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Reliability and Factorial Validity of Badminton Basic Skill among Badminton Beginner Athletes: *A Preliminary Study*

Yusuf Hidayat*, Yunyun Yudiana, Burhan Hambali, Reshandi Nugraha

Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia

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Abstract This preliminary study aimed to conduct factorial validity and reliability of the Badminton Basic Skills (BBS), involving both outcome-based (quality of hit) and process-based (quality of movement) on two basic skills (BS), namely high service and clear lob. The study was conducted on 20 beginner badminton athletes aged 10 to 12 from two badminton clubs. The instrument used was an adapted action method developed by Novick (1996) for law tennis to measure the constructs, further elaborating on the dimensions, indicators, and behavioral items. Analysis was conducted using Lawshe's CVR formula, exploratory factor analysis, inter rater validity, Pearson Product Moment Correlation, interclass correlation, and Cronbach Alpha. Data analysis showed estimation of content validity (0.25-1.00), factorial validity (0.62-0.83), test and retest reliability (0.80-0.94), and interrater reliability (0.82-0.92). This early validation study confirmed that both outcome and process-based BBS tests could be used to measure and evaluate the BBS acquisition level for badminton beginning athletes aged between 10 and 12 years old.

Keywords Reliability, Factorial Validity, Badminton Basis Skills, Beginner Athletes

1. Introduction

The success of a badminton player is determined by many factors. One of them is basic badminton skills (BBS) acquisition [1–3]. BBS is the ability to perform various basic movement techniques or basic skills needed in playing badminton effectively and efficiently, including the basic skill components of grip, ready position, footwork, and stroke [1,4–7]. The four components of these basic skills complement and strengthen each other. High service and clear lob include basic hitting technique skills, which are generally first things to be taught for novice athletes [1,5], and beginner athletes who have mastered these basic types of strokes are considered to have had the minimum ability to perform simple games in the game of badminton. The BBS is very important to be mastered by novice athletes because it becomes the basis for skill development at the next learning stages and also for the mastery of more complex technical skills [1]. Some reports emphasized that the appearance of correct movement techniques plays a very important role in the success of athletes from early stages of learning [8].

In the process of measuring mastery of movement skills (including BBS), there are two orientations of measurement objectives, namely measuring quality of hit and quality of movement. Tests aimed at measuring the quality of hits include objective or accuracy-based tests, while those oriented towards the quality of movement include subjective rating tests [9]. These two tests are categorized as performance tests [10-12].

Several measurement objectives are related to basic skills in sport, generally more oriented to the quality of hits

which measure the accuracy of the stroke results in a certain target area [4,6,13]. The measurement oriented to the quality of movement is still relatively limited, for example, tests of racquetball skills [14], squash skills [15], and handball [16], including badminton are still very limited, for example, the test developed by several researchers [4,7,17].

Regarding the above description, the main objective of this preliminary study was to develop a BBS test for beginner badminton athletes aged 10-12 years with a goal orientation of measuring the quality of hits and quality of movement. Theoretically, the development of the BBS test is based on the technical framework in the action method developed by Novick in the field of law tennis [18]. This technical framework assumes that an action in sport is related to an initial situation and a goal to be achieved. The initial situation relates to tactical issues about what to do, while the goals to be achieved relate to how or the technique of making the movement. An effective and efficient sports performance can be observed in detail by analyzing its parts, specifically the preparation and the hitting phase. Furthermore, the technical framework in the action method was adapted and modified to develop this instrument, especially for process-based tests (see Figure 1).

The BBS test as a construct based on mastery consists of two sub-tests, namely the high service and clear lob test (see Figure 1). Each sub-test has the dimensions of the preparation phase and hitting phase. The preparation phase dimension consists of indicators of perceiving to target and shuttlecock, body preparation, footwork preparation, and racquet preparation. In contrast, the hitting phase dimension consists of indicators of racquet movement on hitting, body movement on hitting, footwork on hitting, and racquet-shuttlecocks impact. As for the result quality-based BBS test, each sub-test has four indicators in the target area; 0, 1, 2, and 3.

