



Baseline Properties of the Sport Concussion Assessment Tool 3 (SCAT3) in Iranian Professional League Football Players

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Abstract

Background: SCAT3 is a standardized tool, which can evaluate injured athletes for concussion and provide us with the necessary baseline data. Like any other sport, playing football (soccer) carries a high risk of injury. Thus, this study investigated the baseline properties of SCAT3 in Iranian Professional League football players and evaluated the correlation between different factors and a history of concussion.

Methods: All of the players of 16 different teams who would be participating in the 2016 - 2017 Iranian Professional League (n = 368), were enrolled in this study. Completing SCAT3 was part of the pre-competition Medical assessment. Beside presenting the descriptive data, different variables were analyzed to evaluate the association with a "prior history of concussion", in order to find probable risk factors for head injuries.

Results: Forty-one players have had a history of concussion in the previous year and data analysis among the different categories showed that having a history of concussion bore a significant correlation with number of symptoms and symptom severity (P values: 0.023 and 0.041, respectively).

Conclusions: Athletes with a history of concussion reported an increased number of symptoms and a higher severity score, but other SCAT3 properties such as total SAC scores and M-BESS were not affected by a history of concussion. This study aids clinicians in evaluating athletes suffering injuries to the head during football matches.

Keywords: Head Trauma, Sports, Football

1. Background

Football (soccer) is an exciting and undeniably violent sport. Like many other sports, playing football carries a high risk of injury. Despite improvements in technology and equipment, head injuries continue to be one of the most dangerous threats that athletes are faced with through their athletic career. It has been suggested that in the United States, the incidence rate of an athlete sustaining a concussion is approximately 2.5 cases per 10,000 athletic participation exposures (1). Studies show that football has the highest concussion rate among other sports and 5.1% of football players sustain at least one concussion during each season (2). Recently, FIFA medical committee has proposed a new protocol for the management of concussion. According to this protocol, whenever an event of suspected concussion occurs, the referee will have the ability to stop the game for a maximum of three minutes, allow-

ing physicians to evaluate their injured player. Since, recurrent concussion can make athletes susceptible to long-term neurological disorders; its assessment would be valuable in professional players (3).

Evaluation of the cognitive and physical status and subjective symptoms in players that have sustained a concussion is of special importance (3-5). This can aid us in finding possible impairments that can affect balance, coordination, etc.

Collecting baseline data before the start of a new season can also aid diagnosis and facilitate judgment regarding injured players concerning the resumption of practice (6, 7). The Sport Concussion Assessment Tool (SCAT) represents one such tool that can evaluate injured athletes for concussion and also provide us with the necessary baseline data (8). SCAT was initially developed at the second international conference on concussion in sport and has since been revised twice, once in 2008 and a second time in 2012

(9). Sport concussion assessment tool 5th edition (SCAT5), which is the most recent revision of a sport concussion evaluation tool was also published recently, although it was not available at the time we gathered our data (10).

SCAT3 was published in 2013 and is a standardized tool that has been recognized and approved by FIFA and several other large international sporting federations (11). SCAT3 is comprised of 22 questions for symptom evaluation. The evaluation is followed by a cognitive evaluation of the patient as well as a complete neck, balance and coordination examination (11).

Since no previous studies have assessed concussion in adult professional football players, the purpose of this study was to investigate the baseline properties of SCAT3 in Iranian Professional League football players. There are four articles published, evaluating baseline normative values but to the best of our knowledge, no study has evaluated the correlation between different factors and a history of concussion on elite level athletes (7, 12-14). For this reason, we also aimed to analyze different factors that might be affected by a history of concussion.

2. Methods

All of the players of 16 different teams, who would be participating in the 2016 - 2017 Iran Professional League, were enrolled in this study. Since completing SCAT3 was part of the pre- competition Medical assessment (PCMA), all 368 players participated and no one was excluded. All participants were healthy male football players with an average age of 24.9. Minimum and maximum ages were 17 and 40, respectively. Other descriptive variables, which are assessed in the SCAT3 form, are presented in Table 1. The examinations were carried out for all players by the same physician and lasted from May 2016 to July 2016. Testing was done from 9 a.m. to 12 a.m. in the same room, and the players were all examined after having consumed the same breakfast meal. The importance of the SCAT3 was explained to each participant separately, and ethical consent was obtained. It was clarified that the test results would be given to the team physician and would aid diagnosis in the event of concussion. All examinations and SCAT3 tests were done in Persian language and under the supervision of the Iran football Medical assessment and rehabilitation center (IF-MARC).

