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Artificial Intelligence in Physical and Health Education: Applications in Sports and Exercise Physiology

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Abstract

The Technological revolution has significantly impacted human life, breaking boundaries and bridging gaps. Physical education has been an integral part of the educational system, used for evaluating students and assessing performance in various levels. Artificial intelligence (AI) has been considered an aid to remediate old learning patterns, but its gains in physical education in the niche of sports and exercise physiology have not been fully tapped due to poor integration. This study explores the use of virtual reality technology, big data analysis, injury prevention systems, and intelligent recognition technology in solving problems presented by traditional teaching methods. AI is a field of computer science and engineering that focuses on creating machines that can perform tasks that require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. It has evolved over time, with its history dating back to Aristotle and Alan Mathison Turing. In the field of Physical and Health Education, AI is being used to meet lifelong learning needs and professional needs at various levels. Artificial Intelligence (AI) has evolved through three stages: Symbol, Data, and Third Generation. The development of AI has been influenced by three schools: Symbolicism, Connectionism, and Actionism. AI is now being applied in various fields, including industry, finance, medicine, education, and agriculture. Currently, AI is integral to human life, with applications in face brushes, payment, driverless cars, and voice assistants. It has a strong foundation in education and health professionals, who are one of the largest occupational groups in the world.

Keywords: Artificial intelligence, Exercise, Sport, Exercise physiology, Physical and health education

Introduction

Artificial Intelligence (AI) is rapidly becoming a powerful tool in the field of Physical and Health Education. AI is being applied to various aspects of sports and exercise physiology, from performance monitoring and analysis to injury prevention and rehabilitation. However, there are challenges and opportunities associated with the application and sustainability of AI in the field. AI has the potential to improve athlete performance, prevent injuries, and optimize training programmes. The advent of massive breakthroughs in technological revolution spurred on by civilization has permeated the entirety of human life breaking boundaries and bridging gaps (Zhang, 2020). Physical Education has been part of human life from inception of creation and remains an indispensable and integral organ of the general educational system used in evaluating students in performance in terms of quality assessment in Elementary, Post-primary, Colleges and Universities of learning. It is obvious that the traditional modus operandi of the instructional process is inadequate with the myriads of shortcomings it presents and as such,

artificial intelligence, which has come to stay, is considered an aid to remediation of the old patterns of teaching and learning. Noteworthy is the fact that presently, the gains of artificial intelligence in the field of physical education have not been fully tapped due to the poor level of integration in its contents. It can be said to still be at an exploratory stage. The use of virtual reality technology, big data analysis, injury prevention systems, intelligent recognition technology and the likes are the innovations that shall be considered in this study and also the exploration of their usefulness in solving the problems presented by the traditional methods of teaching to the letter (Zhang, 2020).

Artificial Intelligence (AI) is a field of computer science and engineering which involves the use of machines and man-made systems with abilities that require the use of advanced modes of operation and human intelligence. The world of technology is undergoing a revolution like never before with new inventions and human-like machines being created. Artificial intelligence cuts across all aspects of life and influences the activities of man in many ways (Can *et al.,* 2021). It is imperative to identify that the most obvious and distinguishing characteristic of humans from other beings is intelligence. Artificial Intelligence from the view of scientists is defined in divergent ways. Artificial intelligence is a science field of its own and is conceptualized as the ability of a machine to imitate behaviours that require human intelligence (Krittanawong *et al.,* 2017; Hamet & Tremblay, 2017; Russel & Ve Norvig, 2010). In other words, it is the science that focuses on creating machines that can perform tasks that normally requires human intelligence such as visual perception, speech recognition, decision making and translating between languages and that contributes to the theory and development of computer systems (Lexico, 2021).

