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Technical and Physical Match Demands of a NCAA Division I Soccer Goalkeeper

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Technical and Physical Match Demands of a NCAA Division I Soccer Goalkeeper

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ABSTRACT

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The purpose of this study was to provide a better understanding of the goalkeeper position in order to prepare goalkeepers for competition. The objectives of this study were to characterize the technical and physical demands of an NCAA Division I collegiate goalkeeper over three seasons and examine trends from season to season. Count and frequency for each definition were analyzed. Results show that although the goalkeeper's technical demands were characterized by engaging in play without action and being in the goal area, the gradually increased use of the feet over three season's hints on the importance of skills performed with the lower body. Findings suggest that most shots faced by the goalkeeper were from direct attacks, outside the box and from central positions. Foot skills may be relied on with increasing experience. Over the course of three seasons, forward and lateral movements were the most common and second most common.

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CHAPTER 1
INTRODUCTION

The goalkeeper is a unique playing position in soccer with different physical and technical demands than those of outfield players (Bangsbo, Mohr, & Krustrup, 2006). Information on movement patterns performed by goalkeepers in matches, as well as technical aspects of those movements can help coaches optimize training and establish competition demands.

The available research on soccer players focuses primarily on analyzing their physical parameters, or a combination of physical and a few technical parameters (Liu, Gomez, Concalves & Sampaio, 2016), but there is very little published data regarding the on-field performance of goalkeepers in soccer. The development of technical performance profiles for goalkeepers can be an important task to reveal new trends and establish new practice methods.

Quantitative match analysis is invaluable to coaches as it can help create an objective, unbiased view of events and provide a solid platform on which to make informed decisions (Carling, Williams, & Reilly, 2005). The analysis process is an important component in the coaching process, data collected should be managed in an objective manner to develop training programs and determine in-match demands.

Problem Statement

The purpose of this study was to provide a better understanding of the goalkeeper position in order to better prepare goalkeepers for competition. The objectives of this study were to characterize the technical and physical demands of a goalkeeper at the NCAA Division I collegiate level over three seasons and examine trends in the physical and technical demands from season to season.

CHAPTER 2

REVIEW OF THE LITERATURE

Soccer is an internationally recognized sport with participants ranging from the youth level to the collegiate, national and professional level in both men's and women's play. Because of soccer's worldwide popularity continued research relating to the development of athletes in the sport is valuable to players and coaches at all levels.

This literature review is an examination of the technical and physical demands of the soccer goalkeeper positon in match play. Special attention has been paid to methods of video and notational analysis of soccer match performance to better identify differences in methods of analysis. Match demands and on-field performance of goalkeepers, with an emphasis on positional differences to outfield players and gender differences, will be examined to distinguish whether there are any differences. The literature review will aim to evaluate if there are any practical methods to evaluate goalkeepers' technical and physical demands during match play and also help sport practitioners and coaches identify important measures in evaluating goalkeeper's performance during match play.

Video and Notational Analysis

Video analysis is a medium that involves recording performance via digital camera or specific software and that video is used along with notational analysis or software algorithms to analyze the video. In the author's opinion, the advancement of digital video and computer technology over the past few decades has seen a considerable increase in the use of video analysis as a coaching tool in soccer. There are several methods of match analysis in soccer that include the use of video or notational analysis. There is video-based analysis, Global Positioning Systems (GPS), and multi-camera match analysis systems but most studies focus on movement

patterns of soccer players and not the combinations of physical movement with technical movement. The most common method of manual video analysis is to position the video camera near the side of the pitch, at the level of the midfield line, at a height of approximately 15m (ranges from 15-20m) and a distance of 30-40m from the touchline (Bangsbo, Norregaar & Thorsoe, 1991). Other studies have used the same set up but vary in how high the camera is placed, but did not state if the height of the camera influenced data collection or analysis in any way (Mohr, 2003; Randers et al, 2010). This set up is used as it gives the best picture of the field that can include as much of the field at once without zooming in and cutting players out that are a part of the play. It also helps observers have a clear view of as many players as possible, players' numbers and position on the field.

Before advanced technology was available other techniques were necessary in video analysis. For example, Erdmann developed a system for player tracking by recording an entire match that included the whole field. A camera with a wide lens (130 degrees) was used above the field and positioned so that the whole field could be seen at one time. Video was played back at a frequency of 50Hz and white tape was marked every 1 meter across the field. The position of this white tape was then transferred from a TV monitor to a semi-transparent foil so that a reference grid could be created to manually record positional information using set standards.

Studies from the past ten years of outfield players in soccer have adopted a multi-camera system that ranges from using two to four cameras (Mallo & Navarro, 2008; Mallo, Navarro, Aranda & Helsen, 2009) and the video is then synchronized and manually evaluated at a frame of 25Hz (Navarro, Aranda, & Helsen, 2009). These types of techniques are labor-intensive in terms of capture and analysis of the data. In this respect, the detailed manual methodology used by Bloomfield et al. (2005) to code manually and determine the physical demands of English

Premier League Football was described by the authors as extremely time consuming and laborious.

Over the past decade or so, technological advances have included the introduction of increasingly advanced video and motion analysis systems that can evaluate multiple players at one time. A study conducted by Rampinni, Coutts, Castagna, Sassi, and Impellizezeri, (2007) used a video match-analysis system called Corso Match Analysis (Vicenza, Italy). Corso Match analysis is a match analysis system that is recorded and then performance is analyzed by trained analysts employed by the company using a set formant and processed into various performance statistics for coaches and players to review. The reliability and validity of the product comes from certified training that all analysts must complete (SICS.it)

Other studies have made use of computerized video tracking systems for data collection of physical and technical demands of matches. Prozone is a video computerized, semi-automated multi-camera image recognition system that allows the tracking of many individuals performing a sporting activity. This system generally requires the installation of several cameras fixed in certain positions to cover the entire surface of the field. The players' movements can then be tracked on the video by computer software by either manual operation or automatic tracking processes. Prozone has been found to be a valuable data collection tool that can help identify physical demands of players during match play and does not require any equipment to be worn by the players. Systems like Prozone still require operator intervention to process data afterwards and are limited to the soccer fields that the system has previously been installed. It should also be noted that Prozone is designed to track players during matches only (Barris & Buttom, 2008; Brucheit, Poon, Allen, Modonutti, Gregson, & Di Salvo, 2011; Castellano, Alvarez-Paster, & Bradley, 2014; Di Salvo, Benito, Calderon, & Pigozzi, 2008). The computer system is typically

used to measure both physical and technical demands of the game (Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009).

