Pravara Med Rev; June 2026, 18 (02), 1-6
DOI: 10.36848/PMR/2026/40000.10999

Review article

Precision Lifestyle Medicine: Transforming Disease Prevention and Personalized Healthcare in the Era of Artificial Intelligence

Dr Motilal C Tayade

Head and Professor, Department of Physiology, DBVP Rural Medical College, Pravara Institute of Medical Sciences (DU), Loni.
E- Mail id: drmctayade@gmail.com

Abstract

Precision Lifestyle Medicine integrates evidence-based lifestyle interventions with genomics, metabolomics, microbiome science, artificial intelligence (AI), wearable technologies, and digital health platforms to provide individualized preventive and therapeutic strategies. Unlike conventional approaches that frequently rely on generalized recommendations, PLM recognizes the biological uniqueness of each individual and tailors interventions according to genetic susceptibility, metabolic characteristics, behavioural patterns, environmental exposures, and psychosocial determinants of health. AI-powered algorithms can process enormous datasets from electronic health records, wearable sensors, imaging, laboratory investigations, and genomic databases to generate individualized recommendations that improve clinical outcomes while reducing unnecessary interventions. Despite these remarkable advances, significant challenges remain, including data privacy, algorithmic bias, ethical concerns, inequitable access, regulatory uncertainties, and the need for clinician education. Future healthcare systems will increasingly depend on multidisciplinary collaboration among clinicians, researchers, data scientists, nutritionists, behavioural psychologists, and public health experts. This editorial review discusses the evolution of Precision Lifestyle Medicine, highlights the transformative role of artificial intelligence in personalized healthcare, summarizes current evidence, explores implementation challenges, and outlines future directions toward sustainable, patient-centred healthcare.

Keywords: *Precision Lifestyle Medicine; Artificial Intelligence; Personalized Healthcare*

Introduction

The twenty-first century has witnessed remarkable advances in medical science, biotechnology, and digital innovation. Despite these achievements, chronic non-communicable diseases—including cardiovascular disease, type 2 diabetes mellitus, obesity, cancer, chronic respiratory disorders, and neurodegenerative diseases—continue to account for nearly three-quarters of global mortality. (1) Importantly, many of these disorders are largely preventable through healthy lifestyle practices, yet conventional healthcare systems continue to focus predominantly on diagnosing disease after its clinical manifestation rather than preventing its development. (2)

The traditional "one-size-fits-all" model of healthcare is increasingly inadequate because individuals exhibit substantial heterogeneity in genetic makeup, metabolism, environmental exposures, microbiome composition, socioeconomic factors, and behavioural responses. (3) Two patients with identical diagnoses often respond differently to identical treatments, highlighting the limitations of generalized clinical recommendations.(4)

Precision Lifestyle Medicine (PLM) represents the convergence of preventive medicine, lifestyle medicine, precision medicine, systems biology, digital health, and artificial intelligence. Rather than treating established disease alone, PLM aims to identify individual risk factors before clinical illness develops and implement personalized interventions that optimize long-term health outcomes.(1)

Recent advances in artificial intelligence have dramatically accelerated this transition. Machine learning algorithms are capable of analysing complex interactions among genomic profiles, dietary habits, physical activity, sleep behaviour, laboratory biomarkers, wearable sensor data, and environmental influences to generate individualized preventive strategies. Consequently, healthcare is progressively shifting from episodic clinical encounters toward continuous, data-driven, patient-centred care. (5, 6) Our editorial explores the scientific foundations of Precision Lifestyle Medicine and discusses how artificial intelligence is redefining disease prevention, risk prediction, and personalized healthcare delivery.

The Evolution of Precision Lifestyle Medicine

Lifestyle medicine has long emphasized six evidence-based pillars: healthy nutrition, regular physical activity, restorative sleep, stress management, avoidance of harmful substances, and positive social relationships.

Numerous epidemiological studies have demonstrated that these interventions substantially reduce morbidity and mortality associated with chronic diseases. (6)

However, conventional lifestyle recommendations have generally been population-based. For example, dietary guidelines recommend similar nutritional patterns for large populations despite considerable interindividual variation in glucose metabolism, lipid responses, insulin sensitivity, gut microbiota composition, and genetic polymorphisms. (7)

