

# Risk of Concussion During Sports Versus Physical Education Among New Mexico Middle and High School Students

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**Objectives.** To measure the risk of concussion among New Mexico middle and high school students during both sports and physical education.

**Methods.** Athletic directors or athletic trainers in 147 schools were asked to report the number of concussions occurring during sports and physical education in the 2013 to 2014 school year. We calculated 1-year cumulative incidence rates.

**Results.** Of the 147 schools, 99 responded (67%). During the school year, 598 students were removed from athletics because of a concussion, a 1-year cumulative incidence of 3.5 per 100. The concussion rate during sports was 3.0: 3.5 for boys and 2.4 for girls (relative risk [RR] = 1.5; 95% confidence interval [CI] = 1.2, 1.7). An additional 335 students experienced concussions during physical education. Concussion rates during physical education were 60% higher than during sports (RR = 1.6; 95% CI = 1.4, 1.8).

**Conclusions.** In our data, the risk of concussion was higher in physical education than in sports. This suggests that concussions should be tracked for a wide range of youth athletic activities, not just for sports. Monitoring cumulative incidence, in addition to other measures, may allow comparisons across schools and regions. More prevention efforts are needed. (*Am J Public Health.* 2018;108:93–95. doi: 10.2105/AJPH.2017.304107)

Concussion in youths participating in sports and recreation is common and is increasingly viewed as a significant public health concern.<sup>1</sup> Typically, the effects of a single concussion are thought to be benign and to resolve within 7 to 10 days without long-lasting effects. However, in some cases, symptoms are prolonged.<sup>2,3</sup> Because neuroimaging studies have reported subtle changes in brain morphology and function after pediatric concussion,<sup>4</sup> there is also growing concern about the potential long-term effect of repeated concussions.<sup>5</sup> Some evidence suggests that the developing brain is more vulnerable to concussions, although this has not been well established, with conflicting evidence for both increased susceptibility and resilience.<sup>6</sup> Given that acute and long-standing effects of concussion are not well understood, there is a critical need to better track and improve the recognition, management, and prevention of sports-related traumatic brain injuries.

Early estimates of sports-related traumatic brain injury in youths based solely on emergency department data are between 1.8 and 3.8 million cases annually.<sup>7</sup> Relatively few studies have investigated the incidence of sports-related concussions in young athletes without using hospital records. More recent estimates indicate that 1.1 to 1.9 million sports- and recreation-related concussions occur in youths, taking into account multiple points of health care access.<sup>8,9</sup> We found no

studies that reported the risk of concussion during physical education classes. At the time of the study, New Mexico schools did not have mandatory reporting requirements for concussions.

The goal of this study was to estimate the 1-year incidence of concussion in New Mexico middle and high school students during sports and physical education by sex.

## METHODS

Athletic directors or athletic trainers from New Mexico Activities Association middle and high schools (n = 147) were invited to participate in a Web-based survey about the number of concussions that had occurred during organized sports or physical education in their schools during the 2013 to 2014 school year. We also asked about the number of students participating in each activity by gender. For each concussion reported, we asked respondents whether it had been treated in an emergency department. After the initial invitation, 2 reminder e-mails were sent. Study research assistants contacted nonresponders up to 3 times to encourage participation. Participants were provided a \$25 gift card.

We calculated 1-year cumulative incidence rates and 95% confidence intervals

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(CIs) with the OpenEpi online statistical program ([http://www.openepi.com/Menu/OE\\_Menu.htm](http://www.openepi.com/Menu/OE_Menu.htm)). Concussion rates are reported per 100 students participating.

## RESULTS

Of the 147 schools, 99 (67%) athletic directors or athletic trainers completed surveys. During the 2013 to 2014 school year, 598 athletes (392 boys and 206 girls) were removed from athletics as a result of sustaining a concussion (Table 1), a rate of 3.5 per 100. Fewer than one third (27.3%) of the reported concussions were treated in an emergency department. The rate of concussion during sports was 3.0: 3.5 for boys and 2.4 for girls (relative risk [RR] = 1.5; 95% CI = 1.2, 1.7). Highest rates of concussions among boys were in lacrosse (12.9), football (8.2), horseback riding or rodeo (7.7), wrestling (6.3), and soccer (4.8). For girls, the highest rates of concussions were in wrestling (5.6), soccer

(5.3), cheerleading or spirit (4.2), volleyball (3.5), and softball (2.7).

An additional 335 students (171 boys and 164 girls) experienced concussions during physical education, a rate of 4.7 per 100. Concussion rates for physical education were 60% higher than for sports (95% CI = 1.4, 1.8). Girls had slightly higher rates (5.2) than boys (4.4), although the confidence interval crossed 1.0 (RR = 1.2; 95% CI = 0.9, 1.4). For girls, the risk of concussion during physical education was more than twice the risk during sports (RR = 2.2; 95% CI = 1.8, 2.7). The proportion of concussions treated in the emergency department was similar between boys (26.5%) and girls (28.6%).

