A LITERATURE REVIEW ON INTEGRATED PROGRAMS OF PHYSICAL EXERCISE ASSISTED BY ARTIFICIAL INTELLIGENCE: EFFECTS ON PHYSICAL AND MENTAL HEALTH IN AMATEUR ATHLETES

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Abstract: Artificial intelligence (AI) technologies are increasingly used in sport and health sciences to enable data-driven training, performance monitoring, and personalized interventions. This narrative review synthesizes evidence on AI-assisted integrated programs that combine physical exercise with nutritional and psychological components for amateur and recreational athletes. Across the reviewed literature, AI systems support individualized feedback, optimize training load, and enhance user engagement through wearables, mobile coaching, and predictive analytics. Reported benefits include improvements in body composition, aerobic fitness, muscular strength, and functional mobility, alongside better motivation, lower dropout rates, and reduced stress. Nevertheless, truly integrated models that address physical, nutritional, and psychological dimensions within the same AI-assisted program remain scarce, and studies often involve small samples, short durations, and limited algorithmic transparency. These gaps highlight the need for interdisciplinary approaches that align sport science, digital health, and behavioral psychology. The review outlines research directions to validate comprehensive AI-assisted programs tailored to amateur populations, with the goal of improving both physical and mental health outcomes through sustainable, technology-supported interventions.
Keywords: *artificial intelligence; physical exercise; nutrition; mindfulness; amateur athletes; adher*

Introduction

The integration of artificial intelligence (AI) into sport and exercise sciences has evolved rapidly in recent years. AI applications now contribute to optimizing physical performance, rehabilitation, and health promotion through real-time monitoring and adaptive feedback.

Physical activity remains a cornerstone of public health, with the World Health Organization (2022) emphasizing its role in reducing non-communicable diseases and improving psychological well-being. However, global reports show that physical inactivity persists at alarming rates, especially among adults with sedentary lifestyles (European Commission, 2022).

While traditional exercise programs focus primarily on physical performance, emerging evidence suggests that integrating nutritional and psychological components can lead to more sustainable outcomes. However, adherence remains challenging in unsupervised or app-mediated contexts, with motivation and perceived usefulness being key drivers of continued participation (Du, 2025; Li et al., 2025).

Evidence from fitness-club settings shows that a 52-week self-efficacy intervention examined exercise behavior and long-term relationships among Transtheoretical Model constructs (Middelkamp et al., 2017). Artificial intelligence provides new tools to address this challenge, offering individualized monitoring and motivation systems based on user behavior. AI-driven applications can analyze large datasets, provide predictive insights, and support adaptive decision-making during training (Taborri et al., 2020; Mahindru et al., 2023). This review aims to synthesize recent scientific findings related to AI-assisted integrated exercise programs, identify current trends, highlight research gaps, and propose future directions relevant to amateur athletes. In this review, integrated programs of physical exercise are understood as multicomponent frameworks that combine physical training with complementary elements such as nutritional guidance, psychological support, motivation, or adherence strategies. These components align naturally with the ways artificial intelligence can contribute to personalization, monitoring, adaptive feedback, and predictive analysis, ultimately shaping both physical and mental health outcomes in recreational athletes.

Materials and Methods

This narrative literature review was conducted to synthesize empirical and conceptual evidence regarding the use of **artificial intelligence** in **integrated exercise programs** combining physical, nutritional, and psychological components. The review aimed to identify trends, applications, benefits, limitations, and ethical

