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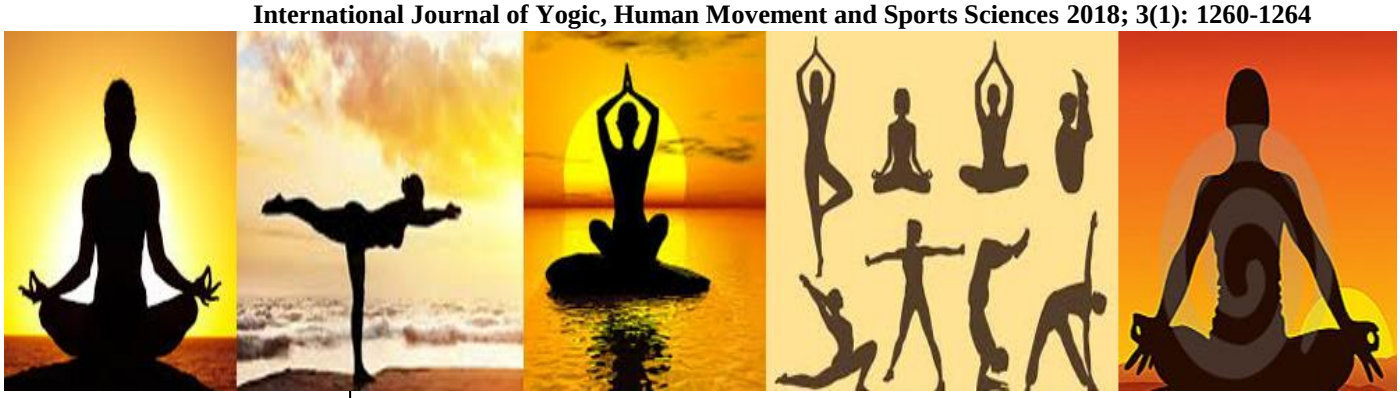

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Reliability and factorial validity of the out-swing bowling test battery in cricket

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Abstract
The gained popularity of sports/games in the competitive sporting industry invites an enormous participation of youth resulting to a valid, reliable, objective and authenticated skill test for the selection of the players on the basis of their skill acquitted. Based on the fact the scholar initiated to develop and validate a skill test for the selection of Out-Swing bowlers in Cricket. For the construction of Out-Swing bowling playing ability test, a total of 200 cricket players were selected from different affiliated clubs with minimum experience of 5 years playing in the registered clubs under Delhi District Cricket Association (DDCA). The age group of the subjects ranged from 18 to 22 years and the mean age of the subjects was found to be 19 years. The study was conducted only on male players. In the first stage with the help of the experts and keeping in mind the feasibility criterion a total of four skill tests were developed for assessing the performance of the in-swing bowlers. All the 4 skill test items were administered to the Cricket players at the selected Cricket Academies/Clubs in the South West Delhi Region. Factor Analysis was used as a tool to select the best suited skill test items. The factor analysis was applied by using the Principal Component Analysis (Unrotated Factor Loadings with Varimax Rotation). Final solution so obtained was used to identify the different factors. These factors were given an appropriate name depending upon the characteristics of the variables contained in it. Test Retest method was used to establish the reliability of the skill test battery. The factor analysis yielded 2 factors for Out-Swing Bowling. A high Reliability, Validity and Objectivity coefficients were established for the selected skill tests of the playing ability battery of Out-Swing Bowling. Hull scale norms were developed for interpreting the results.

Keywords: Reliability, factorial validity, out-swing, bowling

Introduction
The time when sports were nothing more than an enjoyable recreation for individual is irrevocably past. The phenomenon of sports today intervenes in almost all fields of human endeavor and very often it even has a central position. Sports, thus has experienced an enormous intention, quantitatively as well as qualitatively with many positive aspects (Gupta, 1982) [3].

Sports are accepted as a cultural phenomenon. There is constant endeavor to achieve higher standards of performance, as a result, today's sports demands optimum physical fitness and highest degree of performance. Many people take part in sports activities for the fun of it or for health and fitness, sports have become a profession to some with high skills, with ample financial benefits linked with high degree of popularity (Bucher C.A., 1976) [1].

History reveals that as human become more civilized they also become more scientific, and subsequently sought more exact way to measure. For many decades knowledge and skill in the area of measurement have been considered important for graduate study in the field of Physical Education and Sports. But today measurement skill and knowledge are also deemed and necessary part of professional preparation of physical education teachers, athletic coaches, sports medicine specialists, and sports management professionals (Harold M. Borrow, 1989) [4].

