



Empowering Athletic Excellence: The Survey on Physiotopia's Use of AI-Powered Solutions to Transform Sports Health and Rehabilitation

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Abstract: Physiotopia is a pioneering entity in the field of sports health, exemplifying the merging of cutting-edge artificial intelligence (AI) technology with the critical need for injury prevention and rehabilitation in athletics. However it also Grounded in the fundamental understanding of the critical relevance of recovery-focused exercises, Physiotopia orchestrates a paradigm change through its novel AI-driven solutions, precisely created to enhance athlete performance while protecting their physical well-being. Physiotopia's disruptive approach is based on a comprehensive integration of AI algorithms, precisely calibrated frameworks like TensorFlow, PyTorch, Rasa, and Dialogflow, and an uncompromising commitment to precision and personalisation. Generally Physiotopia transforms the landscape of sports health with bespoke rehabilitation models, bespoke dietary guidance, and AI-powered chatbots providing rapid first aid advice, ushering in an era of unmatched efficacy and personalised treatment. This scientific exposition delves into Physiotopia's unique ethos and operational procedures, unravelling the intricate fabric of its AI-powered interventions and their profound consequences for athletic success and overall well-being. By delving into the complexities of Physiotopia's AI infused ecosystem, this discourse reveals the transformative potential inherent in its approach, empowering athletes and healthcare practitioners alike to leverage the full spectrum of technological innovation in pursuit of peak performance and sustained vitality.

Index Terms - TensorFlow, PyTorch, Rasa, Dialogflow, Flask, Django.

I. INTRODUCTION

Physical therapy, a cornerstone of healthcare, is critical in promoting overall human health, particularly by improving bodily movement and increasing mobility. This inquiry digs into the diverse contributions of physical therapy in the setting of Physiotopia, emphasising its critical role. Injury Recovery: Injuries, whether from accidents or physical activity, can significantly limit mobility. Consequently, physical therapists use specialised knowledge and techniques to perform focused exercises and interventions that improve flexibility, restore strength, and relieve pain. Pain Management: Physical therapy emerges as an important resource for addressing a variety of illnesses, providing manual therapies, personalised exercises, and movement based interventions to alleviate discomfort and inflammation. Restoring Mobility: Physical therapy uses comprehensive tactics to restore function and develop optimal movement patterns. Moreover, individualised regimens that include stretches, exercises, and practical measures promote improved mobility, balance, and physical synchronisation. Chronic Disease Management: Physical therapy plays an important part in treating chronic illnesses such as arthritis, heart disease, and neurological diseases. Nevertheless, therapists work with patients to develop individualised techniques for symptom management and general well-being. Post-Surgical Rehabilitation: Following surgical procedures, physical therapy becomes an important part of the rehabilitation process, helping to restore mobility, manage pain, and facilitate a return to pre-surgery levels of function. Enhancing Athletic Performance: Physical therapy is an important technique in sports and athletics for improving performance, reducing injuries, and easing rehabilitation. Accordingly, therapists provide specialised rehabilitation plans, offer targeted training programmes, and execute injury prevention techniques. Women's Health Focus: Physical therapy now addresses women's health concerns, including pelvic floor dysfunction, urinary incontinence, and pregnancy-related discomfort. Therefore, physical therapists help women improve their functional ability and well-being by offering individualised interventions. Elderly Care: Physical therapy plays an important role in managing age-related difficulties such as osteoporosis, mobility limits, and balance impairments. Ordinarily, physical therapy increases independence and

quality of life by focusing on therapies that improve daily living skills and reduce fall risk. While artificial intelligence (AI) has potential for improving numerous aspects of physical therapy, human-therapist interaction remains essential. This investigation looks into how AI integration might supplement and improve the exceptional care delivered by human practitioners in the Physiotopia sector.

