
Research Submission

A Survey of Neurologists on Postconcussion Syndrome

Randolph W. Evans, MD; Kamalika Ghosh, PhD

Background and Objectives.—Postconcussion syndrome (PCS) has been controversial for more than 150 years. As there have not been any surveys of PCS among neurologists in the United States since 1992, another was performed using most of the prior items to assess current opinions and practices and whether there have been any changes since 1992.

Methods.—Two hundred and eighty-nine neurologists attending the Texas Neurological Society 20th Annual Winter Conference continuing medical education meeting in 2017 were supplied the survey instrument with registration materials. The 25 item instrument (including 7 new items) contained items on demographics, definitions, causation, prognosis, medico-legal aspects, testing, and treatment. Forty percent of attendees completed the survey.

Results.—The majority of respondents agree with the following: PCS is a clearly defined syndrome with a solid basis for determining prognosis with an organic basis; accept the authenticity of patients' reports of symptoms; effective treatment is available for headaches lasting 3 months or more; headaches persist in over 20% 1 year after injury; and cognitive rehabilitation is effective. The majority of the respondents do not agree with the following: symptoms improve in a relatively short period of time and quickly resolve once litigation is settled; effective treatment is available for PCS; and return to play guidelines are strongly evidence based. One year after injury, 68.4% disagree with the following: I would support my son or grandson (or if you do not have one, relative's or friend's) playing football.

Conclusions.—There has been growing acceptance of the organicity of PCS among neurologists in the last 25 years. There is significant concern over the long-term sequelae of concussion as most respondents would not recommend that their son or grandson play football.

Key words: postconcussion, neurologists, survey

(*Headache* 2018;00:00-00)

INTRODUCTION

Concussion is a clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, that may or may not involve loss of consciousness.¹ The following symptoms and signs are associated with postconcussion syndrome (PCS), which develops in more than 50% of patients who have mild head injuries:

headaches, dizziness, vertigo, tinnitus, hearing loss, blurred vision, diplopia, convergence insufficiency, light and noise sensitivity, diminished taste and smell, irritability, anxiety, depression, personality change, fatigue, sleep disturbance, decreased libido, decreased appetite, posttraumatic stress disorder, memory dysfunction, impaired concentration and attention, slowing of reaction time, and slowing of information processing speed.^{2,3}

PCS has been controversial for more than 150 years.⁴ In one of the first uses of the term in 1934, Strauss and Savitsky's concluded: "In our opinion, the subjective post-traumatic syndrome, characterized by headache, dizziness, inordinate fatigue on

From the Department of Neurology, Baylor College of Medicine, Houston, TX, USA (R.W. Evans); Department of Psychology, Rice University, Houston, TX, USA (K. Ghosh).

Address all correspondence to R.W. Evans, Department of Neurology, Baylor College of Medicine, 1200 Binz #1370, Houston, TX 77004, USA, email: revansmd@gmail.com

Accepted for publication December 1, 2017.

Conflict of Interest: None.

effort, intolerance to intoxicants and vasomotor instability, is organic and is dependent on a disturbance in intracranial equilibrium due directly to the blow on the head. We suggest the term “postconcussion syndrome” for this symptom complex.”⁵

Summarizing the viewpoint that PCS was a compensation neurosis, in 1961 Miller stated, “The most consistent clinical feature is the subject’s unshakable conviction of unfitness for work.”⁶ In 1962, Symonds took an equally strong opposing viewpoint: “It is, I think, questionable whether the effects of concussion, however slight, are ever completely reversible.”⁷

Evans and colleagues performed a survey among neurologists in the United States in 1992 (published in 1994) finding that 25% believed that prolonged postconcussion symptoms were likely psychogenic in origin rather than due to any true pathology and 35% agreed that effective treatment of PCS was available.⁸ A survey using the same instrument was performed among Greek neurologists.⁹

Little is known about whether the attitudes and beliefs about PCS have changed among US neurologists in the 25 years since,⁹ although there has been a dramatic increase in interest in PCS among neurologists and the public with studies of athletes and soldiers.¹⁰ In two other surveys, respondents were asked to respond to the following statement using a 5-point Likert scale (from 1, strongly disagree to 5, strongly agree): “I like to treat this disease or disorder [PCS].” The mean response of Texas neurologists¹¹ and members of the American Headache Society¹² (91.6% neurologists) were the following, respectively: 3.17 and 3.66.

