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Estimated costs of injuries in college and high school female sports

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A B S T R A C T

Injury rates in thirteen U.S. women's college sports and four U.S. girls' high school sports are examined in this paper. The sports are categorized as high injury (*H*) or low injury (*L*) and differences in injury rates between the two are examined. Estimates are presented of the injury savings that would result if the *H* sports were changed to have injury rates similar to those in the *L* sports.

1. Introduction

This study provides for women's and girls' sports a broad comparison of injury rates across injuries and sports, and it incorporates economic cost into the analysis. Injury rates in thirteen U.S. women's college sports and four U.S. girls' high school sports are examined for the 2009/2010–2013/2014 period. The college data are from the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP)—the Datalys data.[1] The high school data are from the High School RIO (Reporting Information Online) project.[2] The data are compiled from a sample of reporting colleges and high schools and blown up to national totals.

The sports are categorized as high injury (*H*) or low injury (*L*) and differences in injury rates between the two are examined. Estimates are presented of the injury savings that would result if the *H* sports were changed to have injury rates similar to those in the *L* sports. The estimated college savings are 13,610 fewer injuries per year and 2,020 fewer healthy years lost-to-injury per year. The estimated high school savings are 143,900 fewer injuries per year and 24,300 fewer healthy years lost-to-injury per year. For concussions the savings are 2,750 per year for college and 49,390 per year for high school. The estimated dollar value (in 2022 dollars) of the total injury savings is between $150 million and $606 million per year for college and between $1.6 billion and $6.1 billion per year for high school.

This paper is not a policy paper in that no policy recommendations are made. There are many important and controversial issues in college sports. On the negative side there are concerns that academic standards are being lowered in the interest of sports and that there is too much of a sports culture relative to an academic culture at some colleges. On the positive side, sports provide considerable enjoyment to fans and added gifts from alumni to colleges. Also, team sports have social benefits—learning how to work with others, socializing, learning leadership skills. And exercise is healthy. This paper does not consider these issues. It simply estimates possible injury costs that would be saved if injury rates were lowered in the *H* sports. It provides estimates of injury costs for college and high school administrators and government policy makers that would be saved by doing this. These estimated savings can be weighed against the benefits of keeping the *H* sports as they are now. The cost estimates have the advantage that the base case is not zero injuries. All activities have some risk of injury, even walking. The base case is the injury experience in the *L* sports.

Seven sports are categorized as *H* in college: soccer, gymnastics, basketball, volleyball, ice hockey, field hockey, and lacrosse. Two are categorized as *H* in high school: soccer and basketball. Could these sports be changed to have fewer injuries without destroying the sports? The team aspect of sports mentioned above would be retained, but there are undoubtedly different views on whether the sports would survive. The rules would have to be changed to make the sports less rough and the refereeing would have to be made tighter. Some experimentation would undoubtedly be needed to change the rules for each sport to achieve lower injury rates.

The results in this paper are only approximations. The data are based on surveys, and there is obviously sampling error. Much of the analysis in this paper focuses on the aggregation of all five years, all three divisions

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[1] These data are created, compiled, or produced by the Datalys Center for Sports Injury Research and Prevention, Inc. on behalf of the National Collegiate Athletic Association.

[2] Various reports produced by Comstock et al. (2010-2011–2014-2015).

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(for colleges), and all injuries. To the extent that sampling errors are not perfectly correlated with each other, aggregation should lessen the effects of sampling error.

The college results are discussed first in Sections 3–6, followed by the high school results in Sections 7–10. Section 11 provides a comparison of the female and male results.

2. Literature

Many of the previous studies that have used the Datalys data, which are also used here, have focused on specific sports or injuries. One approach is to fix a sport and determine the breakdown of injuries incurred while playing this sport. Roos et al., 2017 analyze all injuries reported in men's and women's soccer. They compare injury rates per athletic exposure between genders, and they characterize the quality of these injuries. Kerr et al. (2016) examine cross country injuries, comparing, among other things, injury rates across genders. Lynall et al., 2016 examine tennis injuries.

Another approach is to fix a particular injury and analyze its distribution across sports. Hibberd et al. (2016) and Dalton et al. (2015) examine acromioclavicular joint sprain. Some studies fix a particular sport and injury. Dalton et al. (2016) examine hip/groin injuries in ice hockey. Gardner (2015) examines head, face, and eye injuries in women's field hockey.

Regarding the high school RIO data, which are also used in this study, Marar et al. (2012) used the data to examine concussions in 20 sports for the 2008–2010 academic years. They found that concussions occur in a wide variety of high school sports. Rosenthal et al. (2014) used the RIO data to examine trends in concussion rates in 9 sports for the 7 academic years 2005/2006 through 2011/2012. They found an increase in the concussion rate in each of the 9 sports, with the increase being statistically significant in 5 of the sports over the 7-year period.

Lutter et al. (2022) reviewed studies that analysed various injury prevention measures on healthcare expenditures. They found that neuromuscular training can be important in reducing injuries and that disallowing body checking in 11-12-year-old ice hockey reduced healthcare expenditures considerably.

Both the Datalys data and the RIO data cover only short-term injury costs. There is a growing literature examining potential long-term health consequences of competing in high-injury sports, such as Montenigro et al., 2017, but this is a question beyond the scope of the data used here. It may be that the long-term costs are much larger than the short-term costs computed here.

3. College data

The NCAA-ISP data are created from a sample of schools. Each participating school reports injury information to the NCAA. As discussed below, multiplication factors are used to blow the sample values up to national totals.

The NCAA-ISP data contain two files. The first file documents athletic exposures. An exposure is defined as "a practice or competition in which a student-athlete was exposed to the possibility of athletic injury, regardless of the time associated with the participation." In the file each "exposure" is one observation, with a unique identifier key and the number of athletes who participated in the session. An exposure is thus a record of a practice or competition. If one observation in the file records, say, 20 athletes participating in the session, that observation actually codes for 20 total athlete exposures. For each observation there are codes for the sport, the college division, and the academic year. There are 13 sports, three college divisions, and five academic years.

The second file documents injuries. One observation records a single injury. Included in each observation are codes for the specific injury classification, a 50 group injury classification, the year, the sport, the division, the number of days lost, whether or not the injury required surgery, and various other data.

For a given injury classification, the injury rate is the number of injuries divided by the number of exposures. Rates are calculated by simply counting the total number of athlete exposures for a certain sport, division, and year, counting the number of injuries of a particular classification in the same sport, division, and year, and dividing the two. For any given sport, division, and year, the number of exposures will always be the same. Rates only differ because the number of injuries differs, not because the number of exposures differs.

In this paper four injury types, based on 15 injury group classifications, are examined. The aggregation of the injuries into the four types is presented in Table 1. Fifteen of the 50 injury group classifications have been used. The four types are roughly: concussions, bone injuries, tear injuries, and muscle injuries. Other injury groups were deemed too rare or too mild to warrant consideration. The injury rate for all injuries, all sports, all divisions, and all years is 5.23 per 1,000 exposures. This compares to 3.40 per 1,000 for only the four injury types in this analysis.

