

Test-Retest Reliability and Consistency of Electronic Jamar Hand-Grip Dynamometer in Cricket Players

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Abstract: Handgrip strength plays a important role in cricket as various roles played in cricket rely on the continuous use of wrist and digits flexor muscles when catching, holding bat and ball, throwing the ball. Therefore, the assessment of handgrip strength is used in 31 cricket players. The purpose of this study was to examine the reliability of handgrip strength in cricket players. Each participant performed three maximal isometric contractions in six different positions on each hand for two occasions, at least one day apart. Intraclass correlation coefficient (ICC)- (Single- Pearson's correlation coefficient (*r*) and Average- Cronbach's alpha)- with 95% CI were calculated. Internal consistency (Cronbach's alpha) was excellent (0.956-0.982 for right and 0.956-0.984 for left). The test-retest reliability (Pearson's 'r') was high for both right (0.743- 0.856) and left (ICC = 0.781-0.899) hands. The present results indicate that maximum handgrip strength can be measured reliably, using the Jamar hand dynamometer, in cricket players.

Keywords: Batsmen, Bowlers, All-rounders, Wicket-keepers, ICC, Cronbach's alpha

I. Introduction

The estimation of handgrip strength is of immense importance in sports like cricket, wrestling, tennis, football, handball, basketball, volleyball, and baseball where a sufficient degree of grip strength is necessary to be successful play (Koley and Kaur, 2011). In cricket, hand-grip plays a significant contribution in roles (i.e) Batting, bowling and fielding.

Grip strength plays a key role in injury prevention and overall strength development (Budoff, 2004; Yasuo et al., 2005). Grip strength is often used as an indicator of overall physical strength (Foo, 2007), hand and forearm muscles performances (Nwuga, 1975) and as a functional index of nutritional status (Chilima and Ismail, 2001; Pieterse et al., 2002; Wang et al., 2005), physical performance (Samson et al., 2000; Onder et al., 2002).

Hand-grip dynamometers measures hand grip based on 4 principles: sealed hydraulic system (Hydraulic), compression of an air-filled compartment (Pneumatic), amount of tension produced in a spring (mechanical), variation in electrical resistance of length of wire (Strain) (Roberts et al., 2011). Jamar dynamometer uses hydraulic principle and widely used in literature. Recently Jamar dynamometers are produced in electronic format which reliability, consistency has not checked.

Thus purpose of this paper is to check the internal consistency, test-retest reliability of electronic Jamar hand-grip dynamometer in Indian cricket players of 18-25 years. Then discuss the results with literature.

II. Methodology

Present study was a cross sectional study with convenient sample of 37 cricket players. The inclusion criteria were male cricket players with experience of at least two years training and played at least district level. Player age should be 18 or more. Players with following conditions were excluded from the study: Not trained in last 2 months due to any injury or illness, having musculoskeletal injuries in upper limb which may affect hand-grip, cervical pain, any neurological injury. All players were representing a club in Hisar, Haryana and gave their verbal informed consent to participate the study.

All players were asked to come two times (1st and 2nd visit) with at least one day gap and maximum of three days from initial assessment. Demonstration was given to each player on how to hold each position. There was total of six positions for both right and left hand. The six positions were P1- Shoulder adducted, elbow extended, forearm supinated; P2- Shoulder adducted, elbow extended, forearm pronated; P3- Shoulder adducted, elbow flexed 90 degree, forearm in mid pronation; P4- Shoulder 90 degree abducted, externally rotated, elbow 90 degree flexed, forearm pronated; P5- Shoulder 170-180 degree flexed, externally rotated, elbow 20 degree

flexed, forearm pronated; P6- Shoulder 20-30 degree flexion, 20-30 degree abduction, medially rotated, elbow 90 degree flexed, forearm pronated; in all positions wrist was slightly extended. 3 trials were given for each position and one minute rest was given between the trials. Instruction given for grip measurement was “Bring your fingers towards 1st web base/palm with as hard as possible.....harder.....harder.....relax”.

Electronic Jamar hand-grip dynamometer [Jamar Plus, Sammons Preston, Bolingbrook, IL] was used to assess hand-grip. It has five handle positions which can be adjusted according to the span of hand. We used second handle as this is universally used in literature.

The data collected was analysed using IBM SPSS (20.0 version) software. Data was presented as mean ± SD. Unrelated ‘t’ test was used to see the difference between 1st and 2nd time hand-grip mean. Intraclass correlation coefficient (ICC) was used for both consistency (Cronbach’s alpha) and reliability (Pearson’s correlation) with 95% CI (confidence interval).

