



Trends in the Use of Artificial Intelligence (AI) Technology in Increasing Physical Activity

Nur Indri Rahayu^{1,*}, Affero Ismail²

¹ Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung, Indonesia

² Universitas Tun Hussein Onn Malaysia, Persiaran Tun Dr. Ismail, 86400 Parit Raja, Johor, Malaysia

*Correspondence: E-mail: nurindirahayu1910@upi.edu

ABSTRACT

The integration of emerging technologies, such as artificial intelligence (AI), is revolutionizing the ecosystem of physical activity, fitness, and rehabilitation. This study conducts a bibliometric analysis of emerging technology trends in artificial intelligence and physical activity, focusing on identifying the challenges and potentials that define this interdisciplinary field. This study consists of 6 stages, namely data collection, data processing and filtering, quantitative analysis, data visualization, and interpretation and conclusions. The results of the publication trend analysis study from 2004 to 2025, this study shows that AI and Physical Activity have increased significantly, especially after 2016, with a sharp turn after 2020. This study confirms the role of AI as a key technology in the digital transformation of various sectors, including physical activity and health monitoring. Overall, this study confirms that the integration of technology, especially AI and machine learning, with physical activity has become a major trend in global research. This trend is expected to continue to grow along with technological advances, opening up wider opportunities for innovation in improving the quality of life and human well-being.

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1. INTRODUCTION

Physical activity is any bodily movement that involves muscle contraction, increases energy expenditure, and is typically performed as part of daily living, sports, or exercise (Martin et al., 2016). Physical activity is essential for maintaining a person's physical and mental health (Baxromovich, 2024). Physical activity is a cornerstone of health promotion, disease prevention, and overall well-being. Physical activity can include a variety of activities, from light to intense. Despite widespread awareness campaigns and global health initiatives, physical inactivity remains a significant public health problem, contributing to non-communicable diseases such as obesity, cardiovascular conditions, and diabetes (Menhas et al., 2021). Over the past two decades, emerging technologies have offered innovative solutions to this challenge, improving the way individuals and communities engage with physical activity. In this regard, technology can be used as a new pathway to promote and sustain physical activity.

There have been many studies that utilize the use of technology to promote and maintain physical activity, including the use of hand-held computer technology (King et al., 2008), mHealth technologies (O'Reilly & Spruijt-Metz, 2013), smartphone applications (Coughlin et al., 2016), games (Gao, 2017), and Artificial intelligence (Oh et al., 2021; Zhang et al., 2020). However, innovation also comes with complexity. While emerging technologies offer significant potential, they also present challenges, such as ensuring equitable access, addressing ethical issues (e.g., data privacy), overcoming barriers to user adoption, and evaluating long-term effectiveness. Understanding the breadth and depth of research addressing these challenges requires a systematic approach to analyzing the growing literature in this domain. Bibliometric analysis provides both quantitative and qualitative perspectives to assess the research landscape. By examining publication trends, citation networks, geographic distribution, and key thematic areas, bibliometric studies offer critical insights into the evolution of knowledge, influential contributors, and future research directions. This study conducts a bibliometric analysis of emerging technology trends in artificial intelligence and physical activity, with a focus on identifying the challenges and potentials that define this interdisciplinary field.

This analysis seeks to answer several key questions: The topics of artificial intelligence (AI) for personalized fitness, and wearable technologies in health monitoring are explored in depth. The focus is on countries, institutions, and authors who have made significant contributions to the field. Through this bibliometric study, we aim to provide a comprehensive overview of the current state of research, identify gaps, and offer recommendations for future directions. This analysis is highly relevant for researchers, practitioners, and policymakers seeking to leverage technology to improve physical activity, health outcomes, and overall quality of life.

2. METHODS

This study employs a bibliometric approach to analyze the development of research on emerging technologies in the context of physical activity. This method ensures that the analysis is conducted systematically, comprehensively, and in-depth, offering a clear overview of research progress in the field of emerging technologies for physical activity. The analysis was conducted through the following steps (see **Figure 1**):

- (i) Data Collection. Research data were retrieved from leading Scopus databases, using a combination of relevant keywords including *emerging technologies*, *physical activity*, and *artificial intelligence*. The publication period analyzed covers the past two decades (e.g.,

2004–2024). The search was limited to journal articles (49,7%), conference papers (19,1%), and reviews (31,2%) that matched the research scope. Data diambil pada tanggal 18 Desember 2024.