Also included with the NCAA-ISP data are multiplication factors to convert the sample values to national totals. Each observation in both files includes a weight, which varies by sport, division, and year. For example, the weight for division I women's softball for the 2009/2010 academic year is 79.37. This means that each exposure or injury in the sample is assumed to be 79.37 exposures or injuries at the national level. The multiplication factors are computed by a simple formula: for each sport, division, and year, the weight is just the number of sponsoring schools divided by the number of schools participating in the ISP program, where a sponsoring school is a school with a team for the particular sport, division, and year. For additional information on the weighting procedure, Kerr et al. (2014) provide a complete guide on the methodology of the collection and weighting processes of the ISP program. See also Kerr et al. (2015). The majority of the available literature uses these weights, and our analysis has done the same.

Although the Datalys data are widely used, they have limitations. They come from a convenience sample of NCAA institutions, with athletic trainers voluntarily documenting injuries. The data are not necessarily a representative sample of the national population. The data may also be subject to underreporting. It may be that athletes experience conditions that do not quite qualify as injury, but still adversely impact health. See Baugh et al. (2014) for a discussion on college football underreporting. Athletic trainers may also differ in what qualifies as an injury, and so there is some subjectivity involved in reporting injuries.

Privacy issues also limit the amount of information that can be obtained from the data. The only personal information on an athlete is gender. For example, it is not known whether an injured athlete was a starter or a bench player. The college is also not known except for which division it is in.

Although the data are not perfect, they are generally accepted as being reasonably accurate. Kucera et al. (2011) analyzed the effectiveness of the ISP by performing a capture-recapture analysis of ISP data for men's and women's soccer teams at 15 universities for the time period 2005–2008. The authors reviewed hard-copy athletic trainer injury assessments and clinician notes to come up with an independent database on injuries. They then compared this database with the ISP database for

Table 1
The four injury types.

concuss	concussion, nervous system
Bone	exostosis, fracture, fracture (stress), myositis ossificans, osteochondritis
Tear	cartilage injury, dislocation, sprain, strain, strain/tear, subluxation
Muscle	contusion (hematoma), spasm

Not used: Abrasion, arthritis/chondromalacia, avascular necrosis, avulsion, avulsion/fracture, bursitis, capsulitis, cardiovascular, compartment syndrome, cysts, dental, dermatology, effusion, endocrine system, entrapment/impingement, environmental, gastrointestinal, genitourinary, hematology, illness, infection, infectious disease, inflammation, internal organ, laceration, miscellaneous, neoplasm, psychological, respiratory, rheumatology, synovitis, tendinitis, tendinosis, tenosynovitis, thrombosis.

Table 2
Injury rates: Injuries per 1,000 exposures all five years, all three divisions.

	1000(*I*/*E*)				
	all 4injuries	concuss	bone	tear	muscle
Soccer	6.70	0.64	0.33	4.27	1.46
Gymnastics	6.20	0.31	0.76	4.18	0.95
Basketball	4.83	0.62	0.24	3.16	0.81
Ice Hockey	4.60	0.67	0.20	2.51	1.22
Field Hockey	4.48	1.05	0.15	1.87	1.41
Volleyball	4.28	0.38	0.21	3.22	0.47
Lacrosse	3.98	0.58	0.13	2.39	0.88
L: Low Injury	2.63	0.12	0.17	1.94	0.40
Softball	3.49	0.36	0.20	1.95	0.99
Tennis	3.33	0.19	0.18	2.70	0.27
Indoor Track	2.64	0.04	0.09	2.19	0.32
Cross Country	2.20	0.02	0.29	1.70	0.19
Outdoor Track	1.84	0.07	0.16	1.45	0.15
Swimming	0.68	0.07	0.02	0.47	0.12

Low injury sports are taken to be tennis, softball, indoor track, cross country, and outdoor track.

the same teams over the same time period. Based on proportions of injuries captured in one, both, or (an estimate of) neither database, the authors determined that the NCAA ISP program captured 88.3% of all time-loss relevant injuries over that period.

4. Injury rates

Consider first the aggregation of the three divisions and the five academic years. For this aggregation let E_k denote the number of exposures in sport *k*; let I_{ik} denote the number of injuries of type *i* in sport *k*; let D_{ik} denote the number of days lost from injuries of type *i* in sport *k*; and let S_{ik} denote the number of injuries of type *i* in sport *k* that required surgery. The injury rate for injury of type *i* and sport *k* is I_{ik}/E_k.[3]

Injury rates for the four types of injuries are presented in Table 2 for the 13 sports. These rates are for the aggregation across the five years and the three divisions. Five of the sports have been classified as low injury: softball, tennis, indoor track, cross country, and outdoor track. Swimming has been excluded from the low injury category because it is almost injury free. It is not representative of the other low injury sports. Injury rates for the low injury category, denoted *L*, are also presented in Table 2.

Soccer has the highest overall injury rate: 6.70 per 1,000 exposures. Field hockey has the highest concussion rate at 1.05. Ice hockey, soccer, and basketball have the next highest: 0.67, 0.64, and 0.62 respectively. Of the sports classified as low injury, softball has the highest overall rate at 3.49, followed by tennis at 3.33. Lacrosse, classified as a high injury sport, is only slightly higher than softball and tennis at 3.98, but it has a larger concussion rate: 0.58 versus 0.36 and 0.19. For all the sports *tear* has the highest injury rates.

For L the overall injury rate in Table 2 is 2.63 per 1,000 exposures.

[3] The number of days lost was computed as follows. Included for each observation in the second ISP file is a variable that gives the exact number of days lost for each specific injury. Denote this variable *D*1. Unfortunately, *D*1 has many missing observations. Also included is a variable giving rough categories of days lost due to an injury. The categories are: 1) did not have to sit out, 2) sat out but returned within the same practice or competition, 3) missed 1–6 days of participation, 4) missed 7–13 days, 5) missed 14–29 days, 6) missed 30+ days, or 7) missed the entire season. Denote this variable *D*2. It has only a few missing observations. To come up with a value for the number of days lost for categories 3) through 7), when data were available on both *D*1 and *D*2 the average of the *D*1 values was computed for each of the categories. This gave five numbers: 3.303, 9.477, 19.620, 53.330, and 147.880. Values of 0.5 and 1.0 were assigned to categories 1) and 2) respectively. These seven numbers were then used to fill in the missing values for *D*1, given the information on the classification from *D*2.

Table 3
Total injuries and severity all five years, all three divisions.

	1000 (*I*/*E*)	*E* mil.	*I* thous.	*D* thous.	*D*/*I*	100(*S*/*I*)
	all four injury types					
Soccer	6.70	9.01	60.39	941.17	15.58	4.47
Gymnastics	6.20	0.66	4.10	85.38	20.84	8.76
Basketball	4.83	8.36	40.38	595.66	14.75	5.29
Ice Hockey	4.60	1.02	4.67	46.13	9.87	3.16
Field Hockey	4.48	1.18	5.30	94.04	17.76	0.70
Volleyball	4.28	6.96	29.77	479.47	16.11	6.75
Lacrosse	3.98	2.87	11.43	145.29	12.71	3.65
L Low Injury	2.63	38.03	100.16	879.06	8.78	1.69
Softball	3.49	8.25	28.81	250.65	8.70	4.51
Tennis	3.33	3.31	11.01	32.59	2.96	0.00
Indoor Track	2.64	12.18	32.16	230.16	7.16	0.70
Cross Country	2.20	5.40	11.85	164.34	13.87	0.00
Outdoor Track	1.84	8.89	16.33	201.32	12.33	1.02
Swimming	0.68	9.02	6.15	67.50	10.97	0.60

See notes to Table 2.
D = number of days lost due to injuries.
S = number of injuries that required surgery.