II. LITRETURE SURVEY

Overview of the Current Work and Systems: We shall provide a summary of earlier research on injury detection and rehabilitation exercises, focusing on the implementation of machine learning techniques. Here are a few illustrations:

Reference [1] The paper focuses on innovations designed for performance. Specific efforts are highlighted, such as The Ohio State University (OSU), which is monitoring ACL injuries in basketball players, and the University of Utah, which is developing sensor-controlled insoles to improve gait. One direction for comprehensive athlete monitoring is the trend of combining wearables, data analytics, and cutting edge technology. This article also discusses the use of technology in Olympic sports. Examples include the use of cutting-edge equipment to analyze swimming jumps and the real-time data collection of boxers. Overall, biomedical engineering is considered an important resource for understanding, preventing, and improving sports-related problems. The future scope of these projects is as follows:

Advanced Injury Prevention and Rehabilitation Techniques:

- Use biomechanical data to scale customized injury prevention efforts.
 - Integrate artificial intelligence (AI) algorithms to predict and prevent sports injuries in real time.
 - Develop rehabilitation techniques that promote wound healing. This could include robotics and cutting-edge physical therapy techniques.
- Understanding Biomechanics and Improving Performance:**
- Conduct in-depth studies of biomechanical data to find new information about injury processes and athletic performance.
 - Implement customized training plans based on an individual's biomechanical profile to strengthen weaknesses and improve areas of strength.

Data Integration and Analysis:

- Continuously integrate technology to provide a single platform for data collection, analysis, and interpretation. Utilize sophisticated analytics techniques like machine learning and predictive modeling to mine large datasets amassed over time for insights that may be put to use

Reference [2] Analysis of human motion in kinaesthetic rehabilitation is covered in this article. It focuses on learning ideal motions through expert demonstrations and evaluating patient movements with real-time multi-level analysis. The proposed method extracts orientation and position data from Microsoft Kinect v2 using a Gaussian Mixture Model. This makes it possible for the robot coach system to suggest coaching for patients' increasing mobility. The paper proposes using a robot coach system to analyze human motion during kinaesthetic rehabilitation. In order to identify the optimal movements from expert demonstrations, a Gaussian Mixture Model (GMM) obtains position and orientation data from Microsoft Kinect v2. The research does not disclose the amount or variety of the dataset used to design and test the suggested approach. The article does not compare the suggested approach's performance to current methodologies or benchmarks. Our goal is to translate human motion into robot motion so that robots may automatically pick up exercises from expert models. Extending the method to include scenarios where a patient is unable to do an activity due to physical limitations or discomfort. This involves developing an adaptable model that takes into account the unique characteristics of patients.

Reference [3] This article examines the long-term consequences of sports injuries, including how they may impact an athlete's ability to continue competing and the onset of conditions like osteoarthritis and stunting, particularly It demonstrates how it might impact athletes' activity. youthful sportsperson. Of note are the association between sports injuries and osteoarthritis of weight-bearing joints, persistent symptoms and increased risk of arthritis after ankle ligament injuries, and persistent upper extremity problems in overhead athletes, particularly in the elbows. and the emphasis on shoulder injuries. The study also investigated the outcomes of surgical techniques such as meniscectomy and ACL reconstruction, highlighting the need for further research on the increased risk of osteoarthritis after ACL repair and meniscectomy. There is. In conclusion, this paper highlights the importance of understanding the long-term effects of sports injuries to guide future management and preventive measures.

Reference [4] This article describes a nutritional approach to healing sports-related muscle injuries. Vital nutrients like antioxidants, omega-3 fatty acids, probiotics, and protein are emphasized. This study highlights the importance of nutrition to enable a quick and safe return to sport after muscle injury. Find out more about the phases of muscle injury, which include remodeling, repair, inflammation, and destruction. The focus is on protein intake, energy guidelines, and the role of antioxidants in reducing oxidative stress. We also discuss the potential benefits of probiotics and omega-3 fatty acids in promoting muscle recovery. This paper calls for further clinical research to better understand how these nutrients impact recovery time in injured athletes.