- (ii) Data Processing and Filtering. Retrieved data were screened based on inclusion and exclusion criteria. Irrelevant articles, duplicates, or those without full-text availability were excluded. The final dataset consisted of metadata, including titles, authors, institutions, abstracts, keywords, and citation counts.
- (iii) Quantitative Analysis. Bibliometric analysis was conducted using tools such as VOSviewer and Biblioshiny (R-package). The analysis included Publication Trends, Collaboration Networks, Citation Analysis, and Keywords and Research Themes.
- (iv) Qualitative Analysis. Articles grouped within major thematic clusters were analyzed further to understand their specific contributions to the challenges and potentials of emerging technologies in physical activity. This included identifying research gaps and areas for future exploration.
- (v) Data Visualization. The results were presented through graphs, network maps, and trend diagrams to provide clear visual insights into the research structure and dynamics within the field.
- (vi) Interpretation and Conclusions. The findings were synthesized to address the main research questions, such as identifying trends, geographical contributions, dominant themes, and the challenges and opportunities highlighted in the literature.

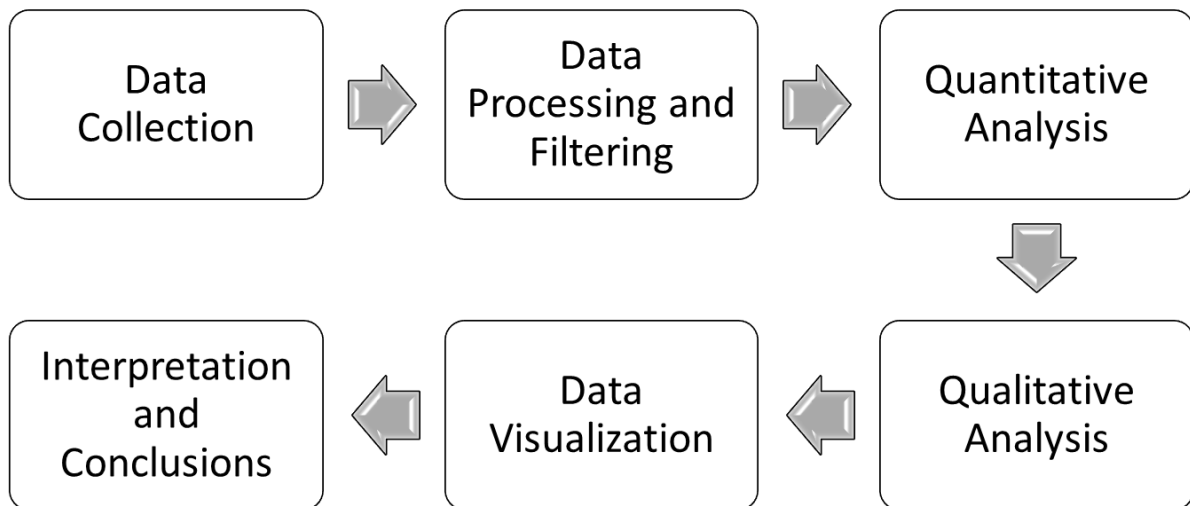


Figure 1. Research procedure.

3. RESULTS AND DISCUSSION

3.1. Publication Trends

Figure 2 shows the annual publication trend related to AI Technology in Increasing Physical Activity indexed in Scopus from 2004 to 2025. This data illustrates a significant development in the number of publications, especially after 2020. Before 2014, the number of publications tended to be low and stable, below 5 publications per year. This indicates that research on the topic has not received much scientific attention during that period.

Since 2015, there has been an increase in the number of publications, although relatively slow. However, a significant spike occurred starting in 2021, with a sharp increase in 2022 and a peak in 2024, when the number of publications reached 90. This phenomenon indicates an increasing global interest in applying artificial intelligence technology to increase physical

activity, which is likely driven by technological advances, the need for a healthy lifestyle, and the influence of the COVID-19 pandemic which has triggered innovation in health technology (Salam & Bajaba, 2021; Wang et al., 2021; Zimmerling & Chen, 2021).