Prozone has been used to examine the activity profiles of goalkeepers during matches measuring distances covered, the frequency of frontal and later actions with distance covered during that movement, and different levels of intensity in regards to distance covered. The mean total distance that goalkeepers covered during a match was 5611 ± 613 m, the distance covered at high intensity was 56 ± 34 m, and the distance covered sprinting was 11 ± 12 m. The goalkeeper was found to walk 73% of the match spending just 2% moving at high-intensity (Di Salvo et al., 2008). Goalkeepers were found to perform 17.5 ± 7.56 m of forwards changes of direction and 15.5 ± 7.78 m of lateral changes during a match. Lateral and forwards movements were also recorded, and are analyzed in this case study, showed results of 52 ± 24 total forward actions per game performed and 40 ± 28.2 lateral actions per game (Padulo, Haddad, Arigo, Chamari, & Pizzolato, 2015)

Due to the time commitment required to manually collect and analyze data in the manual format, research has focused on smaller numbers of players or set positions. Video analysis that includes manual notational analysis is convenient, practical and inexpensive compared to other video analysis software packages mentioned above that have a software package that does the brunt of the work. The validity and reliability of the process can vary depending on the study and the number of observers included, their experiences and the quality of video collected (Hughes & Franks, 2004). The video-based methods mentioned above like manual notational analysis by observers using video have generally demonstrated high levels of reliability, objectivity and validity (Carling et al., 2005).

Typically, reliability and validity are specific to the variables used by the study itself. From the literature review, variables that are chosen for a study depend on the purpose of each study and there is not any discrimination on choosing one technical or physical variable over another. To the author's knowledge there are has been only one other study that used notational analysis of technical characteristics of soccer goalkeepers and those variables and definitions were used so that observers could be objective when analyzing matches. The variables from the study had been determined by a group of expert coaches and inter-reliability of two separate observations was calculated to determine the reliability of the observation system, and a reliability index of 0.95 was observed. Results showed that goalkeepers during the 2002 FIFA World Cup spent 44.4% of their time in the penalty area, followed by 17.7% in the goal area. It also observed 23.4 technical actions per match and the save was used 41.3% of the time followed by foot control with 27.8% of the time. Results of physical actions performed by the goalkeeper showed that on average the goalkeeper dived 6.2 times per match, and had 18.7 displacements per match (lateral, backwards and forwards movement). A reliability index of 0.95 was observed (intra-class correlation coefficient and Kappa index) (Di Salvo et al., 2008).

Notational analysis is a method used to provide game information including technical and physical characteristics of players through frequency of occurrences, total occurrences, direction of movement etc. Notational analysis makes use of video analysis and technology and requires systematic techniques of observation (Bartlet, 2001). This type of analysis is an objective way of recording performance, so that events in match performance can be quantified in a consistent and reliable manner and hopefully aid in the improvement of sports performance (Hughes & Franks, 2004). .

Information gained from notational analysis can be analyzed and processed in a variety of ways to provide a descriptive profile that can help provide feedback in regard to in-match demands (Hughes & Franks, 1997). Notational analysis is an inexpensive way for sport practitioners to gain knowledge of match demands in both physical and technical areas. For this reason, notational analysis is used more than other methods. It is important that studies use the same definitions of variables so that results can be compared study to study (Scarfone et al., 2015). Video-based software systems such as Prozone are reliable systems that typically measure physical parameters more than technical. Systems like Prozone are expensive and require fixed camera which typically means the system can only be used at home venues and for matches only, which limits sport practitioners if they want to monitor movement outside of matches (Shafizadeh & Taylor, 2013; Winter & Pfeiffer, 2016).

Match Demands and On-field Performance

In the United States of America, the college game is governed by the NCAA (National Collegiate Athletic Association) and is played for 90 minutes, with the potential for two sudden victory 10 minute halves, and penalties in tournament situations. When measuring physical and technical demands of a soccer match, there are various factors that must be taken into account. Cultural and environmental factors of match days, pitch dimensions and tactical demands of the match are going to influence the outcome as well as the player's individual performance (Alexander, 2014). Match analyses are a popular method to help assist coaches in identifying physical and technical demands of soccer and how that player performs within those demands (Di Salvo et al., 2008). To begin to understand the demands of a goalkeeper, physical match demands is a simple place to begin.

Studies that have focused on match demands of goalkeepers have examined physical characteristics primarily. Even when comparing positions, total distance covered is the main way to differentiate goalkeepers with field players. Goalkeepers typically cover smaller total distances (5,611 ± 613 m) compared to outfield players who cover up to 10,440 ± 150m (Mohr et al., 2008) per match (Bangsbo et al., 2006), and with the majority of the 5,000 m distance being covered by either walking (73%) (Ziv & Lidor, 2011). Studies have compared different positions but have focused on anthropometrics and results show the goalkeepers are typically heavier and taller (86.1 ± 5.5 kg) than fullbacks (75.4 ± 4.6 kg), midfielders (73.2 ± 4.8 kg) and forward (76.4 ±7.2 kg) and found to 3cm taller on average than other positions (De Paz et al., 1995., Davis et al., 1992). Other studies have compared goalkeepers from different teams and examined the activity profile of goalkeepers during matches. Results show that there is no difference in activity of walking, high-intensity movement and sprinting between first and second half performance of goalkeepers (Di Salvo et al., 2008).

One study looked at shots on target and goals scored during the European Championship in 2012 and the implications this would have on coaching and training goalkeepers. The study looked at 31 matches and identified shots on target and goals scored. They also looked at what distance shots were taken, from what angle, and when on target, where the ball ended. Results showed that 72% of shots on target and 53.4% of goals scored were aimed at the lower zones of the goal. Goalkeepers blocked 65% of shots that came from outside the penalty area while 65% of goals were scored inside the penalty area. The authors also found that 55% shots came from the same angle (Park, Choi, Bang, & Park, 2016). No information was collected on any physical or technical actions performed by the goalkeeper.

