# ESTIMATED COSTS OF CONTACT IN MEN'S COLLEGIATE SPORTS

By

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# Estimated Costs of Contact in Men's Collegiate Sports

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**Abstract**

Injury rates in twelve U.S. men's collegiate sports are examined in this paper. The twelve sports ranked by overall injury rate are wrestling, football, ice hockey, soccer, basketball, lacrosse, tennis, baseball, indoor track, cross country, outdoor track, and swimming. The first six sports will be called "contact" sports, and the next five will be called "non-contact." Swimming is treated separately because it has many fewer injuries. Injury rates in the contact sports are considerably higher than they are in the non-contact sports and they are on average more severe. Estimates are presented of the injury savings that would result if the contact sports were changed to have injury rates similar to the rates in the non-contact sports. The estimated savings are 49,600 fewer injuries per year and 5,990 fewer injury years per year. The estimated dollar value of these savings is between about 0.5 and 1.5 billion per year. About half of this is from football. Section 7 speculates on how the contact sports might be changed to have their injury rates be similar to those in the non-contact sports.

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# 1 Introduction

Injury rates in men's collegiate sports are examined in this paper for the 2009/2010–2013/2014 period using data from the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP)—the Datalys data.[1] Data are available for the three college divisions, twelve sports, and 1,085 specific injury classifications. The specific injury classifications are also aggregated into 50 group classifications. Data are also available for the number of days lost due to the injury and whether the injury required surgery. In this paper four injury types, based on 15 injury group classifications, are examined. These are discussed in Section 3.

The paper examines the differences in injury experiences among the sports. The twelve sports ranked by overall injury rate are wrestling, football, ice hockey, soccer, basketball, lacrosse, tennis, baseball, indoor track, cross country, outdoor track, and swimming. The differences can be compared across the four types of injuries, the three college divisions, and the five academic years. The first six sports will be called "contact" sports. Basketball is not necessarily a contact sport, but its injury rate is close to the rate for soccer and greater than the rate for lacrosse, and so it has been put in the category of a contact sport. The other six sports except for swimming have been put in a "non-contact" category. Swimming is an outlier in that it has relatively few injuries.

After examining the injury rates, the paper then considers how many injuries would be saved if the contact sports were changed to have injury rates the same as those for the non-contact sports category. Dollar values (in 2015 dollars) are estimated for the injury savings. The estimated savings are 49,600 fewer injuries per year and 5,990 fewer injury years per year. The estimated dollar value of these savings is between about 0.5 and 1.5 billion per year. About half of this is from football.

[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.

Section 2 reviews the literature, and Section 3 discusses the data. The injury rates are examined in Section 4. The injury savings are estimated in Section 5, and dollar values are put on these estimates in Section 6. Section 7 speculates on how the contact sports might be changed to make them non-contact. Wrestling would have to be eliminated, but modifications seem possible for the other sports.

## 2 Literature

Many of the previous studies that have used the Datalys data 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. (2016) 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. (2015) 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. Lynall et al. (2016) find that concussive injuries division I football games occur more frequently at higher altitudes.

McAllister et al. (2012), not using Datalys data, examine the difference in the quantity of head impacts and subsequent cognitive effects between collegiate contact sports (football and ice hockey) and non-contact sports (rowing, track, and skiing). They used accelerometer data for a single season, finding that there was no significant difference in performance across the different sports in most cognitive tests. They did find, however, that in the contact sports the players averaged over 400 hits above the $14.4g$ threshold in the season, which could have longer term consequences. Using a longer time horizon, Montenigro et al. (2016) found that the estimated number of hits sustained by football players in college and high school, found through surveys and published accelerometer data, strongly predicts emotional and mental issues in later life. Their cumulative head impact index had more explanatory power than just concussive history in a probit model. This suggests that cumulative hits may be important in long-term health.