## DISCUSSION

To our knowledge, this was the first statewide study of cumulative incidence of concussion rates during sports and physical education among high school and middle

school students in New Mexico. In our data, fewer than one third of all concussions were treated in an emergency department, consistent with the literature indicating that most sports concussions are initially treated in health care settings (e.g., primary care or specialty clinics) other than emergency departments.<sup>9</sup>

Our unexpected finding was that the concussion risk for students during physical education was 60% higher than for students during sports. This finding may reflect decreased identification of possible concussions during sports, less attention to preventing head injury in physical education, or differences in reporting between physical education and sports. Students playing sports also may be in better physical condition than students taking physical education, which is protective. Additional study is needed to determine whether the risk of concussion is higher in students participating in physical education and, if so, to understand the reasons.

New Mexico high schools require only 1 semester of physical education to graduate.

**TABLE 1—One-Year Incidence of Concussion Among New Mexico Student Athletes, by Sport, Physical Education, and Sex: 2013–2014**

	Boys			Girls			Total	
	No. Removed With Concussion	No. Participated	Concussion Incidence per 100	No. Removed With Concussion	No. Participated	Concussion Incidence per 100	No. Removed With Concussion	1-Year Concussion Incidence per 100 Among All Student Athletes
<b>Sport</b>								
Baseball or softball	24	1 665	1.4	30	1 107	2.7	54	1.9
Basketball	55	2 189	2.5	39	1 790	2.2	94	2.4
Cross-country	0	596	0.0	0	423	0.0	0	0.0
Diving	0	22	0.0	0	16	0.0	0	0.0
Football	233	2 846	8.2	0	0	0.0	233	8.2
Golf	0	210	0.0	0	111	0.0	0	0.0
Horseback riding or rodeo	1	13	7.7	0	10	0.0	1	4.3
Lacrosse	4	31	12.9	0	18	0.0	4	8.2
Snow sports	0	44	0.0	0	45	0.0	0	0.0
Soccer	39	815	4.8	37	696	5.3	76	5.0
Spirit or cheerleading	0	88	0.0	38	895	4.2	38	3.9
Swimming	0	203	0.0	0	184	0.0	0	0.0
Tennis	1	286	0.3	0	253	0.0	1	0.2
Track and field	3	1 738	0.2	1	1 456	0.1	4	0.1
Volleyball	0	0	0.0	60	1 705	3.5	60	3.5
Wrestling	32	509	6.3	1	18	5.6	33	6.3
Total sports <sup>a</sup>	392	11 255	3.5	206	8 727	2.4	598	3.0
Physical education	171	3 886	4.4	164	3 174	5.2	335	4.7

<sup>a</sup>There were no reports of athletes participating in field hockey, gymnastics, ice hockey, or water polo.

This may explain why, in our study, more students participated in sports than in physical education.

It is difficult to compare the incidence rates from this study with national rates, because many studies report incidence as a function of athletic exposures (number of games and practices) by sport rather than as a 1-year cumulative incidence as was done in this study. In comparison with methodologically similar studies, the risk of concussion in our population was higher (3.5) than the reported rate (1.1) in high school athletes in Minneapolis, Minnesota.<sup>10</sup> In that study, the sports with the highest concussion rates were boys' football and girls' ice hockey (approximately 6.0 for both). A study in Washington State that focused on girls' soccer and boys' football reported a cumulative incidence rate of 11.1 for girls' soccer and 10.4 for boys' football.<sup>11</sup>

Results from this study indicate that regional differences in risk of concussion in youths need to be better understood. From a public health perspective, estimating cumulative incidence, in addition to other exposure measures, also may be useful for comparing the overall burden of concussion across populations.

This study had important limitations. Although we obtained a satisfactory response rate (67%) for surveys, about one third of the schools did not respond. We based our calculations on athletic trainers' or athletic directors' retrospective reports of the number of concussions and the number of students participating. We did not have the resources to track prospectively the number of concussions per athletic exposure for this preliminary study. This would have been valuable but not a replacement for collecting data on cumulative incidence. This study did not include youth club sports. Thus, the data likely underestimate the incidence of concussion in New Mexico youths.

## PUBLIC HEALTH IMPLICATIONS

We need to better understand regional differences in concussion risk in youths to create more effective interventions (e.g., rule changes, legislation) to reduce those risks.<sup>12</sup> We also must confirm whether the risks of concussion are higher during physical education than during sports. If they are, we need

to understand what is driving the increased risk and how to make physical education safer, because physical education is crucial for students' physical and mental health.

There is a critical need to improve how concussions are tracked over time, to standardize methods across studies for comparing populations, to understand the risk factors, and to improve the recognition, management, and prevention of traumatic brain injuries. **AJPH**

## CONTRIBUTORS

All authors were involved in the design of the study; collection, analysis, and interpretation of the data; and preparation, revision, and final approval of the article.

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**Note.** Study sponsors were not involved in the study collection, analysis, or interpretation of the data. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NMBIAC or NIH. We collected and managed study data via Research Electronic Data Capture (REDCap) tools hosted at the University of New Mexico. REDCap is a secure, Web-based application designed to support data capture for research studies: <https://hsc.unm.edu/research/ctsc/informatics/redcap/index.html>.

## HUMAN PARTICIPANT PROTECTION

Study procedures were approved by the University of New Mexico Health Sciences Center Human Subjects Research Protections Office. All participants provided informed consent prior to having access to the survey.

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