Goalkeepers typically covered shorter distances of up to 5,000 m than those of outfield players during matches, and that distance was covered at either the walking or jogging pace. Although, when goalkeepers did perform a high-intensity action it was typically over a distance of 10m or less. When technical actions were recorded, results showed that the most common technical action is typically the save and displacements (forward, backward and lateral movements) are the most common physical actions used by goalkeepers. Studies have not included any internal-load data on high-intensity actions that are paired with technical actions. It should be noted that the majority of studies have included male goalkeepers typically at the professional level.

Technical Analysis

Studies have mostly focused on physical characteristics (Ramadan & Byrd, 1987) of outfield soccer players and often differentiated between playing positions based on distance covered (Di Salvo et al., 2008) or anthropometrics (Rebelo et al., 2013). Data related to the technical aspects of goalkeepers match performance can provide valuable information on the acts performed during match play, and help separate players based on technical proficiency.

At high levels of play, where games are decided by small margins, the team that is more technically proficient will have an advantage (Reilly, Clarys, & Stibbe, 1983). Although a team is comprised of 11 players, all players assume certain roles, especially that of a goalkeeper. Having an exact technical analysis of the playing requirements of each position would allow accurate player profiles to be established. There are coaching publications that state necessary credentials for certain positions. However, these publications are based on opinion and not research

This study only looked at goalkeepers' physical movements during 10 penalty kicks during the Soccer World Championships in 1990 and found that goalkeepers were better able to anticipate right-footed penalty kicks than left-footed penalty kicks. Angle of approach, foot position at contact, and hip position were all determining factors in aiding the goalkeeper in anticipation (Reilly, Clarys, & Stibbe, 1983).

The literature is lacking in regards to position specific analysis of technical demands in match performance. Bradley et al. (2013) investigated the physical and technical performance of top level English players. Dellal et al. (2011) also studied the technical and physical performance of top level soccer players. Both studies found that the higher level of play maintained higher levels of technical ability including higher pass completion rating and higher number of passes completed. Dellal et al. (2011) compared players from two different top-level leagues in England and Spain and results showed the central defenders and forwards had the least number of ball touches.

Bradley et al. (2014) examined gender differences in match performance characteristics of elite soccer players playing in the UEFA Champions League and found that there were no differences for technical variables, although female players were found to have lost the ball more and displayed lower pass completion rates than males. The majority of studies on gender differences focus on the physical aspect of the game.

There has been a wealth of studies that have focused on the difference in playing position of outfield players during match play (Carling et al., 2009; Carling et al., 2005; Mohr et al., 2003; Reilly, Holmes & Stibbe, 1983). Studies grouped playing positions in three major groups; defenders midfielders and forwards. Results of these studies showed that demands of the

physical and technical demands are different depending on what specific playing position takes on the field (Dellal et al., 2011).

The focus of studies conducted on goalkeepers during match play have been on their physical characteristics. Studies have identified distances covered and at different velocities between first and second half (Di Salvo et al., 2008). They have also focused on what differentiated goalkeepers in high, intermediate, and low level teams. It was found that the goalkeeper save was the sole indicator which differed for all three team levels (Ziv & Lidor, 2011). Variables included in studies were number of frontal and lateral actions with distance covered and total distance covered during match play Bradley et al. (2013). Studies have focused on specific parts of a goalkeeper's game, including one study conducted by Shafizadeh, Davids, Correia, Wheat, & Hizan (2015), where 1v1 duals were investigated to see if perceptual variables can provide information of how successful a goalkeeper will be in intercepting the ball. 1v1 duals are when a goalkeeper is left defending the goal alone with an attacker of the opposing team with the aim to take a shot at goal. Goalkeepers closing down the gap between player and goal saw goalkeepers' successful intercept the ball with a critical time of 760-480 ms before final strike.

Studies that have used notational analysis and focused on match play are in abundance for outfield players there are only a few studies that have specifically looked at on-field technical performance of goalkeepers. To the authors knowledge there is only one study that specifically looks at technical actions. One study attempted to record the actions of goalkeepers when they performed defensive maneuvers during the World Cup Tournament in Japan and Korea in 2002 (De Branda, Ortega, & Palao, 2008).In this study, 34 goalkeepers in 54 games were analyzed. The study found that Goalkeepers mostly intervened in the penalty area (44.4%) followed by the

goal area (17.7%, and outside the penalty area (6.6%.), and they performed 23.4 defensive technical actions per game (De Branda, et al., 2008).

There has not been a great deal of research focused specifically on goalkeepers and the technical attributes they have during match play. That being said, the save seems to be the most important technical skill a goalkeeper can have and displacements (front, back and lateral movements) are the most common physical skill a goalkeeper uses during the match. Goalkeepers also spend the majority of the match at low-intensity levels like walking and jogging and only a small percentage of the game at higher-intensity levels.

Conclusion

The literature shows that while different methods of analysis have advantages and disadvantages, notational analysis using filmed performance is the most economical method and provides valuable measures when evaluating on-field performance. Although research has been limited in studying goalkeeper's performance, available research suggests that measures in high intensity running, jogging and time spent walking along with anthropometric data may be important in helping differentiate goalkeepers' from other positions based on physical qualities. However, literature has been limited when studying goalkeepers' technical performance, research suggests that the save, foot control, and forward and lateral movements can be important factors in technical performance. The ability to differentiate between technical abilities of goalkeepers' based on gender or different positions on the field appears to need more research, as at the current time there does not appear to be enough research.

CHAPTER 3

TECHNICAL AND PHYSICAL MATCH DEMANDS OF A NCAA DIVISION I SOCCER GOALKEEPER

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ABSTRACT

The purpose of this study was to provide a better understanding of the goalkeeper position in order to better prepare goalkeepers for competition. The objectives of this study were to characterize the technical and physical demands of an NCAA Division I collegiate level goalkeeper over three seasons and examine trends from season to season. Count and frequency for each definition were analyzed. Results show that although the goalkeeper's technical demands were mostly characterized by engaging in play without action and being in the goal area, the gradually increased use of the feet over the three season's hints on the importance of skills performed with the lower body. Findings suggest that most shots faced by the goalkeeper were from direct attacks and from outside the box and central positions. Foot skills may be relied on more with increasing experience and can be heavily used in some games. Over the course of three seasons, forward and lateral movements were the most common and second most common movements.

