Gender Differences in Awareness and Outcomes During Acute Traumatic Brain Injury Recovery

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Abstract

Background: Recent literature on traumatic brain injury (TBI), though mixed when reporting outcomes, seems collectively to suggest possible gender advantage for women in postinjury recovery, especially in executive functions. Hormonal neuroprotection, through female reproductive hormones, is often proposed as an underlying factor in these results. We explored potential gender differences in an aspect of executive functions, self-awareness (SA), which is often impaired after TBI, limits patient effort in critical rehabilitation, and increases caregiver burden.

Methods: Within a prospective survey, repeated-measures design, 121 patients with moderate or severe TBI undergoing acute rehabilitation in a Level 1 trauma center, a family member or caregiver informant, and a treating clinician were asked to complete the Patient Competency Rating Scale (PCRS) and the Frontal Systems Behavior Scale (FrSBe) at admission and discharge.

Results: Although overall, women and men with TBI showed generally similar levels of SA, women had significantly better awareness of their injury-related deficits at acute rehabilitation discharge, even when controlling for age, education, and injury severity.

Conclusions: Mixed findings in this study mirror the pattern of results that dominate the published literature on gender and TBI. Gender differences in executive dysfunction may not be as large or robust as some researchers argue. In addition, complex interplays of socialization, gender-role expectations, naturally occurring male and female ability differences, and differences in access to postinjury rehabilitation are understudied potential moderators.

Introduction

BRAIN INJURY INVESTIGATORS have noted stronger executive functions for women after traumatic brain injury (TBI),¹ though findings are mixed across the variables studied. Executive functions include problem solving, planning, purposive behavior, self-awareness, performance effectiveness, and appropriateness of interpersonal and situational behavior^{2,3} and are often associated with injury to the frontal area of the brain, especially in motor vehicle crashes.^{2,3} Intact executive functions are critical for resuming responsible and successful behavior in one's community.^{2,3} Niemeier and colleagues¹ specifically explored gender differences in executive-function deficits after TBI; after controlling for

education, ethnicity, and injury severity, they found superior executive functioning for women as measured by the Wisconsin Card Sort Test.⁴

Recovery advantage in executive functions can help individuals with TBI overcome barriers to independent living.^{2,3} Among the executive deficits associated with TBI, impaired self-awareness (SA) of injury-related cognitive deficits is one of the most challenging, affecting effort in needed rehabilitation therapies and increasing caregiver burden and stress.^{3,5–11} Rehabilitation clinicians use the term self-awareness, or insight, to describe how well or poorly patients understand their strengths and limitations. An ability to understand the nature and degree of the deficits and their impact on one's capacity to perform daily and independent-living tasks are important

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ingredients in successful recovery. Self-awareness is seen as both a cognitive and an emotional process of integrating information from external reality and inner experience.^{9,10}

Several models of unawareness, or anosognosia, have been proposed.^{3,7,8} Clinicians have observed that patients can exhibit more psychologically based denial by itself or in combination with unawareness, owing to cognitive deficits as a manifestation of the underlying neurologic injury.^{3,7,11} Several measures have been developed to track the severity and improvement of this prognostically negative postinjury problem, including the Patient Competency Rating Scale (PCRS)^{12–14} and the Frontal Systems Behavior Scale (FrSBe).^{15–18} A comparison between responses of an informant, usually a family member or clinician, and the patient on the same questionnaire produces a “discrepancy” score that is used as a measure of patient SA.^{12–18}

Mixed findings are typical in studies comparing broad post-TBI outcomes for men and women.^{19–31} On the one hand, research has shown that women with TBI outperform men in executive functions,¹ working memory,²⁷ delayed visual memory,²⁰ and written language,²¹ as well as in rehabilitation outcomes²¹ and community integration.^{22,23} Investigators have also noted that women are more likely to survive their injuries and less likely to have postinjury complications than men.²⁴ However, other researchers have found that women are more likely to die from their TBI and have worse outcomes than men.^{25,26} Men exceed women in post-TBI bilateral strength, fine motor speed, vocational successes,²¹ visual analysis,¹⁹ and verbal and visual memory.²¹ Variables found to moderate the preceding findings include age, injury severity, education, and amount of rehabilitation received.³²

