Evaluation of the Impact of Soccer Shoe Stud Design on the Performance of Non-Professional Soccer Players

Amir Supriadi[1*], Mesnan Mesnan[1], Budi Valianto[1], Muhammad Reza Adistya[2], Armansyah Maulana Harahap[1], Hazri Bimantara Ritonga[3], Ima Pareme Oppu Sunggu[3]

[1] Physical Education Health and Recreation , Faculty of Sport Science, Universitas Negeri Medan, North Sumtara, Indonesia
[2] Sport Science, Faculty of Sport Science, Universitas Negeri Medan, North Sumatra, Indonesia
[3] Master of Sport Education , Faculty of Sport Science, Universitas Negeri Medan, North Sumtara, Indonesia
amirsupriadi@unimed.ac.id

Abstract. Soccer is the number one sport in the world in terms of both popularity and technological development. Its popularity and rapid development turned soccer into a huge industry, where winning is the most important goal in thesport. The intense competition makes all teams want to win. Football competitions have now reached the amateur level with the aim of finding hidden talents in the game. Therefore, investment in research in science and technology is deepening to support the need to find strategies to improve the performance of amateur soccer athletes to achieve these results. Some adaptation changes in soccer occur as technology develops, changes in field types, training types and equipment types. These changes are used by coaches and analysts in the world of football to find gaps in the performance development of existing soccer players. One of the most visible changes is the number of soccer shoes with different types of designs, from the type of surface design to the type of shoe pul design. Soccer shoes are considered the most important tool in an athlete's performance during training and matches. With the increasing number of design models available in the market, it is important to review the interaction effects of different puled soccer shoes on athlete performance. This review is aimed at identifying and evaluating the type of soccer shoe that best responds to the needs of teams based on different positions in improving the performance of amateur soccer athletes. In this research, performance analysis is used with stages based on ergonomics in sports and performance assessment by the coach, the results obtained are in the form of recommendations for the type of shoe that is most suitable for use on the synthetic field of the Medan State University Stadium for amateur soccer players, then recommendations for the most suitable type of soccer shoe per position and further analysis of the *Key Performance Index* given by the coach.

Keywords: Sport Ergonomics, Ergonomics in Sport, Performance Measurement, Performance Analysis, Performance Enhancement, Key Performance Index.

I. I. I. Pane and Y. Putri (eds.), *Proceedings of the 2nd International Conference of Sport Science, Sport Coaching Science, and Physical Education, Health and Recreation 2025 (ICOSSCOPER 2025)*, Advances in Social Science, Education and Humanities Research 1022,
https://doi.org/10.2991/978-2-38476-591-1_3

1 Introduction

In the development of the world of sports today, soccer is one of the most popular sports in the world, both from the number of players to the number of supporters (*fans*). In 2017, Fédération Internationale de Football Association (FIFA) calculated that 265 million people actively play soccer around the world[1]. This represents 4% of the world's population. Of these, around 25% are amateur players. Then, for now there are 209 recognized countries for men and 177 women listed in the FIFA World ranking list. Football is a multi-billion dollar business with the richest club Real Madrid, valued at $3.44 billion and the average salary for players in the English Premier League around $3.7 million per year. Investment in the field of sports science and fields to improve performance lags behind player salaries despite the tendency to explore all avenues to improve player and team performance[2]. Therefore, investment in research in this field of science and sport to support the need to find strategies to improve athlete performance is important, but it is also fundamental for management and coaches to get the most out of every match and competition. This will allow players to provide the best spectacle to their fans, while widening the career path of the athlete and the team[3].

During the sport of soccer, athletes perform thousands of movements such as kicking, running, jumping, accelerating, decelerating and changing direction, which are replicated during training. Each movement category varies greatly in the physiological demands of the soccer player or athlete. In creating a profile of each athlete's activity form, it is necessary to measure movements in both training and competition[4]. Research data in youth to senior men's soccer and various playing standards exist in the literature.