III. Results

Table 1 shows mean measurement of 1st and 2nd time in right side. P6 (Shoulder medially rotated-batting position) has the least grip-strength (43.70 Kg in 2nd time) and P1 (Shoulder adducted, elbow extended and forearm supinated) has maximum grip strength (49.33 Kg in 1st time) in right side of cricket players. 1st time measurement has always greater than 2nd time without significant difference. Mean difference is less than 3% higher than 2nd time.

Table 1: Comparison of two measurements in right side with Jamar dynamometer

	Mean ± SD of 1 st measurement	Mean ± SD of 2 nd measurement	Mean difference (p value)
RJP1	49.33 ± 6.96	48.88 ± 8.41	0.453 (0.809)
RJP2	46.78 ± 6.92	45.25 ± 8.29	1.539 (0.407)
RJP3	48.64 ± 7.12	46.59 ± 8.43	2.046 (0.282)
RJP4	48.37 ± 6.76	46.47 ± 8.72	1.904 (0.314)
RJP5	47.04 ± 7.28	45.99 ± 8.26	1.054 (0.578)
RJP6	45.13 ± 6.98	43.70 ± 7.97	1.432 (0.433)

Table 2: Comparison of two measurements in left side with Jamar dynamometer

	Mean ± SD of 1 st measurement	Mean ± SD of 2 nd measurement	Mean difference (p value)
LJP1	46.60 ± 8.35	45.82 ± 8.54	0.775 (0.707)
LJP2	44.83 ± 7.95	42.31 ± 7.79	2.528 (0.192)
LJP3	46.09 ± 7.75	43.37 ± 7.75	2.714 (0.155)
LJP4	45.54 ± 7.57	42.97 ± 7.43	2.582 (0.163)
LJP5	44.71 ± 7.48	42.48 ± 7.63	2.229 (0.229)
LJP6	42.72 ± 6.86	41.58 ± 7.16	1.140 (0.506)

Table 2 shows mean measurement of 1st and 2nd time in left side. Left side grip-strength values are less than that of right side in all six positions. Like right side, left side too P6 position (Shoulder medially rotated-batting position) has the least grip-strength (41.58 Kg in 2nd time) and P1 (Shoulder adducted, elbow extended and forearm supinated) has maximum grip strength (46.60 Kg in 1st time) in cricket players. 1st time measurement has always greater than 2nd time without significant difference. Mean difference is less than 5% higher than 2nd time.

Table 3 shows that internal consistency (Cronbach’s alpha) of right side in both 1st and 2nd visits for all six positions with 95% CI. There was an excellent consistency in both 1st visits (0.956-0.975) and 2nd visits (0.969-0.982). Internal consistency was maximum in P3 position (traditional-Shoulder adducted. Elbow flexed 90 degree, forearm midpronation) and least in P4 position (Shoulder abducted 90 degree, externally rotated, elbow flexed 90 degree, forearm pronated) for both 1st and 2nd visits.

Table 3: Internal consistency (3 trials each visit) of Jamar dynamometer at right side.

Position	1 st visit measurement (n=37)			2 nd visit measurement (n=31)		
	Single	Average	95% CI of average	Single	Average	95% CI of average
RJP1	0.901	0.964	0.938-0.980	0.918	0.971	0.948-0.985
RJP2	0.906	0.965	0.939-0.981	0.939	0.977	0.957-0.988
RJP3	0.931	0.975	0.956-0.986	0.950	0.982	0.968-0.991
RJP4	0.880	0.956	0.924-0.976	0.914	0.969	0.944-0.984
RJP5	0.919	0.968	0.944-0.982	0.941	0.980	0.964-0.990
RJP6	0.889	0.960	0.930-0.978	0.934	0.975	0.954-0.987

Single also known ICC (Single) or average of Pearson’s correlation (r), Average also known as ICC (Average) or Cronbach’s alpha

Table 4: Test-retest reliability of Jamar dynamometer at right side (n=31)

	ICC (Single)	95% CI of ICC	Cronbach's Alpha	95% CI of Cronbach's Alpha
RJP1	0.768	0.573-0.881	0.869	0.728-0.937
RJP2	0.743	0.532-0.867	0.853	0.695-0.929
RJP3	0.764	0.565-0.879	0.866	0.722-0.935
RJP4	0.807	0.637-0.902	0.893	0.778-0.948
RJP5	0.786	0.602-0.891	0.880	0.751-0.942
RJP6	0.856	0.722-0.928	0.922	0.839-0.962

ICC (single) also known as Pearson's correlation (r)

Table 4 shows test-retest (1st and 2nd visits mean) reliability of right side of cricket players in all six positions. The results showed there was a moderate to high correlation between 1st and 2nd visits hand-grip strength (0.743-0.856). The reliability was low in P2 position (shoulder adducted, elbow extended, forearm pronated) and maximum in P6 position (batting position-Shoulder 20 degree flexed, 20 degree abducted, internally rotated, elbow 90 degree flexed, forearm pronated). Correlation between 1st and 2nd visits right side hand-grip values is diagrammatically given in Figure 1 (for P1 to P3) and Figure 2 (P4 to P6). Line given in figures is linear regression fit line with R² values.