The rates for soccer and gymnastics are about 2.5 times this. The rates for basketball and ice hockey are about 1.8 times this, and the rates for field hockey, volleyball, and lacrosse are about 1.5 times this.For *concuss* the rates for soccer, basketball, and ice hockey are a little greater than 5 times the rate for *L*. For field hockey the rate is about 9 times greater.

Table 3 presents the injury rates plus the total number of exposures, the total number of injuries, the number of days lost from the injuries, the number of days lost per injury, and the percent of injuries that required surgery. Table A1 in the Appendix is the same table disaggregated by the four injury types. The data are for all five years and all three divisions.

Indoor track has the largest number of exposures at 12.18 million. Soccer, basketball, softball, and outdoor track have a similar number of exposures at 9 million or a little less. Gymnastics has the smallest number of exposures at 0.66 million. The number of days lost per injury is highest for gymnastics, followed by field hockey, volleyball, and soccer. The number of days lost per injury for *L* is 8.78. The percent of injuries that require surgery is highest for gymnastics at 8.76 percent, followed by volleyball at 6.75 percent.

For *concuss* in Table A1 the most concussions are in soccer at 5,760, followed by basketball at 5,140.

Table 4 presents the injury rates for the three divisions, aggregated by

Table 4
Injury rates by division all five years.

	1000(*I*/*E*)			
	I	II	III	All
	all four injury types			
Soccer	7.79	4.15	7.53	6.70
Gymnastics	6.58	7.11	4.85	6.20
Basketball	6.11	3.12	4.80	4.83
Ice Hockey	2.71	8.29	5.66	4.60
Field Hockey	2.46	NA	7.02	4.48
Volleyball	4.57	3.68	4.42	4.28
Lacrosse	2.79	0.94	5.34	3.98
L: Low Injury	3.33	1.56	2.54	2.63
Softball	3.72	2.89	3.75	3.49
Tennis	5.11	NA	1.95	3.33
Indoor Track	3.70	1.49	2.29	2.64
Cross Country	1.86	0.91	3.09	2.20
Outdoor Track	2.77	0.51	1.59	1.84
Swimming	0.71	0.70	0.62	0.68

See notes to Table 2. NA: no data.

Table 5
Injury rates over time all three divisions.

	1000(I/E)					
	Years					
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	All 5Years
	all four injury types					
Soccer	5.38	8.78	6.13	6.39	6.87	6.70
Gymnastics	6.66	6.53	5.75	6.22	5.80	6.20
Basketball	4.76	5.03	5.55	4.43	4.44	4.83
Ice Hockey	4.35	2.63	3.81	5.32	6.63	4.60
Field Hockey	2.42	6.07	8.29	1.39	2.40	4.48
Volleyball	4.51	3.93	4.37	4.09	4.52	4.28
Lacrosse	4.05	4.17	5.39	3.77	3.22	3.98
L: Low injury	4.13	2.62	2.35	1.86	2.68	2.63
Softball	3.08	3.51	3.50	3.27	3.88	3.49
Tennis	5.60	3.97	3.54	2.30	1.92	3.33
Indoor Track	4.09	2.64	2.88	1.40	2.64	2.64
Cross Country	5.69	2.36	1.28	1.10	1.82	2.20
Outdoor Track	3.44	1.54	1.32	1.74	2.39	1.84
Swimming	1.00	0.42	0.97	0.25	0.86	0.68
	Concuss					
Soccer	0.38	1.09	0.72	0.52	0.51	0.64
Gymnastics	0.19	0.04	0.38	0.06	1.06	0.31
Basketball	0.45	0.63	0.62	0.74	0.61	0.62
Ice Hockey	0.47	0.25	0.64	0.81	1.13	0.67
Field Hockey	0.36	0.73	3.80	NA	0.06	1.05
Volleyball	0.16	0.60	0.47	0.32	0.37	0.38
Lacrosse	0.33	0.35	0.99	0.52	0.65	0.58
L: Low injury	0.16	0.07	0.23	0.06	0.11	0.12
Softball	0.45	0.26	0.52	0.13	0.36	0.36
Tennis	NA	0.19	0.47	NA	0.25	0.19
Indoor Track	0.07	NA	0.03	0.04	0.04	0.04
Cross Country	NA	NA	0.07	NA	NA	0.02
Outdoor Track	NA	NA	0.18	0.12	NA	0.07
Swimming	0.13	0.03	0.15	0.02	0.07	0.07

See notes to Table 2. NA: no data.

the five years. There is no strong pattern in the table, although there is considerable variation across divisions. Tennis is much higher for Division I than for Division III. The sample sizes for some of the divisions and sports are small, and so some of the differences across divisions in Table 4 are likely due to sampling error.

Table 5 presents the injury rates for each of the five academic years, aggregated by the three divisions. Five years is not a long enough time period to test for any trend effects, but the data can at least be examined to see if any trends look like they are developing. Again, the sample sizes are small for some years and sports. For the aggregation of all four injury types, there are no systematic patterns in the table. For tennis and cross country the rates are noticeably higher in 2009/2010 than in the other four years. This results in the rate for *L* being higher in 2009/2010. The are also no obvious patterns for the concussion results in Table 5.

5. Estimated injury savings from Decreasing injury rates

It is interesting to consider the injury savings that would result if the high injury sports could be changed so that their injury rates were the same as those for the low injury sports (*L*). An attempt is made in this section to estimate these savings. It will be assumed that soccer, gymnastics, basketball, ice hockey, field hockey, volleyball, and lacrosse can be changed to have the same injury rates as for *L*.

Table 6
Injury savings estimates all four injury types, all five years, all three divisions.

		1000 (I/E)	E mil.	I thous.	D/I	D thous.
L: Low injury	actual	2.63	38.03	100.16	8.78	879.06
Soccer	actual	6.70	9.01	60.39	15.58	941.17
Soccer[a]	like *L*	2.63	9.01	23.70	8.78	208.07
Difference	actual - like *L*			36.69		733.10
Gymnastics	actual	6.20	0.66	4.10	20.84	85.38
Gymnasitcs[a]	like *L*	2.63	0.66	1.74	8.78	15.24
Difference	actual - like *L*			2.36		70.14
Basketball	actual	4.83	8.36	40.38	14.75	595.66
Basketball[a]	like *L*	2.63	8.36	21.99	8.78	193.04
Difference	actual - like *L*			18.39		402.62
Ice Hockey	actual	4.60	1.02	4.67	9.87	46.13
Ice Hockey[a]	like *L*	2.63	1.02	2.68	8.78	23.55
Difference	actual - like *L*			1.99		20.78
Field Hockey	actual	4.48	1.18	5.30	17.76	94.04
Field Hockey[a]	like *L*	2.63	1.18	3.10	8.78	27.25
Difference	actual - like *L*			2.20		66.79
Volleyball	actual	4.28	6.96	29.77	16.11	479.47
Volleyball[a]	like *L*	2.63	6.96	18.30	8.78	160.72
Difference	actual - like *L*			11.47		318.75
Lacrosse	actual	3.98	2.87	11.43	12.71	145.29
Lacrosse[a]	like *L*	2.63	2.87	7.55	8.78	66.27
Difference	actual - like *L*			3.88		79.02
Total savings				76.05		1,691.2
Total savings per year				15.21		338.24

Actual values are from Table 3.
[a] Values if I/E and D/I were like L.

