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Enhancing goalkeeper reaction speed in football: The impact of ball launcher training in physical training methods

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ABSTRACT

The football goalkeeper position arguably represents a unique role in team sports. This research aimed to increase the reaction speed of football goalkeepers using a ball launcher. The research method was experimental using a one-group pretest-posttest design. The research was conducted by applying reaction speed training using a ball launcher to measure and found out the results of the data obtained by researchers using the Statistical Package for the Social Sciences (SPSS) software. The research sample consisted of 20 students of the Department of Sports Coaching Education at Universitas Negeri Medan who specialised as football goalkeepers. The instrument used in data collection techniques was the Nelson Foot Reaction. The data analysis technique used was a t-test with a significance level of 0.05. The research results concluded that there was a significant effect of training using a ball launcher on the reaction speed of the goalkeeper. The results can be used as a basis for developing more effective and innovative training methods in the sport of football. In addition, the findings can provide guidance for coaches and researchers in developing relevant and efficient training methods. This study also opens the door for further research to explore the impact of reaction speed in actual match situations, which may yield further insights into the development of quality goalkeeping athletes.

Keywords: Ball launcher; reaction speed; goalkeeper



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INTRODUCTION

Football is one of the sports that requires high physical ability and hand skills. In this game, goalkeepers have a central role in guarding their team's goal (Otte et al., 2020). They have unique skill demands and special requirements relating to tactical, technical, physical, and psychological aspects (Chen et al., 2013; Otte et al., 2020). Despite the importance of the goalkeeper's role in a team's success, to date, the literature and research

on football goalkeepers has only sporadically examined the position within isolated and limited parameters (e.g., physiological characteristics of goalkeepers by Nisplaidis et al. 2015).

In general, research on soccer has either deliberately excluded the goalkeeper position from analysis due to large differences in behaviour from outfield players (Santos et al., 2018) or only analysed rare events, such as penalty kicks (Woolley et al., 2015). Goalkeepers have unique training demands, with isolated performance tests showing different profiles between goalkeepers and outfielders (White et al., 2018). Overall, research suggests that reaction speed is an important aspect of a goalkeeper's ability (Knoop et al., 2013), allowing him or her to anticipate and overcome opponent attacks (Silva et al., 2021), and can be improved through specialised training tools and tests.

Several studies have been conducted to develop and evaluate training tools and tests specifically designed to improve and assess goalkeepers' reaction and action speed (Jara et al., 2019; Sagala & Sitepu, 2022). These tools and tests have been validated by experts, shown positive results (Knoop et al., 2013), and can help goalkeepers train (Gelade, 2014). Increasing goalkeepers' reaction speed is a major challenge in football training (Sagala & Sitepu, 2022), and quickly adapting to changing situations is key to their success on the pitch.

Although goalkeeper reaction speed is recognised as a key element in football performance (Hidayat et al., 2022; Knoop et al., 2013), there are several challenges that must be overcome in order to improve this ability. Previous researchers have provided valuable insights related to physical and technical training that can support the improvement of reaction speed (Atan, 2021; Zhang, 2022). However, to date, it remains unclear about the impact of ball launcher training on improving goalkeepers' reaction speed as well as how such training can be integrated into broader physical training methods. A ball launcher in football serves as a specialised device designed to propel the ball in various directions for targeted training purposes (Negrón et al., 2017). Unravelling the potential benefits of incorporating this technology into goalkeeper training could unveil new dimensions in honing their reaction speed, promising exciting prospects for future advancements in football performance methodologies.

In the current literature, research on improving goalkeepers' reaction speed is limited. Most studies tend to focus more on the technical and tactical aspects of the game of football. Some of these include analysing the technical and tactical offensive and defensive actions of goalkeepers (de Baranda et al., 2019). In addition, research has also investigated how field size can affect goalkeepers' technical and tactical actions when playing in small ball games (Jara et al., 2018). Furthermore, some studies have explored the effect of variations in reaction training on improving goalkeepers' reaction speed (Pulungan & Siregar, 2022). However, no studies have addressed the exploration of the impact of ball launcher training on goalkeepers' reactions.

