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SPORT CONCUSSION ASSESSMENT TOOL - FIFTH EDITION NORMATIVE REFERENCE VALUES FOR PROFESSIONAL RUGBY UNION PLAYERS

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ABSTRACT

Objective: To describe distributions, and establish normative ranges, for new or changed subcomponents of the SCAT-5

Design: Cross-sectional study

Setting and participants: Professional Rugby Union players performing 2017 preseason baseline SCAT-5 testing.

Independent Variables: Subcomponent tests newly introduced or changed in the SCAT-5:

Main Measurements: The 10 word immediate and delayed recall tests, and the rapid neurological screen.

Results: 1,203 players were included in complete case analyses. The 10 word immediate recall test (median score 15, IQR 15-22, range 3-30) showed an asymmetrical, bimodal distribution. The delayed recall test (median score 7, IQR 5-9, range 0-10) demonstrated a left skewed distribution. The diplopia and reading/following instruction tests of the neurological screen were performed normally by virtually all participants (98.5 and 99.6% respectively). Normative classification ranges for each SCAT-5 sub-components of interest were determined.

Conclusions: The increased spread of scores, with improved mid-range centring, suggests that the increase to 10 word list lengths should improve the performance of immediate and delayed recall tests. Normative ranges will provide a distribution against which post-injury SCAT-5 scores can be compared and interpreted.

Background

Concussion is a common injury in contact and collision sports. Given the diverse array of presenting symptoms and signs that can occur following concussion, a standardised multi-modal diagnostic approach has been recommended. The International Consensus Conference for Concussion in Sport therefore developed the Sports Concussion Assessment Tool (SCAT) to standardise evaluation of sports related concussion, track player recovery and serve as a tool for player education. Development of the SCAT has been an iterative process with the SCAT5, recently introduced following the 5th International Consensus Conference on Concussion in Sport.[1,2] This instrument remains largely unchanged from previous versions, but included the following changes:

- An optional increase in words list length from 5 to 10 for the Immediate Recall Test.

- A rapid neurological screen including diplopia and following instructions/reading tests.

- An optional increase in words list length from 5 to 10 for the Delayed Recall Test, with a stipulation that the delayed recall test should be performed 5 minutes after the end of the Immediate Recall Test.

Normative data from a representative reference population can provide a distribution against which post-injury SCAT scores can be compared and interpreted.[3] We have recently described baseline SCAT data for the preceding version of the SCAT (SCAT-3) using a large sample of professional Rugby Union players.[4] The objective of the current study was to update these findings and establish normative reference data for new or changed subcomponent tests in the SCAT-5.

Methods

A cross sectional study was performed in a convenience sample of professional male Rugby Union players undergoing pre-season, or pre-tournament, baseline SCAT-5 testing in 2017, where the electronic CSX data collection system was used.[5] This represented a majority of eligible players in domestic and international competitions globally. Where players underwent repeat testing, their earliest result was retained to minimise learning effects. Subcomponent tests newly introduced or changed in the SCAT-5 were examined, namely: The 10 word list length immediate and delayed recall tests; and the diplopia and following instructions/reading tests of the rapid neurological screen. Players with incomplete data on any SCAT-5 subcomponent of interest were excluded from complete case analyses.

The SCAT-5 was administered individually to every player before or after team practice prior to the commencement of the relevant competition season or tournament. Testing was performed in a single session, in a distraction-free environment with the athlete in a resting state (either pre-exercise or after return to a resting pulse rate), in accordance with standard instructions.[1] The SCAT-5 was administered by an accredited, appropriately trained team physiotherapist or physician. The English version of the SCAT-5 was used for all athletes. Results were collected immediately using CSX, a bespoke tablet software application designed for real time SCAT-5 data collection. Word and digit strings were randomly selected. Data was instantaneously uploaded to a secure CSX server.[5]

Statistical analyses proceeded in four stages. Firstly, the demographic features of the sample were described. Secondly, descriptive statistics were calculated for each SCAT-5 subcomponents of interest. Distributions of numerical variables (immediate and delayed recall tests) were visualised using

frequency histograms and summarised using mean (M), median (Md), standard deviation (SD), interquartile range (IQR), and range. Distributions of categorical variables (diplopia and understanding/reading tests) were evaluated using percentages. Thirdly, normative ranges for each SCAT-5 variable of interest were determined. Cut-offs were selected based on distribution percentiles consistent with previous SCAT normative value studies and followed conventions used in cognitive assessments (e.g. Wechsler intelligence quotient classifications).[6,7] Classifications were defined based on the direction of scoring for abnormality in each new/changed SCAT component i.e. worsening performance on cognitive and neurological tests was denoted as low. The below average cut-off was defined as close as possible to the 25th percentile ranks. Unusually low scores corresponded to the 10th percentile ranks, and extremely low scores aimed for the 2nd percentile ranks. Fourthly, the association between player characteristics (age, recent concussion, learning difficulties, and educational index) and performance in SCAT5 subcomponents were investigated in exploratory analyses with appropriate hypothesis tests using Bonferroni's correction for multiple comparisons (further details provided in the web appendix).

