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Correlation of balance, core endurance and power performance in male cricketers of different maturity status

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Abstract
Cricketers have specific roles which include batting, wicket keeping, fielding and bowling. For better performance, knowledge of capacities and their relationship with maturational status is of utmost importance so that we can develop strategies at the adolescent age and impart proper training to them. 71 cricketers were included. Static balance was measured by Standing Stork balance test and dynamic balance by modified SEBT. For core muscle endurance, Sport specific endurance plank test was done, while power was evaluated with backward overhead medicine ball throw. The results showed static balance had moderate correlations (p<0.05) with core endurance in the whole group. Significant moderate correlations were found between static balance (eyes closed) and core endurance (p<0.05) in Pre PHV group. It was concluded that static balance and core endurance were correlated among cricketers. But no correlation exists between dynamic balance, core endurance and power performance in cricketers of different maturity status.

Keywords: adolescents, balance, core endurance, cricketers, peak height velocity, power performance

1. Introduction
The importance of fitness in any sport cannot be underlined. The fitter you are the better you'll play. Since cricket is a team sport, all of the players are required to be in action from 3 hours to 5 days match, the game requires a high level of fitness for a professional player to perform effectively [1].

Cricket is played with three skills; batting, fielding and bowling, which requires a good focus, postural control, strength, muscular endurance, explosive bursts and fitness [2]. Each of these roles has its own demands and its own unique set of associated injuries [3].

In recent times, scientists and coaches have shown an increasing interest in the long-term development of young athletes. The new long-term athlete development (LTAD) model was introduced that attempted to address the interaction between growth, maturation, and training. The model suggests that measures of height and weight are routinely collected to be able to identify peak height velocity (PHV) and peak weight velocity (PWV), which reflect individual maturation rates [4].

Knowledge of when to apply an appropriate training stimulus during long-term athlete development is essential for effective programming and improving athletic performance.

Lloyd *et al.* recently stated the importance of muscular strength and power for long-term athletic development for performance enhancement and injury prevention [5].

An effective player needs great balance and core strength, speed for running between the wickets and in the field, and fast bowlers especially require great speed and power [6]. Optimal balance is crucial where bowlers rely on balance especially during the single limb support phase of the bowling action where the bowler has to maintain his balance during this high load activity [3]. Core stability is the foundation for explosive movements and control (agility, balance and co-ordination). In cricket terms, you become more stable while batting, have better control while bowling, and become solid in your ability to catch and throw the ball [1]. The ability to generate or transfer explosive muscle power is a key element to the success of many athletic activities [7]. The influence of strength and power on velocity provides a viable method through which performance can be improved in overhead throwing athletes [8].

Knowledge on performance in balance and muscular strength/power and their interrelation is of particular interest in sports in which the proficiency level is sufficiently determined by these neuromuscular capacities [5].

For better performance of athletes in future, knowledge of performance capacities and their relationship with maturational status is of utmost importance so that we can develop strategies at the adolescent age and impart proper training to them.

2. Materials and Methodology

Ethical approval was taken from the Institutional Review Board. Cricket players were taken from various academies of Ahmedabad. Athletes fulfilling the inclusion criteria were explained about the study and written informed consent form was taken from their parents/coaches. Prior to beginning of the study warm up session was conducted and they were explained about the procedure. The inclusion criteria were male cricketers having experience of 2 years of systemic cricket training with minimum of 3 sessions per week of age 10 – 18 years. The exclusion criteria were any history of recent injury or surgery (last 4-6 months). Anthropometric measurements like height, weight, sitting height and limb length were taken before performance testing.

Subjects were allocated to three groups (Pre PHV, PHV and Post PHV) according to their maturity status. Participants' maturity status was calculated using the equation of Mirwald *et al*. [5, 9].

To measure static balance, the Standing Stork balance test was performed on the dominant leg with eyes opened and closed. The dominant leg was determined according to the lateral preference inventory [10]. For dynamic balance, the modified SEBT was used and conducted with the dominant side. For core muscle endurance, Sport specific endurance plank test was done, while power was evaluated with backward overhead medicine ball throw test.

2.1 Standing Stork Balance test [5, 11]

Participants stood with their non dominant foot against the inside of the supporting knee (dominant leg) with both hands on the hips. On the command, the subject raised the heel of their foot from the floor and attempted to maintain their balance as long as possible. This test was carried out with eyes open as well as with eyes closed. The trial ended if the subject either moved or if the heel touched the floor. The test was timed (seconds) using a stop-watch. The recorded score was the best of three attempts.

2.2 Modified star excursion balance test (modified SEBT) [12]

Subjects stood on the dominant leg, with the most distal aspect of their great toe on the centre of the grid. The subjects were asked to reach in the specified direction [i.e. anterior (A), posteromedial (PM) and posterolateral (PL)], while maintaining their single-limb stance. The SEBT composite score was calculated by summing the 3 reach directions and normalizing the results to the lower limb (LL) length. The greatest of 3 trials for each reach direction was used for analysis of the reach distance in each direction.

