

Design validity and reliability of test instruments for measuring football heading accuracy and coordination

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ABSTRACT

This study aimed to design, validate, and test the reliability of test instruments for measuring the accuracy and coordination of football headings. The research design employed a research and development approach based on the Gall and Borg developmental steps, which encompass needs analysis, product development, expert assessment, Group I test, Group II test, and the final product. A total of 100 male football players and 100 female football players participated in evaluating the design of the soccer heading skills test instrument. Three experts were invited to assess validity. Data analysis was performed using Aiken V to assess validity and Cronbach's alpha to assess reliability. The results indicated the following: (1) needs analysis, based on observation, found that football players' heading mastery was still low; (2) product design included numbered targets within the goal, comprising 10 points, the implementation of a header toss by the examiner during the heading test, and the specification of the heading zone; (3) the results of the validity test based on the expert's assessment showed an Aiken V value of $0.86 > 0.77$ so that it was stated that the football heading test instrument was valid; (4) the test results for group I showed a reliability value of > 0.60 (0.878 for male players; 0.810 for female players) thus indicating consistency in the developed heading test instrument; (5) the test results for group II also showed a reliability value of > 0.60 (0.828 for male players; 0.802 for female players) thus indicating consistency in the developed heading test instrument; (6) the test results showed that the heading test instrument is valid and reliable so that the designed test becomes the final product. This heading test instrument can be used as a normative reference to measure the accuracy and coordination of football headings.

KEYWORDS

Design; Validity; Reliability; Instruments; Football

1. INTRODUCTION

Football is a team sport played by using a ball by two teams, consisting of 11 players from each team (Ćwiklinski et al., 2021). A good, strong, and tough team is a team capable of displaying a cohesive game, meaning that the team is good when there is good team work. To get a formidable cooperation, a team needs players who control parts of the various basic techniques of playing football. The quality of each player's basic playing techniques related to physical and tactical conditions will determine the level of play of a football team. The better the mastery level of playing basic techniques in playing and controlling the ball is, the faster and more accurate collective cooperation will be achieved. As a result, the teams will have longer ball possession which will have physical and tactical benefits for the team. Attractive football requires having a variety of techniques, a variety of game views, and players' personality to enable them to cope with all the situations that can occur during a match (Li et al., 2018).

The role of a coach is teaching football basic playing techniques properly, with hopes that the training can produce players with personality and sportsmanship. The quality of a team is determined by mastery of basic football techniques. Football is basically an attempt to control the ball, or to reclaim it when it is being controlled by an opponent. If the basic techniques are mastered, the ball will be in control longer. Maintaining possession of the ball is a tactic that must be mastered by players in the football game. The tactics are played by the team in a match in order to be superior to the opponent (Li et al., 2018). Teams that do not master basic techniques lose the ball more often.

Basic techniques are techniques where the process of movement is the basis, and the movement is in simple and easy conditions. Technique mastery factor can be owned by regular, programmed, serious, and continuous practice. By mastering the basic techniques, football players can easily control the ball with their feet, legs, body, and head quickly and carefully. Football technical skills are passing, shooting, heading, and dribbling (Ganesh et al., 2019).

Heading is a contact between the head and the soccer ball in the air (Smith et al., 2021). Heading is a basic technique that is unique and must be mastered by players. With ball heading, the player can score a goal against the opponent's goal when attacking. Similarly, the skills are needed in defense when blocking the opponent's attack through the air. Therefore, football players in every position such as forward, middle, back, and even goalkeeper have to master the heading technique in various ways according to their needs. Through heading, players can use their head to direct the ball towards the target in a football game (Wahlquist & Kaminski, 2021). In its development, the football game now often utilizes attacks from the right and left flanks and uses pull bait to the penalty area to

take opportunities from these drags only with the correct heading technique in fast situations and to block the ball for defenders.

In fact, through observations, it was found that the mastery of football heading was still low in which the player had not been able to pass the ball to a fellow team correctly and could not put the ball into the goal by using the heading technique. The football performance increase faces obstacles due to the lack of theory development, use of training methodologies, development of instruments supported by various scientific disciplines, and improvement in sport coaching training quality. Training results need to be tested to determine the training's success or failure, and thus a test instrument is needed. In fact, the heading test instrument used at this time has not been developed. Currently the heading test instrument is carried out in a standing position. However, in competition headings are performed not only in a still position, but also in a running position.

In the Rosch instrument (Rosch et al., 2000) there has been a development with 2 tests carried out in still and running positions to receive the ball, but only using goals without target numbering, and there is no norm for football heading test results. Due to this limitation, it is necessary to develop a heading test instrument with a running position and a target numbering in the goal. In research, interpretation of results depending on the validity of the tools used, so researchers need to ensure the instrument validity. Instrument validity assesses the extent to which measurement instruments are designed for measurement. Reliability refers to a measurement that provides consistent results with the same value. Validity and reliability indicate the extent to which the instrument is error-free, and therefore guarantee consistent measurements across time and instrument items. Reliability is the stability of measures given at different times in the same individual and the equivalence of the set of items from the same test. This study aims to design, validate, and test the reliability of the test instrument in measuring the accuracy and coordination of football headings.