Normative data derived from these studies provide descriptive information about team and individual demands. This information can be used to identify individual strengths and weaknesses[5]. To ensure prescribed training demands match competitive demands, assessments of in-game activities can be established to prepare top-performing amateur players for competition[6].

The adaptation of the football world has become a real thing every year. Changes in design and materials in *football* shoes, especially *Football Cleats Studs* are included in the adaptation of the football world in the face of globalization[7].These changes correspond to the increasing possibility of *Football Cleats Studs* interaction on performance and injury risk. Several studies have been developed in this area. However, there is no further research on the relationship between *Football Cleats Studs* design to performance, there is only a systematic review collected to look at the interaction of football cleats and field design on performance and injury risk[8].

Several forms of adaptation have been introduced in soccer over the years. The increased use of artificial grass pitches (FIFA, FIFA Quallity Concept for Football and changes in the form of equipment used in soccer are examples of these adaptations, particularly soccer shoes. Soccer shoes are the most important tool, playing an important role in the performance of athletes. This soccer equipment in the form of soccer shoes is a tool to help soccer players achieve the maximum results of their own abilities. However, for this very new development, some attention is needed, especially on the effect of soccer shoes on the athlete's ability or best performance in the game [1].

In addition to the best performance, fatigue caused by wearing the *equipment* in a soccer game is a big influence in the game. This fatigue can cause possible injuries to soccer athletes[9]. With an average of 118,632 soccer players sustaining injuries due to prolonged play per year, soccer causes the most injuries out of the 33 sports in the NEISS database. On average, the sport causes 28,301 injuries annually in the United States [10].

2 Materials and Methods

2.1 Sampling

Primary data is data collected directly for research purposes. In this study, primary data was obtained through direct experiments in the field, along with supporting data from the coach (*expert*). This experiment was prepared based on a literature study and the sampling was carried out on Amateur Football Players at the Faculty of Sports, Medan State University. Before conducting the experiment, the research subject filled in personal data based on soccer activities that had been carried out in the past year. Then the research subjects will be measured their game performance (*kicking, jumping and dribbling*) based on soccer shoes with different shapes. The results of the data obtained will be quantitative.

2.2 Location and Time of Research

The research was conducted at the artificial turf field of Medan State University Stadium. The selection of this location is intended to maintain the consistency of field surface conditions that will affect player activity and performance. The research time was set from 8am to 12pm, a time when the weather and environmental conditions were considered stable and ideal for testing athlete performance according to reference standards.

2.3 Equipment and Variables Used

All subjects used the same model of soccer shoe, the Adidas X with three different types of ground: Turf, Soft Ground, and Hard Ground. This was done to keep one variable fixed so that the effect of pul shape could be specifically analyzed. The main variables measured were player performance factors obtained from training activities or matches which included indicators such as the ability to kick, jump, and carry the ball.

2.4 Test Field Preparation

Before the test was conducted, the researchers prepared the measurement points on the field, including a spot on the goal to measure kicking performance, a small circle

for measuring jumping ability, and a special lane to measure ball carrying performance. This preparation is important so that all measurements are taken systematically and can be compared between subjects.

2.5 Testing and Data Collection

Testing was conducted for two consecutive weeks. Each week, 15 subjects were tested for a total of 30 research subjects. The performance data obtained was randomly selected to ensure a representative distribution and avoid data bias. Each testing session followed an agreed protocol to maintain consistency and validity of the data.

2.6 Data Processing

The collected performance data was then inputted into an Excel file as the initial stage of data management. Next, statistical analysis was conducted using the SPSS program to see if there was a significant effect of shoe pul shape on player performance. This analysis process includes hypothesis testing by setting H0 (no effect) and H1 (significant effect).

2.7 Evaluation and Inference

After the data was analyzed, the researcher evaluated the results to determine if the variation in shoe pul shape did affect soccer player performance based on the predetermined indicators. Conclusions are drawn based on statistical results that show whether the hypothesis is accepted or rejected, so that a clear picture of the effect of equipment on athlete performance is obtained.