Combined score = {[(A + PM + PL)/ (LL * 3)] * 100}

2.3 Sport specific endurance plank test (SEPT) [13]

Participants started the test by holding a basic plank position – a prone bridge supported by the forearms and feet. The neck was kept neutral so that the body remained straight from the head to the heels. Participants were required to maintain the prone bridge in a good form throughout the 9 stages with no rest in between.

The measured time to exhaustion was used to reveal the endurance capacity of the global core muscle of the participant.

2.4 Backward overhead medicine ball throw (BOMB) [7, 14, 15]

3 kg medicine ball was used in this study. The test consisted of 4 phases: preparatory, countermovement, upward acceleration, and deceleration phases. The distance of the medicine ball throw was recorded (m), and the best throw was used for the statistical analysis.

3. Results and Discussions

The present study was aimed to correlate balance, core endurance and power performance in male cricketers of different maturity status. 71 male subjects were included in this study according to inclusion criteria from various cricket academies of Ahmedabad. The demographic data is shown in Table 1. Data of outcome measures in Table 2.

Statistical analysis was done using SPSS version 20 and Microsoft Excel 2007. Level of significance was kept at 5% with confidence interval at 95%. SEBT was found to be normally distributed and rest all outcome measures were not normally distributed using Shapiro-Wilk Test. As the maximum data was found to be not normally distributed, Spearman's correlation was used for correlation of all outcome measures.

Further, when the groups were divided according to their maturity status, Spearman's correlation was used for correlation of all outcome measures according to their maturity status.

3.1 Between groups comparison was done using

1. Kruskal Wallis One Way Analysis for all outcome measures which were not normally distributed
2. ANOVA one way analysis was used for the measures whose data was normally distributed.

The cricketers were divided into three groups i.e. Pre PHV, PHV and Post PHV on the basis of the Mirwald *et al*. maturity offset formula. According to that, Pre PHV had 45, PHV had 16 and Post PHV had 10 athletes respectively.

Statistically significant moderate correlation was seen between measures of static balance and core endurance ($p<0.05$) as seen in (Table 3). Standing stork balance test (eyes open) showed medium sized correlations(r=0.344) with core endurance. Standing stork test (eyes closed) showed medium sized correlations(r=0.390) with core endurance. No significant correlation was present between other measures of balance, core endurance and power performance in the cricketers group.

This comes in agreement with Deepika Singla *et al*. who demonstrated that no statistically significant correlations existed between upper body balance and power and upper body balance and muscular strength in these athletes. Thus, the authors speculated that upper body balance performance is not dependent on back strength. Non significant correlations found in the above study imply that these are independent upper body bio-motor abilities and should be trained separately [16].

A study was done to evaluate the relationship between performance of core stability and the lower extremity static balance performance in recreationally active individuals by Anoop Aggrawal *et al*. [17]. Core stability was assessed using prone plank test and static balance by Standing Stork Test on both legs. Results indicated that static balance performance was significantly correlated with that of prone plank test. These results coincided with the findings of the present study. Prone bridge (prone plank) selectively recruits anterior trunk muscles like external oblique and lateral stabilizers [18]. This controls the spine in sagital plane thus possibly influences the stork balance test performance.

Muehlbauer *et al*. in a meta-analysis reported non-significant correlations of static (one-legged stance), and reactive (perturbed postural sway) balance with strength and power in non athletic children. Similarly, a number of studies by Granacher, Muehlbauer and colleagues reported lack of significant or small-sized correlations of static and dynamic balance with strength and power measures in recreationally active pre- pubertal children and adolescents [19, 20, 21, 22]. The results of present study are in accordance with the literature mentioned above. Based on these results, it seemed that balance, isometric strength, and power are independent neuromuscular capacities in children, adolescents, and in young adults who may have to be trained complementarily [23].

Statistically significant moderate correlation was seen between static balance with eyes closed and core endurance (r=0.333) in Pre PHV (Table 4). No significant correlation was present between other measures of balance, core endurance and power performance in Pre PHV, PHV (Table 4) and Post PHV (Table 4) group.

Between groups comparison showed that there was a statistically significant difference in static balance between the groups. There were statistically, no significant differences between static balance of Pre PHV vs. PHV and PHV vs. Post PHV. There was statistically significance between static balance of Pre PHV vs. Post PHV. There was no statistically significant difference (p<0.05) in dynamic balance between the groups (Table 5).

There was a statistically significant difference in core endurance between the groups. There were statistically, no significant differences between core endurance of Pre PHV vs. PHV. There was statistically significance between core endurance of Pre PHV vs. Post PHV and PHV vs. Post PHV (Table 5).

There was a statistically significant difference in power performance between the groups. There was statistically significance between power performance of Pre PHV vs. PHV, PHV vs. Post PHV and Pre PHV vs. Post PHV (Table 5).