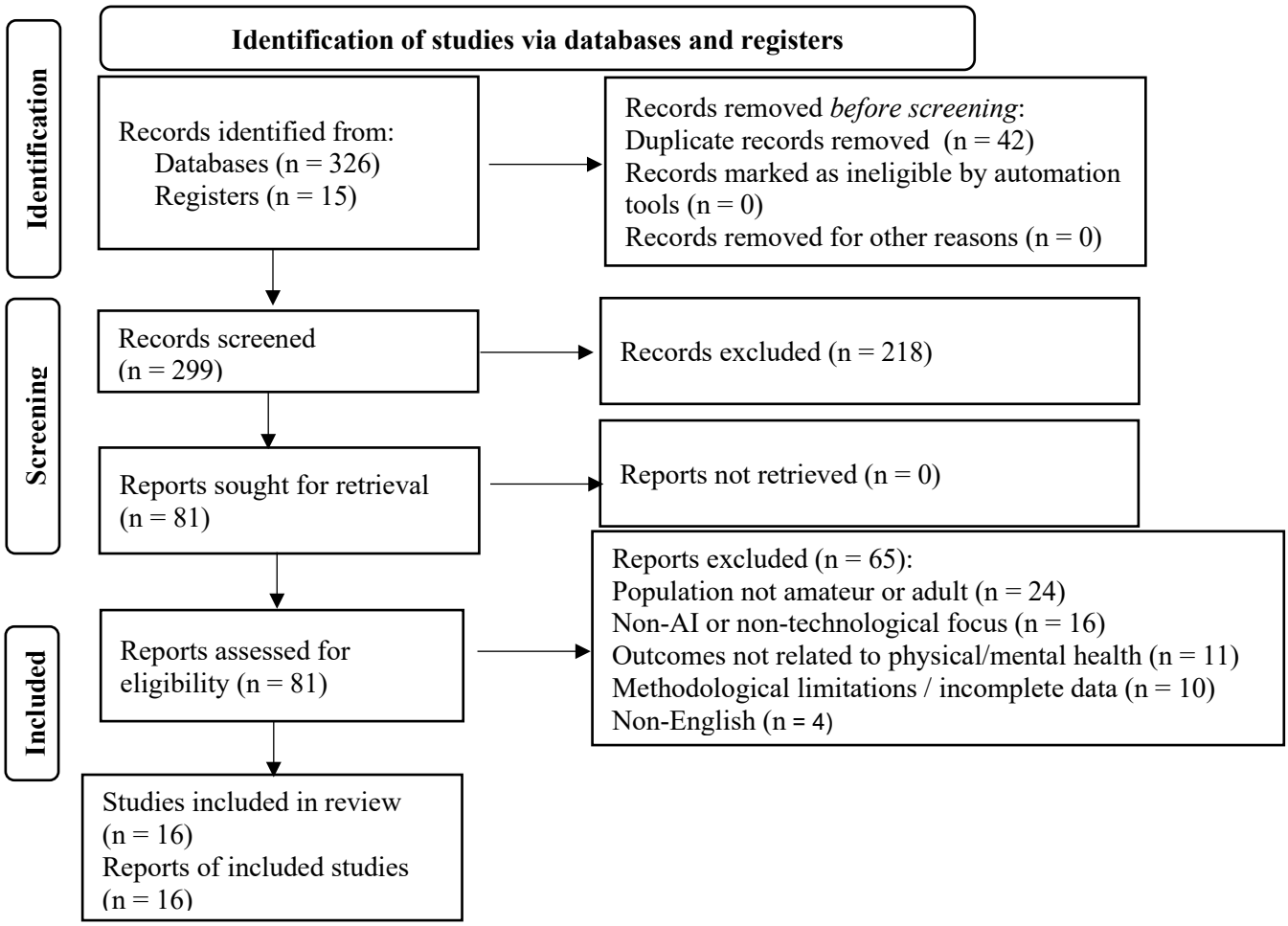
considerations of AI-assisted interventions designed to improve physical and mental health outcomes among amateur and recreational athletes.

The review followed the core recommendations of the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure transparency and reproducibility, although a formal meta-analysis was not conducted due to heterogeneity of study designs and outcomes. A PRISMA-style flow diagram was used to illustrate the identification, screening, eligibility, and inclusion phases.

