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The Relationship Between Gender and Postconcussion Symptoms After Sport-Related Mild Traumatic Brain Injury

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Abstract

Objective—The authors sought to define the relationship between gender and postconcussion symptoms (PCSx) at 3 months after sport-related mild traumatic brain injury (mTBI) and, further, to examine whether age (minors vs. adults), source of PCSx reporting (self-reported vs. proxy), previous head injury or loss of consciousness, or the sport type in which the mTBI was incurred explain any observed gender differences in PCSx.

Design—Prospective nested cohort study.

Setting—Regional trauma center emergency department.

Patients—A total of 260 patients who presented with sport-related mTBI, as defined by American Congress of Rehabilitation Medicine criteria, began the study. The participants who lacked litigation concerning the mTBI and had participated in the follow-up assessment completed the study (n = 215).

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Assessment of Risk Factors—Self, proxy, and interviewer report of age, gender, previous head injury or loss of consciousness, and sport in which injury was sustained.

Main Outcome Measurements—Rivermead Post Concussion Symptoms Questionnaire (RPQ).

Results—Adult females are at greater risk for elevated RPQ scores (odds ratio [OR] = 2.89, 95% confidence interval [95% CI] = 1.25–6.71; *P* = .013) but not female minors (OR = 0.87, 95% CI = 0.45–1.71]; *P* = .695), as compared with male subjects. Adjustment for empirically identified confounders in each age group revealed persisting elevated risk for adult females (OR = 2.57, 95% CI = 1.09–6.08; *P* = .031), but not minor females (OR = 1.07, 95% CI = 0.52–2.19, *P* = .852). The risk associated with female gender in adults could not be explained by characteristics of the sports, such as helmeted versus not, or contact versus no contact, in which women incurred mTBIs. No sport characteristics were associated with increased risk of PCSx after mTBI.

Conclusions—Adult females, but not female minors, are at increased risk for PCSx after sport-related mTBI as compared with male patients. This increased risk cannot be explained by self-report, rather than proxy report, of symptoms, previous head injury or loss of consciousness, age, or sport characteristics. Further research is needed to elucidate the processes of age-differential recovery from mild brain injury in women and on how to most effectively incorporate appropriate follow-up after emergency department evaluation.

INTRODUCTION

Mild traumatic brain injuries (mTBIs) are a frequent occurrence and are a significant public health issue in the United States. According to epidemiological estimates from the Centers for Disease Control and Prevention, of the 1.5 million TBIs incurred annually in this country, approximately 75% are mild (ie, mTBI) and cost the nation $17 billion each year [1]. In the first few weeks after a mTBI, patients very commonly complain of physical, cognitive, and emotional/behavioral symptoms [2,3], such as headache, fatigue, dizziness, nausea, noise or light sensitivity, sleep disturbance, irritability, depression, frustration, poor concentration, blurred vision, memory problems, and restlessness. Sequelae such as these often resolve within a few weeks. However, in a certain percentage of patients, these postconcussion symptoms (PCSx) persist, causing psychosocial and physical distress and loss of productivity. Anywhere from 30% to 80% of patients with mTBI will experience such PCSx [3,4], which are classified by clinical criteria (eg, *Diagnostic and Statistical Manual of Mental Disorders* IV, [DSM-IV] or International Classification of Diseases 10 [ICD-10]), 3 months after their injury, and 15% will have persistent symptoms at 1 year [5].

Several variables contribute to outcome after mTBI, including severity of underlying brain injury, premorbid coping style, previous head injury, and perception of blame [6–15]. One of the most interesting factors to emerge is gender. Current findings indicate women appear to be at greater risk for persisting PCSx at 1–3 months after injury in nonsport mTBI patient samples [16–19]. Although the exact reasons for these gender differences are not known, several theories exist. These theories include psychosocial factors [17], gender differences in symptom reporting, hormonal influences, and the use of ICD-10 rather than DSM-IV criteria to diagnose PCSx [18].

