A Note on Estimating Sports Injuries at Ivy League Universities

Ray C. Fair*

July 2022

Introduction

The Big Ten-Ivy League Traumatic Brain Injury Research Collaboration (TBI) has collected concussion data by sport for the eight Ivy League universities and some of the Big Ten universities for the six academic years 2013/14 through 2018/19. Two main reports from the TBI have so far been published—Putukian et al. (2019) and Bretzin et al. (2021).

Given the TBI data that have been released to date, it is possible to compute the average number of concussions per sport across the eight universities and six years. These calculations are discussed in this note. In addition, it is possible using NCAA results that Christopher Champa and I, Fair and Champa (2019a, 2019b) (FC), have obtained to estimate the average number of total injuries per sport, and these calculations are discussed. Finally, it is possible from my earlier work with Champa to estimate how many concussions and injuries would be saved (eliminated) if the contact sports were changed to be non contact, and these estimates are presented.

*Cowles Foundation, Department of Economics, Yale University, New Haven, CT 06520-8281. e-mail: ray.fair@yale.edu; website: *fairmodel.econ.yale.edu*. My two papers with Christopher Champa can be downloaded from this website.

Estimates Based on Averages

In Table 2 in Bretzin et al. (2021) the total number of concussions is presented for men and women for each sport summed over the six years and the eight Ivy League universities. For example, there were 487 concussions in football. This number is the sum of 48 numbers (6×8). If it is assumed that each year and school are the same, then the number of football concussions per year and school is 487 divided by 48, which is 10.1. This assumption of similarity is crude, but it is the best one can do absent more detailed data. These average numbers are presented in columns (1) in Table 1.

It turns out that there is an independent check on the 487 number for football concussions to see if it is in the ballpark of what one might expect. In Fair and Champa (2019a) we have computed using NCAA data collected for the 5 academic years 2009/10 through 2013/14 the number of concussions in college football per 1,000 exposures. (An exposure is one practice or game per athlete.) This number is 0.92. On Yale's 2018 football team there were 110 players, and there are about 100 practices plus games per season, so about 11,000 exposures. If there are 10.1 football concussions in a season, this is a rate of 0.92 per 1,000 exposures, the same as the NCAA number. Also, in Figure 2 in Putukian et al. (2019) a rate of 1.26 is given for the two academic years 2016/17 and 2017/18. Finally, Carolyn S. Campbell-McGovern in a March 2017 talk at the MIT/Sloan Analytics Conference reported football concussion rates for the four academic years 2013/14–2016/17 of 1.18, 1.62, 1.08, and 0.99, respectively. The reported Ivy League rates are thus a little higher than 0.92, but not too far off. This closeness suggests that the Ivy League has similar outcomes than the overall NCAA, which is encouraging for this note in that some NCAA results are used below.

Table 1
Average Number of Concussions per
Ivy League University and Year

	Men				Women			
	(1) # concus	(2) # players	(3) prob 1 season	(4) prob 4 seasons	(1) # concus	(2) # players	(3) prob 1 season	(4) prob 4 seasons
Football	10.1	110	9.18	32.0				
Ice Hockey	2.5	28	8.93	31.2	1.9	24	7.92	28.1
Soccer	1.8	32	5.63	20.7	2.0	30	6.67	24.1
Basketball	1.3	18	7.22	25.9	1.3	16	8.13	28.8
Lacrosse	2.4	46	5.22	19.3	1.6	40	4.00	15.1
Field Hockey					1.2	21	5.71	21.0
TOTAL	18.1	234			8.0	131		

Column (1) computed from data in Bretzin et al. (2021).
Column (2) from Yale web sites.
Column (3) is $100 \cdot [(1)/(2)]$.
Column (4) is $100 \cdot [1.0 - [1.0 - (3)/100]^4]$.

The six sports in Table 1 are labelled as contact in Bretzin et al. (2021) and in FC. Two of the main contact sports not listed in Table 1 are Rugby and Wrestling. The non contact sports have many fewer concussions. The focus here is on the six sports in Table 1.