Brain injury researchers investigating gender differences in post-TBI outcomes largely conceptualize this area of study in terms of physiologic or injury-related variables that may underlie these differences, although there may be other physical,^{33,34} social psychologic,³⁵ or mental health explanations,³⁶ such as societal expectations for men and women,^{37–39} or ability differences in healthy males and females.^{40–42} Our study’s approach is consistent with the predominant focus of the TBI literature reviewed on potential physiologic or neurologic, injury-related underpinnings of postinjury gender differences in functional and cognitive outcomes. Therefore, based on the review of literature showing evidence, albeit mixed, of superior executive functions and outcomes for women with TBI, we maintain that there is a need for further study of gender differences specific to this deficit domain.

This investigation focuses on the particular postinjury executive functions impairment of SA because of the significant negative impact it has on patient rehabilitation participation, as well as on caregiver burden and stress.^{3,5–11} To date, very little research has explored possible gender differences in SA of injury-related deficits among TBI patients during the acute phase of recovery. Accordingly, the first aim of our study was to characterize possible gender differences in SA of injury-related deficits in 121 inpatients with moderate and severe TBI. A second aim was to explore possible reasons for these gender differences, if present. Study hypotheses were based on the evidence that, compared to men with TBI, women may have superior postinjury executive functions and were as follows.

- Hypothesis 1: As compared to men, women with TBI will exhibit smaller discrepancies between self- and family ratings on the PCRS and FrSBe at Time 1 and Time 2, indicating more awareness of their own deficits.
- Hypothesis 2: As compared to men, women with TBI will exhibit smaller discrepancies between self- and clinician ratings on the PCRS at Time 1 and Time 2, indicating more awareness of their own deficits.

Materials and Methods

Participants

A total of 121 participants enrolled in the study included 77 individuals (63.6%) with severe TBI and 44 individuals (36.4%) with moderate TBI who were receiving acute rehabilitation services at a Level 1 trauma center brain injury rehabilitation unit. The culture of rehabilitation on the unit was strongly interdisciplinary. Participants generally experienced 3 hours or more daily of physical therapy, speech language pathology, occupational therapy, neuropsychology, and recreational therapy. To be included in the study, participants had to have emerged from posttraumatic amnesia (PTA) as measured by the Galveston Orientation and Amnesia Test (GOAT)⁴³ with a score of 70 or above for 3 days in a row, speak English, and be medically stable. The sample consisted of 81 men (66.9%) and 40 women (33.1%). Table 1 shows detailed participant demographic information broken down by participant gender. In order to identify gender differences in participant demographics, *t*-tests were run for continuous variables, and χ^2 tests were run for categorical variables (Table 1).

Measures

PCRS. The PCRS^{12–14} is a measure of perceived competency in performance of 30 specified daily tasks and is rated on a five-point Likert scale related to how easy or difficult a task is to perform. This scale, developed to measure the degree to which patients are aware of their symptoms after TBI, compares patient self-report of competencies to ratings by family and clinician. Discrepancies between patient and family ratings and between patient and clinician ratings of the PCRS are used as standard measures of patient SA.^{12–14}

The rater selects from the following responses: “1. can’t do it,” “2. very difficult to do it,” “3. can do it with some difficulty,” “4. fairly easy to do it,” and “5. can do it easily.” Rated activities include scheduling daily activities, participating in group activities, and keeping appointments. Reliability and validity of the PCRS have been well documented.¹⁴ A factor analytic study¹³ yielded several domains of activities within the PCRS, including instrumental activities of daily living (IADLs), cognitive competency, and emotional and interpersonal competency. Patients’ self-report of perceived competency is often significantly different from clinician and family ratings. The discrepancies between clinician and patient ratings and between patient and family ratings of the PCRS were used in this study as a measure of SA at Time 1 and Time 2.