Overall, despite varying entrance criteria and outcome measures, these reports suggest a greater risk of PCSx in women, particularly older women. Because none of the authors in these studies examined PCSx specifically in sport-related mTBI, the extent to which this relationship between gender and PCSx may hold true in sport-related mTBI is uncertain. The authors of a few recent studies specifically examined gender differences in outcomes among athletes who sustain concussion. The data showed a greater rate of impaired memory tasks and cognition in female high school and/or collegiate athletes with mTBI compared with pre-season baseline testing [20–22].

If, as recent data suggest, a gender difference in sport-related mTBI outcomes such as PCSx exists, it is unclear to what extent it may be confounded by other factors associated with PCSx, such as source of symptom reporting (self or proxy), previous head injury or loss of consciousness, sport type, and age. Previous head injury is suggested to increase the risk of cognitive symptoms in soccer players [23,24], and several studies have examined the cumulative effects of multiple head injuries, including cognitive symptoms, hypopituitarism, motor systems dysfunction, symptom reporting, and memory performance [25–30].

The elderly are more likely to have PCSx and poor outcomes after mTBI [31,32], whereas children appear to exhibit a greater degree of neuroplasticity than adults [33–36]. Children and adults are liable to sustain injuries in different contexts or activities, are treated emergently via different systems (adult vs. pediatric emergency department), and adults are legally responsible for their treatment decisions whereas children are not; therefore, if mTBI outcome is related to age, several factors could be associated with outcome. In terms of severity of injury, mTBI that results in loss of consciousness/amnesia is considered more severe than mTBI that results in the patient just being dazed [37–39]. Finally, mTBI after some sports may be more likely to produce PCSx than mTBI from other sports; this difference may be related to differences in impact forces. For example, the acceleration forces applied to the head in football has been reported to range from 21 to 168*g* [40–42], whereas such peak accelerations of the head during a hockey game can be significantly lower [40].

The objective of the current study was to examine the relationship between gender and PCSx at 3 months after sport-related mTBI to determine whether female patients have a greater risk of PCSx, as has been suggested in nonsport mTBI. Further, the authors examined whether age (minors vs. adults), source of PCSx reporting (self vs. proxy), previous head injury or loss of consciousness, and the sport type in which the mTBI was incurred explained any observed gender differences in PCSx after sport-related mTBI.

METHODS

This study is a nested cohort study derived from a National Institutes of Health (NIH)-funded TBI registry designed to evaluate the epidemiology and 3-month outcomes of mild brain injury [43]. The NIH study sample of 1438 patients consisted of individuals who presented to a regional trauma center emergency department with mTBI, defined by the American Congress of Rehabilitation Medicine as a blow to the head or acceleration/deceleration movement of the head resulting in one or more of the following: loss of consciousness less than 30 minutes or amnesia less than 24 hours or altered mental status at the time of injury and a Glasgow Coma Score of 13 or greater measured 30 minutes or more after the injury [44]. Subjects were recruited between February 3, 2003, and September 20, 2003; they were initially identified by a trained research assistant, then diagnosed by an attending emergency medicine physician.

The initial data collection, performed by a trained research assistant, included demographics (race, ethnicity, gender, age), historical factors (loss of consciousness, amnesia, seizure, dizziness, headache), physical examination factors (Glasgow Coma Score, presence of significant additional injuries), mechanism of injury, psychosocial factors (drug or alcohol intoxication), and the results of neuroimaging.

Follow-up assessments were completed 3 months after the initial assessment. The presence, nature, and extent of postconcussive symptoms were obtained either via patient self-report or by proxy respondent by use of the Rivermead Post Concussion Symptoms Questionnaire (RPQ), which was administered over the telephone by interviewers who were blinded to the initial emergency department assessment. The RPQ is a 16-question survey that asks patients to rank the significance of their symptoms compared with pre-morbid status on a 5-point Likert scale. This scale has been validated previously in mild brain-injured patients and has been shown to be reliable in rating a total PCSx score [45,46]. Oftentimes the individual symptoms will vary, but the initial study done by King et al [45] showed that the “general level of subjective experience [was] unchanged.” They concluded that the total score is sufficiently reliable as a general indication of severity. A subsequent study [47] of the psychometric properties of the RPQ demonstrated that 3 items— headaches, dizziness and nausea—form a cluster empirically distinct from the rest of the items and represent “early” symptoms, whereas the other 13 items represent “late” PCSx. Thus, the RPQ score was analyzed as a total score in primary analyses but also as RPQ-3 and RPQ-13 subscales in secondary analyses.