5.1. *Use of datalys data only*

Calculations of the savings using the Datalys data are presented in Table 6. The table estimates the number of injuries that would be saved if the high injury sports were changed to have injury rates like those for *L*. The table considers all four injury types together, all three divisions, and all five years.

The actual injury rate for soccer is 6.70, and the table shows that if this rate were instead the rate for *L*, namely 2.63, the number of injuries would be 23,700 instead of 60,390. The difference of 36,690 injuries is the number of injuries saved. The table also shows that if the number of days lost per injury were 8.78, the rate for *L*, instead of the actual rate of 15.58, there would be 733,100 fewer days lost. The calculations for the other sports are similar. The total savings over the five years are 76,050 fewer injuries and 1,691,200 fewer days lost. On a per year basis the totals come to 15,210 fewer injuries and 338,240 fewer days lost.

The same calculations in Table 6 can be done for concussions alone. Consider soccer. Using the data for *concuss* in Table A1, the concussion rate for soccer is 0.64 and the number of days lost per injury is 10.49. For L the two rates are 0.12 and 9.33 respectively. Using 0.12 in place of 0.64 and 9.33 in place of 10.49 yields the number of soccer concussions saved over the five years of 4,680 or 936 per year and the number of days lost saved over the five years of 50,340 or 10,068 per year. These calculations can be done for the other five high-injury sports. The number of concussions saved per year is 26 for gymnastics, 828 for basketball, 112 for ice hockey, 220 for field hockey, 364 for volleyball, and 264 for lacrosse. The total across the six sports is 2,750 concussions saved per year.

5.2. *Use of Mathers et al. (1999) disability indices*

Mathers et al. (1999) in a massive study in Australia have estimated disability indices for many diseases and injuries. The values range from 0 for no disability (no loss of quality of life) to 1 for essentially death. These indices pertain to a year of life. Let Z denote this index. If Z is 0, there is no loss in the quality of life for the year. If Z is, say, 0.3, the quality of life for the year is 70 percent of a healthy or injury free year of life.[4]

Table A2 in the Appendix presents the Mathers et al. disability indices. The NCAA injury categories in Table 1 are matched to the Mathers et al. injuries. For two of the injury groups that make up *bone*, fracture and fracture (stress), there are a number of different injuries in Mathers et al. (depending on where the fracture is). In this case the more detailed Mathers et al. categories were used and matched to the more detailed NCAA fracture and fracture (stress) injuries.

There are 33 injuries in Table A2 and thus 33 disability index values. Some of the values are the same because the same Mathers et al. category was sometimes matched to more than one NCAA injury. Given the values of *Z*, it is possible to do the following, as presented in Table 7. Take, for example, soccer, where there are 60,390 injuries across the four injury types, the three divisions, and the five years (from Tables 3 and 6). This number is in row (1) in Table 7. There is a value of *Z* for each injury, i.e., each NCAA injury falls into one of the 33 categories in Table A2. For a particular injury, *Z* is the fraction of the year that is not healthy, i.e., injured. Summing the values of *Z* for all 60,390 injuries gives the total number of healthy years lost-to-injury, which is 6,650 years. This number is in row (2) of the table. Row (3) is the ratio of row (2) to row (1), which is the average number of healthy years lost-to-injury per year. For soccer this average is 0.110 years.

Rows (4) through (8) in Table 7 assume that the high injury sports are like *L*. Row (4) is the number of injuries from Table 6. Row (5) is the average number of healthy years lost-to-injury computed for *L* using the Mather et al. disability indices, which is 0.093. Row (6), which is row (4) times row (5), gives the total number of healthy years lost-to-injury. Row (7) is the actual number of healthy years lost-to-injury from row (2) minus the number of healthy years lost-to-injury from row (6), which is the number of healthy years lost-to-injury saved. Row (8) is row (7) divided by five, which is the number of healthy years lost-to-injury saved per year. For soccer this is 0.89 years per year. The last column in Table 7 gives the totals. The total number of healthy years lost-to-injury saved per year is 2.02.

It is interesting to compare the average number of days lost per injury in Table 6, namely *D/I*, to the average number of healthy years lost-to-injury in row (3) in Table 7. The sum of all the actual injuries in Table 6 (not counting *L*) is 156,040, and the sum of all the actual days lost is 2,387,140. The overall average of the number of days lost per injury is thus 15.30 (2,387,140/156,040). The average number of healthy years lost-to-injury in Table 7 for all sports is 0.114, which is about 42 days. The number of days computed using the Mathers et al. disability indices is thus larger than the number of days lost from the Datalys data (42 days versus 15.30 days). The number of days lost in the Datalys data is the number of days before the student returns to his sport. For better or worse, the Mathers et al. disability indices are in effect assuming some continuing loss to the student after she returns.

6. Estimated dollar savings

The estimated injury savings in Tables 6 and 7 are descriptive statistics. They are not based on any assumptions about the cost of an injury or the value of a year of life. In this section an attempt is made to put dollar values on these estimates. How should they be valued? One possibility would be to ask students and their parents how much they would be willing to pay to have avoided an injury. If this were done by injury types, one could attempt to value the saved injuries. Specific college surveys of this type do not appear to exist, but there are injury cost estimates available. These estimates are in part based on medical costs, but they also take into account pain and suffering and opportunity cost of lost time. They are thus likely to be picking up some of what would be revealed by willingness-to-pay surveys.

6.1. National safety council estimates

The National Safety Council (2015) (NSC) puts an estimated cost of a disabling injury at $9,000 for a home injury and $8,800 for a public injury in 2015, which in 2022 dollars are $10,960 and $10,720, respectively. (The cost of a work injury is estimated to be about four times larger.[5]) A disabling injury is "one which results in death, some degree of permanent impairment, or renders the injured person unable to effectively perform his or her regular duties for a full day beyond the day of injury." The cost includes "wage and productivity losses, medical expenses, and administrative expenses."

If $10,960 per injury is used and there are 13,610 fewer injuries per year, as estimated in Table 6, this is a cost saving of $150 million per year. With 338,240 fewer days lost, also from Table 6, this comes to $443 per day. Put another way, the estimated average cost of a day lost due to an injury is $443 using the $10,960 figure.

6.2. Department of Health and Human Services estimates

Estimates are also available from the Department of Health and Human Services (2014), ASPE Office of Health Policy, which are roughly supportive of the NSC estimates. The ASPE estimates are for medical expenses only and so are narrower in scope than the NSC estimates. Converted into 2022 dollars. the ASPE estimates for 10–19 year olds are $6,019 for fracture of leg, $3,685 for fracture of arm, $2,945 for sprains and strains, and $8,912 for dislocation. These estimates are thus not too far off from the NSC estimate of $10,960, especially considering that the NSC estimate also includes wage and productivity losses. They provide at least mild support to the use of the $9,000 figure.

