One-Year Concussion Prevalence in Marion County, Florida High School Athletes

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ABSTRACT

Objective: The purpose of this study was to evaluate data on concussion prevalence in 1 geographic location and to identify which sports have a higher prevalence of concussion in the Marion County, Florida, school district.

Methods: High school athletic trainers in Marion County, Florida, are required to compile statistics related to number of participants and concussions sustained in the county school district during each season. They provided the data for the 2011-2012 school year to independent analysts with the permission of the athletic director. The study evaluated 3689 student-athletes (2102 male, 1587 female), and 34 concussions (24 male, 10 female) were reported. Concussions were self-reported by the athletes and diagnosed by trainers on field or by follow-up after physician referral. Consent was included in consent to participate in interscholastic athletics, and all athletes enrolling in a sport during the 2011-2012 academic year were included regardless of participation level. Number of participants and concussions sustained was calculated per 100 participants for each sport and in total for 1 year.

Results: The percentages of concussions per sport were as follows: basketball, 1.83%; cheerleading, 0.40%; football, 2.83%; soccer, 1.84%; track and field, 0.44%; and wrestling, 0.70%. Ten additional sports were included in the study but had no reported concussions. Total prevalence for the district was 0.922% (1.14% male, 0.63% female) during a 1-year period.

Conclusion: The concussion prevalence in this district during the 2011-2012 school year was just under 1%. The sport reporting the highest prevalence was football, followed by soccer. Females reported a higher rate of concussions than males in sports played by both male and female participants. This highlights the need to minimize risk for concussion, especially in noncollision contact sports, and in female athletes. (J Chiropr Med 2016;15:204-207)

Key Indexing Terms: *Brain concussion; Sports; Adolescent*

INTRODUCTION

As many as 3.8 million concussions occur in the United States per year during competitive sports and recreational activities. However, up to 50% of the concussions may go unreported.[1,2] A Joint Commission of the American Academy of Neurology, American Neurology Society, and Child Neurology Society report describes an ethical obligation to protect the athletes' current and future physical and mental health while informing athletes, parents, and medical professionals about the risks of concussion and postconcussive impairments.[3] Although some agreement exists, diagnosis and management of concussion are continually evolving as new data become available.[4] The International Conference on Concussion in Sport and an elevated level of media attention[5] in recent years have spurred sports medicine clinicians to standardize diagnosis, management, and reporting guidelines for athletes sustaining traumatic brain injury during athletic competition.[4,6–8] To date, most attention on concussion has been devoted to collision sports such as football to reduce the risk for serious complications such as second-impact syndrome and potential links to other neurologic disorders.[9,2] This attention has led to updated guidelines for reporting and management of concussion or mild traumatic brain injury in athletic competition.[10] These new

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expectations open the door to challenge the findings of prior prevalence studies from an era where reporting was often minimized to reduce time out of competition.[2] In Marion County, Florida, the athletic director has established guidelines requiring all trainers to document each concussion reported during practice or competition.

We sought to understand concussion prevalence and examine its impact upon specific sports and sexes in an effort to identify which of these factors present more significant risk at the high school level. Understanding these factors may provide greater insight into the etiologic factors that increase risk for concussion in high school athletes. Several authors have compiled information about how type of sport and/or sex may impact the prevalence of concussion.[6,11,12,1,13,14] The International Conference on Concussion in Sport document also describes the influence of sex differences as less conclusive but still likely a modifying factor.[4] The knowledge of how these risk factors affect concussion prevalence can be used to implement measures to reduce risk while informing sports physicians to allow for more effective resource allocation. Comparison of data from multiple districts will allow involved parties to compare prevention strategies such as rule changes and equipment to determine which are having the most dramatic effect on preventing concussion or minimizing postconcussive complications.

The purpose of this study is to report concussion prevalence in 1 geographic location, to identify which sports have higher prevalence in the region, and to document the sex breakdown in concussion rates. This information will help to build greater understanding of how concussion impacts young athletes while informing decisions related to rule changes and resource allocation that minimize the risk and effects of concussion in high school athletes.

