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COMMENTARY

The Injury Proportion Ratio: What's It All About?

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We thank the *Journal of Athletic Training* (*JAT*) and Deits et al[1] for allowing us to comment on the analysis of national emergency department (ED) surveillance data on hockey injuries appearing in this issue. This commentary focuses on the use in descriptive epidemiology of the injury proportion ratio (IPR). We are prompted to comment on the IPR due to its increasing use in the sports injury-prevention literature, including *JAT*. Our comments are aimed at examining the IPR and highlighting the usefulness and limitations of the measure in relation to other measures in injury-prevention research, notably the injury rate ratio. Our concern is that, without understanding the assumptions underlying these measures, the IPR can be easily misinterpreted, thereby leading readers to draw false conclusions.

Published research[2–6] has used IPRs in the context of hospital-based surveillance data as well as a Web-based high school surveillance system.[7–16] By design, hospital-based ED injury surveillance systems, such as the National Electronic Injury Surveillance System (NEISS), collect information only on injured individuals. Such surveillance systems provide useful descriptive information about severe injury patterns, such as who was injured, what types of injuries occurred, what was happening at the time of injury, and the type of care provided for that injury. However, NEISS does not collect information about the population among whom these injuries occurred or arose: the population of hockey players, in this case. Additionally, NEISS does not collect information on hockey injuries that do not result in a visit to the ED, an issue we will ignore for the purposes of this commentary.

WHAT IS THE IPR?

A Ratio of 2 Percentages

The IPR has been defined as a χ^2 ratio to compare the relative proportions of categorical variables.[1] In their analysis of NEISS data, Deits et al reported that the proportion of head injuries seen at the ED among females was 2.22 times greater than the proportion of head injuries among males. Because 19.9% of the females' injuries were to the head, we can deduce that the proportion of head injuries to males was approximately 9%. In the context of all injuries seen in an ED, this measure represents the injury-care burden to the health care providers: Of all patients with injuries reporting to the ED, providers will treat twice as many head injuries among females as among males.

However, no data are included in the NEISS system about the male-to-female sex ratio in the hockey-playing general population. Therefore, the IPR says nothing about the rate of head injury for a female playing hockey compared with a male playing hockey. In other words, the IPR is not the same as the injury rate ratio.

Relationship to the Proportional Mortality Ratio

The IPR is analogous to another epidemiologic measure, the proportional mortality ratio (PMR), which is used to study proportionate index causes of disease or death in the absence of a defined cohort or population at risk.[17] The PMR is most often used in occupational studies when researchers have access to causes of disease or death but have no way of identifying the population of workers among whom these events occurred (ie, the denominator).[17] For example, the PMR compares the *observed* proportion of cancer deaths of all deaths in a defined group to the *expected* proportion of cancer deaths in a referent or comparison population. It is a useful surrogate of disease risk and can inform the direction of prospective research studies examining risk factors. The limitations of this measure are well described and include the following: (1) No population-at-risk information (denominator) means that diseases or deaths cannot be attributed to actual exposures or risk factors, and (2) the sum of all proportionate causes must equal 1, so any proportion is dependent on the value of all other proportions.[17] In other words, an excess in one cause is offset by a deficit in another cause. These limitations significantly limit the validity and generalizability of the PMR.

The PMR has been adapted for nonfatal work-related injury studies and called a proportionate injury ratio. In an analysis of construction injuries reported as workers' compensation cases, Dement et al,[18] Lipscomb and Li,[19] and Lombardi et al[20] compared the observed causes of injury among teen construction workers with those expected from a referent population of adult construction workers.

WHAT THE IPR IS NOT

The IPR Is Not Based on Incidence Rates

Consider a hypothetical study, identical to the NEISS analysis of Deits et al[1], with one exception: It also includes data on the total hockey-playing population in the United States and total time spent playing hockey, presented separately for males and females. Clearly such a rich source of exposure data is not available in the NEISS (or anywhere else in the United States). If it was, Deits et al would have been able to compute incidence rates for ED-attended hockey injuries for males and females and compute the ratio of these 2 sex-specific rates (ie, the true injury rate ratio).