3 Results and Discussions

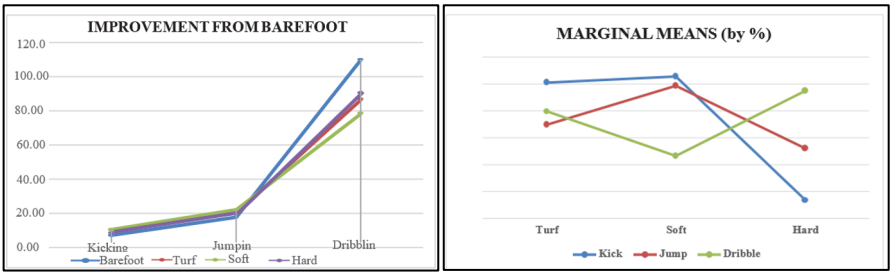

Fig 1. Performance Improvement and *Marginal Means* of all measurements in percent.

The performance improvement was 41.86%, 42.60%, and 23.22% for Turf, Soft Ground and Hard Ground pul type shoes on kicking performance, then for jumping performance there were performance improvements of 15.99%, 22.81%, and 11.32% for Turf, Soft Ground and Hard Ground pul type shoes. For a decrease in time of -27.71%, 41.58% and -22.23% occurred in the performance of carrying the ball (dribbling) This study supports the statement of previous research [11] that the difference between wearing soccer shoes and not wearing soccer shoes is quite large in measuring performance. Then the number of incidents of wrong possession of the ball, wrong kicking, and wrong keeping of the ball in training and research proves that the influence of soccer shoes is quite large on improving the performance of amateur soccer players. the average amount of Soft Ground soccer shoes, has the highest results in the performance of kicking movements, jumping movements and has the least time in carrying the ball.

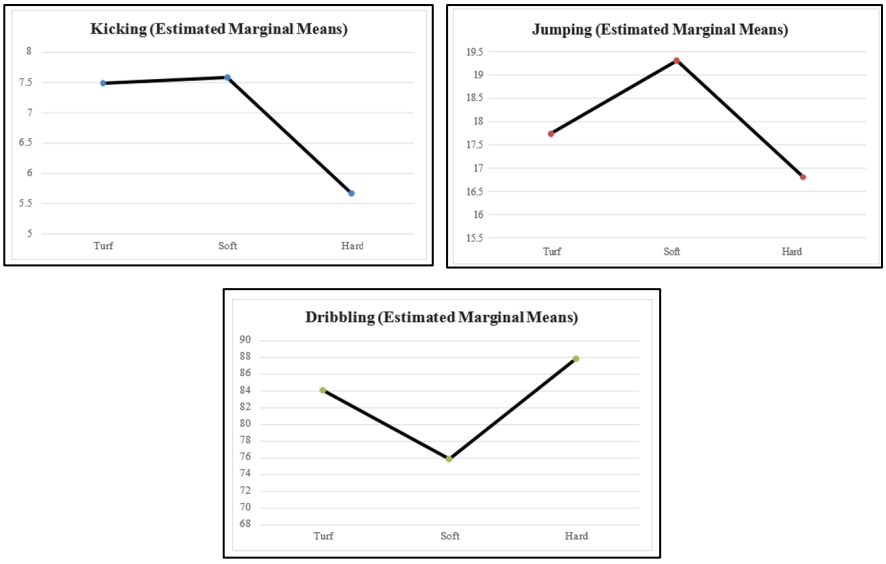

Fig 2. Analysis of Shoe Effect on Performance

The average magnitude of the Soft Ground soccer shoe type, has the highest results on the performance of kicking movements, jumping movements and has the least time on ball carrying movements [12].