Reference [5] This article examines the importance of strength and performance in athletic recovery, while also highlighting the value of accurate and reliable testing. Tests of the upper and lower extremities are covered(MVIC), such as the Wingate test, maximal isometric voluntary contraction, and one repetition maximum (1-RM). Each test is different and is a useful tool to assess your recovery and determine whether you should aim to return to your sport. The paper highlights the need for a complete strategy, including various tests, psychosocial evaluation and a phased-in return to engagement, to achieve the best results and pre-injury levels in sport. The StARRT framework is presented to assess injured athletes based on health risks, activity risks, and risk tolerance stages. It emphasizes the importance of considering a variety of psychological considerations and using individual strategies when deciding to return to sport.

Reference [6] With an emphasis on male athletes specifically, this study explores the complex relationship between elite sport and mental health. sports injuries' effects on mental health, Stress factors prevalent in elite sports, The link between depression and sports careers, Anxiety issues, Difficulties in distinguishing between overtraining and mental health problems, Nutritional intake in male athletes Concerns about eating disorders, substance abuse patterns, stigma, seeking help, and the importance of mental strength are some of the key topics. This study highlights the need for more knowledge, education, and support to encourage open conversations about mental health among elite male athletes. It also emphasizes the need to combat stigma to encourage people to seek help quickly. • Injury as a risk factor: 4,444 sports injuries are considered to be a significant risk factor for psychological distress in male athletes. If an athlete's illness is related to mental health, they may be more willing to talk about it. • Stress in Elite Sports: Tension and stress in athletes due to performance, competition, and adverse living conditions can exacerbate psychological problems. Stress factors can continue even after retirement and are not limited to an active player's career. • Depression in athletes: Because of the physical and mental strain of competitive sports, players may be more prone to depression. Athletes who have worsening symptoms of mental illness may perform poorly and be more vulnerable to developing new mental health issues.

Reference [7] The observer offers a unique approach termed the Hybridised Hierarchical Deep Convolutional Neural Network (HHDCNN) For sports and exercise rehabilitation. Overall, the proposed HHDCNN strategy outperforms other sports-HE rehabilitation methods, as evidenced by improved segmentation accuracy and convergence speed. In the context of sports medicine data, this study focuses on the use of deep learning algorithms, specifically convolutional neural networks, for image segmentation and popularity analysis of human activities. This study found that HHDCNN could significantly improve the accuracy and effectiveness of rehabilitation methods and positively impact sports rehabilitation outcomes. However, it is important to remember that certain aspects of the study and the material provided must be considered.

Reference [8] Research has demonstrated that exposure to sunlight and fresh air can improve mood. No wonder so many people look forward to winter every year. The clinical study examined the health status of 3,661 athletes. The method chosen to analyze athletes' recovery behavior was machine learning. The preceding arguments are accepted as valid. The first sentence definitely turned out to be totally true. Monitor blood biomarkers to support dietary changes, training, and recovery. Key indicators are identified using multiple regression and decision forest models, where data is periodically removed and rearranged. This study yielded encouraging results. The diversity of individuals comprising the research sample allowed for a more comprehensive understanding of the issue. In summary, this study provided valuable insights and insights that can be applied to future field studies. When identifying liver and muscle metabolites, the random forest model showed good performance in terms of recall and precision. Although it seemed reasonable, the performance of the multiple regression model was worse than the random forest model.

Reference [9] 'Such a massive part of rehab is between the ears'; barriers to and facilitators of anterior cruciate ligament reconstruction rehabilitation: a qualitative focus group analysis This article presents a qualitative study of rehabilitation after anterior cruciate ligament (ACL) repair. Twenty people took part in an online survey, answering questions about their personal lives, sports, injuries, and demographics. The study found that kinesiophobia, fatigue, and weight gain were the main barriers to completing treatment and returning to sport. Results indicate that rehabilitation programs should use less jargon and clearer instructions to improve participant understanding and compliance. The Bond University Human Research Ethics Committee approved this study, and the authors disclosed no conflicts of interest that might have influenced the study results. This brochure also includes a list of related resources for additional reading on the topic of ACL reconstruction therapy. This study provides insightful information on the barriers and enablers of rehabilitation after ACL repair and suggests possible avenues to improve rehabilitation service delivery.