SCAT3 is a standardized tool for assessing concussion in athletes aged 13 or more. It is composed of several subsections including symptom and cognitive evaluation, and examination of the neck, balance and coordination. Symptom evaluation is comprised of 22 questions that athletes answered based on how they felt at the time of the interview. Each symptom was rated as non-existent (0), mild (1-

Table 1. Descriptive Data of 368 Players Participating in the Study

Variable Name	Values	N ^a	Frequency, %
Post of the player	Defender	119	32.3
	Goalkeeper	44	12.0
	Midfielder	141	38.3
	Striker	64	17.4
Dominant leg	Left	46	12.5
	Right	322	87.5
History of concussion in the last year	Positive	41	11.4
	Negative	320	88.6
Imaging after concussion	Yes	20	48.8
	No	21	51.2
Hyperactivity	Positive	5	1.4
	Negative	356	98.6
Migraine	Positive	9	2.5
	Negative	352	97.5
History of psychological problem	Yes	355	98.3
	No	6	1.7
Family history of hyperactivity, migraine or any psychological problems	Positive	24	6.7
	Negative	336	93.3
Neck examination	Normal	362	97.6
	Abnormal	6	2.4
Coordination test result	Normal	367	100.0
	Abnormal	0	0.0

^aN, sample size.

2), moderate (three-4) or severe (5 - 6). The total number of symptoms (with a maximum of 22) and their severity (with a maximum of 132) was then calculated. Standardized assessment of concussion (SAC) consisted of orientation scores (0 - 5), immediate memory scores (0 - 15), concentration scores (0 - 5) and delayed recall score (0 - 5). In order to examine balance, the number of errors in single leg, double leg and tandem stance for 20 seconds were calculated. The modified balance error scoring system (M-BESS) is calculated by adding one error point for each error during these three 20-second tests. Tandem gait testing time was also recorded. The coordination score was based on athletes' ability to repeat the five finger-to-nose action correctly in less than 4 seconds. The delayed recall test was carried out after completion of the balance and coordination examination. Participants' descriptive data and SCAT3 measures/variables are shown in Tables 1 and 2.

Besides presenting the descriptive data, we analyzed different variables with a "prior history of concussion" in

Table 2. Means and Standard Deviations for SCAT3 Scores^a

Test	All Players			Without History of Concussion			With history of Concussion		
	N	M	SD	N	M	SD	n	M	SD
Symptom severity	359	2.66	5.29	318	2.48	5.06	41	4.05	6.74
Symptom score	359	1.41	2.32	318	1.35	2.32	41	1.90	2.23
SAC total score	356	24.54	3.07	315	24.53	3.11	41	24.61	2.79
Orientation	360	4.45	0.74	319	4.44	0.75	41	4.51	0.64
Immediate memory	357	13.87	1.50	316	13.83	1.53	41	14.17	1.18
Concentration	359	3.16	1.18	318	3.17	1.18	41	3.10	1.18
Delayed recall	356	3.04	1.52	315	3.06	1.49	41	2.83	1.76
M-BESS	367	2.25	2.24	319	2.23	2.18	41	2.56	2.76
Single leg stance	367	1.75	1.68	319	1.75	1.64	41	1.90	2.06
Double leg stance	367	0.02	0.19	319	0.02	0.21	41	0.00	0.00
Tandem stance	367	0.48	0.95	319	0.46	0.94	41	0.66	1.02
Tandem gait time, s	366	9.19	2.00	318	9.11	1.78	41	9.56	3.20

Abbreviations: M, Mean; SD, Standard Deviation.
^aN, sample size.

the past year, in order to find probable risk factors to evaluate the short term and long term probable effects. The correlation between categorical variables was assessed using either a chi-square test or a Fisher's exact test if indicated.

Due to a lack of normality, the distribution of numerical variables across the categorical variable "history of concussion in the last year" was assessed using a Mann-Whitney U test. Finally, correlation between the numerical variables was assessed using a nonparametric approach. Data analysis was performed using IBM™ SPSS version 19 and P values less than 0.05 were considered statistically significant.

