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J Safety Res. Author manuscript; available in PMC 2023 August 21.

Published in final edited form as:

J Safety Res. 2023 June ; 85: 507–512. doi:10.1016/j.jsr.2023.02.011.

Healthcare provider influence on driving behavior after a mild traumatic brain injury: Findings from the 2021 SummerStyles survey☆

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Abstract

Introduction: Research shows that a mild traumatic brain injury (mTBI) impairs a person's ability to identify driving hazards 24 h post injury and increases the risk for motor vehicle crash. This study examined the percentage of people who reported driving after their most serious mTBI and whether healthcare provider education influenced this behavior.

Methods: Self-reported data were collected from 4,082 adult respondents in the summer wave of Porter Novelli's 2021 ConsumerStyles survey. Respondents with a driver's license were asked whether they drove right after their most serious mTBI, how safe they felt driving, and whether a doctor or nurse talked to them about when it was ok to drive after their injury.

Results: About one in five (18.8 %) respondents reported sustaining an mTBI in their lifetime. Twenty-two percent (22.3 %) of those with a driver's license at the time of their most serious mTBI drove within 24 h, and 20 % felt very or somewhat unsafe doing so. About 19 % of drivers reported that a doctor or nurse talked to them about when it was safe to return to driving. Those who had their healthcare provider talk to them about driving were 66 % less likely to drive a car within 24 h of their most serious mTBI (APR = 0.34, 95 % CI: 0.20, 0.60) compared to those who did not speak to a healthcare provider about driving.

☆Special Report from the CDC. ***The Journal of Safety Research has partnered with the Office of the Associate Director for Science, Division of Injury Prevention, National Center for Injury Prevention and Control at the CDC in Atlanta, Georgia, USA, to briefly report on some of the latest findings in the research community. This report is the 73rd in a series of "Special Report from the CDC" articles on injury prevention..***

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

9.Disclaimer

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsr.2023.02.011.

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Conclusions: Increasing the number of healthcare providers who discuss safe driving practices after a mTBI may reduce acute post-mTBI driving.

Practical Applications: Inclusion of information in patient discharge instructions and prompts for healthcare providers in electronic medical records may help encourage conversations about post-mTBI driving.

Keywords

Traumatic brain injury; Injury prevention; Driving; Public health; Survey research

1. Introduction

Each year, millions of Americans of all ages sustain a mild traumatic brain injury (mTBI)—often referred to as a concussion—making it a common injury treated by emergency and primary care providers in the United States (Cassidy et al., 2004). mTBIs are associated with neuronal dysfunction involving a cascade of ionic, metabolic, and physiologic events (Giza & Hovda, 2014; McAllister, Sparling, Flashman, & Saykin, 2001; Meaney & Smith, 2011) that result in signs and symptoms that evolve during the course of recovery (Centers for Disease Control and Prevention [CDC], 2015; Giza & Hovda, 2014). Symptoms of mTBI can include slowed processing speed (Mayer et al., 2012; Shumskaya, Andriessen, Norris, & Vos, 2012), problems with attention (Catale, Marique, Closset, & Meulemans, 2009; Mayer et al., 2012), sensitivity to light and noise (Shepherd et al., 2020), changes to motor function and control (Buttner et al., 2019; Howell et al., 2020; Howell, Buckley, Lynall, & Meehan, 2018), mental fogginess or difficulty remembering (Wammes, Good, & Fernandes, 2017), and sleep-related difficulties (Mantua, Henry, Garskovas, & Spencer, 2017; Mathias & Alvaro, 2012).

Symptoms of mTBI are generally most pronounced within the first few days of the injury (Dwyer & Katz, 2018). This is also when symptoms are most likely to affect a person's daily activities such as driving a car (Eisenberg, Meehan, & Mannix, 2014; Schmidt et al., 2017; Silverberg et al., 2016). Research using video-based simulators have shown that an mTBI impairs a person's ability to identify driving hazards within the first 24 h after the injury and increases the risk for a motor-vehicle crash (Baker, Unsworth, & Lannin, 2015a; Preece, Horswill, & Geffen, 2010). Research on driving safety among individuals with mTBI following the 24 h timeframe is currently inconclusive (Preece, Horswill, & Ownsworth, 2016), and few studies have explored how driving performance evolves during recovery (Schmidt et al., 2017). However, previous studies have shown that deficits in cognition (e.g., executive function), motor control, and vision may contribute to poor driving performance (Anstey, Horswill, Wood, & Hatherly, 2012; Pomidor, 2019; Schmidt et al., 2017).