Precision Lifestyle Medicine extends this concept by recognizing that optimal lifestyle interventions differ among individuals. Instead of asking, "What is the best diet?" PLM asks, "Which diet is best for this individual?" Similarly, exercise prescriptions are increasingly personalized according to genetic predisposition, cardiovascular fitness, metabolic phenotype, musculoskeletal health, inflammatory status, and personal preferences. Such individualized interventions improve adherence, clinical effectiveness, and patient satisfaction. The integration of genomics, transcriptomics, proteomics, metabolomics, microbiomics, and exposomics has further enhanced our understanding of disease susceptibility. These technologies generate multidimensional biological information that can now be interpreted using artificial intelligence, making personalized prevention increasingly feasible.(8)

Artificial Intelligence: The Driving Force behind Personalized Healthcare

Artificial intelligence represents one of the most transformative technologies in modern medicine. AI encompasses machine learning, deep learning, natural language processing, predictive analytics, computer vision, and generative models capable of analysing large and complex healthcare datasets beyond human analytical capacity. Healthcare data are expanding exponentially. Electronic medical records, wearable devices, smart watches, continuous glucose monitors, genomic sequencing, imaging studies, laboratory investigations, and patient-reported outcomes collectively generate enormous quantities of information. Traditional statistical methods often struggle to integrate these multidimensional datasets effectively.

Machine learning algorithms can identify hidden patterns associated with disease development years before symptoms appear. AI systems are increasingly capable of predicting cardiovascular events, diabetes progression, kidney disease, hospital readmissions, and adverse drug reactions with impressive accuracy. AI in Precision Lifestyle Medicine enables individualized risk assessment by integrating age, sex, family history, genetic variants, dietary behavior, physical activity, sleep duration, stress biomarkers, environmental pollution, gut microbiome characteristics, laboratory biomarkers, and medication adherence into a comprehensive personalized health profile.

These integrated analyses generate personalized recommendations rather than generic advice, thereby improving preventive healthcare outcomes. AI-powered conversational assistants and digital coaching platforms are also transforming patient engagement. Instead of receiving annual lifestyle counselling during clinic visits, patients now benefit from continuous behavioural guidance, automated reminders, nutritional coaching, exercise recommendations, medication alerts, and real-time health feedback. (9)

Personalized Risk Prediction

One of the greatest strengths of artificial intelligence lies in predictive medicine. Rather than waiting for disease onset, clinicians can estimate an individual's probability of developing illness years in advance.

Examples include:

- Prediction of type 2 diabetes before biochemical abnormalities become evident.
- Early identification of cardiovascular risk using multidimensional biomarkers.
- Personalized cancer screening recommendations.
- Prediction of cognitive decline.
- Identification of individuals likely to benefit from intensive lifestyle interventions.

Such predictive capability shifts healthcare from reactive treatment toward proactive prevention.

Digital Twins: The Future of Precision Medicine

One of the most exciting developments in AI is the concept of the **digital twin**—a virtual computational representation of an individual that integrates physiological, genomic, metabolic, imaging, and behavioural data. Digital twins may eventually allow clinicians to simulate how a patient will respond to dietary modifications, medications, exercise programmes, or surgical interventions before these are implemented in real life. This approach has the potential to minimize treatment failures, reduce adverse events, and optimize personalized

therapeutic strategies. Although still in its early stages, digital twin technology exemplifies the future direction of precision healthcare. (10)

Table 1. Components of Precision Lifestyle Medicine and the Role of Artificial Intelligence (11,12,13)

Component	Traditional Approach	Precision Lifestyle Medicine Approach	Role of Artificial Intelligence
Nutrition	General dietary guidelines	Personalized nutrition based on genetics, microbiome and metabolism	Predicts individualized dietary responses
Physical Activity	Uniform exercise advice	Customized exercise prescription	Monitors performance and adapts programs
Sleep	Self-reported assessment	Continuous sleep monitoring	Detects sleep disorders and predicts risk
Stress Management	Generic counselling	Personalized behavioural interventions	Digital coaching and mood prediction
Disease Risk	Population-based scoring	Individual risk prediction	Machine learning risk models
Monitoring	Periodic clinic visits	Continuous remote monitoring	Wearables and real-time analytics
Clinical Decision Making	Physician experience	Data-driven precision recommendations	Clinical decision support systems

Precision Nutrition: Moving Beyond Universal Dietary Recommendations

Nutrition remains the cornerstone of disease prevention; however, substantial evidence indicates that individuals exhibit remarkably different metabolic responses to identical foods. Variations in postprandial glucose levels, lipid metabolism, insulin sensitivity, inflammatory pathways, gut microbiota composition, and genetic polymorphisms explain why standardized dietary recommendations often fail to achieve optimal outcomes for every patient. (11)