This study provides a broader comparison across injuries and sports than has been done so far, and it incorporates economic cost into the analysis. Note, however, that the Datalys data cover only short-term injury costs. There is a growing literature examining potential long-term health consequences of competing in contact sports, such as Montnigro et al. (2016), but this is a question beyond the scope of the Datalys data.

# 3 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 12 sports, three college divisions, and five academic years. The data are for men only.

The second file documents injuries. One observation records a single injury. Included in each observation are codes for the specific injury classification, the 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.

The aggregation of the injuries into 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 6.42 per 1000 exposures. This compares to 4.92 per 1000 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 men's baseball for the 2009/2010 academic year is 111.11. This means that each exposure or injury in the sample is assumed to be 111.11 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. The majority of the available literature uses these weights, and our analysis has done the same.

**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.

For more discussion on collection methodology and summary statistics, see Kerr et al. (2015).

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 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. (2016) 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 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.

Kerr et al. (2014) provide an overview of the data collection process and quality control measures.

# 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 $I_{ik}/E_k$.[2]

[2]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. Unfortunately, this variable 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. This categorical variable has only a few missing observations. To come up with a number for the total number of days lost, when data were available we averaged the exact number of days lost within each of the categories and used that average to impute the missing data. For example, say for a particular injury, sport, year, and division there were four injuries causing 1-6 lost days. Say two of the observations had missing elements for exact number of days lost, one observation had 3 days lost, and the last observation had 5 days lost. The 3 and 5 days lost would be averaged to get 4 days lost, which would be assigned to the two missing values. The total number of days lost would then be 3+5+4+4=12.

**Table 2**
**Injury Rates: Injuries per Exposure**

| | 100($I/E$) | | | | |
|---|---|---|---|---|---|
| | **all 4** | **concuss** | **bone** | **tear** | **muscle** |
| Wrestling | 0.834 | 0.135 | 0.042 | 0.567 | 0.090 |
| Football | 0.779 | 0.092 | 0.034 | 0.513 | 0.141 |
| Ice Hockey | 0.777 | 0.087 | 0.046 | 0.371 | 0.272 |
| Soccer | 0.650 | 0.037 | 0.029 | 0.434 | 0.150 |
| Basketball | 0.633 | 0.044 | 0.034 | 0.400 | 0.155 |
| Lacrosse | 0.549 | 0.040 | 0.028 | 0.346 | 0.135 |
| $N$: Non-contact | 0.262 | 0.006 | 0.016 | 0.189 | 0.051 |
| Tennis | 0.350 | 0.009 | 0.016 | 0.295 | 0.030 |
| Baseball | 0.317 | 0.011 | 0.022 | 0.196 | 0.088 |
| Indoor track | 0.243 | 0.003 | 0.009 | 0.202 | 0.029 |
| Cross country | 0.226 | 0.006 | 0.031 | 0.157 | 0.033 |
| Outdoor track | 0.175 | 0.002 | 0.005 | 0.135 | 0.033 |
| Swimming | 0.070 | 0.004 | 0.004 | 0.051 | 0.012 |

$I$ = number of injuries, $E$ = number of exposures,
Non-contact sports are taken to be tennis, baseball, indoor track, cross country, and outdoor track.

Injury rates for the four types of injuries are presented in Table 2 for the 12 sports. Injury rates are also presented for the five non-contact sports aggregated together, denoted $N$. Wrestling has the highest injury rates for $concuss$ and $tear$. The rate is particularly high for $concuss$. Football and ice hockey are similar, as are soccer and basketball. Lacrosse has the lowest overall rate of the six contact sports. The rates are noticeably lower for the five non-contact sports, especially for $concuss$. The main type of injury for these sports is $tear$. As noted earlier, swimming has very low rates.

For $N$ the overall injury rate is 0.262 percent. The rates for wrestling, football, and ice hockey are about three times this. The rates for soccer and basketball are about two and a half times this, and the rate for lacrosse is about two times this.