For many, driving is an integral part of daily life. As such, restricting an individual's ability to drive, even for a short time, especially in areas with limited public transportation, may be associated with increased isolation and psychological sequalae (DeCarlo, Scilley, Wells, & Owsley, 2003; Fonda, Wallace, & Herzog, 2001; Ragland, Satariano, & MacLeod, 2005). This may help explain why studies of adolescents and athletes with mTBI indicate that

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they may return to driving earlier than they return to exercise or sports and may hide their symptoms due to concerns about being prohibited from driving (McDonald et al., 2021; Schmidt, Lynall, Lempke, Weber, & Devos, 2018). Schmidt and colleagues found that 56.2 % of college athletes did not refrain from driving at any point following their previous concussions, despite many reporting feeling unsafe driving after their injury (Schmidt et al., 2018). They also found that being restricted from driving would influence these athletes' decision to report a future head injury to a healthcare provider (Schmidt et al., 2018). Similarly, a survey by Preece and colleagues found that less than half of adult patients (48 %) seen in an emergency department for an mTBI intended to limit their driving during recovery (Preece, Geffen, & Horswill, 2013). Although valuable early contributions, these two prior studies utilized small, specialized, convenience samples (patients seen in the emergency department, college athletes) that may not represent the behaviors or behavioral intentions of the broader population of those with mTBI.

Unlike guidelines for the care of athletes (Harmon et al., 2019) and individuals with moderate or severe TBI (Ontario Neurotrauma Foundation, 2017), which include information about safe driving practices after TBI, current guidelines for adults or adolescents of driving age (Jagoda et al., 2008; Lumba-Brown et al., 2018) with mTBI from a non-sports related mechanism do not include recommendations on when it is safe to begin driving after an mTBI. Moreover, no validated assessment tool currently exists for healthcare providers to determine when a patient is fit to drive following an mTBI. This leaves healthcare providers and patients with no standardized management practice to rely on. Understanding driving behaviors following an mTBI may help inform updates to clinical practice guidelines and build upon emerging research. Thus, this study used a large, geographically diverse sample to examine the percentage of adults who reported driving within 24 h after sustaining a concussion or mTBI and their perceptions of driving safety during recovery. Further, this paper will examine whether receiving education from a healthcare provider on driving after an mTBI is associated with refraining from driving within 24 h after injury.

2. Materials and Methods

2.1. Sample

Self-report data were collected from the summer wave ("SummerStyles") of Porter Novelli's 2021 ConsumerStyles survey. SummerStyles is an annual Web-based survey of U.S. adults aged 18 years and older that was fielded in June of 2021. A total of 4,085 adults completed the SummerStyles survey out of a total of 5,741 households who were invited. This resulted in a completion rate of 71.2 %. Respondents were drawn from the Ipsos KnowledgePanel® that gathers insights about consumers in the United States. Panel members were initially recruited using probability-based sampling of addresses. Adults who completed the survey received 10,000 cash-equivalent reward points (worth approximately $10). Data were weighted to be nationally representative based on sex, age, race/ethnicity, education, household income and size, U.S. census region, metropolitan status, and parental status of children ages 12 to 17 years. This study was exempt from institutional review board

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review because personal identifiers were not included. Access to the SummerStyles data was granted through a data-use agreement with Porter Novelli Public Services.

2.2. Measures

As part of a separate project examining the impact of question wording on TBI reporting, respondents were randomly assigned to receive one of two questions to assess self-reported lifetime history of a brain injury (full survey in Appendix A):

1. In your lifetime, do you believe that you have ever had a concussion?
2. In your lifetime, do you believe that you have ever had a mild traumatic brain injury?

While a significantly higher proportion of respondents reported having sustained a concussion (26.2 %) than an mTBI (11.4 %) during their lifetime, no significant differences were seen in the outcome of interest (i.e., driving behavior). Therefore, responses to these two questions were combined to create a dichotomous “yes, concussion or mTBI” and “no, no concussion or mTBI” variable. Henceforth, all self-reported brain injuries will be referred to jointly as mTBIs.

Respondents who self-reported a lifetime history of mTBI were asked a series of questions regarding their driving behaviors including what they were doing when they experienced of their injury most serious mTBI, and if they had a driver’s license at the time of their injury. They were also asked whether they drove a car right after their most serious mTBI (within 24 h); if so, how safe they felt driving a car (within the first 24 h) after their injury; and finally, whether a healthcare provider (i.e., doctor or nurse) talked to them about when it is okay to drive after their most serious mTBI.