However, in 2025, there is a drastic decline in the number of publications, returning to 0. This decline can be interpreted as a prediction of the lack of complete data or the non-inclusion of publications in that year into the Scopus database. Other factors that may have an influence include changes in research focus or limitations in data collection. Thus, this trend needs to be further analyzed to understand the factors causing this sharp decline.

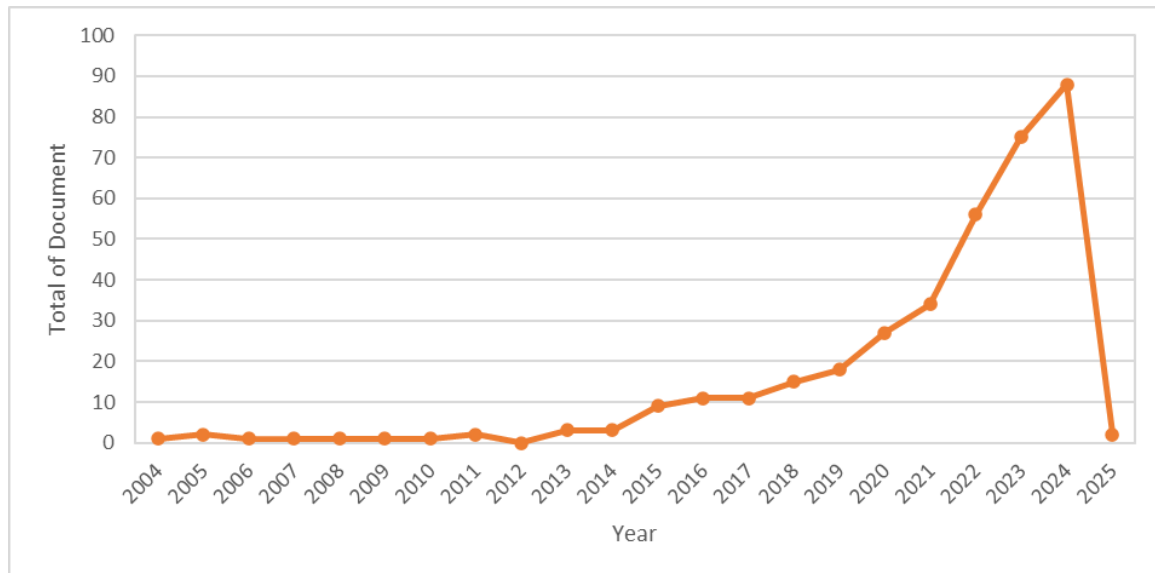


Figure 2. Annual report publication of Artificial Intelligence Technology in Increasing Physical Activity by Scopus.

Figure 3 shows the distribution of citations per year. MeanTCperArt refers to the average citations per article, N indicates the number of articles published, MeanTCperYear is the average citations per year, and CitableYears reflects the number of years in which an article is still considered relevant for citation.

The data trend shows that the average citations per article (MeanTCperArt) tend to fluctuate from year to year. In early years such as 2004-2009, this value is quite low, indicating a relatively small impact of publications. However, there are large spikes in certain years, for example in 2007 (170) and 2015-2016 (73.33 and 74.36). The number of published articles (N) shows a significant increase from year to year, starting from only 1 article in 2004 to 88 articles in 2024. The average citations per year (MeanTCperYear) also show an upward trend, with the highest peak in 2020 (11.84), before decreasing again to 2.64 in 2024. This decrease may be due to the increasing number of articles making the distribution of citations more even. Meanwhile, the number of CitableYears has consistently decreased, reflecting the decreasing time of citation relevance for more recently published articles. Overall, these data reflect a significant growth in scientific publications in number but with changing dynamics in terms of relevance and impact.

