Is migraine a risk factor for the development of concussion?

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PostScript

LETTER

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Concussion, which is defined as ''a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces'',[1 2] is a poorly characterised clinical syndrome. Prospectively validated features include loss of consciousness, amnesia, headache, blurred vision, dizziness, nausea, and attention deficit,[3] although none of these phenomena is mandatory. There has been a recent increase in both awareness of and interest in sports related concussion.[1 2 4 5]

Trauma has also been associated with migraine. Matthews[6] identified footballer's migraine in which soccer players suffered migraine headaches after heading the ball. Typically the head injury was minor and was not associated with loss of consciousness, although confusion and impaired consciousness was more likely to be reported in children.[7 8]

The congruence of symptoms in migraine and concussion may lead to confusion in diagnosing the adolescent who has suffered a head injury, reportedly leading to a possible over-diagnosis of concussion and under-recognition of trauma induced migraine.[9] The overlap between migraine and concussion may also reflect an increased propensity in migraineurs for concussion.

This study was designed as an exploratory analysis to investigate an observed clinical association between migraine and concussion.

Methods

The Canadian Community Health Survey is a cross sectional survey that collects information on health status, healthcare utilisation, and health determinants for the Canadian population. A stratified cluster sample design is used to obtain information on Canadians aged 12 years or older living in private dwellings in the 10 provinces and the three territories, exclusive of persons living on First Nations Reserves or Crown Lands, residents of institutions, full time members of the Canadian Armed Forces, and residents of certain remote regions. Information is collected every two years.[10 11]

Our analysis was based on the public use microdata set of the Canadian Community Health Survey, Cycle 1.1 (2000–2001)[12] and Cycle 2.1 (2003).[13]

Each respondent was asked, ''In the past 12 months, did you have any injuries that were serious enough to limit your normal activities?'' Subjects responding affirmatively to this question were subsequently asked about the nature of the most serious injury. For the public use microdata set, concussions and internal injuries were coded together. Only those reporting concussions/internal injuries that occurred during ''sports/physical education/leisure or hobby'' or within a ''sports or athletics area'' were considered as the dependent variable for this study. Reported concussions/internal injuries occurring outside these parameters were excluded from analysis. Respondents reported whether they had ''migraine headaches diagnosed by a health professional'' and were subsequently asked: ''Have you done any of the following in the past 3 months?'' with a sequence of 20 specified exercise patterns (table 1). We limited our analysis to respondents aged 12 through 24 years, typical ages at which sport related concussion is incurred.

Table 1 Activity related variables considered in the multivariate model

Walking for exercise	Golfing
Gardening or yard work	Exercise class or aerobics
Swimming	Skiing or snowboarding
Bicycling	Bowling
Popular or social dance	Baseball or softball
Home exercises	Tennis
Ice hockey	Weight training
Ice skating	Fishing
In-line skating or roller blading	Volleyball
Jogging or running	Basketball

The data were analysed using Systat v9.0 (Systat, Chicago, Illinois, USA: SPSS Incorporated, 1998) and Stata/SE 7.0 (Stata/SE, College Station, TX, USA: Stata Corporation, 2002). Weights were recoded to reflect the sample size (an average weight of 1) in each dataset, before amalgamation. As this was an exploratory analysis, with known correlation between variables—for example, activities and sex; migraine and age and sex; concussion and age and sex—we elected to use a multivariate analysis. We used both backwards and forwards stepwise logistic regression with migraine, age, sex, dataset (2000–1 *v* 2003), and exercise data included in the model. The factors in the final multivariate logistic regression model are reported as odds ratios with appropriate confidence intervals.

Results

There were 50 352 respondents, in the two samples, age 12–24 years. A total of 330 respondents reported incurring a concussion and/or internal injuries within the previous 12 months, with 270 of these occurring during sports/physical education/leisure or hobby or within a sports or athletics area. The rate of injury was 450/100 000 for the 2000–1 data and 530/100 000 for the 2003 data ($p = 0.18$).

The dataset was remarkably complete, with no missing data for age and sex and less than 0.5% missing data for migraine and injury. Data were either missing or not applicable for 10.4% for the 2000–1 exercise data and 2.6% for the 2003 exercise data for all exercise data. The final multivariate model used 93.2% of the dataset.

In the multivariate model (table 2), sport related concussion/internal injury was associated with being younger, male, and having migraine diagnosed by a health professional. Activity related variables associated with sport related concussion/internal injury in order of strength of association were: ice hockey, jogging or running, weight training, and skiing, or snowboarding.

Discussion

For many concussed patients, headache is a major complaint, and loss of consciousness may be brief, or even absent.[2] Given the symptom overlap, it may be difficult to distinguish acutely between headache as an entity and headache as a symptom of concussion. Furthermore, head trauma may also act as a precipitant of migraine. In 1898, Walton described stupor, vomiting, and hemiparesis of several days duration in two children dazed by mild head injuries.[14] In the neurology literature, this is largely felt to be migraine precipitated by head injury, but clearly underscores the diagnostic challenge presented to doctors.

