

**YOU ARE INVITED TO ATTEND THE  
DEFENSE OF THE DOCTORAL  
DISSERTATION**

**“SIDELINE ASSESSMENT OF SYMPTOMS AND CEREBRAL  
BLOOD FLOW ALTERATIONS IN MEN AND WOMEN RUGBY  
PLAYERS IMMEDIATELY FOLLOWING A HEAD INJURY”**

by

**Stephanie Iring-Sanchez**  
Biomedical Engineering Program  
B.S. 2013, Rutgers the State University of New Jersey  
M.S. 2016 New Jersey Institute of Technology Newark, New Jersey

Thesis Advisor:  
Dr. Jorge Serrador, Ph.D.  
Associate Professor Associate Professor  
Rehabilitation and Movement Sciences, School of Health Professions  
Dept. of Pharmacology, Physiology and Neuroscience, New Jersey Medical School

Wednesday, May 25th, 2022  
8:00 a.m.  
Medical Science Building H-609  
Zoom Link Below:  
<https://rutgers.zoom.us/j/92071261463?pwd=bHVlMG4zdTEsK0s0T21zQlRlY0Yydz09>

Meeting ID: 920 7126 1463  
Password: 802149

## **Abstract**

There are up to 3.8 million sports-related concussions in the U.S. each year, which makes it a significant public health issue. Symptoms of concussions are reported to resolve within two weeks, however, increasing evidence shows long-term neurophysiologic abnormalities. There are limitations to current self-reporting assessments and neuroimaging techniques, including the underreporting of symptoms; the unreliability of diagnostic methods; and excessive time lapse for evaluation following an injury. Given the prevalence of sports-related concussions, the development of an on-field assessment protocol is needed to indicate the severity of a concussion for follow-up treatment and to predict which players can return to play. This thesis studies the immediate effects of a head injury by evaluating physiological and symptomatic responses. Physiological changes were measured using non-invasive techniques such as transcranial Doppler to record middle cerebral artery blood flow velocity; duplex ultrasound to measure internal carotid artery blood flow; finger plethysmography to measure blood pressure; ECG to monitor heart rate; and capnography to measure end-tidal CO<sub>2</sub> from participating rugby players with a mobile laboratory tent on the field. To assess symptomatic and cognitive changes, the Sport Concussion Assessment Tool 3 (SCAT3) evaluated men and women immediately after the rugby game. An evaluation of cerebral blood flow immediately following injury (95±139 minutes) determined there are significant changes dependent on both body position and sex. Males demonstrated cerebral hypoperfusion in the supine position. In contrast, females were hyperperfused when seated. In addition, males were slightly hypertensive compared to non-injured players, while females did not show any blood pressure changes. Examination of symptoms found greater symptom reporting in head-injured players with a Principal Component Analysis highlighting 4 factors of which hypersensitivity and headache were most related to head injury. Interestingly, uninjured players who had just completed a match also showed increased symptom severity, highlighting the importance of considering exercise effects on symptoms, independent of head injury. This work demonstrates that examination of sex differences and posture are critical in evaluating the extent of sports-incurred head injuries on the field.