Given the numbers in columns (1) in Table 1 and the number of players on a team, one can calculate the probability that a given player gets a concussion during the season. Yale data for 2018/2019 were used to estimate the number of players per each sport. These data are in columns (2). The data were taken from various Yale sports websites. For the following calculations it needs to be assumed that the average number of players per sport across the other Ivy League universities is equal to Yale's. Columns (3) present the one-season probabilities. They are based on the assumption that no player has more than one concussion per season. Some players do get more than one, and so the probabilities in the table are least slightly

biased upward. The probabilities vary from 4.00 for women's lacrosse to 9.18 for football. Ice hockey is high for both men and women, 8.93 and 7.92, respectively.

Presented in columns (4) in Table 1 are estimates of the probability that a player who plays all four seasons gets at least one concussion in this time. These estimates are based on the assumption that the one-season probabilities are independent across seasons. For football the probability of at least one concussion in four seasons is 32.0 percent. For ice hockey it is 31.2 and 28.1 for men and women, respectively. Remember these values are only for concussions. Results for total injuries are presented in the next section.

The numbers in columns (3) are measures of how risky each sport is regarding concussions. Another measure is to look at concussion $rates$, the number of concussions per 1,000 exposures. These numbers are reported in FC, Tables 2, using NCAA data. For men, the rates are 0.92 football, 0.87 ice hockey, 0.37 soccer, 0.44 basketball, and 0.40 lacrosse. This ranking is the same as in column (3) except soccer and lacrosse are switched. For women, the rates are 0.67 for ice hockey, 0.64 for soccer, 0.62 for basketball, 0.58 for lacrosse, and 1.05 for field hockey. Here the match is not as good. Basketball and field hockey are switched. What is important to note, however, is that these rates are all considerably higher than the rates for the non contact sports. For men for tennis, baseball, indoor track, cross-country, and outdoor track the average cooncussion rate is 0.06. For women for softball, tennis, indoor track, cross-country, and outdoor track the average concussion rate is 0.12.

Estimates Using NCAA Data

Estimates for all injuries are presented in Table 2. These estimates are based on NCAA results in FC. The NCAA data include concussions plus other injuries. From the NCAA results in FC one can compute the ratio of total injuries to concussions for each sport for men and women. The numbers in columns (3) are

Table 2
Estimates of All Injuries and Saved Injuries
per Ivy League University and Year

	Men				**Women**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	concus		**all inj**		**concus**		**all inj**	
	total	saved	total	saved	total	saved	total	saved
Football	10.1	9.4	85.9	57.0				
Ice Hockey	2.5	2.3	22.7	15.0	1.9	1.6	13.3	5.7
Soccer	1.8	1.5	21.8	19.0	2.0	1.6	20.5	12.5
Basketball	1.3	1.1	18.6	10.9	1.3	1.0	10.4	4.7
Lacrosse	2.4	2.0	32.6	17.0	1.6	1.3	10.7	3.6
Field Hockey					1.2	1.1	5.2	2.1
TOTAL	18.1	16.3	181.6	118.9	8.0	6.6	60.1	28.6

- **all inj** = **concus** times NCAA ratio of **all inj** to **concus**.
- "saved" = number of concussions or injuries eliminated if the contact sports were changed to be non contact.

these ratios times the concussion numbers in columns (1), thus estimating the total number of injuries.[1] For example, for men there are 85.9 estimated injuries for football and 181.6 in total across the five sports. For women there are 60.1 total across the five sports.

The numbers under the "saved" columns in Table 2 are estimates of injuries that would be saved if the contact sports were changed to have the same injury rates as the non contact sports. These estimates are based on results in FC comparing contact to non contact sports. For example, for football 9.4 of the 10.1 concussions would be saved if there were no contact in football. For football the total number of injuries would fall from 85.9 to 57.0. The fraction saved for total injuries is

[1] "All injuries" here do not cover all recorded injuries by the NCAA. The injuries covered are concussions, nervous system, exostosis, fracture, fracture (stress), myositis ossificans, osteochondritis, cartilage injury, dislocation, sprain, strain, strain/tear, subluxation, contusion (hematoma), and spasm.

smaller than the fraction saved for concussions for all sports. The fraction of total injuries in non contact sports relative to contact sports is higher than the fraction of concussions in non contact sports relative to contact sports, which is the reason for the difference. This makes sense since concussions in non contact sports are fairly rare.

