

## SPORT MEDICINE

# Concussions and Their Effects on Performance Measures of Major League Soccer Players: A Teaching Tool for Physical Education Teachers

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### Abstract

*Concussions are a brain injury that affects the athlete on and off the playing field. The aim of our investigation was to give PE teachers another strategy to use in addition to the recommended approaches set forth by national organizations to convey the message to adolescents regarding the negative effects of concussion. Using the website [www.mlssoccer.com](http://www.mlssoccer.com), we evaluated the performance measures of MLS players. We compared career performance measures of a control group to the career performance measures of a concussed group, compared career performance measures per position, and compared career performance measures occurring prior to concussion onset to performance measures obtained after concussion occurrence for the concussed group. Of the 2,214 listed players, 288 were eligible for the study. From our sample, 34% sustained a concussion while competing in MLS and 66% were placed in the control group (nonconcussed). In a comparison of the control*

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*to the concussed group, total number of shots decreased per season for the concussed group. When the performance measures of both groups were compared by position, midfielders had fewer shots per season, and total shots on goal per season had a trend toward statistical significance. In the comparison of games measures before and after concussion, the total number of seasons and the average games played, total minutes, and shots on goal all decreased per season after concussion occurrence. Concussions negatively affected performance measures of MLS players. PE teachers can use this data to engage with their students about the importance of preventing concussions.*

With the larger societal recognition that concussions are causing health problems, the Centers for Disease Control and Prevention (CDC) initiated a campaign to bring awareness to this issue. To do so, the CDC developed several tool kits to educate professionals who work with athletes. One such tool kit, titled “Heads Up to Schools: Know Your Concussion ABCs,” was targeted for school personnel who work with children from kindergarten through 12th grade. The goal was to heighten awareness and provide strategies for the prevention, recognition, and response to concussions and concussion-like symptoms (Sarmiento, Mitchko, Klein, & Wong, 2010). The CDC (n.d.-c) published an anecdotal statement from an athlete named “Sarah” that read,

My concussion didn’t just sideline me from sports; it also sidelined me from school. Before my injury, I was taking advanced classes. Immediately afterward, I couldn’t even do simple math problems in my head and couldn’t keep up with the lessons. Without extra support, my injury could have had a significant negative impact on my academic record. (para. 8)

One of the National Physical Education Standards set forth by the National Association for Sport and Physical Education (now SHAPE America) stated that the physically educated person achieves and maintains a health-enhancing level of physical activity (Lambert, 2000). Unfortunately, physical activity may be negatively affected by a concussion. Physical educators are gaining recognition concerning

their ability to address critical issues such as obesity and unsatisfactory academic progress (CDC, n.d.-b). Therefore, physical education (PE) teachers could be a great asset for medical professionals to educate youth regarding the negative effects of a concussion and to teach students preventive strategies. They have the ability, through their teachings of activities and life management skills, to connect students to knowledge that is beneficial to them beyond the school environment (Rink, Hall, & Williams, 2010)

By educating students about the negative effects of a concussion, PE teachers can influence students to tell the appropriate personnel about a concussion that they have possibly endured, rather than ignoring the symptoms. Currently, athletes who sustain a concussion in sport hesitate to tell anyone about the injury because they fear being removed from the sport altogether (McCrory et al., 2005; Register-Mihalik et al., 2012; Williamson & Goodman, 2006). It is evident that concussion prevention begins with education, and PE teachers have influence over their students. Bramley, Patrick, Lehman, and Silvis (2012) found that soccer players who received education on concussions were more likely to notify their coach or certified athletic trainers after sustaining a concussion in comparison to athletes who did not receive such education. The fact that PE reaches all children is encouraging to move this initiative further, as it provides an excellent environment for students to learn about concussions in which the teacher's focus is on activities that enhance health (Cook & Kohl, 2013)

