Early Screening and Evaluation of Sarcopenia Based on Stretchable Strain Sensors Jia-Yu Yang, Yi-Wen Chen, Cheng-Hsin Chuang. *Gerontechnology* 25(s)

Purpose With the global population aging rapidly, sarcopenia is recognized as a critical condition involving the age-related decline of skeletal muscle mass and strength. It is not a normal part of aging and is closely associated with chronic diseases, frailty, falls, and increased mortality (1,2). Despite the availability of precise clinical diagnostic tools, limitations such as high cost, professional requirements, and limited accessibility hinder large-scale early detection (3). This study aims to develop and validate a wearable stretchable capacitive sensing system that can continuously monitor muscle strength in real time. Beyond clinical diagnosis, this study aligns with gerontechnology goals by proposing a proactive, accessible solution to support active aging and prevent frailty in community settings. **Methods** Eighty participants (aged 25-85 years) were recruited. Stretchable capacitive strain sensors were attached to the forearm muscles and knee joints to capture muscle deformation. Participants performed standardized upper (grip) and lower limb (Five-Times-Sit-to-Stand, FTSST) tests. Raw sensor data were normalized to the initial capacitance ($\Delta C/C_0$) before analysis. Reference measurements were obtained via digital dynamometer, DEXA, and BIA. Predictive models were constructed using multiple linear regression and machine learning algorithms (Gradient Boosting, Random Forest, SVR, XGBoost) to estimate grip strength and skeletal muscle mass index (SMI). **Results** The wearable sensor demonstrated a strong correlation with the digital handgrip dynamometer (r = 0.913, R^2 = 0.834). Regarding SMI estimation, machine learning models outperformed linear regression. Specifically, Gradient Boosting achieved the best performance for BIA_SMI (R^2 = 0.937, RMSE = 0.285), while SVR was optimal for DEXA_SMI (R^2 = 0.708, RMSE = 0.608). In sarcopenia risk classification, the Random Forest model achieved an accuracy of 0.90 (AUC = 0.97) under BIA standards. **Discussion** These results confirm the feasibility of using wearable sensors for early screening. By enabling convenient, non-invasive monitoring outside of hospitals, this technology contributes to "aging in place," allowing for early detection of muscle loss. This facilitates timely intervention (e.g., exercise or nutrition), thereby reducing caregiver burden and maintaining the quality of life for older adults. Future work will focus on optimizing sensor integration for long-term home monitoring.

References

1. Chen LK, Woo J, Assantachai P, Auyeung TW, Chou MY, Iijima K, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. Journal of the American Medical Directors Association. 2020 Mar 1;21(3):300-307.e2.
2. Rosenberg IH. Summary comments. The American Journal of Clinical Nutrition. 1989 Nov;50(5):1231–3.
3. Ha YC, Kim S, Yoo JI. Open, Active-Controlled Clinical Study to Evaluate the Correlation between Whole Body DEXA and BIA Muscle Measurements. J Bone Metab. 2024 Aug 31;31(3):219–27.

Keywords: sarcopenia, handgrip strength, muscle mass, stretchable sensor, early screening, machine learning

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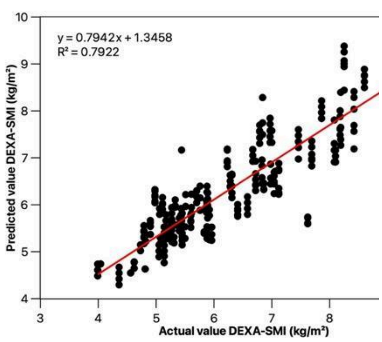

Figure 1. Actual and predicted DEXA_SMI values.

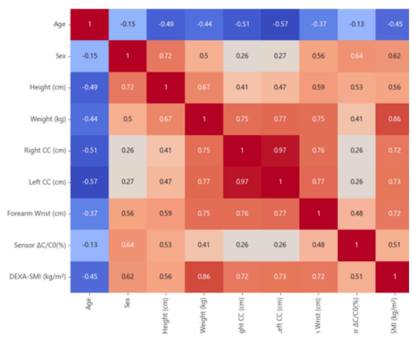

Figure 2. Feature correlation matrix for DEXA_SMI prediction

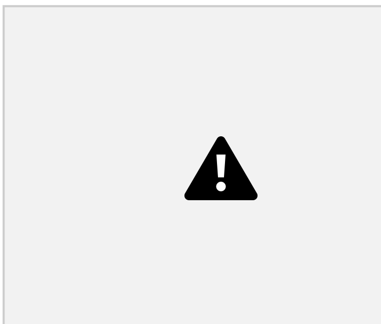

Figure 3. ROC curves of machine learning models based on DEXA_SMI