We found that reporting concussion/internal injuries was associated with being both younger and male and with having migraine diagnosed by a health professional. As expected, activities that increased the risk of concussion were ice hockey and skiing/snowboarding. Jogging/running and weight training probably served as proxy risk factors for people who were active and involved in competitive athletics. It is unlikely that concussion or internal injuries would occur as a direct result of jogging or running.

Migraine and concussion may be associated through a number of mechanisms. Concussion may trigger migraine, migraine may be misdiagnosed as concussion, or they may co-occur either through similar mechanisms or by chance.[7]

Mild head trauma can trigger both typical migraine and acute confusional migraine, although the prevalence of trauma induced acute confusional migraine is unknown. Clinically distinguishing between confusional migraine and concussion may be difficult, although those with concussion are less likely to have agitation.[7 8] Both are more prominent in male patients and are associated with a history of headaches, confusion, both family history and past personal history of migraine, and normal neuroradiological examinations.[8]

Misdiagnosing migraine as concussion is possible, as the International Headache Society criteria for migraine[15] are so broad that many post-traumatic headaches would qualify as migraine.[16] The pathogenesis of both conditions remains speculative, but they may share common pathophysiological pathways.[17] Mild head trauma may induce a transient disruption of brainstem function similar to the mechanisms proposed for migraine.[3 18] This may explain the comorbidity of headaches with mild but not severe head injury.[17] A shared basis is also suggested by the response of post-traumatic headaches to numerous drugs that have been used in the management of migraine, such as triptans, β adrenergic blockers, non-steroidal anti-inflammatory drugs, and calcium channel blockers.[19]

It seems unlikely that the relation between migraine and concussion is serendipitous, although migraine may be more common in

Table 2 Multivariate model for the reporting of concussion/internal injuries occurring during sports/physical education/leisure or hobby or within a sports or athletics area

Risk factor	OR	95% CI
Age (12–14, 15–19, 20–24)	0.69	0.55 to 0.86
Sex (M, F)	0.38	0.24 to 0.60
Migraine diagnosed by a health professional	2.36	1.20 to 4.65
Ice hockey	2.85	1.90 to 4.28
Jogging or running	1.97	1.41 to 2.76
Weight training	1.92	1.35 to 2.75
Skiing or snowboarding	1.74	1.09 to 2.78

OR, Odds ratio; CI, confidence interval.

those who are more likely to be exposed to concussion. McCrory *et al*[20] have reported an increased prevalence of migraine in elite athletes, compared with age and sex matched controls, especially during the times when they are competitively active. Canadian adolescents who report migraine are more active than their peers and may therefore be more likely to suffer concussion.[21] In athletes such as Australian footballers, concussion is common, with an incidence of 0.49/1000 player hours.[22] Those who engage in sports are more likely to be health conscious and may be more likely to report health problems, including migraine and concussion. The increase in reports of concussion, especially in professional sports, may therefore reflect an increase in recognition and reporting.[23]

Defining the correlation between migraine and concussion is difficult. Our study was based on a large cross sectional, nationally representative population with a remarkably complete dataset. Such nationally representative datasets are designed to guide health policy. Supplementary analyses of these same datasets have the potential to answer clinically relevant, important questions. One drawback to these supplementary analyses is that relevant and pertinent questions may not have been asked of the respondents in the original survey. The questions and/or coding may change between surveys, and validity data may not be available for the questions. Nevertheless, the representativeness of the sample and the completeness of the data are superior to studies carried out in a clinical setting.

Weaknesses of our study include the amalgamation of concussion and internal injuries. We limited the analysis to injuries that were logically associated with concussion. By selecting for sporting activities and locations, the rates of internal injury are likely to be low. A further weakness is the incompleteness of the exposure data, as not all sports and activities were reported on. Activities were limited to seasonal sports, as respondents were asked about sports activities within three months of data collection. Data on injury were gathered over a year and thus different time frames were used for injury and activity exposure.

For concussion to be reported, it is necessary for several conditions to be met.[25] Concussions had to be recognised, diagnosed, and reported as the most severe injury by the respondent. The concussion literature describes significant under-recognition and under-reporting,[26] and limited healthcare access.[27] Fortunately, the awareness of concussion has increased significantly.[23] Given the age range of the subjects, we cannot be sure that the recognition, diagnosis, and reporting of concussion was consistent. It is likely that only the more severe concussions were reported, as, in order to be reported, the condition had to be severe enough to limit ordinary daily activities. For rare individuals accruing multiple injuries at one time, or injuries at different times, the concussion had to be recognised as the most severe injury. Finally, the diagnosis of concussion remains a medical diagnosis, so that our unverified ''cases'' must only be seen in the context of this, an exploratory epidemiological study designed to explore the association between migraine and concussion.

Conclusion

In this exploratory analysis, reported migraine may be an independent risk factor for concussion along with younger age and male sex. Although the activity exposure data were incomplete, ice hockey and skiing or snowboarding are known high risk sports. Although running and weight training are also associated, they probably served as proxy variables for people involved in competitive athletics. The association of migraine and concussion requires confirmation using a more rigorous epidemiological study design.

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