The existing research gap raises the need to further explore the contribution of ball launcher training to goalkeeper reaction enhancement. In filling this gap, this study aimed to understand the extent to which such exercises can affect goalkeepers' reaction abilities and whether their integration into physical training methods will bring additional benefits. This research makes a significant contribution to the effort to improve goalkeeper performance in football. The research incorporated ball-launching elements into existing physical training methods and test their impact on goalkeepers' reaction speed. Thus, this research brings novelty by incorporating elements that have not been widely explored in previous literature.

With the increasing competition in football, improving goalkeeper performance is becoming increasingly important. With a better understanding of how ball launcher training can affect reaction speed, coaches, and players can develop more effective training methods. Therefore, the purpose of this study was to investigate the impact of ball launcher training on improving goalkeepers' reaction speed and clarify the role of such training in football physical training methods.

METHOD

This study used an experimental method with a one-group pretest-posttest research design. The research sample consisted of 20 students of the Department of Sports Coaching Education at Universitas Negeri Medan who specialised as football goalkeepers. The sample characteristics included 20 participants with the criteria of a minimum height of 175 cm, a minimum weight of 70 kg, and experience playing as a goalkeeper for at

least 3 years. The research procedure began with a pretest to assess the initial abilities of the participants before receiving treatment from the researcher. Furthermore, treatment was carried out using training with a ball launcher for 14 meetings. The training protocol consists of basic assessment, agility drills, quick hands drills, dynamic ball launches, vision and reflex drills, and game simulation. The total duration of training per day was 40 minutes, including warming up and cooling down, and 3 days per week for a duration of 12 weeks. After that, the researcher conducted a posttest using the Whole Body Reaction Test to evaluate the participants' reaction speed after training. Table 1 shows the training protocol for the past 12 weeks.

Table 1. A 12-Week Ball Launcher Training Programme for Goalkeeper Reaction Speed

Week	Exercise	Repetitions/ Duration	Sets	Total Duration (mins) Including warming up and cooling down
1-2	Basic Assessment	-	-	
3-4	Agility Drills	-	3	40:00
5-6	Quick Hands Drill	25-30 sec	3	40:00
7-8	Dynamic Ball Launch	20-25 sec	4	40:00
9-10	Vision and Reflex Drills	-	3	40:00
11-12	Game Simulation	-	2	40:00

The main data collection technique was the measurement of reaction speed, specifically using the whole-body reaction test. To ensure the validity of the data, a normality test, and a homogeneity test were conducted using SPSS. Data analysis involved descriptive statistics, including mean, total data, standard deviation, and percentage. The normality test was used to assess whether the data was standardised or not. Furthermore, hypothesis testing using the t-test was used to determine if there was a significant effect after treatment by the researcher. This methodological approach was systematically designed to investigate the impact of training with ball launchers on improving the reaction speed of football goalkeepers.

RESULTS AND DISCUSSION

After the researcher got the data, the researcher conducted an analysis. The result of the analysis was presented in Table 2 as follows:

Table 2. Data Description

Type of Tests	Group	Mean	Deviation	SD
Pretest	Whole Body Reaction	0.30	0.1	0.35
Posttest	Whole Body Reaction	0.29		0.32

Based on the test results, the average of the Whole Body Reaction pretest group was 0.30. The whole body reaction posttest was 0.29 and had an average deviation of 0.1. The normality test was carried out with the Lilliefors test. The normality test results on the research variables, namely Training using a ball launcher (X), Reaction Speed (Y), can be seen in Table 3:

Table 3. Normality Test

Test	L-Count	L-Table
Whole Body Reaction Pre-test	0.1746	0.242
Whole Body Reaction Post-test	0.1960	0.242

Based on Table 3, it was known that the data from the pre-test whole-body reaction after the calculation results in a L_{count} was 0.1746, and a L_{table} was 0.242. It meant that the L_{count} was lower than the L_{table} . It can be concluded that the distribution of data from the pre-test whole-body reaction was typically distributed. For testing the data, the results of the whole body reaction post-test resulted in a L_{count} of 0.1960, which was smaller than the L_{table} of 0.242. Thus, it can be concluded that the distribution of the Whole Body Reaction post-test data was normal. A homogeneity test was conducted to find out whether the sample came from the same variance or homogeneous. The homogeneity test in this research used Levene statistics by testing the pretest

and posttest data. The homogeneous results can be seen in Table 4 as follows:

