Exploring the Role of Computing in the Prevention of Falls in Older Adults and the Improvement of Well-Being*

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ABSTRACT

This study seeks to clarify the interplay whether exposure to stressful situations, or lack thereof, can induce neuromuscular changes that may impact postural and motor control in elderly, and to assess whether these changes correlate with an increased risk of falls. While the study is in its early stages and has only involved younger adults so far, the relationship between stress and motor unit recruitment becomes apparent.

CCS CONCEPTS

• Applied computing • Health informatics

KEYWORDS

Fall risk, stress detection, biosignal, wearable sensor.

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1 Introduction

The aging process induces physiological changes in organs and tissues, elevating the susceptibility to frailty and falls among the elderly. According to the WHO, falls are the second leading cause of unintentional injury deaths worldwide [1], having in older women an increased injury severity [2].

2 Work description

Although this study is in an early stage, it aims to determine if exposure to stressful situations, or lack thereof, can induce neuromuscular changes impacting postural and motor control in adults. To achieve this, the system shown in Figure 1 has been designed. Biosignals acquired through wearable sensors, which have demonstrated effectiveness in detecting physiological changes related to stress [3], are treated and prepared to create a dataset for Machine Learning analysis.

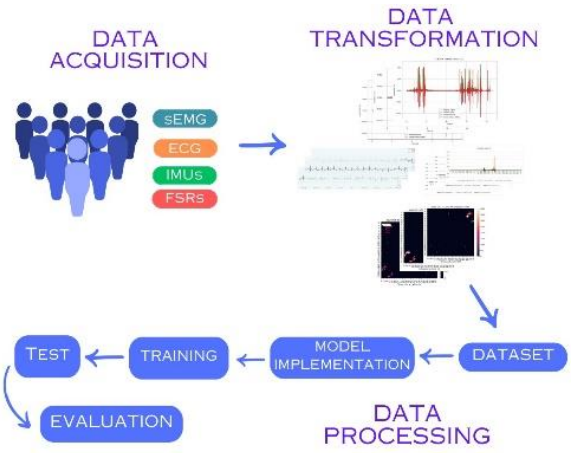

Figure 1: Steps to be carried out in the study.

2.1 Data acquisition

Data acquisition involves nine young adults (mean age 23 ± 5), 5 males and 4 females, without diagnosed pathologies. Non-invasive, highly sensitive, and accurate sensors capture ElectroMyoGraphic (EMG) signals from limb and trunk muscles. Force Pressure Sensors (FPS) measure tread pressure during gait, while ElectroCardioGram (ECG) signals assess Heart Rate Variability (HRV). The effectiveness of using EMG and ECG signals for stress detection is well-documented in the literature [4]. Additionally, Inertial Measurement Unit

(IMU) sensors track movement parameters to assess postural control and balance with and without stressors. Emotional stress is induced using aversive images from the International Affective Picture System (IAPS).

2.2 Data transformation

Bio-signals are captured and processed to create a dataset for evaluating variations in balance, mass displacement, and muscle activation. Rigorous processing ensures data quality. Indices include Mean Absolute Value (MAV), Maximum Peak interval, and others related to the PNS and SNS. Figure 2 and Figure 3 show heatmaps depicting correlations between these indices before and after stressor exposure. HRV indices related to the PNS exhibit low correlation with SNS indices, while HRV indicators linked to sympathetic activation and greater motor unit recruitment, such as MAV and MaxPeak, show higher correlation post-stressor. By observing the images:

In Figure 2, the indices related to the parasympathetic nervous system PNS, such as RMSSD, do not have a high correlation with the SNS indices and other metrics. This suggests a situation of lower sympathetic activation.

In Figure 3, the indices related to sympathetic activation SNS and motor unit recruitment metrics, such as MaxPeakEMG and MAV, show higher correlation among themselves and with other indices. This indicates higher sympathetic activation due to stress induction.

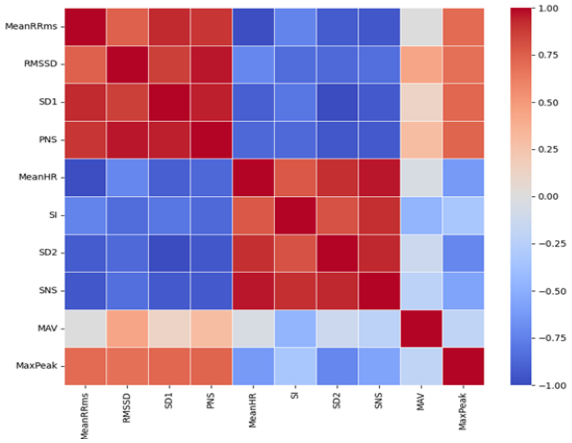

Figure 2: Correlation of HRV and EMG indices before stress induction.

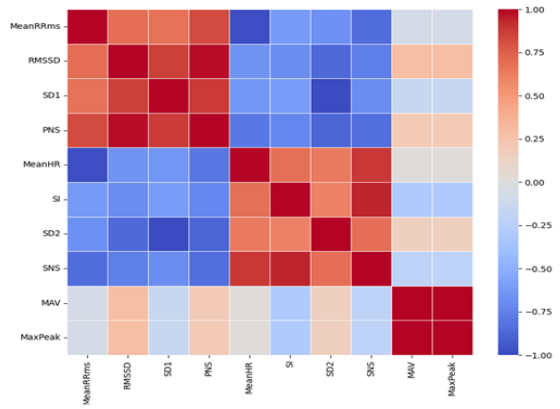

Figure 3: Correlation of HRV and EMG indices after stress induction.

2.3 Data processing

This phase, yet to be undertaken, involves creating a machine learning model that will be applied to the processed bio-signal dataset. This includes dividing the dataset into training and testing sets. The model will be trained to learn patterns and relationships between stress-induced neuromuscular changes and measured outcomes such as balance, mass displacement, and muscle activation.

3 Conclusion

Preliminary data reveal a clear relationship between stress and motor unit recruitment in younger adults, highlighting the impact of emotional stressors on neuromuscular function. These findings have significant implications for balance and fall risk. Further understanding can guide strategies to prevent adverse outcomes in at-risk populations. Including older adults will enrich the study, emphasizing postural control, detecting weaknesses, and enabling effective fall prevention.

ACKNOWLEDGMENTS

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