FrSBe. The FrSBe^{15–18} is a self-report measure of emotional and neurobehavioral deficits. Development of the items and subscales of the FrSBe was informed by neurology

TABLE 1. PARTICIPANT DEMOGRAPHICS

Variable	Women (n = 40)	Men (n = 81)	p-value
Age, years, mean (SD)	43.67 (18.81)	42.83 (18.76)	NS
Time to commands, days (SD)	6.87 (11.04)	10.17 (14.09)	NS
Employed/full-time student prior to injury, %	67.6	66.2	NS
Injury severity, %			NS
Moderate	45.0	33.3	
Severe	55.0	66.7	
Race/ethnicity, %			NS
White	66.7	62.5	
Minority	33.3	37.5	
Marital status, %			NS
Single	31.5	33.3	
Partnered	68.5	66.6	
Education, %			NS
Less than high school	17.9	35.8	
High school diploma/GED	33.3	33.3	
Some college	30.8	17.3	
College degree or above	17.9	13.6	
Cause of injury, %			0.041
Vehicular	65.8	56.9	
Assault	10.5	2.8	
Fall	15.8	26.4	
Pedestrian	7.8	2.8	
Other	0.0	11.1	

GED, general equivalency diploma; NS, not significant; SD, standard deviation.

in that they were thought to reflect common behavioral syndromes following damage to the frontal lobes and frontal systems.¹⁸ The FrSBe contains 46 Likert-type items and assesses neurobehavioral deficits following brain injury. Higher scores reflect greater neurobehavioral and cognitive impairments. Example items from the self-report measure include “I do things impulsively,” “I sit around and do nothing,” “I laugh or cry too easily,” “I start things but fail to finish them,” “peter out,” and “I am unaware of my problems or when I make mistakes.”

The FrSBe has been hailed as an accurate measure of neurobehavioral symptoms and is useful for illuminating improvement in these symptoms over time for a wide range of neurological and medical patient populations. Cronbach's alphas have ranged from 0.83 to 0.89 for the total score.^{15,16} Velligan¹⁶ found the FrSBe to have a test-retest reliability coefficient of 0.78, and Grace and Malloy¹⁸ reported split-half coefficients ranging from 0.93 to 0.95 for pre- and postinjury ratings. An exploratory factor analysis performed by the test developers,¹⁷ using a mixed brain injury diagnostic sample, led to the extraction of three factors represented by its three subscales (Apathy, Disinhibition, and Executive Dysfunction). The FrSBe was recommended as one of several common data elements that will most accurately measure neurobehavioral deficits and outcomes in recovery from TBI by the interagency Traumatic Brain Injury Outcomes Workgroup.⁴⁴ Originally developed for use in postacute settings, the FrSBe asks the patient and an informant to rate the patient's competency in daily life activities following brain injury. The discrepancy between the informants' and patients' self-report FrsBe scores is regarded as a measure of patient SA.¹⁵ Only patients and family members completed the FrSBe in our study at Time 1 and Time 2.

Procedure

Individuals with TBI and their participating family members provided informed consent upon enrolling in the study. Following patients' emergence from PTA (Time 1), both the PCRS and the FrSBe were administered to patients and family members. These same measures were administered to patients and family members at discharge from inpatient rehabilitation (Time 2). Acute rehabilitation outcomes were measured with Functional Independence Measure (FIM) ratings by the rehabilitation team at these same time points, and the PCRS was also administered to clinicians at Time 1 and Time 2. The average time between administrations was 7.24 days (standard deviation [SD] = 10.03).