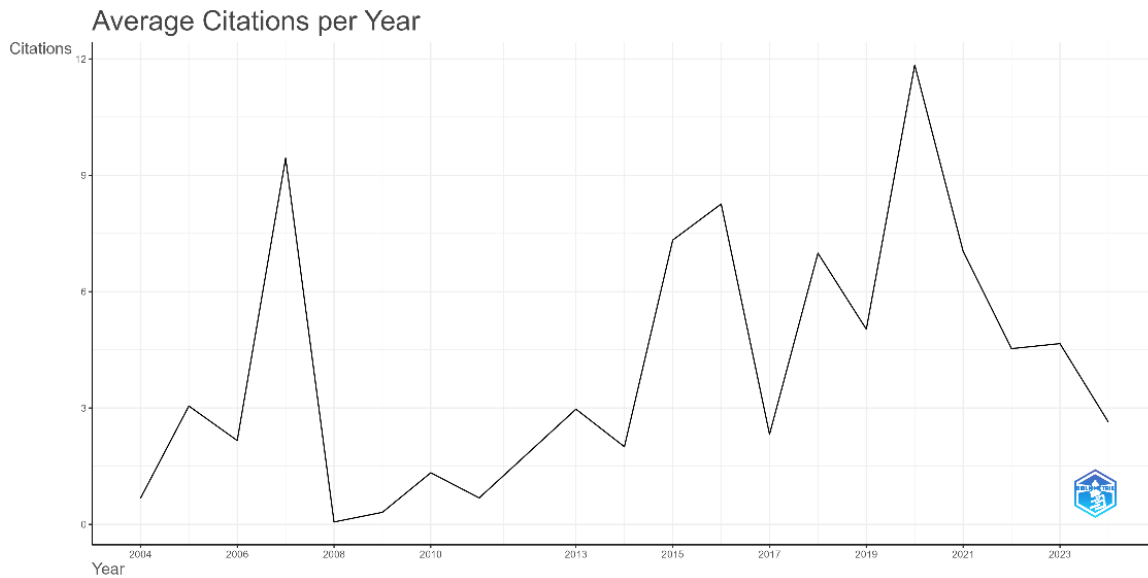


Figure 3. Average citations per year.

3.2. Geographical Contributions

Figure 4 shows the frequency of contributions from different regions, with significant dominance by certain countries. The USA region tops the list with 378 contributions, reflecting the country’s dominance in the activity measured, both in terms of resources, global influence, and access to opportunities. The implication is that the USA is likely to play a leading role in determining trends or development directions in the activity. Other countries with large contributions such as CHINA (111), UK (94), ITALY (87), and AUSTRALIA (85) also demonstrate economic and technological strengths that allow them to compete globally. This has a major impact on innovation, international collaboration, and global perceptions of their capabilities.

In contrast, countries with low frequencies, such as UKRAINE, THAILAND, TANZANIA, and others with only 1 contribution each, face a different impact. Small contributions may indicate limited resources, lack of access to technology, or low participation in global activities. The implication is that these regions may not have a major influence in setting global policies or trends, making them more likely to be followers than leaders. The impact of this distribution is also seen in countries with medium contributions, such as INDIA (53), SINGAPORE (32), and GERMANY (42). These countries have the potential to serve as strategic partners in global collaboration. They may not dominate, but their contributions are significant enough to drive regional or sector-specific innovation.

Based on the number of publications related to the use of AI in physical activity, Europe is in the top position with a total of 502 publications, indicating the dominance of this region in contributing research and development of related technologies. The Americas are in second place with 430 publications, reflecting the significant research strength of countries such as the USA and Canada. Next, Asia follows in third place with 356 publications, driven by contributions from countries such as China, India, and Japan. Oceania, dominated by Australia and New Zealand, recorded 94 publications, while Africa is in last place with only 12 publications. This difference reflects the gap in contributions between continents in the field of AI use in physical activity.

