# Standard Assessment of Concussion Baseline Scores Differ between Gender but not Age in High School Athletes
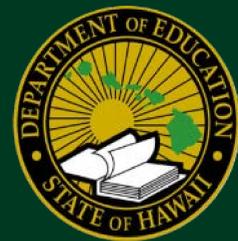
Goeckeritz LM*, Wahl TP†, Cleary MC†, Oshiro RS*, Kocher MH†, Furutani TM*, Kanaoka T*, Stickley CD†, Kimura, IF†, Murata, NM†:

*State of Hawaii Department of Education, †Department of Kinesiology and Rehabilitation Sciences, University of Hawaii at Manoa, Honolulu, HI,

Context

On-site mental status is a key component of concussion evaluation and a comprehensive concussion management program (CMP). Baseline values for mental status are an important piece of data when screening for concussion or making return to participation (RTP) decisions, and may not always be available. Using age and gender-specific norms may be useful in cases where no baseline data exist. Normative values of the Standard Assessment of Concussion (SAC) for age-stratified high school athletes have not been previously reported.

Objective

To determine differences in age and gender, and to provide normative values for SAC baseline scores of healthy high school athletes.

Design

Retrospective cross-sectional study.

Setting

Controlled environment free of external stimuli in 11 participating high schools. Starting in 2010, baseline concussion testing was implemented by a statewide CMP led by a contingent of athletic trainers funded by the State of Hawaii Department of Health.

Participants

De-identified data from baseline SAC tests for 854 [age=15.2±1.2 years old (y/o), females (F) n=308, males (M) n=546] high school athletes free of injury.

Interventions

Baseline SAC testing during 2010-2011 for all contact sport athletes was administered on an individual basis prior to their respective competitive seasons by athletic trainers who had prior knowledge utilizing the SAC.

Table 1. SAC score means

SAC Domain	Age	Male	Female
Orientation	13-14	4.80	4.88
	15-16	4.87	4.92
	17-18	4.83	4.93
Immediate Memory	13-14	13.72	13.38
	15-16	13.55	14.26
	17-18	13.38	14.14
Concentration	13-14	3.08	3.02
	15-16	3.09	3.08
	17-18	3.21	3.18
Delayed Recall	13-14	4.23	4.23
	15-16	4.06	4.06
	17-18	4.22	3.84
Total SAC	13-14	25.87	25.94
	15-16	25.57	25.55
	17-18	25.23	26.29

Figure 1. Orientation SAC score for Males and Females across age groups

Significant (p=.030) difference between male and female's Orientation score
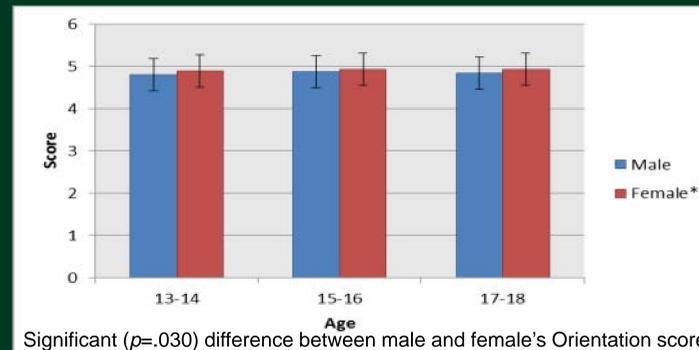
Figure 2. Immediate Memory SAC score for Males and Females across age groups

Significant (p≤.000) difference between male and female's Immediate score
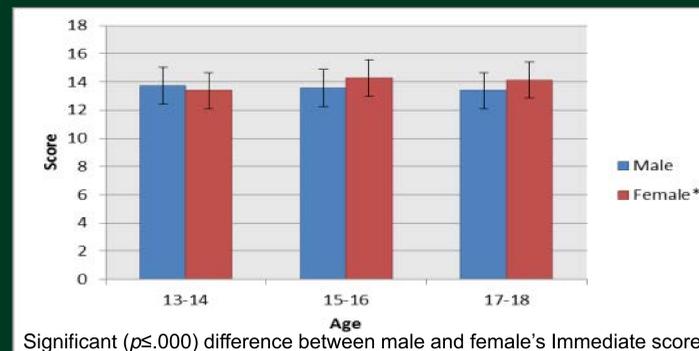
Figure 3. Concentration SAC score for Males and Females across age groups