The patients considered for inclusion in the present study were the subset of NIH registry patients who reported their mechanism of injury involved a sport and who did not report intentions to file a law suit as a result of their injury. The latter were excluded to eliminate bias caused by potentially inflated, litigation-driven reports of PCSx. In their initial assessment, subjects chose from a list of 36 sport types or entered an “other sport” response. Because of the relatively large number of sport types and relatively rare frequencies of participation in many sports, the sport types were grouped into a number of logical yes/no categories, reflecting salient characteristics of the sports: contact and noncontact, high velocity and non-high velocity, helmet required and no helmet requirement, added height and no added height, team sport and nonteam sport, and projectiles and no projectiles. For instance, ice hockey would qualify as a contact, helmeted, and projectile sport. This served the purpose of examining potential injury mechanisms that transcend specific sports (ie, contact), while allowing for the fact that multiple hazards could be associated with any given sport (ie, physical contact and flung projectiles, both hazards of ice hockey). Details on the wide range of specific sports reported by the sample are briefly described in the Appendix; complete lists aggregating the specific sports into types, or categories of sport, are too lengthy to list here and may be obtained from the authors upon request.

STATISTICAL ANALYSIS

The dependent variable was the RPQ score. Because the distribution was severely skewed, it could not be analyzed as a continuous variable, but response frequencies permitted preservation of ordinal score categories of 0, 1–5, 6–14, and 14. Proportional odds models [48] were used to examine whether female gender conferred risk for greater scores. These models estimate the odds of a greater score, averaging across all cut points (ie, 0 vs. 0; 5 or less vs. 5; 14 or less vs. 14), and thus provide a summary measure of risk for an elevated RPQ score. When proportional odds assumptions (ie, that the odds of being in a worse category were relatively equal across each cut point) were not met, partial proportional odds models were used, which permitted the odds of a worse score for female subjects to vary over each cut point.

Before examining minors and adults separately in stratified analyses, the authors first examined whether the risk associated with female gender varied across age group by fitting a model in the entire sample including female gender (coded 1, against a reference category of male), age, and an interaction term between these 2 variables. Age was treated as both binary (adult vs. minor) and continuous to examine the possibility of both linear and nonlinear (ie, threshold) interactions. The risk associated with gender in adults (18 years of age or older) and minors (17 years of age or younger) was examined separately because adults are legally responsible for their own decisions about medical treatment, whereas a minor's treatment decisions are in the hands of their guardians. This difference could affect both initial and follow-up care. In addition, medical care for the 2 groups often is divided between adult and pediatric emergency departments, as was the case in the current cohort.

Then, unadjusted models examining the association of female gender were fit with RPQ scores in each age group. To examine whether any observed risk for greater RPQ scores associated with female gender could be explained by self versus proxy report, previous loss of consciousness or emergency department visit for head injury, or sport type, the authors then used standard criteria to assess confounding [49,50]. If candidate factors were associated with both gender (using χ^2 and t tests, $P < .20$) and RPQ scores (using proportional odds models, $P < .20$), they were treated as potential confounders and entered into a multivariate model in each age stratum to obtain adjusted risk estimates for female gender.

Sensitivity analyses examined the robustness of the gender effect across different RPQ scores cut points shifted up (0, 1–5, 6–15, ≤16) and down (0, 1–4, 5–11, ≤12), and across covariate adjustment selected by a stepwise approach (P for entry < .20). Secondary analyses examined each study hypothesis with the RPQ-13 and RPQ-3 as outcomes.

RESULTS

In total, 260 patients were admitted during the study period with a primary sporting injury. Of these, 33 could not be reached at 3-month follow-up (87% follow-up rate), 4 reported that they were intending to or in the process of filing a law suit and were excluded, and 8 lacked data on one or more variables of interest, leaving 215 eligible for analysis. These individuals did not differ from baseline sports injury admissions with respect to age, gender, previous history of loss of consciousness or emergency department visit for head injury, or any of the sport types. Descriptive statistics for the sample stratified by adults (n = 78) and minors (n = 137) are presented in Table 1.

