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Content Validity: Air Pressure and Bounce Measurement Tool For Soft Tennis Balls

Yoga Irawan[1]✉, Ranu Baskora Aji Putra[2], Rivan Saghita Pratama[3], Hermawan Pamot Raharjo[4]

[1] Universitas Negeri Semarang, Indonesia; yogairawan696@students.unnes.ac.id
[2] Universitas Negeri Semarang, Indonesia; ranu_baskora@mail.unnes.ac.id
[3] Universitas Negeri Semarang, Indonesia; rivan.saghita.pratama@mail.unnes.ac.id
[4] Universitas Negeri Semarang, Indonesia; hermawan_pamot@mail.unnes.ac.id

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Abstract

This study was conducted to address the lack of objective and accurate measurement tools for assessing air pressure and ball bounce in soft tennis, which are crucial factors affecting game quality and fairness. Currently, ball inspection is often performed using subjective and manual methods, leading to inconsistent decisions by referees. The objective of this research was to develop and examine the content validity of an air pressure and ball bounce measuring instrument specifically designed for soft tennis balls. The study employed a research and development (R&D) approach using mixed methods. Content validity was evaluated through expert judgment involving three experts: a national soft tennis referee, a sports technologist, and an electronics expert. Data were collected using a questionnaire consisting of 20 items rated on a five-point scale and analyzed using Aiken's V formula. The results showed that all items achieved Aiken's V values ranging from 0.83 to 1.00, indicating good to excellent content validity. The findings demonstrate that the developed instrument is valid, relevant, and suitable for measuring soft tennis ball quality. Importantly, the instrument has the potential to improve measurement accuracy, reduce referee subjectivity, and support standardized ball inspection procedures in soft tennis competitions.

✉ Address correspondence:
Universitas Negeri Semarang, Kampus Sekaran, Gunungpati, Semarang
E-mail: (imronnugrohosaputro@students.unnes.ac.id)

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INTRODUCTION

Exercise is an important element in human life that benefits physical, social, psychological, and cognitive health (Eather *et al.*, 2023), not only as a means of maintaining physical and mental health, but also as a forum for achievement development (Sulistyowati & Nurharsono, 2020). The development of achievements needs to be considered as an effort to improve good human quality (Rumbino, 2021). Achieving the highest achievement is the goal of achievement sports (Sari, 2024). However, it is not easy to do because it requires a holistic or comprehensive approach (Holden *et al.*, 2025; Putra *et al.*, 2023; Thompson *et al.*, 2022). In the development of athletes, it must be carried out in a structured, integrated, gradual, and sustainable way, and supported by the application of science and technology in the field of sports (Laoly, 2022; Pratama *et al.*, 2019). The achievement of athlete achievement is influenced by various factors, one of which is science and technology in the training process (Li, 2023). In today's modern era, technology plays an important role in supporting the improvement of athletes' achievements (Frevel *et al.*, 2022; Ratten, 2020).

The use of this technology is not the only factor in an athlete's achievement, but one of the supporting factors in achieving athlete achievements (Rizal *et al.*, 2018). The application of technology in sports has resulted in innovative solutions in the development of athlete performance (Cossich *et al.*, 2023; Xu & Baghaei, 2025). Sports technology allows sports equipment to be more up-to-date, efficient, easy to use, and have more use value (Noury *et al.*, 2022; Won *et al.*, 2023; Yang & Cole, 2022). Technology is now a key supporter in improving game quality, training, and accelerating performance analysis (Huang & Deng, 2020; Radošević & Denić, 2022).

One of the sports that is also experiencing development today is *soft* tennis. *Soft* tennis is a sport similar to court tennis, developed by Japan (Takayama *et al.*, 2023). The way of play and the dimensions of the court are similar to that of court tennis, which differs only in its equipment and the rules of the match (Han *et al.*, 2022; Thongthanapat & Khamros, 2024). The kinematics *of serve* and *soft* stroke tennis are similar to the game of court tennis (Tanabe et al., 2024). The most significant difference is the use of a much softer rubber ball and the use of a lighter, more flexible racket with a lower string tension (M.-K. Kim & Jung-Hee, 2023). *Soft* tennis became the official sport of the Asian Games in 1994 in Hiroshima, Japan, and was first officially competed at the SEA Games in 2011 in Jakarta. *Soft* tennis has also been officially competed at the 2024 Aceh-North Sumatra PON XXI event.