Methods

Subjects and Ethics

A chiropractic physician contracted with the Marion County, Florida, school district collaborated with the district athletic director to obtain concussion prevalence data. This school district consists of 7 high schools. The athletic trainers overseeing sports at all 7 schools within the district provided data for the 2011-2012 academic year at the request of the athletic director. The participants were high school students (age range, 14-18 years) participating in interscholastic athletics during the aforementioned seasons. All athletes were included as "participants" regardless of frequency of competition, and athletes participating in multiple sports were not separated. Consent to use the data is included in the forms signed by each athlete and/or parent prior to beginning their season. The study was approved by the institutional review board of Palmer College of Chiropractic.

Data Collection

The trainers were asked to submit data regarding total number of participants, number of male and female participants, and the number of concussions sustained in each sport during the respective season by sex. The trainers provided these data after removing all personal identifying information. Concussion diagnosis was performed either by the trainer at the event or by report from physician/emergency department based upon self-reporting of symptoms. Diagnosis criteria were not standardized. Multiple concussions sustained by 1 athlete during the season were included separately (each concussion was counted as distinct). This study sought to use blinded data collectors (athletic trainers) in a retrospective format to improve the effectiveness of reporting and data collection but was unable to account for standardization of data collection because of the retrospective nature of the analysis. Each athletic trainer used a different style of data collection including spreadsheet, Word document, or pen and paper.

Data Analysis

The data from all schools were tabulated by school, matching the number of participants per sport and the number of concussions reported, each separated by sex. The total prevalence of concussion was calculated as the number of concussions divided by the number of participants multiplied by 100 to reflect the percentage of concussions sustained during a given year. The size and resources of the schools determined which sports were available. Therefore, not all schools had participants in all sports analyzed in the study. This was accounted for by calculating the number of participants by sport. Those sports with lower participation present with smaller n value and as a result have a lower power of significance.

Results

The reported concussion incidence is shown in Table 1 comparing the total incidence to the number of participants, finally reflected as percentage of concussions during the 2011-2012 academic year. Football had the highest incidence, followed by soccer and basketball. Wrestling was the other collision sport where concussion was reported; track and field and cheerleading were noncollision sports reporting concussions. *Collision sports* are defined as those where contact is the intent of the sport, whereas *noncollision contact sports* refer to those where physical contact may occur but is not intended by rule. Baseball, bowling, cross country, golf, softball, swimming, tennis, volleyball, and weightlifting had no concussions reported during the season. Concussion incidence was further

Table 1. *Concussion Incidence by Sport and by Sex During 2011-2012 Academic Year*

Sport	Participants			Incidence					
	Male	Female	Total	Male	% Male	Female	% Female	Total	%
Baseball	166	0	166	0	0	0	0	0	0
Bowling	0	52	52	0	0	0	0	0	0
Cross country [a]	91	58	149	0	0	0	0	0	0
Golf [a]	77	45	122	0	0	0	0	0	0
Softball	0	217	217	0	0	0	0	0	0
Swimming [a]	118	91	209	0	0	0	0	0	0
Tennis [a]	87	57	144	0	0	0	0	0	0
Volleyball	0	137	137	0	0	0	0	0	0
Weightlifting [a]	178	177	355	0	0	0	0	0	0
Cheerleading	1	247	248	0	0	1	0.404858	1	0.403225806
Football	606	30	636	18	2.9703	0	0	18	2.830188679
Wrestling	139	4	143	1	0.71942	0	0	1	0.699300699
Basketball [a]	159	114	273	2	1.25786	3	2.631579	5	1.831501832
Soccer [a]	198	182	380	2	1.0101	5	2.747253	7	1.842105263
Track [a]	282	176	458	1	0.35461	1	0.568182	2	0.436681223
Totals	1463	1115	2578	19	1.14177	1	0.63012	20	0.77579519

[a] Denotes sports with separate male and female teams but similar rules.

reported by sex for sports that have male and female counterparts participating under similar rules. These data are also reflected in Table 1. For all sports combined, the incidence was higher for males than for females. However, for sports with similar male and female counterparts such as basketball and soccer, females had more than double the prevalence of concussion compared with their male counterparts.