INTRODUCTION

Most of the reviewed studies focused on physical characteristics and physiological attributes of GKs (Ziv & Lidor, 2011), but very little research has been conducted in regards to on-field performance specifically for goalkeepers (Rebelo, et al, 2013). Analysis of the main actions demonstrated by a goalkeeper during a match may provide soccer coaches with more relevant information on aspects related to goalkeeper training programs and to clarify competition demands. Data collected can also help in the development of an on-field performance test specifically for goalkeepers.

A case study design was used to help gather detailed information that would be difficult to acquire through a common study design because there is only one goalkeeper that plays on the field at a time per side. In order to gain a better idea of a recruited goalkeeper, she was studied over three seasons. Despite a case study, examination of a goalkeeper over three seasons were expected to provide greater in-depth analysis for the goalkeeper position (Baxter & Jack, 2008). To the authors knowledge no other study, of any kind, has identified in-match demands of goalkeeper over several seasons.

METHODS

This study included 39 matches across three seasons. Season one included 10 matches with a mean of 92.4 ± 6.31 minutes per match. The goalkeeper had a season record of three wins, seven losses and two ties during her first season. Season two included 13 matches with a mean of 93.84 ± 7.41 minutes per match, and the goalkeeper finished the season with a record of nine wins and four losses. Season three included 16 matches with a mean of 91.5 ± 5 minutes per match and a final record of nine wins and seven losses.

All video footage was obtained from an archive at the conclusion of the third season. Video footage was then analyzed over a three week period and entered into an excel document before all data were analyzed.

Subjects

The sample included one female goalkeeper, with Youth National team experience, from an NCAA Division I program that participated in 39 matches over three seasons (2013, 2014, and 2015). This study was approved by the East Tennessee State University Institutional Review Board. The data used for analysis in this study was obtained retrospectively from the repository of an on-going athlete monitoring program.

Procedures

Data were collected from all matches via video recording into MP4 format. The game footage was recorded in a continuous fashion, was filmed from the half-way line at no less than 12 feet, and captured at least a third of the field at all times. Video footage was captured using a 60Hz video camera (HDR-CX430 Sony Ltd., USA) at a frequency of 30 frames per second.

Each game was hand coded by the primary investigator using a notational template created in Excel over a three week period. The excel document was created based on the variables of this study. Analysis was done by systematic observation using the definition of each event so that bias was reduced or eliminated.

Data Analysis

For each variable measured, the number of occurrences and the frequency per game were quantified. Frequency was calculated by dividing the number of occurrences in each match by the number of minutes played. All events and actions were based on a previous study by DeBranda et al. (2008). Events were subdivided into four main situations. The movements

categorized under type of attack, and the field zone from where shots were taken in relation to shooting angle and distance were examined for frequency and count, each of which is defined here.

Variables

1. Type of attack:
    - Direct play – playing forward towards goal quickly with passes or dribbling.
    - Possession based attack – opposing team maintains possession of the ball, building up the field by passing, ball does not always go forward, until the team enters the attacking half and moves towards goal.
    - Counterattack – A quick play by the opposing team once they regain possession of the ball that was on the defensive previous to the attack.
    - Set piece – Corner, penalty and free kicks.
        i. Corner kick – A direct kick from a corner of the field awarded to the attacking team in soccer when the ball has been driven out of bounds over the goal line by the defending team.
        ii. Penalty kick - a direct kick 11 meters out from goal on the penalty mark.
        iii. Free kick – A place kick awarded for a foul or infringement, either direct, from which a goal may be scored, or indirect, from which the ball must be touched by at least one other player before a goal can be allowed.
    - Cross – a pass from a wide area of the field towards the center of field near the opponent's goal.
2. Field zone from where shots were taken; different zones were differentiated in relation to shooting angle (figure 2) and distance (figure 3) from goal.

3. Area of goalkeeper interventions was examined. The zone from which the ball was passed or shot and the goalkeeper's reactions. The frequency and count of two scenarios were examined, which are explained below.
    1. When the ball ended up close to the goal and the goalkeeper performed a technical action, as defined below, the area in which the goalkeeper performed an action was registered (goal area, penalty area, or outside penalty area).
    2. When a team-mate made a pass to the goalkeeper, the area in which the goalkeeper received the ball was registered (goal-area, penalty area, or outside the penalty area)
4. Type of actions by the goalkeeper: The frequency and count of technical actions and physical actions performed by the goalkeeper was examined.

Physical actions

- Locomotions – an action that results in the goalkeeper moving laterally left of right (sideways), moving forwards by stepping or running, and backwards by jockeying, stepping or running.
- Dive – a plunge action using the lower extremity that results in the project of the goalkeeper's body either the left or right side on the ground or into the air.
- Jump – an upward action using the lower extremity that results in the project of the goalkeeper's body into the air.

Technical actions

- *No action taken* – the goalkeeper was engaged in the play and in the ready stance but no technical action was taken, but a physical action was.

- Save – catching, blocking, smothering, tipping, punching or parrying a shot which prevents the opponent from scoring including when the goalkeeper completed this action and it was outside the frame of the goal (caught or blocked with the body)
- Foot control – controlling the ball with the feet and trying to return it to a team-mate with a pass, or kicking a ball that cannot be controlled by clearing it from the penalty area.
- Fly – Attempting a save without contacting the ball because it was deflected or the attempt at the save mistimed.
- Throwing – When the goalkeeper passed the ball to a teammate or started an attack by throwing the ball either underhand or overhand.
- Goal kick or Free-kick – A place kick taken on the six-yard line or around the penalty area by the goalkeeper after being awarded by the referee.
- Punting – A kick from the goalkeepers hands down field.

