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**INTRODUCTION**

Wearable technology systems (WTS), such as the Xsens MVN system have emerged, allowing an unrestricted, three-dimensional analysis of performance, in both laboratory and field environments [1]. These systems overcome limitations within traditional biomechanical analysis techniques, allowing for ‘real-world’ testing scenarios, such as measuring rugby or soccer kicking in front of goal, to improve the ecological validity of biomechanical findings.

WTS have been shown to have acceptable levels of concurrent validity when measuring kick-leg kinematics for punt kicking (CV%=<4.0%; r=>0.91) in Australian football, when compared to a motion analysis (MA) system [2]. However, the kick-leg motion for punt-kicking is too dissimilar to running mechanics, requiring separate validation for other kick types that involve greater segmental rotations, such as soccer and rugby place-kicking.

The aim of this study was to examine the concurrent validity of kinematics measured by a WTS against a MA system during place-kicking in the rugby codes and soccer.

**METHODS**

Following ethical approval, 20 players (Age:21±3yrs; Height:182±6cm; Mass:82±6kg) performed 3 types of rugby (5x20m, 5x40m, 5xMax) or soccer (5x12m, 5x20m, 5xMax) place kicks towards a target, using their preferred foot.

The WTS utilized in this research was the Xsens MVN link system (Xsens, Enschede Netherlands), which is composed of 17 inertial measurement sensors built into a compression suit. Each sensor integrates a tri-axial accelerometer (±160m.s<sup>2</sup>), gyroscope (±2000deg.s) and magnetometer (±1.9Gauss). Data fusion was made using the Xsens Kalman filter (XKF), to estimate sensor orientations and calculate full-body kinematics.

Three-dimensional kinematic measurements were captured at 240Hz, with concurrent acquisition of the WTS and a 12-camera MA system (T40-series, Vicon, Oxford, UK). Forty reflective markers were attached to the lower extremities [3]

on the outside of the Xsens suit. Data analysis for both systems was conducted in Visual 3D software (C-motion, Inc. Germantown, USA), with all kicks analysed from kick foot toe-off until the instant before ball contact [2,3].

Concurrent validity was assessed using mean and standard deviations (SD), mean bias, Cohen’s thresholds (ES) Pearson’s correlations (r), typical error of the estimate (CV%) and 90% confidence limits (CL).

**RESULTS AND DISCUSSION**

Trivial differences between means, good correlations (r= ≥0.89) and low measurement errors (CV%= ≤9.8%) were reported for all parameters between the WTS and MA system (Table 1). Results were found to be similar between the rugby and soccer place kicks for each parameters.

The low magnitude of measurement error present in the WTS would still allow for true differences between different kicking tasks [4] or populations [5] to be detected. Therefore, the WTS demonstrated acceptable levels of concurrent validity (CV%= ≤9.8%; r= ≥0.89) for all parameters, which is consistent with our previous validation of WTS to measure punt-kicking in Australian Football [2].

**CONCLUSIONS**

Our findings demonstrated acceptable levels of concurrent validity between the WTS and MA system, advocating the use of WTS to measure place kicking kinematics in the rugby codes and soccer.

**REFERENCES**

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**Table 1:** Concurrent validity of kinematic parameters measured by the WTS compared with a MA system (n=150 per code).

		MA mean±SD	WTS mean±SD	Mean bias(CL)	ES	r	CV%(CL)
Footspeed at BC (m.s <sup>-1</sup> )	R	17.8 ± 1.7	17.6 ± 1.8	-0.2 (0.1)	-0.12*	0.89	4.6 (0.5)
	S	16.3 ± 1.9	16.2 ± 1.9	-0.1 (0.1)	-0.05*	0.92	4.8 (0.4)
Minimum knee angle (deg)	R	105 ± 10	105 ± 10	-0.5 (0.4)	-0.05*	0.96	2.7 (0.2)
	S	104 ± 12	105 ± 11	0.6 (0.4)	0.05*	0.96	3.3 (0.3)
Shank angular velocity at BC (deg.s)	R	1585 ± 232	1587 ± 225	3.0 (5.0)	0.01*	0.99	2.4 (0.2)
	S	1503 ± 206	1511 ± 199	7.9 (5.5)	0.04*	0.98	2.7 (3.0)
Thigh angular velocity at BC (deg.s)	R	194 ± 80	190 ± 79	-4.8 (2.1)	-0.06*	0.98	9.6 (0.9)
	S	116 ± 31	115 ± 32	-1.2 (1.4)	-0.04*	0.95	9.8 (0.9)

BC= Ball contact; R= Rugby codes; S= Soccer; \*Trivial effect