The popularity of *soft* tennis is increasing due to the uniqueness of the game that demands a combination of speed, agility, and strategy (Aoki *et al.*, 2018). In *a soft* tennis match, the characteristics of the ball bounce are one of the most important technical aspects because they directly affect the course of the game. The bounce characteristics of *tennis soft* balls are influenced by the air pressure factor in the ball. A ball with a standard pressure produces a consistent bounce, thus supporting the quality of play. Conversely, a ball with too low or too high a pressure can disrupt the rhythm of the game and even hinder the athlete's skill(Kilit et al., 2024; McLean et al., 2024; Tunçel et al., 2024).

A good understanding of the bounce of the ball is key for athletes to improve their performance and win games. Unfortunately, the method currently used to measure the bounce of the ball is still fairly simple and subjective. Measurements are often done manually or only based on visual observations, resulting in less accurate and consistent results. In the rules of *the game of*

soft tennis, the bounce of the ball is measured by the way the ball is dropped at a height of 150cm and the bounce of the ball after being dropped must be in the range of 70cm-80cm from the floor (International Soft Tennis Federation, 2024).

Based on the results of observations at the PESTI Cup match throughout Indonesia held in Semarang on October 26-27, 2024, players complained about the pressure of the ball to be played, players often protested to the referee regarding the problem of air pressure on balls that were too deflated or too hard. The results of an interview with Rafi Ghalib as the national referee of soft tennis said that the current measurement of ball pressure uses a manual method by dropping the ball at the level of the referee's shoulder and the ball bounce at thigh level. The disadvantage of this method is that there is no definite indicator of whether the ball has been dropped at the height set in the *rules of the soft* tennis game, which is 150cm and whether the ball bounce is right between 70-80cm from the floor (International Soft Tennis Federation, 2024). In addition, this method can cause bias because the inconsistency of the ball bounce is produced, especially the high anthropometry of the referee who leads the match is not the same.

Limitations in accurately measuring air pressure and ball bounce are common problems. Referees often rely only on subjective estimates by pressing the ball or dropping it manually. In fact, without reliable quantitative data, the assessment of the feasibility of a product becomes scientifically unaccountable because there is no guarantee that the measurement results reflect the actual conditions repeatedly (Adetya & Yuliana, 2025). In addition, most of the measuring instruments that exist today are only intended for football sports such as football, volleyball, and basketball.

Research shows that the air pressure inside the ball greatly affects the bounce and initial velocity of the ball. In tennis balls, increased air pressure increases the initial speed and bounce distance, while a decrease in pressure leads to a decrease in bounce and shorter bounce duration (Bjelica et al., 2018). In football and volleyball, pressure variations have been shown to affect ball bounce (Irwanto et al., 2021). However, specific studies on air pressure and ball bounce in the context of *soft* tennis are still limited. Instruments that have been tested for validity and reliability allow coaches and researchers to objectively assess athletes' abilities, so that the results of the evaluation can be trusted and used as a basis for decision-making (Hermanzoni et al., 2024; Hidayat et al., 2024). Without accurate measuring tools, assessments tend to be biased and inconsistent (Buka et al., 2025; McClintock et al., 2021).

The development of sports technology has brought innovations such as digital pressure sensors, high-speed cameras, and smartphone-based applications that have significantly changed the way athletes train, monitor, and analyze performance (Lehti, 2025; Passos et al., 2021; Zhao et al., 2024). However, the majority of these innovations are still focused on popular sports. In *soft* tennis, there has not been much attention in the development of ball measurement technology. The development of air pressure and tennis ball bounce measuring devices can be carried out through experiments, statistical analysis, and conformity testing with international standards. Thus, the results of this study not only make a theoretical contribution, but also practical applications.

The majority of previous research on *soft* tennis has focused more on aspects of the technique, game strategy, or psychology of the athlete (Kusubori & Tanaka, 2023; Thongthanapat & Khamros, 2024). Very few have examined air pressure and ball bounce as determinant variables of the game. This is the research gap that underlies this study. Therefore, there is a need to develop new instruments that are relevant to the needs of the field. With accurate measurement

instruments, this research is expected to improve the quality of *soft tennis competition standards* . A measuring instrument that can be used by the referee to ensure the eligibility of the ball.