1.1. Literature Review

Instrument Development

An instrument is an indication that assesses the expected attitudes, behavior, and circumstances. The development and validation of instruments are essential for research efforts (Bichi et al., 2019). Development is a conceptual framework that is procedural in nature from the embodiment of a theory or a representative of the processes and variables included in the theory in the form of a pattern or design that can be used as a review in the development of an activity program as a tool that helps to get information, ideas, skills, values, mindsets, and to derive other information from players' self-expression to help conceptualize a representation of reality. Development research

is an activity needed to improve performance (Ghaffar & Khan, 2014). Research-and-development is a cycle that begins with a need requiring a solution by using a particular product. The development research procedure basically consists of three steps, namely a preliminary research, product testing, and implementation in achieving the goal. Preliminary research is carried out by identifying problems found in the field, analyzing instrument requirements, planning and compiling materials. Product testing is carried out by testing, evaluation, and revision, used to see the achievement of the goals and objectives of collecting appropriate data by the instrument. Implementation is performed after the developed product meets two criteria, namely assessment and performance criteria.

Football Headings

Heading is a form of ball maneuvering using a football player's head (Sandmo et al., 2020). The right heading technique requires neck muscle strength with head acceleration when it comes into contact with the ball (Snowden et al., 2021). The movement of ball heading involves positioning the whole of body in an arched position, tensing the neck, hitting the ball on the forehead, keeping the eyes open, pushing the head forward or sideways, and maintaining stability with both hands at the sides of the body. Ball heading in football game are used to pass the ball to a friend to put the ball into the opponent's goal and to sweep the ball in his own defense and break the opponent's attack (Perroni et al., 2018). Heading techniques are described as follows:

1. The basic technique of ball heading in standing position

The technique of ball heading with this position is often used to pass the ball to a friend. The technique will be described as follows: (a) The body position faces ball direction, the legs stand astride forward with the knees slightly bent, (b) The body is pulled back, the posture is leaning backward, the neck muscles are strengthened until the chin is against the neck, and the gaze is directed towards the arrival of the ball, (c) All body weight is brought forward, the body is leaning forward until the forehead is right on the ball and continued motion towards the target by lifting the back of the legs forward followed by running into the planned position.

2. The basic technique of ball heading during running

Ball heading in a running position is often used in football games to put the ball into the opponent's goal or save action. The techniques are described as follows: (a) The running player picks up the direction of the ball with the eyes fixed on the ball, (b) The neck muscles are moved, then the chin is pulled closer to the neck, (c) The body is pulled back and arched to the waist area, then moved to the whole body so that the forehead can hit the ball, (d) When heading the ball, the eyes should be

kept open and always follow ball direction, and then followed by further motion to immediately run to find a position.

2. METHODS

This research is developmental research that adopts Gall and Borg's research steps, as modified by the researchers (Borg, 2014). The research samples were 200 male and female professional football players, consisting of 100 male players and 100 female players. To test the instrument validity, we used 3 experts, namely a football coach holding license as a coach and a professor of sport science. Experts were given a questionnaire to investigate their opinions regarding the instruments being developed. Expert assessment used a Likert scale ranging from 1 to 5, used to provide a scientifically accepted and validated measurement (Joshi et al., 2015). The players performed heading test for 2 times in different times, where every player was given the three trial opportunities.

The instrument validity test was based on expert assessment by using the Aiken V coefficient. This coefficient allows interpretation of the relevance of a particular item by an expert group. To achieve a critical value with a 95% confidence level, an Aiken V value of 0.69 was required, while to achieve a 99% confidence level an Aiken V value of 0.77 was required (García-Ceberino et al., 2020). Therefore, if the Aiken V value was greater than 0.77, the instrument was considered valid. Aiken V value was calculated by using the following formula:

$$V = \frac{\sum s}{[n(c - 1)]}$$
$$s = R - Lo$$

Where *s* is the significance level, *R* is the value of the expert. *Lo* is the minimum value in an item, *n* is the number of experts, and *c* is the maximum value in an item. Meanwhile, the reliability testing used Cronbach's alpha. If the value was greater than 0.60 then the instrument was declared reliable/consistent.

3. RESULTS AND DISCUSSION

3.1. Need Analysis

A need analysis was carried out to identify problems. The researchers conducted field observations and discussion with football experts. The observations results found that the mastery of football headings was still low, in which players could not pass the ball to a friend correctly and could not put the ball into the goal by using the heading technique. Based on the expert discussion, it

was concluded that the previous heading test instrument only used goal targets without any target numbering and there was no norm for the results of the football heading test.