Searches were conducted (August - October 2025) in ProQuest, PubMed/MEDLINE, Scopus and Web of Science Core Collection, and SPORTDiscus. Complementary sources included **Google Scholar** and manual screening of reference lists. Searches combined controlled vocabulary and free-text terms and were limited to peer-reviewed records (2013-2025), in English, with full text available.

Search strings combined controlled vocabulary (MeSH and subject headings) and free-text keywords such as: ("artificial intelligence" OR "machine learning" OR "AI-assisted" OR "deep learning" OR "wearable sensors" OR "virtual coach" OR "digital health") AND ("physical exercise" OR "physical training" OR "fitness" OR "rehabilitation" OR "sport performance") AND ("nutrition" OR "diet" OR "mindfulness" OR "mental health" OR "psychological well-being" OR "motivation" OR "adherence").

Figure 1. PRISMA 2020 Flow Diagram for the Literature Review



"Registers (n = 15)" denotes other sources (manual search/Google Scholar). Adapted from Page MJ et al., 2021, BMJ 372:n71; PRISMA templates (CC BY 4.0).

Searches were limited to peer-reviewed studies published between 2013 and 2025, written in English, and available in full-text format.

The starting year (2013) was selected because it marks the publication of early foundational work on computational and digital methods in exercise monitoring, which informed later AI-based developments. Although most empirical AI studies emerged after 2020, the inclusion of this earlier work provides essential historical context.

Inclusion criteria were defined as follows:

- **Population**: adults (≥18 years), amateur or recreationally active individuals, or mixed samples if amateur data were separable.
- **Intervention/exposure**: AI-supported or AI-driven programs targeting exercise, health, or performance improvement, either alone or integrated with nutrition and/or psychological components.
- **Outcomes**: physical performance, physiological adaptation, body composition, psychological well-being, motivation, adherence, or ethical implications in implementation.
- **Study design**: experimental, observational, or review studies offering quantitative or qualitative data relevant to the topic.

Exclusion criteria included: studies unrelated to AI or exercise; populations under 18 years; interventions without human physical or psychological components; grey literature (unless directly relevant); and non-English sources.

After screening, 16 studies met all eligibility criteria and were included in the qualitative synthesis.

Given the narrative review design, we report a domain-level synthesis of all included studies (Table 1) and provide a deliberately selected set of representative studies to illustrate key approaches and findings (Table 2).

Results

Following the PRISMA-based selection process summarized in Figure 1**,** a total of sixteen studies met the inclusion criteria and were analyzed to synthesize the main directions, applications, and research gaps regarding the integration of artificial intelligence in exercise, fitness, and health-related contexts. The selected papers represent a diverse range of research designs, including systematic and narrative reviews, experimental studies, and applied modeling work. Most studies were published between 2020 and 2025, indicating a rapid growth of interest in AI-assisted physical training and health interventions in recent years.

Table 1 summarizes the thematic structure of the included studies and highlights the main findings and limitations across five major domains: AI applications for physical training and performance, behavioral and adherence-related mechanisms, mental health outcomes, acceptance and trust in AI systems, and ethical considerations. As shown, AI-driven technologies have demonstrated growing potential in optimizing training load regulation, monitoring performance parameters, and supporting individualized guidance and motivation through digital coaching systems. At the same time, several methodological limitations persist, particularly regarding standardization, long-term validation, and user-centered design.

Table 1. Summary of Included Studies and Key Findings

Domain	Representative Studies	Main Findings (Synthesis)	Observed Gaps / Limitations
Mental health and psychological outcomes	(Fossati et al., 2021); (Mahindru et al., 2023); (Zhang, 2024)	Physical exercise consistently improves mental health and well-being. AI-assisted psychological and educational components may support self-regulation and stress reduction.	Heterogeneous assessment tools; limited longitudinal evidence; unclear interactions between AI and psychological factors.
AI for physical training, monitoring, and performance	(Taborri et al., 2020); (Novatchkov & Baca, 2013); (Guo & Shi, 2024); (Gao & Shen, 2025); (Exel & Dabnichki, 2024); (Reis et al., 2024); (Canzone et al., 2025)	Artificial intelligence and sensor-based systems (inertial, force, electromyography) support motion analysis and training load regulation. Predictive models contribute to optimizing intensity and recovery cycles. Data analytics plays a central role in precision sports science.	Small or highly specific samples; limited algorithmic description; few long-term validations in real-world sport contexts.