Artificial Intelligence has its own history and has evolved over time. As such, the history of artificial intelligence (AI) - how human thought came to being; the idea of objects thinking and acting like humans; how to write the algorithm of thought and much more, dates back to the documents of a famous Greek philosopher, Aristotle, who lived between 384 BC and 322 BC (Uzun, 2020). The idea of artificial intelligence according to historical rendering was first brought up by Alan Mathison Turing in the 1950s. It was later in the 1970s that AI became more widespread especially with the rapid increase of knowledge in the field of Health (Can *et al.,* 2021). In our present world, AI has permeated almost, if not all facets of human endeavour. In the field of Physical and Health Education, which is the area of focus in this study, the integration of AI enhances personalized instruction, improves training and health outcomes, and facilitates data-driven decision making, leading to more effective and engaging educational experiences. As technology continues to evolve, its role in physical and health education is likely to expand further, reshaping how it is taught and practice. This view is shared by Davis *et al.,* (2008) who posit that day after day, AI becomes applications with decreasing costs and increasing performance with a view to meeting specific needs of individuals and communities.

The history of artificial intelligence also shows that AI followed three stages of evolution and development. It is generally accepted that, the evolution of artificial intelligence (AI) can be broadly categorized into three main schools of thought: symbolic AI, connectionism, and evolutionary computation. Symbolic AI also known as "Good Old-Fashioned AI" (GOFAI), focuses on the manipulation of symbols and rules to perform reasoning and problem-solving tasks. Early AI systems were rule-based and relied heavily on logical sequences and human-like reasoning. This approach is exemplified by systems like expert systems, which use well-defined rules and knowledge bases to emulate human decision-making (Russell & Norvig, 2016). Connectionism is centred around artificial neural networks, which are inspired by the structure and function of the human brain. Connectionism emphasizes learning through patterns and data rather than explicit rules,

enabling AI systems to learn from experience. This approach has gained prominence with the rise of deep learning, significantly advancing fields such as image and speech recognition (LeCun etal., 2015). Evolutionary Computation uses principles of natural selection and genetics to solve optimization problems. Algorithms like genetic algorithms and genetic programming simulate the process of evolution to find solutions over successive generations. This approach allows for exploring complex solution spaces and has applications in various domains, from engineering to economics (Holland, 1975).

Zhang et al. (2020), suggested that the development of AI can be conceptually divided into three stages: (1) Symbol AI, also called knowledge-driven approach; (2) data-driven approach, based on deep learning; (3) the Third Generation AI–an interpretable robust theory, combines knowledge-driven and data-driven theory. In reality, the development of AI in the last decade has wholly established people's cognition of AI and has become the so-called Fourth Industrial Revolution. Additionally, this happened when Geoffrey Hinton introduced DBN in 2006 and the layer-wise pre-training technique, opening the current deep learning era (Hinton et al., 2006). However, it has only been few years since the modern deep learning era began at the 2012 ImageNet competition (Krizhevsky et al., 2017). Since then, AI represented by deep learning is advancing by leaps and bounds. At the same time, the application of AI in many fields is exploding. As a remarkable phenomenon, people call it AI Plus (AI+), such as the AI application in industry, finance, medicine, education, agriculture, etc. The application of AI in these fields increases the innovation and productivity of society as a whole.

At the present, it is impossible to divorce the life of people from Artificial Intelligence, such as in face brush, payment, driverless cars and intelligent voice assistant which is common with smart-phones and other technological devices, all of which have influenced human life in general (Howard, 2019). Artificial intelligence has a firm foundation in the field of education. It is interesting to note that health professionals constitute one of the largest occupational groups in the world and their tentacles of operation extend to critical areas including administration, clinical, research, policy and education (Buchanan *et al.*, 2020). Drawing from the above, a safe health system is necessary to provide for the basic conditions for consultancy services through education and or training of health professionals in order to set up a workforce that is accountable, skilled and knowledgeable using the right equipment.

Physical and Health Education (PHE) is a very crucial part of the total human development process (Evans, 2024). Technology when applied to this field therefore serves to enrich and enhance educational content, promote the perception of approach as well as rebranding and promoting the continuous development. The use of artificial intelligence has no less implication for PHE as it reshapes the processes in delivery and the various aspects of sports and exercise physiology. At present, physical and health education activities are not only restricted to the classrooms alone but dynamics are now introduced.