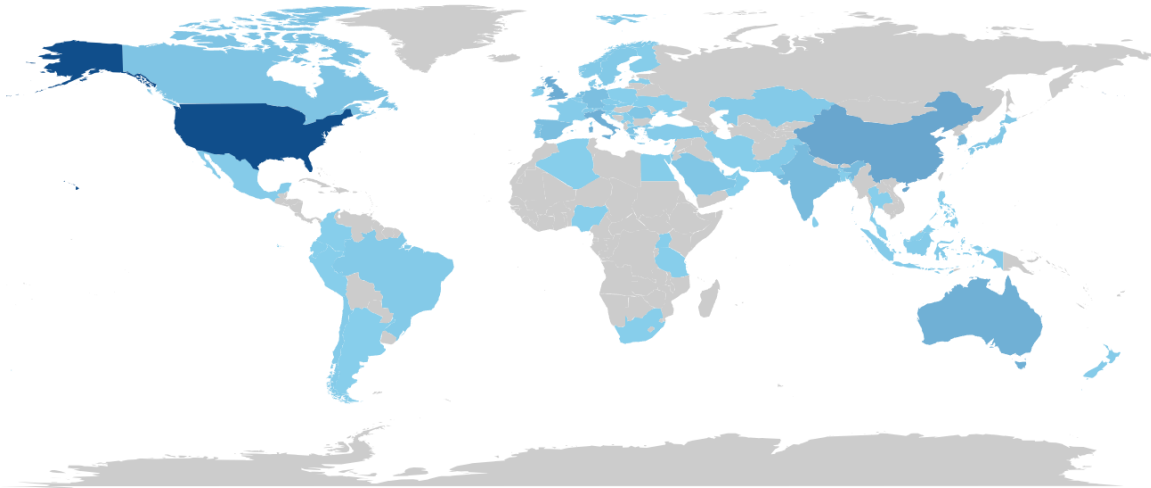


Figure 4. Countries' scientific production.

3.3. Key Research Theme

Trend topics in **Table 1** show interesting dynamics related to the popularity of various topics on the use of technology, especially AI, in health and physical activity. AI tops the list with the highest frequency (345) and the median for 2022, reflecting the rapid growth of its use in various applications over the past decade. The topics Physical Activity (243) and Human (211) also show high frequencies, with the trend peaking after 2020, likely influenced by the increasing attention to health and active lifestyles. In addition, topics such as Telemedicine (88), Review (88), and Quality of Life (64) saw significant growth, especially after 2020, with the COVID-19 pandemic being a major catalyst driving interest in health technology-based solutions. Smart device technology trends, such as Wearable Technology (39) and Wearable Sensors (21), have been prominent since 2017, in line with the increase in real-time health monitoring devices.

On the other hand, innovation-based areas, such as Big Data (18), Learning Algorithms (16), and Signal Processing (17), reflect the need for advanced data analytics to support medical decisions. Similarly, Smartphone (15) and Mobile Application (32) are key pillars in providing easily accessible health solutions. Traditional topics such as Monitoring (20), Diet (18), and Blood Pressure (19) maintain their relevance, especially in supporting daily health management. However, some specific topics such as Image Enhancement (7) and Ubiquitous Computing (7) have lower frequencies but remain important for specific applications. Overall, this data shows how AI and related technologies have become a key foundation for innovation, especially after 2020, with an increasing focus on technology-based health solutions to support quality of life and physical activity.

Table 1. Trend topic.

item	freq	year_q1	year_med	year_q3
artificial intelligence	345	2020	2022	2023
physical activity	243	2020	2022	2024
human	211	2021	2022	2024
review	88	2022	2023	2024
telemedicine	88	2020	2023	2024
quality of life	64	2022	2023	2024
wearable technology	39	2017	2019	2022
learning systems	32	2016	2017	2021

Table 1. Trend topic.

item	freq	year_q1	year_med	year_q3
mobile application	32	2019	2020	2022
Internet	25	2018	2021	2024
insulin	24	2021	2024	2024
clinical outcome	22	2022	2024	2024
pattern recognition	21	2016	2017	2021
wearable sensors	21	2017	2018	2021
monitoring	20	2015	2018	2021
patient monitoring	19	2017	2021	2024
blood pressure	19	2022	2024	2024
algorithms	18	2013	2016	2023
diet	18	2020	2020	2023
big data	18	2020	2021	2023
signal processing	17	2015	2016	2022
health	17	2015	2017	2020
learning algorithms	16	2016	2018	2022
smartphone	15	2018	2019	2024
physiology	15	2016	2020	2024
devices	11	2018	2019	2024
image enhancement	7	2012	2013	2022
ubiquitous computing	7	2015	2016	2017
methodology	6	2008	2012	2017
computer-assisted	5	2007	2010	2015