Obviously, this would have been the first preference of the researchers. But playing-time data were not available, let alone presented separately for males and females. Therefore, in the absence of any data on the playing population, researchers used the IPR.

Note that the IPR does not use the sex distribution of the playing population as its denominator. Instead, it uses the sex distribution of the injured population. Thus, a male-to-female head-injury IPR of 2.22 does not inform the reader about the actual rate of incident head injuries among hockey players but about the relationship between the 2 subgroups of injured participants. In fact, the IPR is something the reader can deduce by looking at the proportions alone (19.9% versus 9%).

It is important to note that the reader should not draw conclusions about relative injury rates based on the IPR. It would be incorrect to infer that in this study, females had twice the rate of head injury resulting in ED treatment. Interpreting frequency measures as measures of relative risk or rate ratios results in the reader drawing erroneous conclusions about increased or decreased risk or rate based on the IPR estimate itself.

Example Comparing the IPR With the Injury Rate Ratio

Females are overrepresented in head injuries, but underrepresented in nonhead injuries, relative to males, creating a 2-fold IPR. However, this does not necessarily mean that the true injury rate ratio would also be elevated. Based on USA Hockey registration estimates,[21] females accounted for about 13% (59 506/465 975) of registered hockey players in the 2008–2009 season. Thus, if the 2008–2009 season was typical of female participation in the sport over the 17-year time period of the Deits et al[1] study (which it probably is not; see below), and if playing time (minutes on the ice) and other types of exposure did not vary by sex, the true rate ratio would be about 1 (ie, approximately the same incidence in females and males). This is because the estimated rate of head injury in females (3942 injuries / [17 years × 59 506 athletes], if we used an athlete-years analysis) would be very similar to the estimated rate of head injury in males (25 318 injuries / [17 years × 465 975 athletes]).

A rate ratio of 1 (no difference in the rate) is vastly different from the IPR observed by Diets et al[1] of 2.2 (2-fold greater in females), simply because the IPR draws from only one part of the equation—the injured athletes—and does not use data on the playing population at risk (which includes the uninjured).

In fact, the Deits et al[1] study covers a long time period (1990–2006) and, for much of that time, female participation in hockey was much lower than it is today. This suggests that the true injury rate ratio very probably is elevated above 1. Thus, the authors are correct in calling attention to an excess proportion of head injuries in female hockey players seen in EDs.

SUMMARY

Conclusions from hospital-based ED surveillance data, as with NEISS, are limited without access to data on the source population (in this instance, the general population of ice hockey players). Focusing only on the injured athletes can provide valuable information regarding severity of injury for those who went to the ED, but, without information about uninjured athletes, injury risk factors cannot be properly identified and evaluated.

In past published analyses, ED injury data were presented appropriately as a description of injury patterns without implying increased or decreased risk or rate based on specific characteristics, such as the injury mechanism, age, sex, or race. A dearth of descriptive papers on sports injury has existed for far too long, and this research group is to be congratulated for their impressive work in publishing informative descriptive papers from data sources such as NEISS.

In the case of such surveillance studies, it may be appropriate to use ratio measures such as a PMR as long as such measures are interpreted appropriately. However, the use of such measures when information about a population at risk is available is not warranted and can be easily confused as rate ratios or risk ratios. It is important to bear in mind that the IPR is not the same as the rate or risk ratio and should be interpreted with caution.