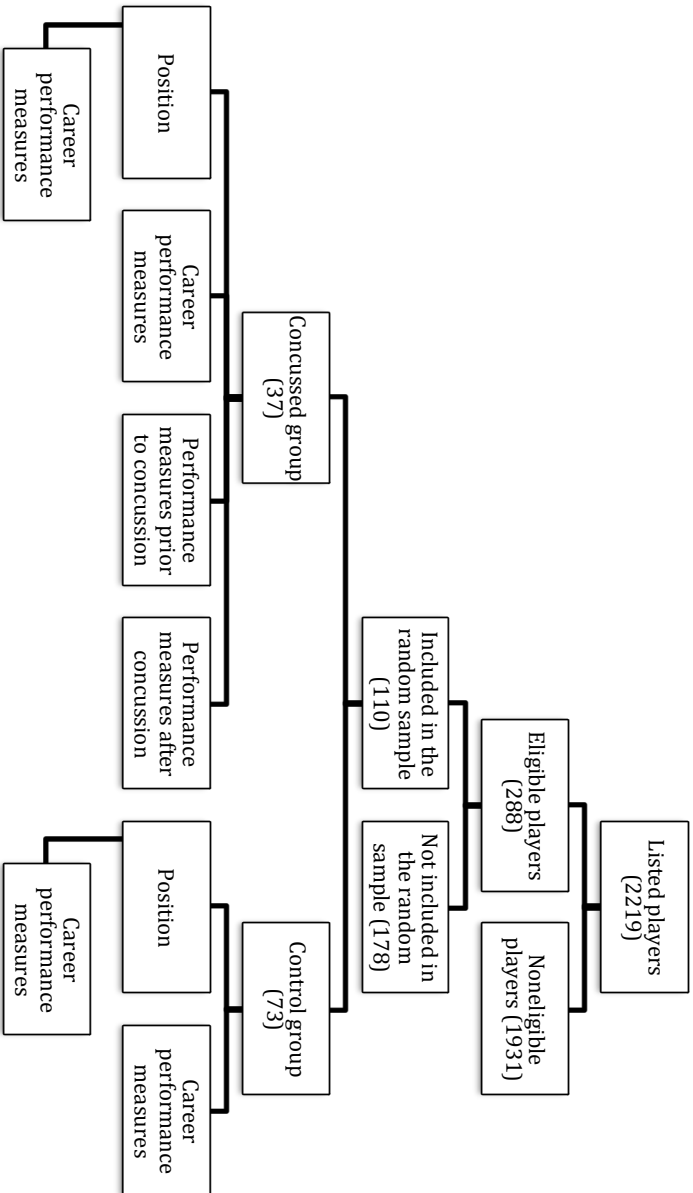
PE teachers should inform students that all concussions are serious and should not be overlooked. The long-term health effects that may arise should be emphasized as more than a distant outcome, but as an extremely likely future. Students should be aware that concussions may be of serious consequence as they may negatively affect memory, make learning difficult, and cause health problems or even death. Concussion signs and symptoms, such as changes in behavior, thinking, or physical functioning, should be taught to students with the emphasis that concussions can happen by any activity that may produce a bump on the head, whether through a single blow or by rapid movements to the head. Furthermore, students need to understand what to do if they suspect that they have endured a concussion (CDC, n.d.-a).

The aim of our investigation was to give PE teachers another strategy to use in addition to the recommended approaches set forth by national organizations to convey the message to adolescents regarding the negative effects of concussion. Our goal was not to replace any of the recommended guidelines, but rather to enhance the current educational practices with additional resources to emphasize that concussions can negatively affect student-athletes current playing ability, which in turn could affect their skill level for their chosen sport. Failure to play at top ability could forfeit any hopes of attaining a starting spot or attaining athletic achievements including all-conference and all-state honors or dilute hopes of attaining an athletic scholarship or even playing at the collegiate level, if desired.

## Method

Our sample consisted of field players who competed in Major League Soccer (MLS) between 1996 and 2014. To be eligible, the player must have been identified as an MLS player, had career performance measures listed on [www.mlssoccer.com](http://www.mlssoccer.com), played at least three seasons in the MLS, played a field position (goalenders were excluded), suffered at least one concussion, minimally played one entire season prior to their concussion and 1-year postconcussion, and listed as inactive on the MLS website.

Of the 2,214 listed players, 288 were eligible for the study. We randomly selected 110 of the 288 players for our investigation (Figure 1). To determine concussion occurrence, we searched Google using the terms *<player name> concussion*, *<player name> <year> concussion*, *<player name> MLS concussion*, *retired MLS players*, *MLS concussion <year>*, and *MLS injury report <year>*. If a concussion was discovered, the year of concussion and associated game performance measures were documented. If a concussion was not discovered, they were placed in the control group.



*Figure 1.* The process of the investigations inclusion and exclusion methods and the variables analyzed for each group.

For the concussion group, we analyzed the performance measures that occurred prior to concussion and the performance measures occurring after concussion. The performance measures that occurred during the year of the concussion were not analyzed, because we wanted to know if concussion affects future performance of the players. We also compared the career performance measures of the concussed to those of the control group and further compared the career performance measures of the concussed to those of the control group, by position.

Performance measures were total number of years in MLS, total number of seasons, total number of games played, total games started, total minutes, total goals, total assists, total shots, and total shots on goal.

A paired *t* test was used to compare the concussion cohort before and after the concussion to evaluate the effects of a concussion on individual game performance measures. To compare performance measures of concussed to nonconcussed players and performance measures of concussed to nonconcussed players grouped by position, we used a graphical analysis of the performance measures, which showed that the data were not normally distributed; therefore, we used the Kruskal–Wallis test to compare the groups. Analysis was completed using MYSTAT (12.02.00).

