Original Article

Battery test innovation for table tennis skills: Content validity

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ABSTRACT

Table tennis is a sport that requires skill as a determining factor in athletes competing at the elite level. This is inseparable from tests and measurements of athlete skills. This study's objective was to evaluate the battery test's content validity for table tennis skills. This study uses a mixed method of qualitative and quantitative, explorative sequential model design. The Delphi technique was utilized to collect the study data, with the subjects including thirty players of table tennis as well as four professional specialists in the sport as well as three academic experts. This study used an instrument with a rating scale of one to five. Furthermore, the data obtained were analysed using the Aiken formula. The qualitative results explained that the dominant variables of the battery test for table tennis skills that need to be measured included forehand drive, backhand drive, forehand topspin, backhand topspin, backspin service, and topspin service. The results showed that the table tennis skills battery test obtained a value of V = 0.969 for the first aspect, the second aspect obtained a value of V = 0.969, the third aspect obtained a value of V = 0.969, the fourth aspect obtained a value of V = 0.969, the fifth aspect obtained a value of V = 0.906, the sixth aspect obtained a value of V = 0.875, and the seventh aspect obtained a value of V = 0.844. Furthermore, the ICC results show that the average points of each athlete are categorized as good. Based on these results, the table tennis skills battery test has high content validity and has good reliability so the table tennis skills battery test can be used to measure table tennis skills.

Keywords: Performance analysis of sport, Table tennis, Skills, Battery test.

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INTRODUCTION

Table tennis is a primary example of a technique-based sport. Players aiming at the elite level need to develop extraordinary technical skills: the ability to switch quickly to match hitting technique, footwork, flexibility and speed, ability to anticipate and react, precise positioning, and control of balance (Akpinar et al., 2012; Emre & Koçak, 2010; Malagoli et al., 2011). Skill or technique ability is one of the supporting factors because table tennis performance is very complex, considering technical and tactical aspects that require a variety of technically different strokes (Munivrana et al., 2015). Ideally, table tennis skills include forehand drive, forehand topspin, backhand drive, backhand topspin, and services that are often used in games (He et al., 2021; Marsan, 2020; Suisdareni & Tomoliyus, 2021; Tamaki, 2021). Skills are considered a classic constraint in the early stages of development and at the stage of the 8 to 12-year age range, which is an important milestone of opportunity for young high potential players to develop their technical skills as a foundation for reaching elite level *("Critical Periods, Sensitive Periods, and Readiness for Motor Skill Learning*" David, Anderson, Richard, A. Magil, 2020). Therefore, mistakes that can hinder the development of player techniques must be considered in improving player skills (Lehrplanreihe, n.d.).

However, the training method used to determine the increase in table tennis technique skills in these studies has also been used in several previous studies, one of which included the instrument used to determine the technical skills of table tennis athletes (Le Mansec et al., 2018). Instruments also have an important role in the athlete development process. Measurement and evaluation tests in sports are used to determine weaknesses, and strengths, and to guide the design of training programs. This is reinforced by the literature that tests and measurements are important instruments in sports science and for evaluating athletes who are developing potential technical skills (Rietveld et al., 2019). Previous research used forehand and backhand topspin instruments that applied robots, providing 45 trials and target accuracy divided into three targets (Le Mansec et al., 2018). In other research, the service instrument was used to determine the accuracy of the player's serve, the target service was divided into six parts, and ten attempts were made (Van Biesen et al., 2010).

From the results of previous literature reviews, the skills instruments used in the previous studies needed fixing regarding their measurements. Generally, the instruments used had only one element of technical skills and were separate. Accuracy is the main parameter in measurement, but the weakness is in the target, which is only limited to one point (Faris et al., 2022). The game of table tennis requires placing the ball in a part that is difficult for the opponent to reach or makes it difficult for the opponent to return the ball (Djokić, 2020). Therefore, the instrument used has norms in accordance with table tennis performance to evaluate players to make training programs. When an instrument measures the intended outcome with high levels of accuracy and precision, it is considered to be effective or to have a high level of validity (Pojskic et al., 2022; Utama et al., 2023). Therefore, an instrument or battery test for table tennis skills is needed, which has good validity. These previous studies and literature reviews became the basis for this study to perform battery tests for table tennis skills. The purpose of this study was to assess the content validity and reproducibility of the battery test construction of table tennis skills.

