A NORMATIVE STUDY OF THE SPORT CONCUSSION ASSESSMENT TOOL (SCAT2) IN CHILDREN AND ADOLESCENTS

By

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To my Mother, Father, Walt, and Alesia
ACKNOWLEDGMENTS

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Concussion is a complex pathophysiological process caused by mechanical forces to the head that affects domains of everyday functioning including, but not limited to, behavior, emotion, and cognition. Concussion is relatively common in organized sports and active recreation, and children are particularly vulnerable due to their common involvement in youth sports and physical education activities at a time of continuing brain development. Recent practice parameters encourage the systematic use of concussion surveillance/management tools that evaluate participating athletes at baseline and after a concussion. Office-based tools (Sports Concussion Assessment Tool [SCAT2]) are useful candidate measures, but require accurate baseline assessment to maximize utility. The American Academy of Pediatrics (AAP) endorses the use of the SCAT2 by pediatricians to diagnose incident concussions in practice, but no normative data exist for children, limiting the identification of “normal” or “impaired” score ranges by the practitioner. The SCAT2 measures several domains of functioning including self-reported symptoms, orientation, cognition, and postural stability (Balance Evaluation Scoring System; BESS) to create a summary performance index. In this study, a community-based approach was implemented to compile baseline performance
data on the SCAT2 in 720 children aged 9-18 to create age-graded norms stratified by ethnicity. Preliminary findings indicate a significant age effect on SCAT2 performance. Older adolescents and teenagers (ages 12-18) scored higher than younger children (ages 9-11), and significant age differences were also found on symptom report, SAC, and BESS components of the SCAT2. Sex was also associated with differences on SCAT total and symptom report. Males scored higher than females on the overall SCAT2 composite due to females reporting more physical symptoms at baseline than males. Data are provided on healthcare provider concussion training and the effect of data collection setting on SCAT2 testing characteristics. Overall, findings support the SCAT2 as a useful clinical tool for assessing baseline functioning in teenagers, but suggest that clinical utility may be limited in children under the age of 11.
CHAPTER 1
INTRODUCTION

Literature Review

Mild traumatic brain injury (mTBI), also known as “concussion”, is defined as “a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces” (McCrory, Meeuwisse, Johnston, Dvorak, Aubry, Molloy, & Cantu, 2009). Concussion symptoms cross several domains that can profoundly affect children’s academic and social functioning including cognition, emotional regulation, and physical well-being (Broglio, Moore, & Hillman, 2011; Erlanger, Kaushik, Cantu, Barth, Broshek, Freeman, & Webbe, 2003; Fazio, Lovell, Pardini, & Collins, 2007; Guskiewicz, 2001). Young children and adolescents are highly vulnerable to concussion for several reasons as they are in a critical period for physiological and cognitive development, which affects postural stability and also decision-making about risk taking behavior (Centers for Disease Control and Prevention, 2010; McKeever & Schatz, 2003). Not only is this population at higher risk for sustaining a concussion, but they may also be more sensitive to post-concussive effects due to their developing neural status, and, therefore, may exhibit protracted recovery times compared to adults and show greater long-term neurobehavioral impairment (Giza & Hovda, 2001; Kutcher & Giza, 2010; Toledo, Lebel, Becerra, Minster, Linnman, Maleki, 2012). As of 2010, children and adolescents under the age of 19 had the highest rates of traumatic brain injury hospitalization with adolescent males at particularly high risk (Centers for Disease Control and Prevention [CDC], 2010). Concussion incidence in high school and pre-adolescent youth athletes is steadily rising, which is likely attributable to several factors including increased recognition and awareness by coaches, parents, and athletic
administrators, higher rates of diagnosis among healthcare providers, and greater 
participation in youth sports (Barlow, Crawford, Stevenson, Sandhu, Belanger, & 
Dewey, 2010; Guerriero, Proctor, Mannix, & Meehan, 2012). Regardless of the reason, 
this increase underscores the need for effective concussion recognition and 
management protocols on and off the field.

Cumulative effects of concussion can be especially devastating in a youth 
population. Not only are repetitive injuries associated with increased susceptibility to 
future concussions (Collins, Lovell, Iverson, Cantu, Maroon, & Field, 2002) and lower 
grade point averages in high-school age children (Moser, Schatz, & Jordan, 2005), but 
recent findings have associated multiple concussions with risk of catastrophic injury. 
Although rare, Second Impact Syndrome (SIS) is a devastating condition that produces 
acute cerebral edema upon sustaining a second concussion before full recovery of a 
prior concussion has occurred (Cantu & Gean, 2010; Weinstein, Turner, Kuzma, & 
Feuer, 2013). Long-term neurodegenerative processes such as Alzheimer’s disease 
are also thought to be associated with multiple concussion history (Journal of 
Alzheimer’s Disease, 2009; Plassman, Havlik, Steffens, Helms, Newman, Drosdick, et 
al., 2000; Scher, 2012). Chronic traumatic encephalopathy (CTE), another more 
recently identified neurodegenerative process, is thought to be caused by, or associated 
with, cumulative head impacts of a sub-concussive or concussive nature typically 
sustained over the course of an athletic career (McKee, Stein, Nowinski, Stern, 
Daneshvar, Alvarez, e al., 2012; Omalu. DeKosky, Minster, Kamboh, Hamilton, & 
Wecht, 2005; Omalu, Hamilton, Kamboh, DeKosky, & Bailes, 2010; Saulle & 
Greenwald, 2012). Again, these findings underscore the need for sensitive diagnostic
strategies to address concussion in children so that these severe consequences may be reduced or eliminated through appropriate return-to-play practices in youth sports.