The development of the BBS test will have strategic value, because the testing procedure already has reliability and validity. This validity and reliability lie in the quality of the results and the quality of the process. This instrument is useful for monitoring and providing feedback on the effectiveness of training programs, and for talent scouting purposes [19,20], especially for beginner athletes who have the largest population in the spectrum of badminton coaching levels, and are also ideal assets to be fostered and developed, especially in the badminton sport which is proven to have succeeded in carrying the pride and glory of the nation in the international world [21].

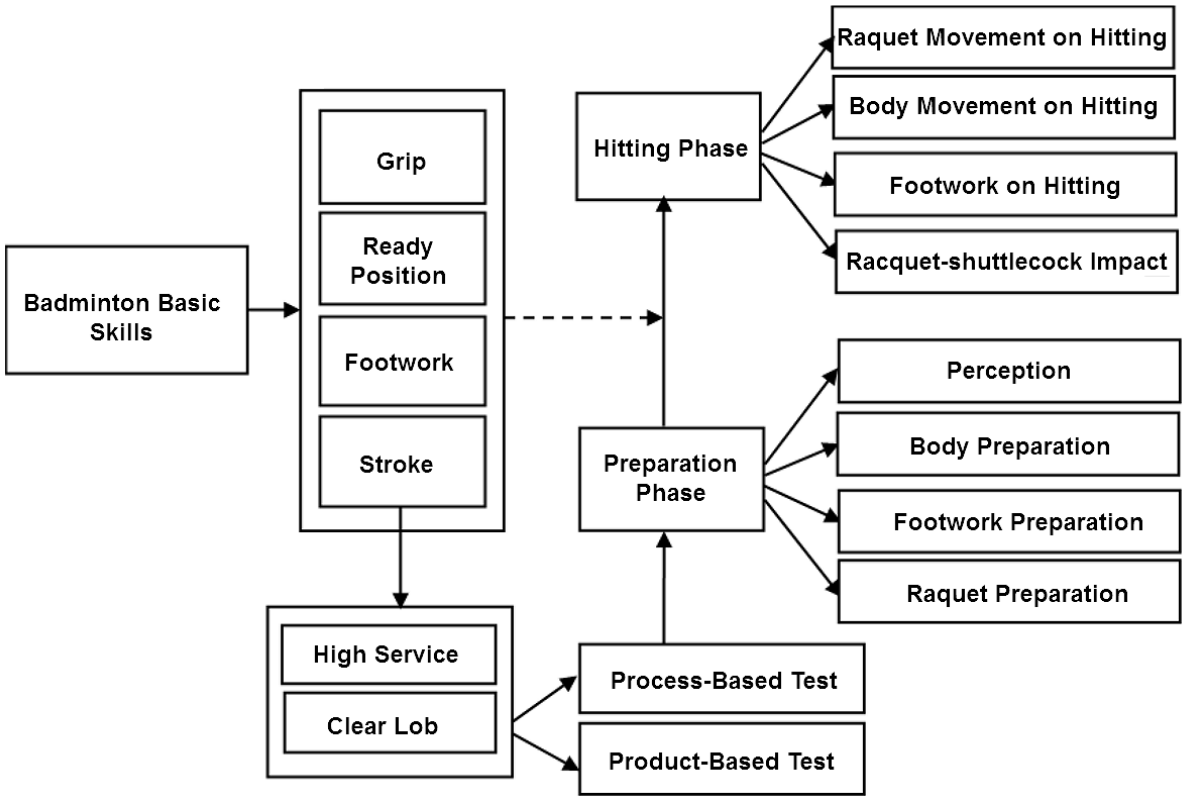

Figure 1. BBS Schematic Constellation Diagram Based on Action Method Framework

2. Materials and Methods

2.1. Participants

The participants involved in this study were 20 beginner badminton athletes aged 10-12 years (M_{age} = 11.5, SD_{years} = 0.42), consisting of 10 male beginner badminton athletes (M_{age} = 11.5, SD_{years} = 0.45) and ten female beginners (M_{age} = 11.4, SD_{years} = 0.40) from the badminton school of Universitas Pendidikan Indonesia and the Bandung City Badminton Club in Indonesia. Participants were selected by using an objective sampling technique [22,23] according to the inclusive criteria, namely (1) male and female beginner athletes, (2) registered and actively participating in training at badminton clubs, and (3) have attended training for between 1 and 2 years.