Long Run Health Issues

The estimated health savings from eliminating contact are likely much larger than one might conclude from the number of concussions saved in Table 2. These savings are likely just the tip of the iceberg. In July 2011 the Ivy League released an informative report on concussions in football, which led to rule changes regarding football contact. The report examined data on long-term effects and concluded "...the multiple hits that are sustained in football, distinct from those causing a concussion, may have a role in the development of Chronic Traumatic Encephalopathy (CTE) in some individuals." It reviewed a number of studies, including Crisco et al. (2010), who examined data from Brown, Dartmouth, and Virginia Tech using Head Impact Telemetry (HTM) system technology. This study found that football players received up to 1,444 head impacts in one season, with an average of 6.3 impacts per practice and 14.3 impacts per game. The report also examined actual cases of diagnosed CTE based on autopsies from the Boston University Center. The report concluded from this examination that "Cumulative trauma, not necessarily concussion, is felt to be the major risk factor for CTE."

McAllister and McCrea (2017) provide a comprehensive review of the literature on long-term effects and conclude: "To date, no prospective, longitudinal studies of well-defined cohorts over longer periods (eg, years, decades) have been conducted to determine how exposure to multiple concussions early in life may affect one's risk for late-life cognitive problems or neurodegenerative disease." They point out that what is needed is a longitudinal study of a large cohort of contact-sport

athletes with concussion, a cohort of contact-sport athletes without concussion, and a cohort of relatively unexposed athletes. This group would need to be followed over a long period of time. The fact that there is no study does not mean, however, that the conclusion of the Ivy League report is wrong, just that there is no definitive proof. Regarding the Ivy League report, although it found concerning evidence of the negative effects of contact, it made only modest suggestions for lessening contact and only for football.

What Could Be Done With More Data?

Data on the number of concussions per sport, per year, and per Ivy League university exist, but have not been released. (See my quest for more data in the Appendix.) The results in this note run off the averages in columns (1) in Table 1. Having the exact data would greatly improve the accuracy of the table. There would one table per university, or if years were separated, there would be six tables per university.

A number of interesting questions could be examined with more disaggregated data. Are there large differences across universities in particular sports, and if so why? Are there differences in sports programs that lead to different concussion rates? Do universities differ in concussions for men versus women? Are there differences across time; in other words, is a given sport becoming more or less safe? These questions have not been examined so far by the TBI researchers.

How Would Contact Sports Be Changed?

If the savings in Table 2 were to be realized, the contact sports would have to be changed. Rule changes would be needed, and they would obviously differ by sport. The most problematic is football, which would likely require something like flag football. Headers in soccer are also problematic. An example of a rule change in the right direction is a change made by the National Hockey League for the 2021-22 season. The change is to have strict enforcement against cross checking. Some experimentation would undoubtedly be needed in each sport to see what is necessary to significantly lower contact.

Conclusion

Most things that people do in life have some element of injury risk. One could not design a collegiate sports program that eliminated all injuries, even concussions. However, the results in Tables 1 and 2 show that concussion rates and all injury rates in the contact sports are large absolutely and large relative to those in non contact sports. They also likely underestimating long run health effects. Do universities need contact to reap the benefits of sports? Sports are an important part of campus life, both playing and watching. They build character; they lead to comradeship; they teach cooperation and selflessness. But it does not seem that contact is needed for any of this. Adjustments can be made, even in football, without changing the benefits of sports just mentioned. It seems that universities are putting students in harm's way more than is needed. It's not that the contact sports would be eliminated, just adjusted to make them safer.