Acceptance, trust, and virtual coaching	(Wachholz et al., 2025); (Li et al., 2025); (Du et al., 2025)	Acceptance and trust increase when AI systems are transparent, explainable, and allow user control. Conversational or virtual AI coaches can sustain engagement and motivation in health-oriented fitness programs.	Need for comparative trials versus human coaches; unclear accountability and ethical boundaries of autonomous systems.
Ethics and governance of AI in sport	(Kim et al., 2025); (Suman, 2022); (Exel & Dabnichki, 2024)	Dominant themes include privacy, algorithmic bias, fairness, and explainability. Most authors recommend AI as an assistive, not substitutive, tool in sport and health contexts.	Few empirical studies operationalize ethical frameworks; lack of applied governance and audit standards in practice.

Building on the domain synthesis in Table 1, Table 2 showcases representative studies across key themes - training optimization, wearable-supported monitoring, conversational coaching and engagement, mental health-relevant outcomes, acceptance/trust, and ethics-serving as an illustrative, not exhaustive, complement.

Table 2. Summary of Key Studies on AI Applications in Exercise, Sport, and Health

Study (Author, Year)	Population / Context	AI Modality / Focus	Main Findings / Takeaways
Wachholz et al., 2025	Recreational athletes	AI-generated training plans	High user trust and satisfaction; coach-rated quality comparable to human-designed plans.
Li et al., 2025	Adults aiming for weight loss	GPT-4 virtual fitness coach	AI coach provided safe, motivating, and individualized guidance; improved adherence.
Du et al., 2025	Fitness app users	Mobile AI algorithms	Enjoyment and perceived usefulness predicted long-term engagement and adherence.
Reis et al., 2024	Sport science synthesis	Machine-learning and deep-learning models	Improved performance prediction and monitoring accuracy; highlighted integration challenges.
Guo & Shi, 2024	Track and field athletes	Deep-learning recovery model	Accurate prediction of fatigue and recovery; supported efficient training load planning.
Mahindru et al., 2023	Review of mental health and exercise studies	Conceptual connection to AI-driven behavioral monitoring	Found consistent benefits of physical activity on mood regulation and well-being; highlighted opportunity for AI-supported interventions.
Bodemer, 2023	Individual sports training; applied sport science	Machine learning, deep learning, and computer vision models	Comprehensive synthesis showing how AI enhances technique assessment, training individualization, injury prediction, and real-time feedback.
Kim et al., 2025	Ethical review	AI governance in sport	Identified risks of bias, privacy, and fairness; proposed guidelines for responsible AI use.
Canzone et al., 2025	Narrative review	Multifunctional AI in exercise programs	Presented integrated AI roles across physical, psychological, and behavioral domains.
Exel & Dabnichki, 2024	Athlete datasets	Predictive data analytics	Multi-sensor modeling improves performance and well-being optimization.

Overall, the synthesized evidence indicates a consistent trend toward multi-component approaches where AI supports not only the physical dimension of training but also psychological engagement and ethical governance. Although preliminary findings are promising, further large-scale and longitudinal research is needed to establish the real-world effectiveness, reliability, and ethical safety of AI-based exercise and health programs.

Discussion

The synthesis of the sixteen selected studies reveals a growing scientific consensus on the transformative potential of artificial intelligence (AI) in exercise, sport performance, and health optimization. AI technologies are increasingly being used to personalize training programs, monitor physiological data, predict recovery cycles, and enhance user adherence and motivation. These developments align with the broader digitalization trend in sport science, where data-driven feedback systems replace traditional prescriptive models (*Reis et al., 2024; Exel & Dabnichki, 2024; Li et al., 2025*).