For $N$ the $concuss$ rate is 0.006 percent. The rate for wrestling is about 22 times this; the rates for football and ice hockey are about 15 times this, and the rates for soccer, basketball, and lacrosse are about 7 times this. There is obviously a clear difference between the contact and non-contact sports, with the differences for $concuss$ being particularly large. .

Table 3 present 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.

Tables 3 and A1 are self explanatory. Football has the largest number of exposures, followed by baseball and indoor track. Ice hockey, wrestling, and tennis are relatively small. The injury rates have already been discussed. The number of days lost per injury is highest for wrestling, followed by tennis and football. The number of days lost per injury for $N$ is 9.8, which is smaller than for the contact sports except basketball. Excluding swimming, the percent of injuries that require surgery is highest for football at 0.0740 percent, followed by lacrosse, wrestling, and baseball. The percent for swimming is high, but the overall number of injuries for swimming is small and this percent is probably not trustworthy.

Table 4 presents the injury rates for the three divisions, aggregated by the five years. Except for lacrosse, the rates are higher for division I than for division II. In most cases they are considerably higher. The rates for division III are generally higher than those for division II. Comparing division III to division I, the rates are higher for division III for ice hockey, soccer, lacrosse, cross country, and swimming. It is interesting that division III is closer to division I than is division II. Division III is even higher than division I for ice hockey, soccer, lacrosse, cross country, and swimming.

**Table 3**
**Total Injuries and Severity**

| | 100($I/E$) | $E$ mil. | $I$ thous. | $D$ thous. | $D/I$ | 100($S/I$) |
|---|---|---|---|---|---|---|
| | | | **all four injury types** | | | |
| Wrestling | 0.834 | 2.87 | 23.9 | 444.8 | 18.6 | 4.69 |
| Football | 0.779 | 25.77 | 200.7 | 2985.9 | 14.9 | 7.40 |
| Ice Hockey | 0.777 | 1.93 | 15.0 | 180.8 | 12.1 | 3.17 |
| Soccer | 0.650 | 8.42 | 54.8 | 567.3 | 10.4 | 2.62 |
| Basketball | 0.633 | 9.76 | 61.8 | 522.0 | 8.4 | 3.91 |
| Lacrosse | 0.549 | 4.26 | 23.4 | 298.5 | 12.8 | 5.56 |
| $N$: Non-contact | 0.237 | 40.35 | 105.9 | 1034.3 | 9.8 | 2.83 |
| Tennis | 0.350 | 3.12 | 10.9 | 167.1 | 15.3 | 0.68 |
| Baseball | 0.317 | 14.26 | 45.2 | 464.1 | 10.3 | 4.06 |
| Indoor track | 0.243 | 10.44 | 25.4 | 181.0 | 7.1 | 1.87 |
| Cross country | 0.226 | 4.72 | 10.7 | 88.0 | 8.2 | 0.00 |
| Outdoor track | 0.175 | 7.81 | 13.7 | 134.1 | 9.8 | 2.55 |
| Swimming | 0.070 | 6.23 | 4.4 | 16.5 | 6.4 | 8.68 |

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

Table 5 presents the injury rates for each of the five academic years, aggregated by the three divisions. There is no systematic pattern in the table. The rate for wrestling is highest in the first year, and the rate for football is highest in the fifth year. For $N$ the rate is highest in the first year and then essentially flat for the remaining four years. Basketball and lacrosse are fairly flat for all five years. Ice hockey and soccer are erratic.