It has been said that the orderly progress towards goals in education depends on measurement, because measurement and purposeful activity are inseparable. Generally the more valid the measurement and the more careful the evaluation of results, the sooner the goals will be attained. This becomes especially true if proper criteria have been established for the instrument of measurement (Willgoose, 1961) [8].

Excellence in the performance of his or her chosen sport is the major aim of any elite athlete. The drive to win, the desire to succeed and the ambition to push beyond the present limits of performance all essential features of achieving excellence in elite sports. Athlete must constantly strive to attain peak levels of performance to reach and subsequently stay at the top. Fundamental to elite performance in field sports is the need to capture, analyze and evaluate information on key areas such as physical or technical capacities of the players. This information on the numerous characteristics of sports performance is the foundation for providing feedback on how the player or athlete is performing. In turn, this feedback leads to the development of informed coaching interventions centered on.

For many motor skills, performance is a reliable means of evaluating instructional objectives. Some authors refer to such measures as skill tests or rating scales, which in a sense they are. However, it is important to remember that in this context the performance environment is also the evaluation environment. The instructional objectives and the performance may be identical and logical validity more readily assured (Jackson, 1991) [5].

The science of testing sports skill is not very old. It is only during last 55 years or so that attempts have been made to develop skill testing in sports As usual with the new branch of development, there have been frequent revisions of the tests constructed for evaluating sports skills, many factors have resulted in quick progression of developments in skill testing procedures. Some of the factors resulting in the revision of the skill test include improvement in measurement procedure, development of new skill pattern, new identification of skill item, revision of game rules and playing procedures etc. Hence, many of the old skill tests have become irrelevant, redundant and obsolete. Thus, it is very important to use the knowledge of the procedures involved in the test construction for sports skill testing. In other words, it is very important to ascertain validity, reliability and objectivity of the tests before their administration for skill testing. In addition, it is equally important to use relevant norms and standards for comparing and evaluating the results of skill testing. The researcher must be conversant with the fact that the norms to be used must have been developed on the population for which they are to be used; otherwise their conclusion will be quite irrelevant. In the absence of regional norms of a particular skill test, it becomes necessary that first of all norms are developed before the sports skill of a regional group could be properly evaluated (Kansal, 1996) [6].

The test may serve the purpose of classification of players in a homogenous group for facilitating instruction. As this is achievements test it may be used for evaluation achievements (Saha A.K., 1985) [7].

From the said discussions it is philosophically understood that there may be certain qualities (Physical and Motor) which are contributing to the performance in cricket, but so far scientifically very little, if any has been done to establish relationship between playing ability in cricket and certain qualities assumed to be related. In sports and physical education, as in life, teachers and coaches are constantly measuring and evaluating. They measure their students, players, associations, opponents, programs, teaching strategies, coaching techniques and many other facts of the education continuous. The least valid forms of evaluation they might employ are hunches or calculated guesses. The most valid form is the use of well-established criteria as a basis for comparison. Usually this is done by means of tests and measures that have been developed through research and validated against suitable criteria (Dobbins, 1998) [2].

Objectives of the study

- The main purpose of the study is the development and validation of a fundamental skill test battery for Out-Swing bowlers in Cricket game.

Sub objectives of the study were

- To select the variables for development and validation of the test for Out-Swing bowling in Cricket.
- To construct a skill test battery for Out-Swing bowling in Cricket.
- To establish the reliability of the test battery.
- To establish the validity of the test battery.
- To Establish the Objectivity of the test battery.
- Development of Norms.

Procedure and methodology

For the construction of Out-Swing bowling playing ability test, a total of 200 cricket players were selected from different affiliated clubs with minimum experience of 5 years playing in the registered clubs under Delhi District Cricket Association (DDCA). The age group of the subjects ranged from 18 to 22 years and the mean age of the subjects was found to be 19 years. The study was conducted only on male players. In the first stage with the help of the experts and keeping in mind the feasibility criterion a total of four skill tests were developed for assessing the performance of the Out-swing bowlers. All the 4 skill test items were administered to the Cricket players at the selected Cricket Academies/Clubs in the South West Delhi Region. To avoid the players from facing fatigue and monotony all the test items were conducted on three consecutive days of the week i.e. Fridays, Saturday and Sunday in two session's i.e. morning and evening sessions. For the morning sessions the data was collected from 7.00 A.M to 10.00 A. M. and for the evening session it was conducted from 3.00 P. M. to 6.00 P.M.

