Manuscript title: Reliability of the 30-seconds crossbar jumps water polo test in female

players

Running head: Reliability of the 30-s crossbar jumps water polo test

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ABSTRACT

Monitoring performance of sport-specific skills is important for elite athletes. The 30 second cross bar jump test is a commonly used assessment tool in water polo, assessing players' ability to repeatedly elevate their body out of the water. The study aimed to examine the reliability of this test. Thirteen elite female water polo players performed the test on two separate occasions. Correlation ($r = 0.61$), coefficient of variation (CV = 11.6%) and limits of agreement (95% limits of agreement = $\pm$ 3.3 jumps) found between the two occasions indicated that the test was not sensitive enough for monitoring performance changes in elite female water polo players. Additionally, no correlation of anthropometric characteristics was found with crossbar jumps. It is suggested the 30 seconds crossbar jumps test is not a reliable test and should not be used by water polo coaches for evaluating the ability of players to repeatedly jump out of the water.

Keywords: aquatics, performance monitoring, sport-specific test, test-retest design

INTRODUCTION

Water polo is a game with several unique features imposed by the aquatic environment and the intermittent nature of the sport posing high physiological demands upon the athlete (Smith, 1998). A number of valid and reliable tests have been developed to monitor the aerobic and match fitness of water polo players. Rechichi et al (2000) developed a multistage swimming shuttle test, which assessed the aerobic fitness of players by repeated 10m shuttles with swim speed increasing every 1 minute. Mujika et al (2006) developed a more match-specific test, assessing match fitness through repeated 7.5m shuttles interspersed with 10 seconds of active recovery, with the velocity increasing after a variable number of shuttles.

Additionally, the ability to perform a single explosive jump and the capacity for repeated explosive jumps in the water are very important in water polo performance (Platanou, 2005; Tumilty et al, 2000). Water polo players frequently perform actions such as shooting, passing, blocking and scrimmaging (Platanou, 2004; Platanou and Geladas, 2006). These actions require excellent technical execution of the 'eggbeater kick' to generate downward forces in the water (Platanou, 2005; Tumilty et al, 2000). The eggbeater is a cyclical action of the legs with the two legs performing similar but alternative actions. Execution of this skill is vital in the game of water polo, as water polo players lack the advantage of fixed resistance to push against; their feet can not reach the bottom of the pool. The ability of the players to execute these skills is commonly assessed by 'in-water' tests, such as the vertical jump (single explosive jump aiming for height) or water polo crossbar jumps.

Platanou (2006) examined the 'in-water' vertical jump test and found it to be a reliable method of assessing the ability of water polo players to move their bodies vertically out of

the water. The crossbar jumps test is an anaerobic power test and has been used to assess the ability of players to repeatedly elevate their bodies out of the water. It involves repeated explosive jumps, aiming to touch (with both arms) a regulation water polo goal crossbar (0.90m height above water surface), as many times as possible in 30 seconds. Notwithstanding the specificity of this test, even when compared against more established tests of anaerobic power (Bampouras and Marrin, 2009), no scientific evidence exists for its reliability.

This lack of information together with the possibility that the test could be affected by the anthropometric characteristics of players, raise concerns about its use as a monitoring tool. Therefore, the aim of the current study was to examine the reliability of this commonly used water polo test in female players. It was hypothesised that the test would not be sensitive enough to detect performance changes.

MATERIALS AND METHODS

Subjects

Thirteen female water polo players (mean ± SD: age 22.0 ± 4.4 years, height 168.7 ± 7.9 cm, body mass 65.9 ± 6.1 kg, maximum oxygen uptake 51.4 ± 4.5 ml·kg^{-1}·min^{-1}) who were all members of a National team for over two years at the time of the study, provided written informed consent. The study took place in the preparation training phase. The study was approved by the Institutional Ethics Committee.

The current sample size falls below the recommended population size ($\geq$ 40 subjects) for reliability studies (Altman, 1991). However, such a sample size would be unrealistic for the present study investigating a sport-specific test and, hence, requiring subjects to be

proficient in its execution. In situations like this, it has been strongly suggested to assess the impact of statistical precision on the sample estimates of error (Bland and Altman, 1999). Therefore, 95% confidence interval (CI) was calculated to indicate the likely range of the true value.

Measurements

Height (Ht) was measured to the nearest 0.1 cm using a stadiometer (Holtain, Crymch, UK), while body mass (BM) was measured to the nearest 0.1 kg using a calibrated balance beam scale (Seca, Birmingham, UK). Sum of four skinfolds (SUM4SF) was calculated from measurements at the biceps, triceps, subscapular and suprailiac sites using skinfold callipers (Harpenden, Burgess Hill, UK), and measurements were taken to the nearest 1 mm. For all anthropometric measurements, standard International Society for the Advancement of Kinanthropometry (ISAK) procedures were followed (Marfell-Jones et al, 2006).

