Using artificial intelligence for physical exercise and healthy ageing among older adults: A scoping review

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Background

WHO recommends older adults complete ≥150 mins moderate-intensity aerobic exercise weekly, yet large proportions of older adults maintain sedentary lifestyles.
AI has evolved from rule-based systems to data-driven technologies (ML, DL, LLMs) with real-time feedback and personalised guidance to boost exercise adherence.
This study aims to conduct a scoping review to systematically map and synthesize evidence regarding the use of AI in exercise for older adults. Given the lack of comprehensive reviews that fully characterize existing AI intervention programmes, the outcomes assessed in such interventions, implementation challenges, and theoretical foundations, four specific research questions are developed to address these critical gaps.

Research Questions
RQ1: What are the main characteristics of AI-based tool exercise intervention programmes in existing studies?
RQ2: What types of exercise motivation, physical function, and mental health outcomes have been assessed in studies using AI-based exercise interventions for older adults?
RQ3: What are the difficulties or limitations in the article included when conducting the AI intervention programmes?
RQ4: What theories have been used to guide the design of AI-based tools and/or the design of the study?

Methods

Identifying Relevant Literature

- Guided by Arksey & O'Malley scoping review framework.
- Databases: Scopus, MEDLINE, Web of Science, PubMed, Google Scholar, IEEE Xplore; English-only articles without publication restriction.
- Initial search yielded 5760 records (Figure 1); final 18 eligible studies screened via PICOS criteria (only data-driven AI, adults ≥60 years, empirical exercise research; exclude rule-based smart wearable bands).
- Dual independent data extraction, inter-rater reliability Kappa ≥ 0.897.

Databases	Search string
Scopus MEDLINE (via EBSCOhost) Web of Science IEEE Xplore Digital Library Google Scholar	(("artificial intelligence" OR AI OR "AI-based application" OR "AI-based tool" OR "AI-based software") AND ("exercise" OR "physical activity" OR "physical fitness" OR "motor activity" OR "active lifestyle" OR "physical exertion" OR "sport" OR "physical inactivity" OR "sedentary behavior" OR "sedentary lifestyle" OR "inactive lifestyle" OR "active living" OR "active lifestyles" OR "physically active" OR "physically inactive")) AND ("older adults" OR elderly OR "older generations"). In Scopus, the search was conducted in title, abstract and key words.
PubMed	(("artificial intelligence"[MeSH] OR "artificial intelligence" OR AI) AND ("exercise"[MeSH] OR "Physical Activity" OR "Physical Fitness"[MeSH] OR "Motor Activity"[MeSH] OR "active lifestyle" OR "physical exertion" OR "sport" OR "Sedentary Behavior"[MeSH] OR "sedentary behavior" OR "sedentary lifestyle" OR "inactive lifestyle" OR "active living" OR "active lifestyles" OR "physically active" OR "physically inactive")) AND ("aged"[MeSH] OR "older adults" OR elderly OR "older generations")

Table 1 Search string in databases

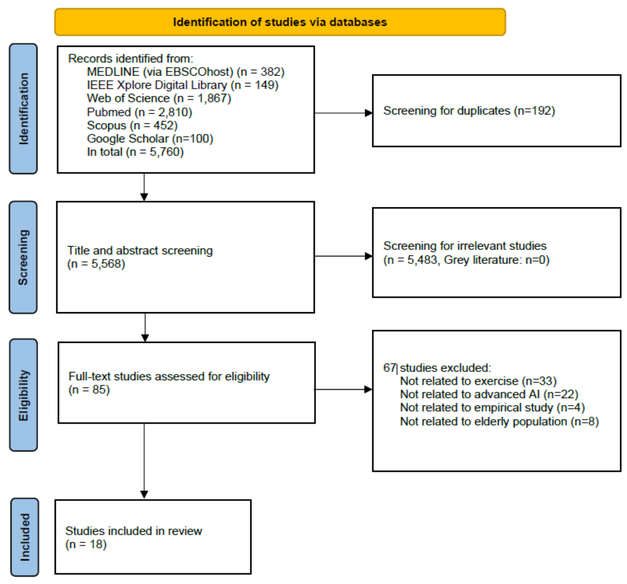

Figure 1 PRISMA flow diagram of included studies from search to inclusion

Key Results

1. Basic study characteristics

- Publication year (Figure 2): 2020–2025, peak publication in 2024 (33%). East & Southeast Asia dominate relevant publications, fewer studies from Europe, America and Middle East.
- Dominant design: Randomized controlled trials (RCTs, n=7); total enrolled participants =950, valid sample=638.
- 8 studies applied robotic AI devices (Pepper, Nao, Bot Fit, Lokomat, GEAR etc.).
- Assistance demand: 5 articles did not explicitly mention whether older adults required assistance when using AI tools. Among the remaining 13 articles, 6 indicated that assistance was not needed, and 7 stated that assistance was required

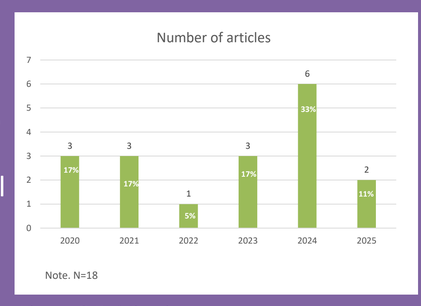

Figure 2 Publication year

2. Eight core AI functional features

- Real-time feedback & Personalized guidance (both n=12, top two features)
- Sensing, tracking & analysis (n=10)
- Engagement & motivation design (n=8)
- Personal exercise plan, adaptive intervention, progress management (n=5 respectively)
- Multi-modal interaction (n=3)

3. Intervention outcomes

✓ Positive findings
•55.6% studies improved older adults' exercise motivation
•72.2% showed significant improvements on balance, gait, muscle strength and movement accuracy
? Inconsistent outcomes
•No consistent positive effects found on grip strength, activities of daily living, lower limb function, range of motion; only 44.4% of studies assessed the mental health, with inconsistent results ranging from positive changes to non-significant effects, and one assessment interrupted by the COVID-19 pandemic.