Statistical analysis

The first method of the statistical analysis was factor analysis, which was used as a tool to select the best suited skill test items. The factor analysis was applied by using the Principal Component Analysis (Unrotated Factor Loadings with Varimax Rotation). Final solution so obtained was used to identify the different factors. These factors were given an appropriate name depending upon the characteristics of the variables contained in it. Finally a skill test battery for measuring performance of In-Swing bowlers in Cricket was prepared by picking up the variables having highest loading from each factor. Pearson Product Moment Correlation was used for the establishment of Reliability and validity of the skill test battery. Norms were developed on basis of Hull Scale.

Results and Discussions

Factor Analysis of Out-swinger Bowling

Exploratory Factor analysis was performed on selected 200 bowlers for the Out Swinger test items (Out Swinger Bowling Test, Out Swinger Accuracy Test, Out Swinger Body Position Test and Out Swinger Circle Test). The obtained results have been presented in Tables from 1 to 7.

Table 1: Kaiser Meyer Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.672
Bartlett's Test of Sphericity Approx. Chi-Square	33.474
df	6
Sig.	.047

Table no. 1 clearly indicates the tests for sampling adequacy for the selected test items for Out Swinger Bowling, it was observed that the Bartlett's Test of Sphericity was found to be 33.474, which is significant (p< .047, df 6), whereas the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1960), was found to good (0.672), which is close to 1.00, providing further support for the appropriateness of the data to be used for factor analysis (Sharma, 1996; Tabachnick & Fidell, 1996) and most importantly the determinant value for the data is 0.971, which is greater than the necessary value of 0.00001, which shows that multicollinearity is not a problem for this data.

Table 2: Exploratory factor analysis: factor loadings, communalities, eigenvalues, percentage of explained variance and cumulative percentage of out swinger test (Rotated Factors Loadings: Varimax Solution)

	Component		Communalities
	1	2	
Out Swinger Circle Test	.697		.713
Out Swinger Body Position Test	-.571	-.544	.293
Out Swinger Accuracy Test	.538		.622
Out Swinger Bowling Test		.836	.586
Eigenvalues	1.115	1.099	
% of Variance Explained	27.867	27.475	
Cumulative %	27.867	55.342	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation Converged in 3 iterations.

Table no. 2 clearly indicates the values of rotated factor loadings with varimax solution, which suggested the retention of two factors, accounting for 55.342% of the total variance. The two selected tests together contribute to the assessment of Out Swinger with a cumulative percentage of 55.342%. The two test items selected were, Out Swinger Circle Test with highest value (0.697) from component I and Out Swinger Bowling Test with highest value (0.836) from factor II and both the tests were selected with having eigenvalues more than 1, which were set as the upper values for extraction. Additionally, the items revealed high Communalities (Proportion of variance of the variable) ranging from 0.293 to 0.713 which is acceptable and shows that selected factors belongs to the variable.

Table 3: Loading of Factor I

S. No.	Name of the Variable	Un Rotated	Rotated	Factor Name
1.	Out Swinger Body Position Test	-0.782	-0.571	"General Bowling Factor"
2.	Out Swinger Accuracy Test	0.469	0.538	
3.	Out Swinger Bowling Test	0.402		
4.	Out Swinger Circle Test	0.374	0.697	

This factor is named General Bowling Factor considering the following

1. Loading variables in the factor, i.e. Out Swinger Circle Test (0.697), Out Swinger Accuracy Test (0.538) and Out Swinger Body Position Test (-0.571) respectively were significant, above the value of 0.300 which was set as the upper value for extraction and highest (Table No. 3).
2. Testing profile of Test/Variable shows that the selected test Out Swinger Circle Test measures the accuracy in pitching the ball by an out swing bowler, Out Swinger Accuracy Test measures ability to hit the wickets with an out swinging ball with accuracy and finally the Out Swinger Body Position Test measures posture/body position of an out swing bowler while delivering a ball. Keeping in mind the criterion been assessed by the respective tests the factor has been named as General Bowling Factor, as the selected tests are all together measuring the accuracy, the direction of the delivery and the body posture of the bowler along with accuracy of bowling.
3. The polarization for instance in Factor I shows Out Swinger Circle Test with highest positive bearing and Out Swinger Body Position Test with a negative bearing giving a overall negative bearing.
4. The correlation Table No. 4 between the significantly loaded variables have been found insignificant in the 3×3 = 09 matrix, hence the variables were independent in nature and the highest loaded variable have been selected as the factor representative, i.e. Out Swinger Circle Test.