MATERIAL AND METHODS

Mixed qualitative and quantitative methodologies were used in this study, using an exploratory type design included in the sequential model to obtain complete and valid data. The stages in this study consisted of four stages, namely: The first stage is a qualitative approach is used, with articles, journals, and textbooks reviewed as part of the literature review process (Ferrari, 2015), which have links with existing table tennis

skill instruments to develop conceptual and operational definitions of table tennis skill instruments. The second stage is applying the Delphi technique to collect the content validity (Cox et al., 2016; Green, 2014; Hsu & Sandford, 2007). To test the design of the table tennis skill battery test building, the Delphi technique was used with the note that the experts did not meet each other in assessing. This technique is used to reach the opinion of experts on a particular subject in a gradual and iterative process (Hasson et al., 2000). The third stage is qualitative analysis, where the input results from expert judgment are analysed for revision until the construction of the table tennis skills instrument is accepted without further improvement (Fraenkel, J. R., Wallen, N. E., & Hyun, 2017) and is given a mark. The fourth stage is testing the results of the experts' assessment with Aiken's formula. The fifth stage of testing the battery test with thirty table tennis athletes analysed using Intraclass Correlation Coefficients (ICC).

Participants

A The subjects in this study included seven qualified experts: four professional table tennis experts and three academic specialists, with a minimum criterion for a coach having a national trainer certificate or a coach who has brought athletes to regional and national level competitions. Thirty table tennis athletes aged 12-16 years with the criteria of having participated in national and regional matches.

Table tennis skills battery test procedure

The purpose of the battery test

The test aimed to measure forehand drive, backhand drive, forehand topspin, backhand topspin, backspin service, and topspin service skills.

Tools

- 20 tennis balls provided to perform the test and 10 spare balls.
- 1 bed.
- Tennis table board and the net.
- Test forms and pens.

Operators

- 1 note taker.
- 1 person as a counter and ball bounce observer.
- 1 person as ball taker.
- An operator for forehand and backhand drive, forehand and backhand topspin using the coach to pass the balls and operate the robot.

Forehand drive and backhand drive performances

- First, the examinees performed warming-ups.
- The examinees stood and held the bed, and when they were ready, they performed the forehand drive movement aimed to the signed area.
- The examinees performed the forehand drive by aiming the balls to Box A first, then to Box B, and then Box C, and performed it repeatedly by alternately directing the target.
- After that, a backhand drive is continued by directing the ball to box A first, after that it is aimed at box B, and then directed to box C, repeated by taking turns directing the target.
- The examinees given the opportunity 20 times in each test with techniques according to regulations.

Forehand topspin dan backhand topspin performances

- First, the examinees performed warming-ups.
- The examinees stood and held the bed, and when they were ready, they performed the forehand topspin movement aimed to the signed area.
- The examinees performed the forehand topspin by aiming the balls to Box A first, then to Box B, and then Box C, and performed it repeatedly by alternately directing the target.
- After that, a backhand topspin is continued by directing the ball to box A first, after that it is aimed at box B, and then directed to box C, repeated by taking turns directing the target.
- The examinees given the opportunity 20 times in each test with techniques according to regulations.

Backspin service performances

- First, the examinees performed warming-ups.
- The examinees stood and held the bed, and when they were ready, they performed the backspin service movement aimed to the signed area.
- The examinees performed the backspin service movement by aiming the balls to Box A first, then to Box B, and then Box C, and performed it repeatedly by alternately directing the target.
- The examinees were given 20 chances using the allowed technique.

Topspin service

- The examinees performed warming-ups.
- The examinees stood and held the bed, and when they were ready, they performed the topspin service movement aimed to the signed area.
- The examinees performed the service by aiming the balls to Box CC first, then to Box DD, and performed it repeatedly by alternatively directing the target.
- The examinees were given 20 chances using the allowed technique.

Marking

- The score taken is when the ball enters the box, it gets a value of 1, if it does not enter the box, it is considered a failure or gets a value of 0.
- Movements that fail and have a value of 0, apart from not entering the box, are as follows: Drive, Topspin and Service Movements that do not comply with the game rules, balls that go out of bounds, balls that do not cross the net (get stuck).
- The total score is the value obtained at each measurement.

Research instruments

The instrument used to collect data in this study was a questionnaire with a rating scale of 1 to 5 which was given at the expert judgment stage, namely 5 = very relevant, 4 = relevant, 3 = sufficient, 2 = not relevant, and 1 = very irrelevant. In addition, another instrument for this research was in the form of score sheets for material experts and sports evaluation experts. Expert assessment sheets were used to find out how relevant conceptual and operational definitions were, stimulus for respondents, (1) items, (2) suitability of the number of targets, (3) target width, and (4) procedures, (5) number of repetitions, (6) sequence stage, and (7) score calculation.