**Table 4**
**Injury Rates by Division**

| | $100(I/E)$ | | | |
|---|---|---|---|---|
| | **I** | **II** | **III** | **All** |
| | **all four injury types** | | | |
| Wrestling | 1.074 | 0.347 | 0.888 | 0.834 |
| Football | 0.957 | 0.596 | 0.660 | 0.779 |
| Ice Hockey | 0.713 | 0.679 | 0.836 | 0.777 |
| Soccer | 0.743 | 0.329 | 0.752 | 0.650 |
| Basketball | 0.794 | 0.529 | 0.551 | 0.633 |
| Lacrosse | 0.354 | 0.445 | 0.673 | 0.549 |
| $N$: Non-contact | 0.328 | 0.181 | 0.240 | 0.262 |
| Tennis | 0.458 | 0.319 | 0.249 | 0.350 |
| Baseball | 0.398 | 0.253 | 0.298 | 0.317 |
| Indoor track | 0.314 | 0.189 | 0.194 | 0.243 |
| Cross country | 0.219 | 0.116 | 0.296 | 0.226 |
| Outdoor track | 0.265 | 0.050 | 0.093 | 0.175 |
| Swimming | 0.054 | 0.049 | 0.104 | 0.070 |

See notes to Table 2.

# 5 Estimated Injury Savings from Banning Contact

It is clear that injury rates are higher in contact than non-contact sports. It is interesting to consider the injury savings that would result if contact sports could be changed so that their injury rates were the same as those for $N$. An attempt is made in this section to estimate these savings. It will be assumed that football, ice hockey, soccer, basketball, and lacrosse can be changed to have the same injury rates as for $N$. It will also be assumed that wrestling is eliminated, since there is no way to exclude contact in wrestling.

**Table 5**
**Injury Rates Over Time**

| | $100(I/E)$ Years | | | | | |
|---|---|---|---|---|---|---|
| | **2009/ 2010** | **2010/ 2011** | **2011/ 2012** | **2012/ 2013** | **2013/ 2014** | **All 5** |
| | **all four injury types** | | | | | |
| Wrestling | 1.464 | 0.849 | 0.634 | 0.619 | 0.779 | 0.834 |
| Football | 0.795 | 0.650 | 0.754 | 0.774 | 0.911 | 0.779 |
| Ice Hockey | 0.593 | 0.910 | 0.786 | 0.811 | 0.789 | 0.777 |
| Soccer | 0.532 | 0.755 | 0.631 | 0.645 | 0.683 | 0.650 |
| Basketball | 0.607 | 0.678 | 0.613 | 0.611 | 0.656 | 0.633 |
| Lacrosse | 0.533 | 0.502 | 0.543 | 0.632 | 0.533 | 0.549 |
| $N$: Non-contact | 0.408 | 0.234 | 0.249 | 0.226 | 0.246 | 0.262 |
| Tennis | 0.408 | 0.320 | 0.275 | 0.294 | 0.420 | 0.350 |
| Baseball | 0.354 | 0.261 | 0.317 | 0.351 | 0.314 | 0.317 |
| Indoor track | 0.400 | 0.224 | 0.303 | 0.153 | 0.194 | 0.243 |
| Cross country | 0.792 | 0.207 | 0.086 | 0.216 | 0.170 | 0.226 |
| Outdoor track | 0.372 | 0.164 | 0.160 | 0.164 | 0.151 | 0.175 |
| Swimming | 0.024 | 0.048 | 0.116 | 0.055 | 0.094 | 0.070 |

See notes to Table 2.

### 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 wrestling were eliminated and the other contact sports were changed to have injury rates like those for $N$. The table considers all four injury types together, all three divisions, and all five years.

The actual injury rate for football is 0.779, and the table shows that if this rate were instead the rate for $N$, namely 0.262, the number of injuries would be 67.5 thousand instead of 200.7 thousand. The difference of 133.2 thousand injuries is

