

Application Fields and Innovative Technologies

Digital Physical Activity Metrics from Wearable Devices and Handgrip Strength in Middle-Aged Adults: A Cross-Sectional Study Using Smartwatch-Based Monitoring

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Purpose Age-related declines in muscle strength begin during midlife and contribute to reduced functional capacity, mobility limitations, and increased risk of disability over time. Handgrip strength (HGS) is widely recognized as a robust indicator of musculoskeletal health and a predictor of morbidity, mortality, and future functional decline. Concurrently, wearable devices such as smartwatches have become increasingly accessible tools capable of objectively capturing daily physical activity patterns, including step count and intensity levels. These technologies offer promising opportunities for early detection of functional decline during the midlife period—a critical stage for preventive interventions. Understanding how digital activity biomarkers relate to muscular strength can inform gerontechnological strategies that promote healthy ageing and support autonomy across the life course. To analyze the association between smartwatch-derived physical activity indicators and handgrip strength in community-dwelling middle-aged adults. A secondary aim was to examine whether sociodemographic variables were associated with activity levels and muscular strength. **Method** This observational, cross-sectional, descriptive-analytical study included 18 middle-aged adults (50–58 years) residing in Recife, Brazil. Sociodemographic, anthropometric, and functional data were collected. Handgrip strength was assessed using a Jamar® hydraulic dynamometer following standardized procedures. Physical activity was continuously monitored for seven days using a Garmin® Forerunner 245 smartwatch. Daily metrics included step count, total active minutes, and minutes spent in moderate-to-vigorous physical activity (MVPA). Functional performance was assessed using the Short Physical Performance Battery (SPPB). Data distribution was analyzed, and correlations were tested using Spearman and Pearson coefficients. **Results and Discussion** Participants were predominantly women (88.9%) with a mean age of 54.3 ± 2.76 years. Mean handgrip strength was 27.3 ± 12.5 kgf, and functional performance was intermediate (SPPB mean = 7.56 ± 1.6). Wearable-derived activity metrics indicated an average of 8,155 steps/day, 197 active minutes/day, and 19.3 ± 14.3 minutes/day of MVPA. A significant positive correlation was identified between HGS and MVPA ($\rho = 0.688$; $p = 0.007$), suggesting that higher-intensity physical activity is more strongly associated with muscular strength than total active time. No significant associations were found between HGS and age, education, income, or body weight. These findings highlight that behavioral rather than sociodemographic factors play a key role in peripheral muscle strength during midlife. The results suggest that engaging in moderate-to-vigorous physical activity may be crucial for maintaining muscle strength during midlife—a period in which early musculoskeletal decline often begins. Wearable devices proved valuable for capturing objective behavioral biomarkers, supporting their use as gerontechnology tools for functional monitoring and early risk identification. The absence of associations between sociodemographic factors and HGS reinforces the importance of lifestyle patterns over structural determinants in this age group. Smartwatch-derived activity metrics, particularly MVPA, were significantly associated with handgrip strength in middle-aged adults. Encouraging higher-intensity physical activity may play a vital role in preventing early functional decline. Wearable technologies represent accessible and scalable tools for monitoring musculoskeletal health, guiding personalized interventions, and promoting healthy ageing.

References

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Table 1. Spearman correlation between handgrip strength and moderate-to-vigorous physical activity (MVPA)

| Correlation Pair | ρ (rho) | p-value |
|---|--------------|---------|
| Handgrip Strength \times MVPA (min/day) | 0.688 | 0.007 |