2.3. Statistical analysis

The analytic sample was composed of the 4,082 adult respondents who answered the concussion or mTBI-related questions. Estimates and 95 % confidence intervals (CIs) were calculated for lifetime prevalence of mTBI and follow-up questions listed in Appendix A. The authors calculated χ^2 tests to determine whether driving behavior differed by whether the respondent talked to their healthcare provider about driving safety and selected demographic characteristics. Estimates were considered statistically significant if $p < 0.05$. Additionally, a logistic regression model with predicted marginals (Bieler, Brown, Williams, & Brogan, 2010) was employed to examine driving behaviors following an mTBI with adjustment for variables from the χ^2 tests. Associations are presented as adjusted prevalence ratios (APRs) and 95 % confidence intervals (CIs). Selected characteristics that were hypothesized to potentially influence driving a car after an mTBI were included in APR calculations. Analyses were conducted using SAS version 9.4 and SUDAAN version 11.0.0 (SAS Institute Inc. and Research Triangle Institute, Cary, North Carolina, USA) and IBM SPSS Statistics Subscription. The complex survey design was taken into account.

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3. Results

Table 1 presents the demographic characteristics after weighting was applied. A nearly even split is seen between males (48.4 %) and females (51.6 %). About half of individuals were between the ages of 30 and 44 years (25.4 %) or 44 and 59 years (25.0 %). Almost 4 in 10 (38.4 %) respondents had a high school diploma or less and about two-thirds (63.2 %) were non-Hispanic White. More respondents lived in the South (38.0 %) than any other U.S. census region. Finally, more than half of individuals (52.7 %) had a household annual income of at least $75,000.

Nearly-one-fifth (18.8 %) of respondents reported sustaining an mTBI in their lifetime (Table 2). About half (49.2 %) had their driver's license at the time of their most serious mTBI and 22.3 % of this group reported driving within 24 h after their most serious mTBI. Approximately 20 % of people who reported driving right after their mTBI said they felt somewhat unsafe (13.1 %) or very unsafe (6.5 %) while driving. Finally, almost half (46.2 %) of those who reported an mTBI indicated that a doctor or nurse did not talk to them about when it was okay to drive, while 34.4 % reported that they did not get checked by a doctor or nurse after the most serious mTBI. When looking at just those who got checked by a doctor or nurse after their injury (n = 521), 29.6 % reported that a doctor or nurse talked to them about when it was okay to drive (data not shown).

Self-reported driving after their most serious mTBI was associated with whether the respondent had talked to a doctor or nurse about when it was okay to drive after their injury (Table 3). A smaller percentage of those who spoke to a doctor or nurse reported driving within 24 h after their most serious mTBI (10.2 %) compared to those who did not speak to a doctor or nurse (31.4 %) or did not get checked by a doctor or nurse (34.0 %). Respondents who had a healthcare provider talk to them about driving were 66 % less likely (APR = 0.34, 95 % CI: 0.20,0.60) to drive a car within 24 h of their most serious mTBI. Driving within 24 h after the most serious mTBI did not vary by age but was associated with the mechanism of injury. Respondents who reported sustaining their most serious mTBI from a car, motorcycle, or bike crash were less likely to report driving within 24 h after their most serious injury (APR = 0.35, 95 % CI: 0.17, 0.71) than those who received their injury from sports or recreation.

4. Discussion

This study examined data from a large national survey to explore driving behaviors among a geographically and demographically diverse population. Findings show that most respondents who had a driver's license at the time of their most serious mTBI did not drive within 24 h of the injury. This finding is encouraging given the potential for an mTBI to inhibit a person's vision, cognitive, and motor skills, and the recorded deficits in driving ability shown from driving simulators within the first 24 h post-injury (Baker et al., 2015a; Preece et al., 2010; Schmidt et al., 2017). Still, nearly-one-quarter of respondents in this study reported driving within 24 h of their injury. One in five felt somewhat or very unsafe doing so.

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Estimates of the percentage of persons who reported driving after an mTBI are lower than those in the only other prior study on this topic, which showed that 56.2 % of college athletes who sustained a concussion returned to driving immediately (Schmidt et al., 2018). Unmeasured differences in populations examined, types of care received (e.g., medical setting, healthcare provider type), mechanism of injury, and level of severity of the injury may help explain these variations. For example, respondents in this current study who reported sustaining their most serious mTBI by a car, motorcycle, or bike crash were less likely to report driving within 24 h than from being injured during a sports or recreation activity. This finding is not surprising given the potential to sustain multiple injuries in a motor vehicle or bike crash, as well as damage to a motor vehicle making it unusable.