Objective diagnosis of concussion depends upon identification of characteristic signs and symptoms. This can be complicated because definitive neuroimaging findings are typically absent (Jacobs, Beems, Stulemeijer, van Vugt, van der Vliet, Borm, & Vos, 2010; McCrory et al., 2009), and because identification of concussion symptoms is partly reliant on self-reports of participants who may be motivated to minimize or hide their symptoms in order to “stay in the game.” Post-injury symptom presentation is difficult to predict across individuals and often differs depending on age and sex (Covassin, Elbin, Harris, Parker, & Kontos, 2012; McCrory, Collie, Anderson, & Davis, 2004; Preiss-Farzanegan, Chapman, Wong, Wu, & Bazarian, 2009). Covassin et. al (2012) found a complex interaction with age and sex on measures of memory and postural stability following concussion. In this study, younger male athletes experienced longer recovery times and more impaired balance and memory than did their college age counterparts. In contrast, younger female athletes performed better on balance measures than did college female athletes. While symptom report can be a useful indicator of clinical concussion severity (Erlanger et al., 2003), prevalence of symptoms in pre- and post-injury reports can also differ based on age and sex (Lovell, Iverson, Collins, Podell, Johnston, Pardini, Pardini, Norwig & Maroon, 2010). Historically, females tend to report more symptoms than males (Broshek, Kaushik, Freeman, Erlanger, Webbe, & Barth, 2005; Covassin et al., 2012; Colvin, Mullen, Lovell, West, Collins, & Groh, 2009), but this sex difference diminishes in younger, non-adult populations (Preiss-Farzanegan, et al., 2009).
Symptom report in isolation is not necessarily a reliable source of post-concussion functioning as athletes may not be completely truthful about their experiences in order to remain in play. Additionally, younger children may be less able to verbally express their somatic experiences and symptoms post-concussion. Taken together, it is clear that a multifaceted approach to concussion assessment is the most desirable and should include cognitive, balance, and symptom measures to paint a more comprehensive and objective picture of post-concussion impairment (McCrory, et al., 2009).

The Sport Concussion Assessment Tool (SCAT2) is one such multi-component assessment approach that is open source and endorsed by 3rd International Conference on Concussion in Sport (2008) for standard clinical assessment in sport. In a position statement in 2010, the American Academy of Pediatrics also identified the SCAT2 as a recommended tool for sideline and in-office assessment for concussion (Halstead, Walter, & The Council on Sports Medicine and Fitness, 2010). The SCAT2 provides brief concussion assessment and incorporates symptom report with existing measures of cognition (Standardized Assessment of Concussion; SAC – McCrea, Kelly, Randolph, Kluge, Bartolic, Finn & Baxter, 1998) and postural stability (Balance Error Scoring System; BESS – Guskiewicz, Ross, & Marshall, 2001). The SAC and BESS were independently developed and have demonstrated utility in detecting clinical changes post-injury (Davis, Iverson, Guskiewicz, Ptito, & Johnston, 2009; Grubenhoff, Kirkwood, Gao, Deakyne, & Wathen, 2010a; Guskiewicz, 2001). Ideally, concussion assessment should include individual baseline evaluation at pre-season (Moser, Iverson, Echemendia, Lovell, Schatz, Webbe, et al., 2007), but not all athletes are
presented with the opportunity to receive baseline concussion testing. Therefore, establishing a normative comparison group based on age, sex and, possibly, race/ethnicity status is useful for improving clinical concussion diagnostics especially for cases where individual baselines are unavailable. Additionally, norms can aid interpretability in cases where athletes may be purposefully “sandbagging” or demonstrating learning effects (Valovich McLeod, Perrin, Guskiewicz, Shultz, Diamond, & Gasneder, 2004).

**Previous Research**

Attempts to establish SCAT2 normative comparison groups in non-adults under the age of 18 have only begun to appear in the past year. Valovich McLeod et al. (2012) designed a descriptive epidemiological study to establish representative baseline SCAT2 scores for high school athletes. Similarly, Jinguji et al. (2012) produced normative baseline SCAT2 scores for high school athletes without prior history of concussion. Overall, average baseline SCAT2 scores for a non-concussed population of high school aged children was found to be roughly 90 out of 100. Both studies found significant variability in overall SCAT2 and subcomponent scores based on sex and age. Consistent with previous findings from neuropsychological testing literature (Hunt & Ferrara, 2009; Saykin, Gur, Gur, Shtasel, Flannery, Mozley, et al., 1995), females performed better than males on cognitive (SAC) and balance (BESS) subcomponents, and age was associated with lower overall SCAT2 scores. Neither study offers normative data on younger, elementary and middle school aged children, however, they do support the necessity for stratifying norms based on age and sex.
Current Study

The purpose of the current study is to define normative population estimates for pre-season, baseline SCAT2 testing based on demographic factors including age, sex, and race/ethnicity for children between the ages of 9 to 18. A demographically stratified normative table will be created in the course of this study and implications for using the SCAT2 in concussion assessment of pre-adolescent (ages 9 to 11) and adolescent (ages 12 to 18) populations will be investigated and discussed.