Precision nutrition seeks to overcome these limitations by integrating genetic information, metabolomic profiles, microbiome characteristics, lifestyle behaviours, clinical biomarkers, and environmental influences to formulate individualized dietary plans. Instead of prescribing a universal "healthy diet," clinicians can now recommend nutrition strategies tailored to an individual's biological profile. Artificial intelligence has become indispensable in precision nutrition. Machine learning algorithms analyse dietary records, wearable sensor data, laboratory investigations, genomic information, microbiome sequencing, and continuous glucose monitoring to predict individual metabolic responses to specific foods. AI-assisted dietary platforms can continuously refine recommendations as additional health data become available, making nutritional advice dynamic rather than static. (11,12)

The Gut Microbiome: A Central Pillar of Precision Lifestyle Medicine

The human gastrointestinal tract harbours trillions of microorganisms that collectively constitute the gut microbiome. These microorganisms influence nutrient metabolism, immune regulation, endocrine signalling, inflammatory responses, neurotransmitter synthesis, and intestinal barrier integrity. Growing evidence suggests that alterations in microbial diversity are associated with obesity, diabetes mellitus, inflammatory bowel disease, cardiovascular disorders, neurodegenerative diseases, autoimmune conditions, and certain malignancies. (12,14)

Unlike the relatively stable human genome, the gut microbiome is highly dynamic and responds rapidly to dietary patterns, medications, antibiotic exposure, sleep quality, stress, environmental factors, and physical activity. This plasticity makes the microbiome an attractive therapeutic target for lifestyle interventions. Artificial intelligence enables the analysis of enormous microbiome datasets that would otherwise be impossible to interpret manually. Machine learning algorithms identify microbial signatures associated with disease susceptibility and predict individualized responses to dietary interventions, probiotics, prebiotics, and lifestyle modifications. (15,16,17) Future clinical practice may involve routine microbiome profiling integrated with genomic, metabolomic, and clinical data to generate personalized preventive healthcare strategies. Although microbiome-guided therapy remains an evolving field, it represents one of the most promising frontiers in precision lifestyle medicine.

Physical Activity as Precision Therapy

Exercise has traditionally been prescribed using generalized recommendations such as 150 minutes of moderate-intensity physical activity per week. While these guidelines provide valuable public health benefits, individual responses to exercise vary considerably. Factors influencing exercise responsiveness include age, sex, genetics, baseline fitness, cardiovascular health, metabolic phenotype, muscle fibre composition, inflammatory status, hormonal profile, sleep quality, and psychosocial characteristics. Consequently, identical exercise programmes may produce vastly different physiological outcomes among individuals.

Precision exercise medicine aims to optimize health outcomes by tailoring physical activity prescriptions according to individual biological characteristics. Artificial intelligence facilitates this process by analysing data from wearable devices, heart rate monitors, accelerometers, smart watches, and fitness applications.

AI algorithms continuously monitor heart rate variability, exercise intensity, recovery patterns, sleep quality, oxygen saturation, and physical performance. These data enable dynamic adjustment of exercise prescriptions, minimizing injury risk while maximizing cardiovascular and metabolic benefits. In patients with chronic diseases, AI-assisted exercise programmes may improve adherence through personalized coaching, motivational feedback, remote monitoring, and behavioural reinforcement. Such approaches are particularly valuable for patients with obesity, diabetes, hypertension, cardiovascular disease, and cancer survivorship.

Sleep: An Underestimated Therapeutic Target

Sleep is increasingly recognized as a fundamental determinant of metabolic, cardiovascular, neurological, endocrine, and psychological health. Chronic sleep deprivation contributes to obesity, insulin resistance, hypertension, immune dysfunction, depression, impaired cognition, and premature mortality. Traditional sleep assessment has relied heavily on patient-reported questionnaires and overnight polysomnography. Although valuable, these methods provide only limited snapshots of an individual's habitual sleep behaviour.Wearable technologies have transformed sleep assessment by enabling continuous monitoring of sleep duration, sleep stages, heart rate variability, respiratory parameters, body temperature, and nocturnal movement.

