

Testing the effectiveness of two age simulation gloves

Esma Hidayet Lüleci¹, Angela E. Kedgley¹

¹ Department of Bioengineering, Imperial College London, UK

Email: e.luleci-katirci22@imperial.ac.uk

Summary

This study evaluated simulation gloves designed to mimic age-related hand function decline. Fifteen participants were tested under three conditions using functional and tremor assessments. Results showed increased tremor metrics and decreased hand performance scores, except for power grip. While the gloves replicated tremor characteristics of elderly individuals, they did not fully induce the expected functional impairments.

Introduction

Simulation gloves offer a practical alternative for product testing when direct engagement with elderly or disabled individuals is difficult. Hand function declines significantly after the age of 65 years [1], accompanied by increased physiological tremor amplitude, particularly in the 8-12 Hz range [2]. This study examined the effectiveness of the Cambridge Simulation (CG) and Tremor Simulator (TS) gloves in replicating age-related hand limitations.

Methods

15 participants (7 females, 8 males; aged: 26±3 years) were tested under three randomized conditions: No Glove (NG), CG, and CG+TS. Tremor was quantified with the arm static and outstretched, using a MetaMotionC board (MMCr0.2, MBIENTLAB) placed on the dorsum of the hand. Data recorded at 100 Hz were analysed over time and frequency domains (MATLAB, MathWorks). Hand performance was assessed using the Southampton Hand Assessment Procedure (SHAP) with the Linear Index of Function (LIF) and its sub-parameters: power, spherical, tripod, lateral, extension, tip and weighted scores [3]. LIF sub-scores were derived from 26 grip types and daily activities, categorized into six fundamental grips, standardized on a 100-point scale [3]. Depending on distribution, two-way repeated measures ANOVA (post hoc: Bonferroni) or Friedman tests (post hoc: Bonferroni-corrected Wilcoxon) were conducted. Significance was set at $p < 0.05$ (SPSS, IBM Corp.).

Results and Discussion

There was no effect of gender. LIF power grip scores showed no differences between conditions, while LIF weighted scores remained consistently lower ($p \leq 0.03$). LIF tripod, extension, and tip scores were similar between NG and CG but significantly lower in CG+TS ($p \leq 0.03$, Figure 1). Parameters with changes were compared to normative elderly data [4]. Functional performance, except for power grip, declined but did not reach the full range observed in older adults. Peak amplitude and frequency increased significantly in CG+TS relative to NG, aligning with elderly tremor characteristics

(Table 1) [2]. CG had minimal impact, while CG+TS replicated some tremor aspects, particularly peak frequency, but failed to replicate age-related functional decline fully. This highlights the partial effectiveness of CG+TS in replicating tremors while highlighting its limitations in modelling broader hand function impairments.

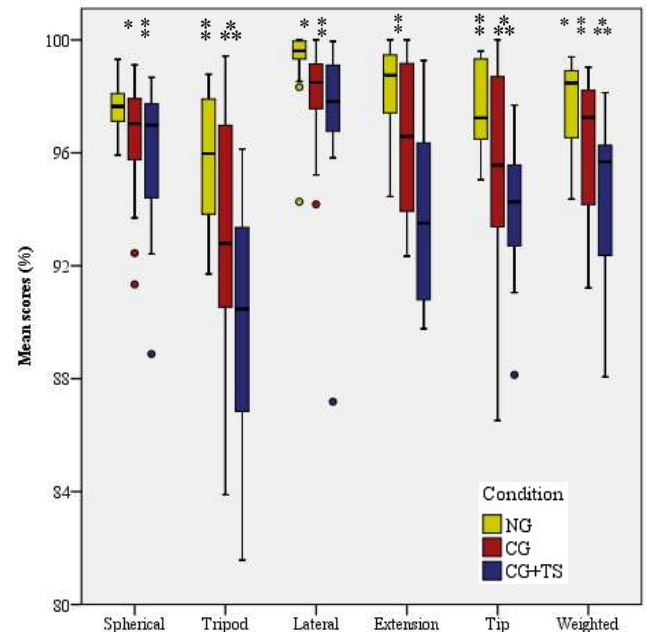


Figure 1: LIF sub-scores * $p < 0.05$ for NG vs. CG. * $p < 0.05$ for NG vs. CG+T. ** $p < 0.05$ for CG vs. CG+TS.

Table 1: Mean tremor (SD) peak frequency and amplitude. * $p < 0.05$ for NG vs. CG+T. ** $p < 0.05$ for CG vs. CG+TS.

	NG	CG	CG+TS	Sig-p
Frequency (Hz)	5.1 (3.6)	4.7 (3.5)	10.8 (5.6)	** **
Amplitude(m/s ²)	0.01 (0.0)	0.02 (0.0)	0.13 (0.1)	** **

Conclusions

Further refinement is needed to improve accuracy in replicating age-related hand impairments.

Acknowledgments

Esma Hidayet Lüleci is supported by the Ministry of National Education, Republic of Türkiye.

References

- [1] Carmeli E et al. (2003). *J. Gerontol*, **2**: 146-152.
- [2] Sturman MM et al. (2005). *J. Neurophysiol*, **93**: 3064-74.
- [3] Burgerhof JGM, et al. (2017). *J. Hand Ther*, **30**: 49-57.
- [4] Metcalf CD et al. (2008). *Hand Ther.*, **13**: 79-83.