* (Gajalakshmi et al., 2025) blend these biological insights with practical constraints, generating meal plans that align workouts, circadian rhythms, and even work schedules with nutritional needs.

Yet limitations persist. Solomon and Laye (2025) found that while AI chatbots excel at disseminating sports nutrition facts, they falter in addressing emotional eating or budget barriers—reminders that technology complements, but doesn’t replace, human nuance.

**Food Composition & Safety: AI as the Guardian of Nutritional Integrity**

AI’s role extends beyond meal planning to ensuring food quality itself. Traditional nutrient analysis—proximate methods, chromatography—is slow and costly. AI accelerates this through spectral analysis and pattern recognition.

Magdas et al. (2025) demonstrated how ML models identify bioactive peptides in underutilized protein sources (e.g., sesame meal), enabling their use in malnutrition interventions. Similarly, AI-driven spectroscopy detects adulterants—like melamine in milk or starch in spices—with **95% sensitivity** (Canatan et al., 2025), a boon for food regulators.

Supply chains also benefit. Shehzad et al. (2025) deployed hyperspectral imaging AI to grade fruit ripeness and predict shelf-life, reducing supermarket waste by **22%**. Meanwhile, blockchain-integrated sensors track contamination outbreaks in real time, slashing response times during foodborne illness incidents (Almoselhy & Usmani, 2024).

**AI Tools**

The technological backbone of AI applications in nutrition consists of machine learning models, deep learning architectures, mobile applications, and wearable devices. Machine learning enables pattern recognition in complex nutritional datasets, while deep learning, particularly convolutional neural networks, excels in image-based dietary assessment and food classification (Armand et al., 2025; Nelson et al., 2025).

Mobile AI applications, such as goFOOD and FRANI, facilitate user-friendly dietary monitoring and feedback, increasing engagement and adherence (Phalle & Gokhale, 2025). Wearable devices equipped with AI algorithms continuously track physiological parameters and dietary intake, providing actionable data for personalized nutrition plans (Lyroi et al., 2025; Prasad & Raj, 2025).

Natural language processing (NLP) enhances user interaction with AI through chatbots and virtual assistants, although current limitations exist in replacing dietitians’ nuanced expertise (Solomon & Laye, 2025). Nevertheless, AI tools are rapidly evolving, with potential to integrate multi-modal data streams and offer comprehensive nutrition guidance.

**AI-Based Mobile Applications and Wearables**

Mobile health (mHealth) technologies augmented with AI are transforming dietary monitoring and nutrition education by leveraging smartphone cameras, motion sensors, and wearable devices. Phalle and Gokhale (2025) described how image-based dietary assessment tools utilize smartphone cameras to capture food intake and apply convolutional neural networks to classify foods and estimate nutrient content in real time. These applications enable users to log meals effortlessly, reduce reliance on memory, and improve dietary self-monitoring accuracy.

Wearable sensors integrated with AI track physiological signals such as heart rate, glucose levels, and activity patterns, facilitating dynamic nutrition recommendations. Lyroi et al. (2025) reported that AI-powered wearables can provide continuous feedback, alerting users to dietary imbalances and prompting behavior modifications. Similarly, Prasad and Raj (2025) demonstrated that integration of wearable device data with AI algorithms enhances personalized diet planning, especially in managing metabolic diseases like diabetes and obesity.

Chatbots and virtual assistants such as ChatGPT have been evaluated for their capacity to deliver sports nutrition knowledge; however, Solomon and Laye (2025) caution that while useful for information dissemination, these AI tools cannot substitute the personalized, empathetic counseling provided by professional dietitians.

**Positive Aspects of AI in Nutrition**

AI offers several advantages in nutrition science and practice. Abdallah et al. (2024) noted that AI-driven dietary assessments minimize human errors and biases inherent in self-reported data, improving data quality for research and clinical decision-making. Personalized AI nutrition interventions account for individual metabolic variability, genetics, and lifestyle, enhancing efficacy in disease prevention and management (Detaskevi et al., 2023; Ferreira et al., 2025).

In food production and safety, AI optimizes quality control, reduces contamination risks, and facilitates rapid identification of adulterants, thereby safeguarding consumer health (Almoselhy & Usmani, 2024; Savaş et al., 2024). AI’s ability to process large-scale data efficiently supports the development of customized food products that meet specific health needs, potentially transforming food systems globally (Shehzad et al., 2025).

**Future Directions of AI in Nutrition**

Despite promising advances, AI applications in nutrition are still evolving and face several challenges. Detaskevi et al. (2023) emphasize the need for rigorous validation studies to assess AI models’ accuracy and cost-effectiveness in diverse populations. Incorporating genetic data and other omics technologies into AI frameworks is anticipated to refine personalized nutrition further (Prasad & Raj, 2025; Kassem et al., 2025).

Technological innovations, including AI robotics, blockchain integration in food supply chains, and 3D food printing, are expected to revolutionize the food industry and nutritional interventions (Shehzad et al., 2025). Addressing ethical concerns, ensuring data privacy, and promoting equitable access remain critical to maximizing AI’s benefits in nutrition (Wah, 2025).

Interdisciplinary collaboration between nutritionists, computer scientists, ethicists, and policymakers will be essential to develop robust, culturally sensitive, and accessible AI nutrition solutions tailored to global needs (Abdallah et al., 2024).

**Can AI Outrun Dietitians?**

The rapid advancement of AI in healthcare raises the question of whether AI can replace trained dietitians. While AI excels at processing large datasets and providing evidence-based recommendations rapidly, it currently lacks the ability to fully replicate the nuanced understanding, empathy, and cultural competence that human dietitians bring to patient care. Güner and Ülker (2024) evaluated AI chatbots such as ChatGPT and concluded that although these tools can offer theoretical nutrition knowledge and support decision-making, they do not yet possess the capability to account for individual psychosocial factors and behavioral motivators essential in effective nutrition counseling.

Solomon and Laye (2025) similarly underscored the limitations of large language models in sports nutrition advice, highlighting that AI tools cannot substitute for personalized guidance tailored to individual goals, preferences, and responses. Moreover, AI systems are limited by the quality and representativeness of their training data, which can introduce biases and reduce applicability across diverse populations (Stoian et al., 2025). Therefore, AI is best positioned as a powerful adjunct to, rather than a replacement for, professional dietitians, enhancing their capabilities and efficiency in delivering personalized care.

**The Road Ahead: Challenges and Collaborative Potential**

AI won’t supplant dietitians—but it will redefine their toolkit. As Güner and Ülker (2024) noted, while ChatGPT can explain ketosis, it can’t yet navigate a patient’s cultural aversion to fatty meats or budget-driven fast-food reliance. The future lies in synergy: AI handling data-crunching, while clinicians focus on empathy and education.

To realize this, the field must address:

1. **Bias Mitigation**: Diversifying training datasets to serve global populations.
2. **Transparency**: Demystifying “black box” algorithms for clinician trust.
3. **Accessibility**: Lowering costs to prevent AI from widening health disparities.

**Conclusion**

Artificial intelligence is fundamentally transforming nutrition science by enhancing the precision and efficiency of dietary assessment, enabling personalized nutrition interventions, improving food quality monitoring, and supporting population-level public health nutrition strategies. The integration of AI tools across these domains offers unprecedented opportunities to optimize nutritional outcomes and address global health challenges.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that no generative AI technologies such as Large Language Models and text-to-image generators have been used during the writing of this manuscript.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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