The subjects performed a crossbar jumps test (CJ) on two separate occasions (CJ1 and CJ2). The subjects started from the fundamental floating position with their heads and shoulders just above the water, and had to repeatedly jump out of the water and touch the vertical bar of the water polo goal with both hands, as many times as possible in 30 seconds.

In order to jump, the subjects used their arms, vigorously treading water (sculling) to position the body in an upright position. At the same time, they used a high-intensity eggbeater kick to lift the body out of the water. The jumping movement was completed with a simultaneous powerful downwards kick, which lifted the body out of the water (Platanou, 2005). The subjects touch the vertical bar of the water polo goal with both hands

at the highest point of the jump. Eggbeater was used again after the jump to decelerate the body's return to the water; the cycle is then repeated.

The team's coach supervised all testing to ensure appropriate technique was adhered to throughout the 30 second period. All tests took place with a minimum of 24 hours intervening and at the same time of the day in order to avoid circadian rhythm effects (Atkinson and Reilly, 1996).

Statistical analysis

Homoscedasticity of data was examined and subsequently confirmed. Systematic bias between CJ1 and CJ2 was assessed by paired Student's t-test. Pearson's correlation coefficient (*r*), adjusted for individual repeated measures (Bland and Altman, 1995), and intraclass correlation coefficient (ICC) were calculated to examine for relation of CJ1 and CJ2. A two-way mixed model for absolute agreement was used for ICC calculation. Absolute agreement was examined with standard error of the mean (SEM) (calculated as SD x $\sqrt{(1-ICC)}$, coefficient of variation (CV) (calculated as (sample SD) / (sample mean) x 100) and 95% limits of agreement (LoA) (Bland and Altman, 1986). 95% CI were calculated for the above measures (Atkinson and Nevill, 1998). It was deemed that test-retest measurement error of CJ would be acceptable on the basis of excellent correlation (*r* > 0.90), a low CV (CV < 10%) and a SEM < 2 jumps.

Finally, Pearson's correlation was also used to examine for relationships between CJ and anthropometric variables (Ht, BM, SUM4SF). 95% CI were also calculated for the above measures. Statistical significance was set at $p < 0.05$.

RESULTS

Descriptive statistics of all variables are reported in Table 1.

TABLE 1 HERE

A significant bias of 2 jumps was found between CJ1 and CJ2, with CJ2 scores being consistently higher. Pearson's correlation coefficient showed a lower than stipulated correlation between the two trials, a finding supported by the ICC value. SEM value was 1.7 jumps and CV showed a lower relationship than stipulated between CJ1 and CJ2. Finally, 95% LoA indicated that CJ scores between future repeated CJ trials will differ by ± 3.31. Values of the above results and associated 95% CI can be found in Table 2.

TABLE 2 HERE

Finally, no statistically significant correlations were found between CJ1 and CJ2 and the anthropometric variables examined (Table 3).

TABLE 3 HERE

DISCUSSION AND PRACTICAL APPLICATIONS

The aim of the current study was to examine the reliability of a water polo sport-specific test. The findings indicate that the 30 seconds water polo crossbar jump test is not acceptably reliable to monitor performance changes in elite athletes.

 The analytical goals were not fully met as the correlation was lower than stipulated while the coefficient of variation was higher than practically meaningful. The systematic bias of 2 jumps was deemed very close to the value expected for any improvement in the test. Furthermore, very small variation would be expected between the two testing points because of the level of the athletes. Finally, LoA produced a range of -1.3 – 5.3 jumps,

which is a wide range for subsequent test scores. Perhaps more indicatively, the 95% CI for the above statistic value also showed a wide range in which the value could fall in if the experiment was repeated. Based on these findings, it is suggested that this test is not sensitive enough to monitor the small changes induced by training of elite athletes. Caution needs to be exercised in the use of non-validated tests as they potentially provide the coach with unreliable information, as demonstrated by this study.

It was considered possible that anthropometric characteristics may affect the results, as taller or lighter individuals could reach the crossbar easier and as a result, score higher. Therefore anthropometric characteristics were examined for relationships to the CJ. No statistically significant relationship was found for either CJ1 or CJ2 and anthropometric characteristics. The results are attributed to correct execution form and commitment of the participants. All players followed the instructions closely by starting from the fundamental floating position and only touching the crossbar at the highest point of each jump. As a result, the potential variability due to anthropometric differences was minimised.