REFERENCES

1. Deits J, Yard EE, Collins CL, Fields SK, Comstock RD. Patients with ice hockey injuries presenting to US emergency departments, 1990–2006. *J Athl Train*. 2010;45(5):467–474.
2. Yard EE, Comstock RD. An epidemiologic comparison of injuries presenting to a pediatric emergency department and local urgent care facilities. *J Safety Res*. 2009;40(1):63–69.
3. Collins CL, Smith GA, Comstock RD. Children plus all nonautomobile motorized vehicles (not just all-terrain vehicles) equals injuries. *Pediatrics*. 2007;120(1):134–141.
4. Yard EE, Comstock RD. Injuries sustained by pediatric ice hockey, lacrosse, and field hockey athletes presenting to United States emergency departments, 1990–2003. *J Athl Train*. 2006;41(4):441–449.
5. Yard EE, Comstock RD. Injuries sustained by rugby players presenting to United States emergency departments, 1978 through 2004. *J Athl Train*. 2006;41(3):325–331.
6. Mello MJ, Myers R, Christian JB, Palmisciano L, Linakis JG. Injuries in youth football: national emergency department visits during 2001–2005 for young and adolescent players. *Acad Emerg Med*. 2009;16(3):243–248.
7. Yard EE, Comstock RD. Effects of field location, time in competition, and phase of play on injury severity in high school football. *Res Sports Med*. 2009;17(1):35–49.
8. Yard EE, Schroeder MJ, Fields SK, Collins CL, Comstock RD. The epidemiology of United States high school soccer injuries, 2005–2007. *Am J Sports Med*. 2008;36(10):1930–1937.
9. Yard EE, Collins CW, Dick RW, Comstock RD. An epidemiologic comparison of high school and college wrestling injuries. *Am J Sports Med*. 2008;36(1):57–64.

10. Rechel JA, Yard EE, Comstock RD. An epidemiologic comparison of high school sports injuries sustained in practice and competition. *J Athl Train*. 2008;43(2):197–204.
11. Ingram JG, Fields SK, Yard EE, Comstock RD. Epidemiology of knee injuries among boys and girls in US high school athletics. *Am J Sports Med*. 2008;36(6):1116–1122.
12. Collins CL, Fields SK, Comstock RD. When the rules of the game are broken: what proportion of high school sports-related injuries are related to illegal activity? *Inj Prev*. 2008;14(1):34–38.
13. Collins CL, Comstock RD. Epidemiological features of high school baseball injuries in the United States, 2005–2007. *Pediatrics*. 2008;121(6):1181–1187.
14. Borowski LA, Yard EE, Fields SK, Comstock RD. The epidemiology of US high school basketball injuries, 2005–2007. *Am J Sports Med*. 2008;36(12):2328–2335.
15. Fernandez WG, Yard EE, Comstock RD. Epidemiology of lower extremity injuries among U.S. high school athletes. *Acad Emerg Med*. 2007;14(7):641–645.
16. Yard EE, Comstock RD. A comparison of pediatric freestyle and Greco-Roman wrestling injuries sustained during a 2006 US national tournament. *Scand J Med Sci Sports*. 2008;18(4):491–497.
17. Checkoway H, Pearce NE, Crawford-Brown DJ. Overview of study designs: proportionate mortality studies. In: Checkoway H, Pearce N, Kriebel D, eds. *Research Methods in Occupational Epidemiology*. New York, NY: Oxford University Press, 58–61.
18. Dement JM, Hensley L, Kieding S, Lipscomb H. Proportionate mortality among union members employed at three Texas refineries. *Am J Ind Med*. 1998;33(4):327–340.
19. Lipscomb HJ, Li L. Injuries among teens employed in the home-building industry in North Carolina. *Inj Prev*. 2001;7(3):205–209.
20. Lombardi DA, Pannala R, Sorock GS, et al. Welding-related occupational eye injuries: a narrative analysis. *Inj Prev*. 2005;11(3):174–179.
21. USA Hockey. 2009 USA Hockey registration reports. http://www.usahockey.com/uploadedFiles/USAHockey/Menu_Membership/Menu_Membership_Statistics/0809%20Final%20Reports.pdf. Accessed March 30, 2010.

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