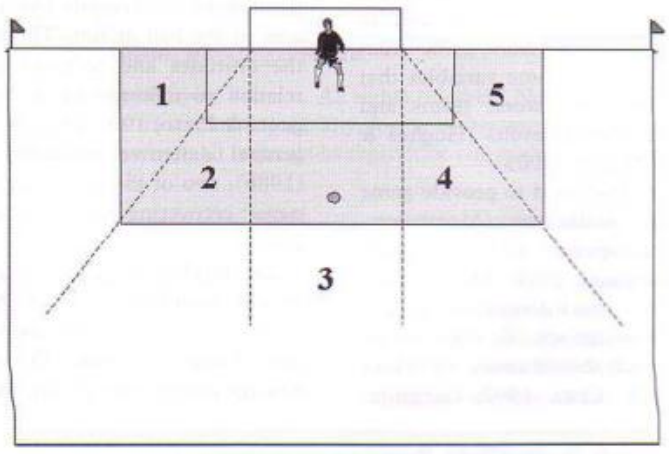

Figure 1. Field zones used in shooting in relation to shooting angle

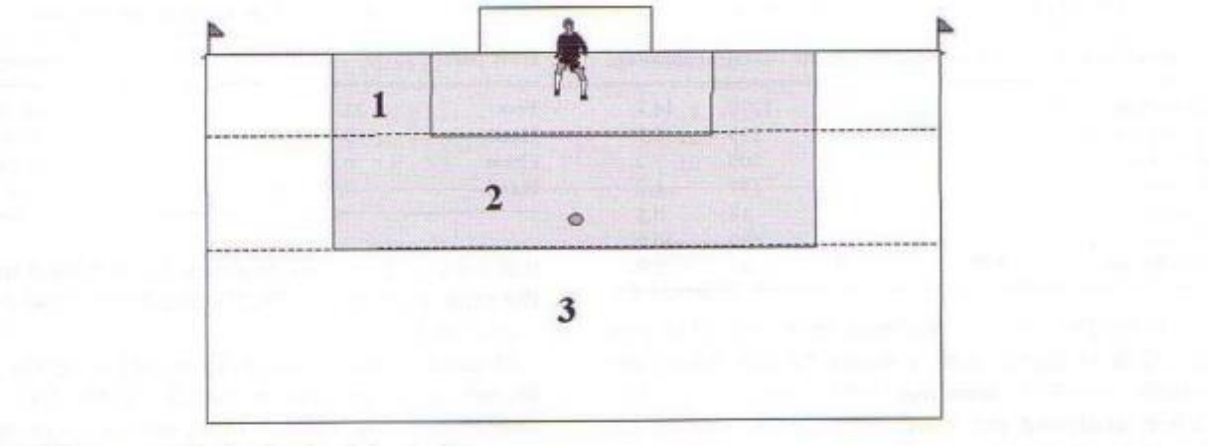

Figure 2. Field zones used in shooting in relation to distance.

Statistical Analysis

Means and standard deviation were calculated for the number of actions taken across all games and for each year, and also for the frequency of actions per minutes across all games and for each year. The coefficient of variation was calculated for each variable to establish the variation in measures across the analyzed matches. All statistics were performed in Microsoft Excel, Redmond, WA. For each variable measured, the number of occurrences and the frequency of actions per minute during each game were quantified. Frequency was calculated by dividing the number of occurrences by the number of minutes of the entire game including extra time, per game.

RESULTS

The purpose of this study was to provide a better understanding of the goalkeeper position in order to better prepare goalkeepers for competition. The objectives of this study were to characterize the technical and physical demands of the NCAA Division I collegiate goalkeeper over three seasons and examine trends in the physical and technical demands from season to season.

Technical Measures

A total of 1560 attacks by opposing teams were analyzed in 39 matches. Direct attack was the most common type of attack across all games and during each year (Table I). The second most common type of attack across all games was the cross. This was also the second most common type of attack in 2013 and 2015. In 2014, the set piece was the second most common type of attack. Direct attack was the least variable attack across all games making it the most consistent attack faced by the goalkeeper, whereas possession based attack had the highest CV value, indicating that the goalkeeper faced possession based attack more in some matches than others (Table I).

In 2013, the highest frequency of attacks was observed. Direct attack was the most frequent attack across all three seasons (Table I). The cross was the second most frequent type of attack in 2013. In 2014 and 2015, the cross and set piece were both the second most frequent type of attack. When the data of the three years was combined, the frequency of events was much larger than individual years.

Table I. *Occurrences for Attack by opposing team*

Type of attack		2013	CV	2014	CV	2015	CV	All Games	CV
Direct	Occurrence	16.8 ± 3.46	20.60%	10.92 ± 4.55	41.67%	11.75 ± 4.86	42.30%	12.77 ± 4.97	38.92%
	Frequency	0.18 ± 0.03	16.66%	0.11 ± 0.04	36.36%	0.13 ± 0.05	38.46%	0.32 ± 0.81	253.12%
Possession	Occurrence	6.7 ± 5.38	79.85%	3.38 ± 2.57	76.04%	3.31 ± 2.15	64.95%	4.43 ± 3.56	80.36%
	Frequency	0.07 ± 0.05	71.42%	0.03 ± 0.02	66.66%	0.04 ± 0.02	50%	0.68 ± 0.99	150%
Counter	Occurrence	5.1 ± 2.88	56.47%	4.07 ± 1.75	43.00%	5.94 ± 2.72	45.79%	5.10 ± 2.55	50.00%
	Frequency	0.05 ± 0.03	60%	0.04 ± 0.01	25%	0.07 ± 0.03	42.85%	0.11 ± 0.22	200%
Set piece	Occurrence	10.7 ± 3.27	30.56%	7.91 ± 3.80	48.04%	8.25 ± 4.95	60.00%	8.79 ± 4.26	48.46%
	Frequency	0.11 ± 0.03	27.27%	0.07 ± 0.04	57.14%	0.09 ± 0.05	55.55%	0.17 ± 0.42	247.05%
Cross	Occurrence	14 ± 6.09	43.50%	7.07 ± 2.87	40.59%	8.31 ± 2.12	25.51%	9.36 ± 4.59	49.04%
	Frequency	0.15 ± 0.06	40%	0.07 ± 0.03	42.87%	0.09 ± 0.02	22.22%	0.18 ± 0.34	188.88%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences

In regards to shooting angle of shots taken by opposing teams, Zone 3 was the most common area where shots were taken across all games (Table II). This was also true for all three years. Zone 3 saw the lowest CV score among each zone compared to other zones, and Zone 1 had the highest variability indicating that in some matches, shots very rarely came from that angle while in other matches, this was a common angle of shots. Zone 4 was the second most common angle shots came from in 2013 and 2015. Zone 2 was the second most common area in 2014 (Table II). The variability in the number of occurrences for attack when the data of the three years was combined were consistent with the variability during each season. This may suggest that the zones most commonly used are used consistently from season to season.