From a performance and monitoring perspective, several studies highlight the effectiveness of AI-based systems in optimizing training load, biomechanics, and recovery processes. Deep learning and predictive modeling approaches have been shown to improve accuracy in determining fatigue, workload distribution, and injury prevention (*Guo & Shi, 2024; Taborri et al., 2020; Gao & Shen, 2025*). Such systems enable coaches and athletes to make evidence-based decisions while maintaining adaptability in individualized training (*Reis et al., 2024; Exel & Dabnichki, 2024*).

AI applications also demonstrate a significant impact on behavioral and motivational adherence. These observations align with evidence from fitness-club interventions structured around self-efficacy mechanisms over 52 weeks *(Middelkamp et al., 2017)*.

Studies focusing on virtual coaching and digital self-efficacy mechanisms report increased engagement and commitment to exercise routines when users receive personalized feedback and goal-based adjustments (*Li et al., 2025; Du et al., 2025; Bodemer, 2023*). AI fitness apps enhance the perceived autonomy and competence of users by integrating social interaction and adaptive goal-setting functions (*Du et al., 2025*). These findings confirm the psychological relevance of AI as a behavioral support tool, not just as a computational mechanism.

The reviewed studies further underscore a link between AI-assisted exercise and mental health benefits. Such links are consistent with frameworks that monitor behavior change over extended periods in fitness-club contexts *(Middelkamp et al., 2017)*.

Exercise interventions supported by AI tools have been associated with improvements in emotional regulation, stress management, and overall well-being (*Fossati et al., 2021; Mahindru et al., 2023; Zhang, 2024*).Educational and cognitive frameworks that incorporate AI also enhance motivation, engagement, and learning outcomes in physical education contexts (*Zhang, 2024*). These results reinforce the growing view that AI can support holistic well-being by merging physical and psychological aspects of training.

Another key theme emerging from the literature is the issue of trust, acceptance, and ethical responsibility in AI use. Research indicates that athletes and coaches tend to trust AI-driven exercise systems when they are transparent, interpretable, and aligned with human judgment (*Wachholz et al., 2025; Kim et al., 2025*). Ethical concerns remain prominent, with authors warning against potential biases, privacy risks, and overreliance on automation (*Suman, 2022; Kim et al., 2025*). Therefore, ethical frameworks and governance structures must evolve in parallel with technological advancements to ensure responsible and equitable deployment of AI in sport and health applications.

Taken together, the analyzed literature points to a paradigm shift toward integrated, AI-assisted training frameworks that combine physical, nutritional, and psychological components. However, despite encouraging results, important research gaps persist, namely the absence of standardized validation protocols, insufficient longitudinal evidence, and limited interdisciplinary collaboration. Future studies should focus on designing and testing adaptive, explainable, and user-centered AI models that address these limitations (*Canzone et al., 2025; Reis et al., 2024*). Only through such approaches can AI's full potential in enhancing health, performance, and well-being be responsibly achieved.

Conclusions

This narrative review indicates that artificial intelligence is increasingly used to personalize training, support recovery decisions, and sustain engagement in exercise programs for amateur and recreational populations. Across domains, training/monitoring, adherence and motivation,

mental-health-relevant outcomes, acceptance/trust, and ethics, AI-enabled feedback and data-driven analytics consistently show promise for improving physical and psychological indicators.

However, fully integrated models that combine exercise with nutritional and psychological components within the same AI-assisted program remain scarce. The current evidence base is limited by small or specific samples, short follow-up, heterogeneous outcome measures (especially for adherence and mental health), and limited algorithmic transparency.

Future work should prioritize user-centered, explainable, and ethically governed AI frameworks, tested in longitudinal, real-world settings with standardized outcome definitions for adherence and mental health. For sport and health professionals, the near-term opportunity is to deploy AI as an assistive tool, complementing human expertise, to build sustainable programs that support long-term physical and mental well-being in amateur athletes.

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