3.2. Product Development

The researchers developed an instrument based on the Rosch heading instrument (Guskiewicz et al., 2000). In the Rosch test, the test is carried out twice with the help of the examiner throwing the ball to the player. In contrast, in the instrument developed by the researcher on heading test for male and female players, there are 10 target numbers in the goal: 3 numbers in the right, 3 numbers in the left, and 4 numbers in the middle. In the male player heading test, the implementation of the test was assisted by an examiner who stood at the side of the goal, 5.5 meters forward and threw the ball from the side of the goal to the players while the players positioned themselves 14 meters from the goal. We set the heading zone in the development of the male player’s heading test, which was 3 meters from the penalty point. For the female player heading test, the examiner stood on the left side of the goal and then threw the ball to the players who stood 8.5 meters from the goal. We set the female player’s heading zone which is 3 meters from the goal area.

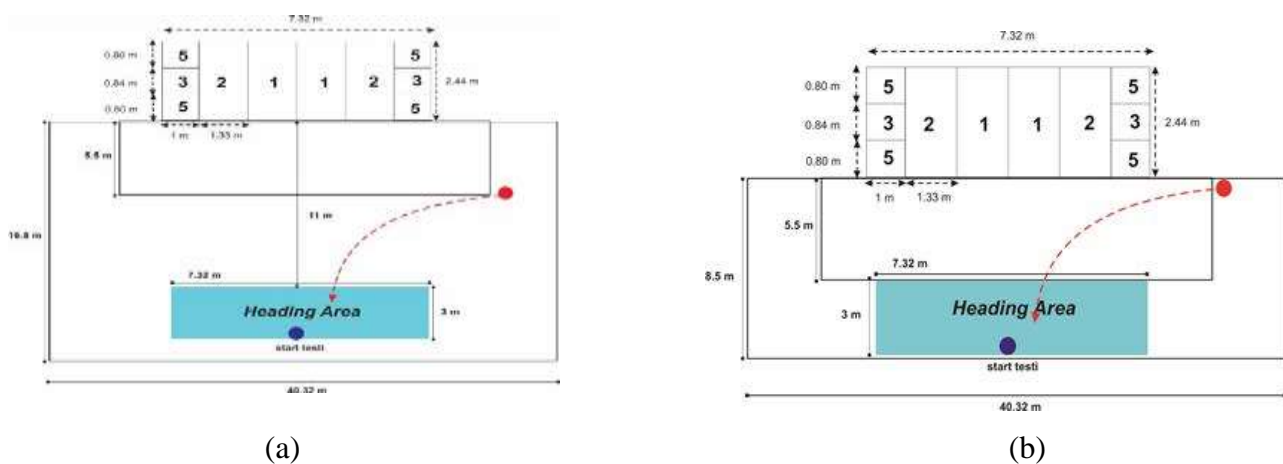


Figure 1. Initial Products (a) Male Player; (b) Female Player

Table 1 displays the results of expert assessments. According to the table, the Aiken V value was determined to be 0.86, exceeding the threshold of 0.77. Consequently, it can be concluded that the football heading instrument is deemed valid and thus suitable for group testing.

3.3. Group Test (I)

Table 2 presents the results of the reliability test for the initial heading test, which involved 200 football players. Each player was given three chances to perform heading. It was observed that the reliability value exceeded 0.60. Consequently, it can be concluded that the developed instrument is reliable and consistent for measuring football headings. Moreover, in order to assess the consistency of the developed tests, the researchers conducted additional group testing.

Table 2. Reliability of the Heading Test (I)

Subject	Reliability	α (significance)
Male Player	0.878	0.60
Female Player	0.810	0.60

3.4. Group Test (II)

Table 3 displays the results of the reliability test for the second heading test, which also involved 200 football players. Similar to the previous testing, each player was given three chances to perform heading. It was observed that the reliability value exceeded 0.60. Therefore, it can be concluded that the developed instrument is reliable and consistent for measuring football headings.

Table 3. Reliability of the Heading Test II

Subject	Reliability	α (significance)
Male Player	0.828	0.60
Female Player	0.802	0.60

3.5. Final Products

After the developed instrument underwent an expert validation process and reliability tests on a group of male and female football players, a valid and reliable heading test instrument was produced. The following describes the heading test along with the implementation instructions and assessment norms.