Reference [10] AI ChatGPT/GPT 4: An Booster for the Development of Physical Medicine and Rehabilitation in the New Era! This communication is a letter to the editor addressing the potential impact of ChatGPT/GPT-4 on physical therapy and rehabilitation (PM&R). This paper draws attention to the growing need for rehabilitation physicians and the shortage of rehabilitation physicians worldwide. It also shows how ChatGPT/GPT-4 can help with this problem. This letter describes his four potential key roles for his ChatGPT/GPT 4 for PM&R. These responsibilities include addressing physician shortages in rehabilitation, providing patient education and support, and serving as a virtual partner for rehabilitation education. It also calls attention to the shortcomings of ChatGPT/GPT-4 in the healthcare field, including its tendency to "hallucinate" false information and display harmful social biases. Rehabilitation education is also essential to PM&R, as it provides patients, families, and healthcare professionals with information and skills regarding self-management, rehabilitation support, and the rehabilitation process itself. The value of rehabilitation education has been demonstrated in many ways, and ChatGPT/GPT-4 increases rehabilitation awareness by providing detailed information and answers to questions about the techniques, rehabilitation and process, rehabilitation. self-management Enhance Virtual Rehabilitation and is considered an educational partner.

Reference [11] Exercise science students have insufficient awareness of fall prevention strategies. There is a need for an evidence-based curriculum module for fitness instructors. The survey measured the knowledge of exercise science students. Knowledge levels improved during the study year, but remained limited. Exercise science students' knowledge levels improved year after year of study. Overall knowledge levels were well below 70%. A structured survey was performed during lectures in universities. Knowledge is measured by the percentage of accurate responses. Exercise science students possess limited knowledge. Current knowledge does not align with the desired skill level. Current exercise science training in Australia does not provide workers with the necessary information to prevent falls in older adults. Developing an evidence-based "exercise for fall prevention" curriculum module is necessary for exercise practitioners.

Reference [12] Biomarkers can help track performance, recovery, and overall health. A comprehensive biomarker collection should include signs for inflammation, muscle state, endurance performance, injury risk, nutrition, and hydration. The discovery and validation of biomarkers in food and exercise. Suggested biomarker panels for recovery, performance, and health. The study advises employing confirmed biomarkers to track improvements in fitness training and physical activity programs. Biomarkers may indicate

inflammation, muscular status, endurance performance, injury risk, nutrition, metabolic health, and muscle status. An analysis of recent works. Validated biomarkers in key categories are indicated. Identifying biomarkers for recovery, performance, and health. Suggestions for the Efficiency Biomarker Board.