**Table 6**
**Injury Savings Estimates**
**All Four Injury Types, All Five Years, All Three Divisions**

| | | $100(I/E)$ | $E$ mil. | $I$ thous. | $D/I$ | $D$ thous. |
|---|---|---|---|---|---|---|
| $N$: Non-contact | actual | 0.262 | 40.34 | 105.9 | 9.8 | 1034.3 |
| Wrestling | actual | 0.834 | 2.87 | 23.9 | 18.6 | 444.8 |
| Wrestling* | none | 0 | 2.87 | 0 | 0 | 0 |
| Difference | actual - none | | | 23.9 | | 444.8 |
| Football | actual | 0.779 | 25.77 | 200.7 | 14.9 | 2985.9 |
| Football* | like $N$ | 0.262 | 25.77 | 67.5 | 9.8 | 661.7 |
| Difference | actual - like $N$ | | | 133.2 | | 2324.2 |
| Ice hockey | actual | 0.777 | 1.93 | 15.0 | 12.1 | 180.8 |
| Ice hockey* | like $N$ | 0.262 | 1.93 | 5.1 | 9.8 | 50.0 |
| Difference | actual - like $N$ | | | 9.9 | | 130.8 |
| Soccer | actual | 0.650 | 8.42 | 54.8 | 10.4 | 567.3 |
| Soccer* | like $N$ | 0.262 | 8.42 | 22.1 | 9.8 | 216.6 |
| Difference | actual - like $N$ | | | 32.7 | | 350.7 |
| Basketball | actual | 0.633 | 9.76 | 61.8 | 8.4 | 522.0 |
| Basketball* | like $N$ | 0.262 | 9.76 | 25.6 | 9.8 | 250.9 |
| Difference | actual - like $N$ | | | 36.2 | | 271.1 |
| Lacrosse | actual | 0.549 | 4.26 | 23.4 | 14.0 | 298.5 |
| Lacrosse* | like $N$ | 0.262 | 4.26 | 11.2 | 9.8 | 109.8 |
| Difference | actual - like $N$ | | | 12.8 | | 188.7 |
| Total savings | | | | 248.1 | | 3843.7 |
| Total savings per year | | | | 49.6 | | 768.7 |

the number of injuries saved. The table also shows that if the number of days lost per injury were 9.8, the rate for $N$, instead of the actual rate of 14.9, there would be 2,324.2 thousand fewer days lost. The calculations for the other sports are similar except for wrestling, where all injuries and days lost are saved because the sport is eliminated. The total savings over the five years are 248.1 thousand fewer injuries and 3,843.7 thousand fewer days lost. More than half of the total is from football

(133.3 thousand fewer injuries and 2,324.2 thousand fewer days lost). On a per year basis the totals come come to 49.6 thousand fewer injuries and 768.7 thousand fewer days lost.

**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.[3]

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 spelled out in Table 7. Take, for example, football, where there are 200.7 thousand 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 200.7 thousand injuries gives the total number of injury years, which is 22.6 thousand years. This number

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

**Table 7**
**Estimates of Injury Years Saved**
**All Four Injury Types, All Five Years, All Three Divisions**
**Numbers are in Thousands**

| | Wrest-ling | Foot-ball | Ice Hockey | Soccer | Basket-ball | Lac-rosse | Total |
|---|---|---|---|---|---|---|---|
| **Actual** | | | | | | | |
| (1) No. of Injuries (Table 6) | 23.9 | 200.7 | 15.0 | 54.8 | 61.8 | 23.4 | 379.6 |
| (2) No. of Injury Years | 2.9 | 22.6 | 1.8 | 5.4 | 6.3 | 2.4 | 41.5 |
| (3) (2)/(1) Ave. No. Injury Years per Injury | 0.121 | 0.113 | 0.120 | 0.099 | 0.102 | 0.103 | 0.109 |
| **No wrestling; Others Same as $N$** | | | | | | | |
| (4) No. of Injuries (Table 6, like $N$) | 0 | 67.5 | 5.1 | 22.1 | 25.6 | 11.2 | 131.5 |
| (5) Ave. No. Injury Years for $N$ per Injury | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 |
| (6) (4)×(5) No. of Injury Years | 0 | 5.94 | 0.45 | 1.94 | 2.25 | 0.99 | 11.57 |
| (7) (2)−(6) Injury Years Saved | 2.90 | 16.66 | 1.35 | 3.46 | 4.05 | 1.41 | 29.93 |
| (8) (7)÷5 Injury Years Saved per Year | 0.60 | 3.33 | 0.27 | 0.69 | 0.81 | 0.28 | 5.99 |

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

is in row (2) of the table. Row (3) is the ratio of row (2) to row (1), which is the average number of injury years per injury. For football this average is 0.113 years.