METHODS

Sampling and Response Rate.—Two hundred and ninety-eight neurologists who attended the Texas Neurological Society 20th Annual Winter Conference continuing education meeting from February 24 to February 26, 2017 in Austin, Texas, were presented with the survey instrument with the registration materials. There was no compensation for completing the survey. Completed instruments were submitted at the end of the meeting. The overall response rate was 40.27% (N = 120).

The Survey Questionnaire.—The 25 question survey instrument consisted of 11 items from the Evans et al 1992 survey⁷ and seven new items (in Table 2, new items are presented in italics). Among the survey questions, four questions were on demographics. Nondemographic questions were answered using a 5-point Likert scale (1, strongly agree; 2, disagree; 3, neutral/no opinion; 4, agree; and 5, strongly agree).

Sources of Error and Biases.—Many respondents did not complete the second page of the survey, which contains items 15 to 25 on the back side of this one-page questionnaire. Incomplete responses were treated as missing data without statistical imputation because of the content of the items.

RESULTS

Demographics.—The demographic characteristics of the respondents are summarized in Table 1 including 37 (30.8%) female and 68 (56.7%) male. Fifteen respondents did not specify their gender, 19 did not indicate their age, and 16 did not indicate their number of years in practice. The mean age of respondents is 56.07 years (SD = 12.39). The mean years in practice is 22.81 (SD = 12.59).

Definitions, Causation of Symptoms, and Treatment.—Table 2 presents current and 1992 survey responses on items including definition, causation of symptoms, and treatment of PCS. There is increasing acceptance of PCS. Fewer current respondents believe that effective treatment for PCS as compared to 1992.

Asked to rank as 1-2-3, from most to least important, which factors were responsible for PCS symptoms, the order most commonly given was the following: 1, organic; 2, emotional; and 3 compensation (litigation). This item was not used in the 1992 survey.

Testing.—Asked to rank as 1-2-3, from most to least important, what motivates you to order a scan of the brain in the typical patient with PCS, the order most commonly given was the following: 1, rule out subdural hematoma; 2, reassure patient; and 3, litigation concerns. In the 1992 survey, ruling out subdural hematoma was the first choice of 75%.

Table 1.—Demographics (N = 120)

<i>Age</i>	
<30	1.6%
31-40	9.9%
41-50	15.7%
51-60	23.4%
>60	33.3%
<i>Gender</i>	
Male	56.7%
Female	30.8%
<i>Years in practice</i>	
<5	5.9%
5-10	12.6%
11-20	25.8%
21-30	19.1%
31-40	17.5%
>41	5.6%
<i>Subspecialty</i>	
General neurology	15.83%
Psychiatry	0.83%
Electrophysiology	0.83%
Pediatric neurology	3.33%
Neurohospitalist	0.83%
Sleep medicine	0.83%
Neurophysiology	2.5%
Epilepsy	6.67%
Headache medicine	5.83%
Neurocritical care	0.83%
Multiple sclerosis	0.83%
Disorder of spine	0.83%
Traumatic brain injury (TBI)	1.67%
Attention deficit disorder (ADD)	0.83%
Sleep	3.33%
Neuromuscular	3.33%
Neuro-ophthalmology	0.83%
Movement disorder	3.33%
Stroke	0.83%

In some of the items, the cumulative total percentage may not add up to 100% because of missing response.

Prognosis.—Table 3 reports the prognosis of PCS. The median recovery time of PCS patients is less than 3 months, which is faster than the median 1992 response of 3-6 months. The median percentage of PCS patients reporting headache has increased from 11-20% in 1992 to 21-30%.

Table 4 presents medico-legal aspects. Most neurologists give no depositions. Most neurologists see 25% or less of their overall patients for pending litigation or for sports injuries.

DISCUSSION

There were 120 respondents for a response rate of 40%, which is similar to other physician surveys.^{11,13,14}

Our response rate may have been higher as 24 of the meeting registrants were speakers, many of whom gave their presentations and immediately left perhaps without looking through the meeting materials. This study may have limited generalizability because this is a convenience sample of self-selected Texas neurologists and we have no information on nonrespondents.

