



Effect of Baseline Timing Relative to Basic Training on Concussion-Related Measures in Service Academies: A CARE Consortium Study

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Background and Initial Aims

Concussion-related baseline measures are often assumed to reflect stable pre-injury functioning. However, among U.S. service academy cadets, scores may vary by academy and by the timing of assessment relative to military basic training, a period of intense physical and psychological stress.

Objectives

- Characterize timing-related patterns in symptom, psychological, balance, and cognitive baseline measures across four service academies.
- Evaluate whether accounting for site, timing, and their interaction reduces variation in baseline scores, and explore whether these patterns differ by sex.

Why it matters

- Baseline scores guide post-injury concussion interpretation, and training-related shifts may change who appears impaired, recovered, or unchanged.
- Timing-aware analysis can reduce testing-related bias in military academy concussion assessment.

Methods

COHORT

CARE baseline data from cadets/midshipmen at USAFA, USCGA, USMA, and NAVY were analyzed. Graduate students and participants with missing academic year were excluded, resulting in a study sample of 23,186 participants (Age 18.9 ± 1.3 years; 25.9% female).

EXPOSURE

Baseline timing relative to military basic training (BT) was classified as **during BT** versus **outside BT**. Outside BT included participants assessed before or after BT.

OUTCOMES

SCAT symptom number and severity; BSI global, depression, anxiety, and somatic symptom scores; BESS total score; SAC total score; and ImPACT visual motor speed, visual memory, verbal memory, and reaction time composites.

ANALYSIS

- LOESS-smoothed residual plots were used to visualize timing-related patterns in baseline scores across days relative to the start of basic training.
- Six nested regression models of increasing complexity were compared sequentially, adding site, timing, site $\times$ timing, sex, sex two-way interactions, and sex $\times$ site $\times$ timing to the preceding model.
- Wild-bootstrap was used to evaluate the improvements in model fit while accounting for differences in variability across groups. FDR correction was applied across 72 model comparisons.
- Effect sizes were quantified using partial η^2 . Model terms with partial $\eta^2 < 0.01$ were considered to provide limited additional explanatory value.

Results

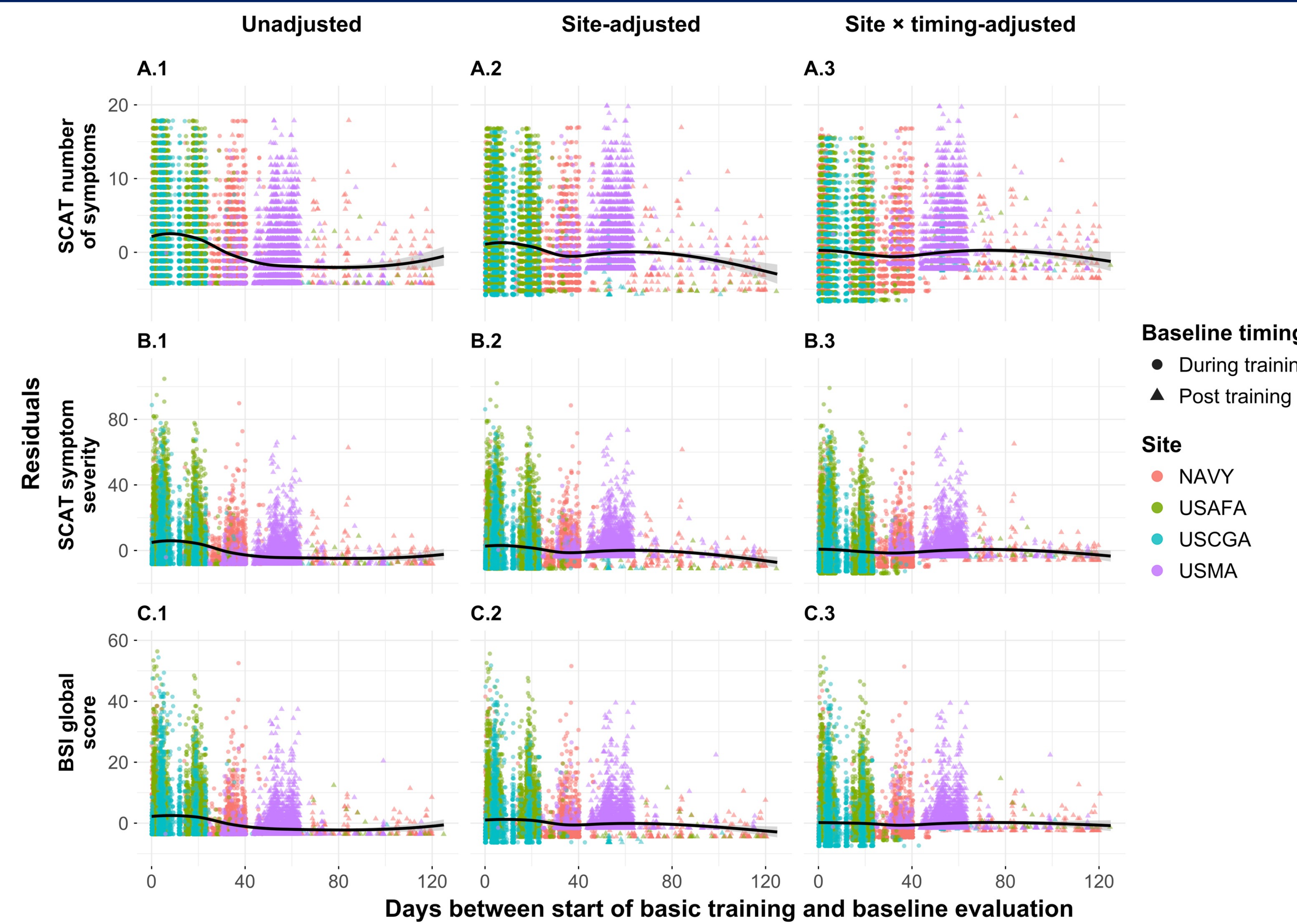


Figure 1. LOESS-smoothed residuals for the baseline measures with the largest timing-related effect. Columns show unadjusted, site-adjusted, and site $\times$ timing-adjusted residuals.