Looking at Figure 2 (Kicking) Soft Ground shoes have a greater average kicking success than the other two types of shoes. This proves that this performance measurement is in accordance with the literature on the effect of the shape of Football Cleats Studs by (Silva et al., 2017a), Soft Ground type shoes have a value of 7.57 which is the highest value in measuring the performance of kicking the ball towards the goal on artificial grass (Medan State University Stadium Field). Figure 2 (Jumping) shows the average number of jumps measured on the research subjects. Soft Ground type shoes have the greatest average success in jumping compared to the other two types of shoes. This proves that Soft Ground type soccer shoes are also in accordance with the literature

on the effect of the shape of Football Cleats Studs [13]. Looking at the measurement results of Figure 2, Soft Ground type shoes have an average speed that is faster than the other two types of shoes. This shows that by using Soft Ground type shoes overall the research subjects have a better time. According to the three performances above represent indicators of technical performance or player skills in the match, therefore, it is important to note that using Soft Ground shoes has a better value than other types of shoes. With these performance values, the research can provide recommendations for amateur soccer players to use Soft Ground soccer shoes in playing games on synthetic fields [14].

Performance Analysis per portion

The position of a soccer player consists of several positions but the most common is divided into 5 positions. Goalkeeper position, defender position, midfielder position, winger position, and forward position. The purpose of the analysis per position in this research is to provide quantitative evaluation and recommendations for the use of soccer shoes based on different types of pul [15].

Fig 3. Performance Analysis per position

From the three data processing results, it can be seen that Soft Ground shoes are the most suitable shoes for the attacking position in the Industrial Engineering Department team, with the highest average number of kicks, the highest average number of jumps and the least time in carrying the ball. Player positions based on soccer shoe performance, between midfielders and defenders, showed similar patterns in performance assessment. In the midfield position, the 12 research subjects used three types of shoes, with the soft ground shoes receiving the highest performance scores of 8.76 kicks, 19 jumps and 76.47 seconds in carrying the ball. Meanwhile, in the 11

defender positions, the soft ground shoes also gave the best performance in jumping and carrying the ball, with 19 jumps and 79.8 seconds. This shows that soft ground shoes are superior in supporting jumping and ball-carrying movements for both positions, due to the needs of defenders and midfielders who more often perform kicks and dynamic movements during the game. For defenders in particular, turf shoes are recommended as they are more suitable for a greater variety of defensive movements[16].

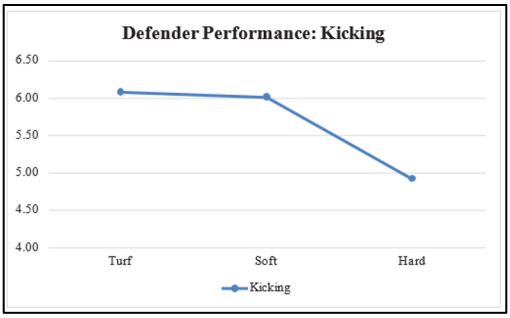

Fig 4. Defender Performance

Figure 5 explains that the unique value of the performance performed by the goalkeeper. Both in kicking performance and ball-carrying movements, pul Hard Ground type shoes are the best shoes, with values of 7.23 and 78.26. (Di Salvo et al., 2007) said that the goalkeeper position is a player position that has a far difference with other positions, especially in performance measurement. So it is possible that goalkeepers can be measured by other performance or not the same as other positions. Because in playing soccer the defender does more kicking movements, the shoes that are suitable for use are Hard Ground type shoes.

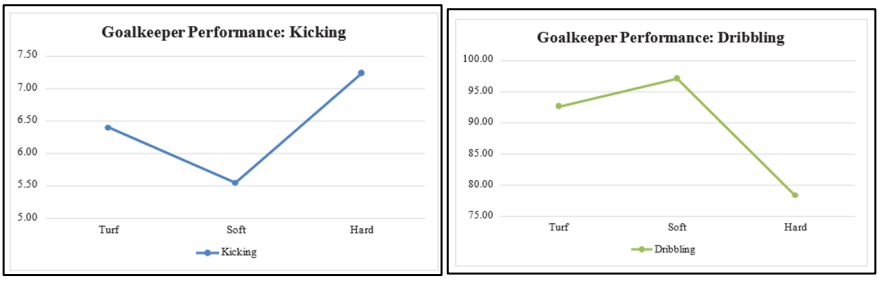

Fig 5. *Marginal means of goalkeeper*

The last position in the research analysis this time is the position of *a winger* or *Winger,* according to (M. Hughes et al., 2012), players with wing positions are players who run fast, move fast and have qualified skills. In this study there were 8 research subjects who could play as winger. The results of the performance assessment show that for jumping and ball carrying performance, Soft Ground shoes are shoes that have better value than other shoes.