Table 4. Homogeneity Test

Test	Signification	Description
Whole Body Reaction Pre-test	0.550	Normal
Whole Body Reaction Post-test	0.547	Normal

Based on Table 4, it is known that the results of the homogeneity test of the training using a ball launcher had a significance value of pretest and posttest > 0.05 , which meant that the data used was homogeneous. The description of the research results on reaction speed data in the pre-test before the treatment and after the treatment (posttest) using a ball launcher produced the following data: data from training results using a ball launcher device before treatment (pretest) was more dominant in the low category with a total of 15 students (75%) with a standard score range of 4-5, deficient category four students (20%) with a standard score range 1-3, for the high category one student (5%) with a standard range of 6-7 scores. While the scores after being given treatment (posttest), four students were in the very high category (20%) with a standard score range of 8-12, the high category was 14 students (70%) with a standard range of 6-7 scores and the low category was two students (10%) with a standard range of 4-5 scores. The results of the data (pretest) and data (posttest) can be seen in Table 5 below:

Table 5. Frequency Distribution of Pretest and Posttest Reaction Speed

Assessment	Standard Score	Pre-Test		Post-Test	
		Absolute (Fa)	Relative (%)	Absolute (Fa)	Relative (%)
Very High	8-12	0	0.00%	4	20.0%
High	6-7	1	5.0%	14	70.0%
Low	4-5	15	75.0%	2	10.0%
Very Low	1-3	4	20.0%	0	0.00%
Quantity		20	100%	20	100%

Based on the effectiveness test to answer whether the research hypothesis was accepted or rejected using the t-test. The results of the reaction speed with a t_{count} of 57.34 were then compared with t_{table} . Then, $d.b = (N-1)$ with a significant level of 5% of 1,679 was obtained. According to the results of the t_{count} and t_{table} calculations, it can be concluded that the reaction speed test with a t_{count} value of 57.34 was $>$ than the t_{table} value of 1.679, which indicates the effect of training using the goalkeeper's reaction speed with a percentage of 45.00%. The results of the processed t-test values can be seen in Table 6 as follows:

Table 6. Processed Values of Pretest and Posttest t-test Percentage Increase

Treatment	Description	t_{count}	d.b	t_{table}	Significance Level	Improvement Percentage
Manipulative Games	Pretest - Posttest	57.34	19	1.679	5%	45.00%.

Based on the research results, it was found that there was an increase in the reaction speed of football goalkeepers. These results could be seen from before the treatment (pretest) and after (posttest) used whole-body reaction tests and measurements. Research conducted by researchers supported these results, and the results of the analysis showed that training using a ball launcher could provide significant benefits for increasing physical performance (Ulfiansyah et al., 2015). It was because the practice of using a ball launcher had a high level of difficulty and was appropriate training for senior goalkeepers. Hoorweg (2019) describes many aspects needed to have the ability to react quickly or have good performance for the goalkeeper. Practice using a ball launcher is the proper training to improve the goalkeeper's power, especially in reaction speed. The ball launcher device has been proven to increase the ability of reaction speed. It was in line with what was stated by Aulia and Endriani (2019) regarding the development of the reaction speed tool, which has advantages, namely: (1) athletes are more enthusiastic in training because of the tools in training reaction

speed, (2) athletes are more motivated in carrying out pieces of training because of variations in reaction speed using tools, (3) the tools used to help coaches easier to train reaction speed by using ball launchers. The definition of a tool is a medium used by the teacher or coach to convey material more quickly and understood by athletes. The emphasis of learning aids is on visual and audio. Visual aids consist of two-dimensional visual aids using only two length and width measurements, such as pictures, charts, and graphs. In contrast, three-dimensional visual aids use three dimensions, namely length, width, and height, such as natural objects, simple imitation tools, and objects.