4. Theoretical application

Only 55.6% studies applied formal theories; Technology Acceptance Model (TAM) is most frequently used mainly for outcome evaluation questionnaires instead of core AI development design.

5. Common research limitations

These included studies have multiple limitations, including small sample sizes, a lack of control groups and short follow-up periods. Older adults also encounter various barriers when using AI-driven exercise interventions, such as limited smartphone access, difficulties sustaining long-term engagement, sensory impairments and the digital divide. Meanwhile, AI systems and social robots have inherent drawbacks like inaccurate algorithms and restricted interactive functions.

Discussion & Future Implications

Proposed model of AI-based exercise for older adults

This model categorizes the AI tool capabilities into six core categories based on features identified in the included articles: sensory AI, analytical AI, interactive AI, personalization & adaptive AI, assistive robotic AI, and gamified AI (Figure 3). These AI capabilities are highly integrated rather than independent, jointly optimizing older adults' exercise experience and outcomes in terms of motivation, physical function, and mental health.

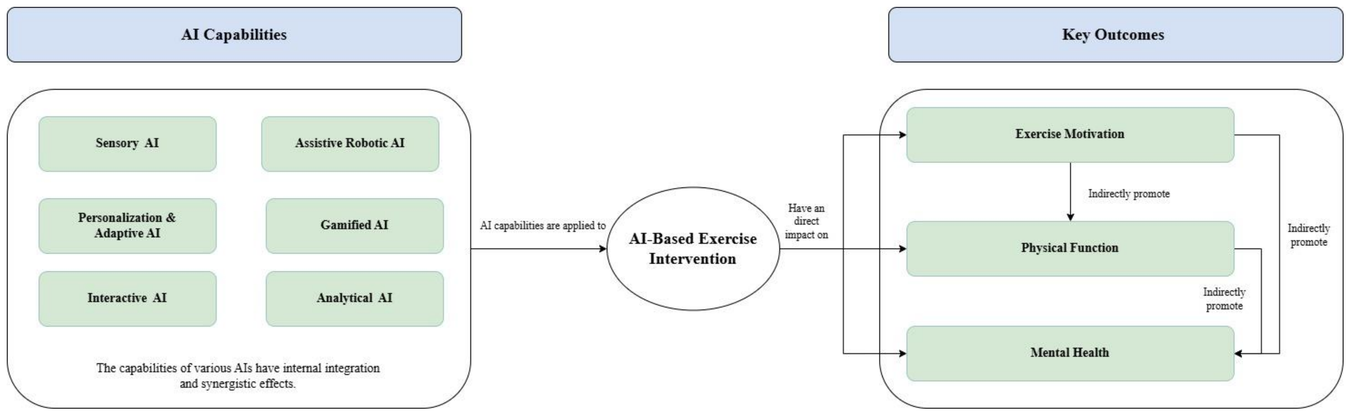

Figure 3 A conceptual model of AI capabilities in physical exercise interventions

Note. ***Sensory AI:*** *This component focuses on perceiving, collecting, and processing data related to users and their surrounding environments. It serves as the AI application's sensory system, laying the foundation for subsequent data analysis [29, 35].*
Analytical AI: *This module processes raw data to evaluate exercise performance, identify behavioral patterns, and understand users' physiological or psychological states [37].*
Interactive AI: *This component emphasizes the AI's ability to provide immediate, actionable, and understandable information or cues to the user during or immediately after exercise [29].*
Personalization & Adaptive AI: *This capability enables AI to dynamically adjust exercise recommendations and difficulty levels according to individual users' specific needs, exercise progress, and personal preferences [30, 32].*
Assistive Robotic AI: *This category integrates AI technology into physical hardware (i.e., robots), enabling physical interaction with users and providing direct exercise assistance during physical activity [25, 33].*
Gamified AI: *This component applies game mechanics, interactive elements, and motivational strategies to physical exercise, enhancing the enjoyment of activity participation and thereby improving user adherence and participation enthusiasm [26].*

Ethical considerations

Algorithm errors may produce inappropriate exercise guidance and lead to physical injury among unsupervised older users at home. AI should function as supplementary assistance rather than substitute professional healthcare providers. Further improvements are required in algorithm verification, health data privacy protection and liability clarification.

Who should be liable if an AI-guided intervention causes harm

—the developer, the healthcare provider, or the user?

Future recommendations

Future studies with robust designs, long-term follow-up, user-centered AI development, and integration of psychological needs (autonomy, competence, relatedness) are needed to support sustainable exercise behavior and healthy ageing..

Conclusion

This scoping review indicates that AI shows potential for supporting exercise among older adults by supporting motivation and specific physical functions, especially balance, gait, and movement accuracy. A conceptual model of AI capabilities in exercise interventions is proposed. Evidence regarding mental health and other physical outcomes remains inconsistent. Future studies with robust designs, long-term follow-up, and user-centered AI development are needed to support sustainable exercise behavior and healthy ageing.