Figure 5 shows the increasing trend of publication frequency related to AI, Physical Activity, and Machine Learning in the period from 2004 to 2025. At the beginning of the period, these three categories had a very low number of publications and were relatively stagnant. However, the trend began to show a significant increase after 2016, with the sharpest spike seen after 2020. This reflects the shift in global research focus towards the use of technology to support physical activity, health, and AI-based innovation. AI is the most dominant category in this graph. Before 2016, publications on AI experienced a slow increase but began to spike significantly after 2019. In 2024 and 2025, the number of AI publications peaked at 345 publications. This trend shows that AI has become a key technology in supporting various aspects of life, including health research, physical activity monitoring, and data-driven solution development. This rapid growth of AI can also be attributed to the advancement of global technological infrastructure and the increasing need for intelligent solutions in various sectors.

Meanwhile, Physical Activity follows a similar growth pattern to AI, albeit in lower numbers. The increasing trend of publications on this topic began to appear after 2016, with a significant spike after 2020. The frequency of publications reached 243 in 2024 and 2025, indicating an increasing interest in research linking technology and physical activity. This is likely driven by the awareness of the importance of a healthy lifestyle and the role of technology such as wearable devices and advanced sensors in monitoring physical activity. On the other hand, Machine Learning experienced slower growth than the other two categories but still showed a steady increase. Before 2018, publications related to Machine Learning were still at a low number. However, along with the development of AI and the need for intelligent algorithms, publications on Machine Learning began to increase gradually. In

2024 and 2025, the number of publications reached 77, reflecting the important role of Machine Learning as a supporting technology in the implementation of AI and physical activity monitoring.

Overall, this graph reflects a significant development in research and utilization of AI and Machine Learning-based technologies in supporting physical activity. The surge in publications after 2020 shows a positive response to the global need for technological innovation in the field of health and active lifestyle. This trend emphasizes the role of technology as an important solution in addressing health challenges and improving the quality of life in the digital era.

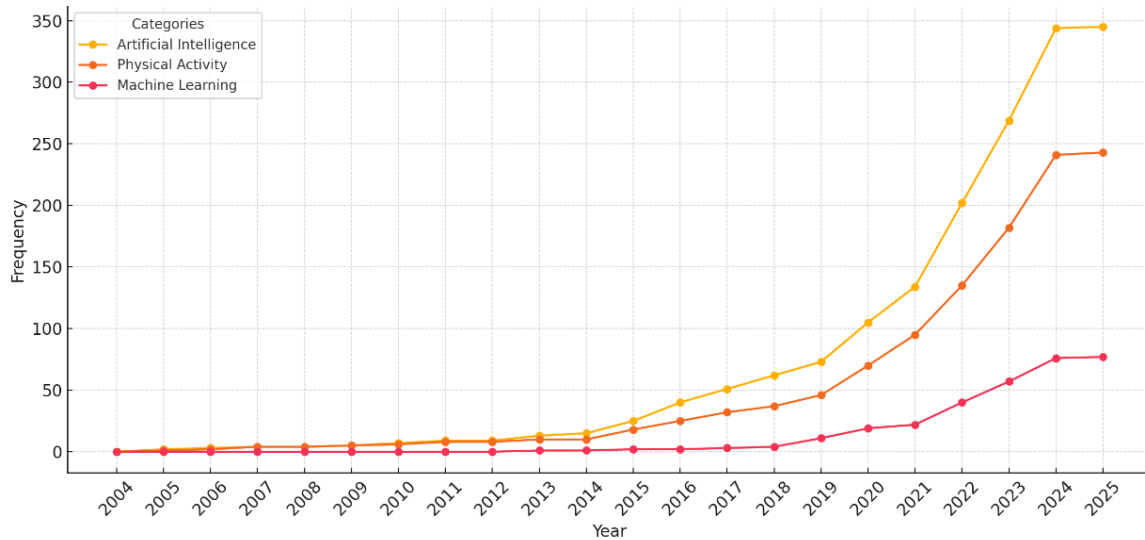


Figure 5. Trends in AI, Physical Activity, and Machine Learning (2004 – 2025).