Rationale and Prediction 1

Since cognitive and balance abilities undergo important maturational changes during adolescence, younger children are expected to produce lower performance on overall SCAT2 scores because of decreased SAC and BESS subcomponent scores. This prediction is supported by general physiological knowledge and cognitive developmental theories. However, previous findings have reported inconsistent age effects for the SAC in youth populations, which may have important implications for determining normative age groups (Grubenhoff, Kirkwood, Gao, Deakyne, & Wathen, 2010b; Jinguji et al., 2012; Valovich McLeod, Bay, Lam, & Chhabra, 2012).

Rationale and Prediction 2

Demographic variables such as sex and race/ethnicity have demonstrated associations with neuropsychological testing in that females tend to perform better than their male counterparts (Barr, 2003). Minority status has been linked with lower performance on certain Wechsler Adult Intelligence Scale, Revised (WAIS-R) subtests (Kaufman, Mclean, & Reynolds, 1988), but a recent study by Kontos, Elbin, Covassian, and Larson (2010) did not find meaningful differences at baseline on a computerized neurocognitive concussion test (Immediate Post-Concussion Assessment Cognitive
Test – ImPACT) between African American and White high school and collegiate athletes. However, post-injury assessment showed African Americans had an increased likelihood to exhibit cognitive decline seven days later than did White peers. Although the ImPACT and SCAT2 tap similar neurocognitive constructs, the SCAT2 incorporates verbal free recall, which may be more influenced by race/ethnicity (Norman, Evans, Miller, & Heaton, 2000), thus warranting the examination of race/ethnicity as a candidate normative variable on the SCAT2.
CHAPTER 2
METHODS

Patient data for the normative study were collected in the context of the University of Florida – Florida State University Community Research and Collaboration Project: Concussion Surveillance and Management Program (UF-FSU CRCP), a network of University-affiliated healthcare providers who administered SCAT2s during routine, qualifying athletic physicals for youth athletes in their community. Providers in this network included medical doctors, registered nurse practitioners, and physician assistants located in cities across Florida including Orlando, Tallahassee, Quincy, and Jacksonville. As part of the study protocol, student-athlete participants who attended these medical practices for qualifying physical examinations agreed to return to the examining physician if and when the participant sustains a concussion during season play for follow-up SCAT2 testing to assist in concussion diagnosis and management.

Revisions to the protocol, approved by the University of Florida Health Science Center Institutional Review Board (IRB-01) enabled three additional data collection approaches to be implemented. The first allowed researchers to administer the SCAT2s during “athlete round-ups” facilitated by community clinics that organized a group approach to provide qualifying sports physicals for large numbers of youth athletes in a short time period. The main purpose of the “round-up” events was to target youths who may not have a primary care provider or other stable healthcare provider from whom to obtain qualifying physical examinations. A second collection approach was approved to provide for the creation of community-based concussion-testing events that functioned independently as a free service to the community for children.
Lastly, a corpus of retrospective clinical data from area high schools was included from SCAT2s collected before the 2012-2013 academic year by athletic trainers from the graduate Athletic Training Program at the University of Florida. As part of the program’s graduate student curricula, trainees are stationed in area high schools throughout the county to provide athletic training services for students. The athletic trainers administer pre-season baseline concussion testing using both the ImPACT computerized program and paper-based SCAT2s for mostly football athletes. Data were obtained primarily in August, 2012 and deidentified after the IRB-01 revision was approved in December 2012 in order to be included in the UF-FSU CRCP database. This methodology added 486 student athletes ranging from ages 11 to 18.

**Subjects**

This study analyzed data from 720 total subjects across all four collection methods. As the goal of this project was to collect a normative sample, no exclusion criteria for participation aside from age (9-18 years old) were included. The average age of the participant group was 14.8 ± 2.2 years, and participants were recruited from rural and urban locations throughout North Florida including Quincy, Orlando, Jacksonville, Alachua, Gainesville, and Tallahassee. Of the total sample, retrospective clinical data accounted for 68% (n = 486), the UF-FSU CRCP network accounted for 21% (n = 151), and community “athlete round ups” accounted for 11.6% (n = 83). Community-based baseline concussion testing will be implemented in the future to supplement the normative sample. The current sample included 634 (88.1%) males and 86 (11.9%) females. Racial/ethnic data were only collected on 93 participants. A total of 20 team and individual sports were included, the most common being American football (75.7%) followed by cheerleading (5.4%), basketball (3.3%), and baseball.
(3.1%), which was expected since the entire retrospective clinical contribution focused on testing football athletes almost exclusively.

**SCAT2 Training**

Network healthcare providers were trained through an online portal provided by the UF-FSU CRCP website (www.healthimpactsflorida.com) accessible through project-administered passwords. The training program study data were collected and managed using REDCap electronic data capture tools hosted at University of Florida. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris, Taylor, Thielke, Payne, Gonzalez, & Conde, 2009). In order to assess the effectiveness of the training program, a pre- and post-test evaluation was included in the training workflow. Initial concussion knowledge was measured by a 20-item, multiple-choice pre-test that was based on content from the Zurich report (McCrory et al., 2009) and National Collegiate Athletic Association (NCAA) concussion guidelines (2010). After completing the pre-test, trainees were automatically navigated to the training modules consisting of:

- **American College of Sports Medicine Webinar on Concussion Management** (NCAA, 2012), which provided basic education on the nature and impact of concussion and outlined basic procedures for evaluation and management of concussion events.

