THE ECOLOGICAL VALIDITY OF INJURY PREVENTION SCREENING MEASURES USED TO IDENTIFY PELVIC INSTABILITY IN ELITE MALE SPRINTERS

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The purpose of this study was to ascertain the ecological validity of clinical measures of pelvic stability currently used in injury prevention programs with elite sprinters. Fifteen elite male sprinters of National level participated in this study. Each participant completed 3 trials for two clinical measures of pelvic stability, the standing hip flexion and dip tests, followed by 3 maximal sprints. A significant moderate correlation coefficient ($r = .46$, $p < .05$) was found between the pelvic list data for the hip flexion test and the pelvic list data for sprinting. Weak non-significant correlation coefficients ($r < .23$), however, were found for the remaining data. These findings suggest the current clinical measures of pelvic stability may not be ecologically valid.

KEY WORDS: pelvic list, pelvic tilt, pelvic stability, ecological validity.

INTRODUCTION: High rates of back, hip and thigh injuries have been reported in the elite athletic sprinting population (Bennell & Crossley, 1996). Past research suggests these injuries are caused by excessive pelvic motion (tilt and list) or pelvic instability (Rankin, 1999; Schache, Bennell, Blanch & Wrigley, 1999; Ashman, Buz Swanik & Lephart, 1996; Bennell, Tully & Harvey, 1998). As a consequence, the Australian Sports Commission's Olympic Athlete Program introduced a series of clinical screening measures for pelvic stability in an attempt to lessen injury rate. These measures were selected on the basis of past use and upon the recommendation of the Australian Sports Medicine Community (Harvey, Mansfield & Grant, 1998). To date, the ecological validity of these measures has not been scientifically tested. The purpose of this investigation, therefore, was to ascertain the ecological validity of these clinical measures by direct comparison with pelvic motion data recorded in the field.

METHODS: Fifteen elite male sprinters (= 25 yrs, = 77 kg) of Australian National level participated in this study. Participants were selected on the basis of having achieved the qualifying standards for the Australian National Championships over 100 m, 200 m or 400 m (Athletics Victoria, 1999). Markers (2 cm diameter foam spheres) were placed on the following anatomical landmarks (refer to figure 1): (1) anterior superior iliac spines (ASIS); and, (2) the mid-point between the posterior superior iliac spines (mid-PSIS). These markers were used to calculate pelvic list and pelvic tilt.

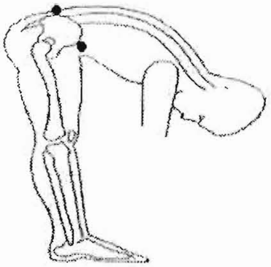

Figure 1: Marker placement protocol.

Following each participant's normal warm-up routine, two clinical tests of (1) standing hip flexion and (2) dip were completed in random order. The hip flexion test involves the participant standing, hands on hips, feet directly under hips, with even weight distribution. The participant flexes the hip and knee to 90 (same side) and then slowly returns to the starting position. In the dip test, the participant stands on a limb with the other foot resting on a chair or low plinth behind them. The participant flexes the knee of the front limb and keeps it over the limb's

second toe until hip or pelvis control is lost. Participants completed three movements for each side of the body for both clinical tests. Upon completion of the clinical tests, 3 maximal sprints were performed over a 50 m distance with the final 10 m section filmed for analysis. Maximal sprinting involved a horizontal velocity of no less than 9 m.s-1. It was performed on a synthetic (tartan) athletic track commonly used by elite athletes for training and competition.
Pelvic motion was filmed by a multiple camera set-up (refer to figure 2) involving 4 Panasonic CCTV cameras (frame rate: 50 Hz; shutter rate: 1/10,000 sec). Three of the cameras recorded pelvic tilt (left side of the body) in the sagittal plane (cameras positioned 3.25 m apart) and the remaining camera recorded pelvic list in the frontal or coronal plane. Video film of each test (clinical and sprint) was analysed with the aid of a 2D Motus Motion Measurement System (Peak Technologies Inc.). In the sprinting task, video footage of a complete stride of the left limb was captured. This stride was also captured by the camera placed on the track (C1). All angular data was smoothed by a 4th order Butterworth filter with a cut-off frequency between 6 and 8 Hz.

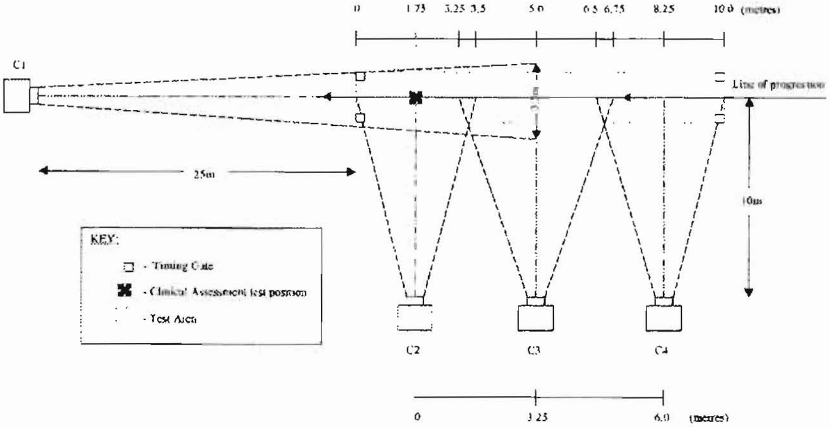

Figure 2: Pictorial representation of the camera configuration used to film the clinical and sprint tasks.