Rows (4) through (8) in Table 7 assume no wrestling and that the other contact sports are like $N$. Row (4) is the number of injuries from Table 6. Row (5) is the average number of injury years per injury computed for $N$ using the Mather et al. disability indices, which is 0.088. Row (6), which is row (4) times row (5), gives the total number of injury years. Row (7) is the actual number of injury years from row (2) minus the number of injury years from row (6), which is the number of injury years saved. Row (8) is row (7) divided by five, which is the number of injury years saved per year. For football this is 3.33 thousand years per year. The last column in Table 7 gives the totals. The total number of injury years saved per year is 5.99 thousand per year. More than half of the total is from football.

It is interesting to compare the average number of days lost per injury in Table 6, namely $D/I$, with the average number of injury years per injury in row (3) in Table 7. For football the average number of days lost is 14.9 and the average number of injury years per injury is 0.113, which is about 41 days. The number of days computed using the Mathers et al. disability indices is thus considerably larger than the number of days lost from the Datalys data. 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 he returns.

# 6 Estimated Dollar Savings from Banning Contact

The estimated injury savings in Tables 6 and 7 can stand by themselves as 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.

### National Safety Council Estimates

The National Safety Council (2017b) (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. (The cost of a work injury is estimated to be about four times larger.[4]) 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 $9,000 per injury is used and there are 49.6 thousand fewer injuries per year, as estimated in Table 6, this is a cost savings of $446 million per year. With 768.7 thousand fewer days lost, also from Table 6, this comes to $580 per day. Put another way, the estimated average cost of a day lost due to an injury is $580 using the $9,000 figure.

**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 2015 dollars using the CPI, the ASPE estimates for 10-19 year olds are $4,941 for fracture of leg, $3,025 for fracture of arm, $2,417 for sprains and strains, and $7,315 for dislocation. These estimates are thus in the ball park of the NSC estimate of $9,000, which also includes wage and productivity losses. They provide at least mild support to the use of the $9,000 figure.

**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 2015 dollars is about $125,000. This estimate, however, assumes that the value of a year of life does not

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

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 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. Figure 2 in Murphy and Topel (2006) shows a value of a year of life at age 20 of $200,000, which is 2015 dollars is about $250,000. Figure 2 in Aldy and Viscusi (2006) gives similar values at age 20—$150,000 cohort-adjusted and $200,000 cross-section (before conversion to 2015 dollars). In the following calculations a value of $250,000 in 2015 dollars will be used.

Table 7 estimates that 5.99 thousand injury years would be saved per year if wrestling were eliminated and the other contact sports were like $N$. Multiplying this number by $250,000 is a cost savings of $1.5 billion per year. This is considerably larger than the $446 million using $9,000 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 about 0.5 and 1.5 billion dollars per year.

# 7 Policy Implications

The results in Section 4 show that college injury rates are on average much higher for contact sports than for non-contact sports. If college wrestling were eliminated and football, ice hockey, soccer, basketball, and lacrosse were changed to have injury rates similar to those in tennis, baseball, indoor track, cross country, and outdoor track, the results in Table 6 estimate that there would be 49,600 fewer injuries per year in the United States. The results in Table 7 estimate that there would be 5,990 fewer injury years per year. The dollar value of these savings is estimated to be between about $0.5 billion and $1.5 billion per year. More than half of these savings are from football.

What would it take to make football, ice hockey, soccer, basketball, and lacrosse have injury rates similar to those in tennis, baseball, indoor track, cross country, and outdoor track? For ice hockey, soccer, and lacrosse, the rules would have to be changed to allow no contact and the refereeing would have to be tighter. In addition, headers would have to be banned in soccer. For football the game would have to be changed to be non-contact football. An example of non-contact football is flag football, although other non-contact options are possible. Basketball is odd in that it is not supposed to be a contact sport, but its injury rates are in the contact sports range. There is, of course, contact in basketball and players frequently fall. Possible rule changes would be banning dunk shots (so that less of the game is in effect played above the rim) and tighter refereeing. Some experimentation would undoubtedly be needed to change the rules for each sport to achieve injury rates no higher than the rates for the currently non-contact sports.