- **Consensus statement on concussion in sport from the 3rd international conference on concussion in sport, held in Zurich, November 2008.**


A 20 item multiple-choice post-test (also based on the Zurich recommendation report) followed the post-test on which providers were required to score an 80% or higher in order to participate in the study. Licensed physicians were eligible to receive 2.5 Continuing Medical Education (CME) credits for successful training completion. A total of 37 UF-FSU CRCP network healthcare providers passed the post-test and 30 earned CME credits.

The training protocol described above was also used to train research assistants who volunteered to administer the SCAT2 in the athlete “round ups” and community-testing events. These individuals were required to view the online training modules but not to complete pre- and post-tests. Additionally, each research volunteer attended an individual training check-out session with the head research coordinator where he or she demonstrated the ability to administer the SCAT2 in a standardized manner. A total of 27 graduate and undergraduate students from the University of Florida participated as research volunteers and successfully completed the training protocol.

**SCAT2**

Individual SCAT2s were administered in one of two formats: paper and pencil and iPad-based using an application designed by Innovap, Inc (see Appendix A). A demographic questionnaire was also administered during the athlete round-ups and community testing events that included questions about race/ethnicity status and previous concussion history (see Appendix B). A positive history of concussion was defined as a head injury diagnosed as such by a medical or healthcare professional,
and responders were also asked to identify the number of confirmed concussions. Parents were the preferential source for completing this background questionnaire. Psychometric properties of the SCAT2 are not well established for the tool as a whole, but the SAC and BESS components have shown validity and reliability in previous studies (Barr & McCrea, 2001; Riemann, Guskiewicz, & Shields, 1999; Valovich McLeod, Barr, McCrea, & Guskiewicz, 2006). A maximum of 100 total points are possible and errors on SAC and BESS subcomponents or symptom endorsement lower the overall score. The SCAT2 begins with a symptom report section containing 22 possible symptoms worth one point each with graded response options (0 through 6) to indicate symptom severity. For incident concussion assessment, physical signs (2 points), Glasgow Coma Scale (15 points), and Maddocks Questions provide additional information about basic neurological, motor, and response functioning, but these sections were omitted for the purposes of baseline assessment, and participants automatically received 17 points for physical signs and GCS. The SAC component score (30 points) is constructed from orientation, immediate memory, attention, and delayed recall measures followed by the modified BESS (30 points), which includes three different stances on a firm surface to assess postural stability.
Table 1-1. Sample Demographic Characteristics

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*Note: AA = African American; H/L = Hispanic/Latino; A/P = Asian and/or Pacific Islander*
CHAPTER 3
RESULTS

Baseline Norms

The purpose of this study was to create a normative table of baseline SCAT2 scores organized by age and sex, which is presented in Table 2. Race and ethnicity were not included in the normative table because this demographic variable was collected on too few individuals to accurately represent trends on SCAT2 concussion testing.

Age

Across all participants, the mean overall SCAT2 score was 88.23, SD = 5.89 (range: 61 - 98) and mean component scores were as follows: SAC (cognition) $M = 25.17$, $SD = 2.77$, range: 12 – 30; BESS (balance), $M = 25.10$, $SD = 3.57$, range: 10 – 30; Symptom Score, $M = 20.03$, $SD = 3.23$, range: 1 – 22; and Symptom Severity (not included in the overall SCAT2 score) $M = 3.35$, $SD = 6.46$, range: 0 - 64. Total SCAT2 and component scores were all negatively skewed and positively kurtic according to the Shapiro-Wilk test of normality; SCAT2 Total: $D(715) = .103$, $p < .05$; SAC: $D(715) = .145$, $p < .05$; BESS: $D(715) = .137$, $p < .05$; Symptom Score: $D(715) = .271$, $p < .05$.

Figure 1 displays the normality distributions for the SCAT2 total and component scores.

Participants were divided into five groups based on age (9 to 10, 11 to 12, 13 to 14, 15 to 16, and 17 to 18) for two reasons: 1) based on graphical analysis of the outcome scores that showed trending differences in the 9 and 10 year olds compared to older peers and 2) these age groups roughly corresponded to academic grade level (i.e. 9 and 10 year olds are typically in 4th grade, 11 and 12 year olds are in 5th grade, etc.). A one-way univariate Analysis of Variance (ANOVA) was conducted using these age
group divisions as a five-leveled independent variable and SCAT2 total score as the dependent variable. Overall, there was a significant effect of age on the SCAT2 total score, \( F(4, 376.54) = 11.5, p < .001, \eta^2 = .061 \), with younger ages linearly associated with lower SCAT2 total scores. A series of Bonferroni-corrected post-hoc analyses were conducted to identify significant differences among specific age groups. The youngest age group (ages 9 and 10; \( M = 83.61, SD = 7.66 \)) scored significantly lower on the SCAT2 compared to all other age groups, and the oldest age group (ages 17 and 18; \( M = 89.46, SD = 5.59 \)), scored significantly higher than all other age groups (\( p < .05 \)).

Separate one-way ANOVAs run for each of the component scores indicated that the age trend on SCAT2 total scores was driven by age differences on component scores. The same trend held across cognition and balance components in that younger children made more errors than older children, SAC: \( F(4, 713) = 3.36, p = .01, \eta^2 = .019 \); BESS: \( F(4, 715) = 3.69, p = .006, \eta^2 = .02 \). Specifically, Bonferroni-corrected post-hocs indicated that the youngest age group (9 to 10; \( M = 24.11, SD = 2.72 \)) was again significantly lower on cognition scores than the oldest age group (17 to 18; \( M = 25.54, SD = 2.68, p < .05 \)), and postural stability (BESS) follow-ups found that the youngest age group (9 to 10; \( M = 23.36, SD = 3.66 \)) made significantly more balance errors than the each of the two oldest age groups, 15 to 16 (\( M = 25.23, SD = 3.61 \)) and 17 to 18 (\( M = 25.55, SD = 3.51; p < .05 \)).