Based on the explanation above, it can be concluded that a tool is an object used to help or relieve an activity. Furthermore, the development of innovations can help the training process in the field of sports. Training is an activity carried out by every athlete to develop the essential abilities he has. With training, the athletes can be confident in facing the matches that will be encountered. Bompaa and Haff (2019) states that training is a systematic process of repeatedly working over a long or long period, increasing gradually and individually to form physiological and psychological functions to meet task demands. Along with the definition of training, there is also the purpose of training, namely to help athletes to reach peak performance, with good improvement in each training. Training is a process to hone, improve abilities to improve performance so that it can be more optimal in a match. Therefore, training is a must in developing goalkeeper skills. Bompaa and Haff (2019) also states that training prepares athletes to perform optimally at the highest level. The purpose of training is to help athletes apply their abilities and skills to develop the athlete's potential to achieve achievement (Ita, 2017). It is in line with Min and Baek (2023), who state that training is essential to developing athletes' abilities, both individually and in preparation for competition. They also agree that the training aims to help athletes improve their skills and achieve maximum achievement. Vecenāne and Vazne (2022) state that training is a crucial part of preparing athletes for sports competitions. In addition, Wachowicz (2019), defines training as one of the means in preparing athletes to achieve the best conditions. Besides, Ulfiansyah et al. (2015) state that the main goal and goal of training is to help athletes improve their performance skills as much as possible. Based on the explanation above, it can be concluded that training is a process of self-empowerment through an activity that is systematic, repetitive, and increasingly adds to the workload. In connection with this research, training was a process of self-empowerment through training activities using a ball launcher against the goalkeeper, which aimed to improve the goalkeeper's abilities.

Training using a ball launcher as a reaction speed training tool was expected to increase reaction speed effectively and efficiently. Hopefully, it will make it easier for athletes and coaches to train the goalkeeper's reaction speed. Reaction speed training aids can assist the trainer in the training process. Hopefully, this tool can increase the goalkeeper's reaction speed and foster enthusiasm for training to get maximum results during matches. This reaction speed is critical in football (Nugroho & Rahayu, 2021). The reaction speed training using a ball launcher causes the ball throw results to be a consistent and average standard deviation. However, based on the ball throw distance data, it can be seen that the results of the throws were inconsistent. It showed that one of the factors that affected the distance itself was seen from the type of ball and the structure of the ball (Amni et al., 2017). As a consequence of using a ball launcher, it could improve the goalkeeper's reaction speed skills. Implementing training activities required a high reaction speed because when the tool threw the ball, it took the right timing to move towards the ball's arrival.

From the explanation above, the reaction speed factor is closely related to the goalkeeper's ability to make sudden movements. Reaction speed is the time it takes from the start of a stimulus to the onset of a conscious movement reaction. Ita (2017) states that reaction speed is a person's ability to respond to a push in the shortest possible time. Reaction speed is the time used between the emergence of a stimulus and the beginning of the reaction. The reaction rate is the shortest time required to give a kinetic response after receiving a trigger. Reaction speed is closely related to reflex time, movement time, and response time. Reflex time is different from reaction time. In reflex, impulses are sent from the sensory nerve to the reflex center, then to the efferent nerve, then to the effector, thus in reflex, there is no thought process at all. While at the time of reaction, there is a thought process. Movement time takes from the moment the move is made to the end of the movement. Response time is the amount of reflex time or movement time (Sugawara & Nikaido, 2014).

Reaction speed in the context of athlete performance is crucial. Roach et al. (2014) highlighted several determinants that specifically affect reaction speed, including irritability and the nervous system, the athlete's situational orientation, sensory acuity, movement speed, and muscle explosiveness. This is in line with the view of Talpey et al. (2018), who explain that speed, in coaching theory, refers to the ability to move a body part or the body as a whole with a maximum level of speed. Efforts to increase reaction speed require the recognition of special perceptual situations and the automation of motor responses or kinetic attitudes. There are certain principles that need to be adhered to in order to optimise the development of reaction speed. Bendersky et al. (2022) emphasize that speed has a central role in achieving the best performance in sporting activities. They define speed as the ability to move the body or body parts with an extraordinary level of speed. They define speed as the ability to move the body or body parts with an extraordinary level of speed. This definition is in line with Plungian and Rakhilina's (2013) interpretation of speed as a comparison of distance and time. Akhmad et al. (2021) add a psychological dimension to the understanding of reaction speed, describing it as a person's ability to respond quickly to stimuli that come through the senses, nerves, or other feelings. The principle of reaction speed training described by them emphasises the transition from simple to complex, from easy to difficult, and from slow to faster movements. Wiyaka et al. (2020) define speed as a person's capacity to carry out continuous movements in the shortest amount of time, outlining the relationship between speed and continuity. They separate the concept of speed from reaction, which is explained as an immediate response to stimuli through the senses, nerves, or other feelings. Thus, reaction speed can be understood as a person's ability to provide an initial response to a stimulus in a very short time.