One of the most interesting findings from this study is the association between whether a healthcare provider discussed driving with a respondent and whether a driver returned to driving within 24 h of the injury. Respondents who talked to their healthcare provider about driving were 66 % less likely to report driving within 24 h of an mTBI compared to those who did not. The potential benefits of a discussion between a patient and their healthcare provider on patient driving behaviors has also been reported by Schmidt and colleagues (2018). However, while driving safety after an mTBI is gaining more attention among medical and brain injury organizations, guidance for healthcare providers on specific symptoms that affect a patient's driving safety and checklists to help patients safely return to driving are currently lacking. This may help explain why this study and prior studies indicate that healthcare provider practices related to counseling patients about driving after an mTBI vary and are generally suboptimal (Sarmiento, Waltzman, & Wright, 2021). In this study, less than a quarter (19 %) of respondents who had a driver's license at the time of their most serious mTBI reported that a healthcare provider talked to them about when it was safe to return to driving. A previous study showed that 58.5 % of athletic trainers provided post-concussion driving recommendations to their athletes (Schmidt, Lempke, Devos, & Lynall, 2019). An examination of emergency departments in Australia showed that only one-third of healthcare providers routinely recommend a period of "no driving" following a concussion (Baker, Unsworth, & Lannin, 2015b). Finally, a survey of healthcare providers in the United States showed that about half (52 %) routinely talk with patients with mTBI about how to safely return to driving and only 40 % regularly check for symptoms that may affect driving, such as blurry vision and slowed reaction time (Sarmiento et al., 2021).

5. Limitations

A limitation of this study is that SummerStyles data are self-reported and may be subject to bias. Recall bias may occur, particularly when a respondent is referencing a concussion or an mTBI that was sustained many years ago. Most of the brain injuries reported by respondents occurred more than 10 years ago—the average time since respondents' most serious injury was 30 years (data not shown). It is possible that respondents whose injuries happened many years ago are less likely to remember whether their doctor or nurse spoke to them about driving and whether or not they drove after their injury. Additionally, the survey did not allow the authors to ascertain the content and context of the conversations that providers had with their patients. SummerStyles is a Web-based panel survey and may not be fully representative of the U.S. adult population. However, the data are weighted to be nationally

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representative. Furthermore, the survey questions used in the study to identify self-reported brain injuries have not been validated and affirmative responses were not validated by independent medical diagnosis.

6. Practical Applications

Future efforts to reduce the number of people who drive immediately after an mTBI may focus on encouraging more healthcare providers to discuss driving safety with their patients. Ideally, patient education involves active engagement (Badaczewski et al., 2017). This may include teach-back strategies, such as having the patient repeat the information provided by the healthcare provider to ensure understanding (Badaczewski et al., 2017). It also means giving patients the opportunity to ask questions (in-person or later by email) and engaging patients in decision-making regarding their care and recovery (Krist, Tong, Aycock, & Longo, 2017). To encourage these conversations, updating patient discharge instructions to include information on driving safety and adapting electronic medical records to prompt healthcare providers to discuss driving safety may be effective (Santana, Martinie, & Gomez, 2020). Still, this is a complex issue, and it is worth recognizing that healthcare providers may be reluctant to discuss driving safety for patients. Studies indicate that healthcare providers are hesitant to restrict driving for other neurological conditions out of fear of affecting the patient-healthcare provider relationship (Devos, Akinwuntan, Gélinas, George, Nieuwboer, & Verheyden, 2012) and prior studies have shown a potentially deleterious effect that driving restrictions might have on patients seeking care after an mTBI (Schmidt et al., 2018). As such, education on driving safety following an mTBI that incorporates transportation options for patients and involves them in decision-making regarding transportation options may be beneficial.

7. Conclusion

Nearly-one in four persons in this study who sustained an mTBI or concussion in their lifetime reported driving within 24 h of their injury. The results suggest that by speaking to patients about driving safety, healthcare providers may positively influence safe driving behavior. Future efforts to encourage these discussions may incorporate the use of prompts in electronic medical records, while also considering healthcare provider and patient concerns regarding driving safety and encouraging active engagement on this topic.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Dr. Daugherty earned her doctorate in sociology from Emory University in Atlanta where she focused on social inequality. Her work at the CDC focuses on disparities in traumatic brain injury and concussion knowledge and prevention. Previously she was employed at CDC's National Center for Health Statistics in Maryland.

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Table 1

Characteristics of Respondents in 2021 Porter Novelli SummerStyles Sample, n = 4,082, United States.