Exercise is any physical activity that is well-planned, structured and fashioned usually following a repetitive sequence with the aim of conditioning the body and on overall, improving health and fitness of the individual who participates in it (American College of Sports Medicine (ACSM), 2018; National Academy of Sports Medicine (NASM), 2019; Centres for Disease Control and Prevention (CDCP), 2020). Exercises can be broadly classified into aerobic, anaerobic and agility exercises (Kianan *et al.*, 2015; Chamari *et al.*, 2015). Aerobic exercises are those requiring a great supply of oxygen to the working muscles of the body and include activities such as long-distance running, hill climbing, cycling, push-ups, etc. Anaerobic exercises are those that are short-term and do not require the supply of oxygen to the working muscles. They are done in short or quick bouts and include bench

press, sprints, power lifting, etc. Both aerobic and anaerobic exercises exert different changes in the physiology of the body, such as in enhancing physical fitness; aiding social, emotional and mental stability and these changes are dependent on the consistency in them (Patel *et al.*, 2017).

This study, therefore, aims at exploring the application of Artificial Intelligence (AI) in Physical and Health Education in the niche of sports and exercise physiology, drawing upon the key aspects of this application and the effects it has and is having on individual athletes and sports teams alike.

Sport, Exercise Physiology and Artificial Intelligence (AI)

Exercise physiology is the science of human performance under physical stress and the relationships between physical activity and the structure and function of the human body (Steinach & Gunga, 2021). It is concerned with how the body responds to the intense demands placed on it by physical activity and the changes that occur in the body as individuals regularly participate in exercise training (Brown *et al.,* 2006). These changes occur usually as improvements in the body's function at rest during sub-maximal and maximal exercise.

Areas of Application of AI

Injury Prediction, Prevention and management

Injuries are bound to occur as one participates in sports and or exercise consistently. This places a need for systems of immediate response to attend to such health needs that may arise. Understanding the inevitability of the occurrence of injury in sports participation therefore informs the idea of injury prevention which is aimed at saving life and or preserving it (Soni et al., 2023). The use of AI in injury prediction, prevention and management is significant in these situations. AI's predictive analytics relies on historical and real-time data to foresee potential injuries. By aggregating data from various sources like athlete tracking devices, wearable sensors, and previous injury reports, AI can detect patterns that signify increased injury risk. For instance, excessive training load combined with insufficient rest periods might increase the likelihood of stress fractures. These insights allow coaches and medical staff to adjust training schedules and loads. They can also identify high-risk players or employees early on, enabling them to implement targeted prevention measures, reducing the overall injury incidence rate (digitaldefynd.com, 2024).

Biomechanical Analysis for Tailored Training Programs

Biomechanical analysis involves a detailed assessment of posture, gait, and muscular dynamics. Advanced AI algorithms process data captured through video-based assessments or wearable sensors to identify movement abnormalities. Athletes and individuals recovering from injuries often have unique biomechanical patterns that predispose them to specific injuries (Zhang & Wang, 2020; Zhou & Zhou, 2021; Khan & Khan, 2021). By understanding these patterns, AI enables therapists to design individualized training or rehabilitation programs that address the root causes of improper form or technique, strengthening specific muscles to correct imbalances and reducing the chance of injury recurrence (Drew & Ross, 2020; Lee & Lee, 2021; Bourde & Rasquin, 2022). The United States Olympic Training Center for instance, employs AI-based biomechanical analysis for athletes to refine their techniques. They use high-speed cameras to capture motion, which is then analyzed by AI algorithms (digitaldefynd.com, 2024).

Virtual Physical Therapy Assistants

AI-enabled virtual assistants guide patients through rehabilitation exercises in the absence of physical therapists. They use computer vision and machine learning to monitor patients' movements and provide real-time feedback, ensuring proper form. These virtual

assistants can be accessed via smart-phones or smart TVs, allowing patients to maintain a rehabilitation schedule conveniently from their homes. A good example is the Kaia Health software which offers an AI-powered mobile app to guide patients through physical therapy exercises at home (Zhou & Zhou, 2021; Khan & Khan, 2021).

