Validity and whole system reliability of a commercially available linear positional transducer across common resistance training exercises

H. F. Dorrell, J. M. Moore, M. F. Smith, and T. I. Gee
School of Sport and Exercise Science, University of Lincoln, Lincoln, UK

PURPOSE: To assess the validity and whole system reliability of the GymAware power tool across a range of traditional strength training exercises.

METHODS: Thirteen resistance trained individuals (mean ± SD, age: 26.5 ± 4.8 years, stature: 174.1 ± 9.5 cm, body mass: 81.9 ± 12.1 kg) were recruited. Subjects completed three repeated visits, each consisting of three repetitions of free-weight back squat, bench press, and deadlift (all at 80% one repetition maximum). Lift displacement data were collected using a linear positional transducer (GymAware; Kinetic Performance Technology, Canberra, Australia) and a five-camera 3D motion capture system (Motion Analysis Corporation, Santa Rosa, CA; 150 Hz). Simultaneous force data were collected (Kistler, Switzerland; 1500 Hz) for all lifts excluding bench press. Lift displacement, peak and mean velocity and force were calculated via the GymAware software and custom written MATLAB code (Mathworks, Natick, MA). Least products regression was calculated between measuring devices for quantification of validity across variables and expressed as an R^2 value. A one-way repeated measures ANOVA, typical error (TE %) and smallest worthwhile change (SWC) were used to assess the between visit data across all variables.

RESULTS: For back squat, comparisons between measuring devices across all variables resulted in an $R^2 \geq 0.99$. Similarly, deadlift comparisons across all variables between measuring devices resulted in an $R^2 \geq 0.92$, excluding mean velocity ($R^2 \geq 0.69$). Correlations between measuring devices across all variables for bench press resulted in $R^2 \geq 0.85$. No significant differences were reported for any variables for the back squat. In contrast, significant differences were observed for bench press visits 2-1 and 3-2 (mean ± SD: visit 1: 0.382 ± 0.063 m; visit 2: 0.383 ± 0.053 m; visit 3: 0.395 ± 0.055 m), with no significant differences recorded between other variables. Significant differences were observed between visits 3-2 for deadlift displacement

(mean ± SD: visit 2: 0.568 ± 0.034 m; visit 3: 0.557 ± 0.034 m), with no significant differences found between other variables. Mean TE % ranged from low to moderate between back squat (0.6-8.1%), bench press (3.0-7.4%), and deadlift (1.6-8.8%) visits, with SWC ranging from 1.7-7.4%.

CONCLUSION: The GymAware provides valid measures of displacement and subsequent derivatives across a range of strength training exercises in resistance trained individuals. Furthermore, low to moderate TE following repeated trials signify high levels of test re-test consistency. The results do suggest care should be taken when monitoring deadlift performance, however further research is required to determine the source of observed error before drawing full conclusions.

PRACTICAL APPLICATION: The data presented provides sufficient evidence that the GymAware can be used to measure kinetic and kinematic outputs both accurately and reliably in a resistance trained population. These findings have several applied applications, including providing real-time feedback to athletes, informing decisions regarding programme progression, determining readiness to train, and longitudinal monitoring of athletic performance. In addition, the confirmation of the GymAware to provide valid and reliable measures of movement performance allows practitioners to utilise this tool within innovative testing and training methods which would otherwise require resource- and labour-intensive protocols.