6.3. Value of a year of life

There is a large literature on estimating the statistical value of a life. Estimates are less often presented of the value of a year of life, which is what is needed here. Cutler (2004) cites a value of $100,000 per year, which in 2022 dollars is about $150,000. This estimate, however, assumes that the value of a year of life does not vary with age. Murphy and Topel (2006), using a utility maximization framework, argue that the value of a year of life varies by age and is hump shaped, peaking at around age 50. Aldy and Kip Viscusi (2008) make a similar argument, where they also estimate a peak at around age 50.

For the calculations here the interest is in people around age 20, namely students. Fig. 2 in Murphy and Topel (2006) shows a value of a year of life at age 20 of $200,000, which in 2022 dollars is about $300, 000. Fig. 2 in Aldy and Viscusi (2006) gives similar values at age 20—$150,000 cohort-adjusted and $200,000 cross-section (before conversion to 2022 dollars). In the following calculations a value of $300, 000 in 2022 dollars will be used.

Table 7 estimates that 2,020 healthy years lost-to-injury would be saved per year if the high-injury sports were like *L*. Multiplying this number by $300,000 is a cost saving of $606 million per year. This is larger than the $150 million using $10,960 as the average cost of an injury. This difference may be due in part to the fact that the Mathers et al. indices are in effect assuming more days lost than are estimated in the Datalys data.

The results thus suggest that the value of the injury costs that would be saved is between $150 million and $606 million per year in 2022 dollars.

7. High school Data

The collection of the high school data is similar to that for the college

[4] Abelson (2004) has used these estimates to examine whether injury compensation in Australia is excessive. See also Abelson (2003).

[5] The larger estimate for a work injury does not seem relevant in the present case because students do not have full time jobs.

Table 7
Estimates of Healthy Years Lost-to-Injury Saved All Four Injury Types, All Five Years, All Three Divisions Numbers are in Thousands.

	Soccer	Gymnastics	Basket ball	Ice Hockey	Field Hockey	Volleyball	Lacrosse	Total
			Actual					
(1) No. of injuries (Table 6)	60.39	4.10	40.38	4.67	5.30	29.77	11.43	156.04
(2) No. of healthy years lost to injury	6.65	0.39	4.65	0.59	0.80	2.98	1.42	17.48
(3) (2)/(1) Ave. No. of healthy years lost-to-injury per injury	0.110	0.095	0.115	0.126	0.151	0.100	0.124	0.114
			High Injury Sports Assumed The Same As L					
(4) No. of injuries (Table 6, like *L*)	23.70	1.74	21.99	2.68	3.10	18.30	7.55	79.06
(5) Ave. No. of healthy years lost-to-injury per injury for *L*	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093
(6) (4) × (5) No. of healthy years lost-to-injury	2.20	0.16	2.05	0.25	0.29	1.70	0.70	7.35
(7) (2) − (6) No. of healthy years lost-to-injury saved	4.45	0.23	2.60	0.34	0.51	1.28	0.72	10.13
(8) (7)÷5 No. of healthy years lost-to-injury saved per year	0.89	0.05	0.52	0.07	0.10	0.26	0.14	2.02

Row (2) is computed using the Mathers et al. disability indices.
Row (5) is the value for *L* computed using the Mathers et al. disability indices.

data. A sample of about 100 high schools is selected, and each of these schools reports injury data. The sample data are then blown up to estimate national totals. The data are on the site: http://www.ucdenver.edu/academics/colleges/PublicHealth/research/ResearchProjects/piper/projects/RIO/Pages/Study-Reports.aspx. The data have been collected since 2005, and yearly reports are available for each year beginning with the 2005/2006 academic year. There are four girls' sports: soccer, basketball, softball, and volleyball.

To match the college results, data for the five academic years 2009/2010 through 2013/2014 were used. For each of the four sports, the following data were collected from the reports: 1) the nationally estimated number of injuries, 2) the injury rate per 1,000 athlete exposures, 3) the number of injuries that required surgery, 4) the number of injuries for each of the top ten injuries for the year, and 5) data to compute the total number of days lost due to injury. Given 1) and 2), the total number of exposures is simply the number of injuries divided by the injury rate times 1,000. The top ten injuries for the year varied slightly by year. For present purposes an "all other" injury category was computed as the difference between total injuries and the sum of the ten injuries.

The number of days lost was computed as follows. Six days-lost categories are listed in the reports, and a frequency is assigned to each category, where the six frequencies sum to one. The categories are 1) 1–2 days, 2) 3–6 days, 3) 7–9 days, 4) 10–21 days, 5) >21 days, and 6) other. "Other" include medical disqualification for the season or for career, athlete chooses not to continue, and the season ended before the athlete returned to play. Frequencies were assigned separately to competition injuries and practice injuries, where the sum of competition and practice injuries is total injuries. For present purposes the following number of days was assigned to each category: 1.5, 4.5, 8.0, 15.5, 30.0, and 50.0. The first four are mid points, and the last two are subjective choices. For competition these numbers were multiplied by the relevant frequency to get total number of days lost from competition. The same was done for practice, and the two were summed to get the total number of days lost.

Regarding the ten injury categories, each category was assigned to one of the four injury types in Table 1. A fifth injury type was also used, which is the "all other" category mentioned above. There was always a concussion category, always first or second in the ranking, but in a few cases there were no injuries for one of the other three types in Table 1. However, the number of injuries in the "all other" category is quite large and clearly includes injuries that would be classified as *bone*, *tear*, or *muscle* if they were known separately (but not *concuss*, which was always available).

Soccer and basketball had noticeably higher injury rates than did softball and volleyball, and so softball and volleyball were chosen as the low injury sports (*L*). For the college results above volleyball was not included in the low injury category because it had fairly high injury rates. For high school the story is different, and so high school volleyball has been classified as a low injury sport.

Like for the college data, much of the following analysis focuses on aggregates—all five years and all injuries. Again, this is to lessen the effects of sampling error.

8. Injury rates

The injury rates are reported in Table 8. This table has the same format as Table 2. The injury rate for all five injuries is smaller for high school than for college. Comparing Tables 2 and 8, the high school rate for soccer is 2.34 per 1,000 exposures and the college rate is 5.35. For basketball the rates are 1.74 versus 4.10. This is not true, however, for the concussion rate in soccer, which is 0.64 in both cases. For basketball the concussion rate is 0.38 for high school and 0.62 for college. It is clear that except for the concussion rate for soccer, injuries are much less prevalent in high school than in college.

Table 9 presents the injury rates plus other information. This table has the same format as Table 3. The number of exposures is much larger for high school than for college. For soccer there are 442.92 million high school exposures versus 9.01 million for college. For basketball the two numbers are 222.93 million versus 8.36 million. Total injuries and total days lost are thus also much larger for high school. For soccer there are 1,038,000 injuries in high school over the five years compared to 48,210 in college. Concussions in soccer totaled 282,300 in high school and 5,760 in college (Table A1). For basketball there are 84,500 concussions for high school and 5,140 for college. The number of days lost per injury are higher for college than for high school (*D*/*I* in Table 3 versus 9).