III TABLE 1. LITRETURE SURVEY TABLE

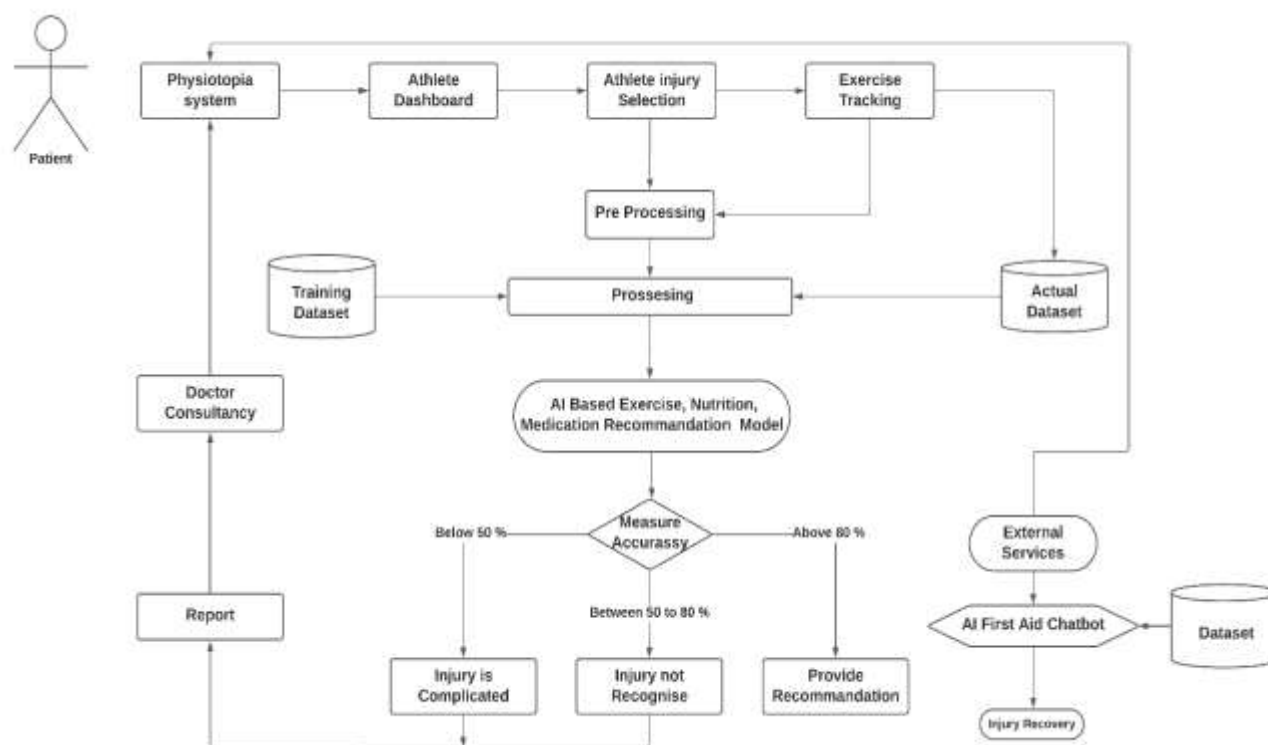
Sr.no	Method Used	Performance Matrix	Challenges	Main Points in Overview
1	Biomedical engineering in sports, Wearables, Data analytics	Advanced injury prevention, AI integration, Rehabilitation techniques	Lack of comprehensive dataset disclosure, Performance comparison not provided	Use of technology in sports for injury prevention and performance enhancement, Future scope includes AI integration and biomechanical analysis for personalized training plans.
2	Gaussian Mixture Model with Microsoft Kinect v2 data	Personalized coaching recommendations, Motion analysis	Dataset details undisclosed, Lack of performance comparison	Utilization of robot coach system for human motion analysis in rehabilitation, Potential extension to accommodate patient-specific needs and physical limitations.
3	Literature review, Outcome analysis	Long-term effects of sports injuries, Surgical outcomes	Need for further research on outcomes, Management strategies	Long-term effects of sports injuries on athletes' health, Importance of understanding for future preventive measures.
4	Literature review, Nutritional analysis	Nutritional strategies for muscle recovery, Clinical research	Lack of clinical data, Need for further research	Highlighting importance of nutrition in sports injury recovery, Emphasis on protein intake and role of antioxidants in promoting muscle healing.
5	Physical testing, Performance assessment	Importance of strength testing, Rehabilitation strategies	Psychological considerations, Gradual return to activity	Need for comprehensive testing strategies in sports rehabilitation, Consideration of psychological factors in return to sport decisions.
6	Literature review, Mental health analysis	Mental health issues in elite sports, Stigma awareness	Lack of awareness, Stigmatization issues	Exploration of mental health challenges in elite male athletes, Emphasis on stigma reduction and support initiatives.
7	Deep learning algorithms, Convolutional Neural Networks	Rehabilitation effectiveness, Image segmentation	Limitations of study scope, Algorithm complexity	Application of deep learning in sports rehabilitation, Improved segmentation accuracy and effectiveness demonstrated with HHDCNN.
8	Machine learning, Statistical analysis	Monitoring blood biomarkers, Dietary support	Dataset size limitations, Model performance variations	Utilization of machine learning in athlete health monitoring, Identification of key biomarkers for dietary and training support.