2.2. Procedure

The research method used in this study was a design-based research aiming to develop, modify, and validate existing models to produce new ones [24,25]. The development of skills tests was carried out through three main stages: (1) the planning and designing phases of the initial product; (2) the expert validation phase, and (3) the trial phase [9,26].

The first phase was planning and designing the initial product, containing activities for compiling and developing the BBS construct, especially those oriented to the quality acquisition process to produce dimensions and indicators. Based on the action method technical framework, the BBS construct was elaborated into dimensions, indicators, and behavioral items, which this is for both outcome-based and process-based tests.

The second phase was the expert assessment, which is a part of the process of validating the content of the developed test or testing the theoretical content of the test. This phase is represented through behavioral items. Thus, the level of conformity with the behavioral indicators to be achieved is known [26]. The content validation process was carried out by five professional judges, consisting of two academics, two nationally certified badminton coaches, and one former international badminton athlete.

The third was the trial phase, the modified BBS test was tested on 20 beginner badminton athletes aged between 10 and 12 years [15,27,28], consisting of 10 male beginner badminton athletes and 10 female beginner athletes from badminton schools.

The trial phase was carried out twice on the same day [9, 12]. Participants hit 12 strokes for each sub-test on each occasion, starting with the high service-BS and clear lob-BS, respectively. Every stroke made was recorded using two digital cameras, and each was to record the process of executing the process-based BBS test, recording the drop of the shuttlecock in the target area for the outcome-based BBS test. The process of implementing the second opportunity was the same as the first opportunity and was carried out according to the order of appearance. The recording results were administered in slow motion for re-observation by the five professional judges. The flow of research and development of the BBS test is presented in Figure 2.

2.3. Data Analysis

The data analysis techniques used to estimate the validity and reliability of the BBS outcome-based test were the following: (1) Content Validity Ratio Lawshe/Lawshe's CVR, used to estimate the content validity of the test based on the assessment of five SMEs [28-31]. (2) Pearson Product Moment Correlation (PPM Correlation) to estimate test and retest reliability [12,32,33], (3) Cronbach's Alpha, and (4) PPM Correlation for estimating criterion-related validity based on expert panels judgment [9,12].