AI-Driven Wearable for Real-Time Monitoring

Wearable sensors such as smart-watches or specialized patches equipped with AI collect data like heart rate, joint angles, and muscle activation in real time. This continuous data stream is analyzed to identify biomechanical stress points or incorrect form, prompting immediate recommendations. Catapult, a sports science company for example, provides wearable GPS devices for athletes. These wearables track metrics like acceleration, deceleration, and heart rate. The AI analyzes data and instantly alerts coaches if an athlete shows signs of overexertion, allowing them to pull players from training sessions before injuries occur (digitaldefynd.com, 2024). Also, the use of force plates and pressure sensors are essential tools for assessing muscle function during various activities, such as walking, running, or jumping. These devices enable researchers to measure ground reaction forces and pressure distribution under the foot, aiding in the analysis of gait patterns and potential injury risks (Soni *et al.*, 2023).

Intelligent diagnosis

The most obvious manifestation of AI in exercise physiology is intelligent diagnosis. Intelligent diagnosis requires relevant personnel in medical institutions to collect and analyze a large amount of data and information by using modern information technology. Machine learning algorithms are then used to quickly identify the database of the cases to help professionals in making highly accurate diagnostic decisions (Ao *et al.*, 2020). Recently, multiple auxiliary diagnostic AI devices have been approved by the U.S. Food and Drug Administration (FDA) for various diseases (Benjamens et al., 2020). IDx-DR is the first FDA-approved autonomous AI system that automatically analyzes retinal images for signs of diabetic retinopathy without the help of medical personnel (Valikodah et al., 2021). The clinical trial results showed that the accurate identification rates of IDx-DR for patients with more than mild diabetic retinopathy and those with less than mild diabetic retinopathy were 87.4 and 89.5%, respectively (Abramoff *et al.*, 2018). Additionally, cancer diagnosis is one of the most important applications of AI-based intelligent diagnosis (Venkadesh *et al.*, 2021; Elemento *et al.*, 2021). The algorithm developed based on deep learning was used to detect mammographic lesions with 99% accuracy, reducing unnecessary biopsies (Courtiol *et al.*, 2019; Wang *et al.*, 2018).

Performance Enhancement and Optimization

As the business of sports continue to undergo series of transformations with the synergy of technology and innovative research, the frontiers of sports performance are further advanced. Clubs and teams are now looking at ways to better optimize performance and derive maximum results (Foster & Vatcher, 2021; Roca & Wang, 2021). The use of sports performance techniques and strategies are now more relied upon especially with the technological provisions that supersede the provision of statistics through human knowledge and understanding. Sports analytic departments are now popping up in nearly all major professional sports companies giving way to the avoidance of the continual decline in the margins of error expected in the sport industry necessitated by the use of AI technology (Soni *et al.*, 2023).

Sports performance analysis is the study of skill, physical fitness, strategy and tactics as they relate to modern sports. This analysis is conducted by Human Action Recognition Software the goal of which is to identify and maximize the talents of athletes. The analyses can then be utilized to create competitive strategies that will be helpful to the team. Since

sports to a large extent constitute fast-paced motions and close contacts, they become increasingly difficult to keep track of using human senses and knowledge (Roca & Wang, 2021). The vast amount of footage available across every sport today lends credence to the capability and viability of AI (Wang et al., 2023).

Virtual Reality (VR) is a computer simulation technology that can create and offer experiences of virtual worlds. VR combines the latest developments in computer graphics, multimedia, AI, human-machine interface technology, dynamic device network, parallel processing technology, and other information technologies to create the experience of a virtual world (Lee & Lee, 2021). It stimulates the desire for information acceptance, which leads to new ideas. The application of VR in PE focuses on utilizing its features to build AI "expert" systems, such as prescribing sports-based expert systems, and utilizing VR's three-dimensional space to build motion models based on human physical activity. VR technology can not only be used to simulate the real world but can also transcend the real world and promote real users' perceptions. Using VR, students can better understand and master educational content (Lee & Jin, 2016).

