Response to Acute Concussive Injury in Soccer Players: Is Gender a Modifying Factor?

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Introduction

The Concussion in Sport Group (CIS) has not included gender as a modifying factor in SRC, concluding that the evidence to date was equivocal. We assessed acute neurocognitive and symptom responses to SRC in equivalent cohorts of male and female soccer players. We **hypothesized that female athletes would experience greater levels of acute neurocognitive impairment and total symptoms than males.**

Methods

Forty male and 40 female soccer players with baseline symptom and neurocognitive scores (ImPACT), who sustained a SRC, and completed post-concussion symptom and neurocognitive testing. Their baseline and post-concussion neurocognitive test scores and symptoms were compared. The athletes were matched on the following variables: sport, age, years of education, number of prior concussions, and number of days post-concussion evaluated.

Means and Standard Deviations of Male and Female ImPACT Variables at Baseline and Post-Concussion Measurements

	Male		Female	
	Mean	Standard Deviation	Mean	Standard Deviation
Baseline Scores				
Verbal Memory	82.47	8.20	84.55	9.95
Visual Memory	76.80	11.55	72.00	13.49
Visual-Motor Speed	38.19	6.22	37.67	5.96
Reaction Time	.612	.14	.58	.072
Impulse Control	6.62	7.57	6.50	3.65
Symptom TOTAL	2.03	2.75	3.95	5.87
Post-Concussion Scores				
Verbal Memory	83.60	13.10	82.15	15.03
Visual Memory	70.58	15.52	68.80	16.28
Visual-Motor Speed	38.12	8.91	37.0098	8.429
Reaction Time	.59	.091	.6103	.13
Impulse Control	7.70	8.43	8.48	5.96
Symptom TOTAL	12.75	21.75	13.18	16.05

Table 1

Gender by Baseline-to-Post-Concussion Split-Plot Analyses of Variance

	Gender Main Effect		Baseline-Post Main Effect		Interaction	
	F	*p*	*F*	*p*	*F*	*p*
A-Priori Tests						
Verbal Memory	.293	.590	.176	.676	1.345	.250
Visual Memory	1.448	233	7.936	.006	.818	.369
Post Hoc Tests						
Visual-Motor Speed	.293	.590	.247	.620	.165	.685
Reaction Time	.072	.790	.074	.786	5.397	.023
Impulse Control	.055	.815	7.687	.007	.669	.416
Symptom Total	.274	.602	21.597	.000	.122	.728

Note: Degrees of freedom for effect and error are 1, 78 for all tests. Critical value of α for declaring significance of the A-Priori tests is $\alpha = .05$, the Bonferroni adjusted critical value of α for Post Hoc Tests is $\alpha = \frac{.05}{4} = .0125$.

Table 2

Results

Specific a-priori hypotheses on differences between males and females at baseline and at post-concussion measurements on verbal and visual memory ImPACT scores were evaluated by simple main effects of the gender by baseline-to-post-concussion interaction of 2 x 2 split plot analysis of variance. Neither the interaction nor the main effects, nor the simple main effects for either ImPACT variable were found to be statistically significant. Exploratory analyses of variance applied to the remaining ImPACT variables of visual-motor speed, reaction time, impulse control, and symptom total scores revealed only a single statistically significant baseline to post-concussion main effect for the symptom total. The mean change, averaged across males and females, increased substantially from baseline (M = 7.5) to post-concussion (M = 17.24).

Conclusions

Our results **failed to replicate prior findings of gender-specific baseline neurocognitive differences in verbal and visual memory.** Our findings also indicated **no differential gender-based acute response to concussion** (symptoms or neurocognitive scores) among high school soccer athletes. The findings from our tightly matched cohort have implications for the inclusion of gender as a modifying factor in the acute evaluation of athletes sustaining SRC.

Learning Objectives

1)Describe the importance of matching cohorts when assessing post-concussion outcome; 2) Discuss how gender may or may not affect post-concussion assessment and treatment; 3) Integrete our findings with the existing literature, that females have been shown to have better verbal memory scores, poorer visual memory scores, and endorse more symptoms.