Walking in virtual reality : is there a difference in muscular activity and exercise intensity?

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Introduction: Frailty is a complex, multifactorial syndrome leading to loss of function and independence [1]. The benefits of exercise in frailty prevention are well established, however, strategies to enable older adults to undertake sufficient exercise safely are challenging [2]. The use of virtual reality (VR) alongside an exercise, might be a safe and engaging solution [3]. This study investigated whether there was a difference in muscular activity and heart rate intensity when comparing overground to seated VR-walking, in a young (TDY) and elderly typically developed (TDE) population.

Methods: Participants were recruited (EthicsRef: HLS/2023/ PH/155), and asked to walk for six minutes overground and six minutes within an interactive VR environment. Heart rate and lower limb muscle activity were assessed via a torsoworn heart rate strap and wireless surface electromyography (EMG) respectively. A Split-Plot ANOVA, Mixed-Design TwoWay Repeated Measures ANOVA, was used to assess for differences between walking conditions and age groups in mean heart rate differences. The EMG data was compared via statistical parametric mapping, with a paired-samples t-test.

Results: Twenty-two participants were recruited (TDY n=12; TDE n=10). EMG analysis showed a higher degree of variability in muscle activity patterns. The rectus and biceps femoris crossed the critical-t value significantly more in the elderly than in the younger population, for example, $t(20) = 1.354$, $p<.001$. The activity of the anterior tibialis and gastrocnemius crossed the critical-t value during the heel strike and toe-off, with a significant difference of $t(11) = 4.254$, $p<.001$ and $t(11) = 2.976$, $p<.001$. A decrease in heart rate was observed in both age groups, between walking conditions for the VR condition, equivalent to 12 beats per minute. The Split-Plot ANOVA, of the heart rate, resulted in an $F(1)=0.907$, $p=0.001$ for the main effect between overground and VR-walking and an $F(1) = 0.001$, $p = 0.913$ for the interaction effect, between the age categories.

Discussion: Results show that seated walking, with VR, does activate muscles in the lower limbs and increases heart rate to a similar range as overground walking. The difference in variability of muscle activity could be caused by unfamiliarity with VR-based interaction(s). The significant differences, between the upper leg muscles, between populations, could be caused by weaker muscles in elderly people. Decreased heart rate in the VR-based environment was expected, yet less than originally expected. More research exploring strength, endurance and patient engagement is needed to evaluate the use of VR in frail patient populations.

Ethics statement: Authors confirm that all relevant ethical standards for research conduct and dissemination have been met. The submitting author confirms that relevant ethical approval was granted, if applicable.

REFERENCES

1. Xue QL. The frailty syndrome: definition and natural history. *Clinics in Geriatric Medicine*. 2011; 27(1):1–15.

2. Elmagd MA. Benefits, need and importance of daily exercise. *International Journal of Physical Education, Sports and Health*. 2016; 3(5):22–27.

3. MotusVR. Available from: https://motusvr.com/. [Accessed 11 March 2024].