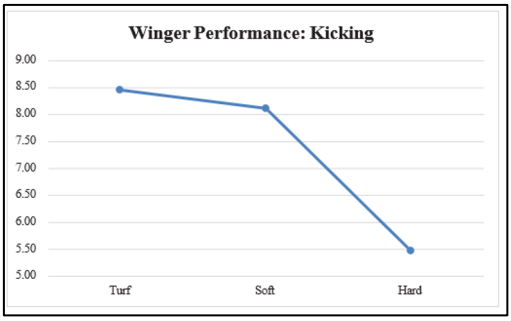

Fig 6. Marginal means of Winger

Figure 6 illustrates the kicking performance of players in the winger position using three different soccer shoe stud designs: Turf, Soft Ground, and Hard Ground. The results indicate that Turf shoes achieved the highest average kicking performance score (approximately 8.4), followed closely by Soft Ground shoes (approximately 8.1), while Hard Ground shoes showed the lowest performance score (approximately 5.5).

The findings suggest that both Turf and Soft Ground shoe designs provide better support for winger players during kicking activities compared to Hard Ground shoes. Wingers require high-speed movements, agility, and precise technical execution, including effective kicking ability. The relatively high scores for Turf and Soft Ground shoes may indicate that these shoe types provide improved traction, stability, and foot-ground interaction during movement and kicking actions. In contrast, the substantial decrease in performance observed with Hard Ground shoes may be associated with less optimal grip and reduced movement efficiency on the testing surface.

These results are consistent with previous findings indicating that stud design can influence biomechanical performance by affecting balance, force transfer, and movement efficiency during soccer activities. Therefore, selecting appropriate shoe stud configurations appears to be an important factor in optimizing the technical performance of winger players, particularly in kicking actions.

Player Fatigue Analysis

In this part of the analysis, the research shows the results of processing the players' fatigue data after doing the training and collecting the performance data on the experiment. This EMG study was conducted by the research subject by kicking to a point so that the muscle tension after training for 90 minutes could be measured. Data processing is carried out using an EMG device to measure how much difference in fatigue in using soccer shoes with different types of pul. The difference in EMG data results is shown in Figure 6.

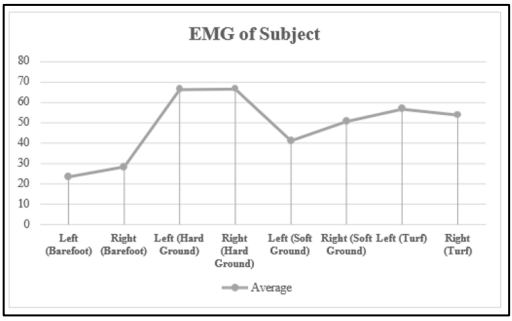

Fig 7. *Average EMG Data of Subject*

4 Conclusion

With the calculation of EMG (muscle tension) on the research subjects, the results show that there are differences in fatigue results caused by different shoe types. This supports the results of Soft Ground shoes as the most suitable shoes used on the synthetic field of Medan State University Stadium in performance value and the least in producing muscle tension compared to other soccer shoes

Acknowledgments. The authors would like to express their sincere appreciation to Universitas Negeri Medan (UNIMED) for its institutional support in facilitating this study. Gratitude is also extended to colleagues and academic peers who provided valuable insights and constructive feedback throughout the research process. Their contributions have significantly enhanced the conceptual clarity and academic quality of this work.

Disclosure of Interests. The authors declare that there are no competing interests associated with this study. The research was conducted independently, without any financial or commercial relationships that could be interpreted as a potential conflict of interest.

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