Initial analyses in the overall sample revealed a significant interaction ($P = .014$) indicating that the effect of gender on RPQ score differed between minors and adults. When age was treated as a continuous variable, the interaction was not significant, meaning that the risk associated with female gender did not increase in linear fashion with each year of age. Shifting the age cut point above or below the adult/minor demarcation yielded interactions of diminishing magnitude, indicating a relatively clear age threshold (18 +), above which female gender conferred risk for greater RPQ scores. The unadjusted estimate, listed in Table 2, shows that adult women were at approximately 2.89 (95% confidence interval [95% CI] = 1.25–6.71, $P = .013$) times greater risk for greater RPQ scores. In minors, gender was unassociated with RPQ scores.

Only age met criteria for potential residual confounding among adults: women (mean age 37 years) were older than men (mean age 30 years) ($P = .02$), and age was associated with increased risk of greater RPQ scores ($P = .001$). However, as Table 2 shows, adjustment for age in adults did not appreciably diminish the risk associated with female gender in adults. In minors, several potential confounders were identified: self (rather than proxy) report was more likely in female subjects ($P = .195$), and a history of loss of consciousness ($P = .012$) and emergency department visit for head injury ($P = .172$) was more likely in male subjects. Each of these factors was also associated with greater RPQ scores (self report, $P = .037$; history of loss of consciousness, $P = .013$; previous emergency department visit for head injury, $P = .041$). However, adjustment for these factors revealed no gender effect in minors (Table 2).

Several symptoms assessed by the RPQ were more common in adult female patients. Age-adjusted logistic regressions were performed examining elevated female risk for any problems versus no problems, first in adults then in minors. Adult female subjects appear to have elevated risk for specific symptoms of headache (95% CI = 1.6–12.4, $P = .004$), dizziness (95% CI = 0.99–7.87, $P = .051$), fatigue (95% CI = 1.03–7.41, $P = .043$), irritability (95% CI = 1.03–7.69, $P = .043$), and concentration problems (95% CI = 1.06–8.39, $P = .036$) at 3 months after sport-related mTBI. No such gender difference was evident at all in symptoms among minors. These findings are consistent with the overall findings of elevated female risk for overall RPQ, RPQ-13 and RPQ-3 in adults, but not in minors (Table 3).

Although adult females were less likely than expected to receive mTBIs in contact, helmeted, team, and projectile sports and more likely to be injured in added height and high-velocity sports (P values from .002 to .022), none of these sports characteristics were associated with greater risk for greater RPQ scores at 3 months (P values all .20). Adjustment for sport characteristics alone or in combination did not diminish the gender effect. In minors, gender differences in sport type of injury were identical to the pattern observed for adults (P values from < .001 to .152, with the exception that there were no gender differences in injury by high-velocity sports), and no sport characteristics were associated with risk for greater RPQ scores (*P* values .20). Because the sport characteristics exerted no confounding influence, they were not included in final models. Figure 1 illustrates the differential risk for greater RPQ scores associated with gender in each age strata, adjusted for empirically identified confounders.

Sensitivity analyses shifting the RPQ cut points up and down revealed similar effects for female gender. Stepwise covariate selection produced very similar adjusted models: self-report and history of loss of consciousness were included as covariates for minors, whereas in adults, no covariates met entry criteria; in both cases, risk estimates for female gender were similar or identical to those reported in Table 2. A model adjusting for all possible covariates also yielded a significant gender effect (odds ratio = 3.77; 95% CI = 1.40–10.16, $P = .009$). Secondary analyses of the proposed subscales RPQ-13 (late symptoms; ordinal levels of 0, 1–5, 6+, based on distribution) and RPQ-3 (early symptom; ordinal levels of 0, 1–2, 3+ based on distributions) are presented in Table 2. A pattern of gender effects very similar to those found for the overall RPQ scale prevailed.