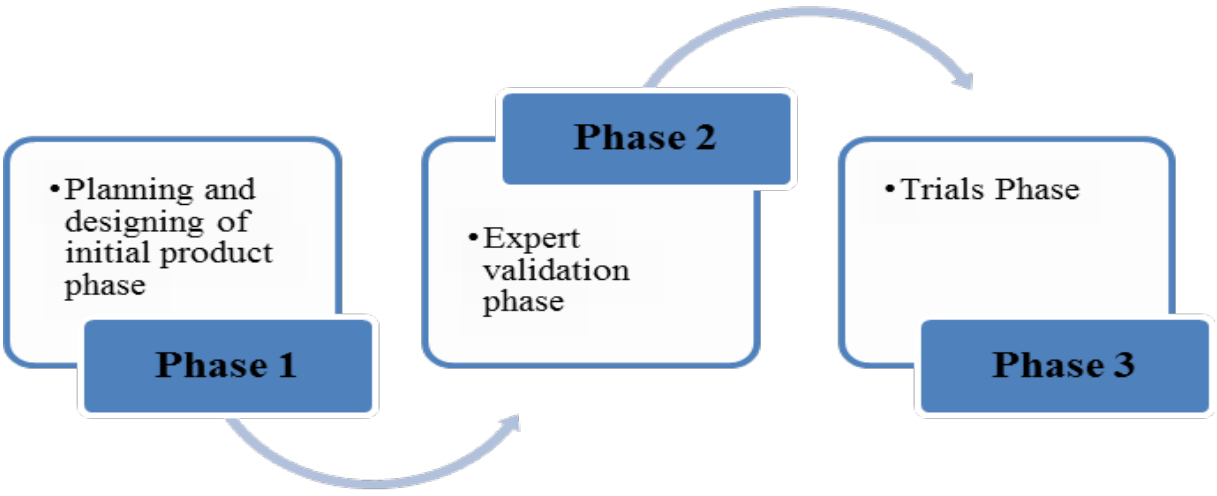

Figure 2. Implementation Stage of BBS Test Development

As for the process-based BBS, the data analysis techniques used are the following: (1) Lawshe's CVR to estimate the validity of the test content based on the assessment of five SMEs [29–31], (2) Interclass Correlation Coefficients (ICC) to see variations between two or more raters which measures the same group of subjects [34,35], and (3) Exploratory factor analysis to estimate construct validity [36,37].

3. Results

3.1. Content Validity

Based on the results of the content validity analysis using the CVR technique, all behavioral items in the outcome-based BBS test have a content validity coefficient index between 0.71-1.00. Coefficient index of the overall outcome-based test of 0.80, respectively 0.81 for high service-BS and 0.79 for clear lob-BS. As for the process-based test, all behavioral items have a coefficient index between 0.25 and 0.90, the overall coefficient index of the process-based test is 0.73, in which 0.71 is for high service-BS and 0.75 for clear lob-BS. Based on the results of the analysis, all content validity coefficient indexes > 0.5, therefore, the BBS test is declared valid, both overall (outcome and process-based test) and in each sub-test, except for items that have a coefficient index of less than 0.5, revised according to suggestions for improvement from experts, until the behavioral items developed can be used in empirical trials. Behavioral items that have a coefficient index of less than 0.5 are the perception items of the shuttlecock direction in the clear lob-BS, which is 0.25.

3.2. Reliability

3.2.1. Descriptive Statistics

Descriptive statistics on the results of the BBS test analysis both for the outcome-based BBS test and the process-based BBS test are shown in Tables 1 and 2. Statistical parameters are expressed in terms of mean (M) and standard deviation (SD), Interclass Correlation Coefficient (ICC), Cronhbach's Alpha (α), and PPM (r) in the category of outcome and process-based BBS test for high service -BS and clear lob -BS (see Tables 3 and 4).

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3.2.2. Outcome-Based BBS Test

The results of the analysis of the test and retest reliability estimation using the PPM correlation analysis technique obtained a correlation coefficient value of 0.94 for high service-BS (Table 3) and 0.83 for clear lob-BS (Table 4), it is proven that all the estimated reliability values for the outcome-based BBS test in both types of BBS exceeded 0.70 (0.83 - 0.94). According to these findings, the outcome-based BBS test is reliable for both high service-BS and clear lob-BS.

Table 1. Descriptive Statistics of the BBS Test for Outcome-Based Test

Time	BBS Test	High Service-BS		Clear Lob-BS	
		M	SD	M	SD
Time 1	MBA	28.1	2.47	21.30	1.90
	FeBA	26.7	1.49	20.00	2.05
	T	27.4	2.19	20.65	2.08
Time 2	MBA	30.1	2.19	23.50	2.06
	FeBA	28.9	1.82	23.20	2.35
	T	29.5	1.82	23.35	2.21
Average	MBA	29.1	2.08	22.40	1.98
	FeBA	27.8	1.61	21.60	2.20
	T	28.4	2.01	22.00	2.15

Note: BBS is the Badminton basic skill; M is the Mean; SD is the Standard Deviation; MBA is the Male-beginner athletes; FeBA is the Female-beginner athletes; T is the Total

Table 2. Descriptive Statistics of the BBS Test for Process-Based Test

Time	Category	High Service-BS		Clear Lob-BS	
		M	SD	M	SD
Time 1	MBA	33.06	1.46	33.30	1.05
	FeBA	32.25	1.09	33.45	0.94
	T	32.65	1.32	33.45	1.00
Time 2	MBA	35.65	1.27	35.60	0.84
	FeBA	34.25	1.09	35.30	1.05
	T	34.54	1.28	35.45	0.95
Average	MBA	34.35	1.27	34.60	0.95
	FeBA	33.25	1.27	34.30	1.01
	T	33.65	1.30	34.45	0.98