Figure 1: Correlation matrix along with regression line between first and second visits readings in jamar position 1 to position 3 of right side (n=31)

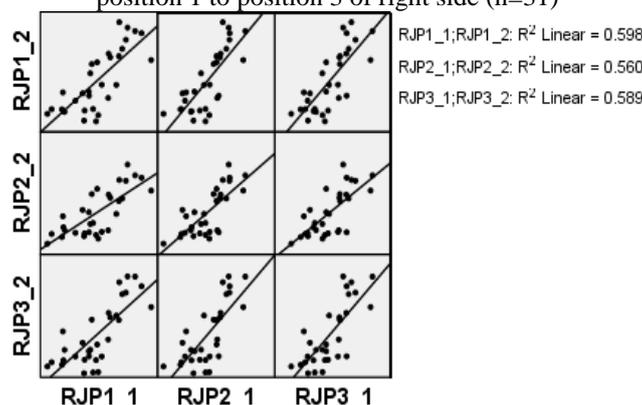


Figure 2: Correlation matrix along with regression line between first and second visits readings in jamar position 4 to position 6 of right side (n=31)

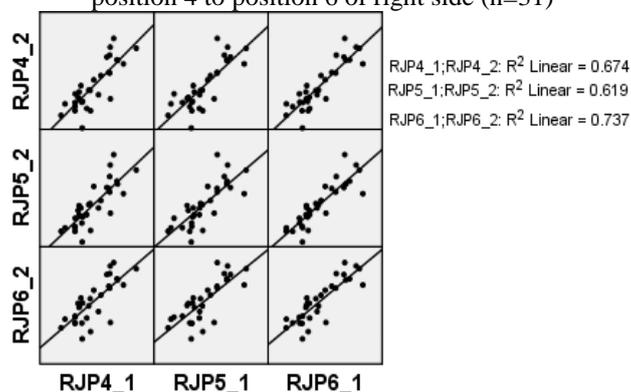


Table 5: Internal consistency (3 repeated measures) of Jamar dynamometer at left side

Position	First measurement (n=37)			Second measurement (n=31)		
	Single	Average	95% CI of average	Single	Average	95% CI of average
LJP1	0.902	0.965	0.940-0.981	0.928	0.975	0.954-0.987
LJP2	0.953	0.984	0.972-0.991	0.932	0.976	0.956-0.987
LJP3	0.951	0.983	0.970-0.991	0.922	0.972	0.950-0.986
LJP4	0.880	0.956	0.924-0.976	0.907	0.965	0.937-0.982
LJP5	0.943	0.980	0.965-0.989	0.899	0.963	0.932-0.981
LJP6	0.905	0.966	0.941-0.981	0.893	0.961	0.929-0.980

Single also known ICC (Single) or average of Pearson's correlation (r), Average also known as ICC (Average) or Cronbach's alpha

Table 5 shows that internal consistency (Cronbach’s alpha) of right side in both 1st and 2nd visits for all six positions with 95% CI. There was an excellent consistency in both 1st visits (0.956-0.984) and 2nd visits (0.961-0.976). Internal consistency was maximum in P2 position (Shoulder adducted, elbow extended, forearm pronated) for both 1st and 2nd visits.

Table 4 shows test-retest (1st and 2nd visits mean) reliability of left side of cricket players in all six positions with 95% CI. The results showed there was a moderate to high correlation between 1st and 2nd visits hand-grip strength (0.781-0.899). The reliability was low in P6 position (Batting position- Shoulder 20 degree flexed, 20 degree abducted, internally rotated, elbow flexed 90 degree, forearm pronated) and maximum in P4 position (Throwing position- Shoulder 90 degree abducted, externally rotated, elbow 90 degree flexed, forearm pronated). Correlation between 1st and 2nd visits left side hand-grip values is diagrammatically given in Figure 3 (for P1 to P3) and Figure 4 (P4 to P6). Line given in figures is linear regression fit line with R2 values.