Statistical analyses

Two repeated measures analyses of variance (RMANOVAs) were performed with patient gender, time, and the gender*time interaction as the independent variables and discrepancy scores between self and family ratings or between self and clinician ratings on the PCRS and FrSBe at Time 1 and Time 2 as the dependent variables (Hypotheses 1 and 2). Discrepancy scores were calculated by subtracting self-ratings from family ratings or self-ratings from clinician ratings. RMANOVA 1 was performed with discrepancy scores between self- and family ratings on the PCRS and the FrSBe at Time 1 and Time 2 as the dependent variables. RMANOVA 2 was performed in the same manner with the substitution of discrepancy scores between self- and clinician ratings on the PCRS at Time 1 and Time 2 as the dependent variable. These RMANOVAs were meant to control for the potential familywise error in running numerous independent analyses of variance (ANOVAs) to explore gender

TABLE 2. MEANS AND STANDARD DEVIATIONS OF RATINGS BY PATIENT GENDER

	Time 1 Women	Time 1 Men	Time 2 Women	Time 2 Men
Self-family discrepancy				
PCRS	-5.88 (24.21)	-12.64 (26.25)	-0.84 (23.94) ^a	-17.00 (20.71) ^a
FrSBe	11.03 (27.46)	6.28 (31.60)	2.47 (24.31)	16.05 (33.27)
PCRS _{est}	-3.35 (27.23)	-13.46 (26.80)	1.40 (20.96) ^a	-16.67 (20.65) ^a
FrSBe _{est}	10.36 (32.53)	2.54 (32.03)	7.32 (30.49)	11.11 (30.05)
Self-clinician discrepancy				
PCRS	-34.03 (26.41)	-42.85 (25.76)	-21.42 (23.05)	-30.89 (25.45)
PCRS _{est}	-35.66 (26.36)	-40.41 (25.96)	-21.54 (25.40)	-29.27 (25.12)

^aThe means within a row were significantly different by gender at $p < 0.01$.

_{est}, Estimated mean after adjusting for age, education, injury severity, and time to commands; FrSBe, Frontal Systems Behavior Scale; PCRS, Patient Competency Rating Scale.

differences. A power analysis was computed using G*Power and suggested that in these RMANOVAs, a sample size of 84 would be needed to detect a large effect and a sample size of 210 to detect the smallest medium-sized effect. Therefore, the current sample size was sufficient to detect all large and many medium-sized effects.

Only when an omnibus RMANOVA had been statistically significant for gender were follow-up ANOVAs run to identify exactly which dependent variables had the significant gender differences. The follow-up ANOVAs were run to pinpoint the significant gender effect(s) on discrepancy scores between self- and family ratings on the PCRS and the FrSBe at Time 1 and Time 2. The same follow-up ANOVAs were performed with the inclusion of patient age, education, injury severity, and time to commands as covariates in order to determine whether these variables accounted for any gender differences that had emerged in the previous RMANOVAs and follow-up ANOVAs.

Results

Hypothesis 1

RMANOVA 1 revealed a statistically significant effect for TBI patient gender, Wilk's Lambda = 0.850, $F(2, 77) = 6.81$, $p = 0.002$, $\eta^2 = 0.150$, but not for time, Wilk's Lambda = 0.989, $F(2, 77) = .41$, $p = 0.663$, $\eta^2 = 0.011$, or the gender*time interaction, Wilk's Lambda = 0.959, $F(2, 77) = 1.64$, $p = 0.200$, $\eta^2 = 0.041$.

The only significant finding in the four follow-up ANOVAs was with discrepancy in PCRS scores at Time 2 as the dependent variable, with men ($M = -17.00$, $SD = 20.71$) exhibiting a larger discrepancy than women ($M = -0.84$, $SD = 23.94$), $F(1, 92) = 11.54$, $p = 0.001$, $\eta^2 = 0.111$. Four additional ANOVAs were run in the same manner with the inclusion of patient age, education, injury severity, and time to commands as covariates. The only significant individual effect of gender again was on the discrepancy in PCRS scores at Time 2, with men ($M = -16.67$, $SD = 20.65$) exhibiting a larger discrepancy than women ($M = 1.40$, $SD = 20.96$), $F(1, 70) = 12.31$, $p = 0.001$, $\eta^2 = 0.150$, suggesting that even with these covariates, men with TBI rated themselves as more competent than their family members did, whereas women with TBI tended to rate themselves at a level of competence equal to that of their family members. In other words, as compared to women, men with TBI displayed a greater im-

pairment in SA of their postinjury deficits. As a result, Hypothesis 1 found partial support in this significant effect. Table 2 shows all means and standard deviations, as well as covariate-adjusted means.