Discussion

The total concussion rate for the district during the 2011-2012 academic year was 0.92 concussion per 100 participants. In total, males experienced more concussions (1.12 to 0.63); however, in sports where both sexes participated with similar rules, females experienced more than double the rate of concussions than their male counterparts. This suggests that there may be sex factors that influence concussion risk. These findings are generally consistent with prior studies,[1,9,11,15] with football reporting the highest percentage (53%) and prevalence (2.83), both of which are substantially higher than other high school sports. In addition, soccer and basketball have elevated risk for concussion, particularly in female participants. The data suggest that professionals working with high school athletes should continue to remain vigilant with respect to football participants. However, it is also important to seek preventive measures in noncollision sports such as soccer and basketball to minimize catastrophic events related to concussion.

There are a variety of factors that may explain the high prevalence of concussion in noncollision sports. A lack of protective equipment combined with absence of collision expectation during frequent physical contact creates increased risk. In high school athletics, there can be significant disparity in skill level and body composition between competitors that further complicates risk.[3] This factor may explain why wrestling, which matches participants by weight, is associated with a lower risk of concussion despite the intent of collision and limited equipment.

Studies have sought to identify the sex differences that result in the disparity in concussion prevalence. However, little to no conclusive evidence exists to confirm any of these standing theories. Most of this evidence points to variation in neck strength combined with head mass.[13,7] However, it is also possible that standardization in reporting plays a role as well.[2,4] Regardless, there is a difference that warrants attention of all invested in the health and safety of young athletes.

The data reported here should be considered when determining resource allocation such as access to medical professionals and protective equipment, as well as for training staff. Stoller et al[16] reported that half of family practice and emergency department physicians had no knowledge of any consensus statement related to concussion in sport, whereas others discuss underreporting of concussion injuries.[1,2,4] This underscores the importance of having adequately trained staff present or readily available to athletes during times of practice and competition, especially for female athletes.

Limitations

Although this study is consistent in ranking of the sports with respect to total risk, a major limiting factor is the lack of athletic exposure data to allow a more direct relationship. Comparable studies added calculation of number of athletic exposures (number of practices/competitions) per participant[9,11,12,1] to further standardize the variability in exposure risk between sports. Although this does provide

improved validity, it still does not account for the number of collisions before concussion is sustained that may further favor noncollision sports. This is important considering that the ratio of concussions to exposure is dramatically different in collision vs noncollision contact sports. The number of participants evaluated in this study was relatively small, and the number of sports was not consistent at all schools. A larger study matching schools by size may provide a more reliable comparison. In addition, sports not separated by sex were reported with respect to typical sex role participation. For example, football was reported for males and cheerleading for females. It is possible, but unlikely from the contracted physician's recollection, that some athletes' sex was misreported as a result of this.

Future Studies

Follow-up studies could add participant sessions (exposures/participant) in larger populations, and more data could be collected including the competitive level of the athletes (top-ranked vs recreational teams) and body composition of the athletes. Such considerations will give a more accurate reflection and perhaps improve our understanding of how common concussion is. Greater understanding of how disparity in skill level and body composition impacts risk may provide insight into how and where risks can be minimized. We suggest replication of this study in other counties and states to increase the rigor of the data available when determining concussion prevalence. Comparison of these data may assist high school officials and athletic directors to evaluate those measures being implemented by schools with a lower prevalence of concussion and therefore to develop more effective prevention plans. A follow-up study with baseline data on functional movement and neurocognitive ability would shed some light on the differences that predispose one athlete to concussion more than another. To account for variability of sports available, it may be advisable to develop prevalence data that are sport-specific to increase validity.

Conclusion

This study reports the rate of concussion in Marion County, Florida, high school athletes. Concussion prevalence in females was more than double that of their male counterparts in shared sports, suggesting further investigation into the precise role of sex in concussion. Football accounted for the highest prevalence. However, it is important not to overlook noncollision contact sports such as soccer and basketball where prevalence was shown to be higher than other collision sports such as wrestling. The data derived from this study can be used by sports physicians, coaches, officials, and school administrators to guide investigation into the etiology and risk reduction for concussion in high school athletes.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

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