DISCUSSSION

Motivated by the dearth of literature on gender differences in PCSx in the context of sport-related injury, the authors investigated whether gender constituted a significant risk for elevated PCSx at 3 months after a sport-related mTBI. These findings indicate that female subjects are at increased risk for PCSx in adulthood (18 years of age and older) as compared with male subjects; this increased risk cannot be explained by age as a continuous variable (eg, risk did not increase in a linear fashion with each year of age), source of symptom reporting (self rather than proxy report), previous head injury or loss of consciousness, or sport characteristics.

The data indicate an elevated risk exists for certain symptoms assessed by the RPQ in women; no such gender differences were evident in minors. Specifically, women appear to have elevated risk for symptoms of headache, dizziness, fatigue, irritability, and concentration problems at 3 months after sport-related mTBI. These findings are consistent with data in concussed female athletes showing more self-reported symptoms after injury, including concentration, fatigue, lightheadedness, and seeing flyspecks [20]. These female athletes experienced more objective and subjective adverse effects of mTBI, even after adjusting for wearing protective headgear [20].

These results demonstrated an increased risk of greater RPQ scores in women after a sport-related mTBI, which suggests that both age and gender affect this particular outcome. With respect to age, children and adolescents appear to have greater potential for neuroplasticity and thus potentially greater recovery after mTBI [33–36]. Thus, an intrinsic mechanism of recovery on the physiologic level may be responsible for differential recovery from mTBI in children as compared with adults. Perhaps there is also an extrinsic factor related to recovery after mTBI. Older age has been shown to be a significant factor for lack of follow-up medical care in patients with TBI [51]. Adult women, in particular, often occupy multiple personal and professional roles that involve the care of others and as a result sometimes neglect their own health care [52]. Although the authors know of no data on this point, perhaps minors are more likely than adults to pursue and receive follow-up medical care after mTBI because parents or guardians are responsible for their care. There is little evidence to date that explores this topic; however, it is a hypothesis the authors find plausible and worthy of further investigation to delineate the importance of such extrinsic factors on recovery after mTBI in adults and children.

With respect to gender, there is evidence that collegiate female soccer players have the greatest number and rate of concussions (as defined by the American Academy of Neurology grading criteria [39]) and that female lacrosse players have the greatest inherent risk of sustaining a concussion during a game [22]. In addition to increased incidence of injury, several studies of nonsporting brain injury have demonstrated poor outcomes, ie, greater risk of PCSx, in female subjects [16–19]. In studies of neuropsychological outcomes after sport-related brain injury, 3 days after a concussion female collegiate athletes performed significantly worse on visual memory scores compared with baseline measurements than their male counterparts [21] and showed a more severe decline on measures of simple and complex reaction times with respect to baseline levels [20]. Thus, these results are consistent with several studies indicating worse outcomes, neuropsychological, etc, in female subjects after sport-related mTBI.

One notable inconsistency in the literature with respect to the current findings regarding gender effects on sport-related mTBI outcome, is a study of prognosis using the IMPACT database of TBI [53], which found clear age differences in the incidence of TBI in younger patients (<65 years); gender, however, was not related to outcome as measured by the Glasgow Outcome Scale. This database included moderate and severe TBI patients pooled from 8 randomized controlled trials and 3 observational studies and included few children (the data were analyzed for patients older than 14 years). Thus, the comparison of these results to the current findings is notable but not entirely equivalent. However, that study did find that age was strongly related to moderate to severe TBI outcome, as is demonstrated by the current findings in mild TBI, although it was a continuous relationship with no significant threshold value [53].

The findings of this current study must be considered in light of both study strengths and limitations. Strengths of this study were a longitudinal design with an excellent follow-up rate, the use of a validated and “industry-standard” PCSx questionnaire, and careful examination of gender effects in both adult and minor subsamples. This study, the first, of which the authors are aware at the time of writing, to examine gender differences in PCSx specifically within the context of sport-related mTBI patients.

As far as limitations, the study sample was limited to a specific regional medical center, which makes generalization to other regions and more specific patient populations uncertain, and the authors were limited to a 3-month follow-up period, so it is unknown whether gender differences eventually diminish or increase beyond that time. Additionally, there were a low number of adult females spread out across multiple sports; therefore, it is possible there was not enough power to detect significance. Control for reporting bias was crude in that the authors only had available data on source of reports. Within the self-reported group, some may be more accurate and others less so; however, the same is true of proxy reporters.