No significant difference between male and female's Concentration score
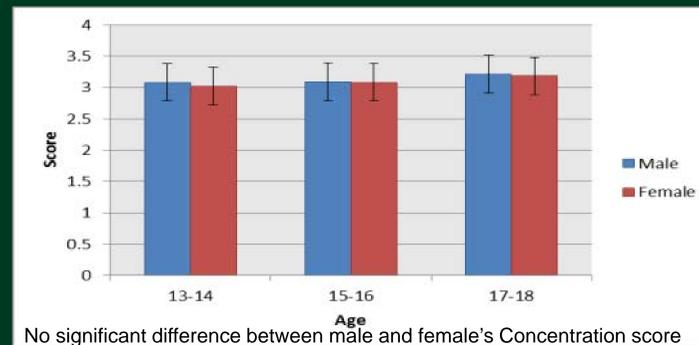
**Figure 4.** Delayed Recall SAC score for Males and Females across age groups

No significant difference between male and female's Delayed Recall score
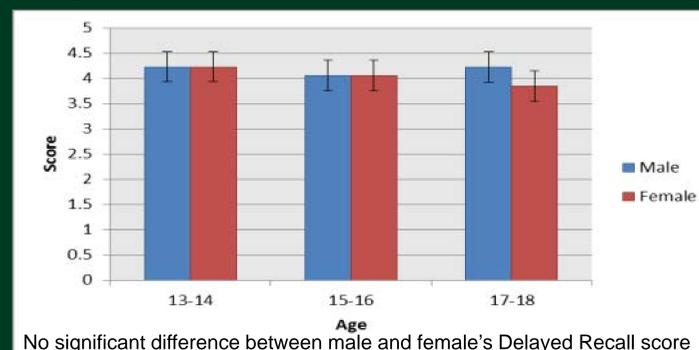
Main Outcome Measures

SAC domain score (Orientation, Immediate Memory, Concentration, Delayed Recall) and Total SAC score was compared using multiple univariate analysis of variance on gender (M, F) and three age groups (13-14y/o n=314, 15-16y/o n=422, and 17-18y/o n=118). Mean, standard deviation (SD), and 95% confidence intervals were reported (Table 1).

Figure 5. Total SAC Score for Males and Females across age groups

Significant (p=.002) difference between male and female's Total SAC score
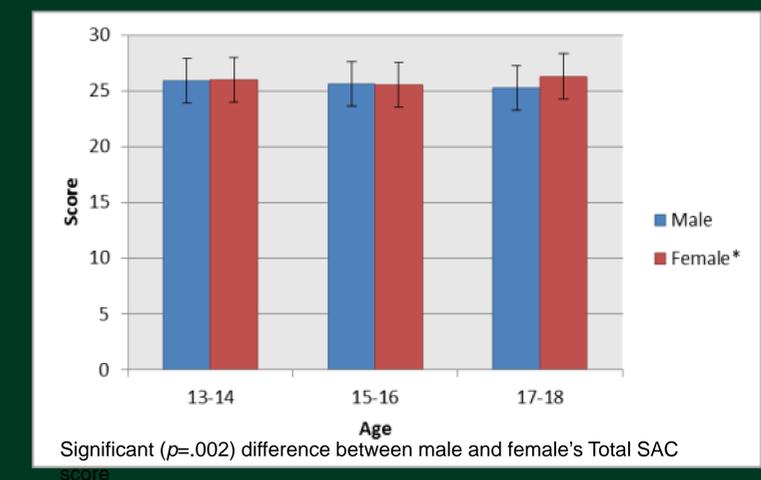
Results

No significant (F_2=.640, p=.528, power=.158) differences in baseline SAC scores were found between 13-14y/o (25.89±2.53, CI=25.61-26.20), 15-16y/o (25.96±2.52, CI=25.81-26.31), and 17-18y/o (25.48±2.92, CI=25.22-26.30). Significantly (F_1=9.729, p=.002) higher Total SAC baseline scores were found for females (26.31±2.40, CI=25.88-26.64) compared to males (25.62±2.65, CI=25.31-25.79). Orientation (F_1= 4.729, p=.030, power=.583) and Immediate Memory (F_1= 15.402, p≤.001, power=.975) SAC domain score were significantly different for males and females with females scoring higher.

Conclusions

In a large sample of high school athletes, we found no age differences and that female high school athletes score better on the SAC than males. These findings suggest that a single SAC baseline may remain valid for high school athletes during their entire high school matriculation. Furthermore, results of this study concur with previous findings by McCrea[1] and Iverson[2] that females score higher on the SAC during baseline testing. Using the SAC on the sideline and comparing to a normal baseline range of SAC scores may be helpful for athletic trainers when determining if scores appear reasonably valid. In cases where no baseline exists, normative data may help health care providers make return to participation decision.

References

1. McCrea M, Kelly JP, Randolph C. The Standardized Assessment of Concussion: Manual for Administration, Scoring, and Interpretation. 2nd ed.Waukesha, WI: CNS Inc; 2000

2. Iverson GL, Lovell MR, Collins MW. Interpreting change in ImPACT following sport concussion. Clin Neuropsychol. 2003;17:460–467.