Test-retest reliability of two different laser-based protocols to assess handgun shooting accuracy in military personnel

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Tactical operations and armed conflicts involve symmetrical and asymmetrical conflicts, often occurring in urban and constantly changing environments. This requires tactical personnel to be prepared for unpredictable threats in dynamic scenarios. In close-quarter situations, short weapons such as handguns are becoming increasingly prevalent over assault rifles, as they are more manageable for manoeuvring and battling. Therefore, accurate handgun shooting is essential for tactical personnel who may encounter close-quarter situations requiring precise shooting. Although regular handgun training is necessary to improve static and dynamic shooting accuracy, implementing basic shooting training is challenging as it includes budget constraints, ammunition costs and limited access to live-fire ranges, necessitating the development and use of new technologies to meet current shooting training standards.

Laser-based shooting simulators have emerged as an alternative to traditional live-fire shooting, offering several benefits such as reduced ammunition and target costs, safety, decreased waste and more frequent and time-efficient training exercises (e.g., no need to replace targets, assemble and clean guns, transports to shooting ranges). Previous researchers have used laser-based systems to evaluate shooting performance under different conditions, such as supplementation, sleep deprivation and psychological or physiological fatigue. However, most studies lacked information on reliability and shooter familiarisation with the protocol. Consequently, the results of those investigations should be interpreted cautiously as the shooting protocols themselves may not have been reliable, possibly affecting the observed effects. Therefore, this study aimed to assess the reliability of two standard-issued shooting protocols using a laser-based handgun system.

Twenty soldiers (22.0±1.9 years) participated in two static and dynamic shooting protocols trials on three separate days to determine the between-day and same-day test-retest shooting accuracy reliability (figure 1). The accuracy (total points scored) for each trial was recorded and analysed for (1) the reliability of each shooting protocol with two-way mixed effects intraclass correlation (ICC) with a coefficient of variation (CV) and the SE of measurement (SEM) and (2) differences in shooting accuracy points scored between days and trials by two-way repeated measures analysis of variance. Associated literature review, ethical approval, methods, analyses and supplements are available at the Open Science Framework (https://osf.io/3n5w2).

The results indicated good between-day test-retest reliability of the average of two trials of both the static (ICC=0.837 (95% CI 0.659 to 0.930), CV=3.78%, SEM=3.37) and dynamic (ICC=0.806 (95% CI 0.597 to 0.917), CV=4.73%, SEM=3.73) protocols. Additionally, there was moderate between-day test-retest reliability of a single trial for static (ICC=0.703 (95% CI 0.383 to 0.872), CV=3.47%, SEM=3.11) and dynamic (ICC=0.585 (95% CI 0.219 to 0.810), CV=4.17%, SEM=3.30) protocols, and moderate same-day test-retest reliability for static (ICC=0.510 (95% CI 0.248 to 0.741), CV=2.57%, SEM=2.31) and dynamic (ICC=0.510 (95% CI 0.243 to 0.791), CV=2.57%, SEM=2.31) protocols.
Our study demonstrates that soldiers’ shooting performance, based on accuracy in static and dynamic protocols, has moderate to good reliability and no statistically significant effect on the difference in shooting accuracy between days and trials. Therefore, the protocols used in this study and the reliability observed may serve as a foundation for future research to establish a more rigorous approach using validated shooting protocols. By following these guidelines, researchers may contribute to the advancement of shooting-related research, ultimately leading to more accurate shooting assessments and training.

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REFERENCES