Statistical analyses were carried out in Stata version 13.1 (StataCorp, College Station, USA). As the study population consisted of a census sample of consecutive cases determined by World Rugby data collection procedures, the final sample size was fixed and formal sample size calculations were not performed. The investigation plan received ethical approval from the University of Sheffield. Study participants provided written consent for the use of anonymised data.

Results

A total of 1,211 individual professional male Rugby Union players underwent baseline SCAT-5 testing. Eight players had incomplete testing on one or more SCAT-5 subcomponents of interest and were excluded, leaving 1,203 players for analysis. The study sample was predominantly aged over 20 years (n=1,055, 87.7%, corresponding to non-youth age group athletes). The educational index of countries of player origin ranged from 0.51 to 0.93 (corresponding to limited completion of secondary schooling and University level education respectively). A large number of players had been diagnosed with concussion earlier in their career (n=521, 43.3%); with a notable minority of 177 players (14.7%) sustaining a recent concussion in the preceding year. The majority of players were first language English speakers (n=1,010, 84%).

Baseline results for the new/changed SCAT-5 subcomponents are summarised in Table 1, with frequency histograms presented for numerical variables in Figure 1. Only 8 (0.7%) athletes performed perfectly on all the studied subcomponents. The 10 word immediate recall test (median score 15, IQR 15-22, range 3-30) showed an asymmetrical, bimodal distribution, with a modal value of 15 and a second peak at a score of 20. The delayed recall test (median score 7, IQR 5-9, range 0-10) demonstrated a left skewed distribution, with a modal score of 10 and a second local maxima at score 5. The diplopia and reading/following instruction tests of the neurological screen were performed normally by virtually all participants (98.5 and 99.6% respectively). All 5 players with abnormal results on the reading/following instructions test were from non-English speaking countries with relatively low educational index (<0.75). The normative classification ranges for the SCAT-5 sub-components of interest are presented in Table 2.

There were no statistically or clinically significant differences in baseline performance in any measurements across subgroups defined by recent concussion or learning difficulty (p>0.1 on all hypothesis tests). There were statistically significant differences of small magnitude for immediate memory delayed recall across subgroups of with different educational index and age (p<0.01, Web appendix), although this did not follow a systematic pattern. Conversely, performance in the diplopia and reading/following instruction tests of the neurological screen did not significantly differ (p>0.3).

Discussion

This is the first study to date exploring baseline performance on new or changed subcomponents of the SCAT-5. The SCAT should not be used by itself to make, or exclude, a diagnosis of concussion, but provides useful information that will helpfully inform a medical evaluation. The importance of background data is highlighted by the imperfect baseline SCAT-5 subcomponent results reported here; with only 0.7% of study participants performing without error. Expert assessment is clearly important to interpret the SCAT in the context of pre-existing and variable cognitive ability.

A major change in the SCAT-5 is an optional increase in the number of words in the immediate and delayed recall tests from 5 to 10 to avoid ceiling effects.[1,8] Heavily left skewed distributions, with a high proportion of perfect scores observed were previously observed.[4,6] The increased spread of scores, distributions centring in the middle of the range of possible scores, and fewer players with perfect scores suggests that the change to increased 10 word list length has addressed this problem and should help improve discrimination.

The new subcomponents in the SCAT-5 neurological screen were performed perfectly by nearly all participants. It is therefore possible that these relatively blunt screening assessments will not be sensitive for subtle post-concussion neurological deficits and may have limited utility. Interestingly, all players with abnormal results on the understanding/reading test were non-English speakers. As the English version of the SCAT is often used, even when formal translations are available, caution should be exercised to avoid over-interpretation of this result. Statistically significant differences in the distributions of immediate memory and delayed recall scores were detected across age and educational

index strata. However these were of small magnitude and did not follow a discernible pattern, suggesting artefactual results secondary to the large sample size and multiple comparisons.

This study has a number of strengths. Standardised testing was performed by trained medical practitioners and the CSX data collection system allowed immediate data collection with minimal missing data. Conversely there are potential limitations. Very poor scores were observed in some players in each of the examined SCAT-5 subcomponents i.e. immediate recall of <10/30; or delayed recall <2/10. Such scores were concentrated in a minority of players (n=6), and correlated with poor performance in other domains, suggesting genuine results. However, we cannot entirely exclude measurement error. Intra- and inter-observer variability was also not assessed.

The large study sample, comprising players of different ages, and from a wide range of countries, educational levels, and playing positions should ensure excellent external validity within professional Rugby Union. However, all testing was with the English SCAT-5 version, and extrapolation of results to other SCAT translations is not possible. However, word choice for immediate and delayed recall tests are designed to maintain the original denotation and connotation of items, and major differences seem unlikely. Generalisability to amateur Rugby Union, and to other sports, is less certain.

In conclusion, this study provides representative normative reference values for new/changed SCAT-5 subcomponents. Notable variability was evident in healthy athletes, and normative ranges should therefore help distinguish normal background levels from abnormal scores related to concussive injury. Of note, the increased spread of scores, with improved mid-range centring, suggests that the increase to 10 word list lengths should improve the performance of immediate and delayed recall tests.

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Figure 1. Frequency histograms illustrating the distribution of 10 word (a) immediate and (b) delayed recall test scores.