Respondents disagree with the statement, “Loss of consciousness has to occur for a PCS to develop.” This is in agreement with the American Academy of Neurology definition, “Concussion is recognized as a clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve loss of consciousness.”¹¹ Using an alteration of mental state at the time of the injury such as dazed, disoriented, or confused can in some cases result in overdiagnosis as the circumstances of the injury can cause similar symptoms.¹⁵ There are broader definitions of concussion by the Centers for Disease Control¹⁶ and the 4th International Conference on Concussion in Sport,¹⁷ which may also lead to overdiagnosis.¹⁸ The lowest threshold to diagnose concussion is not certain.¹⁹

In the 1992 and 2017 surveys, 23.6% and 31.7% of respondents agree that, “PCS is a clearly defined syndrome with a solid basis for determining prognosis.” These opinions reflect that the symptoms of PCS are common base rate²⁰ and posttraumatic stress disorder complaints,²¹ and are a grab bag of symptoms with different pathophysiologies that are incompletely understood.²²

In the 1992 and 2017 surveys, respectively, 63.5% and 34.2% of respondents agree that, “Most physicians tend to question the authenticity of patients’ reports of symptoms with PCS,” and 16.5% and 10.9%, respectively, agree that, “I personally tend to question the authenticity of patients’ reports of symptoms with PCS.” There appears to be growing acceptance of PCS.

Only 10.9% of respondents agree that, “Prolonged symptoms are more likely to be psychogenic in origin than due to any true pathology for patients with PCS” compared to 52.4% in 1992. The 2017 respondents also reported that organic factors were the most important for PCS symptoms. This

Table 2.—Neurologists' Responses to Items About Definition, Causation of Symptoms, and Treatment of Postconcussion Syndrome

	% Strongly Disagree	% Disagree	% Neutral/No Opinion	% Agree	% Strongly Agree	% Agreement (Agree + Strongly Agree) 2017	% Agreement 1992 ⁸
<i>Loss of consciousness has to occur for a postconcussion syndrome (PCS) to develop</i>	77.5	13.3	3.3	5	0.8	5.8	
PCS is a clearly defined syndrome with a solid basis for determining prognosis	14.2	34.2	20	22.5	9.2	31.7	23.6
Most physicians tend to question the authenticity of patients' reports of symptoms with PCS	3.3	26.7	35.8	30	4.2	34.2	63.5
I personally tend to question the authenticity of patients' reports of symptoms with PCS	29.2	43.3	16.7	6.7	4.2	10.9	16.5
Prolonged symptoms are more likely to be psychogenic in origin than due to any true pathology for patients with PCS	32.8	37.8	18.5	9.2	1.7	10.9	24.7
Movie or television portrayals of head injuries, which may minimize their effects or present them in a humorous fashion, may affect the public's perceptions of the effects of head injury	3.3	5.8	12.5	32.5	45	77.5	60
<i>Most physicians believe that PCS symptoms improve in a relatively short period of time</i>	5.8	18.5	25.2	38.7	11.8	50.5	
<i>I personally believe that PCS symptoms improve in a relatively short period of time</i>	31.7	29.2	15	16.7	7.5	24.2	
Once litigation is settled, symptoms quickly resolve in patients with PCS	27.7	29.4	27.7	12.6	2.5	15.1	23.6
Effective treatment is available for PCS	18.5	37	19.3	23.5	1.7	25.2	35.3
<i>Effective treatment is available for headaches lasting 3 months or more</i>	1.7	19.3	21.8	44.5	12.6	57.1	
<i>Cognitive rehabilitation is effective for PCS</i>	0.8	13.3	27.5	44.2	12.5	56.7	
<i>Return to play guidelines after concussion are strongly evidence based</i>	9.2	35	27.5	21.7	6.7	28.4	
<i>I would support my son or grandson (or if you do not have one, relative's or friend's) playing football</i>	46.7	21.7	15	12.5	2.5	15	

Items in italics were not included in Evans et al.⁸

Table 3.—Prognosis of Postconcussion Syndrome (PCS) Patients

	<3 Months (%)	3-6 Months (%)	7-12 Months (%)	>1 Year (%)	Median 2017	Median 1992			
Approximately how long does it take for most patients to recover from PCS?	21.7	40	10.8	13.3	<3 months	3-6 months			
One year after injury, what percentage of patients report headache as part of PCS?	0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	>60%	Median 2017	Median 1992
	14.2	25	20	10	6.7	7.5	5.8	21-30%	11-20%