Hypothesis 2

RMANOVA 2 did not reveal a statistically significant effect for TBI patient gender, $F(1, 96) = 3.75$, $p = 0.056$, $\eta^2 = 0.038$, or the gender*time interaction, Wilk's Lambda = 1.00, $F(1, 96) = 0.02$, $p = 0.903$, $\eta^2 = 0.000$, although it did for time, Wilk's Lambda = 0.818, $F(1, 96) = 21.39$, $p < 0.001$, $\eta^2 = 0.182$. Because the omnibus effect of gender was not statistically significant, no follow-up ANOVAs were run, and Hypothesis 2 was not supported. Means and standard deviations, as well as covariate-adjusted means, appear in Table 2 for reference.

Discussion

The literature on brain injury suggests that women may outperform men in specific neurobehavioral, cognitive, and outcomes domains following TBI, especially in executive functions.¹⁹⁻³¹ However, these research findings are mixed.¹⁹⁻³¹ Our study focused on the specific executive functions deficit in SA after TBI, which not been well studied with regard to gender. The study purpose was to examine (1) possible gender differences in SA of injury-related deficits and (2) possible causes for these gender differences. It was hypothesized, based on the scientific literature, that in comparison to men, women would have better rehabilitation outcomes and more realistically assess their postinjury deficits during the acute phase of rehabilitation. Although the majority of analyses did not support these hypotheses and indicated that women and men showed similar levels of SA, women with TBI had better awareness of their own deficits at hospital discharge, as measured by patient-family discrepancy scores on the PCRS.

Several interpretations of the study findings can be considered. First, a preliminary explanation of the results finds a certain degree of support in recent research into hormonal neuroprotection.⁴⁵⁻⁴⁷ Hormonal neuroprotection is often proposed as an underlying mechanism^{4,48-57} in what the TBI literature collectively suggests is a gender advantage in postinjury recovery. Although typically higher in women, progesterone is produced by neurons and glial cells in the central and peripheral nervous systems by both men and women and has become a

frequent target in efficacy trials.^{49,53,55–57} Progesterone is produced in several organs of the human body, including the ovaries, adrenal glands, and the placenta during pregnancy.⁵⁸ The hormone is also stored in body fat.⁵⁹ In humans, increasing amounts of progesterone are produced during pregnancy. In addition to being present in both human males and females, progesterone can also be found in plants, particularly of the yam family,⁶⁰ and is available in synthetic form.⁶¹ Progesterone has been studied for its many potential medical applications and was approved as an oral capsule by the United States Food and Drug Administration (USFDA) on October 15, 1999 (<http://www.fda.gov/downloads/Drugs/DevelopmentApprovalProcess/UCM071436.pdf>). In females, progesterone rises and falls related to onset and decline of reproductive-life phases^{62–64} (<http://www.nlm.nih.gov/medlineplus/ency/article/003714.htm>), normal fluctuations during the menstrual cycle, and when pregnancy occurs.^{62–64} Progesterone's neuroprotective effects are hypothesized to include protecting the blood-brain barrier, decreasing the development of cerebral edema, enhancing antioxidant mechanisms to reduce excitotoxicity and the inflammatory cascade, enhancing synaptogenesis and dendritic arborization, and limiting cellular necrosis.⁵² Research related to progesterone's health and healing benefits served as a platform for subsequent clinical trials on the efficacy of acute exogenous administration of reproductive hormones to men and women with TBI,^{49,55,56} as well as the administration of female sex hormones, or selective estrogen receptor modulators, to both sexes.^{52,54} In addition to hormonal neuroprotection, researchers have explored the central role of reproductive hormones in improving outcomes for women after TBI from several other vantage points. Some have studied the postinjury effects of TBI on women's reproductive health²⁸; others have examined the possible impact of reproductive-life stage on mortality at the time of injury for women.^{31,46,47} Overall, each approach to the study of hormone-related gender advantage for women following TBI has, much the same as the study of gender differences in post-TBI outcomes, yielded mixed results.⁴⁵