Table 4: Correlation Matrix

		Out Swinger Bowling Test	Out Swinger Accuracy Test	Out Swinger Body Position Test	Out Swinger Circle Test
Out Swinger Bowling Test	Pearson Correlation	1	-.008	-.107	-.070
	Sig (2-tailed)		.934	.246	.445
	N		120	120	120
Out Swinger Accuracy Test	Pearson Correlation		1	-.068	.034
	Sig (2-tailed)			.463	.712
	N			120	120
Out Swinger Body Position Test	Pearson Correlation			1	-.080
	Sig (2-tailed)				.388
	N				120
Out Swinger Circle Test	Pearson Correlation				1
	Sig (2-tailed)				
	N				

Table 5: Loading of Factor II

S. No.	Name of the Variable	Un Rotated	Rotated	Factor Name
1.	Out Swinger Body Position Test		-.544	"Bowling Accuracy Factor"
2.	Out Swinger Bowling Test	-.743	.836	
3.	Out Swinger Circle Test	.668	-.315	

This factor is named Bowling Accuracy Factor considering the following

1. Loading variables in the factor, i.e. Out Swinger Bowling Test (0.836), Out Swinger Circle Test (-0.315) and Out Swinger Body Position Test (-0.544) respectively were significant, above the value of 0.300 which was set as the upper value for extraction and highest (Table No. 5).
2. Testing profile of Test/Variable shows that the selected test Out Swinger Bowling Test measures the position of the seam and the direction of the ball with accuracy while delivering an in swing ball, Out Swinger Circle Test measures the accuracy in pitching the ball by an out swing bowler and finally the Out Swinger Body Position Test measures the posture/body position of an out swing bowler while delivering a ball. Keeping in mind the criterion been assessed by the respective tests the factor has been named as Bowling Accuracy Factor, as the selected tests are all together measuring the Accuracy in bowling a out swing bowl by a bowler along with accuracy in posture of bowling.
3. The polarization for instance in Factor I shows Out Swinger Bowling Test with highest positive bearing and Out Swinger Circle Test with a negative bearing giving a overall negative bearing.
4. The correlation Table No. 6 between the significantly loaded variables have been found insignificant in the 3×3 = 09 matrix, hence the variables were independent in nature and the highest loaded variable have been selected as the factor representative, i.e. Out Swinger Bowling Test.

Table 6: Correlation Matrix

		Out Swinger Bowling Test	Out Swinger Body Position Test	Out Swinger Circle Test
Out Swinger Bowling Test	Pearson Correlation	1	-.107	-.070
	Sig (2-tailed)		.246	.445
	N		120	120
Out Swinger Body Position Test	Pearson Correlation		1	-.080
	Sig (2-tailed)			.388
	N			120
Out Swinger Circle Test	Pearson Correlation			1
	Sig (2-tailed)			
	N			

Validity of the skill test battery

For estimating the validity of the present Skill Test Battery following methods were used,

Construct identification procedures

Factorial validity: Factor analysis is a statistical method used to describe variability among observed variables in terms of a potentially lower number of unobserved variables called factors.

Factor analysis of the skill test battery

In the present study the exploratory factor analysis was done with the help of SPSS16 statistical analysis software. The analysis was done on the data collected from the entire sample i. e. 200 Cricket players on Selected 4 tests. Before applying factor analysis data was analyzed, the determinant value for the data was 0.929, which indicates that the correlation is too high; therefore there is no need to delete any item at this point, similarly for checking the sampling adequacy KMO and Bartlett's Test of sphericity were computed.

- Principal Component analysis was done, Varimax orthogonal rotation was selected for the analysis.
- Kaiser-Meyer-Olkin Measure of Sampling Adequacy for skill test battery of Out-swinger was found to be 0.672, which indicated that the data was appropriate for the factor analysis. It also shows the validity of the inventory.
- Bartlett's Test of Sphericity for skill test battery In-swinger, was found to be 33.474, both the values are significant at 0.000 levels which indicated that the data was appropriate for the factor analysis.
- The communalities and the total variance explained shows that according to the factor analysis 2 factors representing 2 skill tests were extracted for the skill test battery of Out-swing with Eigen value greater than one. This indicates that all the selected tests measure the respective factor. Thus, the results indicate the high validity of the skill test battery for Out-swing bowlers.

Reliability of the skill test battery

In the present study the reliability of the skill test battery was calculated by Test-Retest Reliability.