In some of the items, the cumulative total percentage may not add up to 100% because of missing responses.

may reflect the increasing evidence for organicity in civilians, athletes, and soldiers.²³

In 1992 and 2017, respectively, 60% and 77.5% of respondents agree that “Movie or television portrayals of head injuries which may minimize their effects or present them in a humorous fashion may affect the public’s perceptions of the effects of head injury.” Evans described the “Hollywood Head Injury Myth”²⁴ where the public may underestimate the effects of the depiction of seemingly serious head injury resulting in only a grunt, a grimace, a

few bruises, and a bandage on the forehead which, in real life, would result in significant impairment or death. The infliction of head injuries is also a source of levity in slapstick comedies and cartoons.

Similar to 1992, 2017 respondents reported being primarily motivated to order a scan of the brain to rule out a subdural hematoma although substantial minorities of respondents wanted to reassure patients or had litigation concerns. A systemic literature review estimated a prevalence of CT abnormalities of 5% among those presenting to

Table 4.—Medico-Legal Aspects of Postconcussion Syndrome (PCS)

	0%	1-25%	26-50%	51-75%
Approximately what percentage of your patients do you evaluate for PCS only because of pending litigation (independent medical examinations, insurance company, defense, or plaintiff referrals)?	39.1	26.5	1.6	1.7
	0-25%	26-50%	51-75%	76-100%
Approximately what percentage of your patients do you evaluate for PCS due to sports injuries?	49.1	12.5	4.1	8.3
How many depositions do you give per year about patients with PCS?	0	1	3	12
	86	6	2	1

In all of the items, the cumulative total percentage may not add up to 100% because of missing response.

Table 5.—Selected Comments of Respondents

<p>“The attitude and behavior of the owners and coaches in NFL is criminal and negligent. I think boxers should be required to use effective head gear and 16 oz gloves. Too bad if these safeguards result in less viewership. I don’t think kids (or anyone, really) should play tackle football”</p> <p>“Several questions above highly patient dependent. Emotional, post-traumatic symptoms are frequent major player but are important to address to help patient recover”</p> <p>“It has been an important change that most coaches (not just football) are more aware. There is apparently a significant lag in women’s sports. At high school level soccer and basketball, girls are at significant risk. For five years in a small town, for every boy with concussion, there were 2 girls with sports related concussion, and their coaches were unaware of PCS risks”</p> <p>“I suffered one myself in 1977. I was in neuro residency at the time. Secondary to MVC. No LOC. Duration was about 3-4 months. A long time ago, but I do recall reiterating aloud over and over, ‘This is just not me’. I had decreased working memory, mood swings, fatigue. No headache”</p> <p>“Need more evidence based practice guidelines”</p> <p>“Kids should not be playing football”</p> <p>“We are in the infancy in understanding traumatic brain injury”</p>

a hospital with a Glasgow Coma Scale (GCS) score of 15 and 30% or higher for those presenting with a GCS score of 13.²⁵ In a large prospective Canadian study, the incidence of abnormalities resulting in neurosurgical intervention was 1.5% in the cohort of 2707 adults with mild TBI (GCS, 13-15) and 0.4% in a subgroup of 1822 adults with a GCS of 15.²⁶

Fifty-one percent agree that most physicians and 24% personally believe that PCS symptoms improve in a relatively short period of time with 61.7% concurring with within 6 months. Cognitive deficits associated with mild TBI resolve fully within 3-6 months in about 80-85% and about 15% have persistent deficits²⁷ (although some studies suggest a lower rate of recovery²⁸).

One year after injury, 59.2% of respondents believe that headaches persist in 30% or fewer patients. In studies of civilian adults with TBI, varying percentages with persistent headache have been found at 1 year ranging from 18 to 22%.²⁹ At 1 year, two prospective studies have found 29%³⁰ and 58%³¹ of subjects endorsed new or worse headache compared to pre-injury.