Characteristic	Frequency	Weighted Percent	95 % CI
Sex			
Male	2095	48.4	(46.6,50.2)
Female	1987	51.6	(49.8,53.4)
Total	4082	100.0	-
Age			
18–29	380	19.9	(18.0,21.7)
30–44	1000	25.4	(23.8,27.0)
45–59	1170	25.0	(23.5,26.5)
60 or older	1532	29.7	(28.2,31.2)
Total	4082	100.0	-
Education			
High school graduate or less	1224	38.4	(36.5,40.2)
Some college	1243	30.0	(28.4,31.7)
Bachelor’s degree or higher	1615	31.6	(30.0,33.2)
Total	4082	100.0	-
Race/Ethnicity			
Non-Hispanic White	3025	63.2	(61.3,65.1)
Non-Hispanic Black	311	11.7	(10.3,13.0)
Non-Hispanic other	412	16.3	(7.7,9.9)
Hispanic	334	8.8	(14.7,17.9)
Total	4082	100.0	-
U.S. Region			
Northeast	763	17.4	(16.0,18.7)
Midwest	898	20.7	(19.3,22.2)
South	1467	38.0	(36.1,39.8)
West	954	23.9	(22.3,25.5)
Total	4082	100.0	-
Income			
<$25,000	330	12.3	(10.9,13.7)
$25,000-$74,999	1310	35.0	(33.2,36.7)
≥$75,000	2442	52.7	(50.9,54.6)
Total	4082	100.0	-

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Table 2

Lifetime mild traumatic brain injury (mTBI) prevalence and driving behavior and attitudes post-injury.

	Frequency	Weighted Percent	95 % CI
Lifetime mTBI?			
Yes	802	18.8	(17.4,20.3)
No	3,280	81.2	(79.7,82.6)
Did you have your driver's license at the time of your most serious mTBI?[1]			
Yes	423	49.2	(45.0,53.4)
No	373	50.8	(46.6,55.0)
Did you drive a car right after your most serious mTBI?[2]			
Yes	98	22.3	(17.9,26.7)
No	283	68.6	(63.6,73.5)
Not sure	42	9.1	(6.2,12.1)
How safe did you feel driving a car after your most serious mTBI?[3]			
Very safe	38	39.0	(28.1,50.0)
Somewhat safe	20	20.5	(11.9,29.1)
Neutral	21	20.9	(11.7,30.0)
Somewhat unsafe	13	13.1	(6.1,20.1)
Very unsafe	6	6.5	(0.6,12.4)
Did a doctor or nurse talk to you about when it is ok to drive after your most serious mTBI?			
Yes	148	19.4	(16.0,22.8)
No	373	46.2	(42.0,50.3)
Did not get checked by a doctor or nurse	274	34.4	(30.4,38.4)

[1]Only asked of respondents who indicated they had sustained a concussion or mTBI in their lifetime.

[2]Only asked of respondents who indicated they had their driver's license/permit at time of their most serious injury.

[3]Only asked of respondents who indicated they drove a car right after their most serious injury.

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Table 3

Respondent driving behavior after most serious mTBI by select characteristics.

	Did you drive a car right after your most serious mild traumatic brain injury (within the first 24 h)?[1]						
	Yes			χ^2	p-value	Adjusted prevalence ratio (APR)[2]	
	Frequency	Weighted %	(95 % CI)			APR	95 % CI
Did a doctor or nurse talk to you about when it is ok to drive after your most serious mTBI?				20.0	<0.0001		
No	47	31.4	(23.2,39.6)			REF	REF
Yes	16	10.2*	(5.1,15.3)			0.34	(0.20,0.60)
Did not get checked by a doctor or nurse	35	34.0	(23.3,44.8)			0.98	(0.64,1.50)
Age at most serious mTBI				0.1	0.7031		
0–25	45	23.5	(16.5,30.5)			REF	REF
26+	50	25.4	(18.7,32.1)			1.38	(0.93,2.06)
Mechanism of injury				13.9	0.0075		
Sports or recreation	20	31.9	(14.6,35.5)			REF	REF
A car, motorcycle, or bike crash	9	9.8#	(3.5,16.2)			0.35	(0.17,0.71)
Tripped, slipped, or fell and hit my head	13	21.4	(10.0,32.7)			0.57	(0.30,1.09)
Bumped my head on something	14	35.6	(17.7,53.6)			1.06	(0.60,1.86)
Something else	41	25.1	(22.1,40.3)			0.72	(0.42,1.23)

*significantly different than “no” and “did not get checked”.

#significantly different than “bumped my head on something,” “sports or recreation,” and “something else”.

[1]Only asked of respondents who indicated they had their driver’s license/permit at time of their most serious injury

[2]APR values reflect adjustments for other covariates presented in the table.