Artificial intelligence analyses these multidimensional datasets to identify early indicators of sleep disorders, circadian rhythm disruption, obstructive sleep apnoea, and inadequate sleep recovery. Personalized sleep recommendations generated through AI-based platforms may improve sleep quality and reduce long-term disease risk. Future precision lifestyle interventions will likely integrate sleep optimization alongside nutrition and exercise as equally important therapeutic pillars.(17, 18)

Wearable Technology and Digital Biomarkers

The rapid expansion of wearable health technologies represents one of the most significant developments in personalized healthcare. Smart watches, fitness trackers, biosensors, continuous glucose monitors, electrocardiographic devices, smart rings, and mobile health applications now generate continuous streams of physiological information outside traditional healthcare settings. Artificial intelligence converts these large datasets into clinically meaningful insights. Rather than relying on isolated clinic measurements, clinicians can evaluate long-term physiological trends that better reflect real-world health status. Continuous monitoring also facilitates early detection of disease deterioration, allowing preventive interventions before hospitalization becomes necessary. Remote monitoring is particularly beneficial for elderly individuals, patients with chronic diseases, and populations residing in geographically remote areas. (19)

Behavioural Medicine and AI-Based Health Coaching

Lifestyle modification depends not only on medical knowledge but also on sustained behavioural change. Despite widespread awareness regarding healthy eating, physical activity, smoking cessation, and adequate sleep, long-term adherence remains disappointingly low. Artificial intelligence is transforming behavioural medicine through intelligent coaching systems capable of delivering personalized motivational support throughout the day. These systems analyse behavioural patterns, emotional states, previous adherence, environmental influences, and individual preferences to provide context-specific interventions. Examples include reminders for medication adherence, encouragement to increase physical activity after prolonged sedentary periods, stress reduction exercises, personalized dietary suggestions, and sleep hygiene recommendations. Natural language processing enables conversational AI assistants to communicate with patients using human-like dialogue, improving engagement and accessibility. Such systems may eventually function as continuous lifestyle coaches that complement rather than replace healthcare professionals. (20)

Ethical, Legal, and Regulatory Challenges

Despite remarkable technological advances, Precision Lifestyle Medicine faces several important challenges that require careful consideration. The enormous volume of personal health data generated by wearable devices, genomic sequencing, microbiome analysis, and electronic health records raises substantial concerns regarding privacy, cybersecurity, and informed consent. Robust governance frameworks are essential to protect sensitive patient information while enabling responsible innovation. Algorithmic bias represents another significant concern. AI models trained predominantly on data from specific ethnic or socioeconomic populations may perform less accurately in underrepresented groups, potentially exacerbating healthcare disparities. Transparency also remains problematic. Many machine learning algorithms function as "black boxes," generating predictions without easily interpretable reasoning. Clinicians may hesitate to rely on recommendations that cannot be adequately explained. Finally, AI should augment—not replace—clinical judgement. Human empathy, ethical reasoning, contextual understanding, and shared decision-making remain indispensable components of high-quality medical care.

The concept of the **digital twin** may become one of the most transformative innovations in medicine. By integrating genomic, metabolic, microbiome, imaging, behavioural, and environmental data into a virtual representation of an individual, clinicians may simulate disease progression and evaluate the likely effects of dietary modifications, exercise programmes, pharmacological treatments, or surgical interventions before implementation. Such predictive modelling has the potential to minimize treatment failures and optimize clinical outcomes. (11,14,18)

Precision nutrition will also continue to evolve. Future dietary recommendations are expected to incorporate continuous glucose monitoring, microbiome profiling, metabolomics, nutrigenomics, food-image recognition, and AI-assisted meal planning. Instead of generic dietary advice, patients will receive highly individualized nutritional prescriptions that adapt dynamically according to changing physiological conditions.

Similarly, exercise prescriptions will become increasingly personalized through AI algorithms capable of continuously analysing cardiovascular fitness, recovery patterns, musculoskeletal performance, and behavioural adherence. Exercise will increasingly be prescribed with the same level of precision as pharmacological therapies.(2,4,7)

Artificial intelligence is also expected to accelerate drug discovery, identify novel disease biomarkers, improve early diagnosis through multimodal data integration, and support precision public health initiatives by identifying high-risk populations requiring targeted preventive interventions. Nevertheless, successful implementation of PLM requires substantial investments in healthcare infrastructure, digital literacy, clinician training, regulatory oversight, cybersecurity, and ethical governance. Healthcare professionals must acquire competencies in digital medicine, data interpretation, genomics, and AI-assisted clinical decision-making while maintaining patient-centred communication and shared decision-making. (4)

Conclusion

Artificial intelligence serves as the enabling technology that converts massive multidimensional datasets into clinically actionable knowledge. By analysing genetic, metabolic, behavioural, environmental, and physiological information simultaneously, AI facilitates highly personalized strategies for nutrition, physical activity, sleep optimization, stress management, and chronic disease prevention.

The future of medicine will no longer depend solely on diagnosing disease accurately but increasingly on predicting disease early, preventing its development, and maintaining health through individualized, data-driven lifestyle interventions. Artificial intelligence, when responsibly implemented alongside compassionate clinical practice, offers an unprecedented opportunity to transform healthcare from disease-centred treatment to lifelong health promotion.