Data analysis

The expert judgement results were analysed using Aiken's formula (Aiken, 1985) as follows:

$$V=\frac{\sum(r_i-l_0)}{n(c-1)}$$

S = r – lo
Lo = lowest rating score
C = highest rating score
R = number given by rater

Figure 1. Formula Aiken's.

Data analysis of inter-point reliability test battery test obtained by athletes using (ICC). According to Fleiss (Fleiss, 1986), the ICC calculation results are divided into four groups as follows: ICC values of 0.40 or lower can be interpreted as a low level of agreement, ICC values of 0.41-0.75 as a good level of agreement, and ICC 0.76-1.00 as a high level of agreement.

RESULTS

Literature reviews results

The result is a collaboration between the results of qualitative analysis with systematic literature review techniques and some input from expert judgment regarding the construction of a table tennis skills battery test. The order of the variables and their images is as follows:

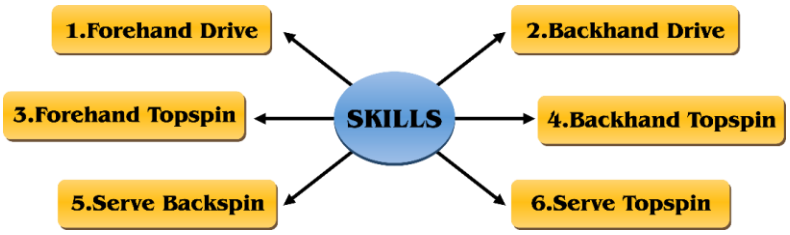

Figure 2. Table tennis skills battery test.

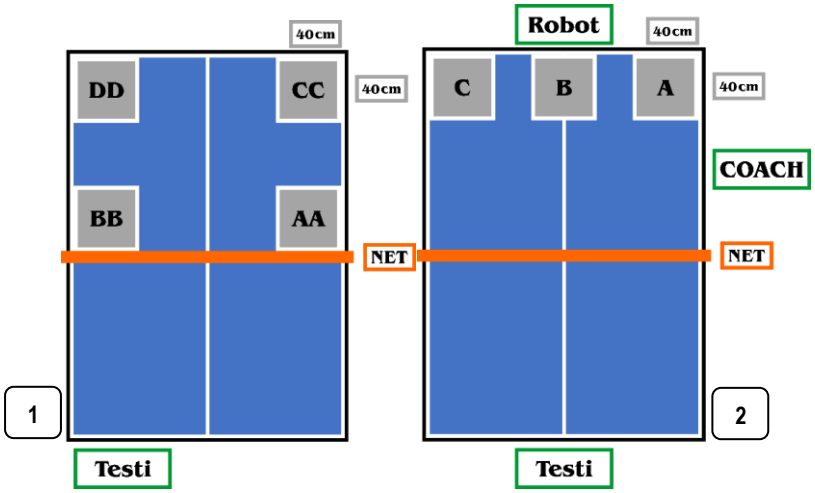

Figure 3. 1. Battery test for forehand drive, backhand drive, forehand topspin, and backhand topspin. 2. Battery test for backspin service and topspin service.

Based on the picture above the results of the literature review, the sequence of table tennis battery test variables includes 1) forehand drive, 2) backhand drive, 3) forehand topspin, 4) backhand topspin, 5) serve backspin, 6) serve topspin. This result is a variable order of implementation of the table tennis player battery test.

The picture above is a battery test instrument used in the assessment of table tennis skills, Figure 3 is the target used Battery test for forehand drive, backhand drive, forehand topspin, and backhand topspin, while Figure 4 is the target Battery test for backspin service and topspin service.

Aiken's validity result

Table 1. Aiken's validity results of tennis table skills battery test.

	Score evaluator							**Rater scale**									**∑ S**	**V**
Aspect 1	5	4	5	5	5	5	5	5	4	3	4	4	4	4	4	4	31	0.969
Aspect 2	5	4	5	5	5	5	5	5	4	3	4	4	4	4	4	4	31	0.969
Aspect 3	5	4	5	5	5	5	5	5	4	3	4	4	4	4	4	4	31	0.969
Aspect 4	5	4	5	5	5	5	5	5	4	3	4	4	4	4	4	4	31	0.969
Aspect 5	5	4	5	4	4	5	5	5	4	3	4	3	3	4	4	4	29	0.906
Aspect 6	5	4	5	4	4	4	5	5	4	3	4	3	3	3	4	4	28	0.875
Aspect 7	5	4	5	4	4	4	5	4	4	3	4	3	3	3	4	3	27	0.844

Based on the results of Aiken's analysis in Table 1, it can be concluded that the suitability aspect of the items used received a value of V = 0.969, the aspect of the number of targets used received a value of V = 0.969, the suitability aspect of target width received a value of V= 0.969, the aspect of the procedure used received a value of V = 0.969, the aspect of the number of repetitions of the implementation received the value of V = 0.906, the aspect of the sequence of tests carried out received the value of V = 0.875, and the score calculation aspect received the value of V = 0.844. The results of Aiken's V analysis calculations show that all aspects of the battery test for table tennis skills can be said to have good content validity because the value of V with eight expert judgments and a 1-5 Likert scale is obtained with a value of > 0.75 (Aiken, 1985).