3. Results

Forty-one players out of 368 were found to have had a history of concussion in the previous year. Data analysis among the different categories showed that having a history of concussion bore a significant association with number of symptoms and symptom severity scores by P values of 0.023 and 0.041, respectively (Table 3). Total SAC and M-BESS scores were not significantly associated with past concussions. It is worthy of note that with a P value of 0.09, player's post is not correlated with history of concussion. Further analysis on the measured numerical variables showed that the number of symptoms and symptom severity are also correlated with both "player's total concussions" and "the time since player's last concussion" (Table 4).

4. Discussion

Our study described the baseline properties of the SCAT3 in Iranian football players participating in the 2016

Table 3. Major SCAT3 Scores Correlation with "Having History of Concussion"

Test	P Values
Symptom score	0.023 ^a
Symptom severity	0.041 ^a
SAC	0.752
M-BESS	0.900

^aShows a significant correlation.

- 2017 Professional League. Further analysis showed that symptoms and their severity might be the most significant factors that are correlated with previous concussions. The associations between concussion history and symptoms is correlational, so it is unclear if the symptoms are a result of the prior concussions versus reflecting a risk factor for the occurrence of concussion. At the baseline point, other factors assessed by SCAT3 are less likely to be affected. This data may aid clinicians in evaluating athletes suffering injuries to the head during football matches.

In 2015, Zimmer et al. reported normative values of major SCAT2 and SCAT3 components for a college athlete population, participating in 14 different sports. During the pre-season, SCAT2 was completed for 477 college athletes (332 male, 145 female) and these data were analyzed for differences in scores based on sex, sport type and other factors. The average number of positive symptoms and SAC were 1.75 and 27.17 with a standard deviation (SD) of 3.00 and 2.01, respectively. However, our study showed that professional football players have a mean symptom score of 1.41 with an SD of 2.32, as well as a total SAC score of 24.54 with an SD of 3.07.

Table 4. Major SCAT3 Scores Correlation with Other Numerical Values

Test	Total of Number of Player's Concussions	player's Last Concussion - Month
Symptom score		
Correlation coefficient	0.140 ^a	0.113 ^a
P values	0.008	0.033
Symptom severity		
Correlation coefficient	0.140 ^a	0.120 ^a
P values	0.008	0.023
SAC		
Correlation coefficient	-0.004	0.011
P values	0.933	0.841
M-BESS		
Correlation coefficient	-0.043	-0.057
P values	0.413	0.286

^aShows a significant correlation.

Chin et al. studied the reliability and validity of SCAT3 in high school and collegiate athletes. They evaluated 2018 athletes to measure their preseason baseline scores, 166 of whom were injured and then re-evaluated. Different factors such as sex, level of competition, learning disability and estimated verbal intellectual ability seemed to affect baseline scores in more than one SCAT3 component. Further analysis showed that symptom scores were significantly higher in those who had suffered a head injury at 24-hour and 8-day assessment, but non-significant at day 15. Effect size for SAC and BESS was small to moderate at 24-hour assessment and became non-significant at day 8 and 15. Our study also showed that a history of head injury during the past year does not affect either SAC or M-BESS. However, an increase in symptoms and severity scores is witnessed in patients with a history of concussion (Table 3). Some studies have described that a concussion can increase the odds of sustaining a lower extremity musculoskeletal injury (15-17). However, due to our SCAT3 results in SAC and M-BESS section, there is not a significant deficit in cognitive and balance evaluation. Such variances may be observed because studies are performed in different languages. However, further research is required in order to find the exact mechanism of lower extremity musculoskeletal injury followed by concussion.

Another study was conducted by Gorman et al., for assessing SCAT3 in non-head-injured and head-injured athletes competing in an international youth football tour-

namment (18). They studied SCAT3 components in three groups of players including non-injured (NI), injured (but not head injured)(I), and head injured (HI) players. Results showed that head injury leads to an increase in both symptoms and severity scores with a P value of less than 0.01. However, no significant change was observed in total SAC score between HI and the other two groups. As mentioned before, we obtained similar results when comparing players with and without a history of concussion. Moreover, data analysis showed that symptoms and severity scores were also correlated with a player's total number of previous concussions and the amount of time that had passed since the player's last concussion (Table 4).

To the best of our knowledge, this was the first time that preseason baseline properties of SCAT3 in professional and elite adult football players were reported. These baseline data can be used as normative values for elite football players to identify those players with outlier scores. We also found that athletes with a history of concussion reported an increased number of symptoms and a higher severity score. Total SAC scores and M-BESS were not affected by a history of concussion. This study was carried out preseason, future studies may help provide data for players during the game season.

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