Note: BBS is the Badminton basic skill; M is the Mean; SD is the Standard deviation; MBA is the Male-beginner athletes; FeBA is the Female-beginner athletes; T is the Total

Table 3. Descriptive Statistics (Mean ± SD), and Reliability (ICC, α, PPM) of High Service BBS Test

High Service-BS/ Behavior Items & Indicators	Mean ± SD	ICC	α	PPM	SE
Outcome-based Test					
Time 1 (test)	27.40 ± 2.19				
Time 2 (retest)	29.50 ± 1.82				
Test and Retest		-	-	0.94	0.12
Process-based Test					
Preparation Phase	33.50 ± 1.57	0.92	0.92		0.13
PTS	33.00 ± 2.49				
BPre	33.50 ± 1.38				
RPre	34.00 ± 1.49				
Hitting Phase	33.65 ± 1.27	0.83	0.83		0.18
RMoH	33.65 ± 1.60				
BMoH	33.35 ± 1.30				
RS-I	34.00 ± 1,41				
Total	33.65 ± 1.00	0.89	0.89		0.20
				0.85	0.25

Note: PTS is the Perceive the target and shuttle cock; BPre is the Body preparation; RPre is the Racquet preparation; RMoH is the Racquet movement on hitting; BMoH is the Body movement on hitting; RS-I is the Racquet-shuttle cock impact

Table 4. Descriptive Statistics (Mean ± SD), and Reliability (ICC, α, PPM) of Clear Lob BBS Test

Clear Lob-BS/Behavior Items & Indicators	Mean ± SD	ICC	α	PPM	SE
Outcome-based Test					
Time 1 (test)	20.65±2.08				
Time 2 (retest)	23.35±2.21				
Test and Retest Reliability		-	-	0.83	0.34
Process-based Test					
Preparation Phase	34.10±0.79	0.82	0.82		0.14
Bpre	34.20±1.29				
Fpre	33.95±2.12				
Rpre	34.20±1.50				
Hitting Phase	33.20±1,47	0.88	0.88		0.18
RMoH	34.00±1,50				
BMoH	32.20±1,95				
FoH	33.30±2,03				
RS-I	34.30±2,28				
Total	33.70±0.92	0.87	0.87		0.12
				0.80	0.33

Note: Bpre is the Body preparation; FPre is the Footwork preparation; RPre is the Racquet preparation; RMoH is the Racquet movement on hitting; BMoH is the Body movement on hitting; FoH is the Footwork on hitting; RS-I; Racquet-shuttle cock impact

3.2.3. Process-Based BBS Test

The results of the interrater reliability estimation analysis (Table 3) obtained ICC values of 0.89 and Cronbach's Alpha of 0.89 for the overall high service-BS (M = 33.65, SD = 1.00). ICC value was 0.92 with Cronbach's alpha of 0.92 for the dimensions of the preparation phase (M = 33.50, SD = 1.57). ICC value was 0.83 with Cronbach alpha of 0.83 for the hitting phase dimension (M = 33.65, SD = 1.27).

The results of the interrater reliability estimation (Table 4) for the overall clear lob-BS (M = 33.70, SD = 0.92), the ICC value was 0.87 with a Cronbach alpha of 0.87. The dimensions of the preparation phase (M = 34.10, SD = 0.79) obtained the value of ICC of 0.82 with Cronbach's alpha of 0.82. For the hitting phase dimension (M = 33.20, SD = 1.47), the ICC value was 0.88 with Cronbach's alpha of 0.88. Based on the results, it is proven that all the estimated reliability values for the process-based BBS test on the high service-BS and clear lob-BS types exceed 0.70 (0.81 - 0.92). Thus, it can be concluded that the process-based BBS test instrument is reliable.