The finding that women with TBI in our study sample were able to appraise their injury-related impairments more accurately than men at discharge is similar to prior evidence^{1,3} of superior postinjury executive functions for females. Researchers examining the role of reproductive hormones in TBI recovery might argue that the difference can be accounted for, in part, by hormonal neuroprotection related to higher levels of progesterone.^{45,48–51} However, blood samples indicating levels of hormones for female study participants were not drawn or analyzed. Future studies may want to add assays of blood levels of reproductive hormones as a variable of interest. Collecting these measures may provide more information about gender differences in SA than the demographic variables in our study, which did not account for study results, as the gender differences were present even after adjusting these covariates.

A second possible interpretation of the study results, which the TBI research literature to date has largely failed to consider, is related to the general societal pressure for men and women to conform to different gender-role expectations. Men are taught from an early age not to show weakness or ask for help,³⁷ whereas women are socialized to ask for help and disclose problems interpersonally.^{37–39} In the general population, women are more likely to report medical and mental

health problems, pain, and disability and to seek help for these difficulties than men are.^{33–36} This tendency also holds for post-TBI symptom self-report, with women reporting higher stress and depression than men,^{64,65} as well as different symptom domains.^{33,34,36}

Women in our study, by virtue of their gender role, may have felt freer to disclose their deficits in comparison to men at discharge. The significant findings in our study may also be owing to differential expectations that family members and clinicians could have for women and men with regard to rehabilitation. For example, the authors of one study³⁵ caution that observer ratings of patients can be influenced by stereotypes, such as gender-role expectations, as well as negative attitudes toward patients who are perceived as being to blame for the cause of injury.

Differential gender-role expectations may contribute to previous research findings that women are less likely to be offered vocational rehabilitation after TBI²¹ and are more likely after TBI to experience disempowerment, isolation, and abuse.³⁹ When applied to our study, this framework could imply that family members have lower rehabilitation expectations for women than for men. Several authors also have suggested that gender differences in socialization, gender-role expectations, disrupted gender and power relations, and differential access to postinjury rehabilitation can moderate the relationship between gender and cognitive outcomes after TBI.^{28,38,39}

A third potential interpretation of our study results could be found in cross-field literatures and findings of comparisons of abilities between healthy males and females of all ages. For example, studies have shown that healthy females from age 11 to 80 have better verbal memory than healthy males and that healthy men have superior visuospatial and visual memory than healthy women.^{41,42} Sports medicine researchers consistently report that biological differences between male and female athletes are expressed in different levels of strength, endurance, and perhaps confidence, that primarily favor men in competition.^{40,65}

A final factor that could have affected the results of our study is the unknown presence of preexisting intellectual challenges in the study sample. In an educational setting, premorbid intellectual disabilities and early environmental condition impact learning and scholastic performance in both genders.⁶⁷ Our study did not examine possible differences owing to the presence of premorbid intellectual challenges, although TBI and attention deficit hyperactivity disorder (ADHD) are known to be strongly associated disorders.⁶⁸