Every attempt was made to control for premorbid and other factors that could influence PCSx and recovery, such as previous head injury, previous loss of consciousness, and litigation. In particular, patients with chronic pain not related to a head injury report similar symptomatology to those with mTBI, including disturbed sleep, fatigue, and irritability [54]; this premorbid condition was not included in the demographic data collection of the NIH mTBI registry and could possibly confound the results. Chronic pain is a significant health issue worldwide, the third-largest health problem according to the NIH in 1982 [55]. Although the authors cannot be entirely certain, it would seem less likely that the type of physically active patients in this sample would also have chronic pain. More recent evidence cited by the NIH suggests, too, that women recover from and seek help for their pain more quickly than men [56]. Future studies would need to control for such preinjury conditions to clearly establish the role of these issues in mTBI outcomes.

Although a few studies have recently been published, there remains a significant knowledge gap regarding gender differential outcome after a sport-related mTBI. Future studies need to prospectively address mTBI outcomes in a wide age-range sample focused on sport-related mTBI to examine whether recent (including the current) findings regarding gender influences on outcome hold true in a more generalizable population. The outcomes to be studied would logically include neuropsychological domains, including attention, concentration and memory, and clinical symptom measurements and would be best evaluated compared with preinjury testing values. Baseline measurements would be difficult to obtain in the general population, although with the increasing abundance of adult recreational sport organizations in addition to the collegiate athlete population, it could be feasible to study a wider range of patients in this manner. To clarify the effect of gender on sport-related mTBI outcomes, future studies may also address hormonal influences via laboratory measurements at time of injury and during the recovery period and use expanding technology such as functional magnetic resonance imaging to identify functional brain differences between female and male subjects that may account for differential recovery.

From a public health perspective, adult women appear to represent a greater risk population toward whom prevention efforts involving sports safety precautions might be devoted. Up to one-quarter of all mTBIs in the United States are thought to be the result of sports and recreational activities. Because the time and location of sporting events is typically known in advance, mTBIs caused by sports are potentially more preventable than mTBIs caused by other mechanisms. Efforts not only to understand the factors that lead to sport-related mTBIs but that contribute to poor outcomes once mTBI occurs could help inform these prevention programs.

CONCLUSION

The current findings present evidence demonstrating that, compared to male subjects, female subjects may be at increased risk for PCSx in adulthood but not as minors. This increased risk was not explained by self report, rather than proxy report, previous head injury or loss of consciousness, age, or characteristics of the sport of initial mTBI. These findings concur with several reports in the literature of elevated risk of mTBI sequelae in women and highlight the need for greater awareness of this risk among physicians who evaluate and treat these patients. Rehabilitation specialists are in a unique position to have an enormous impact on the diagnosis and treatment of mTBI patients. Further research is needed to illuminate risk factors for prolonged recovery and resultant functional impairments and more thoroughly evaluate the basis for why adult women may be at elevated risk for PCSx. Such research would be invaluable to inform targeted preventive and intervention strategies.

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APPENDIX

Classification of Sport Characteristics

Observed frequencies of sports injuries in 215 patients

Sporting Injury	Frequency	Sporting Injury	Frequency
Ice hockey	10	Cheerleading	6
Wrestling	1	Snow sledding	17
Basketball	17	Rollerblading	6
Baseball	15	Snow skiing	13
Football	25	Snowmobiling	2
Rugby	1	Horseback riding	20
Soccer	23	Snow boarding	10

Sporting Injury	Frequency	Sporting Injury	Frequency
Field Hockey	1	Skate boarding	5
Softball	1	Scooter	3
Lacrosse	5	Golfing	2
Auto racing	3	Golf cart	2
Playground	1	Kickball	1
Swimming	4	Mountain biking	2
Ice skating	5	Go-cart	1
Volleyball	2	Bull riding	1
Diving	2	Motorcycle racing	1
Running bungee	1	Tubing	1
Running in gym	1	ATV 4 wheeler	1