Symptom Score (number of symptoms endorsed subtracted from total symptoms possible, 22) and Symptom Severity (total of symptom severity ratings) also demonstrated age effects. Since both of these outcome measures violated the
assumption of homogeneity of variances, Symptom Score, $F(4, 715) = 5.15, p = .001$; Symptom Severity, $F(4, 715) = 3.40, p = .009$, and were significantly non-normal, the Brown-Forsyth robust test of equality of means was used. This produced a significant effect of age for both Symptom Score, $F(4, 223.72) = 4.95, p < .01, \eta^2 = .03$, and Symptom Severity, $F(4, 223.72) = 2.73, p < .05, \eta^2 = .02$. Games-Howell post-hoc follow-ups revealed that the youngest age group (9 to 10), $M = 18.32, SD = 4.58$, reported significantly more symptoms at baseline than the two oldest groups, 15 to 16, $M = 20.37, SD = 2.71$, and 17 to 18, $M = 20.43, SD = 3.08; p < .05$. Symptom Severity trended towards younger children reporting more severe ratings of baseline symptoms as well, but similar follow-ups did not reveal specific differences between age groups.

A univariate Analysis of Covariance (ANCOVA) was conducted on SCAT2 total and component scores (cognition and balance) to isolate the effect of age group covarying for sex and data collection setting. Only test setting as a covariate was significantly related to SCAT2 total score, $F(1, 708) = 10.05, p < .01, \eta^2 = .014$, and the effect of age group on SCAT2 total score persisted after controlling for the effect of sex and test setting, $F(4, 708) = 5.33, p > .001, \eta^2 = .03$. For cognition, both covariates were significantly related to SAC score, sex: $F(1, 711) = 6.56, p < .05, \eta^2 = .01$; test setting: $F(1, 711) = 9.26, p < .01, \eta^2 = .01$, and the effect of age group on SAC score was no longer significant after controlling for these two variables, $F(4, 711) = 1.82, p = .12$. For balance, test setting was the only covariate significantly related to BESS score, $F(1, 713) = 5.20, p < .05, \eta^2 = .01$, and the effect of age group on BESS was still significant after controlling for sex and test setting, $F(4, 713) = 6.11, p < .01, \eta^2 = .03$.  

26
Sex

Independent samples t-tests were used to compare sex on each of the SCAT2 outcome scores. Results indicated that sex is associated with significant differences on SCAT total scores in that males ($M = 88.42, SD = 5.65$) scored higher than females ($M = 86.78, SD = 7.25$), $t(99.62) = 2.02, p < .05, r = .09$; however, this finding reflects a relatively small effect size. No differences in sex were detected for the cognition and balance assessments, but there was a significant difference in symptom reporting, Symptom Score: $W_s = 23,407.5, z = -4.5, p < .001, r = -0.17$, which was tested using the non-parametric independent Wilcoxon rank-sum test due to a significant violation of normality in Symptom Score. On Symptom Score, females endorsed more symptoms ($M = 18.14, SD = 5.00$) at baseline than males ($M = 20.29, SD = 2.82$). Symptom Severity ratings were also significant, $W_s = 38,498, z = 4.436, p < .001, r = -0.17$, which demonstrated that females ($M = 6.71, SD = 9.87$) tended to rate symptoms as more severe than males ($M = 2.90, SD = 5.71$). A two-way univariate ANOVA was run with age group and sex as the independent variables to investigate possible interaction effects, but no significant interaction was detected on SCAT2 total scores, $p > .05$.

Data Setting Analysis

Since our data was collected in office, roundup, high school, and public health environments, we wanted to determine whether significant differences existed as a function of testing site. The contribution of testing-site (a 3-level variable: retrospective clinical data, in-office healthcare provider, and “athlete round-ups”) on baseline SCAT2 scores was explored through a one-way univariate ANOVA with SCAT2 total score as the dependent variable and test setting as the independent variable. Brown-Forsyth F-adjustment was used due to violation of the homogeneity of variance assumption and
showed that there is a significant effect of administration setting on SCAT2 scores, $F(2, 712) = 19.09, p < .001, \eta^2 = .067$. Games-Howell-corrected follow-ups elaborated that the retrospective clinical data contribution ($M = 89.25, SD = 5.16$) produced significantly higher SCAT2 baseline total scores than either the athlete “round-ups” ($M = 85.34, SD = 7.04$) or in-office provider assessments ($M = 86.60, SD = 6.57$). However, this finding is complicated by the fact that the retrospective clinical setting assessed only high school age children (ages 13 to 18) producing a higher mean age ($M = 15.77, SD = 1.42$) compared to the athlete “round-ups” ($M = 12.35, SD = 2.65$) and in-office provider settings ($M = 13.18, SD = 2.11$) where the full range of ages was tested (9-18). The significant effect of test setting on SCAT2 total scores persisted after selecting for only high school aged children (14 – 18 years), $F(2, 73.55) = 9.46, p < .001$. Specifically, follow-up tests indicated that high school athletes tested by graduate athletic trainers in the retrospective clinical setting reported significantly fewer symptoms at baseline ($M = 20.84, SD = 2.21$) than the other two settings (in-office provider, $M = 17.99, SD = 3.98$; “round-ups,” $M = 16.36, SD = 5.81$), and athletes tested by in-office providers ($M = 24.05, SD = 4.46$) scored significantly lower on the cognition assessment (SAC) than the retrospective ($M = 25.15, SD = 2.40$) or “round-up” ($M = 25.89, SD = 2.30$) settings.