Table 6: Test-retest reliability of Jamar dynamometer at left side (n=31)

	ICC (Single)	95% CI of ICC	Cronbach’s Alpha	95% CI of Cronbach’s Alpha
LJP1	0.836	0.688-0.918	0.911	0.815-0.957
LJP2	0.861	0.731-0.930	0.925	0.845-0.964
LJP3	0.801	0.627-0.899	0.890	0.771-0.947
LJP4	0.899	0.801-0.950	0.947	0.890-0.974
LJP5	0.815	0.651-0.906	0.898	0.788-0.951
LJP6	0.781	0.593-0.888	0.877	0.745-0.941

ICC (single) also known as Pearson’s correlation (r)

Figure 3: Correlation matrix along with regression line between first and second readings in jamar position 1 to position 3 of left side (n=31)

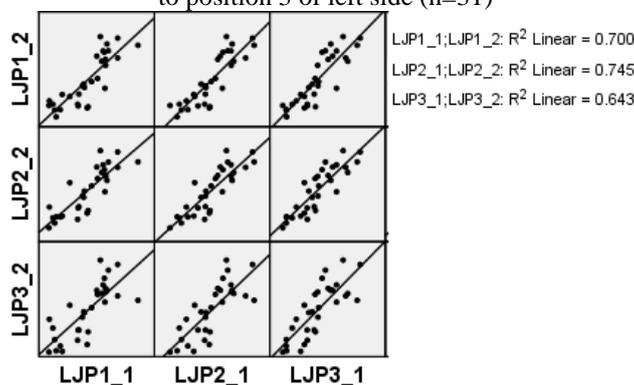
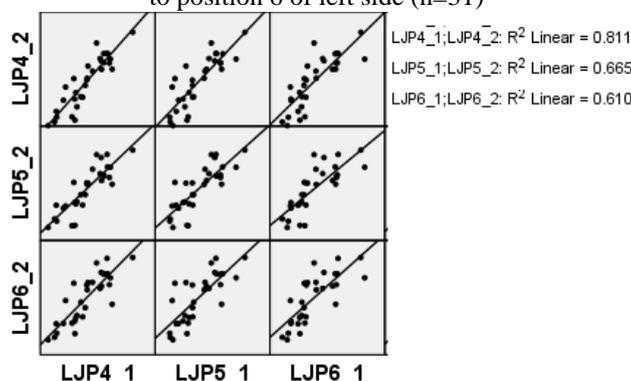


Figure 4: Correlation matrix along with regression line between first and second readings in jamar position 4 to position 6 of left side (n=31)



IV. Discussion

The primary objective of this paper is consistency, reliability of electronic hand-grip dynamometer in cricket players in India. The results showed there is an excellent internal consistency and moderate reliability in electronic hand-grip dynamometer in Indian cricket players.

Measurements of grip strength taken with the Jamar dynamometer have evidence for good to excellent ($r > 0.80$) test-retest reproducibility [Mathiowetz et al., 1984; Haward and Griffin, 2002; Bohannon and Schaubert, 2005; Gerodimos, 2012; Gerodimos and Karatrantou, 2013] and excellent ($r > 0.94$) intra-rater

reliability, internal consistency [Gerodimos and Karatrantou, 2013; Lindstrom-Hazel et al., 2009; Trutschnigg et al., 2008; Peolsson et al., 2001]. Kolber and Cleland (2005) found the ICC of ratters testing participants without known impairments to be 0.52 to 0.93 when using hand-held dynamometry. In a review of 18 studies, Bohannon (1999) found the majority of reliability coefficients for hand-held dynamometry to be above 0.7.

Among sportsmen, pubertal Wrestlers showed excellent internal consistency (correlation between 3 trials ranged 0.993-0.996) and test-retest reliability (ICC ranged 0.990-0.993) (Gerodimos and Karatrantou, 2013). Same author reported excellent test-retest reliability in adolescent and adult Basketball players too (ICC ranged in 0.971-0.997) (Gerodimos, 2012).

Peolsson et al., 2001 examined intra-tester reliability (internal consistency) on healthy volunteers and ranged 0.94-0.98. Trutschnigg et al., (2008) showed internal consistency of 0.996 on repeated measures in advanced cancer patients. Bohannon and Schaubert (2005) evaluated test-retest reliability of Jamar dynamometer on community dwelling elders over 12 weeks period. They found no difference between measurements and ICC of 0.954, 0.912 for right, left hand respectively. Haward and Griffin, (2002) examined the reliability of Jamar dynamometer on University students and employees for 3 successive weeks. Their results showed 'Spearman's Rho' 0.77 (week 1 and 2 on dominant hand) to 0.94 (week 2 and 3 on non-dominant hand). Mathiowetz et al., 1984 studied the test-retest reliability of Jamar dynamometer on 27 University women over less than week period and their results showed 0.883 for right side and 0.929 for left side.

V. Conclusion

Electronic Jamar hand-grip dynamometer is consistent, reliable instrument on sports person especially cricket players. It can be used by physiotherapists in training, pre participation evaluation, rehabilitative (diagnostic and prognostic) settings.

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