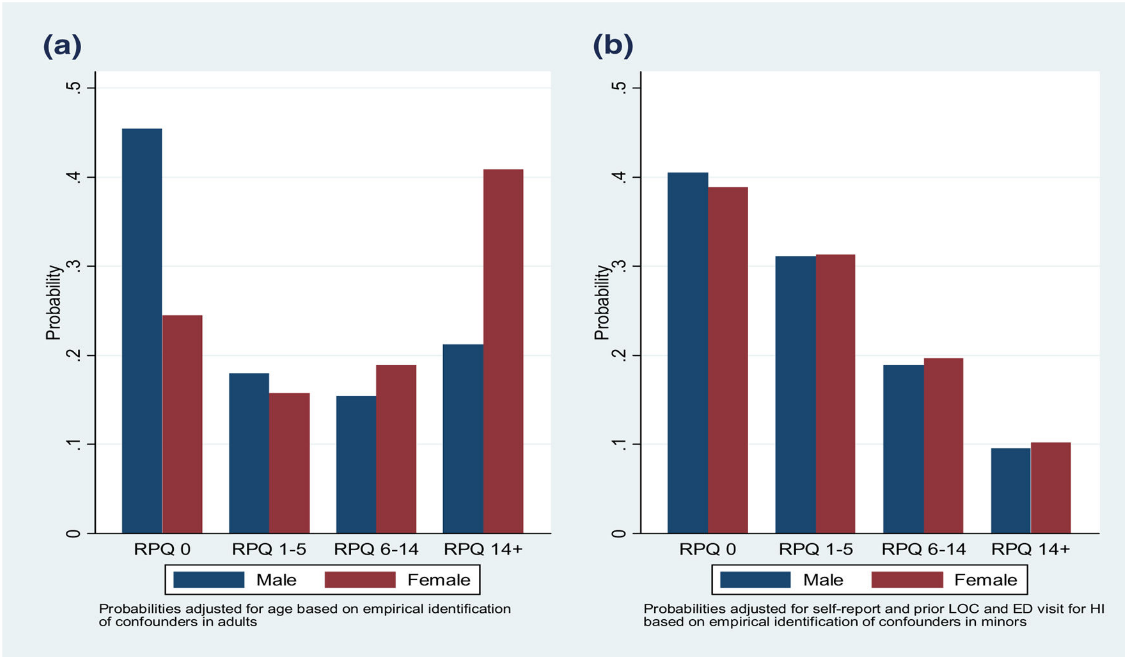

Figure 1.

Probabilities of progressively worse RPQ scores by gender in adults and minors. (**a**) Gender differential probabilities of progressively worse RPQ scores in adults. (**b**) Gender differential probabilities of progressively worse RPQ scores in minors.

Table 1

Descriptive statistics

	Adult (n = 78)				Minor (n = 137)			
	Male		Female		Male		Female	
	N or Mean	% or SD (min–max)	N or Mean	% or SD (min–max)	N or Mean	% or SD (min–max)	N or Mean	% or SD (min–max)
Demographics								
N	47	60%	31	40%	97	29%	40	71%
Caucasian*	40	91%	28	97%	88	87%	33	92%
Age (years)	36.9	13.3 (18–59)	30.1	12 (18–56)	13.1	2.7 (7–17)	13.1	3.0 (4–17)
Sport classifications†								
Contact	25	53%	6	19%	58	60%	13	33%
Helmeted	12	25%	1	3%	36	37%	2	5%
High velocity	21	45%	22	71%	44	45%	18	45%
Team	25	53%	7	23%	59	61%	19	48%
Added height	13	28%	17	55%	25	26%	20	50%
Projectile	27	57%	7	23%	62	64%	13	33%
Other factors								
Self report	40	85%	28	90%	30	31%	17	43%
History of LOC	12	25%	10	32%	26	27%	3	8%
History of ED visit for HI	12	25%	12	38%	19	20%	4	10%
RPQ scores								
Total score								
0	23	49%	6	20%	39	40%	17	43%
1–5	6	13%	7	23%	29	30%	11	28%
6–13	8	17%	5	16%	16	17%	10	25%
≥14	10	21%	13	42%	13	13%	2	5%

ED = emergency department; HI = head injury; LOC = loss of consciousness.