Table 10 presents injury rates over time. It is in the same format as Table 5. There are no obvious patterns in Table 10. Some of the variation from year to year is likely due to sampling error.

9. Estimated injury savings from Decreasing injury rates

Table 11 provides estimates of the injuries that would be saved if soccer and basketball were changed to have injury rates the same as those for *L*. The table is in the same format as Table 6.

Table 8
Injury Rates: Injuries per1,000 Exposures All Five Years.

	1000(*I*/*E*)					
	all 5 injuries	**concuss**	**bone**	**tear**	**Muscle**	**other**
Soccer	2.34	0.64	0.04	1.17	0.12	0.38
Basketball	1.74	0.38	0.05	0.99	0.04	0.29
L: Low Injury	1.06	0.18	0.04	0.55	0.04	0.24
Softball	1.12	0.20	0.07	0.47	0.08	0.31
Volleyball	0.99	0.17	0.00	0.65	0.01	0.16

I = number of injuries, *E* = number of exposures.
The low injury sports are softball and volleyball.

Table 9
Total injuries and severity all five years.

	1000(I/E)	E mil.	I thous.	D thous.	D/I	100(S/I)
			all five injury types			
Soccer	2.34	442.92	1,038.0	11,020.4	10.6	6.96
Basketball	1.74	222.93	387.4	3,393.7	8.8	9.47
L: Low Injury	1.06	509.71	538.7	4,333.9	8.0	5.97
Softball	1.12	266.95	299.3	2,768.4	9.2	7.02
Volleyball	0.99	242.76	239.4	1,565.5	6.5	4.65
			concuss			
Soccer	0.64	442.92	282.3			
Basketball	0.38	222.93	84.5			
L: Low Injury	0.18	509.71	94.1			
Softball	0.20	266.95	53.4			
Volleyball	0.17	242.76	40.7			

See notes to Table 8.
D = number of days lost due to injuries.
S = number of injuries that required surgery.

Table 10
Injury rates over time.

	1000(I/E)					
	Years					
	2009/ 2010	**2010/ 2011**	**2011/ 2012**	**2012/ 2013**	**2013/ 2014**	**All 5Years**
			all five injury types			
Soccer	1.93	2.42	2.29	2.47	2.64	2.34
Basketball	1.73	1.57	1.83	1.88	1.65	1.74
L: Low Injury	0.95	1.25	1.02	0.99	1.05	1.06
Softball	0.94	1.46	1.15	0.99	1.00	1.12
Volleyball	0.96	1.00	0.89	0.99	1.11	0.99
			concuss			
Soccer	0.39	0.58	0.75	0.60	0.91	0.64
Basketball	0.38	0.33	0.39	0.38	0.42	0.38
L: Low Injury	0.12	0.24	0.14	0.19	0.24	0.18
Softball	0.15	0.31	0.15	0.19	0.18	0.20
Volleyball	0.09	0.16	0.14	0.19	0.29	0.17

See notes to Table 8.

Table 11
Injury savings estimates all five injury types, all five years.

		1000 (I/E)	E mil.	I thous.	D/I	D thous.
L: Low Injury	actual	1.06	509.71	538.7	8.0	4,333.9
Soccer	actual	2.34	442.92	1,038.0	10.6	11,020.4
Soccer[a]	like L	1.06	442.92	469.5	8.0	3,756.0
Difference	actual - like L			568.5		7,264.4
Basketball	actual	1.74	222.93	387.4	8.8	3,393.7
Basketball[a]	like L	1.06	222.93	236.3	8.0	1,890.4
Difference	actual - like L			151.1		1,503.3
Total savings				719.6		8,767.7
Total savings per year				143.9		1,753.5

Actual values are from Table 9.
[a] Values if I/E and D/I were L.

Consider soccer. The actual injury rate is 2.34 per 1,000 exposures. If it were instead 1.06, the rate for L, there would be 469,500 injuries in the five-year period instead of the actual 1,038,000 injuries. There would thus be 568,500 fewer injuries. There would also be 7,264,400 fewer days lost using 8.0 as days lost per injury, the rate for L, rather than the actual 10.6 days lost per injury.

Table 12
Estimates of Healthy Years Lost-to-Injury Saved All Five Injury Types, All Five Years Numbers are in Thousands.

	Soccer	Basket-ball	Total
Actual			
(1) No. of injuries (Table 11)	1,038.0	387.4	1,425.4
(2) No. of healthy years lost-to-injury	160.0	53.9	213.9
(3) (2)/(1) Ave. No. of healthy years lost-to-injury per injury	0.154	0.139	0.150
Soccer and Basketball Assumed The Same As L			
(4) No. of injuries (Table 11, like L)	469.5	236.3	705.8
(5) Ave. No. of healthy years lost-to-injury per injury for L	0.131	0.131	0.131
(6) (4) × (5) No. of healthy years lost-to-injury	61.5	31.0	92.5
(7) (2) − (6) No. of healthy years lost-to-injury saved	98.5	22.9	121.4
(8) (7)÷5 No. of healthy years lost-to-injury saved per year	19.7	4.6	24.3

Row (2) is computed using the Mathers et al. disability indices.
Row (5) is the value for L, computed using the Mathers et al. disability indices.

The table shows that for soccer and basketball the total savings on a per year basis are 143,900 injuries and 1,753,500 days lost. These compare to the college numbers in Table 6 of 12,270 injuries and 333,300 days lost. The injury savings are thus about 12 times greater for high school due to the larger number of exposures.

It is interesting to look at concussions for soccer. Table 9 shows that the concussion rate is 0.64 for soccer and 0.18 for L. If the rate for soccer were 0.18, there would be 79,726 concussions rather than the actual number of 282,300. The number of concussions saved is thus 202,574, which on a per year basis is 40,515. For basketball, the number of concussions saved per year is 8,875 (computed from Table 9). The total number of concussions saved is thus the sum of the two: 49,390.

It is also possible to use the Mathers et al. disability indices to estimate the number of healthy years lost-to-injury and the number saved. As discussed in Section 7, data were collected on 10 injury categories per year and sport, where the categories sometimes changed slightly across years. An "all other" category was also created. Each category was matched to one of the Mathers et al. injuries in Table A2, and the corresponding Mathers rate was used. For example, for concussions the rate of 0.359 was used. For the "all other" category the rate of 0.118 was used, which is the Mathers rate for "Sports injuries." This then allowed the number of healthy years lost-to-injury to be calculated per injury category, per sport, and per year. For a given sport and year, the total number of healthy years lost-to-injury is the sum across the injury categories.

Given the estimates of the number of healthy years lost-to-injury, the number saved can be computed. This is done in Table 12, which is in the same format as Table 7. For example, for soccer the number of healthy years lost-to-injury is 160,000 (row (2)), which is an average of 0.154 per injury (row (3)). If soccer were like L, the number of healthy years lost-to-injury would be 61,500 (row 6)). On a yearly basis the number of healthy years lost-to-injury saved is 19,700 (row (8)). For soccer and basketball combined, the total number of healthy years lost-to-injury saved is 24,300 (row 8)). This compares to 1,110 in Table 7 for college.