**Provider Training**

A total of 36 network healthcare providers completed concussion training through the UF-FSU CRCP concussion training protocol for providers. In order to assess the effect of concussion education training on concussion knowledge, a repeated samples t-test was conducted to compare the results of a 20-item multiple choice pre-test to an alternative form 20-item post-test. Only the initial post-test score was used in the following analysis since providers were allowed to retake the post-test as many times as
necessary to obtain a passing score of 80%. Results from a paired-samples t-test indicated that after completing the requisite training modules, providers significantly improved their concussion knowledge (post-test score, $M = 86.41$, $SD = 8.54$) by an average of 23% over their pre-test score ($M = 70.31$, $SD = 11.35$). Most providers achieved a passing score of 80% on the post-test with their first attempt (84.8%), and the average number of attempts to pass the post-test was 1.3.
Table 3-1. Sport Concussion Assessment Tool (SCAT2) Total and Component Scores by Age Group and Sex

<table>
<thead>
<tr>
<th>Age Group</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>p</th>
<th>Male</th>
<th>Female</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCAT2 Total</td>
<td>83.61</td>
<td>7.66</td>
<td>86.99</td>
<td>5.75</td>
<td>87.57</td>
<td>5.89</td>
<td>88.85</td>
<td>5.28</td>
<td>89.46</td>
<td>5.59</td>
<td>&lt;.001</td>
<td>88.4</td>
<td>5.65</td>
<td>86.8</td>
</tr>
<tr>
<td>SAC (Cognition)</td>
<td>24.11</td>
<td>2.72</td>
<td>25.12</td>
<td>2.55</td>
<td>24.81</td>
<td>2.91</td>
<td>25.3</td>
<td>2.76</td>
<td>25.54</td>
<td>2.68</td>
<td>.01</td>
<td>25.1</td>
<td>2.76</td>
<td>25.3</td>
</tr>
<tr>
<td>Symptom Score</td>
<td>18.32</td>
<td>4.58</td>
<td>19</td>
<td>3.91</td>
<td>19.92</td>
<td>3.19</td>
<td>20.37</td>
<td>2.71</td>
<td>20.43</td>
<td>3.08</td>
<td>.001*</td>
<td>20.3</td>
<td>2.72</td>
<td>18.1</td>
</tr>
<tr>
<td>Symptom Severity</td>
<td>6.04</td>
<td>9.31</td>
<td>4.69</td>
<td>7.77</td>
<td>3.6</td>
<td>7.3</td>
<td>2.88</td>
<td>5.31</td>
<td>2.69</td>
<td>5.54</td>
<td>.03*</td>
<td>2.9</td>
<td>5.71</td>
<td>6.71</td>
</tr>
</tbody>
</table>

Figure 3-1. Normality distributions of SCAT2 outcome variables: (A) Total (B) SAC (C) BESS (D) Symptom Score, and (E) Symptom Severity.
Figure 3-2. Mean SCAT2 Total Scores by Age Group and Sex.
The results of the above analyses lead to several findings: (1) Age is significantly associated with total SCAT2 scores in that younger children produce lower baseline scores than older children; (2) Younger age was also significantly associated with decreased scores across all SCAT2 component measures of cognition, balance, and symptom report; (3) Males produced significantly higher baseline SCAT2 total scores than females, and this difference is primarily driven by higher symptom report in females; and (4) The concussion training protocol required by the UF-FSU CRCP improved healthcare providers’ scores on a measure of concussion knowledge compared to pre-training levels.

The present study found that differences in baseline SCAT2 scores exist between age groups, which are consistent with previous normative attempts and a priori expectations based on physiological and neurocognitive developmental literature. Younger age was associated with lower overall SCAT2 scores, and this pattern held true across component measures of cognition (SAC), balance (BESS), and symptom report (Symptom Score). The youngest age group (ages 9 and 10), in particular, made more errors on component measures resulting in significantly lower scores on the BESS and SAC compared to the oldest age groups. Regarding symptom report, younger children (9 and 10) also tended to identify significantly more symptoms at baseline than adolescents ages 15 and up.

Jinguji et al. (2012) and Valovich McLeod et al. (2012) both identified mean SCAT2 baseline scores close to 90 out of 100 for high school aged adolescents (14 to 18 years), but the present study found slightly lower mean baseline SCAT2 score for
this age group (88.7), and an even lower mean baseline score for those younger than high school age (86.6). In addition to developmental factors, this discrepancy may be the result of using baseline tests obtained across three different settings and/or a product of the lack of exclusionary criteria in this study compared to Jinguji et al. (2012), which excluded participants with a history of learning disability, attention deficit hyperactivity disorder, or six-month concussion history and Valovich McLeod et al. (2012), which required a pre-participation physical examination clearance before enrolling in their normative study.