References –

1. Rippe JM. Lifestyle Medicine: The Health Promoting Power of Daily Habits and Practices. Am J Lifestyle Med. 2018 Jul 20;12(6):499-512.
2. Rippe JM. The Academic Basis of Lifestyle Medicine. Am J Lifestyle Med. 2023 Dec 6;18(4):497-511.
3. Mutlu SN, Pasin Ö, Konar NM. The Effect of Nutrition, Physical Activity, and Sleep Pattern on Success in Medical Students. Med Sci Educ. 2024 Sep 30;35(1):245-256

4. Gray ID, Kross AR, Renfrew ME, Wood P. Precision Medicine in Lifestyle Medicine: The Way of the Future? Am J Lifestyle Med. 2019 Mar 20;14(2):169-186.
5. Khan MK, Raza M, Shahbaz M, Hussain I, Khan MF, Xie Z, Shah SSA, Tareen AK, Bashir Z, Khan K. The recent advances in the approach of artificial intelligence (AI) towards drug discovery. Front Chem. 2024 May 31;12:1408740.
6. Ma J, Rosas LG, Lv N. Precision Lifestyle Medicine: A New Frontier in the Science of Behavior Change and Population Health. Am J Prev Med. 2016 Mar;50(3):395-397.
7. Gray ID, Kross AR, Renfrew ME, Wood P. Precision Medicine in Lifestyle Medicine: The Way of the Future? Am J Lifestyle Med. 2019 Mar 20;14(2):169-186.
8. Bailey RL, Stover PJ. Precision Nutrition: The Hype Is Exceeding the Science and Evidentiary Standards Needed to Inform Public Health Recommendations for Prevention of Chronic Disease. Annu Rev Nutr. 2023 Aug 21;43:385-407.
9. Hindhede AL, Andersen VH. The role of AI and personalized medicine in healthcare: balancing technological advancements and the art of medicine. BMC Med Educ. 2025 Nov 11;25(1):1580.
10. Sun T, He X, Song X, Shu L, Li Z. The Digital Twin in Medicine: A Key to the Future of Healthcare? Front Med (Lausanne). 2022 Jul 14;9:907066.
11. Saeed DK, Nashwan AJ. Harnessing Artificial Intelligence in Lifestyle Medicine: Opportunities, Challenges, and Future Directions. Cureus. 2025 Jun 8;17(6):e85580.
12. Ma J, Rosas LG, Lv N. Precision Lifestyle Medicine: A New Frontier in the Science of Behavior Change and Population Health. Am J Prev Med. 2016 Mar;50(3):395-397.
13. Gray ID, Kross AR, Renfrew ME, Wood P. Precision Medicine in Lifestyle Medicine: The Way of the Future? Am J Lifestyle Med. 2019 Mar 20;14(2):169-186.
14. Mousa WK, Al Ali A. The Gut Microbiome Advances Precision Medicine and Diagnostics for Inflammatory Bowel Diseases. Int J Mol Sci. 2024 Oct 19;25(20):11259.
15. Li M., Chen W.-D., Wang Y.-D. The roles of the gut microbiota–miRNA interaction in the host pathophysiology. Mol. Med. 2020;26:101. doi: 10.1186/s10020-020-00234-7.
16. Hornung B., Martins dos Santos V.A.P., Smidt H., Schaap P.J. Studying microbial functionality within the gut ecosystem by systems biology. Genes Nutr. 2018;13:5. doi: 10.1186/s12263-018-0594-6.
17. Ji Y., Li X., Zhu Y., Li N., Zhang N., Niu M. Faecal microRNA as a biomarker of the activity and prognosis of inflammatory bowel diseases. Biochem. Biophys. Res. Commun. 2018;503:2443–2450. doi: 10.1016/j.bbrc.2018.06.174
18. DeVylder J. Sleep as an Underused Target for Rapid Response in the Treatment of Depression and Suicidal Ideation. Health Soc Work. 2016 Aug 1;41(3):211.
19. Ates T, Sukur IH, Ok F, Yilmaz IO, Arikan MG, Akdogan N, Deger M. Wearable technology-derived digital biomarkers for non-invasive assessment of erectile dysfunction: a cross-sectional pilot study. Int Urol Nephrol. 2026 Jul;58(7):2521-2530.
20. Fu L, Burns R, Xie Y, Shen J, Zhe S, Estabrooks P, Bai Y. The Development and Use of AI Chatbots for Health Behavior Change: Scoping Review. J Med Internet Res. 2026 Jan 28;28:e79677.