Athlete Performance Analysis

The performance of athletes is first important to the athlete and then to the team or club. This is sometimes difficult to measure in specific terms. Artificial Intelligence helps to make more detailed and specific measurements and analysis of performance like never before (Danskin, 2023; Loucks, & Tharp, 2020). The use of photo-finisher in races, automatic time tracker and various other technologies are aiding coaches to know the performance level of their athletes and even the athletes themselves (Murray, 2022). Advanced wearable devices from Fibion, equipped with accelerometers, gyroscopes, and magnetometers, can provide continuous and detailed monitoring of physical activity and sedentary behaviour (Fowler, 2021). These sensors collect real-time data on movement and posture, creating a comprehensive dataset for machine learning analysis (Patterson, 2023).

Key sensors used in performance analysis of individual athletes and teams include the use of accelerometers which measure the intensity and duration of physical activities; gyroscopes which keep track of orientation and angular velocity, providing insights into posture and balance and magnetometers, which detect changes in direction and movement patterns (Patterson, 2023; Rogers & Smith, 2021; Shin & Lee, 2021). These devices are accurate to at least 0.1 error margin and are reliable to take detailed statistics and measurements of performance indices (Housman, 2018; McCabe & Trevathan, 2008; Xian, 2010). Integrating AI with advanced sensors for activity and behaviour monitoring offers numerous benefits such as; personal health management that enable individuals track their activity levels and receive personalized advice to improve health outcomes; workplace wellness programs by which coaches and teams can implement programs to monitor and encourage physical activity among players and athletes, reducing health risks associated with sedentary behaviour; clinical support which affords healthcare providers can use this data to develop personalized intervention plans for patients with chronic diseases or those recovering from surgery (Kim & Kim, 2017; Li & Zhang, 2017; Gomes et al., 2022).

Virtual Coaching, Mentoring and Training

The role of AI technology in sports continues to evolve, providing innovative and valuable contributions to sporting events. Two fundamental aspects of sports competitions are adherence to rules and engaging in competitive activities. The integration of AI technology with competitive events enhances training and facilitates advancements in the competition landscape. A critical challenge in competitive sports training lies in analyzing whether athletes' training activities, including speed, angle, and strength, align with the project regulations promptly (Song, 2024). An increasing number of tennis teams and coaches are

embracing the use of AI technology to enhance player training and management. However, as this technology continues to evolve, the specific details and applications are undergoing continuous refinement and updates, with no current unified standard yet.

The integration of AI into competitive sports training involves utilizing cameras to capture athletes' data, analyzing and assessing them through video-based human motion recognition algorithms, and drawing informed conclusion (Kriegeskorte & Golan, 2019; Ghoddusi et al., 2019). This approach allows athletes to gain intuitive insights into their training shortcomings and deficiencies, enabling them to receive higher-quality training plans through coach guidance and analysis. The AI assistant application's visual recording feature enhances the training process's clarity. This capability allows students and instructors to jointly review training videos, facilitating in-person discussions about areas that may need improvement in technical actions. Moreover, students can more effectively identify their shortcomings. Actively correcting errors becomes possible for students as they watch videos and follow the guidance provided by AI teaching assistants. The system visually examines the results, highlighting similarities and differences between players (Minchole & Rodriguez, 2019).