Based on these problems, the researcher has the idea to develop a tool that can measure the air pressure and panning of soft tennis balls with device parameters that can determine the air pressure and the height of the ball bounce from the floor in accordance with the rules *of the game of soft* tennis. In line with technological developments in modern sports, the development of this tool will provide benefits to the standard of *soft* tennis competitions. In official matches, this tool can be used to ensure the conformity of the ball with international standard regulations. The purpose of this study is to develop and test air pressure and tennis *ball bounce* devices that are valid, reliable, and applicative. With the existence of air pressure and ball bounce measuring devices in *soft* tennis games, it is hoped that this sport can continue to develop and compete at the national and international levels

METHODS

This research uses research and development methods (Gall et al., 1996). The research combines qualitative and quantitative data analysis approaches to obtain more valid data (Pratama et al., 2025). This mixed-methods approach combines quantitative data, qualitative data collection from expert interviews, and analytical techniques for in-depth analysis. This research involved three experts (national soft tennis referees, sports technologists, and electronics experts). Data collection involves the use of questionnaires. After that, the results will be analyzed using the Aiken's V formula to assess the validity of the contents of the air pressure and bounce measuring soft tennis balls. Content validity is a validity test conducted by experts to assess the feasibility of the content of the test designed in a questionnaire. The goal is to ensure that the test material is consistent with the goal that needs to be measured (Ihsan, 2016). Aiken's (1985) formula for content validity V is used to determine the content validity coefficient by evaluating expert results on the extent to which an item measures constructs (Hendryadi, 2017). The Aiken's V content validity formula is presented below:

$$V = \sum s \,/\, n(c-1)$$

Description:
s = r –Lo
r = number given by rater
Lo = lowest rating
c = highest rating
n = number of raters

The value of Aiken's V coefficient ranges from 0-1. If the index is ≤ 0.4, it is said to have low validity, 0.4-0.8 is said to have moderate validity, and > 0.8 is said to be very valid (Retnawati, 2016).

RESULTS AND DISCUSSION

Expert Judgment is carried out by 3 experts consisting of (national soft tennis referee, sports technologist, and electronics expert). Data was collected using a questionnaire assessed by experts using a rating scale of 5 with 20 statements/questions asked to the expert. The validation results showed that the design was feasible to continue with several improvement notes, especially related to sensor stability. The following are the final results of the score that has been carried out by the validator and has gone through the data analysis stage using the calculation of the Aiken formula to

determine the validity of the content of the tool that has been developed.

Table 1. Results of Content Validity Test with Aiken Formula

	Expert						SS	n(c-1)	V
	A	S1	B	S2	C	S3			
Item 1	5	4	5	4	4	3	11	12	0,92
Item 2	5	4	4	3	5	4	11	12	0,92
Item 3	5	4	4	3	4	3	10	12	0,83
Item 4	5	4	5	4	5	4	12	12	1
Item 5	4	3	4	3	5	4	10	12	0,83
Item 6	5	4	4	3	4	3	10	12	0,83
Item 7	5	4	5	4	4	3	11	12	0,92
Item 8	4	3	4	3	5	4	10	12	0,83
Item 9	5	4	4	3	4	3	10	12	0,83
Item 10	5	4	4	3	5	4	11	12	0,92
Item 11	5	4	5	4	5	4	12	12	1
Item 12	4	3	5	4	4	3	10	12	0,83
Item 13	4	3	5	4	5	4	11	12	0,92
Item 14	5	4	5	4	4	3	11	12	0,92
Item 15	4	3	4	3	5	4	10	12	0,83
Item 16	5	4	5	4	4	3	11	12	0,92
Item 17	4	3	5	4	4	3	10	12	0,83
Item 18	5	4	5	4	5	4	12	12	1
Item 19	5	4	4	3	4	3	10	12	0,83
Item 20	5	4	5	4	5	4	12	12	1

The results of Aiken's V analysis in Table 1 show that all statements have good to very good content validity. The first item related to the need for a tool to check the quality of the ball before the match obtained a V value of 0.92, which indicates a high level of relevance. The second point regarding the ability of the tool to improve the accuracy of measuring the quality of the ball also obtained a V value of 0.92. Furthermore, the third point related to the ability of the tool to replace the conventional method of checking the ball obtained a V value of 0.83, which indicates a fairly good validity of the content. The fourth point related to the need for referees to measure air pressure and ball bounce obtained a perfect V value of 1.00, which signifies the full agreement of the experts. The fifth item that assesses the increase in the efficiency and effectiveness of the referee in the measurement obtained a V value of 0.83. In terms of functionality, the sixth point related to the accuracy of the tool in measuring the air pressure of the ball obtained a V value of 0.83. The seventh point regarding the accuracy of the tool in measuring the bounce of the ball obtained a V value of 0.92.