- **Test retest method:** The test-retest reliability method is one of the simplest ways of testing the stability and reliability of an instrument over time. Repeatability or test-retest reliability is the variation in measurements taken by a single person or instrument on the same item and under the same conditions.

Table 7: Reliability coefficients of the test retest scores of out-swing bowling test items for the skill test battery of out-swing bowling

S. No.	Variable	Factor Name	Test Items	Coefficient of Correlation
1.	Out Swinger Bowling	General Bowling Factor	Out Swinger Circle Test	0.865**
		Bowling Accuracy Factor	Out Swinger Bowling Test	0.884**

From Table no. 8, it is evident that the reliability of all the test items of Out-Swing bowling was significantly high, which indicates the consistency of the test items, thus establishing the competency of the scholar to administer the tests.

Table 8: Objectivity coefficients of the test retest scores of out-swing bowling test items for the skill test battery of out-swing bowling

S. No.	Variable	Factor Name	Test Items	Coefficient of Correlation
1.	Out Swinger Bowling	General Bowling Factor	Out Swinger Circle Test	0.965**
		Bowling Accuracy Factor	Out Swinger Bowling Test	0.994**

Development of norms

The research scholar has used the hull scales for preparing norms for each of the skill test items, which were included in the Out Swinger skill test battery for Cricket players.

Table 9: Hull Scale Norms for Out Swinger Circle Test

Hull Scale	Playing Ability Performance Scores	Alphabetical Grades	Interpretative Grades
3σ	More than 9	A^+	Excellent
2σ	>7 & ≤9	A	Good
1σ	>5 & ≤7	B^+	Above Average
0	5	B	Average
-1σ	<5 & ≥3	C	Below Average
-2σ	<3 & ≥1	D	Poor
-3σ	Less than 1	E	Very Poor

Interpretation of Playing Ability Score

Based on table no. 9 (Hull Scale for Playing Ability Performance Scores) a 7 grades scale in both Alphabetical as well as interpretive names was developed for the scores of Out Swinger Circle Test, in that the score that is more than 3σ score (i.e. 9) at the Hull scale was given grade 'A^+' or 'Excellent'. The score which is in between the 3σ score and 2σ score (i.e. >7 & ≤9) at the Hull scale was given grade 'A' or 'Good'. The score which is in between the 2σ score and 1σ score (i.e. >5 & ≤7) at the Hull scale was given grade 'B^+' or 'Above Average'. The score which is equal to mean (5) at the Hull scale was given grade 'B' or 'Average'. The score which is in between the -1σ score and -2σ score (i.e. <5 & ≥3) at the Hull scale was given grade 'C' or 'Below Average'. The score which is in between the -2σ score and -3σ score (i.e. <3 & ≥1) at the Hull scale was given grade 'D' or 'Poor' and finally the score which is less than the -3σ score (1) at the Hull scale was given the grade 'E' or 'Very Poor'

Table 10: Hull Scale Norms for Out Swinger Bowling Test

Hull Scale	Playing Ability Performance Scores	Alphabetical Grades	Interpretative Grades
2σ	More than 7	A	Excellent
1σ	>5 & ≤7	B	Good
0	5	C	Average
-1σ	<5 & ≥3	D	Poor
-2σ	Less than 3	E	Very Poor

Interpretation of playing ability score

Based on table no. 10 (Hull Scale for Playing Ability Performance Scores) a 5 grades scale in both Alphabetical as well as interpretive names was developed for the scores of Out Swinger Bowling Test, in that the score that is more than 2σ score (i.e. 7) at the Hull scale was given grade 'A' or 'Excellent'. The score which is in between the 2σ score and 1σ score (i.e. >5 & ≤7) at the Hull scale was given grade 'B' or 'Good'. The score which is equal to mean (5) at the Hull scale was given grade 'C' or 'Average'. The score which is in between the -1σ score and -2σ score (i.e. <5 & ≥3) at the Hull scale was given grade 'D' or 'Poor' and finally the score which is less than the -2σ score (3) at the Hull scale was given the grade 'E' or 'Very Poor'.

Conclusions

Within the constraints and the limitations of the present study the following conclusions were enumerated:

1. The factor analysis yielded 2 factors for Out-Swing Bowling.
2. A high Reliability, Validity and Objectivity coefficient was established for the selected skill tests of the playing ability battery of Out-Swing Bowling.
3. The highest loaded variables from each factor were selected to construct the Cricket playing ability test battery for 18-22 years, the test items are Out swinger Circle Test and Out Swinger Bowling,
4. Hull Scale norms are established for interpreting the scores.

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