4. CONCLUSION

Based on the analysis of publication trends from 2004 to 2025, the study concludes that AI, Physical Activity, and Machine Learning have increased significantly, especially after 2016, with a sharp spike after 2020. This indicates an increasing global focus on the use of technology to support health, physical activity, and data-driven innovation. AI is the dominant category with the fastest growth, reaching its peak in 2024–2025. This confirms the role of AI as a key technology in digital transformation across sectors, including physical activity and health monitoring. The topic of physical activity also shows rapid growth, indicating a higher awareness of the importance of a healthy lifestyle and the contribution of technologies such as wearable devices and digital monitoring. Meanwhile, machine learning, although experiencing a slower increase, continues to play an important role as a supporting technology in the implementation of AI and complex data analysis related to health and physical activity. Overall, the study confirms that the integration of technology, especially AI and machine learning, with physical activity has become a major trend in global research. The significant increase in publications after 2020 shows a response to global challenges such as the COVID-19 pandemic and the need for innovative solutions in the health sector. This trend is expected to continue to grow along with technological advances, opening up wider opportunities for innovation in improving the quality of life and human well-being.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

6. REFERENCES

- Baxromovich, A. D. (2024). The importance of physical activity for mental health. *Western European Journal of Historical Events and Social Science*, 2(4), 68-72.
- Coughlin, S. S., Whitehead, M., Sheats, J. Q., Mastromonico, J., and Smith, S. (2016). A review of smartphone applications for promoting physical activity. *Jacobs Journal of Community Medicine*, 2(1).
- Gao, Z. (2017). Fight fire with fire? Promoting physical activity and health through active video games. *Journal of Sport and Health Science*, 6(1), 1.
- King, A. C., Ahn, D. K., Oliveira, B. M., Atienza, A. A., Castro, C. M., and Gardner, C. D. (2008). Promoting physical activity through hand-held computer technology. *American Journal of Preventive Medicine*, 34(2), 138-142.
- Martin, M., Krystof, S., Jiri, R., Martina, D., Renata, V., Ondrej, M., Stepan, S., and Vladimir, T. (2016). Modulation of energy intake and expenditure due to habitual physical exercise. *Current Pharmaceutical Design*, 22(24), 3681-3699.
- Menhas, R., Dai, J., Ashraf, M. A., M Noman, S., Khurshid, S., Mahmood, S., Weng, Y., Laar, R. A., Sang, X., Kamran, M., Shahzad, B., and Iqbal, W. (2021). Physical inactivity, non-communicable diseases, and national fitness plan of China for physical activity. *Risk Management and Healthcare Policy*, 2319-2331.
- O'Reilly, G. A., and Spruijt-Metz, D. (2013). Current mHealth technologies for physical activity assessment and promotion. *American journal of preventive medicine*, 45(4), 501-507.
- Oh, Y. J., Zhang, J., Fang, M. L., and Fukuoka, Y. (2021). A systematic review of artificial intelligence chatbots for promoting physical activity, healthy diet, and weight loss. *International Journal of Behavioral Nutrition and Physical Activity*, 18, 1-25.
- Salam, M. A., and Bajaba, S. (2021). The role of transformative healthcare technology on quality of life during the COVID-19 pandemic. *Journal of Enabling Technologies*, 15(2), 87-107.
- Wang, Q., Su, M., Zhang, M., and Li, R. (2021). Integrating digital technologies and public health to fight COVID-19 pandemic: key technologies, applications, challenges and outlook of digital healthcare. *International Journal of Environmental Research and Public Health*, 18(11), 6053.
- Zhang, J., Oh, Y. J., Lange, P., Yu, Z., and Fukuoka, Y. (2020). Artificial intelligence chatbot behavior change model for designing artificial intelligence chatbots to promote physical activity and a healthy diet. *Journal of Medical Internet Research*, 22(9), e22845.

Zimmerling, A., and Chen, X. (2021). Innovation and possible long-term impact driven by COVID-19: Manufacturing, personal protective equipment and digital technologies. *Technology in Society*, 65, 101541.