## Results

From our sample, 37 players (34%) sustained a concussion while competing in MLS that was traceable using Google's search engine. From this group, 19 were listed as defenseman, 10 were midfielders, and eight were forwards. The remaining 73 players (66%) were placed in the control group (nonconcussed). This group consisted of 22 defenseman, 36 midfielders, and 15 forwards. There was statistically significant evidence that the distribution of the position for the concussed group versus nonconcussed group was different, based on Fisher's exact test ( $p = 0.047$ ). There were more defenseman (52.8%) in the concussed group than in the nonconcussed group (30.1%).

Comparisons of career performance measures after the concussion between the concussed and the control group showed that the average number of shots decreased per season ( $p = 0.03$ ) for the concussed group (Table 1). When the performance measures of both groups were compared using a subgroup analysis by position, midfielders were the only players for whom a performance measure was affected by concussion. These players averaged fewer shots per season ( $p = 0.02$ ), and the average number of total shots on goal per season had a trend toward statistical significance ( $p = 0.05$ ; Table 2).

**Table 1**

*Comparison of the Career Performance Measures Between the Concussed and the Control Group*

Career performance measure	Concussed group	Control group	<i>p</i>
	$\bar{x}$ (s)	$\bar{x}$ (s)	
Average Games Played	19.21 (4.75)	18.80 (6.33)	0.92
Average Games Started	16.18 (5.71)	15.96 (6.85)	0.99
Average Minutes Played	1455.44 (493.71)	1415.745 (606.97)	0.80
Average Number of Goals	2.15 (2.49)	3.14 (3.58)	0.17
Average Number of Assists	1.84 (1.31)	3.34 (3.33)	0.08
Average Number of Shots	17.2 (15.49)	26.917 (24.00)	0.03
Average Number of Shots on Goal	7.70 (8.01)	11.67 (11.49)	0.28

**Table 2**

*Comparison of Career Performance Measures Between the Concussed and the Control Group Separated by Position*

<b>Performance measure</b>	<b>Concussed group <math>\bar{x}</math> (s)</b>	<b>Control group <math>\bar{x}</math> (s)</b>	<b><i>p</i></b>
<b>Defenders</b>			
Average Games Played	18.07 (5.87)	17.09 (6.92)	0.54
Average Games Started	16.02 (6.72)	15.02 (6.62)	0.47
Average Minutes Played	1436.50 (589.94)	1364.73 (647.85)	0.51
Average Number of Goals	0.95 (1.00)	0.69 (0.64)	0.60
Average Number of Assists	1.18 (1.02)	1.08 (1.11)	0.48
Average Number of Shots	9.84 (9.79)	9.03 (6.42)	0.68
Average Number of Shots on Goal	3.95 (3.90)	3.32 (3.08)	0.63
<b>Midfielders</b>			
Average Games Played	21.49 (2.69)	19.26 (6.16)	0.47
Average Games Started	18.45 (3.66)	16.71 (7.04)	0.63
Average Minutes Played	1637.94 (312.55)	1448.85 (601.28)	0.39
Average Number of Goals	1.65 (1.70)	2.97 (2.74)	0.11
Average Number of Assists	2.25 (1.24)	4.69 (3.83)	0.11
Average Number of Shots	14.85 (10.67)	27.73 (17.83)	0.02
Average Number of Shots on Goal	6.13 (5.62)	11.79 (8.66)	0.05



**Table 2 (cont.)**

<b>Performance measure</b>	<b>Concussed group <math>\bar{x}</math> (s)</b>	<b>Control group <math>\bar{x}</math> (s)</b>	<b><i>p</i></b>
Forwards			
Average Games Played	19.09 (2.68)	20.22 (6.16)	0.58
Average Games Started	13.73 (4.49)	15.57 (7.04)	0.54
Average Minutes Played	1272.30 (382.32)	1411.09 (601.28)	0.47
Average Number of Goals	5.60 (2.82)	7.27 (2.74)	0.33
Average Number of Assists	2.84 (1.29)	3.44 (3.83)	0.77
Average Number of Shots	37.56 (14.56)	51.17 (17.83)	0.47
Average Number of Shots on Goal	18.56 (8.61)	23.62 (8.66)	0.47

In the comparison of games measures before and after concussion, the average number of seasons played (4.8 vs. 3.2,  $p = 0.04$ ), games played (20.5 vs. 16.3,  $p = 0.01$ ), total minutes (1503 vs. 1203,  $p = 0.04$ ), and shots on goal (9.46 vs. 6.52,  $p = 0.02$ ) all decreased per season after concussion, as indicated by statistical significant difference. Mean scores for games started (16.5 vs. 13.5,  $p = 0.08$ ), goals (2.73 vs. 1.78,  $p = 0.09$ ), assists (1.99 vs. 1.48,  $p = 0.09$ ), and shots (19.3 vs. 14.7,  $p = 0.07$ ) all decreased per season after concussion; however, they were not statistically significant at the 0.05 significance level (Table 3).