In 1992 and 2017, respectively, 23.6% and 15.1% agree that, “Once litigation is settled, symptoms quickly resolve in patients with PCS.” This is a little researched area. There is evidence that the symptoms of PCS may be due to overreporting.³² Litigants and nonlitigants respond similarly to treatment for posttraumatic migraines,³³ and there are no significant differences in neuropsychological testing

between litigants and nonlitigants.³⁴ One study found that litigants are not cured by a verdict.³⁵

In 1992 and 2017, respectively, 35.3% and 25.2% agree that “Effective treatment is available for PCS.” Fifty-seven percent of respondents agree that “Effective treatment is available for headaches lasting 3 months or more.” Posttraumatic headaches can be difficult to treat in many cases.³⁶ In 1992, 50% of respondents sometimes recommended cognitive rehabilitation and, in 2017, 56.7% agree that “Cognitive rehabilitation is effective for PCS.” However, most systemic reviews have not resulted in firm support.³⁷

Forty-four percent of respondents disagree with the statement, “Return to play guidelines after concussion are strongly evidence based.” The American Academy of Neurology return to play guidelines¹ are classified as level B (probably effective or useful) or level C (possibly effective or useful) recommendations and are largely consensus based.

In response to the statement, “I would support my son or grandson (or if you don’t have one, relative’s or friend’s) playing football,” 68.4% disagree or strongly disagree. We are not aware of any other physician surveys on this statement. This attitude is not a surprising one for neurologists who are, of course, brain injury specialists even in Texas (home to “Friday Night Lights”) where football is king and a religion of sorts where residents of McKinney recently approved by nearly two-thirds of the vote a bond measure for construction of a new high school stadium with a projected cost of \$70 million.³⁸

More American parents may be agreeing with our respondents and the neuropathologists well known for their research of chronic traumatic encephalopathy, Omalu³⁹ and McKee,⁴⁰ that children should not play football. A 2014 *NBC News/Wall Street Journal* poll found that 40% of Americans would encourage their children to play a different sport than football.⁴¹ Prominent current and former National Football League (NFL) players concur.⁴² The growing awareness of the effects of concussion⁴³ may account for the decrease in youth participation in football, which is as much as 14% from the peak in 2009⁴⁴ (even among Texas high school players⁴⁵), and some of the decline in NFL viewership during the 2016 season of about 1 million viewers per game⁴⁶ and an additional 1.6 million viewers per game decline in 2017 (national anthem protests, over-exposure of NFL programming, and decreased network viewership may be significant contributors).⁴⁷

CONCLUSION

From 1992 to 2017, there has been growing acceptance of the organicity of PCS. Most respondents do not agree that return to play guidelines are evidence based and most would not recommend that their son or grandson play football.

Acknowledgment: The authors thank the Texas Neurological Society (TNS) members for participating in the survey, and the assistance of Ky Camero, executive director of the TNS, for printing and distributing the survey instrument.