Training to increase reaction speed must be done using exercise or a reaction speed test using a tool that can determine how much reaction increases. Besides, the function of the coach is also very vital considering that the coach is a reliable drafter. It is in line with what is stated in the journal by Nurkadri (2017). The training job should not be used just to fill pleasure. A coach should have a coach's academic background and experience and also have to be able to apply sports coaching sciences such as sports physiology, sports psychology, sports biomechanics, and also other supporting sciences that can help in achieving success in doing his role as a coach. In addition, there are many things to do to increase the reaction speed. One of them is by using a ball launcher. A ball launcher is a tool that serves to increase reaction speed. This tool works with the direction of the ball that cannot be read by where it is moving, so the goalkeeper will remain focused on making movements anticipating the ball's direction. Some principles that need to be adhered, to increase the development of reaction speed are increasing recognition of special perceptual situations and automating as much as possible the motor answers that need to be made or the kinetic attitudes that need to be selected in real situations. Therefore, a training method is necessary to condition athletes in an actual competition situation, where athletes are required to make movements as quickly as possible in a short time.

According to the description above, it can be stated that reaction speed is the individual's ability to make movements and start a stimulus to give birth to a response in the shortest possible time. A person also can move his body organs to respond to a stimulus as quickly as possible in achieving good results. Therefore, football athletes, especially goalkeepers, must have good speed in hitting, kicking, and anticipating the ball's arrival. Having technical maturity supported by good reaction speed will affect the goalkeepers' success in carrying out attacks or anticipating opponent attacks. Based on the analysis results that the researchers did, it proved that training using a ball launcher could increase the football goalkeeper's reaction speed. These results were expected to make training using a ball launcher that can be used as an essential concept and point to be applied in the training process to increase the speed of the goalkeeper's reaction correctly and adequately. The advantage of this research was to know that using a ball launcher could increase the reaction speed of the goalkeeper. In addition, the ball launcher used referred to the use of technology in sports, especially as the training tool for goalkeeper reaction speed. The drawback in this research was that the use of a ball launching was still limited. Thus, in doing training, the goalkeeper still had to take turns. Training using a ball launcher to increase the reaction speed of football goalkeepers can also be done using other methods, such as SAQ. Prachita and Josheeta (2023) also state that SAQ training can improve speed and agility skills simultaneously. Its form can also be modified according to the needs and characteristics of the sport as long as it is still within the rules of speed, agility, and speed in responding to non-stimulus stimuli. The shortcomings are also found

in the small number of participants and the time of implementing the training using a ball launcher that has not been too long. Therefore, there is a need for further research to be tested with a broader number of participants for a long time.

CONCLUSION

The results of this study indicate that the application of reaction speed training using a relative ball launcher can improve the reaction speed of football goalkeepers. This improvement was observed in goalkeeper athletes before treatment (pretest) and after treatment (posttest), with assessment indicators using a whole-body reaction measurement tool. The ball launcher training tool is designed like a football game so that goalkeepers cannot predict the direction of the ball. Although the results of this study are promising, there are some limitations to note. Firstly, the study sample may not cover all variations in football goalkeeping. Also, the relatively short training time may not reflect the long-term effects of this training method. Furthermore, this study is limited to the aspect of reaction speed and has not evaluated its impact on actual performance in a match situation. In future research, consider addressing these limitations. This study contributes to the understanding of the importance of reaction speed training in improving the performance of football goalkeepers. The results can be used as a basis for developing more effective and innovative training methods in the sport of football. In addition, the findings can provide guidance for coaches and researchers in developing relevant and efficient training methods. This study also opens the door for further research to explore the impact of reaction speed in actual match situations, which may yield further insights into the development of quality goalkeeping athletes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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