**Table 3**

*Comparison of Performance Measures Before Concussion Occurrence to After Concussion Occurrence*

Performance measures	Before	After	<i>t</i> ( <i>p</i> )
	concussion	concussion	
	$\bar{x}$ (s)	$\bar{x}$ (s)	
Average Seasons Played	4.8	3.2	2.04 (0.04)
Average Games Played	20.5 (5.31)	16.3 (10.98)	2.45 (0.01)
Average Games Started	16.5 (6)	13.5 (9.26)	1.79 (0.08)
Average Minutes Played	1503 (554.04)	1203 (820.61)	2.10 (0.04)
Average Number of Goals	2.73 (4.33)	1.78 (2.92)	1.70 (0.09)
Average Number of Assists	1.99 (1.55)	1.48 (1.90)	1.73 (0.09)
Average Number of Shots	19.3 (19.98)	14.7 (19.11)	1.85 (0.07)
Average Number of Shots on Goal	9.46 (11.74)	6.52 (8.95)	2.30 (0.02)

## Discussion

We found statistically significant evidence that supported our hypothesis. MLS players who suffered a concussion took fewer shots per season than players who did not suffer a concussion. Midfielders were affected the most. They took fewer shots on goal and fewer shots per season. Furthermore, concussions negatively affected performance measures in the seasons following concussion. Players who suffered a concussion competed in fewer seasons and fewer games, had fewer minutes, and had a decrease in number of shots on goal per season following their concussion. The results of this investigation are beneficial for PE teachers to explain to their students that concussions not only affect cognition, but also have a negative influence on their athletic career and physical activity outcome.

Participation in professional and/or amateur soccer has been associated with neurocognitive impairment. Our investigation adds to this preexisting concern and to the findings that show concus-

sions sometimes affect player performance (Matser, Kessels, Jordan, Lezak, & Troost, 1998; Matser, Kessels, Lezak, Jordan, & Troost, 1999). Athletes have opted to end participation because of fear of future health problems resulting from concussion. Professional athletes, such as NFL player Chris Borland, receive the most attention for their decision to end their careers, but athletes at all levels are opting to cease participation in their given sport as well, Jack Miller from the University of Michigan's football team for example (Fantz, 2015; Schad, 2015)

Most high school athletes will not advance to the professional level, but some will continue playing as amateurs and risk additional blows to the head. Research from Theadom et al. (2014) suggested that an incidence rate of 170/100,000 people in the general population suffer a concussion. For adults, concussion typically occurred while participating in rugby, equestrian activities, and motorcross/trail riding, and for children, cycling, rugby, football, and swimming were the most common. This investigation exemplifies the need for concussion awareness programs and concussions to be sustained outside of organized sports.

The benefit of this investigation is that PE teachers can use this information as a tool for engaging with students concerning concussion prevention—their message being that if a person suffers a concussion, he or she may suffer neurocognitive impairments and/or experience a decrease in performance with physical and/or everyday activities. The need for concussion programs in schools is growing. Sady, Vaughan, and Gioia (2011) outlined three steps for implementing a school concussion program: establish policies and procedures, educate school personnel, and implement plans for students who sustain a concussion. One key step is prevention. PE teachers have the ability to incorporate concussion prevention strategies within their curriculum and to educate youth about the seriousness of concussions, their effects, what to do if concussed, and prevention strategies. A quality PE teacher uses a variety of instructional methods to engage students (Michigan Action for Healthy Kids, 2005). This investigation provides the teacher with another method to engage students about the importance of preventing concussions.

## Limitations

This study is limited because it relied on data from the Internet. We were unable to determine the total number of concussions each player sustained, and we also were unable to determine if they suffered a concussion while playing in a different soccer league, because we only analyzed their statistics and concussion histories from the MLS. However, researchers could analyze performance measures of high school athletes who suffered concussion and if a lack of performance occurred following injury.

## Conclusion

Concussions negatively affected performance measures of MLS players. PE teachers can use this data to engage their students about the importance of preventing concussions.

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The first page of the manuscript must include the title of the article only. Do not include your name, affiliation, or other identifying information. An abstract must accompany each manuscript.

Label all charts, graphs, and tables and place them on separate pages. Submit all images 300 dpi with appropriate captions. Number the pages beginning with the title page followed by text, references, figure captions, tables, and figures. Figures must be clean and legible. Freehand art or lettering is not acceptable.

Carefully check references to ensure they are correct, included only when they are cited in the text using APA 6th edition style guidelines. Only include references that have been published or accepted for publication.

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