The ability to jump out of the water to shoot, pass or block is very important for water polo players (Platanou, 2005). Due to its frequency and significance (Platanou, 2004; Platanou and Geladas, 2006), it is important for coaches to be able to develop and monitor their player's capability to repeatedly raise their body out of the water. This is essential for all players, but perhaps particularly so for the centre forwards and centre defenders, as they have been shown to be the two positional roles that involve this type of activity more frequently (Platanou, 2004). Therefore, although the crossbar jump test can not be used as a performance monitoring tool, it can still be used as a training aid. Alternatively, water polo coaches could consider a 25m eggbeater sprint test. Although this test does not assess

the players' ability to repeatedly elevate their bodies out of the water, it provides the coach with an indication of the players' ability to perform high-intensity eggbeater (Tumilty et al, 2000).

Currently, this is the third study to have investigated a water-polo specific skills test. Platanou (2006) used seventeen experienced water polo players to examine the in-water vertical jump and found it to be a reliable test of the player's ability to jump out of the water. Bampouras and Marrin (2009) compared the 30 seconds crossbar jumps test and a 14 x 25m shuttle sprints test to the Wingate anaerobic test, reporting discrepancies in the results provided between the sport-specific and the Wingate test. Other water-polo related tests include a multistage swimming shuttle test (Rechichi et al, 2000), a match-specific test assessing match fitness (Mujika et al, 2006) or a battery of tests (Rodríguez, 1994). However, these tests do not include any skill evaluation or specific skill assessment, as they are predominatly swimming-based. Therefore, a battery of tests with both swimming- and skill-based tests should be developed to assist in more accurate monitor and evaluation of players.

The sample size used in the current study (N = 13) is smaller than suggested for studies of reliability (Altman, 1991) and caution should be exercised in the interpretation of the results. However, the sample was selected due to their playing level in order to minimise any potential learning effect when performing the required task. Therefore, the results are applicable to elite or well-trained female water polo players, and should not be generalized.

CONCLUSION

In order for a training process to be successful, it is vital for coaches to be able to accurately monitor their players' performance. The multi-dimensional nature of water polo, indicates that a number of tests should be used to provide the coaches with an overall player evaluation that will allow them to make judgments on a player's overall physiological status. Therefore, it is imperative for these tests to reliable to ensure that the coach does not obtain erroneous information.

The current study examined the reliability of the 30-seconds crossbar jumps water polo test. It was hypothesised that the test would not be sensitive enough to detect performance changes. The hypothesis has been supported indicating that water polo coaches should identify other assessment tools for repeated, explosive ability of players' to jump out of the water.

ACKNOWLEDGEMENTS

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Table 1. 30-seconds crossbar jumps (CJ1 and CJ2, for trial 1 and 2, respectively) and anthropometric characteristics results. Data is presented as mean ± SD.

Jumps		Anthropometric characteristics	
CJ1 (jumps)	21.4 ± 2.6	Ht (cm)	168.7 ± 7.9
CJ2 (jumps)	23.3 ± 2.6	BM (kg)	65.9 ± 6.1
		SUM4SF (mm)	37.4 ± 10.6

Table 2. Statistical analysis results for 30-seconds crossbar jumps trials (CJ1 and CJ2).

	Bias (jumps)	r	ICC	SEM (jumps)	CV (%)	LoA (jumps)
	2.0	0.61*	0.61*	1.7	11.6	3.3
sig.	0.12	0.022	0.048			
95% CI	0.6 - 3.4	0.26 – 0.93	0.10 - 0.91	1.1 – 3.5	7.7 – 23.6	0.6 – 3.4

Table reports bias, Pearson's correlation coefficient adjusted for individual repeated measures (r), intraclass correlation coeeficient (ICC), standard error of measurement (SEM), coefficient of variation (CV) and 95% limits of agreement (LoA). The sig. row indicates the p value (where appropriate) and the 95% CI row indicates the associated 95% confidence interval. * indicates significance ($p < 0.05$).

Table 3. Statistical analysis results for relationships between anthropometric characteristics and 30-seconds crossbar jumps trials CJ1 and CJ2).

		Anthropometric characteristics		
		Ht	BM	SUM4SF
CJ1	r	0.08	-0.11	-0.18
	p	.788	.731	.558
	95% CI	-0.72 – 0.79	-0.80 – 0.70	-0.82 – 0.66
CJ2	r	0.54	0.44	-0.19
	p	.165	.271	.654
	95% CI	-0.36 – 0.92	-0.47 – 0.90	-0.83 – 0.66

Table reports Pearson's correlation coefficient (r), significance values (p) and 95% confidence interval (95% CI). Significance was set at $p < 0.05$.