9	Qualitative analysis, Focus group discussions	Rehabilitation barriers, Patient education	Limited participant pool, Subjectivity in analysis	Identification of barriers and facilitators in ACL rehabilitation, Recommendations for clearer communication and education in rehabilitation programs.
10	Discussion on AI integration, Healthcare application	Virtual rehabilitation, Patient education	AI biases and limitations, Ethical considerations	Potential of AI in physical medicine and rehabilitation, Role in patient education and support, Awareness enhancement in rehabilitation field.
11	Survey research, Knowledge assessment	Awareness levels, Skill alignment with training	Limited participant knowledge, Curriculum gaps	Need for evidence-based fall prevention curriculum in exercise science education, Importance of aligning knowledge with practical skills.
12	Literature review, Biomarker identification and analysis	Performance tracking, Health monitoring	Biomarker validation, Practical implementation challenges	Importance of biomarkers in athlete performance and health tracking, Suggestions for effective biomarker utilization in fitness training programs.

PRAPOSED SYSTEM:

- **Athletes Dashboard:** Create an interactive dashboard where athletes can track their progress, view injury status, and receive personalised advice.
- **Athletes' Injury Selection:** Implement a feature that allows athletes to select and report their injuries using the dashboard interface.
- **Exercise Tracking:** Integrate exercise tracking functionality to assess athletes' compliance with rehabilitation procedures and performance over time.
- **Pre-processing:** Pre-process incoming data, such as injury reports and exercise monitoring data, to guarantee compatibility and consistency for future analysis.
- **Training dataset:** Create a comprehensive training dataset with injury data, workout regimens, and patient profiles to train AI models.
- **Doctor Consultation:** Allow athletes to communicate with healthcare professionals via the platform for personalised advice and treatment recommendations.
- **Processing:** Utilise AI algorithms to evaluate incoming data, find patterns, and generate insights on injury recovery and rehabilitation.
- **Actual dataset:** Incorporating real-world data from athletes' recovery trips can improve the accuracy and effectiveness of AI models.
- **AI-Based Exercise, Nutrition as well as Medication Recommendation Model:** Create an AI-powered model that suggests personalised training regimens, nutrition plans, and pharmaceutical methods depending on athletes' individual ailments and recovery status.
- **Measure Accuracy:** Implement tools to assess the accuracy of AI recommendations and ensure they reach predetermined thresholds.
- **External services:** Integrate external services, such as medical databases or wearable devices, to expand the platform's capabilities and deliver new insights.
- **Report:** Create detailed reports that summarise athletes' progress, adherence to rehabilitation regimens, and any significant findings or recommendations.
- **Injury is Complicated (10–80%):** Create algorithms to analyse complex injury instances where recognition is difficult, and make specific recommendations based on available data.
- **Injury Not Recognised (Under 50%):** Implement algorithms to detect cases when injuries are not immediately recognised, necessitating further evaluation and advice creation.
- **AI First Aid Chat Bot:** Deploy an AI-powered chatbot to deliver real-time first aid, injury management advice, and suggestions for medical attention.
- **Dataset:** To improve the accuracy and robustness of AI models, the dataset should be continuously updated and expanded with new injury cases and rehabilitation outcomes.
- **Injury Recovery:** Focus on optimising AI-driven treatments for injury recovery, using data analytic insights to improve rehabilitation outcomes and speed up recovery processes.

III. PHYSIOTOPIA'S SYSTEM ARCHITECTURE:



IV. LIMITATIONS AND CHALLENGES:

Data Integration and Analytics: The gathering, examination, and interpretation of enormous datasets are made easier by the use of AI into sports medicine. Predictive modelling and machine learning are examples of advanced analytics that provide insightful information for improving injury prevention and recovery. **Extensive Patient Education:** AI functions as a virtual rehabilitation education partner, offering patients, families, and medical professionals a wealth of knowledge through systems such as ChatGPT/GPT-4. This may help people become more conscious of and knowledgeable about rehabilitation procedures.

