DOI: 10.7860/JCDR/2026/88435.22894 Abstract No.: 48

Development of AI-Driven Fatigue Detection System Using Wearable EMG Sensors for Safe Resistance Training

PRERNA YADAV[1], SADHAN BERRY[2], GAURAV KADYAN[3]

ABSTRACT

Introduction: Muscle fatigue is a key factor contributing to musculoskeletal injuries during resistance training. Traditional physiotherapy assessments, such as manual muscle testing and observational analysis, are often subjective and fail to capture real-time fatigue. Wearable surface Electromyography (sEMG) sensors provide objective monitoring of muscle activity, and when integrated with Artificial Intelligence (AI) methods such as Support Vector Machines (SVMs) and Convolutional Neural Networks (CNNs), they offer promising potential for real-time fatigue detection.

Aim: To review the current literature on AI-driven fatigue detection systems using wearable EMG technology in resistance training and evaluate their clinical implications for physiotherapy-based injury prevention and rehabilitation.

Materials and Methods: A literature search was conducted in PubMed, IEEE Xplore, Scopus, and Google Scholar for studies published between 2010 and 2025. Studies involving EMG-based AI models for fatigue detection in healthy adults during resistance or strength training were included. Extracted data focused on EMG features such as Median Frequency (MF), Mean Power Frequency (MPF), and root mean square (RMS), along with model performance and sensor accuracy.

Results: Twenty-four studies met the inclusion criteria. AI models, including SVM, Random Forest, and CNN, demonstrated fatigue classification accuracies between 82% and 94%. Reductions in MF and MPF by 10-25% consistently indicated fatigue, while correlations with biomechanical markers ($r>0.70$) supported their validity. Real-time EMG feedback reduced compensatory movements by up to 50% during resistance training. Integration with wearable platforms enabled mobile-based alerts, improving exercise safety and personalisation.

Conclusion: AI-integrated wearable EMG systems provide reliable, real-time fatigue detection in resistance training. They enhance physiotherapy assessment by delivering objective, dynamic insights into neuromuscular performance, thereby supporting safer training and individualised rehabilitation strategies.

Keywords: Fatigue detection, EMG, Artificial Intelligence, Resistance training, Wearable technology

PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, MPT First year (Sports), ISIC Institute of Rehabilitation Sciences, Vasant Kunj, New Delhi, India.
2. Associate Professor, ISIC Institute of Rehabilitation Sciences, Vasant Kunj, New Delhi, India.
3. Associate Professor, ISIC Institute of Rehabilitation Sciences, Vasant Kunj, New Delhi, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Ms. Prerna Yadav,
Postgraduate Student, MPT First year (Sports), ISIC Institute of Rehabilitation Sciences, Vasant Kunj, New Delhi, India.
Email: yadav2002prerna@gmail.com