Sport and Exercise Science Research

Studies have shown that sport and exercise science research is greatly being advanced by the various technological innovations that are helping to further discover better ways of improving the field generally (Fritz & Fritz, 2022; 2014; Kim & Kim, 2017). In sport and exercise research, models are constantly developed to improve sport performance and to maximize the use of energy levels in athletes. This boost is changing the global approach to sports and exercise science in a whole new way and creating widespread systems that when adopted yield desired results. Soni *et al.*, (2023) in their study, came up with a model that provided insights into advanced data analysis prediction through reinforcement learning techniques. The study proposed the amalgamation of data from continuous glucose monitoring systems, saliva-based hormone tests, wearable sweat sensors, implantable hormone sensors, acceleromyography, tensiomyography, near-infrared spectroscopy, force plates and pressure sensors through which researchers can gain a comprehensive understanding of the human body and its intricate functions and responses. This model, the study posited would go a long way in the prediction of human behaviour and contribute to the development of personalized Muscle stimuli recording devices serve as crucial tools in research and enable the measurement and recording of electrical activities in the muscles which can be used to predict and prevent injuries and disorders as well as improve performance. The use of the electromyography (EMG) device/machine is one very useful muscle stimuli recording device. This machine detects the electrical signals generated by muscle fibres during contractions and these signals are amplified and recorded for analysis, providing gainful insights into muscle activities (Kim, 2017).

Saliva-based hormone tests provide non-invasive means of measuring hormone levels in saliva samples, including cortisol (a stress hormone), estragon, progesterone, and testosterone. These tests offer valuable information about hormonal status and fluctuations. Wearable sweat sensors are compact devices that detect changes in sweat composition, including hormone levels. By analyzing sweat chemistry, these sensors can provide real-time information on hormone fluctuations during exercise or other activities. (Li, 2017).

Exercise Physiology and Biomechanics

The utilization of AI continues to transform sports in multifarious and incalculable ways, surpassing the current level of comprehension. AI is recently employed to delineate each facet of sports at every conceivable level to facilitate the transformation of statistics and analysis in revolutionizing the approach to strategizing and implementing games on the field.

Furthermore, AI has augmented precision in sports as scores, player movements, and fan behaviours can be readily anticipated through its application.

Another notable facet impacted by AI is acknowledged as the manner of walking, commonly referred to as gait, emblematic of autonomy and distinctiveness in humans; therefore, any aberration from the norm can significantly diminish the standard of living (Molavian et al., 2023). Gait analysis, the research pertaining to human walking, is a methodical approach to identify unfavourable variances within the gait pattern and subsequently ascertain their underlying source and consequential impact (Prakash et al., 2015; Johnson & Bobick, 2001). Analysis of the Gait is a methodology employed to unveil the intricate mechanisms underlying human locomotion through the quantification of factors that govern the functional presentation of the lower extremities.

Summary

In summary, this brief study has reviewed the role of Artificial intelligence in the field of Physical and Health Education, particularly in the areas of sports and exercise physiology. Artificial intelligence has been considered to have tremendous impact on training of the body and mind, which is what the programme of studies in Physical and Health Education seeks to achieve. Areas such as virtual reality in teaching practical movements and skills in sports and other areas have been observed to yield better and long-lasting results for participants in sports – athletes and others. Injury prevention is better attended to with technologies in place to assist injured or sick athletes and see that they are back on the path to recovery and full performance in their chosen careers as soon as possible. As such, this study concludes that artificial intelligence has brought about more effective and efficient ways of addressing issues in Physical and Health Education in niche areas as sports and exercise physiology.

Recommendations

Drawing from the reviews of this study, the researcher makes the following recommendations:

1. Educational Authorities and School Boards should develop and enforce regulations that govern how AI technologies are used in a school setting so that learners are not misguided. Collaborations with policymakers and legal experts may also be necessary to ensure that these regulations are in line with educational goals and student welfare.
2. Schools, colleges, and universities administrators should establish internal monitoring systems to evaluate the effectiveness and appropriateness of AI tools in physical education. This may include setting up committees or hiring specialists in educational technology to oversee these implementations.
3. Sports Organizations and Coaching Associations should create guidelines and best practices for the integration of AI technologies in sports training and exercise programs for the judicious use of and harmonious interface between man and machine for optimum performance in sports and exercises. Collaborations with sports scientists and technology developers may also enhance the effectiveness of these measures.
4. Government bodies should promote policies that ensure equitable access to AI technologies in education and training programs. Educational institutions should also offer training sessions for both educators and students to facilitate the effective use of AI tools, ensuring that they are accessible to all learners regardless of their background.

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