Similar to college, it is interesting to compare the average number of days lost per injury in Table 11, namely D/I, to the average number of healthy years lost-to-injury in row (3) in Table 12. For soccer the average number of days lost per injury in Table 11 is 10.6, and the average number of healthy years lost-to-injury in Table 12 is 0.154, which is about 56 days. As with college, the number of days computed using the Mathers et al. disability indices is considerably larger than the number of days lost from the Datalys data. Remember that the 10.6 number in Table 11 is computed using 30 days for the category >21 days and 50 days for the category "other." These are guesses, and if larger numbers were used, the 10.6 number would increase since there would be more days lost.

10. Estimated dollar savings

As with the results in Tables 6 and 7, the estimated injury savings in Tables 11 and 12 are just descriptive statistics. Dollar values, however, can be put on these using the same methodology as in Section 6. In Table 11 there are 143,900 fewer injuries per year, and at $10,960 per injury this is a saving of $1.6 billion per year. With 1,753,500 fewer days lost, also from Table 11, this comes to $912 per day. This value per day would be smaller if larger values were used for the last two injury categories discussed above. For college the value was $443 per day.

Regarding the value of a year of life, if Fig. 2 in Murphy and Topel (2006) is extrapolated back to age 17, the value of a year of life is about $160,000, which in 2022 dollars is about $250,000. In Table 12 there are 24,300 injury years that would be saved per year if soccer and basketball were like *L*. Multiplying 24,300 by $250,000 gives a cost saving $6.1 billion. As with the college data, computing costs this way gives a larger value than using the cost of $10,260 per injury.

The range of the estimated cost savings is thus $1.6 billion to $6.1 billion, which compares to the range of $150 million to $606 million for college. Again, the high school savings are much larger because of the much larger number of exposures.

Table 14
Female versus male results.

	Estimated Injuries Saved Per Year			
	Total		Concussions	
	Female	Male	Female	Male
College	13,610	48,100	2,750	6,900
High School	143,900	568,600	49,390	161,400
	Dollar Estimates per Year (2022 dollars)			
	Total			
	Female	Male		
College	$150m-$606m	$528m-$1.8b		
High School	$1.6b-$6.1b	$6.2b-$22.4b		

11. Female versus male results

Table 13 provides a comparison of the injury rates in this paper to the injury rates for males in Fair and Champa (2019). For college there are ten sports in common, and for high school there are three. The aggregation is across all three divisions for college and across all five years. .

The college results in Table 13 show that the total injury rates are similar for females versus males except for basketball, ice hockey, and lacrosse, where the rates for males are much higher (likely because of the much larger amount of contact allowed in the men's game as compared to the women's). For concussions, on the other hand, the rates are higher

Table 13
Female versus male results.

	Injury Rates					
	College					
	Total			**Concussions**		
	Female	**Male**	**Diff.**	**Female**	**Male**	**Diff.**
Soccer	6.70	6.50	0.20	0.64	0.37	0.27
Basketball	4.83	6.33	−1.50	0.62	0.44	0.18
Ice Hockey	4.60	7.77	−3.17	0.67	0.87	−0.20
Lacrosse	3.98	5.49	−1.51	0.58	0.40	0.18
Soft/Baseball	3.49	3.17	0.32	0.36	0.11	0.25
Tennis	3.33	3.50	−0.17	0.19	0.09	0.10
Indoor Track	2.64	2.43	0.21	0.04	0.03	0.01
Cross Country	2.20	2.26	−0.06	0.02	0.06	−0.04
Outdoor Track	1.84	1.75	0.09	0.07	0.02	0.05
Swimming	0.68	0.70	−0.02	0.07	0.04	0.03
	High School					
	Total			**Concussions**		
	Female	**Male**	**Diff.**	**Female**	**Male**	**Diff.**
Soccer	2.34	1.59	0.75	0.64	0.36	0.28
Basketball	1.74	1.36	0.38	0.38	0.17	0.21
Soft/Baseball	1.12	0.90	0.22	0.20	0.10	0.10

	bone			tear			muscle		
	Female	Male	Diff.	Female	Male	Diff.	Female	Male	Diff.
Soccer	0.33	0.29	0.04	4.27	4.34	−0.07	1.46	1.50	−0.04
Basketball	0.24	0.34	−0.10	3.16	4.00	−0.84	0.81	1.55	−0.74
Ice Hockey	0.20	0.46	−0.26	2.51	3.71	−1.20	1.22	2.72	−1.50
Lacrosse	0.13	0.28	−0.15	2.39	3.46	−1.07	0.88	1.35	−0.47
Soft/Baseball	0.20	0.22	−0.02	1.95	1.96	−0.01	0.99	0.88	0.11
Tennis	0.18	0.16	0.02	2.70	2.95	−0.25	0.27	0.30	−0.03
Indoor Track	0.09	0.09	0.00	2.19	2.02	0.17	0.32	0.29	0.03
Cross Country	0.29	0.31	−0.02	1.70	1.57	−0.13	0.19	0.33	−0.14
Outdoor Track	0.16	0.05	0.11	1.45	1.35	0.10	0.15	0.33	−0.18
Swimming	0.02	0.04	−0.02	0.47	0.51	−0.04	0.12	0.12	0.00
	High School								
	bone			tear			muscle		
	Female	Male	Diff.	Female	Male	Diff.	Female	Male	Diff.
Soccer	0.04	0.02	0.02	1.17	0.75	0.42	0.12	0.09	0.03
Basketball	0.05	0.06	−0.01	0.99	0.75	0.24	0.04	0.04	0.00
Soft/Baseball	0.07	0.05	0.02	0.47	0.42	0.05	0.08	0.02	0.06

Diff. = Female - Male.

for females except for ice hockey and cross country. The high school results show that for both total injuries and concussions the rates are higher for females for all three sports.

The results in the second part of Table 13 show that bone, tear, and muscle injury rates are lower for females for college basketball, ice hockey, and lacrosse. Otherwise the female-male differences are small.

The generally higher concussion rates for females is consistent with previous results. Schallmo et al. (2017), using data on concussion rates in high school sports, found that girls have a higher risk of concussions than boys. Covassin et al. (2016), using NCAA data for the 2004/2005–2008/2009 period, found that female athletes had higher rates of concussions in baseball/softball, basketball, ice hockey, and soccer than male athletes. The American Medical Society for Sports Medicine in 2013 published a literature review—Harmon et al. (2013)—noting that in sports with similar playing rules, females have a higher incidence of concussions. Lincoln et al. (2011), using data from 25 schools in a large public high school system, found that girls' soccer had the second highest concussion rate following boys' football. A literature review by Dick (2009) found that female athletes have a greater risk of concussions. It seems clear from these studies and from the results in Table 13 that female athletes are more susceptible to head injuries.

Table 14 presents the estimates savings per year for females and males. For females the high-injury sports are as used in this paper. For males the contact sports are as used in Fair and Champa (2019). The male contact sports for college are wrestling, football, ice hockey, soccer, basketball, and lacrosse. For high school the sports are wrestling, football, soccer, and basketball. For the college savings for males a little over half of the savings are from football. For high school a little over 70 percent are from football.