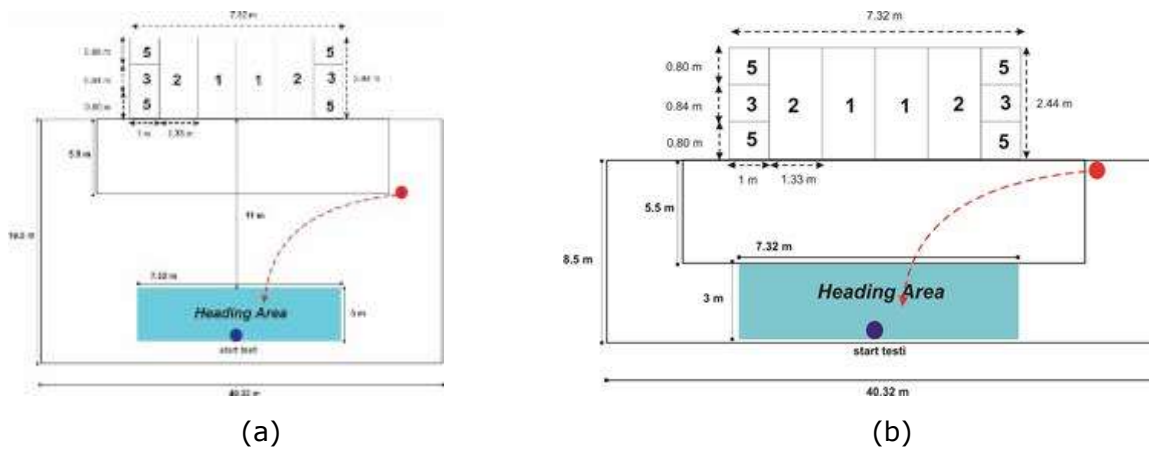


Figure 2. Final Product (a) Male Player; (b) Female Player

This test measures heading accuracy and coordination of male and female football players. The necessary equipment is: 3 balls; a chalk to create a field; measuring tape; a target area of 7.32 meters x 2.44 meters; a field, measuring 40.32 meters x 16.5 meters for men, and 40.32 meters x 8.5 meters for women; a 3-meter heading zone. To implement this test it is necessary one examiner and one person who records the results. The player stands in the starting position. The examiner makes a rebound throw to the heading zone. The player waits for the ball, then runs to receive the ball, and performs heading in the heading zone to the goal which is divided into several score points. Each player is given 3 chances. The score is recorded according to the number of balls that hit the score point and then accumulated.

Table 4. Heading Assessment Criteria

Category	Information	Male	Female
A	Very good	> 13	> 12
B	Good	9 – 13	8 – 12
C	Somewhat Good	7 – 9	5 – 8
D	Less Good	6 – 7	2 – 5
E	Not Good	<6	<2

Almost all over the world, football is considered the most popular sport. There are two teams of eleven players, and thus teamwork and skills from each individual which contains elements of physical condition and basic technical mastery are needed (Bhagat et al., 2020). Football involves perceptual, cognitive, and motor skills in the competitive environment (Bergkamp et al., 2021). Four basic skills must be mastered by players: dribbling, passing, heading, shooting. The skills must be performed in high-level matches. Football players are required to always be on the move and make immediate decisions during attack and defense. Heading is a basic technical skill in football games which uses the head, to be precisely with the forehead. Ball heading in football game is used to pass

the ball to a friend to put the ball into the opponent's goal and to sweep the ball in his own defense and break the opponent's attack. Heading technique is important in football game, since it can be used in attack and defense. Therefore, the technique needs to be instructed by the coach in depth. In training heading techniques, it is necessary to measure training results by using a heading test instrument. Instrument is a general term used by researchers as a measuring tool (Shangraw, 2017). Therefore, an instrument is a measuring tool used to obtain information, either quantitative or qualitative.

This is a development research with a product of a football heading test instrument. Development research attracts new findings validated by experts who can be proven and further developed (Ringuet-Riot et al., 2013). The researchers validated the instrument with 3 experts. A test instrument requires incorporation of elements identified by the expert panel, ease of use by athletes, and practicality for use in a variety of test locations. Validity testing aims to achieve the level of accuracy and suitability through review (Li & Ross, 2021). Validity shows the accuracy of the measure (Graham et al., 2021). Aiken V value was 0.86, meaning that the instrument developed was considered valid and could be tested in a group. Group testing was used to test the reliability of a measuring instrument. Reliability evidence is a requirement to guarantee the quality of measuring instruments (Mohajan, 2017). Test-retest reliability measures stability in repeated measurements (Noble et al., 2021). The test-retest was conducted on 200 football players. The reliability values of the first and second male heading test were 0.878 and 0.828 respectively while the reliability values of the first and second female heading test 0.810 and 0.802 respectively. This showed that the instrument had high consistency in measuring football headings. A test with high consistency means that it is accurate, reproducible, and generalizable against the same test opportunities and instruments. This developed instrument measured more varied player skills, such as the ability to pay attention to the ball direction and to position the heading attempt.

4. CONCLUSIONS

The instrument developed is valid and reliable. It can be used as a normative reference for measuring football heading skills.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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