"to be sure, all that pointless standing about and waiting day after day always starting all over again without any prospect of change, will wear a man down and make him doubtful, and ultimately incapable of anything but that despairing standing about." Franz Kafka, The Castle

Appendix

A Five Year Quest

I first asked to examine the Ivy League data in an email to President Peter Salovey and other Yale administrators dated May 29, 2017, over five years ago. The journey has taken me through all eight Ivy League presidents, Ivy League sports officials, and TBI researchers. I have made little progress. What seems to be the case is that the principle investigator of the TBI, Douglas Wiebe at the University of Pennsylvania, has complete control over who can examine the data, and so far he has not allowed anyone outside of his group to submit proposals to examine the data.

One restriction on the release of data is clear. Data cannot be released that would identify any one student. I have seen a copy of the consent form that each student signs. What is not clear is whether there is a restriction on releasing data by individual university. For example, could the number of concussions in each sport be released by university? As noted above, the data have been released summed across the eight universities, data used in this note. I have not be allowed to see any forms relating to IRB protocols and data use agreements. So I don't know whether the Ivy League, presumably Douglas Wiebe, could make public the number of concussions per sport by university if it wanted to or whether some past agreement prevents it from doing so. The consent form says nothing about individual universities. There is nothing in this form that is violated by simply releasing the total number of concussions in the major sports.

In the five years it is remarkable how many times something has been promised in the near future, like the ability to submit research proposals to the TBI, and never delivered. Early on President Salovey said in an email to me that I could examine the aggregate Yale data once the first TBI report was released. The report was released in 2019, but then President Salovey said he was not allowed to release any Yale data. This exchange is one of many similar examples. The tone of the whole enterprise seems to be to hide the data as much as possible, at least the data by individual university. And the tone is to only have the data examined internally. The following footnote is an example of what I have encountered in my attempt to enter the Castle and of the desire of the Ivy League to suppress the data.[2]

If in fact the Ivy League can release the data by university, it is shameful that it has not done so. Injuries in contact sports is a serious matter, and it seems wrong to prevent the academic community from knowing what the numbers are by individual university. As faculty we care about our students, and shouldn't we be aware of the risks involved in the various sports? Even more so for the students and their families, who are making decisions about sports participation. The suppression is contrary to the free exchange of ideas and research. Regarding future research, as discussed in the section, "What Could Be Done With More Data" in the text, there are many interesting questions that could be examined using the data by university.

[2] As noted in the text, Carolyn S. Campbell-McGovern in March 2017 gave a talk at MIT releasing some concussion rates in Ivy League football. This talk was posted on YouTube at the time. I reported to the TBI that the rates were in line with the NCAA rates that Champa and I were getting and that I would mention this in our paper. The TBI responded by asking me not to report the numbers. I ignored the request, and shortly thereafter the YouTube video was taken down.

References

[1] Bretzin, Abigail C., Carrie Esopenko, Bernadette A. D'Alonzo, and Douglas J. Wiebe, 2021, "Clinical Recovery Timelines following Sport-Related Concussion in Men's and Women's Collegiate Sports," *Journal of Athletic Training*.

[2] Crisco JJ, Fiore R, Beckwith JG, Chu JJ, Brolinson PG, Duma S, McAllister TW, Duhaime AC, Greenwald RM, 2010, "Frequency and Location of Head Impact Exposures in Individual Collegiate Football Players, *J of Athletic Training*, 45(6), 549–559.

[3] Fair, Ray C., and Christopher Champa, 2019a, "Estimated Costs of Contact in College and High School Male Sports," *Journal of Sports Economics*, 20(5), 690–717.

[4] Fair, Ray C., and Christopher Champa, 2019b, "Estimated Costs of Injuries in College and High School Female Sports," July.

[5] Ivy League, 2011, "Report regarding the Ivy League Review of Concussions in Football," July.

[6] McAllister, Thomas, and Michael McCrea, 2017, "Long-Term Cognitive and Neuropsychiatric Consequences of Repetive Concussion and Head-Impact Exposure," *J. of Athletic Training*, 52(3), 309–317.

[7] Putukian, Margot, Bernadette A. D'Alonzo, Carolyn S. Campbell-McGovern, and Douglas J. Wiebe, 2019, "The Ivy League-Big Ten Epidemiology of Concussion Study," *The American Journal of Sports Medicine*.