- Patterns persisted after adjustment for site, but were largely accounted for after adding the site $\times$ timing interaction.



Figure 2. Sequential nested-model comparisons.

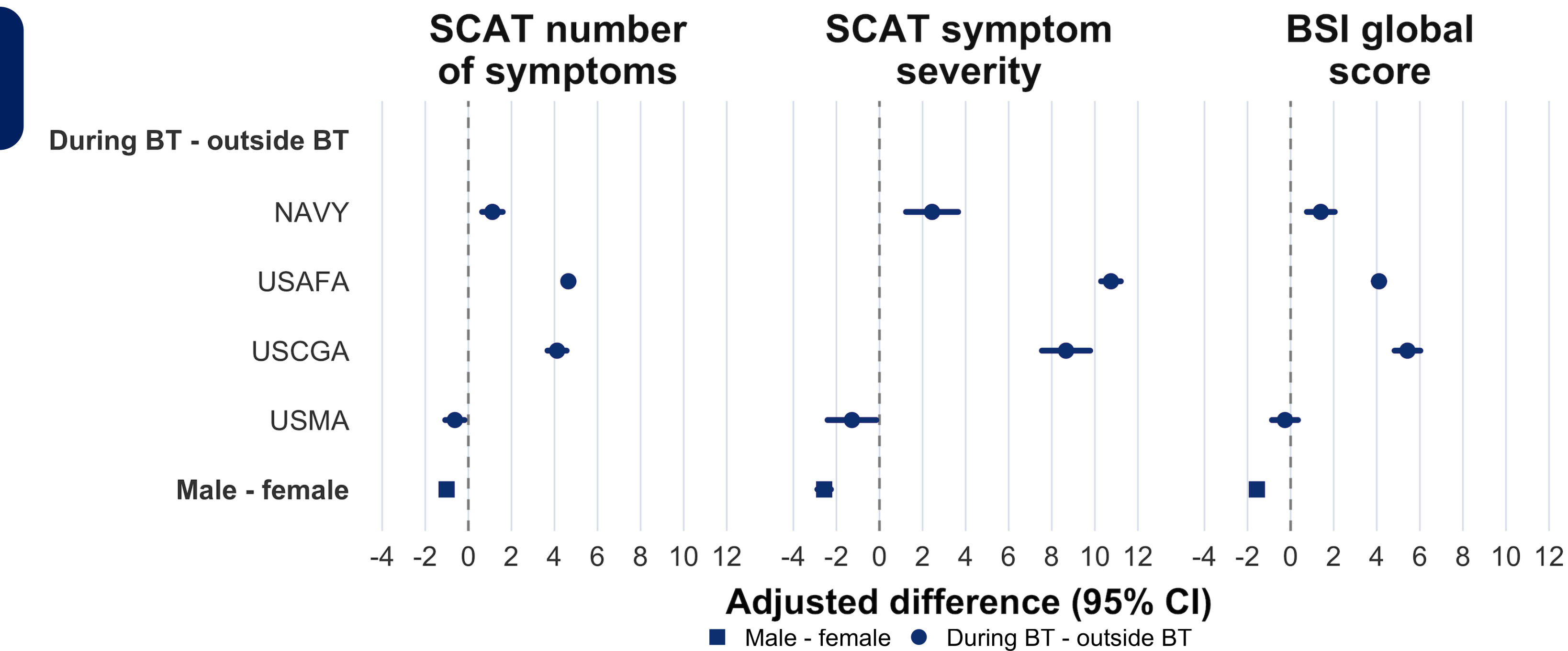


Figure 3. Adjusted sex and within-academy timing contrasts for selected baseline outcomes. BT = basic training. Dots show group differences, and lines show 95% confidence intervals.

- Male showed lower symptom and psychological distress scores than female.
- Baseline scores shifted during basic training, but the size and direction of that shift differed by academy

Discussion

Baseline concussion-related measures differed across academies and when cadets are tested

- Adjustment for academy site reduced but did not eliminate timing-related patterns. Further adjustment for site-by-timing interactions largely accounted for the remaining patterns.
- Timing-related variation were most evident for symptoms, psychological distress, and balance measures, while cognitive outcomes were largely stable.
- Baseline assessments obtained at different academy and times may not be directly comparable without accounting for site, timing, and their interaction.
- Assessments conducted before or after basic training showed less timing-related variation and may provide more stable baseline measures.

Impact and Future Directions

- This study provides a systematic evaluation of basic-training effects on baseline concussion-related measures across four service academies.
- The findings suggest that future studies may benefit from conducting baseline assessments outside basic training to obtain more stable reference measures.
- The study provides a practical framework for accounting for site- and timing-related variation in multisite studies that include baseline assessments collected during basic training.

Next step: Determine whether accounting for site, timing and their interaction when interpreting baseline-to-post-injury change improves clinical decision-making after concussion.