3.3. Validity

3.3.1. Outcome-Based BBS Test

The type of validity used to estimate the validity of the outcome-based BBS test is criterion-related validity, and the criteria used are the results of the five expert panel judgments [12]. The results of the analysis using the PPM Correlation technique obtained a correlation coefficient of 0.73 for high service-BS and 0.70 for clear lob-BS.

3.3.2. Process-Based BBS Test

The process of estimating the validity of the factorial process-based BBS test was calculated using the exploratory factor analysis (EFA) technique, the stages of the process consist of several factors: (1) calculating the correlation between indicators, (2) extracting factors, and (3) rotating factors [38,39].

Table 5. Correlation Analysis Indicator (KMO and Bartlett's Test)

		High Service BS-1	Clear Lob BS-1	Clear Lob BS-2
KMO-MSA		0.83	0.40	0.62
Bartlett's Test of Sphericity	Approx. Chi-Square	57.23	67.09	50.74
	Df	15	28	21
	Sig.	0.00	0.00	0.00

Note: BS is the Badminton Skills 1; df is the degree of freedom; Sig is the Significance

For the correlation between indicators, the analysis between indicators is intended to determine whether the data for factor analysis requirements are met or not. One of the most widely used analytical methods to calculate the correlation between indicators is Kaiser-Meyer Olkin (KMO). The analysis process uses the KMO MSA measure and Bartlett's Test (see Table 5).

According to the results of the correlation analysis between indicators (see Table 5), it is proven that the KMO MSA value for high service-BS is 0.83 (higher than 0.50) and significant at Bartlett's Test value is 57.23 (sig. 0.00) and all indicators on anti-image matrices show MSA values of higher than 0.5 (0.80-0.90). This means that all indicators are suitable for use in factor analysis. Thus, the factor analysis process can be started.

It is different from the KMO-MSA value for clear lob-BS of 0.40 (less than 0.5). The significant result was obtained at the Bartlett's Test value of 67.09 (sig. 0.00), but there are five indicators on anti-image matrices that have an MSA value less than 0.5, namely the perceived indicator for target and shuttlecock (0.17), footwork preparation (0.31), body movement on hitting (0.34), footwork on hitting (0.37), and racquet-shuttlecock impact (0.42). The five indicators are not feasible to be used in factor analysis and must re-do the correlation analysis between the indicators by issuing the indicator that has the smallest MSA value, namely the perceived to target and shuttlecock indicator (MSA = 0.17). The results of the second analysis show the KMO MSA value for clear lob-BS = 0.62 > 0.5, significant at Bartlett's Test value = 50.74 (sig. 0.00), and all indicators on anti-image matrices have MSA values > 0.5 (0.55 to 0.77). This means that all indicators are suitable for factor analysis. The factor analysis process can be started after issuing the perception to the shuttlecock indicator.

The next step is to perform factor extraction. The method is used to reduce data from several indicators to produce fewer factors that can explain the correlation between the observed indicators [39]. The extraction method used is principal components analysis (see Tables 6, 7, and 8).

The results of the correlation analysis between indicators at high service-BS obtained an index of inter-correlation coefficient between indicators ranging from 0.38, namely the correlation between body preparation and racquet-shuttlecock impact to 0.77, namely the correlation between body preparation and body movement on hitting (Table 6). Meanwhile, for the results of factor extraction using the principal components analysis method, high service-BS is formed into one significant component with a total initial eigenvalues above 1 (λ = 3.86), it has a cumulative variance of 64.35% (see Table 7), and a factor loading value all indicators are above 0.5, ranging from 0.71 to 0.87 (Table 8).

Table 6. Intercorrelation Matrix on all of BBS Indicator

High Servis-BS Indicators	**PTS**	**BPre**	**Rpre**	**RMoH**	**BMoH**	**RS-I**
PTS	1.00					
BPre	0.57	1.00				
RPre	0.54	0.41	1.00			
RMoH	0.55	0.64	0.65	1.00		
BMoH	0.62	0.77	0.59	0.73	1.00	
RS-I	0.55	0.38	0.61	0.51	0.42	1.00