Zone 3 was the area with the highest frequency of shots in all three seasons. The variability in the frequency for shots in zone three appeared lowest in 2013 than the other years, indicating that the goalkeeper faced a lot of shots in some matches and very few in other matches. When the data of the three years were pooled together, the variability in the frequency of shots from any zone appeared larger than any other individual years. This may suggest the uniqueness of each season for these variables.

Table II. *Shooting angle*

Angle from which shot was taken		2013	CV	2014	CV	2015	CV	All Games	CV
Zone 1	Occurrence	0.4 ± 0.52	130.00%	0.38 ± 0.51	134.21%	0.5 ± 0.63	126.00%	0.44 ± 0.55	125.00%
	Frequency	0.004 ± 0.005	125%	0.004 ± 0.005	125%	0.005 ± 0.007	140%	0.01 ± 0.04	400%
Zone 2	Occurrence	3.8 ± 2.35	61.84%	3.83 ± 2.04	60.36%	2.69 ± 1.58	58.74%	3.26 ± 2.02	61.96%
	Frequency	0.04 ± 0.02	50%	0.04 ± 0.02	50%	0.03 ± 0.02	66.66%	0.09 ± 0.25	277.77%
Zone 3	Occurrence	8.6 ± 3.92	45.58%	5.69 ± 2.90	50.97%	5.06 ± 2.79	55.14%	6.18 ± 3.39	54.85%
	Frequency	0.09 ± 0.04	44.44%	0.06 ± 0.03	50%	0.05 ± 0.03	60%	0.13 ± 0.30	230.76%
Zone 4	Occurrence	4 ± 2.26	56.50%	3.08 ± 2.06	66.88%	2.94 ± 1.77	166.10%	3.26 ± 2.00	61.35%
	Frequency	0.04 ± 0.02	50%	0.03 ± 0.02	66.66%	0.03 ± 0.02	66.66%	0.08 ± 0.19	237.5%
Zone 5	Occurrence	0.4 ± 0.52	130.00%	0.23 ± 0.44	191.30%	0.5 ± 0.82	157.69%	0.38 ± 0.63	165.79%
	Frequency	0.004 ± 0.005	125%	0.002 ± 0.004	200%	0.006 ± 00.9	150%	0.004 ± 0.006	150%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences

Zone 3 was the most common area that shots were taken from across all three seasons (Table III). The second most common area was Zone 2 and was also true for all three years. In 2013 the most shots taken were in Zone 2. Zone 3 appears to have had a lower CV value indicating that shots came from this distance consistently across all games. Zone 1 had a high amount of variability indicating that the goalkeeper did not face shots from this distance consistently during matches. When data from all three years was pooled, the variability in zones from what distance shots were taken was consistent with the variability during each season. This may suggest that the zones most commonly used are used constantly during each year.

Table III. *Shooting Distance*

		2013	CV	2014	CV	2015	CV	All Games	CV
Zone 1	Occurrence	1.5 ± 1.27	84.67%	1.08 ± 0.76	70.54%	1.44 ± 1.41	98%	1.33 ± 1.18	88.72%
	Frequency	0.02 ± 0.01	50%	0.01 ± 0.008	80%	0.02 ± 0.01	50%	0.02 ± 0.04	200%
Zone 2	Occurrence	6.2 ± 3.12	50.32%	5.77 ± 3.24	56.15%	4.50 ± 2.03	45%	5.36 ± 2.80	52.24%
	Frequency	0.07 ± 0.03	42.87%	0.06 ± 0.04	66.66%	0.05 ± 0.02	40%	0.13 ± 0.29	223.07%
Zone 3	Occurrence	9.5 ± 3.44	36.21%	6. 08 ± 2.72	44.74%	5.75 ± 3.68	64%	6.82 ± 3.61	52.93%
	Frequency	0.10 ± 0.03	30%	0.06 ± 0.02	33.33%	0.06 ± 0.04	66%	0.17 ± 0.43	252.94%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences

In regards to the amount of technical actions performed by the goalkeeper, the most common technical action performed across all matches was the goal kick. The goal kick was performed consistently across games. In 2014, the most common technical action was foot control. No action was the most common action taken by the goalkeeper across all games. This showed that the goalkeeper was engaged in play but not always required to perform an action in all matches that were played. The save was the next most common technical action after no action, goal kick, and foot control, and this was true across all games and during each season.

Foot control had the lowest number of occurrences in 2013 but a higher CV value indicates that there were some matches in 2013 in which the goalkeeper may have used her feet more than other games. In 2014 and 2015, foot control was the third most common technical action performed by the goalkeeper and the CV value was lower in both these years indicating that foot control was used more commonly across games as the years progressed.

In 2013 and 2015 the goal kick was the most frequent technical action (Table IV). Whereas, in 2014, foot control was the most frequent technical action performed. No action was taken by the goalkeeper most frequently (Table IV). When the data of the three years were pooled together, the variability in the frequency of all technical actions appeared larger than any other individual years. This may suggest the uniqueness of each season for these variables.