AI-Driven First Aid Chatbots: AI chatbots that can understand natural language are first aid aides. When users ask these chatbots questions about health, they may respond right away, giving consumers first advice and information in an emergency.

24/7 Accessibility: AI-driven first aid chatbots allow users to get help whenever they need it, day or night. This accessibility is particularly helpful in circumstances where having access to first aid information quickly is essential before receiving expert medical assistance.

Human-Therapist relationship: Although AI improves physiotherapy in many ways, the basic human-therapist relationship is still essential. It's difficult to strike a balance between the advantages of AI and the individualised care given by human practitioners. **Accuracy and Limitations of AI Systems:** As the ChatGPT/GPT-4 debate points out, despite their achievements,

AI systems may have some limitations. Problems like as "hallucination" of incorrect information and biased answers are problematic, particularly in healthcare settings where precision is essential.

Complicated Execution: System integration, UI design, and data quality must all be carefully taken into account when implementing AI solutions, such as motion tracking systems. It might be difficult to ensure a smooth incorporation into current healthcare procedures.

Ethical Issues: The use of AI to sports health presents ethical issues, notably with regard to data protection, informed permission, and the appropriate application of predictive analytics. It's crucial to strike a balance between ethical concerns and technical breakthroughs.

Research and Validation Must Continue: To confirm the efficacy of AI-driven solutions in sports health, research must continue. It will always be difficult to make sure these technologies constantly produce the desired results and to modify them to fit changing healthcare requirements.

User Acceptance and Trust: It's critical to cultivate user trust in AI-powered first aid support. Gaining user adoption requires addressing doubts about the accuracy of AI suggestions and maintaining open lines of communication regarding the chatbot's capabilities and constraints.

Integration with Emergency Services: It might be difficult to arrange for the usage of AI first aid chatbots in conjunction with emergency services. Effective emergency response depends on establishing fluid integration and communication to guarantee a seamless shift from virtual help to trained medical.

V. CONCLUSION AND FUTURE SCOPE:

This survey article exposes the revolutionary potential of AI in improving injury prevention and rehabilitation tactics in sports health by conducting a complete examination of existing research, methodology, and emerging technologies. By synthesising significant data and emphasising developing trends, it is clear that AI-driven solutions provide unparalleled opportunity to improve athlete performance, reduce injury risks, and speed up recovery processes. As the subject evolves, opportunities for future research and use of AI technology in sports health grow more intriguing. This study is an invaluable resource for academics, practitioners, and stakeholders looking to leverage the power of AI to transform sports medicine and raise standards of care for athletes globally.