*Out of 29 female and 44 male adults and 38 female and 96 male minors providing race/ethnicity data.

†Sport classifications not mutually exclusive, for instance, lacrosse qualifies as a contact, team, helmeted, and projectile sport. Percentages refer to percentage of each age/gender group (eg, first column, adult males) participating in each sport or possessing a given characteristic or RPQ score.

Table 2

Unadjusted and adjusted risk of greater RPQ scores for female adults and minors

	Adults Unadjusted		Adults Adjusted		Minors Unadjusted		Minors Adjusted	
	OR [95% CI]	***P* Value**	**OR [95% CI]**	***P* Value**	**OR [95% CI]**	***P* Value**	**OR [95% CI]**	***P* Value**
Overall RPQ scores								
Female	2.89 [1.25–6.71]	.013*	2.57 [1.09–6.08]	.031*	0.87 [0.45–1.71]	.695	1.07 [.52–2.19]	.852
Age (years)			1.02 [0.99–1.06]	.172				
Self report							1.95 [.99–3.84]	.052
Previous LOC							2.38 [1.05–5.41]	.038*
Previous ED visit for HI							1.40 [.60–3.27]	.439
RPQ-13 Scores								
Female	2.85 [1.16–6.97]	.022*	2.54 [1.01–6.38]	.047*	1.11 [0.55–2.26]	.766	1.26 [.59–2.69]	.544
Age (years)			1.02 [0.98–1.06]	.287				
Self report							2.02 [.98–4.17]	.057
Previous LOC							2.56 [1.06–6.17]	.036*
Previous ED visit for HI							1.22 [.47–3.19]	.678
RPQ-3 scores								
Female	3.57 [1.48–8.62]	.005**	2.97 [1.19–7.41]	.019*	.94 [.46–1.91]	.855	1.01 [.48–2.15]	.967
Age (years)			1.02 [.98–1.06]	.317				
Helmeted sport			0.53 [.14–2.00]	.352				
Self report							1.89 [.94–3.79]	.073
Previous LOC							1.47 [.62–3.48]	.377
Previous ED visit for HI							1.65 [.68–4.01]	.264

Proportional odds models.

* $P < .05$,

** $P < .01$, Adjustment based on empirically identified confounders.

Abbreviations are as in Table 1.

Table 3

Risk for specific PCSx in female adults and minors at 3-month follow-up

	Female Adults		**Female Minors**	
Symptom	**OR, 95% CI**	***P* Value**	**OR, 95% CI**	***P* Value**
Headaches	**4.45, 1.6–12.4**	**.004**	1.06, .50–2.24	.885
Dizziness	**2.80, .99–7.87**	**.051**	.58, .20–1.72	.331
Nausea	1.06, .34–3.4	.911	*	
Noise sensitivity	1.43, .52–3.97	.49	.63, .17–2.4	.504
Sleep disturbance	1.0, .35–2.86	.993	.79, .24–2.62	.701
Fatigue	**2.78, 1.03–7.41**	**.043**	.96, .41–2.24	.926
Irritability	**2.82, 1.03–7.69**	**.043**	.96, .41–2.24	.132
Depression	1.19, .41–3.52	.747	.53, .14–1.96	.338
Frustration	1.59, .57–4.43	.38	.50, .18–1.35	.174
Poor Memory	1.82, .66–5.03	.251	.42, .13–1.35	.147
Concentration problems	**2.98, 1.06–8.39**	**.036**	.55, .19–1.60	.272
Longer to think	2.54, .90–7.19	.078	.52, .14–1.95	.337
Blurred vision	1.02, .35–3.01	.972	.41, .09–1.95	.264
Light sensitivity	1.65, .52–5.23	.394	.88, .26–2.98	.836
Double vision	.68, .18–2.64	.578	*	
Restlessness	1.22, .36–4.14	.747	.31, .07–1.44	.136

Results from binary logistic regression predicting report of symptom at any level of severity versus symptom not present. OR, 95% CI = odds ratio, 95% confidence interval for females compared to males. All analyses age-adjusted.

Items in bold indicate significance.

*No female minors reported nausea or double vision.