Table 14 shows that many more injuries are saved for high school than for college, due to the larger number of exposures in high school. More injuries are saved for males than for females, due to the larger number of exposures for males in both high school and college, much driven by football. The savings are large. For concussions for males there are 6,900 fewer in college and 161,400 in college per year. For females the two numbers are 2,750 and 49,390.

More work clearly needs to be done to see how well the current results hold up. Many institutions are reluctant to release data on injuries, and so data are not easy to come by. The hope is that this paper and the increased interest in sports injuries will encourage release of more data.

Appendix

Table A1
Injuries and Severity per Injury Type All Five Years, All Three Divisions

	1000(*I*/*E*)	*E* mil.	*I* thous.	*D* thous.	*D*/*I*	100(*S*/*I*)
			concuss			
Soccer	0.64	9.01	5.76	60.42	10.49	0.00
Gymnastics	0.31	0.66	0.21	9.92	48.09	0.00
Basketball	0.62	8.36	5.14	67.77	13.18	0.00
Ice Hockey	0.67	1.02	0.68	14.43	21.09	0.00
Field Hockey	1.05	1.18	1.24	70.11	56.49	0.00
Volleyball	0.38	6.96	2.66	42.42	15.97	1.52
Lacrosse	0.58	2.87	1.66	39.75	23.94	0.00
L: Low injury	0.12	38.02	4.72	44.06	9.33	0.78
Softball	0.36	8.25	2.93	30.60	10.45	1.25
Tennis	0.19	3.31	0.62	1.14	1.85	0.00
Indoor Track	0.04	12.18	0.43	0.98	2.28	0.00
Cross Country	0.02	5.40	0.09	1.86	20.00	0.00
Outdoor Track	0.07	8.89	0.67	9.47	14.23	0.00
Swimming	0.07	9.02	0.66	38.49	58.16	0.00
			bone			
Soccer	0.33	9.01	3.00	143.41	47.87	17.66
Gymnastics	0.76	0.66	0.50	20.51	40.84	24.32
Basketball	0.24	8.36	2.01	73.20	36.49	14.85
Ice Hockey	0.20	1.02	0.20	12.32	61.08	27.07
Field Hockey	0.15	1.18	0.18	9.85	54.51	0.00
Volleyball	0.21	6.96	1.43	43.55	30.41	2.81
Lacrosse	0.13	2.87	0.39	11.69	30.35	4.29
L: Low injury	0.17	38.02	6.32	267.25	42.29	8.52
Softball	0.20	8.25	1.64	54.58	33.26	28.60
Tennis	0.18	3.31	0.58	8.29	14.21	0.00
Indoor Track	0.09	12.18	1.14	30.24	26.56	6.05
Cross Country	0.29	5.40	1.55	90.13	58.10	0.00
Outdoor Track	0.04	8.89	0.36	41.17	114.31	0.00
Swimming	0.02	9.02	0.15	14.64	99.45	0.00
			tear			
Soccer	4.27	9.01	38.44	707.60	18.41	5.65
Gymnastics	4.18	0.66	2.76	52.61	19.07	8.58
Basketball	3.16	8.36	26.43	440.70	16.68	6.82
Ice Hockey	2.51	1.02	2.55	18.42	7.23	3.64
Field Hockey	1.87	1.18	2.21	12.98	5.86	1.68
Volleyball	3.22	6.96	22.40	377.31	16.84	8.27

(continued on next column)

Table A1 (*continued*)

	1000(*I*/*E*)	*E* mil.	*I* thous.	*D* thous.	*D*/*I*	100(*S*/*I*)
Lacrosse	2.39	2.87	6.87	91.09	13.27	5.84
L: Low injury	1.94	38.02	73.82	538.07	7.29	1.51
Softball	1.95	8.25	16.10	155.88	9.68	4.94
Tennis	2.70	3.31	8.93	20.79	2.33	0.00
Indoor Track	2.19	12.18	26.70	191.38	7.17	0.59
Cross Country	1.70	5.40	9.16	68.64	7.49	0.00
Outdoor Track	1.45	8.89	12.92	101.38	7.85	1.29
Swimming	0.47	9.02	4.24	10.63	2.51	0.00
			muscle			
Soccer	1.46	9.01	13.19	29.76	2.26	0.00
Gymnastics	0.95	0.66	0.63	2.35	3.73	0.00
Basketball	0.81	8.36	6.81	13.99	2.06	0.52
Ice Hockey	1.22	1.02	1.24	0.96	0.77	0.00
Field Hockey	1.41	1.18	1.66	1.11	0.67	0.00
Volleyball	0.47	6.96	3.28	16.23	4.94	2.40
Lacrosse	0.88	2.87	2.52	2.78	1.10	0.00
L: Low injury	0.40	38.02	15.28	29.42	1.93	0.00
Softball	0.99	8.25	8.14	9.61	1.18	0.00
Tennis	0.27	3.31	0.88	2.40	2.73	0.00
Indoor Track	0.32	12.18	3.89	7.32	1.88	0.00
Cross Country	0.19	5.40	1.04	3.65	3.51	0.00
Outdoor Track	0.15	8.89	1.34	6.44	4.82	0.00
Swimming	0.12	9.02	1.11	3.74	3.37	3.35

Table A2
Disability rates from Mathers et al. (1999).

NCAA Category	Mathers Study	Mathers Rate
	concuss	
Concussion	Intracranial Injury (Short-term)	0.359
Nervous System	Intracranial Injury (Short-term)	0.359
	bone	
Exostosis	Sports Injuries	0.118
Myositis Ossificans	Sports Injuries	0.118
Osteochondritis	Sports Injuries	0.118
Fracture and Fracture (stress):		
Ankle	Ankle	0.196
Upper Arm	Clavicle, Scapula or Humerus	0.153
Cervical Spine/Neck	Vertebral Column	0.266
Chest/Ribs	Rib or Sternum	0.199
Elbow	Radius/Ulna	0.180
Foot/Toes	Foot Bones	0.077
Forearm	Radius/Ulna	0.180
Hand/Fingers	Hand Bones	0.100
Head/Face	Face Bones	0.223
Hip/Groin	Pelvis	0.247
Knee	Patella, Tibia or Fibula	0.271
Lower Leg/Achilles	Patella, Tibia or Fibula	0.271
Lumbar Spine	Vertebral Column	0.266
Mouth	Episode Resulting in Tooth Loss	0.014
Nose	Face Bones	0.223
Sacrum/Pelvis	Pelvis	0.247
Shoulder/Clavicle	Clavicle, Scapula or Humerus	0.153
Thigh	Femur - Short Term	0.372
Thoracic Spine	Vertebral Column	0.266
Wrist	Hand Bones	0.100
	tear	
Cartilage Injury	Sports Injuries	0.118
Dislocation	Dislocation	0.074
Sprain	Sprains	0.064
Strain	Sprains	0.064
Strain/Tear	Sprains	0.064
Subluxation	Dislocation	0.074
	muscle	
Contusion (hematoma)	Sports Injuries	0.118
Spasm	Sports Injuries	0.118

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