Overall, these findings suggest that the SCAT2 may have less clinical utility in children under the age of 11 since variance in component scores for these children may be too limited to detect changes after a concussion has been sustained. However, this observation remains at the assumption level only since diagnostic characteristics of the SCAT2 after an incident concussion have not yet been established in children. A longitudinal study of children with baseline data who sustain incident concussions would be needed to address this issue. Another implication of these age trends is the necessity of repeated, annual pre-season baseline testing to accurately reflect maturational changes in youth athletes that manifest through improved neurocognitive ability and postural stability. The natural extension of the present study is to document SCAT2 scores on incident concussions, ideally matched with pre-season baseline, to better understand the clinical utility of the SCAT2 in children.

Sex had a significant relationship with overall SCAT2 scores, but in the opposite direction than expected from past literature, such that males produced higher total SCAT2 scores than females. No sex differences in cognition (SAC) or balance (BESS)
scores were noted; the sex effect resulted exclusively from the fact that females endorsed more symptoms at baseline than did males. This surprising finding is more likely a product of sample characteristics rather than true normative patterns of sex on the SCAT2. In particular, the sample was unbalanced with respect to sex, since there were proportionally fewer females in the older age groups causing an artificial restriction of the upper range of SCAT2 scores associated with older age.

Although not a main focus of this project, data collection setting emerged as a possible influence on the normative data trends, since the retrospective clinical data from local high schools contained significantly higher SCAT2 baseline scores from the other two data collection settings. One limitation of this study is that it is impossible to know if the older average age of this sample fully explains their higher scores because this data was collected by a different cohort of examiners (graduate athletic trainers), thus confounding the results. Interestingly, student-athletes from the high school setting reported significantly fewer baseline physical symptoms when compared to in-office healthcare provider and athlete “round-up” settings. This trend may have resulted from an intentional effort by high school athletes to more positively portray their physical functioning to athletic trainers who, essentially, control athletes’ sports participation eligibility. Individuals who administered SCAT2s in the other two settings - in-office provider assessments and athlete “round-ups” – were all trained in SCAT2 test administration in a similar fashion, through the UF-FSU CRCP prescribed concussion training protocol, and did not differ on baseline SCAT2 scores. Regardless of whether age or examiner cohort explains these differences, these results firmly underscore the
importance of standardized SCAT2 administration and training in order to maximize the usefulness of normative data and individual assessment.

Lastly, an initial attempt to address the “practice gap” in healthcare providers’ knowledge of concussion diagnosis and management was explored. After completing concussion education and training modules, a clear improvement was documented in healthcare providers’ knowledge across important topics such as the incidence, prevalence, signs, and symptoms of concussion, key principles in its management, and current knowledge regarding return-to-play guidelines and protocols. Since concussion legislation in youth sports is on the verge of becoming instituted nation-wide, this aspect of the study will become increasingly important in improving the quality of legislated services provided to youth sports participants. Healthcare providers need to be equipped with the knowledge to accurately assess concussion signs and symptoms, and use objective assessment data to inform clinical decision-making. Toward this end, a standardized, objective, in-office approach using instruments like the SCAT-2 is highly useful in providing a structure in which a range of healthcare providers, permitted legislatively to render care, can collect comparable, simple-to-interpret data. Future research should seek to establish the effects of incident concussion on SCAT-2 component and overall scores in order to provide firmer rules for clinical-decision making including when to order more extensive diagnostic workup or when to allow the child to return to play. Additional research is also needed to better understand sources of variance in SCAT2 administration and to develop training interventions that improve fidelity across administrators from different healthcare professions.
APPENDIX A
SPORT CONCUSSION ASSESSMENT TOOL (SCAT2)

SCAT2
Sport Concussion Assessment Tool 2

Symptom Evaluation

How do you feel?
You should score yourself on the following symptoms, based on how you feel now.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>“Pressure in head”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like “in a fog”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>“Don’t feel right”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trouble falling asleep (if applicable)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>More emotional</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nervous or Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Total number of symptoms (Maximum possible 12)
(Add all scores in table, maximum possible: 12 x 6 = 72)

Symptom severity score

Do the symptoms get worse with physical activity?  Y  N
Do the symptoms get worse with mental activity?  Y  N

Overall rating
If you know the athlete well prior to the injury, how different is the athlete acting compared to his / their usual self? Please circle one response.

<table>
<thead>
<tr>
<th>No different</th>
<th>Very different</th>
<th>Unsure</th>
</tr>
</thead>
</table>

37
Cognitive Evaluation

**Symptom score**
From page 1.

**Physical signs score**
- Was there loss of consciousness or unresponsiveness? [Y/N]
- If yes, how long? [XX minutes]
- Was there a balance problem/orientation? [Y/N]

**Glasgow coma scale (GCS)**

<table>
<thead>
<tr>
<th>Best eye response (E)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No eye opening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye opening to pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye opening to speech</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye opening spontaneously</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best verbal response (V)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No verbal response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confused</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oriented</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best motor response (M)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No motor response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension to pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal flexion to pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion/Withdrawal to pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotory to pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obey commands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Glasgow Coma Score = E + V + M

**Concentration**

**Digits Forward**
I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7.

If correct, go on next string length. If incorrect, read (to 2). One point possible for each string length. Score 2 points per string length. Score 5 points per string length. Score 10 points per string length.

**Digits Backward**
I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7.

If correct, go on next string length. If incorrect, read (to 2). One point possible for each string length. Score 2 points per string length. Score 5 points per string length. Score 10 points per string length.

**Months in Reverse Order**
Now tell me the months of the year in reverse order. Start with the last month and go backwards. So you'll say December, November... go ahead.

Score 2 points for correct answer.