Table IV. *Technical Actions*

Type of action		2013	CV	2014	CV	2015	CV	All Games	CV
No action	Occurrence								
take		41.9 ± 9.83	23.46%	19.62 ± 5.39	27.47%	25.31 ± 6.41	25.33%	27.67 ± 11.23	40.59%
	Frequency	0.45 ± 0.11	24.44%	0.21 ±0.06	28.57%	0.28 ± 0.07	25.00%	0.53 ± 0.97	183.02%
save	Occurrence	6.3 ± 3.53	56.03%	7.92 ± 2.99	37.75%	6.81 ± 3.43	50.37%	7.05 ± 3.29	46.67%
	Frequency	0.07 ± 0.03	42.86%	0.08 ±0.03	37.50%	0.07 ± 0.03	42.86%	0.18 ± 0.44	244.44%
foot control	Occurrence	4.2 ± 4.2	100.00%	14.23 ± 7.46	52.42%	8.44 ± 4.10	48.58%	9.28 ± 6.39	68.86%
	Frequency	0.05 ± 0.02	40.00%	0.15 ±0.08	53.33%	0.09 ± 0.04	44.44%	0.32 ± 0.98	306.25%
Fly	Occurrence	3.7 ± 4.42	119.46%	3.38 ± 2.18	64.50%	4.06 ± 3.09	76.11%	3.74 ± 3.16	84.49%
	Frequency	0.04 ± 0.04	100.00%	0.04 ± 0.02	50.00%	0.04 ± 0.03	75.00%	0.09 ± 0.20	222.22%
Throwing	Occurrence	3.1 ± 2.08	67.10%	4.38 ± 2.02	46.12%	5.25 ± 1.34	25.52%	4.41 ± 1.94	43.99%
	Frequency	0.03 ± 0.02	66.67%	0.05 ± 0.02	40.00%	0.06 ± 0.01	16.67%	0.23 ± 0.55	239.13%
Goal kick	Occurrence	12.2 ± 5.12	41.97%	10.46 ± 4.48	42.83%	9.81 ± 3.49	35.58%	10.64 ± 4.28	40.23%
	Frequency	0.12 ± 0.05	41.67%	0.11 ±0.04	36.36%	0.11 ± 0.03	27.27%	0.10 ± 0.32	320.00%
Punting	Occurrence	5.4 ± 3.66	67.78%	3.25 ± 2.60	80.00%	3.19 ± 1.17	36.68%	3.69 ± 3.22	87.26%
	Frequency	0.06 ± 0.04	66.67%	0.03 ± 0.02	66.67%	0.04 ± 0.03	750.00%	0.10 ± 0.32	310.00%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences and number of actions per minute

Physical Measures

The goalkeeper had the highest amount of presence in the goal area, followed by the penalty area. This was consistent across for all three years. The goal area was the most frequent area for the goalkeeper intervention, followed by the penalty area. The goal area showed the highest frequency of intervention in 2013 compared to other years. (Table V). The goalkeeper rarely performed any actions outside the penalty area. When the data from all three years was combined, the variability in frequency of data indicates that each season was unique in regards to goalkeeper intervention.

Table V. *Area of Goalkeeper Intervention*

Where action was performed		2013	CV	2014	CV	2015	CV	All Games	CV
Goal area	Occurrence	58.9 ±17.03	28.91%	36.15 ± 10.16	28.11%	39.81 ± 10.68	26.83%	43.49 ± 15.26	35.25%
	Frequency	0.64 ± 0.18	28.13%	0.39 ± 0.11	28.21%	0.44 ± 0.12	27.27%	0.90 ± 1.91	212.22%
Penalty area	Occurrence	13.5 ± 4.84	35.85%	13.85 ± 5.34	38.56%	15.06 ± 6.38	42.36%	14.26 ± 5.58	39.13%
	Frequency	0.15 ± 0.05	33.33%	0.15 ±0.05	33.33%	0.17 ± 0.07	41.18%	0.35 ± 0.86	245.71%
Outside penalty area	Occurrence	0.4 ± 0.70	175.00%	0.46 ± 0.88	191.30%	1.00 ±1.51	151.00%	0.67 ± 1.15	225.37%
	Frequency	0.19 ± 0.06	31.58%	0.004 ± 0.008	200.00%	0.01 ± 0.01	100.00%	0.03 ± 0.10	333.33%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences and number of actions per minute

Of the displacements observed, the forward displacement was the physical action that occurred most across all games, followed by side-ways displacement (Table VI). The least common physical action was the backwards movement, and had the lowest CV value indicating that the goalkeeper performed backwards displacement more in some matches than others.

(Table VI). The variability in frequency of physical actions performed when data were combined indicates that each season may have been unique.

Table VI. *Physical Actions*

Type of Movement		2013	CV	2014	CV	2015	CV	All Games	CV
Forward	Occurrence	49.9 ± 10.14	20.32%	36 ± 6.65	18%	39.88 ± 7.13	18%	41.15 ± 9.39	22.81%
	Frequency	0.54 ± 0.10	18.52%	0.38 ± 0.06	15.79%	0.44 ± 0.08	18.18%	0.94 ± 2.13	226.96%
Side-ways	Occurrence	18 ± 5.19	28.83%	16.77 ± 3.79	23%	12.69 ± 4.87	38%	15.41 ± 5.08	32.96%
	Frequency	0.20 ± 0.05	25.%	0.18 ± 0.04	22.22%	0.14 ± 0.05	35.71%	0.35 ± 0.83	237.14%
Backward	Occurrence	2 ± 1.83	91.5%	1.92 ± 1.44	75%	2.69 ± 2.30	86%	2.26 ± 1.92	84.95%
	Frequency	0.02 ± 0.02	100.%	0.02 ± 0.01	50.00%	0.02 ± 0.02	100.%	0.05 ± 0.12	240.00%
Dive	Occurrence	4.4 ± 4.12	93.63%	5.31 ± 2.81	53%	4.06 ± 2.52	62%	4.56 ± 3.05	66.88%
	Frequency	0.05 ± 0.04	80.%	0.06 ± 0.03	50.00%	0.04 ± 0.02	50.00%	0.12 ± 0.33	275.00%
Jump	Occurrence	2.5 ± 1.72	68.8%	3 ± 1.53	51%	3.56 ± 2.28	64%	3.10 ± 1.92	61.93%
	Frequency	0.03 ± 0.01	33.33%	0.03 ± 0.01	33.33%	0.04 ± 0.02	50%	0.07 ± 0.15	214.29%

All values as a mean ± standard deviation and coefficient of variation, type of attack listed as listed as number of occurrences and number of actions per minute

DISCUSSION

The purpose of this study was to provide a better understanding of the goalkeeper position in order to better prepare goalkeepers for competition. The objectives of this study were to characterize the technical and physical demands of the NCAA Division I collegiate goalkeeper over three seasons and examine trends in the physical and technical demands from season to season.

There are 3 major observations in this study. First, that most shots faced by the goalkeeper were from direct attacks and from outside the box and from central positions. Next, although the technical demands on the goalkeeper was characterized by engaging in play without action around the goal area, the goalkeeper gradually increased the use of feet over three seasons. Third, over the course of three seasons, forward and lateral movements were the most common and second most common while backwards movement, jump, and dives were less consistent.