STATEMENT OF AUTHORSHIP

Category 1

(a) Conception and Design

Randolph W. Evans

(b) Acquisition of Data

Randolph W. Evans and Kamalika Ghosh

(c) Analysis and Interpretation of Data

Randolph W. Evans and Kamalika Ghosh

Category 2

(a) Drafting the Manuscript

Randolph W. Evans and Kamalika Ghosh

(b) Revising It for Intellectual Content

Randolph W. Evans and Kamalika Ghosh

Category 3

(a) Final Approval of the Completed Manuscript

Randolph W. Evans and Kamalika Ghosh

REFERENCES

1. Giza CC, Kutcher JS, Ashwal S, et al. Summary of evidence-based guideline update: Evaluation and management of concussion in sports: Report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2013;80:2250-2257.
2. Bazarian JJ, Wong T, Harris M, Leahey N, Mookerjee S, Dombrov M. Epidemiology and predictors of post-concussive syndrome after minor head injury in an emergency population. *Brain Inj*. 1999;13:173-189.
3. Evans RW. Postconcussion syndrome. In: Post TW, ed. *UpToDate*. Waltham, MA: UpToDate; 2018.
4. Evans RW. The post-concussion syndrome: 130 years of controversy. *Semin Neurol*. 1994;14:32-39.
5. Strauss I, Savitsky N. Head injury: Neurologic and psychiatric aspects. *Arch Neurol Psychiatry*. 1934; 31:893-955.
6. Miller H. Accident neurosis. *Br Med J*. 1961;1:919-925.
7. Symonds C. Concussion and its sequelae. *Lancet*. 1962;279:1-5.
8. Evans RW, Evans RI, Sharp M. The physician survey on the post-concussion and whiplash syndromes. *Headache*. 1994;34:268-274.
9. Stranjalis G, Tsamandouraki K, Alamanos I, Evans RW, Singounas E. The physician survey on the postconcussion and whiplash syndromes in Greece. *Headache*. 2000;40:176-178.
10. Evans RW. Posttraumatic headaches in civilians, soldiers, and athletes. *Neurol Clin*. 2014;32:283-303.
11. Evans RW, Evans RE. A survey of neurologists on the likeability of headaches and other neurological disorders. *Headache*. 2010;50:1126-1129.
12. Evans RW, Ghosh K. A survey of headache medicine specialists on the likeability of headaches and their personal headache history. *Headache*. 2016; 56:540-546.
13. Kellerman SE, Herold J. Physician response to surveys. A review of the literature. *Am J Prev Med*. 2001;20:61-67.

14. Evans RW, Lipton RB, Ritz KA. A survey of neurologists on self-treatment and treatment of their families. *Headache*. 2007;47:58-64.
15. Ruff RM, Iverson GL, Barth JT, Bush SS, Broshek DK; NAN Policy and Planning Committee. Recommendations for diagnosing a mild traumatic brain injury: A National Academy of Neuropsychology education paper. *Arch Clin Neuropsychol*. 2009;24:3-10.
16. Centers for Disease Control and Prevention. What are the signs and symptoms of concussion? <https://www.cdc.gov/traumaticbraininjury/symptoms.html>. Accessed November 30, 2017.
17. McCrory P, Meeuwisse WH, Aubry M. Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012. *J Am Coll Surg*. 2013;216:e55-e71.
18. Asken BM, Snyder AR, Clugston JR, Gaynor LS, Sullan MJ, Bauer RM. Concussion-like symptom reporting in non-concussed collegiate athletes. *Arch Clin Neuropsychol*. 2017;32:963-971.
19. McCrory P, Meeuwisse WH, Echemendia RJ, Iverson GL, Dvořák J, Kutcher JS. What is the lowest threshold to make a diagnosis of concussion? *Br J Sports Med*. 2013;47:268-271.
20. Iverson GL, Lange RT. Examination of “postconcussion-like” symptoms in a healthy sample. *Appl Neuropsychol*. 2003;10:137-144.
21. Lagarde E, Salmi LR, Holm LW, et al. Association of symptoms following mild traumatic brain injury with posttraumatic stress disorder vs. postconcussion syndrome. *JAMA Psychiatry*. 2014;71:1032-1040.
22. Blennow K, Brody DL, Kochanek PM, et al. Traumatic brain injuries. *Nat Rev*. 2016;2:16084.
23. McKee AC, Daneshvar DH. The neuropathology of traumatic brain injury. *Handb Clin Neurol*. 2015;127:45-66.
24. Evans RW. The post-concussion syndrome. In: Evans RW, Baskin DS, Yatsu FM, eds. *Prognosis of Neurological Disorders*. New York: Oxford University Press; 1992:97-107.
25. Borg J, Holm L, Cassidy JD, et al. Diagnostic procedures in mild traumatic brain injury: Results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004; (43 Suppl):61-75.
26. Stiell IG, Clement CM, Rowe BH, et al. Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. *JAMA*. 2005;294:1511-1518.
27. Levin HS, Diaz-Arrastia RR. Diagnosis, prognosis, and clinical management of mild traumatic brain injury. *Lancet Neurol*. 2015;14:506-517.
28. McInnes K, Friesen CL, MacKenzie DE, Westwood DA, Boe SG. Mild traumatic brain injury (mTBI) and chronic cognitive impairment: A scoping review. *PLoS One*. 2017;12:e0174847.
29. Lew HL, Lin PH, Fuh JL, Wang SJ, Clark DJ, Walker WC. Characteristics and treatment of headache after traumatic brain injury: A focused review. *Am J Phys Med Rehabil*. 2006;85:619-627.
30. Dikmen S, Machamer J, Fann JR, Temkin NR. Rates of symptom reporting following traumatic brain injury. *J Int Neuropsychol Soc*. 2010;16:401-411.
31. Lucas S, Hoffman JM, Bell KR, Dikmen S. A prospective study of prevalence and characterization of headache following mild traumatic brain injury. *Cephalalgia*. 2014;34:93-102.
32. Tsanadis J, Montoya E, Hanks RA, Millis SR, Fichtenberg NL, Axelrod BN. Brain injury severity, litigation status, and self-report of postconcussive symptoms. *Clin Neuropsychol*. 2008;22:1080-1092.
33. Weiss HD, Stern BJ, Goldberg J. Post-traumatic migraine: Chronic migraine precipitated by minor head or neck trauma. *Headache*. 1991;31:451-456.
34. Leininger BE, Gramling SE, Farrell AD, Kreutzer JS, Peck EA 3rd. Neuropsychological deficits in symptomatic minor head injury patients after concussion and mild concussion. *J Neurol Neurosurg Psychiatry*. 1990;53:293-296.
35. Mendelson G. Not “cured by a verdict”. Effect of legal settlement on compensation claimants. *Med J Aust*. 1982;2:132-134.
36. Minen MT, Boubour A, Walia H, Barr W. Post-concussive syndrome: A focus on post-traumatic headache and related cognitive, psychiatric, and sleep issues. *Curr Neurol Neurosci Rep*. 2016;16:100.
37. Prince C, Bruhns ME. Evaluation and treatment of mild traumatic brain injury: The role of neuropsychology. *Brain Sci*. 2017;7:pii.E105.
38. Peter J. It’s still football. It’s still Texas. *USA Today*. January 29, 2017. <https://www.usatoday.com/story/sports/nfl/2017/01/29/super-bowl-li-51-texas-football-houston/97213092/>. Accessed January 23, 2018.