Clear Lob-BS Indicators	Bpre	FPre	RPre	RMoH	BMoH	FoH	RS-I
BPre	1.00						
FPre	-.042	1.00					
RPre	0.28	-0.31	1.00				
RMoH	0.56	-0.19	0.07	1.00			
BMoH	0.17	-0.17	0.43	0.35	1.00		
FoH	0.72	-0.16	0.16	0.60	0.13	1.00	
RS-I	0.31	-0.25	0.33	0.55	0.76	0.44	1.00

Note: PTS is the perceive to target and shuttlecock; BPre is the Body preparation; RPre is the Racquet preparation; RMoH is the Racquet movement on hitting; BMoH is the Body movement on hitting; RS-I is the Racquet-shuttle coks impact; FPre is the Footwork preparation; FoH is the Footwork on hitting

Table 7. Eigenvalues (λ) & percentage of Explained Variance for all principal components

Component	**Initial Eigenvalues of High Service**			**Initial Eigenvalues of Clear Lob**		
	Total λ	**Percentage of Variance**	**Cumulative Percentage**	**Total λ**	**Percentage of Variance**	**Cumulative Percentage**
PTS	3.86	64.35	64.35	-	-	-
BPre	0.81	13.43	77.780	3.10	44.22	44.22
FPre	-	-	-	1.42	20.27	64.49
RPre	0.51	8.49	86.27	0.95	13.59	78.07
RMoH	0.38	6.25	92.52	0.80	11.40	89.48
BMoH	0.26	4.40	96.92	0.35	4.96	94.43
FoH	-	-	-	0.25	3.556	97.99
RS-I	0.19	3.08	100.00	0.14	2.01	100.00

Note: PTS is the perceive to target and shuttle cock; BPre is the Body preparation; FPre is the Footwork preparation; RPre is the Racquet preparation; RMoH is the Racquet movement on hitting; BMoH is the Body movement on hitting; FoH is the Footwork on hitting; RS-I; Racquet-shuttlecock impact

Tabel 8. Correlation coefficients of all High Service-BS, Clear Lob-BS, and with the extracted principal components, Eigenvalues and percentage of Explained Variance

Component	**High Service-BS**	**Clear Lob-BS**	
	Component 1	**Component 1**	**Component 2**
PTS	0.80	-	-
BPre	0.79	0.86	0.06
FPre	-	-0.03	-0.52
RPre	0.79	0.05	0.69
RMoH	0.86	0.79	0.25
BMoH	0.87	0.13	0.85
FoH	-	0.90	0.08
RS-I	0.71	0.44	0.75

Note: PTS is the Perceive to target and shuttle cock; BPre is the Body preparation; FPre is the Footwork preparation; RPre is the Racquet preparation; RMoH is the Racquet movement on hitting; BMoH is the Body movement on hitting; FoH is the Footwork on hitting RS-I is the Racquet-Shuttle Coks Impact

The results of the correlation analysis between indicators in the clear lob-BS obtained an index of inter-correlation coefficients between indicators ranging from 0.31, namely the correlation between footwork preparation and racquet preparation, to 0.76, namely the correlation between body movement on hitting and racquet-shuttlecock impact (Table 6). Meanwhile, for the results of factor extraction using the principal components analysis method, the clear lob-BS is formed into two significant components with total initial eigenvalues above 1 ($\lambda = 3.10$ and 1.42), having a cumulative variance of 64.49% (Table 7) and a cumulative variance of 64.49% (Table 7), and factor loading of all indicators ranges between -0.52 to 0.90 (Table 8).

4. Discussion

The purpose of this preliminary study was to determine the reliability and factorial validity of the BBS test for beginner badminton athletes aged 10-12 years. As is known, badminton is a game that all age levels can play from children to the elderly, and therefore badminton can be said as a "lifetime sport" [14].