Most shots faced by the goalkeeper were from direct attacks and came from outside the box and from a central position. Direct attack was the most common type of attack with a mean of 12.77 ± 4.97 observations across all games (Table I). Zone 3 (Table II and III) in regards to shooting angle and distance was the most common area that shots were taken from. This is important in regards to training simulations for this goalkeeper as coaches may focus on shots that come from central positions outside the box as it has been a common occurrence over three seasons. For field zones from which shots were taken similar results were observed by De Branda et al. (2002) and by Gomez, Alvaro, & Barriopedro (1999) who saw that 16.4% of goals scored in the 1998-1999 Spanish First Division were from outside the penalty area, and 66.9% of goals were scored from within the penalty area and 16.7% in the goal area. This indicates that the further from goal a shot is taken, the less likely a shot is scored. It is also important to note that it is more difficult to enter the zones closer to the goal because of defenders and the goalkeeper.

This may help explain why the majority of shots are taken from outside the penalty area, as it is easier to take a shot from this zone. However, other studies have indicated that the area that most goals are scored is within the penalty area (Romero, Utrilla & Morcillo, 1997). Although the majority of shots are taken from outside the penalty area, it may still be important for the goalkeeper to prepare for shots in areas closer to the goal as these tend to be the areas where goals are scored more often. It should be noted that these studies focused on men's soccer during a major international soccer tournament or season and not women's soccer over the course of a collegiate season. Although the results were similar the length of an international tournament and season are much different than that of a collegiate season and play a factor in results.

Results show that although the goalkeeper's technical demands were mostly characterized by engaging in play without action and being in the goal area (Table IV and V), the gradually increased use of the feet over the three seasons hints on the importance of skills performed with the lower body (e.g. goal kick, punting, and foot control). The calculated CV value of foot control decreased over the three seasons indicating that the use of feet not only became more consistent from season to season, but from game to game in each season too. The goal kick was the most common type of foot control across all games with 10.64 ± 4.28 observations, followed by foot control which had an average of 9.28 ± 6.39 occurrences across all games. This is important to note because coaches and practitioners can design training that incorporates foot control in both dead ball situations (goal kick) and in the flow of the game (foot control). The technical actions overserved in this study were different to what De Branda et al found in the 2002 world cup. He observed that goalkeepers used the save the most consistently and foot control was the second most common occurring technical action. Although the save was not found to be the most common technical action by the goalkeeper, it is still an important

technique to incorporate into practice as it is an important action for the goalkeeper to prevent the ball from entering the goal and can only be performed by the goalkeeper, as the goalkeeper is the only member of the team permitted to use their hands.

Last, over the course of three seasons, forward and lateral movements were most and second most common while backwards movements, jump, and dives were less consistent but commonly performed in some games more than others. Forward movement has an average of 21.15 ± 9.39 occurrences across all games and lateral movement was the next most common with 15.41 ± 5.08 occurrences across all games. These results were similar to De Branda et al. (2008) as he found that forward displacement was the most common type of movement performed by a goalkeeper. Results were slightly different to those found by Padulo et al (2015), male goalkeepers were found to perform 17.5 ± 7.56 m of forwards changes of direction and 15.5 ± 7.78 m of lateral changes during a match. Lateral and forwards movements were also recorded, and showed results of 52 ± 24 total forward actions per game performed and 40 ± 28.2 lateral actions per game, which is much higher than what was found in this case study. This is important to take into consideration as coaches may want to design drills that incorporate more forward movement rather than lateral movement as forward movement can help the goalkeeper intercept the ball quickly depending on what type of attack is being used. Also, coaches may want to take the same consideration when designing drills for the dive which only had 4.56 ± 3.05 occurrences across all games, and may not have to be the physical action that goalkeepers perform the most frequently in training sessions.

In conclusion, the results of the case study showed certain characteristics of the female goalkeeper, but this is a case study and the generalization to other goalkeepers may be limited. One of the key points is that most shots are taken from the zone outside the penalty area and

central positions. Another key point is that lower body skills including foot control (pass backs and clear outs), goal kicks, and punts can be heavily used in some games and more relied on with increasing experience. The last key point is that forward and lateral movements are the two most likely movements compared to movements of the other directions. Future studies should consider examining the same variables as used in this case study but with a group of goalkeepers with sufficient statistical power.

PRACTICIAL APPLICATIONS

Considering the characteristics of the goalkeeper studied in this case study, coaches working with collegiate female soccer players might consider the following practice. 1) Goalkeepers may have to be proficient in blocking shots taken from outside the penalty area. 2) There may be greater use of foot control such as pass backs and clear-outs than what many would consider normal. 3) Coaches may want to focus more on forward and lateral movements in practice.

CONCLUSION

This case study aimed to provide a better understanding of the goalkeeper position in order to better prepare goalkeepers for competition. The results of this case study suggest that goalkeepers should be proficient in saving shots taken from central positions and from outside the box but this finding does not necessarily mean that the ability to save the ball at close range is not important as these are the most dangerous shots. Foot skills may be relied on more with increasing experience and can be more heavily used in some games than others. This finding may be due to players having more trust in their goalkeeper and feeling comfortable playing the ball back, and it can also be due to the technical and tactical skills of the team that the goalkeeper

plays for. Forward and lateral movements are the most common and frequent movements that the goalkeeper exhibits.

There is very little literature that focuses on analysis of goalkeeper match performance. The findings of this case study are similar to those of DeBranda et al. (2008) who found that foot control and the save were the technical action used most by goalkeepers. Di Branda also found that most shots came from outside the box but noted that shots from inside the box were important too as other studies have found that the area where most goals are scored in the penalty area (De Paz & Yague, 1995; Romero, Utrilla & Morcillo, 1997).

Limitations of this case study include the case study design itself. As only one goalkeeper was observed over three seasons it is difficult to infer the exact findings to a population of goalkeepers. Future research should consider a larger sample size that includes goalkeepers from a variety of teams as only one goalkeeper can play for a team at a time. Similar studies have focused on multiple goalkeepers (DeBranda et al, 2008) but only over a short period like tournament play. Future research should also consider monitoring goalkeepers over a longer period of time such as pre-season, in-seasons, tournament, and post-seasons. Future research could include a similar approach to this case study but observes goalkeepers over several seasons from a specific conference.

Researchers may also want to consider studies that combine physiological responses along with performance characteristics during competition so that a more holistic picture can be formed of what goalkeeper performance looks like. Also, future researchers should include experimental studies that compare training drills so that training programs for goalkeepers can be based on scientific evidence and not what has always been done.

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CHAPTER 4

CONCLUSION

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