Body-based angular conventions were adopted for the measures of pelvic tilt and list (refer to figure 3). Pelvic tilt was measured from a line (relative to the horizontal) joining the ASIS and mid-PSIS markers. Pelvic list was measured from a line (relative to the horizontal) joining the right and left ASIS markers.

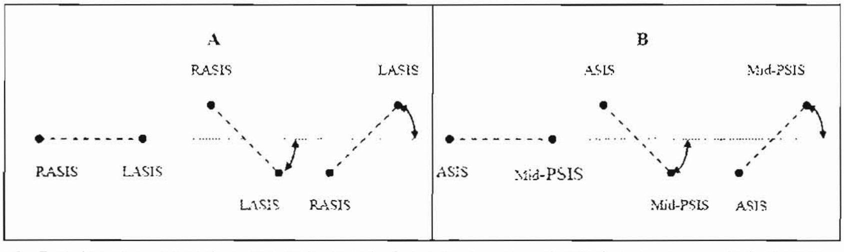

Figure 3: A. Pelvic list convention (frontal plane). A neutral or 0 orientation is shown followed by examples of negative and positive orientations (from left to right). B. Pelvic tilt convention (sagittal plane). A neutral or 0 orientation is shown followed by examples of negative and positive orientations (from left to right).

Intra-class correlation coefficients (ICCs), standard error of measurement (SEM) and 95% confidence interval values were calculated for the pelvic list and tilt data extracted from the standing hip flexion and dip tests, and for the pelvic list and tilt data extracted from the sprint task. These measures were use to ascertain the reliability or response stability of these measures. Minimum and maximum values of pelvic list and tilt were extracted from each task performed. The pelvic list and tilt range of motion (ROM) data for both the hip flexion and dip tests were correlated (Pearson product-moment) with the equivalent ROM data for sprinting.

RESULTS AND DISCUSSION: ICC values ranging from 0.83 to 0.98 were obtained for the measures of pelvic list and tilt across all three tasks. SEMs values ranged from 0.6 to 1.3 with 95% CIs ranging from 1.2 to 2.7 . Overall, these results show good reliability for each measure extracted.

Table 1 ICC, SEM and 95% confidence intervals for pelvic tilt and list for each task.

	Task	ICC	SEM (°)	95% CI (°)
Pelvic List	Standing Hip Flexion	0.98	0.8	± 1.8
	Dip	0.98	0.6	± 1.2
	Sprint	0.90	1.3	± 2.7
Pelvic Tilt	Standing Hip Flexion	0.90	0.8	± 1.7
	Dip	0.93	1.0	± 2.2
	Sprint	0.83	1.0	± 2.2

A significant moderate correlation (r = .46, p < .05) was found between the pelvic list ROM for the hip flexion test and the pelvic list ROM for sprinting (refer to table 2). Weak non-significant correlation coefficients (r < .23), however, were found for the remaining data. Descriptive statistics for the ROM data are listed in table 3.

Table 2 Correlation matrix for pelvic list and tilt measures.

		Sprint	
		Pelvic List	Pelvic Tilt
Hip Flexion Test	Pelvic List	.46	NA
	Sig. (one-tailed)	.043	
	Pelvic Tilt	NA	-.22
	Sig. (one-tailed)		.22
Dip Test	Pelvic List	.03	NA
	Sig. (one-tailed)	.46	
	Pelvic Tilt	NA	.21
	Sig. (one-tailed)		.22

Table 3 Descriptive statistics for the ROM (degrees) of pelvic tilt and list for each task.

	Standing Hip Flexion		**Dip test**		**Sprint**	
	Pelvic List ROM	**Pelvic Tilt ROM**	**Pelvic List ROM**	**Pelvic Tilt ROM**	**Pelvic List ROM**	**Pelvic Tilt ROM**
Mean	24.2°	9.1°	22.7°	7.0°	13.7°	13.1°
SD	4.2°	3.7°	5.5°	2.7°	4.1°	2.5°
Min	18.5°	3.9°	14.2°	2.7°	9.8°	8.5°
Max	36°	17.9°	33.9°	11.4°	24.7°	17.8°

The correlation value of .46 between the list data for the hip flexion test and sprint task suggests that a participant who exhibits a large pelvic list ROM in the standing hip flexion test will generally display a large pelvic list ROM when sprinting. The significant finding (p < .05) indicates that other samples of participants would yield the same correlation coefficient.

The results suggest, with the exception of the pelvic list measure found in the standing hip flexion test, that the range of pelvic motion exhibited during the clinical tests is not related to the pelvic motion exhibited in a sprint. Essentially, the hip flexion test provides more relevant information about a sprinter's pelvic motion. The reason for this finding most likely lies in the functional nature of the test; that is, the hip flexion action in this test is similar to the hip flexion action observed in the swing phase of a sprint (Harvey et al., 1998). Although the dip test is proposed to assess muscular control of the pelvis during sprinting, the action of supporting the body during knee flexion in the manner performed in the dip test is not reflective of any leg action in a sprint. The functional nature of the hip flexion test, therefore, may render it a more appropriate test of pelvic stability for elite sprinters.

CONCLUSION: The findings of this study suggest the clinical measures of pelvic stability may not be ecologically valid. More research, therefore, should be conducted in order to ascertain the value of these measures in injury prevention programs. The present study provides a foundation for future research to begin to evaluate and establish useful, ecologically valid clinical measures of pelvic instability, and to obtain quantitative measures of pelvic motion in an appropriate contextual environment.

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