The BBS test was developed in three phases, starting with the preparation and development of the initial product test items, the stage of determining content validity, and the stage of testing interrater reliability, test and retest reliability, criteria-related validity, and construct validity. The results of the content validity analysis of five SMEs people using Lawshe's CVR, obtained a coefficient index ranging from 0.25-1.00, both for quality of hits and quality of movement. Coefiein index of the overall outcome-based test of 0.74, respectively 0.81 for high service-BS and 0.79 for clear lob-BS. As for the overall content validity of the process-based test, a coefficient index of 0.73 was obtained, each 0.71 for high service-BS and 0.75 for clear lob-BS. There are items that have a coefficient index value below 0.5, namely the skill test item for quality of movement, each for high service-BS as many as four items and clear lob-BS as many as two items. These items basically have a coefficient index value below 0.50 which is 0.43, because there are two experts who state that there is a lack of match between the items compiled and the indicators developed. This shows that the number of SME's in assessing the items that have been developed in a test instrument and the number of SME's stating that they are appropriate in assessing the suitability of items with indicators can affect the results of item validity using the CVR technique [40–42].

Therefore, it is necessary to make a revision in accordance with the suggestions given by the experts; these suggestions are related to the accuracy of the content of the items compiled based on indicators and the accuracy of the sentences that must be appropriate and can be better understood. On the basis of these suggestions, the items were revised and re-consulted until the experts declared that they were suitable and it was declared that the item was valid in the content validates test. After a revision and based on the results of the analysis, it is proven that the content validity coefficient index is more than 0.50, this means that there is a match between the items that have been developed and the indicators and can be said to be content valid. The findings of this study support several previous studies using CVR as a content validity technique in assessing items that have been developed [24,43,44], including the development of instruments in the context of sports [17,24,25,30]. With the proven CVR values above 0.50 at the content validation stage, the next step is to test empirically on 20 samples. Thus, the estimated value of interrater reliability and test and retest as well as construct validity will be obtained.

The results of the test and retest reliability estimation analysis proved that all the estimated reliability values for the outcome-based BBS test were above 0.70 (0.83 to 0.94). The magnitude of the correlation value between the first test and the second test indicates stability or consistency in measurement, meaning that the test scores obtained by test participants are almost the same between the first test and the second test. Therefore, the outcome-based BBS test has a reliable level of reliability estimation, which shows that the outcome-based BBS test instrument for both basic skills is reliable [17,45]. These results corroborate the findings of previous studies examining reliability in the development of test instruments in the context of sports [17,25,46–49].

As for the results of the interrater reliability estimation analysis on the process-based BBS test using the ICC and Alpha Cronbach analysis techniques, it was found that all the estimated reliability values were above 0.70 (0.81 to 0.92). This means that, overall, the five raters have the same perception in measuring the process-based BBS test. This means that the measuring instrument developed has stability in measuring behavioral aspects of the process-based BBS test [50–52]. In addition, the accuracy of the ICC value as interrater reliability is in accordance with the formula developed by Goodwin [50] that the ICC comes from MSind - MSres / MSind [50,52]. This finding strengthens the results of previous studies using ICC as one of the inter-rater reliability techniques in the context of developing sports test instruments [17,32,46,48,53].

The results of the construct validity analysis using EFA proved that the process-based BBS test instrument has been constructively fulfilled, which is evidenced by the KMO anti-image value above 0.50 by forming into one factor or component for high service-BS and two factors or components for clear lob-BS. The formation of components from the results of the analysis is because for high service there is only 1 factor or component that has initial eigenvalues of higher than 1.00 which is 3.86 with a cumulative percentage of 64.35, while for clear lob-BS it is formed into two factors with initial eigenvalues of higher than 1.00, in which 3.10 is for the first component and 1.42 for the second component with a cumulative percentage of

64.49. Assuming the formation of components for each skill sub-test (high service and clear lob), the results of the analysis show that the constructs of the BBS test developed, both on high service and clear lob skills can be declared constructively valid [36]. This finding strengthens the results of previous studies related to factor analysis testing in the context of developing sports test instruments [19,37,48].

5. Conclusions

Based on the results of the reliability and validity testing of the BBS test instrument that has been developed, both in the outcome-based test and the process-based test, it can be concluded that the overall BBS test is estimated to be valid and reliable. This preliminary validation study proves that the results and process-based BBS test can be used to measure and evaluate the level of BBS mastery for beginner badminton athletes aged between 10 and 12 years.

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