Between groups analysis revealed that there is a significant difference between static balance, core endurance and power performance between all three groups. However, no significant differences were found between the groups for dynamic balance (Table 5).

Post hoc analysis revealed that Post PHV group outperformed all other groups in static balance, core endurance and power performance. (Table 5)

Similar to the findings of the present study, Hammami *et al*. [5] also concluded that the more mature group outperformed the less mature groups particularly in proxies of muscle strength and power. In their study the post-PHV children outperformed the younger groups in the 3-hop jump (pre-PHV and circa PHV), back extensor strength (pre-PHV only), and YBT (circa PHV only). Motor control was observed to be improved with physical maturation and thus enhanced coordination of athletic skills [24].

Behringer *et al*. [25] conducted a meta-analysis on effects of strength training on motor performance skills in children and adolescents.

The author emphasized that increased strength enhances motor performance in children and adolescents. Similarly, sprint speed and power improve with maturation [24]; hence the greater power test performances by older children would be expected.

3.2 Tables

Table 1: Demographic Data

Characteristics	Pre PHV (n=45)	PHV (n=16)	Post PHV (n=10)
Age(years)	11.84 ± 0.85	15 ± 0.97	17.3 ± 0.67
Height(cm)	148.3 ± 7.12	161.36 ± 7.35	175.68 ± 5.34
Sitting height(cm)	72.91 ± 3.7	80.84 ± 4.14	89 ± 3.23
Weight(cm)	36.22 ± 6.18	45.25 ± 6.33	55.9 ± 6.76
Limb length(cm)	81.07 ± 5.15	87.94 ± 4.52	94.6 ± 5.19

Mean ± SD

Table 2: Data for outcome measures

Outcome measures	Pre PHV	PHV	Post PHV
SSTO	5.13 ± 3.45	6.36 ± 4.6	10.49 ± 10.99
SSTC	2.54 ± 1.28	2.81 ± 1.43	3.65 ± 1.3
SEBT Composite	118.54 ± 11.29	114.29 ± 9.09	115.01 ± 13.01
SEPT	62.06 ± 22.31	68.56 ± 16.43	103.9 ± 27.38
BOMB	4.5 ± 1.06	5.97 ± 1.62	8.37 ± 1.03

Table 3: Correlation between measures of balance with core endurance (SEPT) and power performance (BOMB) in cricketers

Correlation	Spearman's correlation coefficient r-value (SEPT)	Spearman's correlation coefficient r-value (BOMB)
SSTO	0.344*	0.197
SSTC	0.390*	0.205
SEBT Combined	0.052	-0.163

Table 4: Correlation between measures of balance with core endurance (SEPT) and power performance (BOMB) in groups

Correlation	r-value (SEPT)			r-value (BOMB)		
	Pre PHV	PHV	Post PHV	Pre PHV	PHV	Post PHV
SSTO	0.105	0.314	0.444	0.016	-0.229	-0.297
SSTC	0.333*	0.156	0.012	0.089	-0.253	0.164
SEBT Combined	0.156	0.192	0.164	-0.041	-0.085	-0.382

Table 5: Intergroup comparison between groups

	p value	Difference between (Post hoc analysis)		
		Pre PHV and PHV	PHV and Post PHV	Pre PHV and Post PHV
SSTO	0.010*	0.554	0.318	0.009*
SSTC	0.027*	1.000	0.166	0.022*
SEBT	0.350	0.579	1.000	1.000
SEPT	0.000*	0.291	0.034*	0.000*
BOMB	0.000*	0.029*	0.028*	0.000*

*Significance level is at 0.05.

4. Conclusion

It is concluded from the present study that static balance and core endurance were correlated among cricketers. But no correlation exists between dynamic balance, core endurance and power performance in cricketers. In Pre PHV, correlation existed between static balance (eyes closed) and core

endurance but no such correlations were found in other groups. As no significant correlations were found amongst measures of balance with core endurance and power performance in the maturity groups, it indicated that these capacities are independent of each other and so they should be trained separately across all the age groups.The finding of this study would benefit sports physiotherapist, athletic and fitness trainers and the need for individualization of the training model should not be underestimated when dealing with athletes of different sex, maturity status, and training history.

5. Limitations and Recommendations

Unequal distribution of samples across the groups. Studies with long term follow up across the age group with larger sample size and equal sample size distribution amongst the groups can be done. Cricketers can be grouped according to their specific skills such as batsmen, bowlers and wicketkeepers and the study should be done accordingly.

6. Abbreviations

- SSTO: Standing Stork Balance test (eyes open)
- SSTC: Standing Stork Balance test (eyes closed)
- SEBT: Modified Star Excursion Balance Test
- SEPT: Sport specific endurance plank test
- BOMB: Backward overhead medicine ball throw
- PHV: Peak height velocity

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