Conclusions

Study findings

With regard to interpreting our findings, a consideration of the two primary measures is warranted, especially as only discrepancies on the PCRS were statistically significant. Although patients' scores on the PCRS and the FrSBe are correlated,^{12–18} there are differences in their cognitive requirements of examinees. On the PCRS, respondents rate present patient competencies in a variety of current activity domains. The discrepancy score obtained by comparing the family, clinician, and patient self-report scores is thus based on the present only. The FrSBe requires each respondent to rate patients' competencies both before and after their injury,

within the same item. As a result, the FrSBe likely requires a somewhat more complex level of awareness. Also, on the FrSBe, the respondent must fully understand what is required in the “before” and “after” appraisal and have full knowledge of the unique personality and behavioral characteristics of the patient prior to injury. These additional sources of variance could have accounted for the larger standard deviations for discrepancy scores on the FrSBe in comparison to the PCRS in the study, obscuring mean gender differences on the FrSBe but not on the PCRS.

The significant 16-point gender difference in PCRS discrepancy at Time 2—and in a sense also the nonsignificant gender differences in the other comparisons similarly hinting at larger discrepancies for men—has implications for rehabilitation. In comparison to women, men’s families may need additional training regarding patient self-awareness of deficits and the resulting supervision required in functional domains. Men, for example, may be more likely than women to engage in risky behavior (e.g., driving, cooking, walking in dangerous areas) because of a lack of awareness of their own deficits. However, despite documented gender differences in self-reporting of physical and mental health problems and in gender-role pressures, few gender differences have emerged in the literature related to postinjury-impaired SA in either acute or postacute TBI populations. Although our study found that women’s PCRS ratings of themselves were more in line with their family members’ ratings than were men’s ratings at discharge, the vast majority of gender comparisons in the study did not yield statistically significant results. This pattern of mixed findings mirrors the pattern of results that dominate the published literature to date. The lack of consideration given to similar differences found in healthy males and females of all ages,^{40–42} suggests that gender differences in rehabilitation outcomes may not be as large or of as much significance as some researchers argue.

Limitations and future directions

Our study has several limitations. First, the comparisons and interpretation of the results from this study may be limited by uniqueness in study design and methodological approach, such as the characteristics of the patient population, the amount and timing of the rehabilitation received following TBI, specific neuropsychological and neurobehavioral measures applied, and potential confounding effects for which the study results were not adjusted. For example, because the study sample was from an adult acute brain injury rehabilitation unit, we were not able to compare either pre- and postpubescent males and females or postpubescent and premenopausal females to aged-matched males with TBI related to study variables. One would expect these two comparisons to yield more information or perhaps less equivocal support for our hypotheses.

Our available sample was also relatively small. A larger sample would have provided sufficient power to narrow comparisons to an age range of 18 to 40 years for men and women. Focusing on males and females with TBI in this age range would have made our participants more hormonally comparable.

An additional limitation is related to the scope of the study. In its somewhat narrow focus on gender differences in SA and postinjury outcomes, this study was unable to identify

any systems of connections between awareness and outcomes or any moderating variables that could have affected these connections. For example, future research should consider such factors as documented ability differences for healthy males and females over the lifespan, gender differences in biology that are observed in performance of healthy athletes, and unknown premorbid intellectual disabilities in interpretation of gender difference research findings.

Future investigators may also wish to more deeply explore the role of hormones and biomarkers involved in outcomes of TBI rehabilitation for women and men. Although anti-inflammatory properties of progesterone have been consistently observed, investigators have yet to fully explain how a combination of the TBI and normal fluctuations in reproductive hormones might contribute to a range of outcomes.^{50,52} In addition, although several candidates have been identified for biomarkers of TBI, gender differences in presence and levels of the molecular markers have not been fully researched.^{68,69}

Future researchers should also directly tap gender-role conformity by including measures of the degree to which patients conform to their respective gender roles and explore this as a moderator in outcomes for men and women after TBI. Finally, assessment of the degree to which family members’ and clinicians’ gender stereotypes are influencing the expectations they place on women and men with TBI is recommended. The mixed results reported in this article point to a continued need for larger and more comprehensive studies on gender differences in TBI rehabilitation during both acute and postacute care.

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