People obviously differ on the weights they place on the costs and benefits of collegiate contact sports. For example, changing college football to be a non-contact sport would be a large change in the sports culture in the United States, and it would not be popular among many people. The purpose of this paper is not to advocate for policy changes. The paper is an attempt to estimate the short-term injury costs of contact sports, including estimating dollar costs. The analysis provides cost estimates for college administrators and government policy makers that can be weighed against the benefits of such sports. The analysis has the advantage of not requiring or assuming the elimination of all injuries. All activities have some risk of injury. The base case is the injury experience in non-contact sports.

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. For example, 18 Big Ten and Ivy League universities contribute concussion data to the Epidemiology of Concussions in Ivy League/Big Ten Sports study, which is part of the Big Ten-Ivy League Traumatic Brain Injury Research Collaboration. These data are not available to outside researchers. Also, a survey of 19 Big Ten and Ivy League universities described in Yang et al. (2017) finds that only 16.7 percent to 42.1 percent of concussion data collected by the universities are available for research purposes. The hope is that this paper and the increased interest in sports injuries will encourage release of more data. Data for women would be particularly useful. Datalys data for women exist, but these data were not available to the authors for the current research project.

# Appendix

**Table A1**
**The Four Types of Injuries**

| | 100($I/E$) | $E$ mil. | $I$ thous. | $D$ thous. | $D/I$ | 100($S/I$) |
|---|---|---|---|---|---|---|
| | | | **concuss** | | | |
| Wrestling | 0.135 | 2.87 | 3.9 | 109.6 | 28.1 | 0.00 |
| Football | 0.092 | 25.77 | 23.7 | 314.4 | 13.3 | 0.78 |
| Ice Hockey | 0.087 | 1.93 | 1.7 | 46.0 | 27.1 | 0.00 |
| Soccer | 0.037 | 8.42 | 3.1 | 46.1 | 14.9 | 0.00 |
| Basketball | 0.044 | 9.76 | 4.3 | 34.8 | 8.1 | 0.00 |
| Lacrosse | 0.040 | 4.26 | 1.7 | 18.1 | 10.6 | 0.00 |
| $N$: Non-contact | 0.006 | 40.34 | 2.5 | 47.7 | 19.1 | 0.00 |
| Tennis | 0.009 | 3.12 | 0.3 | 27.7 | 92.3 | 0.00 |
| Baseball | 0.011 | 14.26 | 1.5 | 18.0 | 12.0 | 0.00 |
| Indoor track | 0.003 | 10.44 | 0.3 | 1.5 | 5.0 | 0.00 |
| Cross country | 0.006 | 4.72 | 0.3 | 0.0 | 0.0 | 0.00 |
| Outdoor track | 0.002 | 7.81 | 0.1 | 0.5 | 5.0 | 0.00 |
| Swimming | 0.004 | 6.23 | 0.2 | 2.3 | 11.5 | 0.00 |
| | | | **bone** | | | |
| Wrestling | 0.042 | 2.87 | 1.2 | 42.8 | 35.7 | 9.58 |
| Football | 0.034 | 25.77 | 8.8 | 448.1 | 50.9 | 29.61 |
| Ice Hockey | 0.046 | 1.93 | 0.9 | 33.2 | 36.9 | 15.53 |
| Soccer | 0.029 | 8.42 | 2.4 | 101.0 | 42.1 | 18.37 |
| Basketball | 0.034 | 9.76 | 3.4 | 150.7 | 44.3 | 28.15 |
| Lacrosse | 0.028 | 4.26 | 1.2 | 77.4 | 64.5 | 31.96 |
| $N$: Non-contact | 0.016 | 40.34 | 6.5 | 203.3 | 31.3 | 12.09 |
| Tennis | 0.016 | 3.12 | 0.5 | 40.8 | 81.6 | 0.00 |
| Baseball | 0.022 | 14.26 | 3.2 | 92.2 | 28.8 | 12.44 |
| Indoor track | 0.009 | 10.44 | 1.0 | 14.2 | 14.2 | 14.67 |
| Cross country | 0.031 | 4.72 | 1.5 | 42.5 | 28.3 | 0.00 |
| Outdoor track | 0.005 | 7.81 | 0.4 | 13.6 | 34.0 | 64.24 |
| Swimming | 0.004 | 6.23 | 0.2 | 2.5 | 12.5 | 0.00 |