The eighth item that assesses the consistency of measurement results when the tool is used repeatedly obtains a V value of 0.83. The ninth point related to the speed and accuracy of the tool in measuring air pressure and ball bounce obtained a V value of 0.83. Meanwhile, the tenth item regarding the conformity of measurement results with the applicable standards obtained a V value of 0.92. In terms of convenience the eleventh item related to the ease of operation of the tool obtained a V value of 1.00. The twelfth point regarding the clarity of the tool usage guide obtained a V value of 0.83. The thirteenth point which assessed the ease of installation and use of the tool obtained a V value of 0.92. The fourteenth item regarding the use of tools without the need for special skills obtained a V value of 0.92. The fifteenth item related to the ability of the tool to be used in various field conditions obtained a V value of 0.83. In terms of benefits, the sixteenth point related to increasing objectivity in assessing the quality of soft tennis balls obtained a V value of 0.92. The seventeenth point regarding the improvement of the efficiency of checking the ball before the match obtained a V value of 0.83. The eighteenth point which assesses the role of the tool in helping the referee obtain a V score of 1.00. The nineteenth point related to the ease of measurement of a

soft tennis ball obtained a V value of 0.83. Finally, the twentieth point related to the reduction of referee subjectivity in assessing the quality of the ball obtained a V value of 1.00. Overall, the value of Aiken's V which is in the range of 0.83 to 1.00 indicates that all instrument items are declared valid in terms of content and suitable for use to assess the quality of the soft tennis ball measuring instrument developed.

DISCUSSION

The results showed that the soft tennis ball quality measuring instrument developed had excellent content validity, with Aiken's V value in the range of 0.83–1.00 which emphasized the importance of content validity as the main foundation for the feasibility of technology-based measuring instruments.

Research by Retnawati (2016) asserts that Aiken's V value ≥ 0.80 indicates strong expert agreement and reflects the representativeness of the measured construct. These results strengthen the findings of this study, where all indicators are considered relevant by cross-disciplinary experts, so that the instrument is declared conceptually and substantially feasible. The use of sensor-based tools and electronic systems in sports can improve measurement accuracy as well as reduce reliance on subjective judgment (Prabha et al., 2024). These findings are relevant to the results of the study which showed high validity values in the indicators of the accuracy of air pressure measurement and ball bounce, as well as the reduction of referee subjectivity.

Recent research also highlights the importance of technology in supporting referee decisions and match standards (Thare Hani et al., 2025; Zglinski, 2022). Spitz et al. (2021) states that objective measurement devices play an important role in improving decision consistency and fairness in competitive sports. The high Aiken's V value on the indicator of increasing the objectivity and work efficiency of referees in this study supports these findings, especially in the context of pre-match ball quality.

Aspects of reliability and consistency of the tool, must have consistency of measurement results so that they can be used repeatedly (Rasyid et al., 2025). A good validity value on the instrument usage consistency indicator indicates that the developed tool has met the basic criteria of reliable instruments according to research standards. Study by Kim et al. (2025) It shows that the ease of use in the application system increases the effectiveness and efficiency of the user's tasks. The findings of this study, which show that Aiken's V value is very high in the indicator of ease of use and reinforce the relevance of the research results to practical needs in the field.

The expert validation approach used in this study is in line with the development model Borg & Gall (1983), which emphasizes that expert input is the basis for product refinement before field tests for refinement in the early stages of technology-based sports equipment development. The results of this study are consistent with the view that content validity is an important foundation in the development of effective test instruments that can be applied in sports practice. Studies related to tests and sport measurement confirm that the validation process, especially through expert involvement, is an important stage to produce a truly representative measuring tool against the constructed being measured (Triardhana et al., 2024).

These findings underscore the importance of technological innovation in sports. According to Frevel et al. (2022), The integration of technology in sports has brought significant changes, both in training and monitoring athletes' performance (Frevel et al., 2022). Thus, this research provides a strong scientific contribution and has real implementation potential in improving the quality of referees and soft tennis matches.

CONCLUSION

Based on the results of the research and discussions that have been carried out, it can be concluded that the soft tennis ball quality measuring instrument developed, which includes the measurement of air pressure and ball bounce height, has excellent content validity. This is proven by the results of the content validity test using the Aiken's V formula, which shows that the coefficient value is in the range of 0.83 to 1.00 for all 20 statements items. This value indicates a high level of agreement among experts on the relevance and suitability of each instrument indicator. The validation process involving three cross-field experts, namely national soft tennis referees, sports technologists, and electronics experts, showed that the developed tools were considered feasible conceptually, functionally, and practically. This instrument is considered to be able to improve the accuracy and consistency of air pressure measurements and ball bounce, while reducing the referee's subjectivity in the process of checking the ball before the match. In addition, the results of this study confirm that the air pressure and soft tennis ball bounce measuring device developed has met the content validity criteria and is suitable for use as a supporting instrument in referees and soft tennis matches

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