VI. REFERENCES:

- [1]L. Mertz, "Technology Comes to the Playing Field: New World of Sports Promises Fewer Injuries, Better Performance," IEEE Pulse, vol. 4, no. 5, pp. 12–17, Sep. 2013, doi: 10.1109/mpul.2013.2271683.
- [2]Devanne, M., & Nguyen, S. M. (2017). Multi-level motion analysis for physical exercises assessment in kinaesthetic rehabilitation. Hal. <https://doi.org/10.1109/humanoids.2017.8246923>
- [3]N. Maffulli, U. G. Longo, N. Gougoulas, D. Caine, and V. Denaro, "Sport injuries: a review of outcomes," British Medical Bulletin, vol. 97, no. 1, pp. 47–80, Aug. 2010, doi: 10.1093/bmb/ldq026.
- [4]Quintero, K. J., Da Cunha Resende, A., Leite, G. S. F., & Lancha, A. H. (2018). An overview of nutritional strategies for recovery process in sports-related muscle injuries. Nutrire, 43(1). <https://doi.org/10.1186/s41110-018-0084-z>
- [5]M. Y. Fares, H. H. Khachfe, H. A. Salhab, A. Bdeir, J. Fares, and H. Baydoun, "Physical Testing in Sports Rehabilitation: Implications on a Potential Return to Sport," Arthroscopy, Sports Medicine, and Rehabilitation, vol. 4, no. 1, pp. e189–e198, Jan. 2022, doi: 10.1016/j.asmr.2021.09.034.
- [6]G. Souter, R. Lewis, and L. Serrant, "Men, Mental Health and Elite Sport: a Narrative Review," Sports Medicine - Open, vol. 4, no. 1, Dec. 2018, doi: 10.1186/s40798-018-0175-7.
- [7]D. Tang, "Hybridized Hierarchical Deep Convolutional Neural Network for Sports Rehabilitation Exercises," IEEE Access, vol. 8, pp. 118969–118977, 2020, doi: 10.1109/access.2020.3005189.
- [8]Petrovsky, D. V., Pustovoyt, V. I., Nikolsky, K. S., Malsagova, K. A., Kopylov, A. T., Stepanov, A. A., Rudnev, V. R., Balakin, E. I., & Kaysheva, A. L. (2022). Tracking health, performance and recovery in athletes using machine learning. Sports, 10(10), 160. <https://doi.org/10.3390/sports10100160>
- [9]A. Walker, W. Hing, S. Gough, and A. Lorimer, "'Such a massive part of rehab is between the ears'; barriers to and facilitators of anterior cruciate ligament reconstruction rehabilitation: a qualitative focus group analysis," BMC Sports Science, Medicine and Rehabilitation, vol. 14, no. 1, Jun. 2022, doi: 10.1186/s13102-022-00499-x.
- [10]S. Peng, D. Wang, Y. Liang, W. Xiao, Y. Zhang, and L. Liu, "AI-ChatGPT/GPT-4: An Booster for the Development of Physical Medicine and Rehabilitation in the New Era!," Annals of Biomedical Engineering, vol. 52, no. 3, pp. 462–466, Jul. 2023, doi: 10.1007/s10439-023-03314-x.
- [11]Sturnieks, D. L., Finch, C. F., Close, J. C., Tiedemann, A., Lord, S. R., & Pascoe, D. (2010). Exercise for falls prevention in older people: Assessing the knowledge of exercise science students. Journal of Science and Medicine in Sport, 13(1), 59–64. <https://doi.org/10.1016/j.jsams.2008.11.005>
- [12]Lee, E. C., Fragala, M. S., Kavouras, S. A., Queen, R. M., Pryor, J. L., & Casa, D. J. (2017). Biomarkers in Sports and Exercise: Tracking health, performance, and recovery in athletes. The Journal of Strength and Conditioning Research, 31(10), 2920–2937. <https://doi.org/10.1519/jsc.0000000000002122>
- [13]K. J. Quintero, A. de S. Resende, G. S. F. Leite, and A. H. Lancha Junior, "An overview of nutritional strategies for recovery process in sports-related muscle injuries," Nutrire, vol. 43, no. 1, Nov. 2018, doi: 10.1186/s41110-018-0084-z.
- [14]L. Wang and L. Huang, "Analysis of the Causes and Prevention of Sports Injuries in School Physical Education and Training Based on Big Data Analysis," 2020 International Conference on Computers, Information Processing and Advanced Education (CIPAE), Oct. 2020, Published, doi: 10.1109/cipae51077.2020.00037.
- [15]H. Qi and Y. Feng, "Analysis of Clinical Value of Weight-Bearing Magnetic Resonance Diagnosis of Ankle Ligament Sports Injury," IEEE Access, vol. 8, pp. 62725–62737, 2020, doi: 10.1109/access.2020.2983992.

[16]H. Van Eetvelde, L. D. Mendonça, C. Ley, R. Seil, and T. Tischer, “Machine learning methods in sport injury prediction and prevention: a systematic review,” *Journal of Experimental Orthopaedics*, vol. 8, no. 1, Apr. 2021, doi: 10.1186/s40634-021-00346-x.

[17]X. Wang, Z. Li, and H. Wu, “Personalized Recommendation Method of ‘Carbohydrate-Protein’ Supplement Based on Machine Learning and Enumeration Method,” *IEEE Access*, vol. 11, pp. 100573–100586, 2023, doi: 10.1109/access.2023.3314699.