**Concentration score**
Score of 10.
6 Balance examination

The balance testing is based on a modified version of the Balance Error Scoring System (BESS). A stop watch or watch with a second hand is required for this testing.

Double leg stance:
"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 30 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

Single leg stance:
"If you were to kick a ball, which foot would you use? This will be the dominant foot. Now stand on your non-dominant foot. The dominant leg should be held approximately 20 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 30 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Tandem stance:
"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 30 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Balance testing – types of errors
1. Hands lifted off test area
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip, hip > 20 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec.

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10. If an athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of five seconds at the start are assigned the highest possible score, ten, for that testing condition.

Condition | Total errors
--- | ---
Double leg stance | 10
Single leg stance (non-dominant foot) | 10
Tandem stance (non-dominant foot at back) | 10
Balance examination score (subtract total errors) | 30

7 Coordination examination

Upper limb coordination
Finger-to-nose (FTN) task: "I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended). When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose as quickly and as accurately as possible."

Which arm was tested: Left | Right

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. Failure should be scored as 0.

Coordination score

8 Cognitive assessment

Standardized Assessment of Concussion (SAC)
Delayed recall: "Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Circle each word correctly recalled. Total score equals number of words recalled.

<table>
<thead>
<tr>
<th>Item</th>
<th>Alternative word list</th>
</tr>
</thead>
<tbody>
<tr>
<td>elbow</td>
<td>candle</td>
</tr>
<tr>
<td>apple</td>
<td>paper</td>
</tr>
<tr>
<td>carpet</td>
<td>sugar</td>
</tr>
<tr>
<td>saddle</td>
<td>sandwich</td>
</tr>
<tr>
<td>bubble</td>
<td>wagon</td>
</tr>
<tr>
<td>fry</td>
<td>iron</td>
</tr>
</tbody>
</table>

Delayed recall score

Overall score

Test domain | Score
--- | ---
Symptoms score | 22
Physical signs score | 2
Glasgow Coma score (E + V + M) | 15
Balance examination score | 10
Coordination score | 1
Subtotal | 50

Orientation score | 5
Immediate memory score | 5
Concentration score | 5
Delayed recall score | 5
SAC subtotal | 30

SCAT2 total | 100
Maldeck's Score | 5

Deﬁnitive normative data for a SCAT2 “cut-off” score is not available at this time and will be developed in prospective studies. Embedded within the SCAT2 is the SAC score that can be utilized separately in concussion management. The scoring system also takes on particular clinical signiﬁcance during serial assessment where it can be used to document either a decline or an improvement in neurological functioning.

Scoring data from the SCAT2 or SAC should not be used as a stand alone method to diagnose concussion, measure recovery or make decisions about an athlete’s readiness to return to competition after concussion.
Athlete Information

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

**Signs to watch for**
Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:
- Have a headache that gets worse
- Are very drowsy or can’t be awakened (woken up)
- Can’t recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused, are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet, have slurred speech

**Return to play**
Athletes should not be returned to play the same day of injury. When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:
1. Rest until asymptomatic (physical and mental rest)
2. Light aerobic exercise (e.g., stationary cycle)
3. Sport-specific exercise
4. Non-contact training drills (start light resistance training)
5. Full contact training after medical clearance
6. Return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. Medical clearance should be given before return to play.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test domain</th>
<th>Time</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date tested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days post injury</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SCAT2**
- Symptom score
- Physical signs score
- Glasgow Coma score (E + V + M)
- Balance examination score
- Coordination score

**SAC**
- Orientation score
- Immediate memory score
- Concentration score
- Delayed recall score
- SAC Score

**Total SCAT2**
Symptom severity score (max possible 132)

**Return to play**
- Y N Y N Y N Y N N

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**Concussion injury advice (To be given to concussed athlete)**

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. It is expected that recovery will be rapid, but the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please telephone the clinic or the nearest hospital emergency department immediately.

Other important points:
- Rest and avoid strenuous activity for at least 24 hours
- No alcohol
- No sleeping tablets
- Use paracetamol or codeine for headache. Do not use aspirin or anti-inflammatory medication
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

**Clinic phone number**

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**SCAT2 SPORT CONCUSSION ASSESSMENT TOOL 2 | PAGE 4**
UF-FSU Concussion Program Background Questionnaire

Name:__________________________________________________________
Gender (check one):   M[ ]   F[ ]
Date of Birth (MM/ DD/ YY): _______/_______/_______

Race/Ethnicity (check one):
   _____ White Caucasian       _____ African American
   _____ Hispanic/Latino        _____ Asian/Pacific Islander
   _____ Other

Have you ever been diagnosed by a medical provider with a concussion? (check one): Yes[ ] No[ ]
   If Yes, How many?: _____________________

School Name:_____________________________ Grade: __________

Team and Sport: ____________________________________________

We will send a copy of your child’s SCAT-2 results to you by email. Please provide the necessary address below.

Email Address:_________________________________________________

LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Aliyah Ryan Snyder graduated summa cum laude from Florida Institute of Technology in May 2007 with a Bachelor of Science degree in psychology. After completing her undergraduate degree, Ms. Snyder worked as a graduate assistant at Connecticut College where she coached rowing and studied neurogenesis in rats, then spent a year volunteering at the Central Florida Memory Disorders Clinic in Melbourne, Florida. She plans to pursue a doctoral degree in clinical and health psychology at the University of Florida. Her academic interests lie in clinical neuropsychology with a focus on sports concussion, cognitive rehabilitation, and brain connectivity after mild traumatic brain injury.