**Table A1 (continued)**
**The Four Types of Injuries**

| | 100($I/E$) | $E$ mil. | $I$ thous. | $D$ thous. | $D/I$ | 100($S/I$) |
|---|---|---|---|---|---|---|
| | | | **tear** | | | |
| Wrestling | 0.567 | 2.87 | 39.0 | 284.3 | 7.3 | 5.87 |
| Football | 0.513 | 25.77 | 132.1 | 2117.3 | 16.0 | 8.99 |
| Ice Hockey | 0.371 | 1.93 | 7.2 | 91.4 | 12.7 | 4.39 |
| Soccer | 0.434 | 8.42 | 36.6 | 384.1 | 10.5 | 2.48 |
| Basketball | 0.400 | 9.76 | 16.3 | 313.3 | 19.2 | 3.55 |
| Lacrosse | 0.346 | 4.26 | 14.7 | 193.8 | 13.2 | 5.42 |
| $N$: Non-contact | 0.189 | 40.34 | 76.2 | 703.4 | 9.2 | 2.56 |
| Tennis | 0.295 | 3.12 | 9.2 | 92.5 | 10.1 | 0.81 |
| Baseball | 0.196 | 14.26 | 27.9 | 334.8 | 12.0 | 5.16 |
| Indoor track | 0.202 | 10.44 | 21.1 | 160.6 | 7.6 | 1.59 |
| Cross country | 0.157 | 4.72 | 7.4 | 28.8 | 3.9 | 0.00 |
| Outdoor track | 0.135 | 7.81 | 10.6 | 86.6 | 8.1 | 0.97 |
| Swimming | 0.051 | 6.23 | 3.2 | 4.9 | 1.5 | 11.96 |
| | | | **muscle** | | | |
| Wrestling | 0.090 | 2.87 | 2.6 | 8.1 | 3.1 | 2.00 |
| Football | 0.141 | 25.77 | 36.2 | 106.1 | 2.9 | 0.55 |
| Ice Hockey | 0.272 | 1.93 | 5.3 | 10.2 | 1.9 | 0.42 |
| Soccer | 0.150 | 8.42 | 12.6 | 36.1 | 2.9 | 0.66 |
| Basketball | 0.155 | 9.76 | 15.1 | 23.2 | 1.5 | 0.54 |
| Lacrosse | 0.135 | 4.26 | 5.7 | 9.3 | 1.6 | 1.99 |
| $N$: Non-contact | 0.051 | 40.34 | 20.7 | 79.9 | 3.9 | 0.00 |
| Tennis | 0.030 | 3.12 | 0.9 | 6.1 | 6.8 | 0.00 |
| Baseball | 0.088 | 14.26 | 12.6 | 19.2 | 1.5 | 0.00 |
| Indoor track | 0.029 | 10.44 | 3.1 | 4.6 | 1.5 | 0.00 |
| Cross country | 0.033 | 4.72 | 1.5 | 16.7 | 11.1 | 0.00 |
| Outdoor track | 0.033 | 7.81 | 2.6 | 33.3 | 12.8 | 0.00 |
| Swimming | 0.012 | 6.23 | 0.7 | 6.7 | 9.6 | 0.00 |

**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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