39. Omalu B. Don't let kids play football. *New York Times*. December 7, 2015. <https://www.nytimes.com/2015/12/07/opinion/dont-let-kids-play-football.html>. Accessed January 23, 2018.
40. Would you let your kids play football? *The Frontline Interviews on League of Denial: The NFLs Concussion Crisis*. <http://www.pbs.org/wgbh/pages/frontline/oral-history/league-of-denial/would-you-let-your-kids-play-football/>. Accessed January 23, 2018.
41. O'Connor P. Poll finds 40% would sway children away from football. *The Wall Street Journal*. January 31, 2014. <https://www.wsj.com/articles/poll-finds-40-would-sway-children-away-from-football-1391120696?tesla=y>. Accessed January 23, 2018.
42. Mocella S. Top 12 NFL players who wouldn't let their kids play football. *The Sportster*. January 3, 2016. <http://www.thesportster.com/football/top-12-nfl-players-who-wouldnt-let-their-kids-play-football/>. Accessed January 23, 2018.
43. Perez AJ. Survey: 100% of parents "affected in some way by concussion." *USA Today*. July 20, 2016. <https://www.usatoday.com/story/sports/2016/07/20/concussions-youth-sports-survey-parents/87338008/>. Accessed January 23, 2018.
44. Cook B. Youth football participation trends signal ratings slip will be long term. *Forbes*. November 28, 2016. <https://www.forbes.com/sites/bobcook/2016/11/28/youth-football-participation-trends-signal-whether-nfls-ratings-slip-will-be-long-term/#6a020d902da2>. Accessed January 23, 2018.
45. Goodwyn W. So many sports, so little time: Texas high school athletes opt out of football. *NPR*. September 10, 2015. <http://www.npr.org/2015/09/10/439247006/so-many-sports-so-little-time-texas-high-school-athletes-opt-of-out-football>. Accessed January 23, 2018.
46. Goff B. NFLs missing million viewers. *Forbes*. January 23, 2017. <https://www.forbes.com/sites/briang-off/2017/01/23/nfls-missing-million-viewers/#31c592ef2d5d>. Accessed January 23, 2018.
47. Flint J. NFL ratings fall at a faster pace. *The Wall Street Journal*. January 4, 2018. <https://www.wsj.com/articles/nfl-ratings-fall-at-faster-pace-1515061801>. Accessed January 23, 2018.