The results of the battery test used thirty table tennis athletes with age criteria 12-16 years

Table 2. Table tennis battery test results.

Variable	**Participant (n = 30)**		
	Min	Max	Mean and S. D.
Forehand drive	14	20	1.416
Backhand drive	12	18	1.799
Forehand topspin	13	18	1.526
Backhand topspin	9	16	1.906
Serve backspin	8	17	2.128
Serve topspin	8	17	1.918
Total	**76**	**97**	**5.538**

ICC test results

After testing the table tennis test battery using thirty table tennis athletes followed by ICC analysis, the ICC test results are as follows:

Table 3. ICC test results.

Intraclass Correlation Coefficient							
	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.242	.119	.417	3.230	29	174	.000
Average Measures	.690	.486	.834	3.230	29	174	.000

Based on Table 3, the ICC test results show the results of the average points of athletes doing the battery test of 0.690. In other words, the ICC results can be categorized as having good criteria (Fleiss, 1986).

DISCUSSION

This study aimed to test the battery test's content validity for table tennis skills. According to this study, the battery test of table tennis skills showed good content validity and had good reproducibility and could be used to measure the ability level of an athlete. Based on the results of the perception of experts, the aspects of the suitability of items, the number of targets, the suitability of the target width, the procedures used get the same value of 97.5%. In addition, the aspect of the number of implementation repetitions gets a value of 92.5%, the test sequence stage gets a value of 90%, and the score calculation gets 87.5% these results show the perception of experts in assessing the battery test is feasible to use.

Measurement tests and exercises are inseparable activities (Büyükkarci, 2014). This becomes a series of activities in the sports process, especially tests and measurements closely related to sports achievement. Achievement sports require tests and measurements to see the success of the athlete's performance in carrying out a predetermined training program. The evaluation results are used when tests and measurements have been carried out Measurement activities for table tennis certainly require a more effective and efficient touch as an instrument's attractiveness. For this reason, battery tests were developed to simplify testing and measurement. Tools or test instruments that are more meaningful and innovative to support the achievement of athlete performance. According to previous research, the development of measurement instruments is one of the efforts to support individual and team achievements, which requires someone to continue to innovate to make tools with high novelty (Faber et al., 2014).

The battery test for table tennis skills has the advantage that it can include measurements of table tennis performance skills often used by players in matches and practice. These skills include forehand drive, backhand drive, forehand topspin, backhand topspin, backspin service, and topspin service (Wong et al., 2020). Athletes who can master every element of skill can compete at the elite level of table tennis (Zhang, 2021). It cannot be denied that mastery of athlete skills is the dominant factor in competing (Wong et al., 2020). One example is the accuracy of services which is the first step in playing and developing a playing strategy (Đukić & Ivanek, 2020). In addition, forehand and backhand topspin are offensive shots in table tennis performance and are decisive shots for points (Bánkosz & Winiarski, 2018; Hegazy et al., 2020). Therefore, table tennis performance skills need to be developed and can be improved so that athletes can reach peak performance.

Based on the results of this study, it can be stated that the battery test for table tennis skills has high content validity. Furthermore, the ICC test results show good results so that the table tennis skill battery test is needed in measuring the skills of table tennis athletes. The limitation in this study is a measurement test in the form

of a special table tennis battery test.

CONCLUSION

Based on the results and discussion in this study, it can be concluded that the table tennis skill test containing forehand drive, backhand drive, forehand topspin, backhand topspin, backspin serve, and topspin serve has high content validity and has good reproducibility so that it can be used in measuring the ability of table tennis athletes. For the table tennis skills battery test to be more perfect, further research needs to be continued to test the reliability of this battery test.

AUTHOR CONTRIBUTIONS

Hary Widodo, Tomoliyus, and Abdul Alim, conceived and designed the measuring instrument, collected data, analysed and interpreted the data, drafted the manuscript, and approved the final version submitted.

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DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

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